GORDIAN®

Job Order Contract Technical Specifications

CSI Divisions 01-50 2026

County of Monterey

Facilities

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01 General Requirements

01 00 00 00	General Requirements
01 11 13 00	Work Covered by Contract Documents
01 22 00 00	No Specification Required
01 40 00 00	Quality Requirements
01 42 00 00	References
01 50 00 00	Temporary Facilities and Controls
01 51 13 00	Temporary Electricity
01 54 23 00	Temporary Scaffolding and Platforms
01 56 39 00	Temporary Tree and Plant Protection
01 57 23 00	Temporary Storm Water Pollution Control
01 60 00 00	Product Requirements
01 74 19 00	Construction Waste Management and Disposal
01 00 00 00MOD000	Supplemental Requirements for Electrical

02 Existing Conditions

02 41 16 00	Structure Demolition
02 41 16 13	Building Demolition
02 41 19 00	Selective Demolition
02 41 19 13	Cutting and Patching
02 61 00 00	Removal and Disposal of Contaminated Soils
02 82 16 00	Engineering Control of Asbestos Containing Materials
02 82 33 00	Removal Of Friable Asbestos-Containing Materials
02 82 33 00a	Removal Of Nonfriable Asbestos-Containing Materials
02 83 00 00	Lead Remediation
02 83 19 00	Lead-Based Paint Remediation
02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
02 87 13 00	Mold Remediation
02 87 16 13	Bird Excrement Removal

03 Concrete

03 01 30 00	Maintenance of Cast-in-Place Concrete
03 10 00 00	Concrete Forming and Accessories
03 11 16 00	Architectural Concrete
03 20 00 00	Concrete Reinforcing
03 30 00 00	Cast-In-Place Concrete
03 35 43 00	Polished Concrete Finishing
03 37 13 00	Shotcrete
03 38 16 00	Unbonded Post-Tensioned Concrete
03 41 00 00	Precast Structural Concrete
03 51 13 00	Cementitious Wood Fiber Decks
03 53 00 00	Concrete Topping
03 54 00 00	Gypsum Cement Underlayment
03 54 16 00	Hydraulic Cement Underlayment

04 Masonry

04 01 00 00	Masonry Cleaning
04 01 20 51	Brick Masonry Repair
04 01 20 91	Brick Masonry Repointing
04 20 00 00	Unit Masonry
04 20 00 00a	Masonry Veneer
04 22 00 00	Concrete Unit Masonry
04 23 00 00	Glass Unit Masonry
04 42 00 00	Exterior Stone Cladding

04 72 00 00 Cast Stone Masonry

05 Metals

05 01 70 51 Decorative Metal Cleaning
05 01 70 61 Decorative Metal Repair
05 01 70 63 Decorative Metal Refinishing
05 12 00 00 Structural Steel Framing
05 21 00 00 Steel Joist Framing
05 31 00 00 Steel Decking
05 40 00 00 Cold-Formed Metal Framing
05 50 00 00 Metal Fabrications
05 51 13 00 Metal Pan Stairs
05 51 19 00 Metal Grating Stairs
05 52 13 00 Pipe And Tube Railings
05 53 00 00 Expanded Metal Gratings
05 53 13 00 Bar Gratings
05 53 16 00 Plank Gratings
05 58 00 00 Heating_Cooling Unit Covers
05 70 00 00 Decorative Metal
05 71 00 00 Decorative Metal Stairs
05 71 13 00 Fabricated Metal Spiral Stairs
05 73 00 00 Decorative Metal Railings
05 73 00 00a Glazed Decorative Metal Railings
05 75 00 00 Decorative Formed Metal

06 Wood, Plastics, and Composites

06 10 00 00 Rough Carpentry
06 13 00 00 Heavy Timber Construction
06 15 00 00 Wood Roof Decking
06 15 00 00a Wood Patio Decking
06 16 00 00 Sheathing
06 17 53 00 Shop-Fabricated Wood Trusses
06 18 00 00 Glued-Laminated Construction
06 20 00 00 Interior Finish Carpentry
06 41 00 00 Architectural Wood Casework
06 41 13 00 Residential Cabinets
06 42 16 00 Flush Wood Paneling
06 42 19 00 Plastic-Laminate-Faced Wood Paneling
06 44 00 00 Ornamental Woodwork
06 74 13 00 Fiberglass Reinforced Gratings

07 Thermal And Moisture Protection

07 01 50 19 Preparation for Reroofing
07 11 13 00 Bituminous Dampproofing
07 13 53 00 Elastomeric Sheet Waterproofing
07 14 13 00 Hot Fluid-Applied Rubberized Asphalt Waterproofing
07 14 16 00 Cold Fluid-Applied Waterproofing
07 16 13 00 Polymer Modified Cement Waterproofing
07 16 16 00 Crystalline Waterproofing
07 16 19 00 Metal Oxide Waterproofing
07 17 00 00 Bentonite Waterproofing
07 18 00 00 Traffic Coatings
07 19 00 00 Water Repellents
07 21 00 00 Thermal Insulation
07 21 19 00 Foamed-In-Place Insulation
07 24 13 00 Polymer-Based Exterior Insulation And Finish System (EIFS)
07 25 00 00 Weather Barriers

07 26 00 00 Vapor Retarders
07 31 13 00 Asphalt Shingles
07 31 16 00 Metal Shingles
07 31 26 00 Slate Shingles
07 31 29 00 Wood Shingles And Shakes
07 32 13 00 Clay Roof Tiles
07 32 16 00 Concrete Roof Tiles
07 41 13 00 Formed Metal Roof Panels
07 41 13 00a Standing-Seam Metal Roof Panels
07 41 13 00b Batten-Seam Metal Roof Panels
07 42 13 19 Insulated Metal Wall Panels
07 42 13 23 Composite Wall Panels
07 42 93 00 Soffit Panels
07 46 16 00 Metal Plate Wall Panels
07 46 16 00a Aluminum Siding
07 46 19 00 Steel Siding
07 46 33 00 Plastic Siding
07 46 46 00 Fiber-Cement Siding
07 51 13 00 Built-Up Asphalt Roofing
07 52 13 00 Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 52 16 00 Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 53 16 00 Chlorosulfonate-Polyethylene (CSPE) Roofing
07 53 23 00 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 54 19 00 Polyvinyl-Chloride (PVC) Roofing
07 54 23 00 Thermoplastic-Polyolefin (TPO) Roofing
07 55 52 13 Atactic-Polypropylene (APP) Modified Bituminous Protected Membrane Roofing
07 55 52 16 Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing
07 56 00 00 Fluid-Applied Protected Membrane Roofing
07 57 00 00 Coated Foamed Roofing
07 61 00 00 Sheet Metal Roofing
07 62 00 00 Sheet Metal Flashing And Trim
07 71 00 00 Roof Specialties
07 72 00 00 Roof Accessories
07 72 53 00 Snow Guards
07 81 00 00 Applied Fire Protection
07 81 23 00 Intumescent Fire Protection
07 84 13 00 Penetration Firestopping
07 84 43 00 Joint Firestopping
07 91 00 00 Preformed Joint Seals
07 92 00 00 Joint Sealants
07 92 19 00 Acoustical Joint Sealants
07 95 13 00 Parking Deck Expansion Joint Cover Assemblies
07 95 13 13 Interior Expansion Joint Cover Assemblies
07 95 13 16 Exterior Expansion Joint Cover Assemblies

08 Openings

08 01 52 61 Wood Window Repairs
08 11 13 00 Hollow Metal Doors and Frames
08 11 73 00 Sliding Metal Fire Doors
08 12 13 00 Hollow Metal Frames
08 14 16 00 Flush Wood Doors
08 18 16 00 Sliding Aluminum-Framed Glass Doors
08 18 16 00a Multipanel Sliding Aluminum-Framed Glass Doors
08 18 16 00b Sliding Wood-Framed Glass Doors
08 18 16 00c Multipanel Sliding Wood-Framed Glass Doors
08 31 13 00 Access Doors And Frames
08 33 13 00 Coiling Counter Doors
08 33 23 00 Overhead Coiling Doors
08 33 26 00 Overhead Coiling Grilles
08 33 43 00 Overhead Coiling Smoke Curtains
08 34 73 13 Metal Sound Control Door Assemblies
08 34 73 16 Wood Sound Control Door Assemblies
08 35 13 00 Folding Doors
08 35 13 13 Multipanel Folding Aluminum-Framed Glass Doors
08 36 13 00 Sectional Doors
08 38 00 00 Traffic Doors
08 42 13 00 Aluminum-Framed Entrances

08 42 26 00 All-Glass Entrances And Storefronts
08 42 26 00a All-Glass Entrances
08 42 29 23 Sliding Automatic Entrances
08 42 29 33 Swinging Automatic Entrances
08 42 33 00 Revolving Door Entrances
08 43 13 00 Aluminum-Framed Storefronts
08 44 13 00 Glazed Aluminum Curtain Walls
08 44 13 00a Sloped Glazing Assemblies
08 45 23 00 Fiberglass-Sandwich-Panel Assemblies
08 51 13 00 Aluminum Windows
08 51 13 00a Aluminum Replacement Windows
08 51 19 00 Stainless Steel Windows
08 51 69 00 Metal Storm Windows
08 52 00 00 Wood Windows
08 53 13 00 Vinyl Windows
08 54 00 00 Composite Windows
08 54 13 00 Fiberglass Windows
08 56 19 00 Security Windows
08 62 00 00 Unit Skylights
08 63 00 00 Metal-Framed Skylights
08 71 00 00 Door Hardware
08 71 11 00 Detention Door Hardware
08 71 13 00 Power Door Operators
08 80 00 00 Glazing
08 83 00 00 Mirrors
08 84 00 00 Plastic Glazing
08 88 53 00 Security Glazing
08 91 16 00 Operable Wall Louvers
08 91 19 00 Fixed Louvers
08 95 16 00 Wall Vents

09 Finishes

09 01 20 00 Gypsum Board Renovation
09 01 20 91 Plaster Restoration
09 01 90 52 Maintenance Repainting
09 05 61 13 Moisture Vapor Emission Control
09 22 16 00 Non-Structural Metal Framing
09 23 00 00 Gypsum Plastering
09 24 00 00 Cement Plastering
09 29 00 00 Gypsum Board
09 30 13 00 Ceramic Tiling
09 30 33 00 Stone Tiling
09 51 13 00 Acoustical Panel Ceilings
09 51 23 00 Acoustical Tile Ceilings
09 51 33 00 Acoustical Metal Pan Ceilings
09 54 00 00 Stretched-Fabric Ceiling Systems
09 54 00 00a Fabric-Wrapped Ceiling Panels
09 54 23 00 Linear Metal Ceilings
09 63 13 00 Brick Flooring
09 64 00 00 Wood Flooring
09 64 66 00 Wood Athletic Flooring
09 65 13 00 Resilient Base and Accessories
09 65 16 00 Resilient Sheet Flooring
09 65 19 00 Resilient Tile Flooring
09 65 43 00 Linoleum Flooring
09 65 66 00 Resilient Athletic Flooring
09 66 13 00 Portland Cement Terrazzo Flooring
09 66 23 00 Resinous Matrix Terrazzo Flooring
09 67 23 00 Resinous Flooring
09 68 13 00 Tile Carpeting
09 68 16 00 Sheet Carpeting
09 69 00 00 Access Flooring
09 72 00 00 Wall Coverings
09 77 00 00 Stretched-Fabric Wall Systems
09 77 00 00a Fabric-Wrapped Panels

09 91 13 00 Exterior Painting
09 91 23 00 Interior Painting
09 93 00 00 Staining and Transparent Finishing
09 96 00 00 High-Performance Coatings
09 96 53 00 Elastomeric Coatings
09 97 26 00 Cementitious Coatings

10 Specialties

10 11 00 00 Visual Display Units
10 12 00 00 Display Cases
10 13 00 00 Directories
10 14 16 00 Plaques
10 14 19 00 Dimensional Letter Signage
10 14 23 00 Panel Signage
10 14 23 00a Room-Identification Panel Signage
10 14 23 00b Post And Panel_Pylon Signage
10 14 23 00c Modular Signage
10 14 23 00d Painted Signage
10 21 13 13 Metal Toilet Compartments
10 21 13 14 Stainless Steel Toilet Compartments
10 21 13 16 Plastic-Laminate-Clad Toilet Compartments
10 21 13 19 Plastic Toilet Compartments
10 21 13 43 Phenolic-Core Pedestal-Mounted Privacy Toilet Compartments
10 21 16 17 Phenolic-Core Shower and Dressing Compartments
10 21 23 00 Cubicle Curtains and Track
10 22 00 00 Folding Panel Partitions
10 22 00 00a All-Glass Partitions
10 22 13 00 Wire Mesh Partitions
10 22 19 00 Demountable Partitions
10 22 33 00 Accordion Folding Partitions
10 26 00 00 Wall and Door Protection
10 28 00 00 Toilet, Bath, and Laundry Accessories
10 28 13 63 Detention Toilet Accessories
10 28 19 00 Tub and Shower Enclosures
10 44 13 00 Fire Protection Cabinets
10 44 16 00 Fire Extinguishers
10 51 13 00 Metal Lockers
10 55 00 00 USPS-Delivery Postal Specialties
10 55 00 00a Private-Delivery Postal Specialties
10 56 13 00 Metal Storage Shelving
10 73 13 00 Awnings
10 75 16 00 Ground-Set Flagpoles
10 75 23 00 Wall-Mounted Flagpoles

11 Equipment

11 11 36 00 Vehicle Charging Equipment
11 12 00 00 Parking Control Equipment
11 13 13 00 Loading Dock Bumpers
11 13 16 00 Loading Dock Seals and Shelters
11 13 19 00 Stationary Loading Dock Equipment
11 13 23 00 Portable Dock Equipment
11 30 13 00 Residential Appliances
11 40 00 00 Foodservice Equipment
11 52 13 00 Projection Screens
11 52 13 00a Rear Projection Screens
11 68 00 00 Play Field Equipment and Structures
11 73 00 00 Patient Care Equipment
11 82 26 00 Facility Waste Compactors
11 97 26 00 Detention Gun Lockers
11 98 12 00 Detention Doors And Frames

12 Furnishings

12 21 13 00 Horizontal Louver Blinds
12 21 16 00 Vertical Louver Blinds
12 22 00 00 Curtains and Drapes
12 24 13 00 Roller Window Shades
12 30 00 00 Manufactured Wood-Veneer-Faced Casework
12 30 00 00a Manufactured Plastic-Laminate-Clad Casework
12 31 16 00 Stone Countertops
12 35 00 00 Plastic-Laminate-Clad Laboratory Casework
12 35 00 00a Wood Laboratory Casework
12 36 23 13 Plastic-Laminate-Clad Countertops
12 36 61 00 Simulated Stone Countertops
12 48 13 00 Entrance Floor Mats and Frames
12 55 00 00 Detention Furniture
12 61 00 00 Fixed Audience Seating
12 62 23 00 Telescoping Stands

13 Special Construction

13 34 19 00 Metal Building Systems
13 34 23 16 Fabricated Control Booths
13 46 13 00 Lightning Protection for Structures
13 47 13 00 Cathodic Protection
13 49 00 00 Radiation Protection

14 Conveying Equipment

14 21 00 00 Electric Traction Elevators
14 21 13 00 Electric Traction Freight Elevators
14 21 23 00 Machine Room-Less Electric Traction Passenger Elevators
14 24 00 00 Hydraulic Elevators
14 24 13 00 Hydraulic Freight Elevators
14 26 00 00 Limited-Use_Limited-Application Elevators
14 30 00 00 Escalators
14 41 19 00 Stairway Chairlifts
14 42 00 00 Wheelchair Lifts
14 91 82 00 Trash Chutes

21 Fire Suppression

21 01 10 91 Commissioning Of Fire Suppression
21 05 00 00 Common Work Results for Fire Suppression
21 05 23 00 General-Duty Valves for Water-Based Fire-Suppression Piping
21 05 29 00 Hangers and Supports for Fire-Suppression Piping and Equipment
21 05 33 00 Heat Tracing for Fire-Suppression Piping
21 05 48 00 Vibration And Seismic Controls For Fire-Suppression Piping And Equipment
21 05 48 13 Vibration Controls for Fire-Suppression Piping and Equipment
21 05 53 00 Identification for Fire-Suppression Piping and Equipment
21 07 00 00 Fire-Suppression Systems Insulation
21 10 00 00 Water-Based Fire-Suppression Systems
21 13 39 00 Foam-Water Systems
21 21 00 00 High-Pressure, Carbon-Dioxide Fire-Extinguishing Systems
21 21 00 00a Low-Pressure, Carbon-Dioxide Fire-Extinguishing Systems
21 22 00 00 Clean-Agent Fire-Extinguishing Systems
21 31 13 00 Electric-Drive, Centrifugal Fire Pumps
21 31 13 00a Pressure-Maintenance Pumps
21 31 16 00 Diesel-Drive, Centrifugal Fire Pumps

22 Plumbing

22 05 00 00 Common Work Results for Plumbing
22 05 00 00a Testing, Adjusting, and Balancing for Plumbing
22 05 23 00 General-Duty Valves for Plumbing Piping
22 05 29 00 Hangers and Supports for Plumbing Piping and Equipment
22 05 33 00 Heat Tracing for Plumbing Piping
22 05 48 00 Vibration And Seismic Controls For Plumbing Piping And Equipment
22 05 48 13 Vibration Controls for Plumbing Piping and Equipment
22 05 53 00 Identification for Plumbing Piping and Equipment
22 07 16 00 Plumbing Equipment Insulation
22 07 19 00 Plumbing Piping Insulation
22 11 16 00 Domestic Water Piping
22 11 16 00a Steam And Condensate Piping
22 11 19 00 Domestic Water Piping Specialties
22 11 23 13 Domestic-Water Packaged Booster Pumps
22 11 23 23 Inline, Domestic-Water Pumps
22 12 19 00 Facility Ground-Mounted, Potable-Water Storage Tanks
22 12 23 00 Facility Indoor Potable-Water Storage Tanks
22 13 00 00 Facility Gray-Water Storage Tanks
22 13 16 00 Sanitary Waste And Vent Piping
22 13 19 00 Sanitary Waste Piping Specialties
22 13 19 13 Sanitary Drains
22 13 23 00 Sanitary Waste Interceptors
22 13 29 00 Sanitary Sewerage Pumps
22 14 00 00 Facility Storm-Water Retention Tanks
22 14 13 00 Storm Drainage Piping
22 14 29 00 Sump Pumps
22 15 13 00 General-Service Compressed-Air Piping
22 15 19 00 General-Service Packaged Air Compressors and Receivers
22 31 00 00 Domestic Water Softeners
22 32 00 00 Domestic Water Filtration Equipment
22 33 00 00 Electric Domestic-Water Heaters
22 34 00 00 Fuel-Fired, Domestic-Water Heaters
22 35 00 00 Domestic-Water Heat Exchangers
22 41 00 00 Residential Plumbing Fixtures
22 42 00 00 Commercial Plumbing Fixtures
22 43 00 00 Healthcare Plumbing Fixtures
22 45 00 00 Emergency Plumbing Fixtures
22 46 00 00 Security Plumbing Fixtures
22 47 00 00 Drinking Fountains And Water Coolers
22 63 13 00 Gas Piping For Laboratory And Healthcare Facilities
22 66 00 00 Chemical-Waste Systems for Laboratory and Healthcare Facilities

23 Heating, Ventilating, and Air-Conditioning (HVAC)

23 01 30 51 Existing HVAC Air Distribution System Cleaning
23 05 00 00 Common Work Results for HVAC
23 05 00 00a Coatings for HVAC
23 05 23 00 General-Duty Valves for HVAC Piping
23 05 29 00 Hangers and Supports for HVAC Piping and Equipment
23 05 33 00 Heat Tracing for HVAC Piping
23 05 48 00 Vibration and Seismic Controls for HVAC
23 05 48 00a Vibration Instruments
23 05 48 13 Vibration Controls for HVAC
23 05 53 00 Identification for HVAC Piping and Equipment
23 05 66 00 AntiMicrobial Ultraviolet Lamp Systems for HVAC
23 05 93 00 Testing, Adjusting, and Balancing for HVAC
23 07 13 00 Duct Insulation
23 07 16 00 HVAC Equipment Insulation
23 07 19 00 HVAC Piping Insulation
23 08 00 00 Commissioning Of HVAC
23 09 00 00 Speed Instruments
23 09 23 00 Direct Digital Control (DDC) System for HVAC

23 09 23 00a	Leak Detection Instruments
23 09 23 00b	Position Instruments
23 09 23 00c	Sequence of Operations for HVAC DDC
23 09 23 11	Control Valves
23 09 23 12	Control Dampers
23 09 23 13	Energy Meters
23 09 23 14	Flow Instruments
23 09 23 16	Gas Instruments
23 09 23 19	Moisture Instruments
23 09 23 21	Motion Instruments
23 09 23 23	Pressure Instruments
23 09 23 27	Temperature Instruments
23 11 23 00	Facility Natural-Gas Piping
23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 12 13 00	Facility Fuel-Oil Pumps
23 13 13 00	Facility Underground Fuel-Oil Storage Tanks
23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks
23 21 13 00	Hydronic Piping
23 21 16 00	Hydronic Piping Specialties
23 21 23 00	Hydronic Pumps
23 22 00 00	Underground Steam and Condensate Heating Piping
23 22 16 00	Steam and Condensate Heating Piping Specialties
23 22 23 00	Steam Condensate Pumps
23 23 00 00	Refrigerant Piping
23 25 00 00	HVAC Water Treatment
23 25 00 00a	Water Treatment for Open-Loop Hydronic Systems
23 25 00 00b	Water Treatment for Steam System Feedwater
23 25 00 00c	Water Treatment for Humidification Steam System Feedwater
23 25 00 00d	HVAC Makeup-Water Filtration Equipment
23 25 13 00	Water Treatment for Closed-Loop Hydronic Systems
23 31 13 00	Metal Ducts
23 31 16 00	Nonmetal Ducts
23 31 16 23	Fabric Air-Distribution Devices
23 33 00 00	Air Duct Accessories
23 34 00 00	HVAC Fans
23 34 33 00	Commercial Air Curtains
23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts
23 36 00 00	Air Terminal Units
23 37 13 00	Registers and Grilles
23 37 13 13	Air Diffusers
23 37 13 43	Security Registers and Grilles
23 37 23 00	HVAC Gravity Ventilators
23 38 13 00	Commercial-Kitchen Hoods
23 41 00 00	Particulate Air Filtration
23 41 33 00	High-Efficiency Particulate Air Filtration
23 42 00 00	Gas-Phase Air Filtration
23 43 00 00	Electronic Air Cleaners
23 51 13 00	Draft Control Fans
23 51 13 00a	Gas Vents
23 51 13 00b	Insulated Sectional Chimneys
23 51 13 16	Vent Dampers
23 51 16 00	Fabricated Breechings and Accessories
23 52 13 00	Electric Boilers
23 52 16 00	Condensing Boilers
23 52 23 00	Cast-Iron Boilers
23 52 33 00	Water-Tube Boilers
23 52 39 00	Fire-Tube Boilers
23 53 13 00	Boiler Feedwater Pumps
23 53 16 00	Deaerators
23 54 13 00	Electric-Resistance Furnaces
23 54 16 13	Gas-Fired Furnaces
23 54 16 16	Oil-Fired Furnaces
23 55 23 13	Low-Intensity, Gas-Fired, Radiant Heaters
23 55 33 13	Oil-Fired Unit Heaters
23 55 33 16	Gas-Fired Unit Heaters
23 57 00 00	Heat Exchangers for HVAC
23 62 00 00	Packaged Compressor and Condenser Units
23 63 13 00	Air-Cooled Refrigerant Condensers
23 64 13 16	Indirect-Fired Absorption Water Chillers
23 64 16 00	Centrifugal Water Chillers

23 64 23 13 Air-Cooled, Scroll Water Chillers
23 64 23 16 Water-Cooled, Scroll Water Chillers
23 64 26 13 Air-Cooled, Rotary-Screw Water Chillers
23 64 26 16 Water-Cooled, Rotary-Screw Water Chillers
23 65 13 16 Closed-Circuit, Forced-Draft Cooling Towers
23 65 14 13 Open-Circuit, Induced-Draft, Counterflow Cooling Towers
23 65 14 14 Open-Circuit, Induced-Draft, Crossflow Cooling Towers
23 65 14 16 Closed-Circuit, Induced-Draft, Counterflow Cooling Towers
23 72 13 00 Heat Wheel Air-To-Air Energy Recovery Units
23 72 16 00 Heat Pipe Air-to-Air Energy Recovery Units
23 73 00 00 Indoor, Indirect, Gas-Fired Heating and Ventilating Units
23 73 00 00a Indoor, Direct-Fired Heating and Ventilating Units
23 73 13 00 Indoor, Basic Air-Handling Units
23 73 13 00a Indoor, Semi-Custom Air-Handling Units
23 74 16 13 Packaged, Large-Capacity, Rooftop Air-Conditioning Units
23 74 16 13a Dedicated Outdoor-Air Units
23 74 23 00 Packaged, Indirect-Fired, Outdoor, Heating-Only Makeup-Air Units
23 74 23 13 Packaged, Direct-Fired, Outdoor, Heating-Only Makeup-Air Units
23 81 00 00 Variable-Refrigerant-Flow HVAC Systems
23 81 13 11 Packaged Terminal Air-Conditioners, Through-Wall Units
23 81 13 13 Packaged Terminal Air-Conditioners, Outdoor, Wall-Mounted Units
23 81 23 00 Small Capacity Computer-Room Air-Conditioners Floor-Mounted Units
23 81 23 00a Computer-Room Air-Conditioners, Console Units
23 81 23 00b Computer-Room, Rack-Cooling Equipment
23 81 23 12 Large Capacity (7 Tons (25 kW) and Larger), Computer-Room Air-Conditioners, Floor-Mounted Units
23 81 23 13 Computer-Room Air-Conditioners, Ceiling-Mounted Units
23 81 26 00 Split-System Air-Conditioners
23 81 46 00 Water-Source Unitary Heat Pumps
23 81 46 00a Water-To-Air Heat Pumps
23 82 00 00 Chilled Beams
23 82 16 11 Hydronic Air Coils
23 82 16 12 Steam Air Coils
23 82 16 13 Refrigerant Air Coils
23 82 16 14 Electric-Resistance Air Coils
23 82 19 00 Fan Coil Units
23 82 29 00 Radiators
23 82 33 00 Convectors
23 82 36 00 Finned-Tube Radiation Heaters
23 82 39 13 Cabinet Unit Heaters
23 82 39 16 Propeller Unit Heaters
23 82 39 19 Wall and Ceiling Unit Heaters
23 83 13 00 Radiant-Heating Electric Cables
23 84 13 16 Wetted-Element Humidifiers
23 84 13 23 Direct-Steam-Injection Humidifiers
23 84 13 29 Self-Contained Steam Humidifiers
23 84 16 16 Indoor, Mechanical Dehumidification Units

26 Electrical

26 05 00 00 Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 13 00 Medium-Voltage Cables
26 05 19 00 Low-Voltage Electrical Power Conductors and Cables
26 05 23 00 Control-Voltage Electrical Power Cables
26 05 26 00 Grounding and Bonding for Electrical Systems
26 05 29 00 Hangers And Supports For Electrical Systems
26 05 33 13 Conduits for Electrical Systems
26 05 33 16 Boxes and Covers for Electrical Systems
26 05 33 23 Surface Raceways for Electrical Systems
26 05 36 00 Cable Trays for Electrical Systems
26 05 39 00 Underfloor Raceways For Electrical Systems
26 05 43 00 Underground Ducts and Utility Structures
26 05 46 00 Poles for Electrical Systems
26 05 53 00 Identification for Electrical Systems
26 09 00 00 Addressable Luminaire Lighting Controls
26 09 00 00a Relay-Based Lighting Controls
26 09 23 00 Electrical Power Monitoring
26 09 23 00a Lighting Control Devices
26 11 16 00 Secondary Unit Substations with Switchboard Secondary

26 11 16 00a Secondary Unit Substations with Motor Control Center Secondary
26 11 16 11 Secondary Unit Substations with Switchgear Secondary
26 12 13 00 Liquid-Filled, Medium-Voltage Transformers
26 12 16 00 Dry-Type, Medium-Voltage Transformers
26 12 19 00 Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
26 12 19 00a Low-Voltage Switchgear
26 13 29 00 Medium-Voltage Compartmentalized Switchgear
26 21 16 00 Paralleling Low-Voltage Switchgear
26 22 13 00 Low-Voltage Distribution Transformers
26 24 13 00 Switchboards
26 24 16 00 Panelboards
26 24 16 00a Electronically Operated Circuit-Breaker Panelboards
26 24 19 00 Motor-Control Centers
26 25 00 00 Low-Voltage Enclosed Bus Assemblies
26 27 13 00 Electricity Metering
26 27 16 00 Electrical Cabinets and Enclosures
26 27 19 00 Multi-Outlet Assemblies
26 27 26 00 Wiring Devices
26 27 26 00a Receptacles with Arc-Fault and Ground-Fault Protective Devices
26 27 26 00b Connectors, Cords, and Plugs
26 27 33 00 Power Distribution Units
26 28 13 00 Fuses
26 28 16 00 Enclosed Switches And Circuit Breakers
26 29 13 00 Manual and Magnetic Motor Controllers
26 29 13 00a Soft-Start Motor Controllers
26 29 23 00 Variable-Frequency Motor Controllers
26 31 00 00 Photovoltaic Collectors
26 32 13 13 Diesel-Engine-Driven Generator Sets
26 32 13 19 Bi-Fuel-Engine-Driven Generator Sets
26 33 43 00 Battery Chargers
26 33 43 00a Public Address Systems
26 33 53 00 Static Uninterruptible Power Supply
26 35 33 00 Power Factor Correction Equipment
26 36 00 00 Transfer Switches
26 43 13 00 Surge Protective Devices for Low-Voltage Electrical Power Circuits
26 50 00 00 Lighting
26 55 61 00 Theatrical Lighting
26 55 68 00 Athletic Field Lighting

27 Communications

27 11 00 00 Communications Equipment Room Fittings
27 13 13 00 Communications Copper Backbone Cabling
27 13 23 00 Communications Optical Fiber Backbone Cabling
27 15 13 00 Communications Copper Horizontal Cabling
27 15 23 00 Communications Optical Fiber Horizontal Cabling
27 15 33 00 Communications Coaxial Horizontal Cabling
27 41 33 00 Master Antenna Television System
27 52 23 00 Nurse Call Code Blue Systems
27 53 13 00 Clock Systems

28 Electronic Safety and Security

28 10 00 00 Access Control
28 10 00 00a Access Control Software and Database Management
28 10 00 00b Access Control System Hardware
28 15 00 00 Integrated Access Control Hardware Devices
28 15 00 00a Access Control Credentials
28 15 00 00b Electrified Locking Devices and Accessories
28 15 00 00c Egress Management Devices
28 15 00 00d Telephone Entry Systems
28 15 00 00e Intercom Entry Systems
28 15 00 00f Electronic Key Management Systems

28 15 00 00g Access Control Electronic Turnstiles and Mobility Systems
28 15 11 00 Integrated Credential Readers and Entry Management
28 16 11 00 Intrusion Detection
28 16 11 00a Area and Perimeter Intrusion Detection
28 20 00 00 Video Surveillance
28 40 00 00 Emergency Responder Communications Enhancement System ERCES
28 46 00 00 Fire Detection and Alarm
28 47 00 00 Mass Notification

31 Earthwork

31 10 00 00 Site Clearing
31 20 00 00 Earth Moving
31 23 19 00 Dewatering
31 24 13 00 Levee Closure
31 31 16 00 Termite Control
31 32 19 16 Pond and Reservoir Liners
31 50 00 00 Excavation Support and Protection
31 62 13 00 Concrete Piles
31 62 16 00 Steel Piles
31 62 19 00 Timber Piles
31 62 23 00 Composite Piles

32 Exterior Improvements

32 12 16 00 Asphalt Paving
32 13 13 00 Concrete Paving
32 13 16 00 Decorative Concrete Paving
32 13 73 00 Concrete Paving Joint Sealants
32 14 00 00 Unit Paving
32 14 16 00 Vitrified Brick Pavement Replacement
32 17 13 00 Parking Bumpers
32 17 16 00 Manufactured Traffic-Calming Devices
32 17 23 00 Pavement Markings
32 17 26 00 Tactile Warning Surfacing
32 18 16 13 Playground Protective Surfacing
32 31 13 00 Chain Link Fences And Gates
32 31 13 13 High-Security Chain Link Fences and Gates
32 31 16 00 Welded Wire Fences and Gates
32 31 19 00 Decorative Metal Fences and Gates
32 32 23 00 Segmental Retaining Walls
32 33 00 00 Site Furnishings
32 84 00 00 Planting Irrigation
32 91 13 00 Soil Preparation
32 92 00 00 Turf and Grasses
32 93 00 00 Plants
32 96 00 00 Transplanting

33 Utilities

33 01 30 41 Cleaning of Sewers
33 05 00 00 Common Work Results For Utilities
33 11 13 00 Rehabilitation of Water Supply Wells
33 11 13 00a Potable Water Supply Wells
33 14 00 00 Site Water Distribution Piping
33 31 00 00 Site Sanitary Sewerage Piping
33 32 00 00 Site Packaged Sewage Pumping Stations
33 42 00 00 Stormwater Conveyance
33 44 36 00 Oil Water Separator
33 46 00 00 Subdrainage
33 71 00 00 Overhead Medium-Voltage Wiring

34 Transportation

34 71 00 00 Roadway Crossing Control Equipment
34 71 13 00 Active Vehicle Barriers
34 71 13 26 Vehicle Guide Rails

35 Waterway and Marine Construction

35 22 26 00 Sluice Gates
35 24 00 00 Dredging

41 Material Processing and Handling Equipment

41 22 23 00 Hoists
41 22 23 00a Specialty Hoists
41 22 23 00b Monorails With Electric Powered Hoists
41 22 23 00c Monorails With Manual Hoist

SECTION 01 00 00 00 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 BRACKETED OPTIONS

A. Within these Technical Specifications there are bracketed options. For example **[6ft] [12ft] [24ft]** or **<Insert…>**. The final selection will be made by the Owner and set forth in the Detailed Scope of Work.

1.2 WARRANTY

A. Within these Technical Specifications there are warranty periods listed. The warranty periods listed cover both material and labor for that period. If a manufacture will warranty a material for a longer period than what is listed, the material is covered as a replacement by the manufacture for the extra period. The labor to replace will be at the installation price for the contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 00 00 00

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Task	Specification	Specification Description
01 10 00 00	01 00 00 00	General Requirements
01 11 00 00	01 00 00 00	General Requirements

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SECTION 01 11 13 00 - WORK COVERED BY CONTRACT DOCUMENTS

1.1 GENERAL

A. If any conflicts arise in the Specifications; the Owner's Standard Plans and Specifications supersede the Gordian Technical Specifications. Specification conflicts shall be resolved as directed by the Owner.

B. Contractor is to provide a competent person to ensure operations are completed per plans, specifications, local laws and regulations which pertain.

C. Specification Format
   1. The specification format shall be based on the Construction Specifications Institute (CSI) Section Format.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 11 13 00

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Task	Specification	Specification Description
01 11 13 00	01 00 00 00	General Requirements
01 20 00 00	01 00 00 00	General Requirements

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SECTION 01 22 00 00 - NO SPECIFICATION REQUIRED

1.1 GENERAL

A. A separate specification is not required for this item. The description given in the line item of the Construction Task Catalog completely defines the item.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 22 00 00

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Task	Specification	Specification Description
01 22 00 00	01 00 00 00	General Requirements
01 22 16 00	01 00 00 00	General Requirements
01 22 16 00	01 22 00 00	No Specification Required
01 22 20 00	01 00 00 00	General Requirements
01 22 20 00	01 22 00 00	No Specification Required
01 22 23 00	01 00 00 00	General Requirements
01 22 23 00	01 22 00 00	No Specification Required
01 30 00 00	01 00 00 00	General Requirements
01 35 00 00	01 00 00 00	General Requirements
01 35 29 00	01 00 00 00	General Requirements
01 35 33 00	01 00 00 00	General Requirements

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SECTION 01 40 00 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner,[**Commissioning Authority,**][**Construction Manager,**] or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Requirements:

1. Section 012100 "Allowances" for testing and inspection allowances.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of [**five**] previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.

1. Mockups are used for one or more of the following:

a. Verify selections made under Sample submittals.
b. Demonstrate aesthetic effects.
c. Demonstrate the qualities of products and workmanship.

d. Demonstrate successful installation of interfaces between components and systems.
e. Perform preconstruction testing to determine system performance.

2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect[**or Construction Manager**].

1.3 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting

requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Mockup Shop Drawings:

1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
2. Indicate manufacturer and model number of individual components.
3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses,

certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within [**10**] days of [**Notice of Award**][**Notice to Proceed**], and not less than [**five**] days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager [**may also serve as Project superintendent**][**does not have other Project responsibilities**].

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Owner-performed tests and inspections indicated in the Contract Documents[**, including tests and inspections indicated to be performed by Commissioning Authority**].

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.

2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.9 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor's Responsibilities:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
e. When testing is complete, remove test specimens and test assemblies[**, and mockups**]; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect[**and Commissioning Authority**][**, through Construction Manager**], with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.

2. Build mockups in location indicated or, if not indicated, as directed by Architect[**or Construction Manager**].
3. Notify Architect[**and Construction Manager**][**seven**] days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's[**and Construction Manager's**] approval of mockups before starting corresponding Work, fabrication, or construction.

    a. Allow [**seven**] days for initial review and each re-review of each mockup.

7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for [**integrated exterior mockups**][**preconstruction laboratory mockups**][**and**][**room mockups**].

1.10 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor[**, and the Contract Sum will be adjusted by Change Order**].

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least [**24**] hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect[**, Commissioning Authority**][**, Construction Manager,**] and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect[**, Commissioning Authority,**][**, Construction Manager,**] and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents[**as a component of Contractor's quality-control plan**].

Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect,[**Commissioning Authority,**][**Construction Manager,**] testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified [**testing agency**][**special inspector**] to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner[**, as indicated in the Statement of Special Inspections attached to this Section**], and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect[**, Commissioning Authority,**][**, Construction Manager,**] and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect[**and Commissioning Authority**][**, through Construction Manager,**] with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's[**, Commissioning Authority's,**][**and Construction Manager's**][**and**][**authorities' having jurisdiction**] reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00 00

Task	Specification	Specification Description
01 40 00 00	01 00 00 00	General Requirements
01 41 00 00	01 00 00 00	General Requirements
01 41 00 00	01 40 00 00	Quality Requirements
01 41 26 00	01 00 00 00	General Requirements
01 41 26 00	01 40 00 00	Quality Requirements

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SECTION 01 42 00 00 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. [**Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."**]The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.
24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.
25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.

33. ASME - ASME International; [**American Society of Mechanical Engineers (The)**]; www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BSI - British Standards Institution; www.bsigroup.com.
50. BWF - Badminton World Federation; www.bwfbadminton.com.
51. CARB - California Air Resources Board; www.arb.ca.gov.
52. CDA - Copper Development Association Inc.; www.copper.org.
53. CE - Conformite Europeenne (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
54. CEA - Canadian Electricity Association; www.electricity.ca.
55. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
56. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
57. CGA - Compressed Gas Association; www.cganet.com.
58. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
59. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
60. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
61. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
62. CMHA - Concrete Masonry & Hardscape Association; (Formerly: National Concrete Masonry Association); www.masonryandhardscapes.org.
63. CPA - Composite Panel Association; www.compositepanel.org.
64. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
65. CRRC - Cool Roof Rating Council; www.coolroofs.org.
66. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
67. CSA - CSA Group; www.csagroup.org.
68. CSI - Cast Stone Institute; www.caststone.org.
69. CSI - Construction Specifications Institute (The); www.csiresources.org.
70. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
71. CTA - Consumer Technology Association; www.cta.tech.
72. CTI - Cooling Technology Institute; www.coolingtechnology.org.
73. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
74. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
75. DHI - Door and Hardware Institute; www.dhi.org.
76. ECIA - Electronic Components Industry Association; www.ecianow.org.
77. EIMA - EIFS Industry Members Association; www.eima.com.
78. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
79. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
80. ESTA - Entertainment Services and Technology Association; www.esta.org.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FGIA - Fenestration and Glazing Industry Alliance; https://fgiaonline.org.
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.

85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
87. FM Global - FM Global; www.fmglobal.com.
88. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
89. FSA - Fluid Sealing Association; www.fluidsealing.com.
90. FSC - Forest Stewardship Council U.S.; www.fscus.org.
91. GA - Gypsum Association; www.gypsum.org.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
95. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
96. IAS - International Accreditation Service; www.iasonline.org.
97. ICC - International Code Council; www.iccsafe.org.
98. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
99. ICPA - International Cast Polymer Association (The); www.theicpa.com.
100. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
101. IEC - International Electrotechnical Commission; www.iec.ch.
102. IEEE SA - IEEE Standards Association; https://standards.ieee.org.
103. IES - Illuminating Engineering Society; www.ies.org.
104. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
105. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
106. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
107. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
108. Intertek - Intertek Group; www.intertek.com.
109. ISA - International Society of Automation (The); www.isa.org.
110. ISFA - International Surface Fabricators Association; www.isfanow.org.
111. ISO - International Organization for Standardization; www.iso.org.
112. ITU - International Telecommunication Union; www.itu.int.
113. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
114. LPI - Lightning Protection Institute; www.lightning.org.
115. MBMA - Metal Building Manufacturers Association; www.mbma.com.
116. MCA - Metal Construction Association; www.metalconstruction.org.
117. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
118. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
119. MHI - Material Handling Industry; www.mhi.org.
120. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
121. MPI - Master Painters Institute; www.paintinfo.com.
122. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
123. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
124. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
125. NADCA - National Air Duct Cleaners Association; www.nadca.com.
126. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
127. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
128. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
129. NBI - New Buildings Institute; www.newbuildings.org.
130. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
131. NCMA - National Concrete Masonry Association; (see CMHA).
132. NEBB - National Environmental Balancing Bureau; www.nebb.org.
133. NECA - National Electrical Contractors Association; www.necanet.org.
134. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
135. NEMA - National Electrical Manufacturers Association; www.nema.org.
136. NETA - InterNational Electrical Testing Association; www.netaworld.org.

137. NFHS - National Federation of State High School Associations; www.nfhs.org.
138. NFPA - National Fire Protection Association; www.nfpa.org.
139. NFPA - NFPA International; (see NFPA).
140. NFRC - National Fenestration Rating Council; www.nfrc.org.
141. NGA - National Glass Association; www.glass.org.
142. NHLA - National Hardwood Lumber Association; www.nhla.com.
143. NLGA - National Lumber Grades Authority; www.nlga.org.
144. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
145. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
146. NRCA - National Roofing Contractors Association; www.nrca.net.
147. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
148. NSF - NSF International; www.nsf.org.
149. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
150. NSPE - National Society of Professional Engineers; www.nspe.org.
151. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
152. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
153. NWFA - National Wood Flooring Association; www.nwfa.org.
154. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
155. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
156. PDI - Plumbing & Drainage Institute; www.pdionline.org.
157. PLASA - PLASA; www.plasa.org.
158. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
159. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
160. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
161. RFCI - Resilient Floor Covering Institute; www.rfci.com.
162. RIS - Redwood Inspection Service; (see WWPA).
163. SAE - SAE International; www.sae.org.
164. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
165. SDI - Steel Deck Institute; www.sdi.org.
166. SDI - Steel Door Institute; www.steeldoor.org.
167. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
168. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
169. SIA - Security Industry Association; www.securityindustry.org.
170. SJI - Steel Joist Institute; www.steeljoist.org.
171. SMA - Screen Manufacturers Association; www.smainfo.org.
172. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
173. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
174. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
175. SPIB - Southern Pine Inspection Bureau; www.spib.org.
176. SPRI - Single Ply Roofing Industry; www.spri.org.
177. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
178. SSINA - Specialty Steel Industry of North America; www.ssina.com.
179. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
180. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
181. SWI - Steel Window Institute; www.steelwindows.com.
182. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
183. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
184. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
185. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.
186. TIA - Telecommunications Industry Association; www.tiaonline.org.
187. TMS - The Masonry Society; www.masonrysociety.org.
188. TPI - Truss Plate Institute; www.tpinst.org.
189. TPI - Turfgrass Producers International; www.turfgrasssod.org.
190. TRI - Tile Roofing Industry Alliance; www.tileroofing.org.
191. ULSE - UL Standards & Engagement Inc.; www.ulse.org.

192. UL - UL Solutions Inc.; www.ul.com.
193. USAV - USA Volleyball; www.usavolleyball.org.
194. USGBC - U.S. Green Building Council; www.usgbc.org.
195. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
196. WA - Wallcoverings Association; www.wallcoverings.org.
197. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
198. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
199. WDMA - Window & Door Manufacturers Association; www.wdma.com.
200. WI - Woodwork Institute; www.woodworkinstitute.com.
201. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
202. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - U.S. Department of Commerce; www.commerce.gov.
3. DOD - U.S. Department of Defense; www.defense.gov.
4. DOE - U.S. Department of Energy; www.energy.gov.
5. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
6. DOS - U.S. Department of State; www.state.gov.
7. EPA - United States Environmental Protection Agency; www.epa.gov.
8. FAA - Federal Aviation Administration; www.faa.gov.
9. GPO - U.S. Government Publishing Office; www.gpo.gov.
10. GSA - U.S. General Services Administration; www.gsa.gov.
11. HUD - U.S. Department of Housing and Urban Development; www.hud.gov.
12. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov/.
13. NIST - National Institute of Standards and Technology; www.nist.gov.
14. OSHA - Occupational Safety & Health Administration; www.osha.gov.
15. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
16. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
17. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
18. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
19. USP - U.S. Pharmacopeial Convention; www.usp.org.
20. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.

2. DOD - U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from U.S. General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specifications and Standards; (see DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. BEARHFTI; California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; (see BHGS).
2. BHGS; State of California Bureau of Household Goods and Services; (Formerly: California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation); www.bhgs.dca.ca.gov.
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; https://tfsweb.tamu.edu/.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00 00

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Task	Specification	Specification Description
01 42 00 00	01 00 00 00	General Requirements
01 42 00 00	01 40 00 00	Quality Requirements
01 42 13 00	01 00 00 00	General Requirements
01 42 13 00	01 40 00 00	Quality Requirements
01 42 13 00	01 42 00 00	References
01 42 16 00	01 00 00 00	General Requirements
01 42 16 00	01 40 00 00	Quality Requirements
01 42 16 00	01 42 00 00	References
01 42 19 00	01 00 00 00	General Requirements
01 42 19 00	01 40 00 00	Quality Requirements
01 42 19 00	01 42 00 00	References
01 42 21 00	01 00 00 00	General Requirements
01 42 21 00	01 40 00 00	Quality Requirements
01 42 21 00	01 42 00 00	References
01 45 00 00	01 00 00 00	General Requirements
01 45 00 00	01 40 00 00	Quality Requirements
01 45 23 00	01 00 00 00	General Requirements
01 45 23 00	01 22 00 00	No Specification Required
01 45 23 00	01 40 00 00	Quality Requirements
01 45 29 00	01 00 00 00	General Requirements
01 45 29 00	01 22 00 00	No Specification Required
01 45 29 00	01 40 00 00	Quality Requirements

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SECTION 01 50 00 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
2. Section 011200 "Multiple Contract Summary" for responsibilities for temporary facilities and controls for projects utilizing multiple contracts.
3. Section 012100 "Allowances" for allowance for metered use of temporary utilities.

1.2 USE CHARGES

A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to,[**Owner's construction forces,**] Architect,[**occupants of Project,**] testing agencies, and authorities having jurisdiction.

B. Sewer Service: [**Pay**][**Owner will pay**] sewer-service use charges for sewer usage by all entities for construction operations.

C. Water Service: [**Pay**][**Owner will pay**] water-service use charges for water used by all entities for construction operations.

D. Electric Power Service: [**Pay**][**Owner will pay**] electric-power-service use charges for electricity used by all entities for construction operations.

E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use [**with metering**][**without metering and without payment of use charges**]. Provide connections and extensions of services [**and metering**] as required for construction operations.

F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use [**with metering**][**without metering and without payment of use charges**]. Provide connections and extensions of services [**and metering**] as required for construction operations.

G. Sewer, Water, and Electric Power Service: Use charges are specified in Section 011200 "Multiple Contract Summary."

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within [**15**] days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility, as

directed by the Owner.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by Owner. Include the following:

1. Methods used to meet the goals and requirements of Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with Owner.
6. Indicate locations of sensitive [**research**][**patient**][**equipment**] areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in [**the DOJ's "2010 ADA Standards**

for Accessible Design"][**and**][**ICC A117.1**].

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum **2-inch**, **0.148-inch-** thick, galvanized-steel, chain-link fabric fencing; minimum **6 feet** high with galvanized-steel pipe posts; minimum **2-3/8-inch-** OD line posts and **2-7/8-inch-** OD corner and pull posts[**, with 1-5/8-inch- OD top rails**][**, with galvanized barbed-wire top strand**].

B. Portable Chain-Link Fencing: Minimum **2-inch**, **0.148-inch-** thick, galvanized-steel, chain-link fabric fencing; minimum **6 feet** high with galvanized-steel pipe posts; minimum **2-3/8-inch-** OD line posts and **2-7/8-inch-** OD corner and pull posts, with **1-5/8-inch-** OD top and bottom rails. Provide [**concrete**][**galvanized-steel**] bases for supporting posts.

C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

D. Wood Enclosure Fence: Plywood, [**6 feet**][**8 feet**] high, framed with four **2-by-4-inch** rails, with preservative-treated wood posts spaced not more than **8 feet** apart.

E. Polyethylene Sheet: Reinforced, fire-resistive sheet, **10-mil** minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.

F. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum **36 by 60 inches**.

G. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices:

1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Owner will provide conditioned interior space for field offices [**for duration of Project**][**upon completion of demolition and enclosure**].

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect[**, Construction Manager**], and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.

2. Conference room of sufficient size to accommodate meetings of [**10**] individuals, as directed by the Owner. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and **4-foot-** square tack and marker boards.
3. Drinking water and private toilet.
4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of **68 to 72 deg F**.
5. Lighting fixtures capable of maintaining average illumination of **20 fc** at desk height.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no

longer needed or are replaced by authorized use of completed permanent facilities.

C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed[**in accordance with coordination drawings**].

a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
b. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to [**municipal system**][**private system indicated**] as directed by authorities having jurisdiction.

C. Water Service:

1. Install water service and distribution piping in sizes and pressures adequate for construction.
2. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities [**is not permitted**][**will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use**].

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Electric Power Service:

1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
2. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

    a. Install electric power service [**overhead**][**underground**] unless otherwise indicated.
    b. Connect temporary service to Owner's existing power source, as directed by Owner.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install [**WiFi cell phone access equipment**][**and**][**one**] land-based telephone line(s) for each field office, as directed by the Owner.

1. Provide additional telephone lines for the following:

    a. Provide [**one**] telephone line(s) for Owner's use, as directed by the Owner.

2. At each telephone, post a list of important telephone numbers.

    a. Police and fire departments.
    b. Ambulance service.
    c. Contractor's home office.
    d. Contractor's emergency after-hours telephone number.
    e. Architect's office.
    f. [**Construction Manager's home office**].
    g. Engineers' offices.
    h. Owner's office.
    i. Principal subcontractors' field and home offices.

I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

J. Project Computer: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:

1. Processor: Intel Core i5 or i7.
2. Memory: [**16**] gigabyte.
3. Disk Storage: [**1**] -terabyte hard-disk drive and combination DVD-RW/CD-RW drive.
4. Display: **24-inch** LCD monitor with 256-Mb dedicated video RAM.
5. Full-size keyboard and mouse.
6. Network Connectivity: [**10/100BaseT Ethernet**][**Gigabit**].
7. Operating System: Microsoft Windows 10 Professional.
8. Productivity Software:

    a. Microsoft Office Professional, 2013 or higher, including Word, Excel, and Outlook.
    b. Adobe Reader DC.
    c. WinZip 10.0 or higher.

9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
10. Internet Service: Broadband modem, router, and ISP, equipped with hardware firewall, providing minimum [**10.0**] -Mbps upload and [**15**] -Mbps download speeds at each computer, as directed by the Owner.
11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
12. Backup: External hard drive, minimum [**2**] terrabytes, with automated backup software providing daily backups, as directed by the Owner.

3.4 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

1. Provide construction for temporary field offices, shops, and sheds located within construction area or within **30 feet** of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
2. Utilize designated area within existing building for temporary field offices.
3. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas [**as indicated**][**within construction limits indicated**] on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: [**Provide temporary offsite**][**Use designated areas of Owner's existing**] parking areas for construction personnel.

F. Storage and Staging: [**Provide temporary offsite area**][**Use designated areas of Project site**] for storage and staging needs.

G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

H. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs, so they are legible at all times.

I. Waste Disposal Facilities:

1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

K. Temporary Elevator Use: [**Use of elevators is not permitted**][**See Division 14 elevator Section for temporary use of new elevators**].

L. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

M. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

N. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.

O. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control:

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection:

1. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
2. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

G. Site Enclosure Fence: [**Before construction operations begin**][**Prior to commencing earthwork**], furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: [**As required to enclose entire Project site or portion determined sufficient to accommodate construction operations**][**As indicated on Drawings**].
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.[**Furnish one set of keys to Owner.**]

H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction[**and requirements indicated on Drawings**].

1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
2. Paint and maintain appearance of walkway for duration of the Work.

L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by [**Owner**][**and**][**tenants**] from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard, with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Construct dustproof partitions with two layers of **6-mil** polyethylene sheet on each side. Cover floor with two layers of **6-mil** polyethylene sheet, extending sheets **18 inches** up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

   a. Construct vestibule and airlock at each entrance through temporary partition with not less than **48 inches** between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
4. Insulate partitions to control noise transmission to occupied areas.
5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
6. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

N. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture

and Mold Protection Plan.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

   a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for [**48**] hours are considered defective and require replacing.
   b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for [**48**] hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
   c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within [**48**] hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00 00

Task	Specification	Specification Description
01 50 00 00	01 00 00 00	General Requirements
01 51 00 00	01 00 00 00	General Requirements

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SECTION 01 51 13 00 - TEMPORARY ELECTRICITY

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for electrical renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
1. Regulatory Requirements: Comply with following:
a. Electrical: National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
b. Accessibility:
1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
a) Uniform Federal Accessibility Standards (UFAS).
2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).

B. Project Conditions
1. Existing Conditions: Buildings will be occupied during construction. See Division 1 Section “Summary of Work.” Do not interfere with use of occupied portions of building. Maintain free and safe passage to and from occupied areas.

C. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

D. Alterations, Cutting And Protection
1. Protection: Protect existing finishes, equipment, utilities and adjacent work, which is scheduled to remain, from damage.
2. Existing Operating Facilities: Confine operations to immediate vicinity of new work and do not interfere with or obstruct ingress or egress to and from adjacent facilities.

1.3 PRODUCTS

A. Materials
1. Electrical Materials and Devices: Comply with NFPA 70 (NEC):
a. Boxes: Galvanized steel, not less than 1.6 mm (0.0625 inch) thickness (NEC 370-20) grounded in accordance with NEC, Article 250, suitable for recess mounting.
1) Provide boxes of appropriate shape and size for intended purpose.
b. Devices:
1) Duplex Receptacles: 15 A or 20 A 115 V, UL Listed with screw side connections and corrugated bearing pads.
a) GFIC Outlets: 115 V, 60 Hz, 15/20 A rating, UL Listed.
2) Switches: 15 A. 115 V, single pole, single throw switch, UL Listed, with side screw connections and corrugated bearing pads.

a) Garbage Disposal: Heavy duty, 120/277 VAC, 60 Hz, single pole, single throw, 20 A rate, UL listed and CSA certified.

3) Cover Plates: Smooth plastic in color to match existing.

c. Wiring: Insulated wire, Type NM 600 V with ground wire, sized as appropriate for intended purpose and in accordance with NEC.

1) Aluminum Wire: Not allowed unless existing wiring is aluminum.

2) Provide necessary fittings in accordance with NEC.

1.4 EXECUTION

A. Examination

1. Units, Spaces and Areas to be Renovated: Inspect to become familiar with existing conditions and to take measurements which are necessary for renovation work to be completed in accordance with contract requirements.

a. Carefully inspect condition of existing spaces including, but not limited to walls, floors, plumbing, electrical, etc. as essential to successful completion of renovation work.

b. Survey each space and verify dimensions for work.

B. Preparation

1. Building Occupation: Carry out renovation work to cause as little inconvenience to occupants as possible. See Division 1 Section “Summary of Work.”

2. Protection: Protect and be responsible for existing buildings, facilities, utilities, and improvements within areas of construction operations.

a. Tenant's Property: Be responsible for any damage or loss to residents' property and to other work. Replace any material, which, in opinion of the Owner, has become damaged to extent that it could not be restored to its original condition.

b. Take precautions to protect residents and public from injury from construction operations.

C. Laying Out Work

1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.

a. Prior to commencing work, carefully compare and check Drawings (if any), for discrepancies in locations or elevations of work to be executed.

b. Refer discrepancies among Drawings (if any), Specifications and existing conditions to the Owner for adjustment before work affected is performed.

1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.

2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Location Of Equipment And Piping

1. Drawings (if any) indicating location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always permit their installation in location shown. When this situation occurs, bring condition to the Owner's attention immediately. Relocation will be determined in joint conference.

2. Contractor: Do not relocate any items without first obtaining the Owner's acceptance. Remove and relocate such relocated items at own expense if so directed.

E. Electrical Work

1. General: Install boxes, wiring, and devices as indicated and required to connect and control electrical devices in accordance with NFPA 70 (NEC).

a. Boxes: Solidly anchor to framing or blocking.

2. Removing Electrical Switch or Duplex Outlet (Non-Hazardous Locations):

a. Box to Remain:

1) Remove electrical device; cap hot and neutral with set-screw wire connectors.

2) Attach ground wire to remaining box with solid screw attachment.
3) Provide and install natural finish aluminum blank cover plate with screw fasteners integral to match size of box remaining.

b. Box to be removed:
1) Remove electrical device and box and pull wire out of wall back to first circuit panel, disconnecting from circuit panel.
2) Patch and repair hole in partition to match existing.

3. Garbage Disposal Electrical Hook-up: See Section “Plumbing.” Comply with NFPA 70 (NEC):
a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
b. Switch: Install above counter top backsplash.

4. Range Hood Electrical Hook-up: See Section “Residential Appliances.” Comply with NFPA 70 (NEC):
a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.

5. Water Heater Electrical Hook-up: See Division 15 Section “Domestic Water Heaters.” Comply with NFPA 70 (NEC).

6. Furnace Electrical Hook-up: See Section “Furnaces.” Comply with NFPA 70 (NEC).

7. Smoke Detector Electrical Hook-up: See “Fire Alarm.” Comply with NFPA 70 (NEC).

F. Integrating Existing Work
1. Protection: Protect existing improvements from damage.
a. Where new work is to be connected to existing work, exercise special care not to disturb or damage existing work more than necessary.
b. Damaged Work: Replace, repair and restored to its original condition at no cost to the Owner.

END OF SECTION 01 51 13 00

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Task	Specification	Specification Description
01 51 13 00	01 00 00 00	General Requirements
01 51 13 00	26 24 16 00	Panelboards
01 51 26 00	01 00 00 00	General Requirements
01 52 00 00	01 00 00 00	General Requirements
01 52 13 00	01 00 00 00	General Requirements
01 52 13 00	01 22 00 00	No Specification Required
01 52 13 00	01 50 00 00	Temporary Facilities and Controls
01 52 19 00	01 00 00 00	General Requirements
01 52 19 00	01 50 00 00	Temporary Facilities and Controls
01 53 00 00	01 00 00 00	General Requirements
01 53 16 00	01 00 00 00	General Requirements
01 53 16 00	01 22 00 00	No Specification Required
01 53 23 00	01 00 00 00	General Requirements
01 54 00 00	01 00 00 00	General Requirements

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SECTION 01 54 23 00 - TEMPORARY SCAFFOLDING AND PLATFORMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of scaffolding-tubular steel. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tubular steel or aluminum scaffolding system shall comply with OSHA Safety and Health Standards, Section 29 CFR, 1926/1910.

1.3 EXECUTION - (Section not used.)

END OF SECTION 01 54 23 00

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Task	Specification	Specification Description
01 54 23 00	01 00 00 00	General Requirements
01 54 23 00	01 22 00 00	No Specification Required
01 54 23 00	04 20 00 00	Unit Masonry
01 54 26 00	01 00 00 00	General Requirements
01 54 26 00	01 22 00 00	No Specification Required
01 55 00 00	01 00 00 00	General Requirements
01 55 23 00	01 00 00 00	General Requirements
01 55 23 00	01 22 00 00	No Specification Required
01 55 26 00	01 00 00 00	General Requirements
01 55 26 00	01 22 00 00	No Specification Required
01 56 00 00	01 00 00 00	General Requirements
01 56 16 00	01 00 00 00	General Requirements
01 56 16 00	01 22 00 00	No Specification Required
01 56 26 00	01 00 00 00	General Requirements
01 56 26 00	01 22 00 00	No Specification Required
01 56 29 00	01 00 00 00	General Requirements
01 56 29 00	01 22 00 00	No Specification Required
01 56 33 00	01 00 00 00	General Requirements
01 56 33 00	01 22 00 00	No Specification Required

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SECTION 01 56 39 00 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary controls, utilities, support facilities, temporary site fencing, and, if applicable, temporary erosion and sedimentation controls if not specified in Section 311000 "Site Clearing".
2. Section 311000 "Site Clearing" for removing existing trees and shrubs and for temporary erosion- and sedimentation-control measures if not specified in Section 015000 "Temporary Facilities and Controls".
3. Section 329600 "Transplanting" for relocating existing trees and plants.

1.2 DEFINITIONS

A. Caliper: Diameter of a trunk measured by [**a diameter tape**][**or**][**the average of the smallest and largest diameters**] at a height **6 inches** above the ground for trees up to and including **4-inch** size at this height and as measured at a height of **12 inches** above the ground for trees larger than **4-inch** size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by [**a diameter tape**][**or**][**the average of the smallest and largest diameters**] at a height **54 inches** above the ground line[**for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground**].

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [**indicated on Drawings**][**defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated**][**defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches unless otherwise indicated**]<**Insert requirement**>.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] as directed by the Owner.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

a. Tree-service firm's personnel and equipment needed to make progress and avoid delays.
b. Arborist's responsibilities.

c. Quality-control program.
d. Coordination of Work and equipment movement with the locations of protection zones.
e. Trenching by hand or with air spade within protection zones.
f. Field quality control.
g. <**Insert agenda items**>.

1.4 ACTION SUBMITTALS

A. Product Data:

1. General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction

B. Shop Drawings:

1. Include plans, elevations, and sections showing trees and plants to be protected, locations of protection-zone fencing and signage, and the relationship between equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of utility boring and trenching by hand or with air spade within protection zones.
4. Include existing irrigation system that will be used to water plants.

C. Samples: For each type of the following:

1. Organic Mulch: [**1-pint**][**1-quart**] volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of [**manufacturer's standard size made from full-size components**], as directed by the Owner.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree-Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

F. Mitigation Requirements: As required by jurisdiction or as developed by arborist, for mitigation of damage to trees and other plantings.[**Include the following:**]

1. Local ordinances governing tree mitigation.
2. Standards established under the approved tree mitigation report developed by the arborist.
3. "Digital Guide for Plant Appraisal" by Council of Tree and Landscape Appraisers.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction in accordance with recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications: [**Certified Arborist as certified by ISA**][**Board Certified Master Arborist as certified by ISA**][**Certified Arborist-Municipal Specialist as certified by ISA**][**Licensed arborist in jurisdiction where Project is located**][**Current member of ASCA**][**Registered Consulting Arborist as designated by ASCA**].

B. Tree-Service Firm Qualifications: An experienced tree-service firm that has successfully completed temporary tree- and plant-protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection-zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.7 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

D. Take precautions to protect plants from airborne contaminants, such as paint or fireproofing overspray.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Soil: [**Stockpiled soil from location indicated on Drawings**][**Stockpiled soil mixed with planting soil**][**Planting soil**] of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Mixture: Well-blended mix of [**2 parts stockpiled soil to 1 part planting soil**].
2. Planting Soil: Planting soil <**Insert drawing designation**> as specified in [**Section 329113 "Soil Preparation"**][**Section 329115 "Soil Preparation (Performance Specification)."**]

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: [**Shredded hardwood**][**Ground or shredded bark**][**Wood and bark chips**].
2. Size Range: [**3 inches maximum, 1/2 inch minimum**].
3. Color: Natural.

C. Protection-Zone Fencing: Fencing fixed in position and meeting[**one of**] the following requirements:[**Previously used materials,** as directed by the Owner]

1. Chain-Link Protection-Zone Fencing: [**Galvanized-steel**][**Polymer-coated steel**][**Polymer-coated galvanized-steel**] fencing fabricated from minimum **2-inch** opening, **0.148-inch-** diameter wire chain-link fabric; with pipe posts, minimum **2-3/8-inch-** OD line posts, and **2-7/8-inch-** OD corner and pull posts[**; with 1-5/8-inch- OD top rails**][**; with 0.177-inch- diameter top tension wire**] and **0.177-inch-** diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

   a. Height: [**48 inches**][**72 inches**][**96 inches**].
   b. Polymer-Coating Color: [**Dark green**][**Olive green**][**Brown**][**Black**].

2. Plywood Protection-Zone Fencing: Plywood framed with four **2-by-4-inch** rails, with [**4-by-4-inch**] preservative-treated wood posts spaced not more than **96 inches** apart.

   a. Height: [**48 inches**][**72 inches**].
   b. Plywood and Lumber: Comply with requirements in Section 061000 "Rough Carpentry."

3. Wood Protection-Zone Fencing: Constructed of two **2-by-4-inch** horizontal rails, with [**4-by-4-inch**]<**Insert dimensions**> preservative-treated wood posts spaced not more than **96 inches** apart, and lower rail set halfway between top rail and ground.

   a. Height: [**48 inches**].
   b. Lumber: Comply with requirements in Section 061000 "Rough Carpentry."

4. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with **2-inch** maximum opening in pattern and weighing a minimum of **0.4 lb/ft.**; remaining flexible from **minus 60 to plus 200 deg F**; inert to most chemicals and acids; minimum tensile yield strength of **2000 psi** and ultimate tensile strength of **2680 psi**; secured with plastic bands or galvanized-steel or stainless steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than **96 inches** apart.

a. Height: [**48 inches**].
b. Color: High-visibility orange, nonfading.

5. Gates: [**Single-**][**Double-**] swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width [**24 inches**][**36 inches**][**As indicated**].

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: [**As indicated on Drawings**].
2. Lettering: [**3-inch-**] high minimum, [**white**][**black**] characters on [**white**][**red**] background.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain[**or to be relocated**]. [**Flag**][**Tie a 1-inch blue vinyl tape around**] each tree trunk at **54 inches** above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE PROTECTION

A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply [**2-inch**][**4-inch**] uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within [**6 inches**] of tree trunks.
2. Install temporary root-protection matting over mulch to the extent indicated.

B. Trunk Protection: Protect the trunk of each tree to remain as follows:

1. Install [**2-by-4-inch**][**2-by-6-inch**] wood planks around trunk at maximum **3 inches** apart. Minimum three planks per tree. Band together with no less than three steel bands stapled to the planks to hold them securely in place. [**Wrap orange plastic construction fencing to a minimum of three layers outside slats. Fasten wrap with wire.**]

a. Height: [**48 inches**][**96 inches**][**12 inches from lowest branch**].

2. Wrap trunk with [**orange plastic construction fencing to 2 inches in thickness**][**minimum 1/4-**

inch **closed-cell foam pads**]. Install [**2-by-4-inch**][**2-by-6-inch**] wood planks around trunk over wrap at maximum **3 inches** apart. Minimum three planks per tree. Band together with no less than three steel bands stapled to the planks to hold them securely in place.

a. Height: [**48 inches**][**96 inches**][**12 inches from lowest branch**].
b. Trunk protection to remain in place no longer than [**six months**][**12 months**]. If construction exceeds timeframe indicated, inspect trunk protection at [**six-month**][**12-month**] intervals and loosen if necessary.

3.4 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones[**before materials or equipment are brought on the site and construction operations begin**] in a manner that will prevent people[**and animals**] from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Owner.
3. Access Gates: Install[**where indicated**]; adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
4. Plastic Fencing: Stretch fabric taut and secure to posts without bows or sags.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner as directed by the Owner. Install one sign spaced approximately every [**20 ft.**][**35 ft.**][**50 ft.**] on protection-zone fencing, but no fewer than [**four**] signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

E. Maintain protection-zone fencing and signage in good condition as directed by the Owner and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones in accordance with requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring,

or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

3.6 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots [**as indicated on Drawings**][**.**][**and**][**as follows:**]

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible in accordance with requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots [**12 inches outside**][**12 inches inside**][**6 inches outside**][**6 inches inside**][**flush with the edge**] of the protection zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.7 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches [**as indicated on Drawings, under direction of arborist**][**as directed by arborist**].

1. Prune to remove only[**injured,**] broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
3. Pruning Standards: Prune trees in accordance with ANSI A300 (Part 1)[**and as indicated on Drawings**].

   a. Type of Pruning: [**Cleaning**][**raising**][**reducing**][**and**][**thinning**] where indicated.
   b. Specialty Pruning: [**Structural**][**restoration**][**vista**][**espalier**][**pollarding**][**palm**][**and**][**utility**] where indicated.

B. Unless otherwise directed by arborist and as directed by the Owner, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance pruning during Contract period as recommended by arborist.

F. Chip removed branches and [**spread over areas as directed by the Owner**][**stockpile in areas as directed by the Owner**][**dispose of off-site**].

3.8 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is [**2 inches**] or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.9 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.10 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner **as directed by the Owner**.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, **as directed by the Owner**.

B. Trees: Remove and replace trees indicated to remain that are more than [**25**][**66**] percent dead or in an unhealthy condition[**before the end of the corrections period**] or are damaged during construction operations that the Owner determines are incapable of restoring to normal growth pattern.

1. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures [**6 inches**][**4 inches**] or smaller in caliper size.
2. Large Trees: Provide [**one**][**two**] new tree(s) of [**6-inch**][**4-inch**] caliper size for each tree being replaced that measures more than [**6 inches**][**4 inches**] in caliper size.

   a. Species: as directed by the Owner.

3. Plant and maintain new trees as specified in Section 329300 "Plants."

C. Soil Aeration: as directed by the Owner, aerate surface soil compacted during construction. Aerate [**10 ft.**] beyond drip line and no closer than [**36 inches**] to tree trunk. Drill [**2-inch-**] diameter holes a minimum of **12 inches** deep at [**24 inches**] o.c. Backfill holes with an equal mix of augered soil and sand.

END OF SECTION 01 56 39 00

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Task	Specification	Specification Description
01 56 39 00	01 00 00 00	General Requirements
01 56 39 00	01 22 00 00	No Specification Required
01 57 00 00	01 00 00 00	General Requirements
01 57 13 00	01 00 00 00	General Requirements

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SECTION 01 57 23 00 - TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary stormwater pollution controls.

1.2 STORMWATER POLLUTION PREVENTION PLAN

A. The Stormwater Pollution Prevention Plan (SWPPP) is part of the Contract Documents and is bound into this Project Manual.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with Owner, Architect,[**Construction Manager,**] and earthwork subcontractor, as directed by the Owner.
2. Review requirements of the SWPPP, including permitting process, worker training, and inspection and maintenance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPP): Within [**15**] days of date established for commencement of the Work, submit completed SWPPP.

B. EPA authorization under the EPA's "2017 Construction General Permit (CGP)."

C. Stormwater Pollution Prevention (SWPP) Training Log: For each individual performing Work under the SWPPP.

D. Inspection reports.

1.5 QUALITY ASSURANCE

A. Stormwater Pollution Prevention Plan (SWPPP) Coordinator: Experienced individual or firm with a record of successful water pollution control management coordination of projects with similar requirements.

1. SWPPP Coordinator shall complete and finalize the SWPPP form.
2. SWPPP Coordinator shall be responsible for inspections and maintaining of all requirements of the SWPPP.

B. Installers: Trained as indicated in the SWPPP.

PART 2 - PRODUCTS

2.1 TEMPORARY STORMWATER POLLUTION CONTROLS

A. Provide temporary stormwater pollution controls as required by the SWPPP.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all best management practices, general requirements, performance requirements, reporting requirements, and all other requirements included in the SWPPP.

B. Locate stormwater pollution controls in accordance with the SWPPP.

C. Conduct construction as required to comply with the SWPPP and that minimize possible contamination or pollution or other undesirable effects.

1. Inspect, repair, and maintain SWPPP controls during construction.

a. Inspect all SWPPP controls not less than every seven days, and after each occurrence of a storm event, as outlined in the SWPPP.

D. Remove SWPPP controls at completion of construction and restore and stabilize areas disturbed during construction.

END OF SECTION 01 57 23 00

Task	Specification	Specification Description
01 57 23 00	01 00 00 00	General Requirements
01 58 00 00	01 00 00 00	General Requirements
01 58 13 00	01 00 00 00	General Requirements
01 58 13 00	01 22 00 00	No Specification Required

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SECTION 01 60 00 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
2. Section 012100 "Allowances" for products selected under an allowance.
3. Section 012300 "Alternates" for products selected under an alternate.
4. Section 012500 "Substitution Procedures" for requests for substitutions.
5. Section 014200 "References" for applicable industry standards for products specified.
6. Section 017700 "Closeout Procedures" for submitting warranties.

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluating Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.[**Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.**]

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products

qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Resolution of Compatibility Disputes between Multiple Contractors:

a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Architect will determine which products will be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product and manufacturer.
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.4 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

a. Submit additional documentation required by Architect[**through Construction Manager**] in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [**will**][**will not**] be considered[**unless otherwise indicated**].

a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.

   a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience [**will**][**will not**] be considered[**unless otherwise indicated**].

   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

   a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in

Division 01 sustainability requirements Section and individual Specification Sections.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within [**seven**]<**Insert number**> days of receipt of a request for a comparable product. Architect will notify Contractor[**through Construction Manager**] of approval or rejection of proposed comparable product within [**15**]<**Insert number**> days of receipt of request, or [**seven**]<**Insert number**> days of receipt of additional information or documentation, whichever is later.

1. Architect's Approval of Submittal: [**Marked with approval notation from Architect's action stamp**][**Marked with approval notation from Architect's and Construction Manager's action stamp**][**Indication of approval in web-based Project management software**]<**Insert method**>. See Section 013300 "Submittal Procedures."
2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00 00

Task	Specification	Specification Description
01 60 00 00	01 00 00 00	General Requirements
01 66 00 00	01 00 00 00	General Requirements
01 66 00 00	01 60 00 00	Product Requirements
01 66 19 00	01 00 00 00	General Requirements
01 66 19 00	01 22 00 00	No Specification Required
01 66 19 00	01 60 00 00	Product Requirements
01 70 00 00	01 00 00 00	General Requirements
01 71 00 00	01 00 00 00	General Requirements
01 71 13 00	01 00 00 00	General Requirements
01 71 13 00	01 22 00 00	No Specification Required
01 71 23 00	01 00 00 00	General Requirements
01 71 23 16	01 00 00 00	General Requirements
01 71 36 00	01 00 00 00	General Requirements
01 74 00 00	01 00 00 00	General Requirements
01 74 13 00	01 00 00 00	General Requirements
01 74 16 00	01 00 00 00	General Requirements
01 74 16 00	01 22 00 00	No Specification Required

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SECTION 01 74 19 00 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous [**demolition**][**and**][**construction**] waste.
2. Recycling nonhazardous [**demolition**][**and**][**construction**] waste.
3. Disposing of nonhazardous [**demolition**][**and**][**construction**] waste.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordination of responsibilities for waste management.
2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
3. Section 044313.13 "Anchored Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
4. Section 044313.16 "Adhered Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
5. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may

be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within [**7**][**30**] days of date established for [**commencement of the Work**][**the Notice to Proceed**][**the Notice of Award**].

1.5 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use [**Form CWM-7 for construction waste**][**and**][**Form CWM-8 for demolition waste**]. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in **tons**.
4. Quantity of waste salvaged, both estimated and actual in **tons**.
5. Quantity of waste recycled, both estimated and actual in **tons**.
6. Total quantity of waste recovered (salvaged plus recycled) in **tons**.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the project's LEED certification application. Document correspondence with USGBC as informational submittals.

H. Qualification Data: For [**waste management coordinator**][**and**][**refrigerant recovery technician**].

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

J. Refrigerant Recovery: Comply with requirements in [**Section 024116 "Structure Demolition"**][**Section 024119 "Selective Demolition"**] for refrigerant recovery submittals.

1.6 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent [**may**][**may not**] serve as Waste Management Coordinator.

1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
2. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by EPA-approved certification program.

C. Refrigerant Recovery Technician Qualifications: Comply with requirements in [**Section 024116 "Structure Demolition."**][**Section 024119 "Selective Demolition."**]

D. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

E. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis.[**Distinguish between demolition and construction waste.**] Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of [**demolition**][**site-clearing**][**and**][**construction**] waste generated by the Work. Use [**Form CWM-1 for construction waste**][**and**][**Form CWM-2 for demolition waste**]. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use [**Form CWM-3 for construction waste**][**and**][**Form CWM-4 for demolition waste**]. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in

compliance with [**Section 024116 "Structure Demolition."**][**Section 024119 "Selective Demolition."**]

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use [**Form CWM-5 for construction waste**][**and**][**Form CWM-6 for demolition waste**]. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in transportation and tipping fees by donating materials.
7. Savings in transportation and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of [**50**][**75**] percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials[**.**][**, including the following:**]

1. Demolition Waste:

   a. Asphalt paving.
   b. Concrete.
   c. Concrete reinforcing steel.
   d. Brick.
   e. Concrete masonry units.
   f. Wood studs.
   g. Wood joists.
   h. Plywood and oriented strand board.
   i. Wood paneling.
   j. Wood trim.
   k. Structural and miscellaneous steel.

l. Rough hardware.
m. Roofing.
n. Insulation.
o. Doors and frames.
p. Door hardware.
q. Windows.
r. Glazing.
s. Metal studs.
t. Gypsum board.
u. Acoustical tile and panels.
v. Carpet.
w. Carpet pad.
x. Demountable partitions.
y. Equipment.
z. Cabinets.
aa. Plumbing fixtures.
bb. Piping.
cc. Supports and hangers.
dd. Valves.
ee. Sprinklers.
ff. Mechanical equipment.
gg. Refrigerants.
hh. Electrical conduit.
ii. Copper wiring.
jj. Lighting fixtures.
kk. Lamps.
ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Masonry and CMU.
b. Lumber.
c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Wood pallets.
8) Plastic pails.

m. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

1) Paper.
2) Aluminum cans.
3) Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.[**Coordinator shall be present at Project site full time for duration of Project.**]

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within [**three**] days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

E. Waste Management in Historic Zones or Areas: Transportation equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by [**12 inches**] or more.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in [**Section 024116 "Structure Demolition"**][**Section 024119 "Selective Demolition"**][**Section 024296 "Historic Removal and Dismantling**] for salvaging demolition waste.

B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

C. Salvaged Items for [**Sale**][**and**][**Donation**]: [**Permitted**][**Not permitted**] on Project site.

D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area [**on-site**][**off-site**][**designated by Owner**].
5. Protect items from damage during transport and storage.

E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

G. Plumbing Fixtures: Separate by type and size.

H. Lighting Fixtures: Separate lamps by type and protect from breakage.

I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING [**DEMOLITION**][**AND**][**CONSTRUCTION**] WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall [**accrue to Owner**][**accrue to Contractor**][**be shared equally by Owner and Contractor**].

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

   a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and

shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum [**1-1/2-inch**][**4-inch**] size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum [**1-1/2-inch**][**4-inch**] size.
2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum [**3/4-inch**][**1-inch**][**1-1/2-inch**][**4-inch**] size.

a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as [**general fill**][**satisfactory soil for fill or subbase**].
b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

K. Carpet[**and Pad**]: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet[**and pad**] in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

N. Conduit: Reduce conduit to straight lengths and store by material and size.

O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and

areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner’s property.

C. Burning: Do not burn waste materials.

D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-5 for cost/revenue analysis of construction waste reduction work plan.

F. Form CWM-6 for cost/revenue analysis of demolition waste reduction work plan.

G. Form CWM-7 for construction waste reduction progress report.

H. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 01 74 19 00

Task	Specification	Specification Description
01 74 19 00	01 00 00 00	General Requirements
01 74 19 00	01 22 00 00	No Specification Required
01 74 23 00	01 00 00 00	General Requirements

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SECTION 01 00 00 00MOD000 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AGC: Automatic gain control.
6. AIC: Ampere interrupting capacity.
7. AL, Al, or ALUM: Aluminum.
8. ASD: Adjustable-speed drive.
9. ATP: Acceptance test procedure.
10. ATS: Automatic transfer switch.
11. A/V: Audio/visual.
12. AWG: American wire gauge; see ASTM B258.
13. BAS: Building automation system.
14. BDA: Bi-directional amplifier.
15. BIL: Basic impulse insulation level.
16. BIM: Building information modeling.
17. BMS: Building management system.
18. BNC: Bayonet Neill-Concelman - type of connector.
19. B/W: Black and white.
20. CAD: Computer-aided design or drafting.
21. CATV: Community antenna television.
22. CB: Circuit breaker.
23. CCD: Charge-coupled device.
24. CCTV: Closed-circuit television.
25. cd: Candela, the SI fundamental unit of luminous intensity.
26. CO/ALR: Copper-aluminum, revised.
27. COPS: Critical operations power system.
28. CU or Cu: Copper.
29. CU-AL or AL-CU: Copper-aluminum.

30. DACR: Digital alarm communicator receiver.
31. DACT: Digital alarm communicator transmitter.
32. DAS: Distributed antenna system.
33. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
34. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
35. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
36. dBm: Decibel absolute power with respect to 1 mW.
37. dBmV: Decibel absolute voltage with respect to 1 mV across identical impedance.
38. DC or dc: Direct current.
39. DCOA: Designated critical operations area.
40. DDC: Direct digital control (HVAC).
41. DGP: Data gathering panel.
42. DHCP: Dynamic host configuration protocol.
43. EGC: Equipment grounding conductor.
44. ELV: Extra-low voltage.
45. EMF: Electromotive force.
46. EMI: Electromagnetic interference.
47. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
48. EPS: Emergency power supply.
49. EPSS: Emergency power supply system.
50. ERCES: Emergency responder communications enhancement system.
51. ESS: Energy storage system.
52. EV: Electric vehicle.
53. EVPE: Electric vehicle power export equipment.
54. EVSE: Electric vehicle supply equipment.
55. FACU: Fire-alarm control unit.
56. FAS: Fire-alarm system.
57. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
58. FCC: Federal Communications Commission; fire command center.
59. FLC: Full-load current.
60. ft: Foot.
61. ft-cd: Foot-candle, the antiquated U.S. standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" when the SI unit candela (cd) replaced the international candle; see "fc."
62. FTP: File transfer protocol.
63. FXO: Foreign exchange office.
64. GEC: Grounding electrode conductor.
65. GFCI: Ground-fault circuit interrupter.
66. GFPE: Ground-fault protection of equipment.
67. GND: Ground.
68. GROL: General Radiotelephone Operator License (FCC).
69. H.323: Audio and video protocol.
70. HACR: Heating, air conditioning, and refrigeration.
71. HDPE: High-density polyethylene.
72. HID: High-intensity discharge.
73. HP or hp: Horsepower.
74. HVAC: Heating, ventilating, and air conditioning.
75. Hz: Hertz.
76. I&TFAS: Inspection and testing of fire-alarm system.

77. IB-PSC: In-building public safety communications.
78. IBT: Intersystem bonding termination.
79. ICT: Information and communications technology.
80. IDC: Initiating device circuit.
81. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
82. I/O: Input/output.
83. IP: Ingress protection rating (enclosures); Internet protocol (communications).
84. IR: Infrared.
85. IS: Intrinsically safe.
86. IT&R: Inspecting, testing, and repair.
87. ITE: Information technology equipment.
88. kAIC: Kiloampere interrupting capacity.
89. kcmil or MCM: One thousand circular mils.
90. kV: Kilovolt.
91. kVA: Kilovolt-ampere.
92. kvar: Kilovolt-ampere reactive.
93. kW: Kilowatt.
94. kWh: Kilowatt-hour.
95. LAN: Local area network.
96. lb: Pound (weight).
97. lbf: Pound (force).
98. LCD: Liquid-crystal display.
99. LCDI: Leakage-current detector-interrupter.
100. LED: Light-emitting diode.
101. Li-ion: Lithium-ion.
102. lm: Lumen, the SI-derived unit of luminous flux.
103. LNG: Liquefied natural gas.
104. LP-Gas: Liquefied petroleum gas.
105. LRC: Locked-rotor current.
106. LTE: Long-term evolution (mobile device technology standard).
107. LV: Low voltage.
108. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
109. m: Meter.
110. MATV: Master antenna television.
111. MCC: Motor-control center.
112. MDC: Modular data center.
113. MG set: Motor-generator set.
114. MIDI: Musical instrument digital interface.
115. MLO: Main lugs only.
116. MPEG: Moving Picture Experts Group.
117. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
118. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.
119. MOV: Metal-oxide varistor.
120. MV: Medium voltage.
121. MVA: Megavolt-ampere.
122. mW: Milliwatt.
123. MW: Megawatt.
124. MWh: Megawatt-hour.
125. NAC: Notification appliance circuit.
126. N.C.: Normally closed.
127. NFC: Near field communications.
128. Ni-Cd: Nickel-cadmium.

129. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.
130. Ni-MH: Nickel-metal hydride.
131. NIU: Network interface unit.
132. N.O.: Normally open.
133. NPT: National (American) standard pipe taper.
134. NTSC: National Television System Committee.
135. OCPD: Overcurrent protective device.
136. ONT: Optical network terminal.
137. PC: Personal computer.
138. PCS: Power conversion system.
139. PCU: Power-conditioning unit.
140. Percent obs/ft (percent obs/m): Percent obscuration per unit distance; unit of measure for sensitivity of smoke detectors.
141. PF or pf: Power factor.
142. PHEV: Plug-in hybrid electric vehicle.
143. PIR: Passive infrared.
144. PLC: Programmable logic controller.
145. PLFA: Power-limited fire alarm.
146. PoE: Power over Ethernet.
147. POTS: Plain old telephone service. See "public switched telephone network" definition.
148. PSTN: Public switched telephone network.
149. PTZ: Pan-tilt-zoom.
150. PV: Photovoltaic.
151. PVC: Polyvinyl chloride.
152. pW: Picowatt.
153. RAID: Redundant array of inexpensive disks; redundant array of independent disks.
154. RAM: Random-access memory.
155. RAT: Radio alarm transmitter.
156. REX: Request-to-exit.
157. RF: Radio frequency.
158. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
159. RMS or rms: Root-mean-square.
160. RPM or rpm: Revolutions per minute.
161. SCADA: Supervisory control and data acquisition.
162. SCCR: Short-circuit current rating.
163. SCR: Silicon-controlled rectifier.
164. SIP: Session initiation protocol.
165. SLC: Signaling-line circuit.
166. SPD: Surge protective device.
167. SPDT: Single pole, double throw.
168. sq.: Square.
169. SWD: Switching duty.
170. TCP/IP: Transmission Control Protocol/Internet Protocol.
171. TEFC: Totally enclosed fan-cooled.
172. TR: Tamper resistant.
173. TVSS: Transient voltage surge suppressor.
174. UHF: Ultra-high frequency.
175. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
176. UL CCN: UL Category Control Number.
177. UPS: Uninterruptible power supply.
178. USB: Universal serial bus.
179. UTC: Coordinated universal time.
180. UV: Ultraviolet.
181. V: Volt, unit of electromotive force.

182. V(ac): Volt, alternating current.
183. V(dc): Volt, direct current.
184. VA: Volt-ampere, unit of complex electrical power.
185. VAR: Volt-ampere reactive, unit of reactive electrical power.
186. VFC: Variable-frequency controller.
187. VOM: Volt-ohm-multimeter.
188. VoIP: Voice over Internet Protocol.
189. VPN: Virtual private network.
190. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
191. VU: Volume unit.
192. W: Watt, unit of real electrical power.
193. WAN: Wide area network.
194. Wh: Watt-hour, unit of electrical energy usage.
195. WPT: Wireless power transfer.
196. WPTE: Wireless power transfer equipment.
197. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
31. MC-HL: Metal-clad cable, hazardous location.
32. MI: Mineral-insulated, metal-sheathed cable.
33. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
34. MV: Medium-voltage cable.
35. NM: Nonmetallic sheathed cable.
36. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
37. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
38. NPLF: Non-power-limited fire-alarm circuit cable.
39. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
40. NPLFR: Non-power-limited fire-alarm circuit riser cable.
41. NUCC: Nonmetallic underground HDPE conduit with conductors.
42. OFC: Conductive optical fiber general-purpose cable.

43. OFCG: Conductive optical fiber general-purpose cable.
44. OFCP: Conductive optical fiber plenum cable.
45. OFCR: Conductive optical fiber riser cable.
46. OFN: Nonconductive optical fiber general-purpose cable.
47. OFNG: Nonconductive optical fiber general-purpose cable.
48. OFNP: Nonconductive optical fiber plenum cable.
49. OFNR: Nonconductive optical fiber riser cable.
50. P: Marine shipboard cable.
51. PLTC: Power-limited tray cable.
52. PLTC-ER: Power-limited tray cable, exposed run.
53. PV: Photovoltaic cable.
54. RHH: (high heat) Thermoset rubber, heat-resistant cable.
55. RHW: Thermoset rubber, moisture-resistant cable.
56. SA: Silicone rubber cable.
57. SE: Service-entrance cable.
58. SER: Service-entrance cable, round.
59. SEU: Service-entrance cable, flat.
60. SIS: Thermoset cable for switchboard and switchgear wiring.
61. TBS: Thermoplastic cable with outer braid.
62. TC: Tray cable.
63. TC-ER: Tray cable, exposed run.
64. TC-ER-HL: Tray cable, exposed run, hazardous location.
65. THW: Thermoplastic, heat- and moisture-resistant cable.
66. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
67. THHW: Thermoplastic, heat- and moisture-resistant cable.
68. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
69. TW: Thermoplastic, moisture-resistant cable.
70. UF: Underground feeder and branch-circuit cable.
71. USE: Underground service-entrance cable.
72. XHH: Cross-linked polyethylene, heat-resistant cable.
73. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
4. SEOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
8. SJEOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.

12. SJOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

F. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

G. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

H. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
3. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
6. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.
7. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
8. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
9. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
10. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
11. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
12. Conductive Cable: Cable containing non-current-carrying electrically conductive members such as metallic strength members and metallic vapor barriers.
13. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
14. Conduit: A structure containing one or more duct raceways.
15. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

    a. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).
    b. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
    c. Fire-alarm control unit (FACU).
    d. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

16. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in

accordance with Section 018123 "Facility Seismic and Wind Criteria."

17. Direct Buried: Installed underground without encasement in concrete or other protective material.
18. Downlink: The signal from a base station to portable radios.
19. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
20. Duct Raceway: A single enclosed raceway for conductors or cable.
21. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
22. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

    a. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
    b. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
    c. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).

23. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that is designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety of human life.
24. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
    f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
    g. Device Box: A box with provisions for mounting a wiring device directly to the box.
    h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
    i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
    j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the

entrance of scrub water at the floor level.

l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
p. Raised-Floor Box: A floor box intended for use in raised floors.
q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

25. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
26. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

27. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."
28. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
29. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.
30. Jack: Also commonly called an "outlet," it is the fixed, female connector.
31. Jacket: A continuous nonmetallic outer covering for conductors or cables.
32. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).
33. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
34. Master Control Unit: System component that accepts inputs from other control units and may also

perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

35. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
36. Monitoring: Acquisition, processing, communication, and display of system and equipment status data and event and alarm signals.
37. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
38. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
39. Nonsecure: Unlocked or open. (For doors and gates.)
40. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
41. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
42. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
43. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
44. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
45. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
46. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
47. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
48. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
49. Secure: Closed and locked and with no unlock or open commands pending. (For doors and gates.)
50. Sheath: A continuous metallic covering for conductors or cables.
51. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
52. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
53. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
54. Uplink: The signal from a portable radio to the base station.
55. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
56. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a

single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

57. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.
58. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

a. Exercising generators.
b. Emergency lighting.
c. Elevators.
d. Fire-alarm systems.

4. Arrange to provide temporary emergency and standby electrical [**service**][**or**][**power**] so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.

B. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

C. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of internet service.
2. Do not proceed with interruption of internet service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

D. Interruption of Existing Security System: Do not interrupt security system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of security system.
2. Do not proceed with interruption of security system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

E. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of fire-alarm system.
2. Do not proceed with interruption of fire-alarm system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

1.4 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities[**, including Measurement and Verification Plan**].

B. Communications Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for communications systems.
2. Value analysis proposals and requests for substitution of communications equipment.
3. Utility services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

C. Electronic Safety and Security Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for security, fire-alarm, and other life-safety systems.
2. Value analysis proposals and requests for substitution of electronic safety and security equipment.
3. Monitoring services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

1.5 SEQUENCING

A. Conduct and submit results of power system studies before submitting product data and Shop Drawings

for electrical equipment.

1.6 SCHEDULING

A. <**Insert requirements for unusual scheduling coordination**>.

1.7 ACTION SUBMITTALS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Ceiling Areas: Where indicated on drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment and suspension systems will be attached.
3. Size and location of access panels on ceilings.
4. Elevation, size, and route of sprinkler piping.
5. Elevation, size, and route of plumbing piping.
6. Elevation, size, and route of ductwork.
7. Elevation, size, and route of cable tray.
8. Elevation, size, and route of conduit.
9. Elevation and size of wall-mounted and ceiling-mounted equipment.
10. Access panels.
11. Sprinklers.
12. Air inlets and outlets.
13. Control modules.
14. Luminaires.
15. Communications devices.
16. Speakers.
17. Security devices.
18. Fire-alarm devices.
19. Indicate clear dimensions for maintenance access in front of equipment.
20. Indicate dimensions of fully open access doors.

C. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Elevation, size, and route of cable trays.
2. Relationships between components and adjacent structural, electrical, and mechanical elements.
3. Vertical and horizontal offsets and transitions.
4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
5. Elevation of ceilings and size of ceiling tiles.
6. Locations of access panels on ceilings.
7. Locations where cable tray crosses or parallels sprinkler piping.
8. Locations where cable tray crosses plumbing piping.
9. Locations where cable tray crosses or parallels ductwork.
10. Locations of access panels on ductwork.
11. Locations where cable tray crosses conduit.

12. Items blocking access around cable trays, including the following:

    a. Light fixtures.
    b. Speakers.
    c. Fire-alarm devices.
    d. Power outlets.
    e. Wall-mounted equipment.
    f. Equipment racks.
    g. Furniture.
    h. Door swings.
    i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than **10 ft (3 m)**.
14. Highlight locations where cable tray is greater than **3 ft (1 m)** above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

D. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

E. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
3. Clearances for access above and to the side of enclosed bus assemblies.
4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
5. Support locations, type of support, and weight on each support.
6. Location of adjacent construction elements, including luminaires, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

F. Coordination Drawings for Large Equipment Indoor Installations:

1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

    a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
    b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
    c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.

3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[**, busways,**][**and seismic bracing**].
b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

G. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
b. Indicate clear dimensions for fence gates and wall openings.
c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[**, busways,**][**and seismic bracing**].
f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

I. Sustainable Design Submittals:

1. Electrical Waste Management (Wire): Provide documentation for quantity of abandoned electrical wire that has been removed from Project site, in accordance with Rule 645.5(G) of NFPA 70, and provide verification that abandoned wire containing lead stabilizers has been identified and disposed of in accordance with jurisdictional hazardous waste requirements.
2. Electrical Waste Management (Lamps): Provide documentation that an area has been provided to serve entire Project for collection and storage of fluorescent and HID lamps and ballasts for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.
3. Electrical Waste Management (Electronics and Batteries): Provide documentation that an area has been provided to serve entire Project for collection and storage of electronics, alkaline batteries, and rechargeable batteries for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.

1.8 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.

5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of the communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for the Work specified in other divisions that depends on the Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

C. Installation Schedule for Security, Fire-Alarm, and Other Life-Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire-alarm, and the other life-safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 28.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 28.
6. Security and fire-alarm system outages.
7. Security and fire-alarm system inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the security and fire-alarm Work.
10. System startup, testing, and commissioning activities for security and fire-alarm equipment.
11. System startup, testing, and commissioning activities for fire-alarm interfaces with the Work specified in other divisions.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.

14. Requests for inspections by authorities having jurisdiction.

D. Welding certificates.

E. Seismic Performance Certificates: Provide special certification for designated seismic systems as required to meet requirements specified in Section 018123 "Facility Seismic and Wind Criteria" for all designated seismic systems identified on the Drawings or in the Specifications.

1. Include the following information:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
d. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
e. Equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
f. Equipment manufacturer's written certification that components with hazardous contents maintain containment following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
g. Evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

F. Wind Performance Certificates: Provide special certification for systems and components designated on the Drawings or in the Specifications to be subject to high wind exposure and impact damage.

1. Include the following information:

a. Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
b. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

G. Qualification Statements:

1. For qualified regional manufacturer.
2. For structural professional engineer.
3. For electrical professional engineer.
4. For lighting professional engineer.
5. For EPM specialist.
6. For welder.
7. For ERMC-S-PVC raceway Installer.
8. For medium-voltage cable Installer.
9. For medium-voltage duct Installer.
10. For medium-voltage equipment Installer.
11. For electrical power monitoring Installer.
12. For switchboard Installer.
13. For EVSE Installer.
14. For generator set Installer.
15. For lightning protection system Installer.

16. For theatrical lighting Installer.
17. For exterior athletic lighting Installer.
18. For power quality specialist.
19. For electrical testing and inspecting agency and its on-site electrical testing supervisor.
20. For structural testing and inspecting agency.
21. For outdoor pole testing and inspecting agency.
22. For luminaire photometric testing laboratory.
23. For lighting testing and inspecting agency.
24. For communications design professional.
25. For communications cable Installer.
26. For communications testing and inspecting agency and its on-site communications testing supervisor.
27. For nurse call/code blue system Installer.
28. For security design professional.
29. For fire-alarm system design professional.
30. For mass notification design professional.
31. For IB-PSC design professional.
32. For general radiotelephone operator license (GROL) designer.
33. For emergency communications design professional.
34. For fire-alarm cable Installer and its on-site fire-alarm cable installation supervisor.
35. For security testing and inspecting agency and its on-site security testing supervisor.
36. For intrusion detection systems installer.
37. For perimeter security systems integrator.
38. For fire-alarm testing agency and its on-site fire-alarm testing supervisor.
39. For detention electronics systems Installer.
40. For detention electronics systems integrator.
41. For detention electronics systems testing and inspecting agency.

1.9 CLOSEOUT SUBMITTALS

A. Facility EMP Binders:

1. Complete Set: On [**approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, **28 lb (105 GSM)**, acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:

   a. <**Insert system, equipment, or device**>.

2. Include the following information:

   a. Manufacturer's operating specifications.
   b. User's guides for software and hardware.
   c. Schedule of maintenance material items recommended to be stored at the Project site.
   d. Detailed instructions covering operation under both normal and abnormal conditions.
   e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
   f. List of load-current and overload-relay heaters with related motor nameplate data.
   g. List of lamp types and photoelectric relays used on the Project, with ANSI and

manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
k. Exterior pole inspection and repair procedures.

C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation[**in Facility EPM Binders**], including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

D. Software:

1. Program Software Backup: Provide [**username and password for approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Provide to Owner upgrades and unrestricted licenses[**for Government use**] for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.10 MOCKUPS

A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:

1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of <**Insert identification of room and fabrication**> by [**Architect**][**Owner**][**Tenant**]<**Insert approving stakeholders**> prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination, including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.

B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the

Project performance requirements while significantly increasing value for Owner throughout life of facility.

2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

2.2 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

A. Substitution requests for communications equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.3 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.4 FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP) BINDERS

A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EMP development.

B. Applicable Standards:

1. Regulatory Requirements: Comply with requirements in NFPA 70B.
2. General Characteristics:

a. Volume 1 - Introduction:

1) Summarize how Facility EMP analysis was performed, how data were collected, and how volumes are organized.
2) Describe Facility EMP and provide recommended policies and procedures for implementing the program and keeping it current.
3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EMP.

b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:

1) Include training requirements for employees and contractors.
2) Include list of known facility hazards impacting IT&R activities.
3) Include approval and permitting procedures for IT&R activities.
4) Include incident emergency response procedures.
5) Include emergency shutdown procedures.
6) Include electrical disaster recovery procedures.
7) Include procedures for investigating the following incidents:

a) Electrical safety incidents.
b) Equipment malfunctions.
c) Unintended operations or alarms.
d) Operation of protective devices.

c. Volume 3 - Operating Procedures for Electrical Equipment and Controls:

1) <**Insert requirements**>.

d. Volume 4 - Facility Diagrams and Schedules:

1) Include single-line diagrams.
2) Include grounding and bonding diagrams.
3) Include essential wiring diagrams.
4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
5) Include records of switchgear, switchboard, and panelboard schedules.
6) Include time-current curves for overcurrent protective devices.
7) Include list of load-current and overload-relay heaters with related motor nameplate data.

e. Volume 5 - Inventory of Facility Equipment Using Electrical Power:

1) Include simplified floor plans showing equipment locations.
2) Identify critical equipment (electrical or otherwise).
3) Include identifying designations and nameplate data.
4) Include warranty and maintenance contract information.

f. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:

1) Include schedules of maintenance material items recommended to be stored at facility.
2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
3) Include calibration and servicing data for each item.

g. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:

1) Include tables showing frequency of activities for each item.
2) Include annual schedule with activities mapped to specific days of the year.
3) Include exterior pole inspection and repair procedures.

h. Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:

1) <**Insert requirements**>.

i. Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:

1) **<Insert requirements>**.

j. Volume 10 - Spare Parts List:

1) Include list of all parts required to perform IT&R procedures.
2) Identify quantities of which parts are recommended to be stored on-site.
3) Include source contact information and budget cost for each item.

k. Volume 11 - Construction Project Closeout Record Documentation:

1) Include records of power system studies and photometric studies.
2) Include records of risk assessment studies.
3) Include records of electrical system startup and commissioning activities.
4) Include records of baseline inspections and tests.
5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
6) Include records of baseline settings for adjustable equipment and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. **<Insert Project requirements>**.

B. Preinstallation Testing:

1. **<Insert Project requirements>**.

C. Evaluation and Assessment:

1. **<Insert Project requirements>**.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. **<Insert Project requirements>**.

3.3 DEVELOPMENT OF FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP)

A. Facility EMP must be developed by qualified EMP specialist.

B. Conduct Facility EMP analysis in accordance with NFPA 70B requirements.

1. Renovation Projects:

a. Facility diagrams must include connected existing equipment for entire facility where

known. Areas of uncertainty should be clearly indicated.

b. Obtain copies of existing operation and maintenance data and existing Facility EMP information from Owner.

c. Facility EMP analysis should identify existing equipment that does not have available operation and maintenance data, and should explain Owner's risks because this equipment is not included in Facility EMP.

d. Data for existing equipment outside scope of the Project may be inserted in Facility EMP Binders without analysis.

e. Data for existing equipment impacted by scope of the Project should be analyzed and documented similar to the Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EMP analysis and submit [**updated**] Facility EMP Binders.

3.4 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

3.5 CLEANING

A. Electrical or Electronic Waste Management:

1. <**Insert requirements for special handling or diversion of electrical and electronics waste for recycling or disposal**>.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to implement [**updated**] Facility EMP.

b. <**Insert system or equipment**>.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

END OF SECTION 01 00 00 00MOD000

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Task	Specification	Specification Description
01 00 00 00MOD000	01 00 00 00	General Requirements

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Task	Specification	Specification Description
02 32 00 00	01 22 00 00	No Specification Required
02 32 13 00	01 22 00 00	No Specification Required
02 32 19 00	01 22 00 00	No Specification Required
02 41 13 13	02 41 19 00	Selective Demolition

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SECTION 02 41 16 00 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of buildings or structures.
2. Demolition and removal of site improvements.
3. Abandoning in-place below-grade construction.
4. Removing below-grade construction.
5. Disconnecting, capping or sealing, and abandoning in-place site utilities.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Salvaging items for reuse by Owner.

B. Related Requirements:

1. Section 011000 "Summary" for use of the premises and phasing requirements.
2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements that are not part of building demolition.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated. Include fasteners or brackets needed for reattachment elsewhere.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 COORDINATION

A. Arrange demolition schedule so as not to interfere with [**Owner's on-site operations**][**or**][**operations of adjacent occupied buildings**].

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at [**Project site**].

1. Inspect and discuss condition of construction to be demolished.
2. Review structural load limitations of existing structures.
3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review and finalize protection requirements.
5. Review procedures for [**noise control**][**and**][**dust control**].
6. Review procedures for protection of adjacent buildings.
7. Review storage, protection, and accounting for items to be salvaged and returned to Owner.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**refrigerant recovery technician**][**specialty demolition contractor**].

B. Engineering Survey: Submit engineering survey of condition of building.

C. Survey of Existing Conditions: Submit survey.

D. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property[**, for environmental protection**][**, for dust control**][**and**][**, for noise control**]. Indicate proposed locations and construction of barriers.

1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain[**including means of egress from those buildings**].

E. Schedule of Building Demolition Activities: Indicate the following:

1. Detailed sequence of demolition work, with starting and ending dates for each activity.
2. Temporary interruption of utility services. Indicate how long services will be interrupted.
3. Coordination for shutoff and capping[**or re-routing**] of utility services.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by an EPA-approved certification program.

B. Specialty Demolition Contractor Qualifications: A competent person [**licensed by the authority having jurisdiction,**]who has training, knowledge, or experience in the use of each type of blasting method used and in the field of transporting, storing, handling, and using explosives; and has a working

knowledge of state and local laws and regulations pertaining to explosives.

1.9 FIELD CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than [**72**] hours' notice of activities that will affect operations of adjacent occupied buildings.
2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.

a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Conditions existing at time of inspection for bidding purpose will be maintained the Owner as far as practical.

D. Hazardous Materials:

1. It is not expected that hazardous materials will be encountered in the Work.

a. Hazardous materials will be removed by Owner before start of the Work.
b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. Hazardous materials will be removed by Owner under a separate contract.

2. Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is [**on file**][**included in Section 003126 "Existing Hazardous Material Information"**] for review and use. Examine report to become aware of locations where hazardous materials are present.

a. The Owner will provide material safety data sheets for hazardous materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.

E. On-site sale of removed items or materials is not permitted.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

2.2 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. [**Perform**][**Engage a professional engineer to perform**] an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video[**, measured drawings**][**and**][**templates**]. Comply with Section 013233 "Photographic Documentation."

1. Inventory and record the condition of items to be removed and salvaged. Photograph or video conditions that might be misconstrued as damage caused by removal.
2. Photograph or video existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations or removal of items for salvage.

3.2 PREPARATION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Existing Utilities to Remain: Maintain utility services to remain and protect against damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.

a. Provide at least [**72**] hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

E. Existing Utilities to Be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.

1. Owner will arrange to shut off utilities when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If disconnection of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of [**24 inches**] below grade at or outside the building or structure to be demolished and cap, valve, or plug and seal remaining portion of pipe or conduit [**after bypassing**]in accordance with requirements of authorities having jurisdiction.
5. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing by authorities having jurisdiction.

F. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 SALVAGE

A. Items to be removed and salvaged are indicated[**on Drawings.**][**below:**]

1. Doors and door hardware.
2. Windows.
3. Cabinets.
4. Mirrors.
5. Tackboards.
6. White boards.
7. Plumbing fixtures.

B. Comply with the following for salvaged items:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area [**designated by Owner**][**indicated on Drawings**].
5. Protect items from damage during transport and storage.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated buildings[**and site improvements**] completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain adequate ventilation when using cutting torches.
3. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY EXPLOSIVES

A. Explosives: Perform explosive demolition operations in accordance with ANSI/ASSP A10.7 and regulations of authorities having jurisdiction.

1. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
2. Do not damage adjacent structures, property, or site improvements when using explosives.

B. Comply with recommendation in specialty explosives consultant's report.

3.6 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Below-Grade Construction:

1. Abandon foundation systems and other below-grade construction. Cut below-grade construction flush with grade.
2. Demolish foundation systems and other below-grade construction that are within footprint of new construction and extending [**5 ft.**] outside footprint indicated for new construction. Abandon below-grade construction outside this area.

   a. Remove below-grade construction, including basements, foundation systems, and footings, [**completely**][**to at least 6 inches below grade**][**to at least 12 inches below grade**][**to depths indicated**].

3. Demolish foundation systems and other below-grade construction.

   a. Remove below-grade construction, including basements, foundation systems, and footings, [**completely**][**to at least 6 inches below grade**][**to at least 12 inches below grade**][**to depths indicated**].

D. Existing Utilities:

1. Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
2. Demolish existing utilities and below-grade utility structures that are within [**5 ft.**] outside footprint indicated for new construction. Abandon utilities outside this area.

   a. Fill abandoned utility structures with [**satisfactory soil materials**][**recycled pulverized concrete**] in accordance with backfill requirements in Section 312000 "Earth Moving."

3. Demolish and remove existing utilities and below-grade utility structures.

E. Hydraulic Elevator Systems: Demolish and remove elevator system, including cylinder, plunger, well assembly, steel well casing and liner, oil supply lines, and tanks.

3.7 SITE RESTORATION

A. Below-Grade Areas:

1. Rough grade below-grade areas ready for further excavation or new construction.
2. Completely fill below-grade areas and voids resulting from building demolition operations with [**satisfactory soil materials**][**recycled pulverized concrete**][**recycled pulverized masonry**] in accordance with backfill requirements in Section 312000 "Earth Moving."

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.8 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [**and dispose of them in an EPA-approved**

construction and demolition waste landfill acceptable to authorities having jurisdiction.][**and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."**]

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.10 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 00

SECTION 02 41 16 13 - BUILDING DEMOLITION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for building demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Demolition and removal of buildings and site improvements.
b. Abandoning in place **OR** Removing, **as directed**, below-grade construction.
c. Disconnecting, capping or sealing, and abandoning in-place **OR** removing, **as directed**, site utilities.
d. Salvaging items for reuse by the Owner.

C. Definitions
1. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
2. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

D. Materials Ownership
1. Unless otherwise indicated, demolition waste becomes property of Contractor.
2. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to the Owner that may be uncovered during demolition remain the property of the Owner.
a. Carefully salvage in a manner to prevent damage and promptly return to the Owner.

E. Informational Submittals
1. Qualification Data: For refrigerant recovery technician.
2. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control, **as directed**. Indicate proposed locations and construction of barriers.
a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
3. Schedule of Building Demolition Activities: Indicate the following:
a. Detailed sequence of demolition work, with starting and ending dates for each activity.
b. Temporary interruption of utility services.
c. Shutoff and capping or re-routing of utility services.
4. Inventory: Submit a list of items to be removed and salvaged and deliver to the Owner prior to start of demolition.
5. Predemolition Photographs **OR** Video, **as directed**: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
7. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Quality Assurance
1. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.
   a. Inspect and discuss condition of construction to be demolished.
   b. Review structural load limitations of existing structures.
   c. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review and finalize protection requirements.
   e. Review procedures for noise control and dust control.
   f. Review procedures for protection of adjacent buildings.
   g. Review items to be salvaged and returned to the Owner.

G. Project Conditions
1. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
2. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   a. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   b. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      1) Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
3. the Owner assumes no responsibility for buildings and structures to be demolished.
   a. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.
   b. Before building demolition, the Owner will remove certain items, as directed by the Owner.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and the Owner. Hazardous materials will be removed by the Owner under a separate contract.

   OR

   Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
   c. the Owner will provide safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
5. On-site storage or sale of removed items or materials is not permitted.

H. Coordination
1. Arrange demolition schedule so as not to interfere with the Owner's on-site operations **OR** operations of adjacent occupied buildings, **as directed**.

1.2 PRODUCTS

A. Soil Materials
1. Satisfactory Soils: Satisfactory Soils: For soils which is to be used for backfilling voids that result from demolition operations in below-grade areas, comply with requirements in Division 31 Section “Earth Moving".

1.3 EXECUTION

A. Examination
1. Verify that utilities have been disconnected and capped before starting demolition operations.
2. Review Project Record Documents of existing construction provided by the Owner. the Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
3. Inventory and record the condition of items to be removed and salvaged. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by salvage operations.
4. Perform **OR** Engage a professional engineer to perform, **as directed**, an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
   a. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
5. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

B. Preparation
1. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
2. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
   a. the Owner will arrange to shut off indicated utilities when requested by Contractor.
      OR
      Arrange to shut off indicated utilities with utility companies, **as directed**.
   b. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
   c. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

   OR
   Existing Utilities: Refer to Division 22 & Division 26 for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing, **as directed**.
3. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of demolition.
4. Salvaged Items: Comply with the following:
   a. Clean salvaged items of dirt and demolition debris.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to the Owner.
   d. Transport items to storage area designated by the Owner **OR** indicated on Drawings, **as directed**.
   e. Protect items from damage during transport and storage.

C. Protection
1. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
2. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
   a. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by the Owner and authorities having jurisdiction.
   b. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner and authorities having jurisdiction.
      1) Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
3. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 1 Section “Temporary Facilities And Controls".
   a. Protect adjacent buildings and facilities from damage due to demolition activities.
   b. Protect existing site improvements, appurtenances, and landscaping to remain.
   c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   d. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   e. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
   f. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
   g. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
4. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

D. Demolition, General
1. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
   b. Maintain fire watch during and for a specified time after flame cutting operations as directed by the Owner.
   c. Maintain adequate ventilation when using cutting torches.
   d. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
2. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
3. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   a. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   b. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
4. Explosives: Use of explosives is not permitted, **unless directed otherwise**.

E. Demolition By Mechanical Means
1. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   a. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
3. Salvage: Items to be salvaged are indicated on Drawings **OR** below, **as directed**:
   a. Doors and door hardware.
   b. Windows.
   c. Cabinets.
   d. Mirrors.
   e. Chalkboards.
   f. Tackboards.
   g. Marker boards.
   h. Plumbing fixtures.
   i. Other items as directed.
4. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.
   OR
   Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet (1.5 m) outside footprint indicated for new construction. Abandon below-grade construction outside this area.
   a. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
   OR
   Below-Grade Construction: Demolish foundation walls and other below-grade construction.
   b. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
5. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
   OR
   Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
   a. Fill abandoned utility structures with satisfactory soil materials **OR** recycled pulverized concrete, **as directed**, according to backfill requirements in Division 31 Section “Earth Moving".
   b. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   c. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.
   OR
   Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
   a. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   b. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

F. Demolition By Explosives – ONLY IF APPROVED BY THE OWNER
1. Explosives: Perform explosive demolition according to governing regulations.
   a. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
   b. Do not damage adjacent structures, property, or site improvements when using explosives.
2. Comply with recommendation in Explosives Consultant's report.

G. Site Restoration
   1. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
      OR
      Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials **OR** recycled pulverized concrete **OR** recycled pulverized masonry, **as directed**, according to backfill requirements in Division 31 Section “Earth Moving".
   2. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

H. Repairs
   1. Promptly repair damage to adjacent buildings caused by demolition operations.

I. Disposal Of Demolished Materials
   1. Remove demolition waste materials from Project site and legally dispose of them in EPA approved landfill acceptable to authorities having jurisdiction. See Division 1 Section “Construction Waste Management And Disposal" for recycling and disposal of demolition waste.
      a. Do not allow demolished materials to accumulate on-site.
      b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   2. Do not burn demolished materials.

J. Cleaning
   1. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
      a. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 13

Task	Specification	Specification Description
02 41 16 13	02 41 16 00	Structure Demolition
02 41 16 13	02 41 19 00	Selective Demolition

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SECTION 02 41 19 00 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of selected portions of exterior or interior of building or structure and site elements.
2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.
6. Section 330500 "Common Work Results for Utilities" for removal of site utility systems piping, equipment, and components.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at [**Project site**].

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review and finalize protection requirements.
7. Review procedures for [**noise control**][**and**][**dust control**].
8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Survey of Existing Conditions: Submit survey.

D. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property[**, for environmental protection**][**, for dust control**][**and**][**, for noise control**]. Indicate proposed locations and construction of barriers.

E. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Temporary interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: [**Type I**][**Type II**][**Type III**][**Universal**] certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will [**not**]occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by the Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials:

1. It is not expected that hazardous materials will be encountered in the Work.

a. Hazardous materials will be removed by Owner before start of the Work.
b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

2. Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is [**on file**][**included in Section 003126 "Existing Hazardous Material Information"**] for review and use. Examine report to become aware of locations where hazardous materials are present.

a. The Owner will provide material safety data sheets for hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

E. Historic Areas: Demolition and hauling equipment and other materials to be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by [**12 inches**] or more.

F. On-site sale of removed items or materials is not permitted.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

C. Sustainable Design Requirements for Building Reuse:

1. Maintain the existing building structure, envelope, and interior nonstructural elements of an abandoned or blighted building. Do not demolish such existing construction beyond indicated limits.
2. Maintain the existing building structural systems where indicated to remain. Do not demolish such existing construction beyond indicated limits.
3. Maintain the existing interior ceilings, interior partitions, and/or demountable walls where indicated to remain. Do not demolish such existing construction beyond indicated limits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. [**Perform**][**Engage a professional engineer to perform**] an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video[**, measured drawings**][**and**][**templates**]. Comply with Section 013233 "Photographic Documentation."

1. Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or video conditions that might be misconstrued as damage caused by removal.

2. Photograph or video existing conditions of adjoining construction including finish surfaces, that might be misconstrued as damage caused by selective demolition operations or removal of items for salvage or reinstallation.

3.2 PREPARATION

A. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location[**and cleaned**] and reinstalled in their original locations after selective demolition operations are complete.

D. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND BUILDING SYSTEMS

A. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
4. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug

remaining piping with same or compatible piping material.
b. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment and components.

5. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.

a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

6. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:

a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.
b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.

3.4 SALVAGE/REINSTALL

A. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area [**on-site**][**off-site**][**designated by Owner**][**indicated on Drawings**].
5. Protect items from damage during transport and storage.

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" to mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
2. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive in accordance with recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."[**Do not use methods requiring solvent-based adhesive strippers.**]

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so

that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [**and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.**][**and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."**]

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19 00

SECTION 02 41 19 13 - CUTTING AND PATCHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cutting and patching. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes procedural requirements for cutting and patching.

C. Definitions
1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

D. Submittals
1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform the Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

E. Quality Assurance
1. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.

2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal**.
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Fire-suppression systems.
   d. Mechanical systems piping and ducts.
   e. Control systems.
   f. Communication systems.
   g. Conveying systems.
   h. Electrical wiring systems.
   i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty
   1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS

A. Materials
   1. General: Comply with requirements specified in other Sections.
   2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
      a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

1.3 EXECUTION

A. Preparation
1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

B. Performance
1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   d. Excavating and Backfilling: Comply with requirements in applicable Division 31 where required by cutting and patching operations.
   e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
      2) Restore damaged pipe covering to its original condition.
   c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 02 41 19 13

Task	Specification	Specification Description
02 41 19 13	02 41 19 00	Selective Demolition
02 41 19 16	02 41 19 00	Selective Demolition
02 42 21 35	02 41 19 00	Selective Demolition
02 42 21 47	02 41 19 00	Selective Demolition
02 43 13 00	01 22 00 00	No Specification Required
02 43 13 13	01 22 00 00	No Specification Required

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SECTION 02 61 00 00 - REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for disposal of hazardous materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition
1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

C. Submittals
1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
   a. Copy of State or local license for hazardous waste hauler.
   b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
   c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
   d. List of the employees scheduled to perform this work.
   e. Schedule of start and finish times and dates for this work.
   f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
   g. Safety Data Sheet (SDS) for all materials to be removed.
   h. If contractor introduces any chemical into the work environment, a SDS for that chemical must be presented to the Owner's Representative prior to use.
   i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
   j. Contingency Plan for handling emergencies with spills or leaks.
   k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

1.2 PRODUCTS

A. Materials
1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

1.3 EXECUTION

A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.

B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 61 00 00

Task	Specification	Specification Description
02 61 13 00	02 41 19 00	Selective Demolition
02 61 13 00	02 61 00 00	Removal and Disposal of Contaminated Soils
02 61 26 00	02 61 00 00	Removal and Disposal of Contaminated Soils
02 61 26 00	02 82 33 00	Removal Of Friable Asbestos-Containing Materials
02 65 00 00	02 41 19 00	Selective Demolition

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SECTION 02 82 16 00 - ENGINEERING CONTROL OF ASBESTOS CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for encapsulation (lock-down) of asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
3. Performance Warrantee: Manufacturers performance guarantee.
4. Safety Data Sheet: Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Thinning instructions
5. Application instructions
6. Deliver materials together with a copy of the OSHA Material
7. Safety Data Sheet for the material.

D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

E. Quality Assurance
1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 “Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

F. Warranty
1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL

Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.

a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.

b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.

c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.

d. Coating materials shall have low VOC (Volatile Organic Compound) content.

e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.

f. Coating materials shall have passed the following testing standards:

1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).

2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.

3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).

4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).

5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).

6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.

7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.

8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.

9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.

10) Encasement Systems shall provide additional water-proofing protection.

B. Related Materials:

1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.

C. Applicable Standards

1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

1.3 EXECUTION

A. General

1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.

2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or

separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.

3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.

B. Worker Protection

1. Before beginning work with any material for which a Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

C. Application

1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer’s instructions.
4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer’s written recommendations.
5. At completion of work submit manufacturer’s record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00

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SECTION 02 82 33 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of friable asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Description
1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

C. Scope
1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard
1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
   a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
   b. Workers may not be aware they are inhaling asbestos fibers.
   c. Symptoms of the disease do not appear for many years.
   d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
   e. No insurance is available to provide for asbestos-related disease.

E. Other Hazardous Material
1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications
1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
   a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names

and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.

c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping

1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.
3. Include the following information:
   a. Name and address of the Owner or operator.
   b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
   c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 260 linear feet on pipes and less than 160 square feet on other facility components, explain techniques of estimation.
   d. Location of the facility being demolished or renovated.
   e. Scheduled starting and completion dates of demolition or renovation.
   f. Nature of planned demolition or renovation and method(s) to be used.
   g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
   h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:
   a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.
   b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.
   c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.
   d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
   e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a

minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.

f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.

g. Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.

h. Encapsulation data and encapsulation procedures.

i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.

j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.

6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:

a. Meetings, purpose, attendees, discussions, items of resolution.

b. Visitations, authorized and unauthorized.

c. Sign-in sheets of all personnel entering and leaving the work area.

d. Special or unusual events (i.e., barrier breeching equipment failures).

e. Personal air monitoring results.

f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.

2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.

3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.

4. Amended water - Water to which a surfactant has been added.

5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.

6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).

7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.

8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.

9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.

11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.

12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.

13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.
14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Heath.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations
1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor

is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
   a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      1) U.S. Department of Labor, OSHA, including, but not limited to:
         a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules
            Title 29, Part 1910, Section 1001
            Part 1926, Section 1101 of the Code of Federal Regulations
         b) Respiratory Protection
            Title 29, Part 1910, Section 134 of the Code of Federal Regulations
         c) Construction Industry
            Title 29, Part 1926.1011, of the Code of Federal Regulation
         d) Access to Employee Exposure and Medical Records
            Title 29, Part 1910, Section 2 of the Code of Federal Regulations
         e) Hazard Communication
            Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
         f) Specifications for Accident Prevention Signs and Tags
            Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
         a) Asbestos Abatement Projects Rule
            40 CFR Part 762
            CPTS 62044, FRL 2843-9
            Federal Register, Vol. 50 No. 134, July 12,1985
            P28530-28540
         b) Regulation for Asbestos
            Title 40, Part 61, Subpart A of the Code of Federal Regulations
         c) National Emission Standard for Asbestos
            Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
         a) American National Standards Institute (ANSI)
            1430 Broadway
            New York, NY 10018
            (212) 354-3300
         b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
         c) Practices for Respiratory Protection Publication Z288.2-80
         d) American Society for Testing and Materials (ASTM)
            1916 Race Street
            Philadelphia, PA 19103
            (215) 299-5400
         e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
         f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative
   1. the Owner's Representative is authorized by the Owner to perform the following:
      a. Have free access to all asbestos work areas.
      b. To assist in interpretation of procedures.
      c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
      d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
      e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
      f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
      g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
      h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference
   1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
   2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
   3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
      a. Completion of project closeout requirements.
      b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
      c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
      d. Transmittal of required project construction records to the Owner.
      e. Landfill receipts for all asbestos-containing material.
      f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
      g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
      h. Consent of surety for final payment.

M. Project Closeout
   1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
   2. Include supporting documentation for completion as indicated in these contract documents.
   3. Submit a statement on accounting of changes to the Contract Sum.
   4. Advise the Owner of pending insurance change-over requirements.

5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.
6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting the Owner's Representative inspection for certification of Final Completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.

g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

i. Protective clothing shall not be worn in lieu of street clothing outside the work area.

j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.

3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.

4. Worker and Authorized Visitor Protection Procedures:

a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.

b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.

c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.

d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.

e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.

f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system.
Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.

2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.

3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	**Number of Samples**	**Analysis Method**	**Detection Limit f/cc**	**Minimum Volume Liters**	**Rate LPM**
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM

Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures
1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities
1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials
1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.

4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.
6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
   a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
   b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment
1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
   a. Use non-conductive tools and vacuum attachments.
   b. Utilize "hot line" covers over energized cables and power lines when possible.

c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
d. Avoid stringing wiring across floors. Elevate wiring if possible.
e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
f. Determine operating voltages of equipment and lines before working on or near energized parts.
g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
h. Lock or secure de-energized circuits at panel and post warning signs.
i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities

1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.

14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System

1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
   a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
   b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
   a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
   b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
   c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
   d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
   e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
   f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
   g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.

h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).

i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.

j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).

3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove bag operations and mini-containments**.** Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.

e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.

14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.
17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.

11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block
IN PROGRESS	1" Sans Serif Gothic or Block
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.

c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
d. Install appropriate signs on outside of mini-containment area.
e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

E. Worker Protection
1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”
3. Train in accordance with EPA’s Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
   a. Methods of recognizing asbestos.
   b. Health effects associated with asbestos.
   c. Relationship between smoking and asbestos in producing lung cancer.
   d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

   Engineering controls
   Work practices
   Respirators
   Housekeeping procedures
   Hygiene facilities
   Protective clothing
   Decontamination procedures
   Emergency procedures
   Waste disposal procedures
   Appropriate work practices for the work
   Requirements of medical surveillance program
   Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
   Pressure differential systems
   Work practices including hands on or on job training
   Personal decontamination procedures
   Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual’s ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner’s Representative.

a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
b. Courses outline or name of institution providing the worker training course.
c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.

7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.
10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove <u>all</u> street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
   a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
   b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
   c. NIOSH - National Institute for Occupational Safety and Health.

d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator	over 1000

Pressure demand
Full facepiece

I. Air Purifying Respirator
   1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
   2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
   3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.

J. Powered Air Purifying Respirator (PAPR)
   1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
   2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
   3. Provide non-cloth belts capable of being decontaminated in shower.
   4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
   1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
      a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
   1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
   2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
   3. Changing (Clean) Room:
      a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
      b. Locate so that access to work area from changing room is through shower room.

c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.

4. Shower Room:
   a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
   b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
   c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
   d. Provide splash proof entrances to Drying Room and Airlock.
5. Equipment Room (contaminated area):
   a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
   b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.
6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
7. Load-out Area:
   a. The load-out area is the transfer area from the building to a truck or dumpster.
   b. Wet wipe bags before they are passed through the equipment decon-chamber.
   c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
   d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
   e. Require these workers to wear full protective clothing and appropriate respiratory protection.
   f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
   g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

<u>LEGEND</u>
DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

   h. Provide spacing between respective lines at least equal to the height of the respective upper line.
   i. <u>Additional Signage:</u> Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

   a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
   b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
   c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
      1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
      2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
      3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
      4) Carefully wash face-piece of respirator inside and out.
   d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
      1) Shower completely with soap and water.
      2) Rinse thoroughly.
      3) Rinse shower room walls and floor prior to exit.
      4) Proceed from shower to changing room and change into street clothes or into new disposable work items.

e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
   1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
   2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   3) Thoroughly wet body from neck down.
   4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
   5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
   6) Dispose of wet filters from air purifying respirator.
   7) Carefully wash facepiece of respirator inside and out.
   8) Shower completely with soap and water.
   9) Rinse thoroughly.
   10) Rinse shower room walls and floor prior to exit.
   11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination
1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
4. First Cleaning
   a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
   b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
5. Second Cleaning
   a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.

3) Personnel Decontamination Unit.
4) Pressure Differential System in continuous operation.

b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.

6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
   a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
   b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
   c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
   d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
1. Air Monitoring
   a. Visual Inspection is required as a prerequisite of air testing.
   b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.
2. Aggressive Sampling
   a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
   b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
   c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples
   a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.
   b. Transmission Electron Microscopy (TEM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
      2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

3) TEM Analysis_will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

c. Phase Contrast Microscopy (PCM) Samples:
1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.
5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation
1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph "Temporary Facilities."
3. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Pressure Differential System."
    a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
    b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
    c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
    e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
    f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
    a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.
    b. HEPA vacuum the work site.
    c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
    d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
    e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
    f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
    g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
    h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
    i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
    j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.

k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.
a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 1, apply to work of this section.
a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
c. Performance Warrantee: Submit manufacturer's performance guarantee.
d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
e. Safety Data Sheet: Submit the Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   a. Name or title of material
   b. Manufacturer's stock number and date of manufacture
   c. Manufacturer's name
   d. Thinning Instructions
   e. Application Instructions
4. Deliver materials together with a copy of the OSHA Safety Data Sheet for the material.
5. Job Conditions
   a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
   a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
   b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
   d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
   a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.
   b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
   b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
   a. Before beginning work with any material for which a Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.

11. Substrate
    a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.
    b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile
1. This section applies to the removal of floor tile.
    a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
    b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
    c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”
    d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
    e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing
1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
    a. Isolate the floor per Paragraph “Temporary Enclosure.”
    b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
    c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”
    d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.
    e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
    f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.
    g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into

disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.

i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.

j. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.

k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.

1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   a. Isolate the floor per Paragraph "Temporary Facilities."
   b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph “Temporary Facilities.”
   b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      1) Remove all small debris with the HEPA vacuum.
      2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph “Disposal of Asbestos Containing Waste Material.”
      3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.

4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph "Disposal of Asbestos-Containing Waste." Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
5) HEPA vacuum the entire plaster ceiling surface.

c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.

1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.
6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: _____

PROJECT ADDRESS: _____

CONTRACTOR: _____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

Physical characteristics of asbestos
Health hazards associated with asbestos
Respiratory protection
Use of protective equipment
Pressure differential systems
Work practices including hands-on or on-the-job training
Personal decontamination procedures
Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature _____ Witness _____

Printed Name _____ Social Security Number _____

CERTIFICATION OF VISUAL INSPECTION

AREA _____

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: _____

Signature _____ Date _____

Print Name _____

Print Title _____

OWNER'S REPRESENTATIVE CERTIFICATION

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature _____ Date _____

Print Name _____

Print Title _____

RESPIRATORY PROTECTION PROGRAM

Project Name _____

Location _____

Date _____

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor _____

Signature _____ Date _____

Print Name _____ Title _____

END OF SECTION 02 82 33 00

SECTION 02 82 33 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of nonfriable asbestos-containing materials. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. Requirements

1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
   a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
   b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and

exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.

   a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.

4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.

5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.

   a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.

6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

   a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.

7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.

8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.

9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and

recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to be used including, but not limited to, respiratory protection, type of whole-body protection , the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
1. Submit the following in accordance with Section "Submittal Procedures."
a. Vacuums and tools
b. Respirators
c. Wetting Agent
d. Safety Data Sheets (SDS) for all materials proposed for transport to the project site
e. Local exhaust system
f. Pressure differential automatic recording instrument
g. Daily Reports
h. Asbestos hazard abatement plan
i. Testing laboratory
j. Training Certificates
k. Landfill approval
l. Employee training
m. Medical certification requirements
n. Waste shipment records/Asbestos waste manifest
o. Respiratory Protection Program
p. Negative Exposure Assessment
q. Local Exhaust system
r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
s. Permits, licenses, and Notifications
t. Rental equipment
u. Respirator program records
v. Protective clothing decontamination quality control records
w. Protective clothing decontamination facility notification.

E. Quality Assurance
1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
1. See Division 21 Section “Facility Fire-Suppression Water-Service Piping".

1.3 EXECUTION

A. Equipment
1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
2. Exterior Whole Body Protection
a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head

coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

b. Work Clothing-Not Used

c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

c. Provide the following asbestos labels, of sufficient size to be clearly legible, for display on waste containers (bags or drums) which will be used to transport asbestos contaminated material in accordance with United States Department of Transportation 49 CFR Parts 171 and 172.

NA2212, (WASTE) ASBESTOS, 9, PGIII

4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General
1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
1. Exposed Pipe Insulation Edges-Not Used
2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
   a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All

employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.

b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:

a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.

b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.

c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall-be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.

d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements

1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.

2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.

a. Sampling Prior to Asbestos Work (Not Used)

b. Sampling During Asbestos Work

1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.

2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately.

Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.

3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping

a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.

b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC,. mechanical, and electrical systems in proper working order.

2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.

3. Disposal of Asbestos

a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.

b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.

c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner's property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00a

Task	Specification	Specification Description
02 82 33 00	01 22 00 00	No Specification Required
02 82 33 00	02 82 16 00	Engineering Control of Asbestos Containing Materials

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SECTION 02 83 00 00 - LEAD REMEDIATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lead paint related abatement procedures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.

15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500µg/m³).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

C. Submissions
1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
   a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
   b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
   c. Copies of current training certificates of Staff to be assigned to the contract.
   d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

D. Applicable Regulations
1. 24 CFR Part 35
2. HUD ”Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing”
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
   a. 29 CFR 1926.20 General safety and health provisions;
   b. 29 CFR 1926.21 Safety training and education;
   c. 29 CFR 1925.25 Housekeeping;
   d. 29 CFR 1926-28 Personal protective equipment;
   e. 29 CFR 1926.51(f) Washing facilities;
   f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.59 Hazardous Communication Standards;
   i. 29 CFR 1926.103 Respiratory protection, and
   j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.

1.2 PRODUCTS – (not used)

1.3 EXECUTION

A. Abatement

1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
    a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.

22. Maintain appropriate records.

B. Paint Removal
1. Do not use the following prohibited paint removal methods:
   a. Dry scraping or sanding (except for limited areas)
   b. Use of heat gun over 1,100°F
   c. Open flame burning or torching
   d. Machine sanding or grinding without HEPA vacuum exhaust tool
   e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
   f. Uncontained hydro blasting or high-pressure wash
   g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

C. Building Component Replacement
1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement
1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000µg/gram lead for the yard or building perimeter or 400µg/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000µg/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
   a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/gram lead).
   b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
   c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
   d. Tie and protect existing trees, shrubs, and bushes.
   e. Have enough tools to avoid handling clean soil with contaminated tools.
   f. Remove soil.
   g. Clean all walkways, driveways, and street areas near abatement area.
   h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
   i. Install new soil covering (grass or sod) and maintain it through the growing season.
   j. Determine if soil waste is hazardous and manage it accordingly
   k. Conduct clean-up and clearance.
   l. Provide walk-off doormats.
   m. Maintain proper documentation.

E. Encapsulation
1. Determine if the applicable regulations aloe encapsulates to be used. Do not encapsulate the following surfaces:
   a. Friction surfaces, such as window jambs and door jambs.
   b. Surfaces that fail patch tests.
   c. Surfaces with substrates or existing coatings that have a high level of deterioration.
   d. Surfaces I which there is a known incompatibility between two existing paint layers.
   e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
   f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.

3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6” x 6” test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2” larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3” x 3” patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer’s installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and Safety Data Sheet (SDS) for the product and provide to the the Owner.

F. Enclosure
1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read “**Danger Lead-Based Paint**”. Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

G. Final Cleaning Procedures
1. Use the following step-by-step procedures

a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
b. Have sufficient cleaning equipment and supplies before beginning work.
c. If contamination is extensive, conduct precleaning of the dwelling unit.
d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
l. Paint and otherwise seal treated surfaces and interior floors.
m. Conduct clearance examination.
n. If clearance is not achieved, repeat final cleaning.
o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
q. Cleaning equipment list is as follows:
    1) HEPA Vacuums
    2) Detergent
    3) Waterproof gloves
    4) Rags
    5) Sponges
    6) Mops
    7) Buckets
    8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    9) 6-mil plastic bags
    10) Debris containers
    11) Waste water containers
    12) Shovels
    13) Rakes
    14) Water-misting sprayers
    15) 6-mil polyethylene sheeting (or equivalent)

2. Order of execution for final cleaning steps should be as follows:

a. As the first stage in final cleaning, floor plastic shall be misted and swept.
b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
   a. Category I. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
   b. Category II. Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
   c. Category III. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
   d. Category IV. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

   If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.
3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.

8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    c. Keep a list of phone numbers of regulatory agencies on site.
    d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.

I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
2. Clearance step-by-step procedures are as follows:
    a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    c. Conduct visual examination
        1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
        2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.

h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.

i. Interpret results by comparing them to Interim Clearance Standards as listed below:

1)	Floors	400 µg/ft2
2)	Window sills	250 µg/ft2
3)	Window Troughs	800 µg/ft2
4)	Soils (Play area with children under 6 years of age)	400 µg/gram

j. If clearance is achieved go to step N.

k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.

l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.

m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).

n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels

1. Use the following labels on drums used for disposal.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME _____

ADDRESS _____ PHONE _____

CITY _____ STATE ____ ZIP _____

EPA-ID NO. / MANIFEST DOCUMENT NO. _____ / _____

ACCUMULATION START DATE _____ EPA WASTE NO. _____

HAZARDOUS WASTE, SOLID, N.O.S.

( )

NA3077

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE HWM12

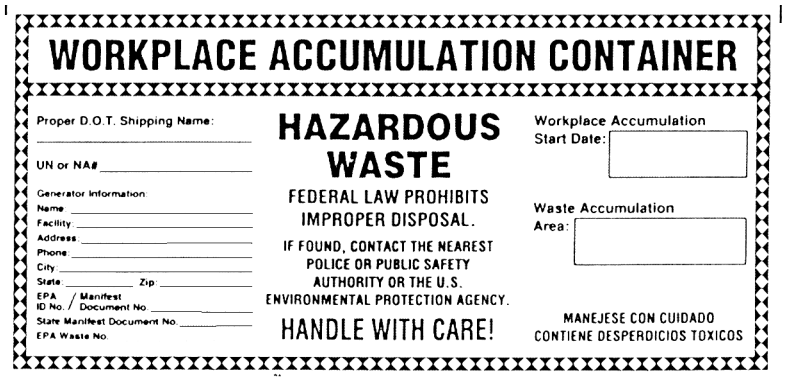

WORKPLACE ACCUMULATION CONTAINER

Proper D.O.T. Shipping Name: _____

UN or NA# _____

Generator Information:
Name: _____
Facility: _____
Address: _____
Phone: _____
City: _____
State: _____ Zip: _____
EPA ID No. / Manifest Document No. _____
State Manifest Document No. _____
EPA Waste No.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

HANDLE WITH CARE!

Workplace Accumulation Start Date:

Waste Accumulation Area:

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K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

Waste Management Practices	Category I: Low Lead Waste	Category II: Architectural Components	Category III: Concentrated Lead Waste	Category IV: Other waste
RCRA Requirements	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
HUD Recommended Practices	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X

solid waste landfill.				

L. Safety Requirements
1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:
1. General
   a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
   b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
   c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
   d. Make certain all electrical connections are properly grounded.
   e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
   a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
   b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
      1) Before assignment to active abatement activity for each worker.
      2) 30 days after active abatement has begun.
      3) At least every two months during the first six months and every six months throughout the deleading job.
      4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
      5) At termination of employment.
      6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
   c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
      1) Written standard operating procedures which oversees the selection and use of respirators.
      2) Selection of respirators on the basis of hazards to which the worker is exposed.
      3) Worker training on the limitations and use of respirators (includes fit testing).
      4) Individual workers assigned respirators for their exclusive use only.

5) Daily cleaning and disinfecting of respirators.
6) Proper storage of all respirators.
7) Proper inspection of all respirators for wear and tear.
8) Continual surveillance of work area conditions and level of worker exposure or stress.
9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.

d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and-shall be responsible for:
1) Monitoring the level of worker protection needed during the abatement process;
2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.

e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
2) Clean changing areas separated from the dirty/contaminated clothes storage area.
3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
4) Instructing worker on proper maintenance of clothing and equipment.
5) Proper disposal of disposable clothing and proper permanent work clothes.
6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
7) Enforcement of the removal of protective shoe covers before leaving work area.

3. Contractor/Worker Daily Safe-Work Procedures

a. Daily Start-Up:
1) Workers to put on protective gear prior to entering work areas.
2) All garment seams to be sealed with duct tape.
3) All non-working garments must be stored in designated changing area.
4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.

b. Temporary depart:
1) All protective clothing to be HEPA vacuumed while still being worn.
2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
4) Wash hands and face.
5) Clean respirators.

c. Daily Shut-Down:
1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
2) Laundered clothes must be placed in closed container.
3) Wash hands and face.
4) Shower if facilities allow and circumstances dictate.
5) Clean all protective gear (respirators included).

4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
   a. Adults
      1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
      2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
      3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
      4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
      5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
   b. Pregnant Women and Children
      1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 00 00

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SECTION 02 83 19 00 - LEAD-BASED PAINT REMEDIATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the removal and disposal of lead-based or lead-containing paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

    PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.

15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:
1. Product Data:
   a. Vacuum filters
   b. Respirators
2. Test Reports
   a. Sampling results
   b. Assessment data report
3. Certificates
   a. Qualifications of CP
   b. Testing laboratory</SUB> qualifications
   c. Third party consultant qualifications
   d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
   e. Rental equipment notification
   f. Respiratory protection program
   g. Hazard communication program
   h. EPA approved hazardous waste treatment or disposal facility for lead disposal
   i. Hazardous waste management plan
   j. Vacuum filters
4. Manufacturer's Instructions
   a. Chemicals and equipment
   b. Materials
   c. Safety data sheets for all chemicals
5. Closeout Submittals
   a. Completed and signed hazardous waste manifest from treatment or disposal facility
   b. Certification of medical examinations
   c. Employee training certification

D. Qualifications Of CP
1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications
1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory
1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)

1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

H. Occupational And Environmental Sampling Results
1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
   a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
   c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.

I. Occupational And Environmental Assessment Data Report:
1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
   a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
   c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.

J. Quality Assurance
1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.

a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

2. Competent Person (CP) Responsibilities
   a. Certify training as meeting all federal, State, and local requirements.
   b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
   c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
   d. Perform air and wipe sampling.
   e. Ensure work is performed in strict accordance with specifications at all times.
   f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
   g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
   a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
   a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
   b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
   a. Identification and classification of hazardous wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
   d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
   g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
   h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment
1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal
1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 2 Section "Selective Structure Demolition", "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals
1. Submit applicable Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials
1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection
1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
   a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
   b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing

ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
5. Furnishings:
   a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.
      OR
      Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.
      OR
      Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
9. Mechanical Ventilation System
   a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
   b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
   c. Vent local exhaust outside the building only and away from building ventilation intakes.
   d. Use locally exhausted, power actuated, paint removal tools.
10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
   1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.
b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

2. Air and Wipe Sampling
   a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
      1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
      2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
      3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
      5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
   b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3. Lead-Based Paint Removal
   a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
   b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 7.
   c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.

d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.

e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.

f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram (µg/g) for soil.

4. Cleanup and Disposal

a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

b. Clearance Certification

1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.

2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.

3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be sued to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.

c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.

d. Disposal

1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner’s property.

2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.
6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

END OF SECTION 02 83 19 00

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SECTION 02 83 19 00a - XRF TESTING FOR LEAD-BASED PAINT

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for XRF testing for lead-based paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.

B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

1.3 SUBMITTALS

A. Notification Before Start of Work
   1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
   2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.

B. Copies of the submissions listed below must be tendered with the bid:
   1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training <u>by all staff to be assigned to the job</u> including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the the Owner.
      a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
   2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
   3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

C. XRF Testing Report Format

a. All XRF report must be made after a formal submittal and approval by the Owner.
b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.
c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

1.4 QUALITY ASSURANCE

A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:
1. XRF Testing
a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.
Note: Testing may be for entire apartments or selected rooms or components within the apartment.
b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm².
c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.
d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.
e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.
f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.
h. XRF field data sheets shall be filled out as they appear on completed Form 7.1(“Single-Family Housing LBP Testing Data Sheet”) and 7.5 (““Multifamily Housing LBP Testing Data Sheet”) in HUD Guidelines.
i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.
2. Laboratory testing of paint chips.
a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.

b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
d. Collect paint chips in accordance with ASTM ES28-94.
e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.

B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.

C. Applicable Regulations
1. ASTME Standards
a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
b. ASTM E 1605 on terminology;
c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
d. ASTM E 1645 on laboratory preparation of paint-chip samples;
e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
f. ASTM PS 53 on identifying and managing lead in facilities;
g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
h. ASTM PS 88 on determining lead by portable electro analysis
2. OSHA Standards (without limitation), include:
a. 29 CFR 1926.20 - General safety and health provisions;
b. 29 CFR 1926.21 - Safety training and education;
c. 29 CFR 1925.25 - Housekeeping;
d. 29 CFR 1926.28 - Personal protective equipment;
e. 29 CFR 1926.51(f) - Washing facilities;
f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
g. 29 CFR 1926.57 - Ventilations;
h. 29 CFR 1926.59 - Hazardous Communication Standards;
i. 29 CFR 1926.10 - Respiratory protection; and
j. 29 CFR 1926.62 - Lead in Construction
3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).

4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf.

1.5 PRODUCTS

A. XRF Instruments and Testing Protocols
1. The Contractor shall use XRF instruments that are approved by the Owner.
2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

1.6 EXECUTION

A. Inspection and Testing
1. Single Family Testing Rules
a. If the housing development has less
1) than 10 units built between 1960-1970 or
2) 20 units built before 1960 or
3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The “SingleFamily Housing LBP Testing Data Sheet” (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
c. Number and Location of XRF Readings
1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the

readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.

3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.

4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.

a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.

d. XRF Instrument Reading Time

1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.

e. XRF Calibration Check Readings

1) Follow manufacturer's instructions per HUD Guidelines.

f. Substrate Correction

1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:

a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.

b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.

c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:

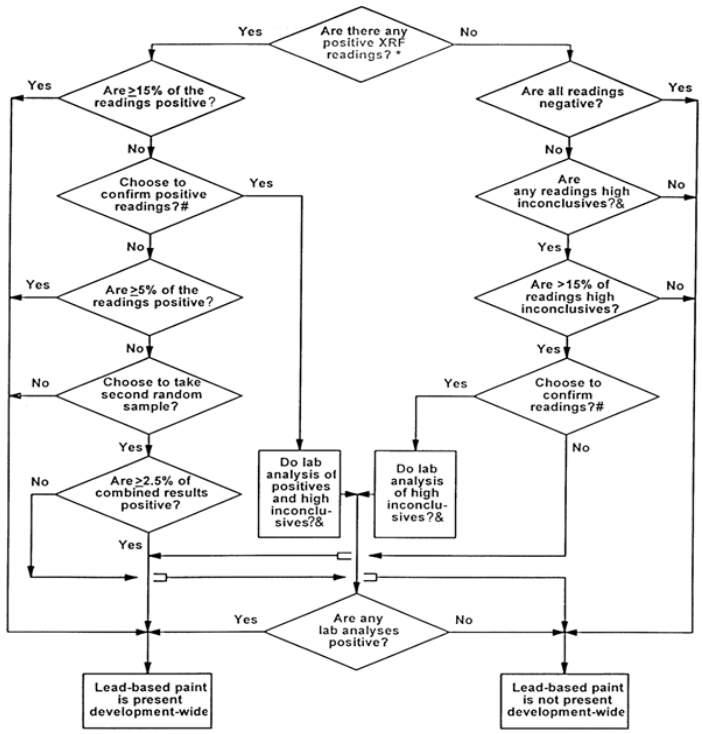

* "Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.

& A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.

\# Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.

1)

2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

2. Multi-family Housing Testing Rules (Random Sampling)

a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit

b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.

Table 7.3 Number of Units to be Tested in Multi-family Building or Developments*

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.

c. An assessment on each tested component must note four attributes, also called a testing combination.
   1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
   2) The component type (door, wall #1 - upper left, etc.)
   3) The substrate (brick, wood, concrete, drywall, plaster or metal).
   4) The color of the paint.
d. These attributes must be included as part of the report.
e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.
f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.
g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.
h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.
i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.
j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
   1) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   2) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:

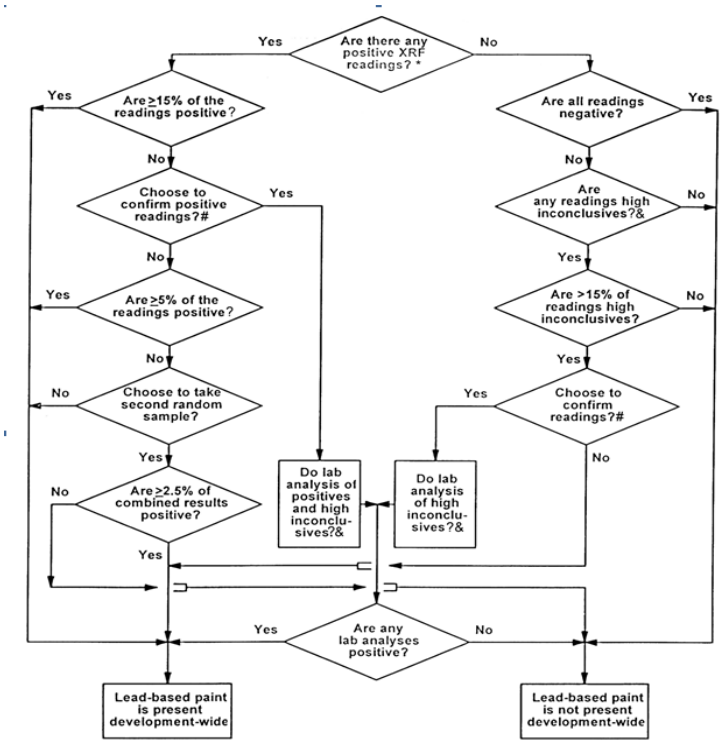

* "Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.

& A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.

\# Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.

l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm² and paint chip samples are submitted to the laboratory, there are two possible results:

1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
   a) Treat the component type as positive throughout the development, or
   b) Test the component type throughout the development, or
   c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
   a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.

b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.

c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.

m. Paint Chip Sample Size: The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16th of an inch) so that the laboratory results can be reported in mg/cm$^{2.}$ Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm^2. Smaller surface area can be used if acceptable to the laboratory. (See ASTME 1729). In all cases those who take the samples should consult with the NLLAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.

n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.

3. Common Areas and Exterior Sites Testing Rules

a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

4. Unit and Common Area Drawings

a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.

b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.

c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

B. Evaluation of the Inspection by the the Owner

1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.

C. Option to do Laboratory Testing only
1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.

D. Waste Disposal
1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

END OF SECTION 02 83 19 00a

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SECTION 02 83 19 00b - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions: Unless otherwise specified the following definitions shall apply:

1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
7. **"HUD"**: the United States Department of Housing and Urban Development.
8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm² as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft² on floors, 250 µg/ft² on interior window sills, and 800 µg/ft² on window troughs.
14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.

16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

Applicable Regulations/References

17. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:

24 CFR Parts 35,36,37	HUD Lead-Based Paint Regulations
Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions	
29 CFR 1910	General Industry Standard
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specification for Accident Prevention
29 CFR 1926	Construction Industry Standards
29 CFR 1926.20	General Safety & Health Provisions
29 CFR 1926.21	Safety Training & Education
29 CFR 1926.25	Housekeeping
29 CFR 1926.28	Personal Protective Equipment
29 CFR 1926.51	Washing Facilities
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts & Mists
29 CFR 1926.59	Hazard Communication Standard
29 CFR 1926.62	Construction Industry Lead Standard
29 CFR 1926.103	Respiratory Protection
40 CFR 61 Subpart A	General Provisions
40 CFR 241	Guidelines for the Land Disposal of Solid Waste
40 CFR 257	Criteria for the Land Disposal of Solid Waste
40 CFR 261/262	Waste Disposal Facilities & Practices
American National Standards Institute (ANSI) Z87.1	Eye Protection
ANSI Z88.2-80	Practices for Respiratory Protection
American Society For Testing Materials (ASTM)	All Applicable Standards

18. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

Scope Of Work

19. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
    a. Dust wipe sampling and analysis
        1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
        2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.
        3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
        4) Provide result of analysis in micrograms per square foot.

5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.

b. Dust Spiked Samples
1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.

NOTE: These samples are separate from the ones required by the Contractor for its own QA/QC

2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
3) Prepare dust spiked samples using the same lot as that to be used in the field.
4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.

c. Air Sampling and Analysis
1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
2) Air samples shall be collected in accordance with ASTM E1553-93.
3) Prepare air samples for analysis in accordance with ASTM E33-94
4) Analyze air samples using FAAS or GFAAS.

5) All equipment required for personal air sampling, including pumps shall be provided by the Contractor at no extra cost to the Owner.
6) Provide results of air samples in micrograms per cubic meter.
7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
10) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"),or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
12) Air sampling technician shall be present during the entire shift of the air sampling.

d. TCLP Sampling and Analysis
1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.
6) Final report must also specify detection limits.
7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

General Provisions

20. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
21. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
22. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
23. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
24. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

Submissions

25. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
    a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training <u>by all staff to be assigned to the job</u> including inspector technicians. As stated previously, training must be provided through an approved program.
    b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
    c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

Waste Disposal

26. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 00b

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Task	Specification	Specification Description
02 83 19 00	02 83 00 00	Lead Remediation
02 83 19 13	02 83 00 00	Lead Remediation
02 83 19 13	02 83 19 00	Lead-Based Paint Remediation
02 83 19 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 19 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 83 33 00	02 83 00 00	Lead Remediation
02 83 33 13	02 83 00 00	Lead Remediation
02 83 33 13	02 83 19 00	Lead-Based Paint Remediation
02 83 33 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 02 84 16 00 - HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBS AND MERCURY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
   a. Copy of State or local license for hazardous waste hauler;
   b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
   c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
   d. List of employees scheduled to perform this work;
   e. Schedule of start and finish times and dates for this work;
   f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
   g. Safety Data Sheets for all materials requiring removal;
   h. If contractor introduces any chemical into the work environmental, a SDS for that chemical is required before use;
   i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
   j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials

1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General
   1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
   2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
   3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
   4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
   5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
   1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
   2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
   1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

SECTION 02 87 13 00 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the removal and disposal of mold. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. List of all personnel to be involved in the work with their training and certifications.
2. List of all products and procedures proposed for use in performance of the work.
3. Test reports.
4. Certificates.

C. References
1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
2. U.S. EPA “A Brief Guide to Mold, Moisture, and Your Home”

D. Quality Assurance
1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
2. Bulk/Surface Sampling
a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface

with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
   a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
   b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
   c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
   d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
   e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
   f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
   a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation
1. General
   a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
   b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below

are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I*: Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II*: Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
h. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
   b. The following procedures *at a minimum* are recommended:
      1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
      3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
      4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
   c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
         b) Disposable protective clothing covering both head and shoes
         c) Gloves
      2) Containment of the affected area:

a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
c) Airlocks and decontamination room

3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems
   a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
      1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
      2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      3) The HVAC system shall be shut down prior to any remedial activities.
      4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
      9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
   b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
         b) Gloves and eye protection

c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.

2) The HVAC system shall be shut down prior to any remedial activities.

3) Containment of the affected area:

a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.

b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.

c) Airlocks and decontamination room if contamination is greater than 30 square feet.

4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.

5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.

6) All areas shall be left dry and visibly free from contamination and debris.

7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.

8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 00

Task	Specification	Specification Description
02 87 13 33	02 87 13 00	Mold Remediation

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SECTION 02 87 16 13 - BIRD EXCREMENT REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for bird-excrement removal.

B. Related Requirements:

1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
2. Section 024296 "Historic Removal and Dismantling" for special requirements related to removing items from historic surfaces.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 PRECONSTRUCTION MEETINGS

A. Preconstruction Conference: Conduct conference at [**Project site**].

1. Review minutes of Preliminary Historic Treatment Conference that pertain to protection of historic areas and surfaces.
2. Review methods and procedures related to excrement removal, including, but not limited to, the following:

a. Bird-excrement-removal specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Fire-protection plan.
d. Coordination with building occupants.
e. Dust and HVAC control.

1.5 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Preconstruction Test Reports: For removal materials and methods.

B. Qualification Statements: For [**bird-excrement-removal specialist**][**and**][**industrial hygienist**].

1.6 QUALITY ASSURANCE

A. Bird-Excrement-Removal Specialist Qualifications: A firm that employs personnel experienced and skilled in the processes and operations indicated.

B. Industrial Hygienist Qualifications: Certified as Industrial Hygienist by the American Board of Industrial Hygiene; having Bachelor's degree in industrial hygiene, public health, biological science, occupational health, or environmental and safety discipline; and experienced in work of types specified.

C. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning excrement-removal work. Comply with collection and disposal regulations of authorities having jurisdiction.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified bird-excrement-removal specialist to perform preconstruction testing on surfaces with accumulations of bird excrement.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

B. Preconstruction Testing: Performed by a qualified bird-excrement-removal specialist to demonstrate effects of removal work on substrate appearance and longevity and set quality standards for materials and execution.

1. Bird-Excrement Removal: Remove excrement from an area [**approximately 25 sq. ft.**][**as indicated**] for each type of [**cornice**][**coping**][**floor**][**and**][**wall**] substrate material.

a. Test chemicals and methods on samples of adjacent building materials for possible adverse reactions. Do not use chemicals and methods known to have deleterious effect.
b. Allow a waiting period of not less than seven days after completion of removal work to permit a study of test area for deleterious effects.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Select materials and methods of use based on the following, subject to preconstruction testing:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with temporary barrier and air quality control requirements in Section 015000 "Temporary Facilities and Controls."

B. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from excrement-removal procedures.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide barricades, dustproof partitions, and temporary directional signage to exclude public from work areas.
3. Contain dust and debris generated by excrement-removal work and prevent it from reaching the public or adjacent surfaces.

C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

3.2 BIRD-EXCREMENT REMOVAL

A. General: [**The Owner will engage**][**Engage**] a qualified industrial hygienist to perform tests, make recommendations, and observe the Work. Follow procedures required by authorities having jurisdiction and recommended by industrial hygienist.

B. Removing Bird Excrement: Have bird-excrement-removal Work performed by a qualified bird-excrement-removal specialist.[**Remove exterior bird-excrement accumulations with building windows and other openings in the building closed or sealed off.**][**Remove interior bird excrement with other parts of the building sealed off from work area and with windows and other openings to exterior areas accessible to the public closed or sealed off.**]

1. Use materials and follow procedures as determined by preconstruction testing.
2. Before removal, treat bird excrement to kill pathogens; dampen excrement to prevent particles becoming airborne.
3. Use only nonmetallic tools, such as plastic spatulas and brushes with natural fiber or nylon bristles.
4. Collect excrement as it is removed, seal it in durable plastic bags, and legally dispose of it off-site.
5. Repeat removal procedure above where required to produce cleaning effect established by preconstruction testing.

C. Removing Bird-Excrement Stain: Clean as required in Section pertaining to cleaning substrate material from which bird excrement was removed.

END OF SECTION 02 87 16 13

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Task	Specification	Specification Description
02 89 00 00	01 22 00 00	No Specification Required
02 89 00 00	02 83 00 00	Lead Remediation
02 89 00 00	02 83 19 00	Lead-Based Paint Remediation
02 89 00 00	02 83 19 00a	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 90 55 00	01 22 00 00	No Specification Required

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SECTION 03 01 30 00 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bonding agents.
2. Patching mortar.
3. Preplaced concrete materials.
4. Joint filler.
5. Epoxy crack-injection materials.
6. Corrosion-inhibiting materials.
7. Polymer-overlay materials.
8. Polymer-sealer materials.
9. Composite reinforcement materials.

1.2 ALLOWANCES

A. Allowances for maintenance of cast-in-place concrete are specified in Section 012100 "Allowances."

B. Field quality-control testing is part of testing and inspecting allowance.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by [**quantity allowances**][**estimated quantities**].
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

B. General: Unit prices include the cost of preparing existing construction to receive the Work indicated[**and costs of field quality control required for units of Work completed**].

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to concrete work, including, but not limited to, the following:

a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Concrete restoration specialist.
c. Materials, material application, sequencing, tolerances, and required clearances.
d. Shoring and bracing.
e. Quality-control program.
f. Coordination with building occupants.

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, project application types consisting of horizontal, vertical or overhead locations and application instructions.

B. Shop Drawings:

1. Shoring and Bracing: Provide Drawings or documentation to ensure that structure and temporary supports withstand the anticipated loads during construction and the effect of demolition on the capacity of the structure. Submit design calculations, sealed by an engineer licensed in state of Project, for shoring and bracing where required by the extent of structural repairs or removal of deteriorated concrete and subsequent replacement.

C. Samples: Cured Samples for each exposed product and for each color and texture specified, [**in manufacturer's standard size appropriate for each type of work**].

D. Samples for Initial Selection: Cured Samples for each exposed product and for each color and texture.

1. Include sets of patching-material Samples in the form of briquettes, at least [**3 inches (75 mm) long by 1-1/2 inches (38 mm) wide**] representative of the range of concrete colors on the building. Document each Sample with product, mix, and/or other information necessary to replicate it.
2. Include sets of Samples for epoxy crack-injection adhesive and capping adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include sets of polymer-overlay Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
4. Include sets of polymer-sealer Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
5. Have each set of Samples contain a close color range of at least [**three**][**six**] Samples of different mixes of materials that match the variations in existing, adjacent concrete when cured and dry.

E. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.

1. Include Samples of each required type, color, and texture of patching material in the form of patches in drilled holes or sawed joints in sample concrete representative of the range of concrete colors on the building.
2. Include Samples of epoxy crack-injection adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include Samples of each required type, color, and texture of polymer-overlay material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].
4. Include Samples of each required type, color, and texture of polymer-sealer material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**concrete-maintenance specialist**][**and**][**manufacturers**].

B. Material Certificates: For each type of [**portland cement**][**aggregate**] supplied for mixing or adding to products at Project site.

C. Product Test Reports: For each [**manufactured bonding agent**][**cementitious patching mortar**][**joint filler**][**crack-injection adhesive**][**polymer overlay**][**polymer sealer**][**and**][**composite structural reinforcement**], for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Quality-Control Program: Submit before work begins.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each [**manufactured bonding-agent**][**packaged patching-mortar**][**joint-filler**][**crack-injection-adhesive**][**corrosion-inhibiting-treatment**][**polymer-overlay**][**polymer-sealer**][**and**][**composite-structural-reinforcement**] manufacturer must employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

B. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply [**packaged patching-mortar**][**crack-injection adhesive**][**corrosion-inhibiting treatments**][**polymer overlays**][**polymer sealers**][**and**][**composite structural reinforcement**] when performing the Work of this Section. Firm must have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.

1. Field Supervision: Concrete-maintenance specialist firm must maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.

C. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

D. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1.8 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Concrete Removal and Patching Mockup: Remove and repair an [**approximately 50 sq. ft. (4.6 sq. m)**][**approximately 100 sq. in. (645 sq. cm)**] area of [**deteriorated concrete deck**][**deteriorated concrete wall**].
2. Floor Joint Repair Mockup: Cut out and reinstall joints in two separate areas [**, each approximately 48 inches (1200 mm) long**][**as indicated on Drawings**].
3. Epoxy Crack Injection Mockup: Perform epoxy crack-injection material in two separate areas [**,**

each approximately 48 inches (1200 mm) long][**as indicated on Drawings**].

4. Polymer-Overlay Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer overlay.
5. Polymer Sealer Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer sealer.
6. Composite Structural-Reinforcement Mockup: Apply composite structural reinforcement [**a minimum of 48 inches (1200 mm) long**][**as indicated on Drawings**].
7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

B. Store cementitious materials off the ground, under cover, and in a dry location.

C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.10 FIELD CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below **40 deg F (5 deg C)** within eight hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below **60 deg F (16 deg C)** within eight hours.
3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above **60 deg F (16 deg C)** for eight hours.

B. Cold-Weather Requirements for Cementitious Materials:

1. Do not apply unless concrete surface and air temperatures are above **40 deg F (5 deg C)** and will remain so for at least 48 hours after completion of Work.
2. Comply with the following procedures:

   a. When air temperature is below **40 deg F (5 deg C)**, heat patching-material ingredients and existing concrete to produce temperatures between **40 and 90 deg F (5 and 32 deg C)**.
   b. When mean daily air temperature is between **25 and 40 deg F (minus 4 and plus 5 deg C)**, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.
   c. When mean daily air temperature is below **25 deg F (minus 4 deg C)**, provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial

shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of **90 deg F (32 deg C)** and above.

D. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below **55 deg F (13 deg C)** or above [**75 deg F (24 deg C)**][**90 deg F (32 deg C)**]. Apply only to [**dry substrates**][**substrates that have been dry for at least 72 hours**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**Master Builders Solutions**]
g. [**Sika Corporation**]
h. [**SpecChem, LLC**]
i. [**Sto Corp.**]

B. Epoxy Bonding Agent: ASTM C881/C881M [**Type II**][**Type V**] bonding system, free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ChemCo Systems, Inc.**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**MAPEI Corporation**]
g. [**Master Builders Solutions**]
h. [**Sika Corporation**]

i. [**Sto Corp.**]
j. [**US SPEC, Division of US MIX Company**]
k. [**Xypex Chemical Corporation**]

C. Latex Bonding Agent, Redispersible: Type I, ASTM C1059/C1059M[**for use at nonstructural and interior locations unless otherwise indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dayton Superior Corporation**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Kaufman Products, Inc**]
d. [**US SPEC, Division of US MIX Company**]
e. [**W. R. Meadows, Inc**]

D. Latex Bonding Agent, Nonredispersible: Type II, ASTM C1059/C1059M[**for use at structural and exterior locations and where indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**US SPEC, Division of US MIX Company**]
g. [**W. R. Meadows, Inc**]

E. Mortar Scrub Coat: Mix consisting of 1 part portland cement and 1 part fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar[**where indicated**] that matches existing, adjacent, and exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, Size No. 8, Class 5S washed aggregate. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Job-Mixed Patching Mortar : 1 part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CGM, Incorporated**]
   b. [**ChemMasters, Inc**]
   c. [**Dayton Superior Corporation**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**Kaufman Products, Inc**]
   f. [**KOSTER American Corporation**]
   g. [**MAPEI Corporation**]
   h. [**Master Builders Solutions**]
   i. [**Sika Corporation**]
   j. [**Simpson Strong-Tie Co., Inc.**]
   k. [**Sto Corp.**]
   l. [**Tnemec Company, Inc.**]
   m. [**US SPEC, Division of US MIX Company**]
   n. [**W. R. Meadows, Inc**]

C. Cementitious Patching Mortar : Packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CGM, Incorporated**]
   b. [**ChemMasters, Inc**]
   c. [**Dayton Superior Corporation**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**Kaufman Products, Inc**]
   f. [**KOSTER American Corporation**]
   g. [**MAPEI Corporation**]
   h. [**Master Builders Solutions**]
   i. [**Schonox HPS North America, Inc.**]
   j. [**Sika Corporation**]
   k. [**Simpson Strong-Tie Co., Inc.**]
   l. [**Sto Corp.**]
   m. [**Tnemec Company, Inc.**]
   n. [**United Gilsonite Laboratories (UGL)**]
   o. [**US SPEC, Division of US MIX Company**]
   p. [**W. R. Meadows, Inc**]
   q. [**Xypex Chemical Corporation**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

D. Rapid-Strengthening, Cementitious Patching Mortar : [**ASTM C928/C928M**] packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**CGM, Incorporated**]
    c. [**ChemMasters, Inc**]
    d. [**Dayton Superior Corporation**]
    e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    f. [**Kaufman Products, Inc**]
    g. [**MAPEI Corporation**]
    h. [**Master Builders Solutions**]
    i. [**Schonox HPS North America, Inc.**]
    j. [**Sika Corporation**]
    k. [**Simpson Strong-Tie Co., Inc.**]
    l. [**Sto Corp.**]
    m. [**US SPEC, Division of US MIX Company**]
    n. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**1000 psi (7.0 MPa)**][**2000 psi (13.8 MPa)**][**3000 psi (21.0 MPa)**][**4000 psi (27.6 MPa)**] within [**three**] hours when tested in accordance with ASTM C109/C109M.

E. Polymer-Modified, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AQUAFIN, Inc**]
    b. [**ARDEX Americas**]
    c. [**CGM, Incorporated**]
    d. [**ChemMasters, Inc**]
    e. [**Cortec Corporation**]
    f. [**Dayton Superior Corporation**]
    g. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    h. [**Kaufman Products, Inc**]
    i. [**MAPEI Corporation**]
    j. [**Master Builders Solutions**]
    k. [**Schonox HPS North America, Inc.**]
    l. [**Sika Corporation**]
    m. [**Simpson Strong-Tie Co., Inc.**]
    n. [**Sto Corp.**]
    o. [**United Gilsonite Laboratories (UGL)**]
    p. [**US SPEC, Division of US MIX Company**]
    q. [**Uzin Utz North America, Inc.**]
    r. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

F. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains silica fume complying with ASTM C1240 and a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AQUAFIN, Inc**]
b. [**CGM, Incorporated**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]
g. [**Simpson Strong-Tie Co., Inc.**]
h. [**Sto Corp.**]
i. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

2.4 PREPLACED CONCRETE MATERIALS

A. Preplaced Aggregate: Washed aggregate, ASTM C33/C33M, Class 5S, with [**95 to 100 percent passing a 1-1/2-inch (38-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, zero to 10 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**][**100 percent passing a 1-1/2-inch (38-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, zero to 15 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**].

B. Fine Aggregate for Grout: Fine aggregate in accordance with ASTM C33/C33M, but with 100 percent passing a **No. 8 (2.36-mm)** sieve, 95 to 100 percent passing a **No. 16 (1.18-mm)** sieve, 55 to 80 percent passing a **No. 30 (0.6-mm)** sieve, 30 to 55 percent passing a **No. 50 (0.3-mm)** sieve, 10 to 30 percent passing a **No. 100 (0.15-mm)** sieve, zero to 10 percent passing a **No. 200 (0.075-mm)** sieve, and having a fineness modulus of 1.30 to 2.10.

C. Grout Fluidifier for Grout: ASTM C937.

D. Pozzolans for Grout: ASTM C618.

2.5 JOINT FILLER

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**SIMIRON Inc.**]
b. [**Abatron, Inc**]
c. [**ChemCo Systems, Inc.**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**Sika Corporation**]

B. Polyurea Joint Filler: Two-component, semirigid, 100 percent solids, polyurea resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**ARDEX Americas**]
c. [**ASTC Global, Inc.**]
d. [**ChemCo Systems, Inc.**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**HTS Chemical; Hi-Tech Systems**]
g. [**Kaufman Products, Inc**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**SpecChem, LLC**]
k. [**US SPEC, Division of US MIX Company**]

C. Color: [**As indicated by manufacturer's designations**][**Matching existing joint filler**][**As selected by Architect from full range of industry colors**].

2.6 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881/C881M, bonding system [**Type I,**][**Type IV,**][**Type IV at structural locations and where indicated, Type I at other locations;**] free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ChemCo Systems, Inc.**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]

e. [**Fyfe Co. LLC**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Sika Corporation**]
j. [**Sto Corp.**]
k. [**US SPEC, Division of US MIX Company**]
l. [**W. R. Meadows, Inc**]

2. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.
3. Color: Provide epoxy crack-injection adhesive and capping adhesive [**as indicated by manufacturer's designations**][**that blend with existing, adjacent concrete and do not stain concrete surface**][**As selected by Architect from full range of industry colors**].

2.7 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Cortec Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2.8 POLYMER-OVERLAY MATERIALS

A. Polymer Overlay: Epoxy adhesive complying with ASTM C881/C881M, bonding system Type III, with surface-applied aggregate for skid resistance; free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**Master Builders Solutions**]
g. [**Sika Corporation**]
h. [**Sto Corp.**]

i. [**US SPEC, Division of US MIX Company**]

2. Aggregate: ACI 503.3, oven-dried, washed silica sand.
3. Color and Texture: [**As indicated by manufacturer's designations**][**Matching existing**][**As selected by Architect from full range of industry colors**].

2.9 POLYMER-SEALER MATERIALS

A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

B. Methacrylate Polymer Sealer: Low-viscosity, high-molecular-weight methacrylate, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**Kwik Bond Polymers**]
c. [**Master Builders Solutions**]
d. [**Sika Corporation**]
e. [**Transpo Industries, Inc.**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

2.10 COMPOSITE REINFORCEMENT MATERIALS

A. Composite Structural Reinforcement: Manufacturer's system consisting of [**carbon-fiber**][**or**][**glass-fiber**] reinforcement in the form of [**tow sheet with field-applied saturant**][**or**][**preimpregnated sheet**]

and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as externally bonded structural reinforcement for concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Fyfe Co. LLC**]
    b. [**MAPEI Corporation**]
    c. [**Master Builders Solutions**]
    d. [**Schonox HPS North America, Inc.**]
    e. [**Sika Corporation**]

2.11 MISCELLANEOUS MATERIALS

A. Curing Materials: For ready-mixed concrete or packaged repair materials.

B. Formwork Materials: Form-facing materials must comply with **ACI 301** **(ACI 301M)** requirements.

C. Water: Potable.

D. Cleaning Agent: Commercial muriatic acid solution.

2.12 MIXES

A. General: Mix products, in clean containers, in accordance with manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete Materials: Comply with [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]

E. Concrete Mixture Materials: Ready mixed.

1. ACI Publications: Comply with **ACI 301** **(ACI 301M)** unless modified by requirements in the Contract Documents.
2. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.
3. Fly Ash: ASTM C618, Class C or F.
4. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
5. Silica Fume: ASTM C1240 amorphous silica.

6. Aggregates: ASTM C330/C330M, nominal maximum aggregate size, gradation and types appropriate for the dimension of the repair area and project application.
7. Air-Entraining Admixture: ASTM C260/C260M.
8. Chemical Admixtures: Certified and as recommended by manufacturer for project applications to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

F. Repair Underlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch** and that can be feathered at edges to match adjacent floor elevations.
2. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

G. Repair Overlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.
2. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

H. Grout for Use with Preplaced Aggregate: Proportion in accordance with ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

PART 3 - EXECUTION

3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

3.2 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls, make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete-maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete-maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
2. Use only proven protection methods appropriate to each area and surface being protected.
3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete-maintenance work is being performed.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete-maintenance work.
5. Contain dust and debris generated by concrete-maintenance work and prevent it from reaching the public or adjacent surfaces.
6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape[**or a liquid-strippable masking agent**]. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Existing Drains: Prior to the start of concrete-maintenance work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin concrete-maintenance work in an area until the drainage system is in working order.

1. Prevent solids, such as aggregate or mortar residue, from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete-maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete-maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Inventory and record the condition of items to be removed for reinstallation or salvage.
3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by [**high-pressure water cleaning**][**abrasive blast cleaning**][**needle scaling**][**or**][**wire brushing**] until only

tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least **3/4-inch (19-mm)** clearance at existing and replacement bars.
3. Splice replacement bars to existing bars in accordance with **ACI 318 (ACI 318M)** by lapping, welding, or using mechanical couplings.

F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.

1. Use [**low-pressure water cleaning**][**detergent scrubbing**][**or**][**sand blasting**].
2. Allow surface to dry before applying corrosion-inhibiting treatment.

H. Surface Preparation for Overlays:

1. Remove delaminated material and deteriorated concrete surface material.
2. Roughen surface of concrete to produce a surface profile matching CSP [**3**][**4**][**5**][**6**][**7**][**8**][**9**] in accordance with ICRI 310.2.
3. Use [**sand blasting**][**shot blasting**][**scarifying**][**needle scaling**][**high-pressure water jetting**][**scabbling**][**flame blasting**][**or**][**milling**].
4. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 in accordance with ICRI 310.2.[**Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.**]

1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable in accordance with sealer manufacturer's written instructions.
4. When pH is acceptable in accordance with sealer manufacturer's written instructions and surface is clean, vacuum dry.

J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.

1. Use [**shot blasting**][**low-pressure water cleaning**][**or**][**detergent scrubbing**].

K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by [**low-pressure water cleaning**][**or**][**detergent scrubbing**] to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.

1. Roughen surface of concrete by sand blasting.
2. Remove delaminated material and deteriorated concrete surface material.
3. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

3.4 REMOVAL OF CONCRETE

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least [**1/2 inch (13 mm)**]. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least [**1/2 inch (13 mm)**] over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least **3/4-inch (19-mm)** clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least **1/8 inch (3 mm)** that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.5 APPLICATION OF BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion System: Apply to reinforcing bars [**and concrete**]by stiff brush or hopper spray in accordance with manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

B. Epoxy Bonding System: Apply to reinforcing bars[**and concrete**] by brush, roller, or spray in accordance with manufacturer's written instructions, leaving no pinholes or other uncoated areas.[**Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat.**] Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface in accordance with manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

E. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete **6 inches (150 mm)** beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar[**mixed with latex bonding agent**] into substrate, filling pores and voids.

3.6 INSTALLATION OF PATCHING MORTAR

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer[**or where dry-pack mortar is indicated**].

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Vertical Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

E. Overhead Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a [**smooth surface with a wood or sponge float**][**rough surface with a broom or burlap drag**][**surface matching adjacent concrete**].

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.7 INSTALLATION OF DRY-PACK MORTAR

A. Use dry-pack mortar for deep cavities[**and where indicated**]. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.8 CONCRETE PLACEMENT

A. Place concrete in accordance with [**Section 033000 "Cast-in-Place Concrete"**][**Section 033300 "Architectural Concrete"**] and as specified in this article.

B. Epoxy-Modified Pretreatment: Apply [**epoxy-modified, cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

C. Latex Pretreatment: Apply [**latex bonding agent**][**Type I latex bonding agent**][**mortar scrub coat**] to concrete substrate.

D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.

1. Use vibrators to consolidate concrete as it is placed.
2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.

E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.

1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to **14 psi (96 kPa)**.

F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.9 GROUTING PREPLACED AGGREGATE CONCRETE

A. Use grouted preplaced aggregate concrete [**where indicated**][**for column and wall repairs**]. Place as specified in this article.

B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.

C. Apply [**epoxy-modified cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.

E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to **14 psi (96 kPa)**.

G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

H. Repair voids with patching mortar and finish to match surrounding concrete.

3.10 FLOOR-JOINT REPAIR

A. Cut out deteriorated concrete [**and reconstruct sides of joint with patching mortar**] as indicated on Drawings. Install joint filler in nonmoving floor joints where indicated and as specified in this article.

B. Depth: Install joint filler to a depth of at least [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]. Use fine silica sand no more than **1/4 inch (6 mm)** deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.

C. Top Surface: Install joint filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

3.11 APPLICATION OF EPOXY CRACK-INJECTION MATERIALS

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least **1/4 inch (6 mm)** thick by **1 inch (25 mm)** wider than crack.

E. Inject cracks wider than **0.003 inch (0.075 mm)** to a depth of **8 inches (200 mm)**.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.12 APPLICATION OF CORROSION-INHIBITING MATERIALS

A. Apply corrosion-inhibiting treatment to [**surfaces indicated on Drawings, from wall to wall or curb to curb and from joint to joint in the perpendicular direction**].

B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete[**or applying a sealer or overlay**].

3.13 APPLICATION OF POLYMER-OVERLAY MATERIALS

A. Apply polymer overlay in accordance with ACI 503.3.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.14 APPLICATION OF POLYMER-SEALER MATERIALS

A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.15 INSTALLATION OF COMPOSITE REINFORCEMENT MATERIALS

A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:

1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
3. Apply epoxy saturant to [**fiber tow sheet**][**or**][**primed and patched surface**] using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.
4. Apply additional layers using same procedure, fully saturating each layer with epoxy.
5. After saturant has cured, apply protective topcoat by [**brush**][**roller**][**or**][**spray**].

B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:

1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
2. Apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)** to prepared concrete surfaces.
3. Clean fiber sheet with acetone or other suitable solvent and apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)**.
4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
5. Apply additional layers using same procedure.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Packaged, Cementitious Patching-Mortar Application: randomly selected sets of samples for each type of mortar required, tested in accordance with ASTM C928/C928M.
2. Job-Mixed Patching-Mortar Application: As directed by the Owner, randomly selected sets of samples for each type of mortar required, tested for compressive strength in accordance with ASTM C109/C109M.
3. Concrete: As specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]
4. Grout for Preplaced Aggregate: Tested for compressive strength in accordance with ASTM C942/C942M.

a. Testing Frequency: One sample for each **25 cu. yd. (19 cu. m)** of grout or fraction thereof,

but not less than one sample for each day's work.

5. Joint Filler: Core-drilled samples to verify proper installation.

   a. Testing Frequency: One sample for each **100 ft. (30 m)** of joint filled.
   b. Where samples are taken, refill holes with joint filler.

6. Epoxy Crack-Injection Materials: Core-drilled samples to verify proper installation.

   a. Testing Frequency: [**Three samples from mockup and**]one sample for each **100 ft. (30 m)** of crack injected.
   b. Where samples are taken, refill holes with epoxy mortar.

7. Product will be considered defective if it does not pass tests and inspections.

C. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:

   a. Bonding-Agent and Packaged Patching-Mortar Installation: [**Three**] inspections.
   b. Joint-Filler Installation: [**Two**] inspections.
   c. Crack-Injection-Adhesive Preparation and Installation: [**Four**] inspections.
   d. Corrosion-Inhibiting Treatment Installation: [**Two**] inspections.
   e. Polymer-Overlay Installation: [**Two**] inspections.
   f. Polymer Sealer: [**Two**] inspections.
   g. Composite-Structural Reinforcement: [**Three**] inspections.

D. Prepare test and inspection reports.

3.17 CONCRETE MAINTENANCE SCHEDULE

A. Garage Level 1 Entrance Ramp: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

B. Elevated Warehouse Floors: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

C. Concrete Walls and Floor in Salt Dome: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement of columns.

END OF SECTION 03 01 30 00

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Task	Specification	Specification Description
03 01 30 51	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 01 30 71	01 22 00 00	No Specification Required
03 01 30 71	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 01 30 72	03 01 30 00	Maintenance of Cast-in-Place Concrete
03 05 13 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 10 00 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.
2. Form liners.
3. Insulating concrete forms.
4. Waterstops.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.

B. Form Lining: Materials used to line the concreting face of formwork to impart a smooth or patterned finish to the concrete surface, to absorb moisture from the concrete, or to apply a set-retarding chemical to the formed surface of the concrete.

C. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

C. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with **ACI 301 (ACI 301M)**.
3. Indicate location of waterstops.
4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

D. Samples:

1. For waterstops.
2. For Form Liners: **12- by 12-inch (305- by 305-mm)** sample, indicating texture.

1.5 INFORMATIONAL SUBMITTALS

A. Research Reports: For insulating concrete forms indicating compliance with ICC's Acceptance Criteria AC353.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

D. Qualification Statements: For testing and inspection agency.

1.6 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Mockups: As directed by the Owner, formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1. Build panel approximately [**100 sq. ft. (9.3 sq. m)**] in the location indicated or, if not indicated, as directed by the Owner.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with **ACI 301 (ACI 301M)**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with **ACI 301 (ACI 301M)**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

a. Wind Loads: As indicated on Drawings.

1) Horizontal Deflection Limit: Not more than [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

1) APA HDO (high-density overlay).
2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.

4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces [**with gradual or abrupt irregularities**][**without spiral or vertical seams**] not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with [**straight**][**or**][**tapered**] end forms.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

2.3 FORM LINERS

A. Form Liners: Architectural finish pattern on the concrete surface can be achieved by attaching form liners to the inside faces of form-facing materials.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Polymers, Inc.**]
b. [**Fitzgerald Formliners**]
c. [**Sika Corporation**]
d. [**Spec Formliners, Inc.**]

2. Face Pattern:
[**Smooth**][**Ribbed**][**Textured**][**Reveal**][**Geometric**][**Stone**][**Brick**][**Block**][**Rock**][**Wood**][**Custom**].

2.4 INSULATING CONCRETE FORMS

A. Insulating Concrete Forms: Concrete-forming system complying with ASTM E2634, consisting of two panels of insulation connected with cross ties.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**BuildBlock Building Systems, LLC**]
c. [**Fox Blocks; Airlite Plastics Co.**]

d. [**Nudura Corporation**]
e. [**Nudura, part of Tremco CPG**]

2. Insulation: ASTM C578, Type II, expanded polystyrene.

a. Thickness: Not less than [**2-1/2 inches (64 mm)**] each face.
b. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 450 or less.

3. Cross Ties: Polypropylene, with integral reinforcement supports, designed to allow passage of concrete during placement.
4. Core Thickness: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (201 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**].

2.5 WATERSTOPS

A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers' CE CRD-C 513,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Williams Products, Inc.**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [**4 by 3/16 inch thick (100 by 4.8 mm thick)**][**6 by 3/8 inch thick (150 by 10 mm thick)**][**9 by 3/8 inch thick (225 by 10 mm thick)**]; nontapered.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops[**with factory-installed metal eyelets**], for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**J P Specialties, Inc.**]
b. [**Sika Corporation**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [**4 by 3/16 inch thick (100 by 4.8 mm thick)**][**6 by 3/16 inch thick (150 by 4.8 mm thick)**][**6 by 3/8 inch thick (150 by 10 mm thick)**][**9 by 3/16 inch thick**

(225 by 4.8 mm thick)][9 by 3/8 inch thick (225 by 10 mm thick)]; nontapered.

C. Flexible PVC Waterstops: U.S. Army Corps of Engineers' CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints, with factory-fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BoMetals, Inc.**]
   b. [**Sika Corporation**]
   c. [**Vinylex Waterstop & Accessories**]

2. Profile: [**Flat dumbbell with center bulb**][**Flat dumbbell without center bulb**][**Ribbed with center bulb**][**Ribbed without center bulb**][**As indicated**].
3. Dimensions: [4 by 3/16 inch thick (100 by 4.8 mm thick)][6 by 3/8 inch thick (150 by 10 mm thick)][9 by 3/8 inch thick (225 by 10 mm thick)]; nontapered.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Coatings & Waterproofing Inc**]
   b. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
   c. [**Concrete Sealants Inc.**]
   d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   e. [**J P Specialties, Inc.**]
   f. [**Sika Corporation**]

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
   b. [**GCP Applied Technologies Inc.**]
   c. [**Kryton International, Inc.**]
   d. [**OCM, Inc.**]
   e. [**Sika Corporation**]

2.6 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than **0.022-inch- (0.55-mm-)** thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than **0.034 inch (0.85 mm)** thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, **3/4 by 3/4 inch (19 by 19 mm)**, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners to be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than **1 inch (25 mm)** to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than **1 inch (25 mm)** in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

G. Sealant: One-part moisture cure silicone sealant used with form liners.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with **ACI 301 (ACI 301M)**.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of **ACI 117 (ACI 117M)** and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes[.][**and Section 033300 "Architectural Concrete."**]

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: **ACI 117 (ACI 117M)** Class D, **1 inch (25 mm)**.
2. Surface Finish-2.0: **ACI 117 (ACI 117M)** Class B, **1/4 inch (6 mm)**.
3. Surface Finish-3.0: **ACI 117 (ACI 117M)** Class A, **1/8 inch (3.0 mm)**.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. [**Chamfer**][**Do not chamfer**] exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than **12 inches (305 mm)**.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.

L. Form Liners: Install per manufacturer's written installation instructions and recommended tolerances.

M. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as directed by the Owner.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

   a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls [**as indicated on Drawings**].

   a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

N. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.

2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

O. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

P. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Q. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-in-Place Concrete."
4. Secure waterstops in correct position at **12 inches (305 mm)** o.c.
5. Field fabricate joints in accordance with manufacturer's written instructions using heat welding.

   a. Miter corners, intersections, and directional changes in waterstops.
   b. Align center bulbs.

6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, in accordance with manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 INSTALLATION OF INSULATING CONCRETE FORMS

A. Comply with **ACI 301 (ACI 301M)** and manufacturer's written instructions.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of **ACI 117 (ACI 117M)**.

C. Install forms in running bond pattern.

1. Align joints.
2. Align furring strips.

D. Construct forms tight to prevent loss of concrete mortar.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

G. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.

3.5 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F (10 deg C)** for [**24**] hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by the Owner.

3.6 INSTALLATION OF SHORING AND RESHORING

A. Comply with **ACI 318 (ACI 318M)** and **ACI 301 (ACI 301M)** for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: [**the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

D. Prepare test and inspection reports.

END OF SECTION 03 10 00 00

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Task	Specification	Specification Description
03 11 00 00	03 10 00 00	Concrete Forming and Accessories
03 11 13 00	01 22 00 00	No Specification Required
03 11 13 00	03 10 00 00	Concrete Forming and Accessories
03 11 13 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 11 16 00 - ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.
2. Concrete materials.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete that apply to architectural concrete.
2. Section 033543 "Polished Concrete Finishing" for concrete polishing.

1.2 DEFINITIONS

A. Aggregate Exposure: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

B. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

C. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

D. Design Reference Sample: Sample designated, as directed by the Owner in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.

E. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.

c. Reinforcement accessory installation.
d. Cold- and hot-weather concreting procedures.
e. Concrete finishes and finishing.
f. Curing procedures.
g. Forms and form-removal limitations.
h. Shoring and reshoring procedures.
i. Concrete repair procedures.
j. Protection of cast-in-place architectural concrete.
k. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
l. Protection of field-cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Form-facing panels.
2. Form liners.
3. Form joint tape.
4. Form joint sealant.
5. Wood sealer.
6. Form-release agent.
7. Surface retarder.
8. Form ties.
9. Bar supports.
10. Portland cement.
11. Fly ash.
12. Slag cement.
13. Blended hydraulic cement.
14. Natural or other pozzolans.
15. Silica fume.
16. Performance-based hydraulic cement.
17. Aggregates.
18. Admixtures:

    a. Include limitations of use.

19. Color pigments.
20. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
    b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
    c. Third-party-verified Declare product label, designated "Red List Free."

d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.
10. Synthetic microfiber content.
11. Amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Intended placement method.
13. Alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings:

1. Formwork: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

a. Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

1) Included separate layout for formwork used in [**field sample panels**][**and**][**mockups**].
2) Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
3) Location of construction joints as directed by the Owner.

E. Samples: For each of the following materials:

1. Form-facing panels.
2. Form ties.
3. Form liners, **12-by-12-inch (305-by-305-mm)** Sample, indicating texture.
4. Manufacturer's standard colors for color pigment.
5. Exposed aggregates.
6. Chamfers and rustications.

F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately **18 by 18 by 2 inches (450 by 450 by 50 mm)**, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

G. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.

4. Formed Surface Finish designation and final finish.
5. Curing process.

H. Placement Schedule: Submit before start of placement operations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Repair materials.

C. Material Test Reports: For the following, by a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates[**: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity**].

D. Research Reports: For concrete admixtures in accordance with ICC AC198.

E. Preconstruction Test Reports: For each mix design.

F. Concrete Repair: Submit a written, detailed description of materials, methods, equipment, and sequence of operations to be used for repairing architectural concrete, including protection of surrounding materials and Project site.

1. If materials and methods other than those indicated are proposed for any repairs to architectural concrete, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and Installer's ability to use such materials and methods properly.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete

Production Facilities."

B. Installer Qualifications: An experienced cast-in-place architectural concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1. Provide written evidence of qualifications and experience.
2. Include locations, descriptions, and photographs of completed projects, substantiating the quality of the installer's experience, as directed by the Owner.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Technical Manager.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level I.
2. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Level II.

D. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately **48 by 48 by 6 inches (1200 by 1200 by 150 mm)** minimum, to demonstrate the expected range of finish, color, and texture variations.

1. Locate panels as indicated or, if not indicated, as directed by the Owner.
2. Demonstrate methods of curing, aggregate exposure, wood sealers, and coatings, as applicable.
3. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces, as directed by the Owner.
4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
5. Demolish and remove field sample panels when directed.

E. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Owner.
2. Build mockups of typical wall of cast-in-place architectural concrete as shown on Drawings, including vertical and horizontal rustication joints, and any sculptured features.
3. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.
4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
5. Damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces, as directed by the Owner.
6. Demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces, as directed by the Owner.
7. Approval of mockups before casting architectural concrete, as directed by the Owner.
8. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

B. Hot-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.

2.2 FORM-FACING MATERIALS

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.

B. Source Limitations: Obtain each type of form-facing material from single source from single manufacturer.

C. Form-Facing Panels:

1. Finishes: [**As cast**][**or**][**exposed aggregate**].

a. Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

b. Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, [**high-density overlay, Class 1, or better**][**medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed**], complying with DOC PS 1[**, or Finnish phenolic overlaid birch plywood**].

D. Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**][**to match design reference sample**]. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments and finishes of concrete.

E. Rustication Strips: Metal[**, dressed wood,**] or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

F. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, **3/4 by 3/4 inch (19 by 19 mm)**, minimum; nonstaining; in longest practicable lengths.

G. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum **1/4 inch (6 mm)** thick.

H. Form Joint Sealant: Elastomeric sealant complying with ASTM C920, Type M or Type S, Grade NS, that adheres to form joint substrates, does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.

I. Wood Sealer: Penetrating, clear, polyurethane wood sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood and does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.

J. Form-Release Agent: Commercially formulated, colorless form-release agent that does not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments and finishes of architectural concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form-release agent for form liners to be acceptable to form-liner manufacturer.

K. Surface Retarder: Water-soluble chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed architectural concrete surface to depth of aggregate exposure specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**Master Builders Solutions**]
c. [**W. R. Meadows, Inc**]

2. Source Limitations: Obtain surface retarder from single source from single manufacturer.

L. Form Ties: Factory-fabricated, [**glass-fiber-reinforced plastic**][**internally disconnecting**][**or**][**removable**] ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties[**with tapered tie cone spreaders**] that, when removed, will leave holes no larger

than [3/4 inch (19 mm)][1 inch (25 mm)][1-1/4 inches (32 mm)][1-1/2 inches (38 mm)] in diameter on architectural concrete surface.

2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm)[**, after exposing aggregate,**] from architectural concrete surface.
3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) and not more than 1 inch (25 mm) in diameter, of color, as directed by the Owner
4. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place.

1. Manufacture bar supports in accordance with CRSI's "Manual of Standard Practice."
2. Where legs of wire bar supports contact forms, use [**gray, all-plastic**][**CRSI Class 1, gray, plastic-protected**][**or**][**CRSI Class 2, stainless steel**] bar supports.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 100 miles (160 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Indigenous Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**Type III**], [**gray**][**white**].
2. Pozzolans: [**ASTM C618, Class C**][**ASTM C618, Class F**][**ASTM C618, Class N**][**Not allowed**].
3. Slag Cement: [**ASTM C989/C989M, Grade 100 or Grade 120**][**Not allowed**].
4. Silica Fume: [**ASTM C1240**][**Not allowed**].

D. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 5S**][**Class 5M**][**Class 1N**] coarse aggregate or better, graded. Provide aggregates from single source from single manufacturer.

1. Alkali-Silica Reaction: Comply with one of the following:

a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at 16 days when tested in accordance with ASTM C1567.
c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).

2. Maximum Coarse-Aggregate Size: [1 inch (25 mm)][3/4 inch (19 mm)][1/2 inch (13 mm)][3/8 inch (10 mm)].
3. Gradation: [**Uniformly**][**Gap**] graded.

E. Normal-Weight Fine Aggregate: [**ASTM C33/C33M**][**or**][**ASTM C144**], manufactured or natural sand, free of materials with deleterious reactivity to alkali in cement, from same source for entire Project.

F. Air-Entraining Admixture: As specified in Section 033000 "Cast-in-Place Concrete."

G. Chemical Admixtures: As specified in Section 033000 "Cast-in-Place Concrete," and certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

H. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alabama Pigments Company, LLC**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]
   d. [**Butterfield Color, Inc.**]
   e. [**Dynamic Color Solutions, Inc**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Hoover Color Corporation**]
   h. [**Lambert Corporation**]
   i. [**Lanxess Corporation**]
   j. [**Master Builders Solutions**]
   k. [**Matcrete Inc.**]
   l. [**NewLook International, Inc.**]
   m. [**Proline Concrete Tools, Inc.**]
   n. [**QC Construction Products**]
   o. [**Scofield, a Business Unit of Sika Corporation**]
   p. [**Solomon Colors Inc.**]
   q. [**Stampcrete International, Ltd**]
   r. [**SureCrete Design Products, a Fenix Group SPC Company**]
   s. [**Venator Materials PLC**]

2. Source Limitations: Obtain color pigment from single source from single manufacturer.
3. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

I. Water and Water Used to Make Ice: ASTM C94/C94M, potable [**or**][**complying with ASTM C1602/C1602M, including all limits listed in Table 2 and requirements of paragraph 5.4**].

2.5 CURING MATERIALS

A. Comply with Section 0330000 "Cast-in-Place Concrete."

1. For integrally colored concrete, curing materials to be approved by color pigment manufacturer.
2. For concrete indicated to be sealed, curing materials to be compatible with sealer.

2.6 REPAIR MATERIALS

A. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C881/C881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements.

1. [**Types I and II, non-load bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES, GENERAL

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs, based on laboratory trial mixtures.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

D. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

E. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved [**design reference sample**][**field sample panels**][**mockups**].

2.8 CONCRETE MIXTURES

A. Class:

1. Normal-Weight Concrete: [**K**].
2. Exposure Class: **ACI 318 (ACI 318M)** [**F0**][**F1**][**F2**][**F3**][**S0**][**S1**][**S2**][**S3**][**W0**][**W1**][**C0**][**C1**][**C2**].
3. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at 28 days.
4. Maximum w/cm: 0.46.
5. Slump Limit: [**3 inches (75 mm), plus or minus 1 inch (25 mm)**][**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing**

admixture or plasticizing admixture at Project site].

6. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
7. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
   b. Exposure Classes F2 and F3: [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

8. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

2.9 CONCRETE MIXING

A. Architectural Concrete:

1. [**Ready mixed**][**or**][**project-site mixed**]. Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[**and ASTM C1116/C1116M**], and furnish batch ticket information.

   a. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
   b. For mixer capacity of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
   c. For mixer capacity larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
   d. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork, embedded items, and shoring and reshoring, and as specified in this Section.

B. Limit deflection of form-facing panels to not exceed **ACI 301 (ACI 301M)** requirements.

C. Limit cast-in-place architectural concrete surface irregularities, as follows:

1. Surface Finish-1.0: **ACI 117 (ACI 117M)** Class D, **1 inch (25 mm)**.
2. Surface Finish-2.0: **ACI 117 (ACI 117M)** Class B, **1/4 inch (6 mm)**.
3. Surface Finish-3.0: **ACI 117 (ACI 117M)** Class A, **1/8 inch (3.0 mm)**.

D. Construct forms to result in cast-in-place architectural concrete that complies with **ACI 117 (ACI 117M)**.

E. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

1. Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.

F. [**Chamfer**][**Do not chamfer**] exterior corners and edges of cast-in-place architectural concrete.

G. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.

H. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

I. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

J. Place form liners accurately to provide finished surface texture indicated.

1. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.
2. Secure form liners in place using fasteners that will not transfer impressions onto surface of concrete.
3. Prevent form liners from sagging and stretching in hot weather.
4. Seal joints of form liners and form-liner accessories to prevent mortar leaks.
5. Coat form liner with form-release agent.

3.2 INSTALLATION OF REINFORCEMENT AND ACCESSORIES

A. Comply with Section 032000 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F (10 deg C)** for [**24**] hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Schedule form removal to maintain surface appearance that matches approved [**design reference sample**][**field sample panels**][**mockups**].
2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
4. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated as directed by the Owner.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated.[**Embed keys at least 1-1/2 inches (38 mm) into concrete.**] Align construction joint within rustications attached to form-facing material.
3. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at top of footings or floor slabs.
5. Space vertical joints in walls [**as indicated on Drawings**]. Unless otherwise indicated on Drawings, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use [**bonding agent**][**epoxy-bonding adhesive**] at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated on Drawings, as directed by the Owner.

3.5 CONCRETE PLACEMENT

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.6 FINISHING FORMED SURFACES

A. Comply with Section 033000 "Cast-in-Place Concrete."

B. Architectural Concrete Finish: Match design reference sample, identified and described as indicated, as directed by the Owner.

C. As-Cast Surface Finishes: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. **ACI 301 (ACI 301M)** Surface Finish-1.0 (SF-1.0).
2. **ACI 301 (ACI 301M)** Surface Finish-2.0 (SF-2.0).
3. **ACI 301 (ACI 301M)** Surface Finish-3.0 (SF-3.0).

D. Final Concrete Finish: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

1. Smooth-rubbed finish.
2. Grout-cleaned rubbed finish.
3. Cork-floated finish.
4. Abrasive-blast finish.
5. Scrubbed finish.
6. High-pressure water-jet finish.
7. Bushhammer finish.

E. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

F. Maintain uniformity of architectural concrete finishes over construction joints unless otherwise indicated.

3.7 CONCRETE CURING

A. Comply with Section 033000 "Cast-in-Place Concrete" using identical curing procedures to that used for [**field sample panels**][**mockups**].

3.8 REPAIR

A. Comply with **ACI 301 (ACI 301M)**.

B. Repair damaged finished surfaces of cast-in-place architectural concrete when repairing, as directed by the Owner.

C. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved [**field sample panels**][**mockups**].

D. Remove and replace cast-in-place architectural concrete that cannot be repaired, as directed by the Owner.

3.9 FIELD QUALITY CONTROL

A. Comply with Section 033000 "Cast-in-Place Concrete."

3.10 CLEANING

A. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

B. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.

1. Protect other Work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

3.11 PROTECTION

A. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards

and barricades.

B. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

3.12 FINAL ACCEPTANCE

A. Final acceptance of completed architectural concrete Work by comparing approved [**design reference sample**][**field sample panels**][**mockups**] with installed Work, when viewed at a distance of [**20 feet (6 m)**], as directed by the Owner.

END OF SECTION 03 11 16 00

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Task	Specification	Specification Description
03 11 16 00	03 10 00 00	Concrete Forming and Accessories
03 11 16 13	03 10 00 00	Concrete Forming and Accessories
03 11 16 13	03 30 00 00	Cast-In-Place Concrete
03 11 16 13	03 11 16 00	Architectural Concrete
03 11 23 00	01 22 00 00	No Specification Required
03 11 23 00	03 10 00 00	Concrete Forming and Accessories
03 11 23 00	03 30 00 00	Cast-In-Place Concrete
03 15 00 00	03 10 00 00	Concrete Forming and Accessories
03 15 13 00	03 10 00 00	Concrete Forming and Accessories
03 15 13 13	03 10 00 00	Concrete Forming and Accessories
03 15 13 13	03 30 00 00	Cast-In-Place Concrete
03 15 13 16	03 10 00 00	Concrete Forming and Accessories
03 15 13 16	03 30 00 00	Cast-In-Place Concrete
03 15 16 00	03 10 00 00	Concrete Forming and Accessories
03 15 16 00	03 30 00 00	Cast-In-Place Concrete
03 15 19 00	03 10 00 00	Concrete Forming and Accessories
03 15 19 00	05 50 00 00	Metal Fabrications

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SECTION 03 20 00 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.
5. Mechanical splice couplers.
6. Structural thermal break insulated connection system.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Type III Environmental Product Declaration (EPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
13. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

C. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

D. Delegated Design Submittal: For structural thermal break insulated connection system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**delegated design engineer**][**testing and inspection agency**].

B. Delegated Design Engineer Qualifications: Include the following:

1. Experience providing delegated design engineering services of the type indicated.
2. Documentation that delegated design engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

C. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

D. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

E. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

C. Mockups: Reinforcing for cast-concrete formed surfaces, to demonstrate tolerances and standard of workmanship.

1. Build panel approximately [**100 sq. ft. (9.3 sq. m) for formed surface**] in the location indicated on Drawings or, if not indicated, as directed by the Owner.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage[**and to avoid damaging coatings on steel reinforcement**].

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design structural thermal break insulated connection system, including attachment to building construction.

B. Structural Performance of Structural Thermal Break Insulating Connection System: Structural thermal break insulated connection system to withstand the following loads and stresses:

1. Dead Loads: As indicated on Drawings.

a. Shear Load: As indicated on Drawings.
b. Bending Moment: As indicated on Drawings.

2. Live Loads: As indicated on Drawings.

a. Shear Load: As indicated on Drawings.
b. Bending Moment: As indicated on Drawings.

C. Seismic Performance of Structural Thermal Break Insulated Connection System: Structural thermal break Insulated connection system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
2. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site.
3. Regional Materials: Steel shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
4. Indigenous Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
5. Regional Materials: Steel shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

B. Reinforcing Bars: ASTM A615/A615M, [**Grade 60 (Grade 420)**][**Grade 75 (Grade 520)**][**Grade 80 (Grade 550)**][**Grade 100 (Grade 690)**], deformed.

C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

E. Galvanized Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100 (Grade 690)**][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

F. Epoxy-Coated Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100 (Grade 690)**][**ASTM A706/A706M**], deformed bars.
2. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each **12-inch (305-mm)** bar length.

G. Dual-Coated Reinforcing Bars: ASTM A1055/A1055M.

1. Steel Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 75 (Grade 520)**][**ASTM A615/A615M, Grade 80 (Grade 550)**][**ASTM A615/A615M, Grade 100**

(Grade 690)][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A1055/A1055M [**Type I**][**Type II**].
3. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

H. Stainless Steel Reinforcing Bars: ASTM A955/A955M, [**Grade 60 (Grade 420)**][**Grade 75 (Grade 520)**], [**Type 304**][**Type 316L**], deformed.

I. Steel Bar Mats: ASTM A184/A184M, fabricated from [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A615/A615M, Grade 40 (Grade 280)**][**ASTM A706/A706M**], deformed bars, assembled with clips.

J. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

K. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

L. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

M. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, [**plain**][**deformed**] steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, plain-steel bars, ASTM A775/A775M epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Mechanical Splice Couplers: **ACI 318 (ACI 318M)** [**Type 1**][**Type 2**], same material of reinforcing bar being spliced; [**compression-only type**][**tension-compression type**][**dowel-bar type**][**mechanical-lap type**].

E. Structural Thermal Break Insulated Connection System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Halfen USA, Inc.**]

2. Tension Rods: [**Carbon steel with crimped Type 316 stainless steel rods**][**Carbon steel, welded with ASTM A276/A276M, Type 316 stainless steel**].
3. Shear Reinforcement Rods: [**ASTM A276/A276M, Type 316 stainless steel tube**][**Carbon steel, welded with ASTM A276/A276M, Type 316 stainless steel bar**].
4. Pressure pads: ASTM A276/A276M, Type 316 stainless steel.
5. Insulation body: Polystyrene.

F. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than **0.0508 inch (1.2908 mm)** in diameter.

1. Finish: [**Plain**][**Galvanized**][**ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch (305-mm) wire length**].

G. Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than **0.0508 inch (1.2908 mm)** in diameter.

H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

I. Zinc Repair Material: ASTM A780/A780M.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than **1 inch (25 mm)**, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with **ACI 318 (ACI 318M)**.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or **24 inches (610 mm)**, whichever is greater.
2. Stagger splices in accordance with **ACI 318 (ACI 318M)**.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.

H. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed **12 inches (305 mm)**.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus **2 inches (50 mm)** for plain wire and **8 inches (200 mm)** for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

J. Dual-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

K. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material in accordance with ASTM A780/A780M.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as directed by the Owner.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with **ACI 117 (ACI 117M)**.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00 00

Task	Specification	Specification Description
03 21 00 00	03 20 00 00	Concrete Reinforcing
03 21 11 00	03 20 00 00	Concrete Reinforcing
03 21 11 00	03 30 00 00	Cast-In-Place Concrete
03 21 13 00	03 20 00 00	Concrete Reinforcing
03 21 16 00	03 20 00 00	Concrete Reinforcing
03 21 16 00	03 30 00 00	Cast-In-Place Concrete
03 22 00 00	03 20 00 00	Concrete Reinforcing
03 22 11 00	03 20 00 00	Concrete Reinforcing
03 22 11 00	03 30 00 00	Cast-In-Place Concrete
03 22 13 00	03 20 00 00	Concrete Reinforcing
03 22 13 00	03 30 00 00	Cast-In-Place Concrete
03 22 16 00	03 20 00 00	Concrete Reinforcing
03 22 16 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 30 00 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Fiber reinforcement.
5. Vapor retarders.
6. Floor and slab treatments.
7. Liquid floor treatments.
8. Curing materials.
9. Accessories.
10. Repair materials.
11. Concrete mixture materials.
12. Concrete mixture class types.
13. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 035300 "Concrete Topping" for concrete floor toppings.
6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 321313 "Concrete Paving" for concrete pavement and walks.
8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
    c. Ready-mix concrete manufacturer.
    d. Concrete Subcontractor.
    e. Special concrete finish Subcontractor.

2. Review the following:

    a. Special inspection and testing and inspecting agency procedures for field quality control.
    b. Construction joints, control joints, isolation joints, and joint-filler strips.
    c. Semirigid joint fillers.
    d. Vapor-retarder installation.
    e. Anchor rod and anchorage device installation tolerances.
    f. Cold- and hot-weather concreting procedures.
    g. Concrete finishes and finishing.
    h. Curing procedures.
    i. Forms and form-removal limitations.
    j. Shoring and reshoring procedures.
    k. Methods for achieving specified floor and slab flatness and levelness.
    l. Floor and slab flatness and levelness measurements.
    m. Concrete repair procedures.
    n. Concrete protection.
    o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
    p. Protection of field cured field test cylinders.
    q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral fillers.
10. Admixtures:

    a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.

11. Color pigments.
12. Fiber reinforcement.
13. Vapor retarders.
14. Floor and slab treatments.
15. Liquid floor treatments.

16. Curing materials.

    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

17. Joint fillers.
18. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Laboratory Test Reports: For [**liquid floor treatments**][**and**][**curing and sealing compounds**], indicating compliance with requirements for low-emitting materials.
4. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
    b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
    c. Third-party-verified Declare product label, designated "Red List Free."
    d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Steel-fiber reinforcement content.
11. Synthetic microfiber content.
12. Synthetic macrofiber content.
13. Intended placement method.
14. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

E. Samples: For [**manufacturer's standard colors for color pigment**][**vapor retarder**].

F. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.
5. Final finish for floors.
6. Floor treatment, if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral filler.
10. Admixtures.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with **ASTM E1155** **(ASTM E1155M)**.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties as directed by the Owner.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.

D. Field Quality-Control Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

E. Mockups: Cast concrete [**slab-on-ground**][**and**][**formed-surface**] panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship. Provide up to two batches of concrete to demonstrate the number of required mockups.

1. Slab-on-Ground: Build panel in the location indicated or, if not indicated, as directed by the Owner.

a. Divide panel into four equal panels to demonstrate saw joint cutting.

2. Formed Surfaces: Build panel in the location indicated or, if not indicated, as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

   a. Admixture dosage rates.
   b. Slump.
   c. Air content.
   d. Seven-day compressive strength.
   e. 28-day compressive strength.
   f. Evaluation of permeability-reducing admixtures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with **ACI 301 (ACI 301M)** as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below **40 deg F (4.4 deg C)** during the protection period, maintain delivered concrete mixture temperature within the temperature range required by **ACI 301 (ACI 301M)**.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than **35 deg F (1.7 deg C)**, other than reinforcing steel.

B. Hot-Weather Placement: Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)**, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed [**95 deg F (35 deg C)**][**other permitted limit**].
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

D. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**Type III**][**Type V**], [**gray**][**white**].
2. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, Portland-pozzolan**][**Type IL, portland-limestone**][**Type IT, ternary blended**] cement.
3. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [**Type GU, general use**][**Type HE, high early strength**][**Type MS, moderate sulfate resistance**][**Type HS, high sulfate resistance**][**Type MH, moderate heat of hydration**][**Type LH, low heat of hydration**].
4. Pozzolans: ASTM C618, Class C, F, or N.
5. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
6. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.
7. Silica Fume: ASTM C1240.

E. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, [**Class 3S**][**Class 3M**][**Class 1N**].
2. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**] nominal.
3. Fine Aggregate: ASTM C33/C33M.
4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with one of the following for each aggregate used:

   a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
   b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
   c. Alkali Content in Concrete: Not to exceed **4 lb./cu. yd. (2.37 kg/cu. m)** for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or **3 lb./cu. yd. (1.78 kg/cu. m)** for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with **ACI 301 (ACI 301M)**. Do not use this option with natural pozzolan or fly ash that has a calcium oxide content greater than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at one year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

F. Lightweight Aggregate: ASTM C330/C330M, [**1-inch (25-mm)**][**3/4-inch (19-mm)**][**1/2-inch (13-mm)**][**3/8-inch (10-mm)**] nominal maximum aggregate size.

1. Limit lightweight aggregate for internal curing to prewetted lightweight fine aggregate in accordance with ASTM C1761/C1761M.

G. Ground Calcium Carbonate or Aggregate Mineral Filler: ASTM C1797. Unless otherwise permitted, do not use mineral filler derived from carbonate sources in concrete for members assigned to Exposure Class S1, S2, or S3.

2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride[**in steel-reinforced concrete**].

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.
7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**MAPEI Corporation**]
4) [**Master Builders Solutions**]
5) [**Sika Corporation**]

8. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline or colloidal [**nano-**]silica admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**AQUAFIN, Inc**]
2) [**AVECS LLC**]
3) [**Barrier One, Inc.**]
4) [**Bone Dry Products, Inc.**]
5) [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
6) [**ISE Logik Industries, Inc.**]
7) [**Kryton International, Inc.**]

8) [**Master Builders Solutions**]
9) [**Penetron USA, Inc.**]
10) [**Xypex Chemical Corporation**]

b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of **200 psi (1.28 MPa)** for 14 days.

9. Moisture-Vapor-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, moisture-vapor-reducing, capable of reducing water absorption in and moisture-vapor emission from concrete (MVRA).

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**AQUAFIN, Inc**]
2) [**AVECS LLC**]
3) [**Barrier One, Inc.**]
4) [**Bone Dry Products, Inc.**]
5) [**Concure Products Inc.**]
6) [**ISE Logik Industries, Inc.**]
7) [**Kryton International, Inc.**]
8) [**Master Builders Solutions**]
9) [**Moxie International**]
10) [**Xypex Chemical Corporation**]

C. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alabama Pigments Company, LLC**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dynamic Color Solutions, Inc**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Hoover Color Corporation**]
h. [**Lambert Corporation**]
i. [**Lanxess Corporation**]
j. [**Master Builders Solutions**]
k. [**Matcrete Inc.**]
l. [**NewLook International, Inc.**]
m. [**Proline Concrete Tools, Inc.**]
n. [**QC Construction Products**]
o. [**Scofield, a Business Unit of Sika Corporation**]
p. [**Solomon Colors Inc.**]
q. [**Stampcrete International, Ltd**]
r. [**SureCrete Design Products, a Fenix Group SPC Company**]
s. [**Venator Materials PLC**]

2. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

D. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602/C1602M.

2.4 FIBER REINFORCEMENT

A. Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of [**1.5 inches (38 mm)**][**2 inches (50 mm)**][**2.4 inches (60 mm)**] long, with an aspect ratio of [**35 to 40**][**45 to 50**][**60 to 65**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bekaert**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**Sika Corporation**]

B. Carbon-Steel Cut Sheet Fiber: ASTM A820/A820M, Type 2, cut sheet, deformed, minimum of [**1.5 inches (38 mm)**][**2 inches (50 mm)**][**2.4 inches (60 mm)**] long, and aspect ratio of [**35 to 40**][**45 to 50**][**60 to 65**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Concrete Fiber Solutions**]
b. [**Fibercon International, Inc.**]
c. [**Sika Corporation**]

C. Synthetic Monofilament Microfiber: Monofilament polypropylene microfibers complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**][**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

D. Synthetic Fibrillated Microfiber: Fibrillated polypropylene microfibers complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**][**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]
e. [**Sika Corporation**]

E. Synthetic Macrofiber: Synthetic macrofibers complying with ASTM C1116/C1116M, Type III, [**1 to 2-1/4 inches (25 to 57 mm)**] long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FullForce by ABC Polymer Industries, LLC**]
c. [**GCP Applied Technologies Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2.5 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A[**, except with maximum water-vapor permeance of**]. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barrier-Bac; Inteplast Group**]
b. [**Foxfire Enterprises, Inc.**]
c. [**ISI Building Products**]
d. [**Poly-America, L.P.**]
e. [**R&D Workshop**]
f. [**Reef Industries, Inc.**]
g. [**Stego Industries, LLC**]
h. [**Tex-Trude**]
i. [**Viaflex**]
j. [**W. R. Meadows, Inc**]

B. Sheet Vapor Retarder, Class C: ASTM E1745, Class C[**, except with maximum water-vapor**

permeance of]; not less than **10 mils (0.25 mm)** thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ISI Building Products**]
   b. [**Stego Industries, LLC**]
   c. [**Tex-Trude**]
   d. [**Viaflex**]

C. Sheet Vapor Retarder/Termite Barrier: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.03 perms; complying with ICC Acceptance Criteria AC380. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Polyguard Products, Inc.**]

2. Low-Temperature Flexibility: Pass at **minus 15 deg F (minus 26 deg C)**; ASTM D146/D146M.
3. Puncture Resistance: **224 lbf (996 N)** minimum; ASTM E154/E154M.
4. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at **70 deg F (21 deg C)**; ASTM D570.
5. Hydrostatic-Head Resistance: **231 ft. (70 m)** minimum; ASTM D5385/D5385M.

D. Bituminous Vapor Retarder: ASTM E1993/E1993M, **110-mil- (2.8-mm-)** thick, semiflexible, seven-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**W. R. Meadows, Inc**]

2. Water-Vapor Permeance: **0.0011 grains/h x sq. ft. x inches Hg (0.063 ng/Pa x s x sq. m)** when tested in accordance with ASTM E154/E154M.
3. Tensile Strength: **156 lbf/inch (27.35 kN/m)** when tested in accordance with ASTM E154/E154M.
4. Puncture Resistance: **140 lbf (662 N)** when tested in accordance with ASTM E154/E154M.

2.6 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20

percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [**3/8-inch (10-mm)**][**No. 4 (4.75-mm)**][**No. 8 (2.36-mm)**] sieve.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Dayton Superior Corporation**]
   c. [**Lambert Corporation**]
   d. [**Laticrete International, Inc.**]
   e. [**Metalcrete Industries**]

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Laticrete International, Inc.**]
   c. [**Master Builders Solutions**]

C. Emery Dry-Shake Floor Hardener: [**Pigmented**][**Unpigmented**], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

1. Color: [**As indicated by manufacturer's designation**][**As directed by the Owner**].

D. Metallic Dry-Shake Floor Hardener: [**Pigmented**][**Unpigmented**], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: **[As indicated by manufacturer's designation][As directed by the Owner].**

E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dayton Superior Corporation**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**Kaufman Products, Inc**]
   d. [**Laticrete International, Inc.**]
   e. [**Master Builders Solutions**]
   f. [**Metalcrete Industries**]
   g. [**SpecChem, LLC**]
   h. [**US MIX Co.**]

F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Butterfield Color, Inc.**]
   c. [**Dynamic Color Solutions, Inc**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
   f. [**Kaufman Products, Inc**]
   g. [**Lambert Corporation**]
   h. [**Master Builders Solutions**]
   i. [**Scofield, a Business Unit of Sika Corporation**]
   j. [**SpecChem, LLC**]

2. Color: **[As indicated by manufacturer's designation][As directed by the Owner].**

2.7 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**SIMIRON Inc.**]
   b. [**Bone Dry Products, Inc.**]
   c. [**ChemMasters, Inc**]
   d. [**ChemTec International**]
   e. [**Concrete Sealers USA**]
   f. [**Curecrete Distribution Inc.**]
   g. [**Dayton Superior Corporation**]
   h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   i. [**HTS Chemical; Hi-Tech Systems**]
   j. [**Kaufman Products, Inc**]
   k. [**Laticrete International, Inc.**]
   l. [**MAPEI Corporation**]
   m. [**Master Builders Solutions**]
   n. [**NewLook International, Inc.**]
   o. [**Nox-Crete Products Group**]
   p. [**Penetron USA, Inc.**]
   q. [**PROSOCO, Inc**]

r. [**SINAK**]
s. [**Solomon Colors Inc.**]
t. [**SpecChem, LLC**]
u. [**Specialty Products Group**]
v. [**US SPEC, Division of US MIX Company**]
w. [**V-Seal Concrete Sealers & Specialty Coatings**]
x. [**Vexcon Chemicals Inc.**]
y. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Master Builders Solutions**]
k. [**Metalcrete Industries**]
l. [**Nox-Crete Products Group**]
m. [**Sika Corporation**]
n. [**SINAK**]
o. [**SpecChem, LLC**]
p. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
q. [**Vexcon Chemicals Inc.**]
r. [**W. R. Meadows, Inc**]

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: **8 ft. (2438 mm)** wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Nox-Crete Products Group**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Vexcon Chemicals Inc.**]
m. [**W. R. Meadows, Inc**]

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]

d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Master Builders Solutions**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**PROSOCO, Inc**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]

H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Master Builders Solutions**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**SpecChem, LLC**]
k. [**V-Seal Concrete Sealers & Specialty Coatings**]
l. [**Vexcon Chemicals Inc.**]
m. [**W. R. Meadows, Inc**]

I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Master Builders Solutions**]

j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**PROSOCO, Inc**]
m. [**Right Pointe**]
n. [**SpecChem, LLC**]
o. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
p. [**Vexcon Chemicals Inc.**]
q. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Right Pointe**]
l. [**SINAK**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.9 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [**epoxy resin with a Type A shore durometer hardness of 80**][**aromatic polyurea with a Type A shore durometer hardness range of 90 to 95**] in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

E. Floor Slab Protective Covering: **8 ft. (2438 mm)** wide cellulose fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**McTech Group, Inc.**]

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch (3 mm)** and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

2.11 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.12 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1-1/2 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1-1/2 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1-1/2 inches (40 mm)**][**30 inches (762 mm), plus or minus 2-1/2 inches (65 mm)**].
6. Air Content:

a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm)**

nominal maximum aggregate size][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cementitious materials.
8. Compressive strength or alternative methods of estimating in-place strength of concrete by maturity or other nondestructive testing with acceptable correlation between test results and concrete compressive strength.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Compressive strength or alternative methods of estimating in-place strength of concrete by maturity or other nondestructive testing with acceptable correlation between test results and concrete compressive strength.

C. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi**

(27.6 MPa)][3500 psi (24.1 MPa)][3000 psi (20.7 MPa)][**As indicated**] at [**28**][**56**][**90**] days.

3. Maximum w/cm Ratio : [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

D. Class D: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Total air content must not exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

E. Class E: Structural lightweight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Equilibrium Density: **115 lb/cu. ft. (1842 kg/cu. m)**, plus or minus **4 lb/cu. ft. (48.1 kg/cu. m)** in

accordance with ASTM C567/C567M.

4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Total air content must not to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.
8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**].
9. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
10. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

F. Class F: Normal-weight concrete used for concrete toppings.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**]at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

5. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

   a. Total air content must not to exceed 3 percent for concrete used in trowel-finished floors.

6. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (29.7 kg/cu. m)**]
7. Synthetic Microfiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**].
8. Synthetic Macrofiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [**4.0 lb/cu. yd. (2.4 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].

G. Class G: Normal-weight concrete used for building frame members.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

H. Class H: Normal-weight concrete used for building walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete**

containing 1-inch (25-mm) nominal maximum aggregate size][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

I. Class I: Normal-weight concrete used for interior metal pan stairs and landings:

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**3000 psi (20.7 MPa)**][**As indicated**] at 28 days.
3. Maximum w/cm Ratio: [**0.53**][**0.45**][**0.40**].
4. Maximum Size Aggregate: **1/2 inch (13 mm)**.
5. Slump Limit: **3 inches (75 mm)**, plus **1 inch (25 mm)** or minus **2 inches (50 mm)**.
6. Air Content: [**0**] percent, plus or minus 1.5 percent at point of delivery.
7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

J. Class J: Normal-weight concrete used for exterior retaining walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [**Class F0**][**Class F1**][**Class F2**][**Class F3**][**Class S0**][**Class S1**][**Class S2**][**Class S3**][**Class W0**][**Class W1**][**Class W2**][**Class C0**][**Class C1**][**Class C2**].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**][**As indicated**] at [**28**][**56**][**90**] days.
3. Maximum w/cm Ratio: [**0.55**][**0.50**][**0.45**][**0.40**].
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**][**5 inches (125 mm), plus or minus 1.5 inches (40 mm)**][**maximum 9 inches (225 mm), plus or minus 1.5 inches (40 mm)**] for concrete.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**][**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**].
6. Air Content:

   a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
   b. Exposure Classes F2 and F3: [**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**][**6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**][**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**][**0.30**][**0.15**] percent by weight of cement.

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

A. Comply with **ACI 117 (ACI 117M)**.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.5 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than **6 inches (150 mm)**, sealing vapor retarder to concrete.
4. Lap joints **6 inches (150 mm)** and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by **6 inches (150 mm)** on all sides and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.6 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. As directed by the Owner, notify the Owner and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301 (ACI 301M)**.

a. Do not use vibrators to transport concrete inside forms.
b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches (150 mm)** into preceding layer.
c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings as directed by the Owner.
2. Place joints perpendicular to main reinforcement.

   a. Continue reinforcement across construction joints unless otherwise indicated.

3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls [**as indicated on Drawings**]. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least [**one-fourth**] of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3 mm)**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch (3-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.8 APPLICATION OF FINISHING FLOORS AND SLABS

A. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of **1/4 inch (6 mm)** in one direction.
3. Apply scratch finish to surfaces [**to receive concrete floor toppings**][**to receive mortar setting beds for bonded cementitious floor finishes**].

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with **ACI 117 (ACI A117M)** tolerances for conventional concrete.
3. Apply float finish to surfaces [**to receive trowel finish**][**and**][**to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo**].

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces [**exposed to view**][**or**][**to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system**].
7. Finish surfaces to the following tolerances, in accordance with **ASTM E1155 (ASTM E1155M)**, for a randomly trafficked floor surface:

   a. Slabs on Ground:

      1) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

2) Specified overall values of flatness, FF 35; and of levelness, FL 25; with minimum local values of flatness, FF 24; and of levelness, FL 17.
3) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.
4) Specified overall values of flatness, FF 50; and of levelness, FL 35; with minimum local values of flatness, FF 40; and of levelness, FL 24.

b. Suspended Slabs:

1) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.
2) Specified overall values of flatness, FF 35; and of levelness, FL 20; with minimum local values of flatness, FF 24; and of levelness, FL 15.
3) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

D. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces [**indicated on Drawings**][**where ceramic or quarry tile is to be installed by either thickset or thinset method**]. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish as directed by the Owner before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish as directed by the Owner before application.

F. Slip-Resistive Finish: Before final floating, apply slip-resistive [**aggregate**][**aluminum granule**] finish to concrete stair treads, platforms, and ramps, as indicated on Drawings.

1. Apply in accordance with manufacturer's written instructions and as follows:

a. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**] of dampened slip-resistive [**aggregate**][**aluminum granules**] over surface in one or two applications.
b. Tamp aggregate flush with surface, but do not force below surface.
c. After broadcasting and tamping, apply float finish.
d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive [**aggregate**][**aluminum granules**].

G. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**] unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.9 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

   a. Patch voids larger than **1-1/2 inches (38 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1 inch (25 mm)**.
   c. Tie holes do not require patching.
   d. Surface Tolerance: **ACI 117 (ACI 117M)**, Class D.
   e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.

2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

   a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1/4 inch (6 mm)**.
   c. Patch tie holes.
   d. Surface Tolerance: **ACI 117 (ACI 117M)**, Class B.
   e. Locations: Apply to concrete surfaces [**exposed to public view,**][**to receive a rubbed finish,**][**or to be covered with a coating or covering material applied directly to concrete**].

3. ACI 301 (ACI 301M) Surface Finish SF-3.0:

   a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
   b. Remove projections larger than **1/8 inch (3 mm)**.
   c. Patch tie holes.
   d. Surface Tolerance: **ACI 117 (ACI 117M)** Class A.
   e. Locations: Apply to concrete surfaces [**exposed to public view,**][**to receive a rubbed finish,**][**or to be covered with a coating or covering material applied directly to concrete**].

B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

   a. Perform no later than one day after form removal.
   b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
   c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
   d. Maintain required patterns or variances as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].

2. Grout-Cleaned Rubbed Finish:

   a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
   b. Do not clean concrete surfaces as Work progresses.
   c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
   d. Wet concrete surfaces.

e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
f. Maintain required patterns or variances as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform abrasive blasting after compressive strength of concrete exceeds **2000 psi (13.8 MPa)**.
2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
3. Surface Continuity:

a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
b. Maintain required patterns or variances in depths of blast to match [**design reference sample**][**field sample panels**][**mockups**].

4. Abrasive Blasting:

a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
b. Determine type of nozzle pressure and blasting techniques required to match field sample.
c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:

1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of **1/16 inch (1.5 mm)**.
3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of **1/4 inch (6 mm)**.
4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of **1/4 to 1/2 inch (6 to 13 mm)**.

d. Maintain required patterns or variances in reveal projection to match [**design reference sample**][**field sample panels**][**mockups**].

D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of **4500 psi (31 MPa)**.
2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
4. Maintain required patterns or variances in reveal projection to match [**design reference sample**][**field sample panels**][**mockups**].

E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of **4500 psi (31 MPa)**.
2. Surface Continuity:

a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

3. Surface Cut:

a. Maintain required depth of cut and general aggregate exposure.
b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

4. Remove impressions of formwork and form facings with exception of tie holes.
5. Maintain required patterns or variances of cut as shown on Drawings or to match [**design reference sample**][**field sample panels**][**mockups**].
6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, windbreaks, or similar devices.

3.10 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**] high unless otherwise indicated on Drawings, and extend base not less than **6 inches (150 mm)** in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**] at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
b. Cast anchor-bolt insert into bases.
c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.11 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with **ACI 301 (ACI 301M)** for cold weather protection during curing.
2. Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)** for hot-weather protection during curing.
3. Maintain moisture loss no more than **0.2 lb/sq. ft. x h (1 kg/sq. m x h)**, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
b. Continuous Sprinkling: Maintain concrete surface continuously wet.
c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

d. Floors To Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.

3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors To Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped **6 inches (150 mm)** and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors To Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

g. Floors To Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than [**three**][**seven**][**14**][**28**] days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface has received a float finish or abrasive surface preparation.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [**one**][**six**] month(s).

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least **2 inches (50 mm)** deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas as directed by the Owner.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a **No. 16 (1.18-mm)** sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of **0.01 inch (0.25 mm)** spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than **1/2 inch (13 mm)** in any dimension to solid concrete.

   a. Limit cut depth to **3/4 inch (19 mm)**.
   b. Make edges of cuts perpendicular to concrete surface.
   c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
   d. Fill and compact with patching mortar before bonding agent has dried.
   e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

   a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
   b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as directed by the Owner.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

   a. Correct low and high areas.
   b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of **0.01 inch (0.25 mm)** wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of **1/4 inch (6 mm)** to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes **1 inch (25 mm)** or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a **3/4-inch (19-mm)** clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes **1 inch (25 mm)** or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, as directed by the Owner, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, as directed by the Owner.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: [**the Owner**][**Engage**] a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
2. Testing agency to immediately report to The Owner and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, the Owner within 48 hours of inspections and tests, as directed by the Owner.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and **ACI 301 (ACI 301M)**, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
        13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94/C94M.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as directed by the Owner.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding **5 cu. yd. (4 cu. m)**, but less than **25 cu. yd. (19 cu. m)**, plus one set for each additional 1**50 cu. yd. (114 cu. m)** or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests as needed.

3. Slump Flow: ASTM C1611/C1611M:

   a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests as needed.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; [**ASTM C173/C173M volumetric method, for structural lightweight concrete**].

   a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:

   a. One test hourly when air temperature is **40 deg F (4.4 deg C)** and below or **80 deg F (27 deg C)** and above, and one test for each composite sample when strength test specimens are cast.

6. Concrete Density: ASTM C138/C138M:

   a. One test for each composite sample when strength test specimens are cast.

7. Unit Weight: ASTM C138/C138M density of fresh structural lightweight concrete.

   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture. The fresh density should be consistent with that associated with the equilibrium density within a tolerance of plus or minus 4 lb/ft.3.

8. Compression Test Specimens: ASTM C31/C31M:

   a. Cast and standard cure two sets of [**two**][**three**][**four**] **6 inches (150 mm)** by **12-inches (300 mm)** or **4-inch (100-mm)** by **8-inch (200-mm)** cylindrical specimens for each composite sample.
   b. Cast, and field cure [**two**] sets of [**two**][**three**][**four**] standard cylindrical specimens for each composite sample.

9. Compressive-Strength Tests: ASTM C39/C39M.

   a. Test one set of [**two**][**three**][**four**] standard cured specimens at seven days and one set of two specimens at 28 [**other age**] days.
   b. Test one set of [**two**][**three**][**four**] field-cured specimens at seven days and one set of two specimens at 28 days.
   c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

10. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
11. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by

more than **500 psi (3.4 MPa)** if specified compressive strength is **5000 psi (34.5 MPa)**, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than **5000 psi (34.5 MPa)**.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by the Owner.

        1) Acceptance criteria for concrete strength to be in accordance with **ACI 301 (ACI 301M)**, Section 1.7.6.3.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with **ASTM E1155 (ASTM E1155M)** within [**24**][**48**][**72**] hours of completion of floor finishing and promptly report test results, as directed by the Owner.

3.16 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using floor slab protective covering.

END OF SECTION 03 30 00 00

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Task	Specification	Specification Description
03 30 53 00	03 30 00 00	Cast-In-Place Concrete
03 31 00 00	03 30 00 00	Cast-In-Place Concrete
03 31 13 00	03 30 00 00	Cast-In-Place Concrete
03 31 13 00	32 13 13 00	Concrete Paving
03 31 13 00	32 13 16 00	Decorative Concrete Paving
03 31 16 00	03 30 00 00	Cast-In-Place Concrete
03 35 00 00	03 30 00 00	Cast-In-Place Concrete
03 35 13 00	03 30 00 00	Cast-In-Place Concrete
03 35 16 00	03 30 00 00	Cast-In-Place Concrete
03 35 19 00	03 30 00 00	Cast-In-Place Concrete
03 35 23 00	03 30 00 00	Cast-In-Place Concrete
03 35 26 00	03 30 00 00	Cast-In-Place Concrete
03 35 29 00	03 30 00 00	Cast-In-Place Concrete
03 35 33 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 35 43 00 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stain materials.
2. Liquid floor treatments.
3. Polished concrete surface finish requirements.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for new concrete designed for polished concrete finishing, including concrete materials, mixture design, placement procedures, initial finishing, and curing.

1.2 DEFINITIONS

A. Aggregate Exposure Class: Visual observation of polished floor aggregate surface exposure area after grinding and polishing operations. Aggregate exposure class ranges are A, B, and C.

B. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

C. Distinctness of Image (DOI): The distinctness (clarity) of images reflected by the glossy coating surface appearance of the polished concrete finish appearance levels. The transmission of this reflection is measured in accordance with ASTM D5767.

D. Haze: The cloudiness or milky appearance of images from objects produced by reflection in a polished concrete surface. The measurement of this appearance is defined in accordance with ASTM D4039. The test method reading is put into a calculation resulting in a Haze Index value.

E. Specular Gloss: A reflectance value determined by a single measurement of gloss from shining a known amount of light at a surface within a specific angle of illumination in accordance with ASTM D523.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with polished concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place concrete subcontractor.
e. Polished concrete finishing subcontractor.

f. Architect.
g. The Owner.

2. Review [**concrete slab design for compressive strength, flatness and levelness,**][**cold- and hot-weather concreting procedures,**][**curing procedures,**][**sequencing,**][**construction joints,**][**concrete repair procedures,**][**concrete finishing,**] polished concrete appearance and aggregate exposure requirements, polished concrete mockups, and protection of polished concrete.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Laboratory Test Reports: For [**stains**][**and**][**liquid floor treatments**], indicating compliance with requirements for low-emitting materials.

C. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product requiring color selection.

E. Samples for Verification: Actual sample of finished products for each type of exposed color.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. An installer experienced in performing polished concrete finishing with a minimum of five previous projects similar in material, design, and extent to that indicated for this Project.
2. Trained and certified by manufacturer of polished concrete system materials.
3. Concrete Polishing Craftsman of the Concrete Polishing Council.

B. Polished Concrete Standards: Comply with ACI 310.1.

1.6 MOCKUPS

A. Build mockups [**10 by 10 ft (3.05 by 3.05 m)**]to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location of the Work and of the size indicated or, if not indicated, as directed by the Owner for [**newly placed**][**existing**] concrete.
2. Demonstrate surface preparation, [**coloring,**][**pattern,**][**curing,**] tested aggregate exposure, tested polish appearance, sealing and protecting of polished concrete.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Remove rejected mockups.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as needed for other construction activities.

B. Ambient Conditions: Ensure installation location and Project ambient conditions comply with manufacturers written instructions.

PART 2 - PRODUCTS

2.1 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]

B. Penetrating Stain: Coloring agents used to add consistent color to polished concrete surfaces without coloring the aggregates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]

h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]

C. VOC Content: For field applications[**that are inside the weatherproofing system**], verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Primers, Sealers, and Undercoaters: 100 g/L.
2. Clear Wood Finishes, Varnishes: 275 g/L.
3. Clear Wood Finishes, Lacquers: 275 g/L.
4. Shellacs, Clear: 730 g/L.
5. Stains: 100 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

F. VOC Emissions: For field applications inside the building, verify wall paints contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.2 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear liquid materials for the applications of cleaning solutions, densifiers, and sealers that strengthen or protect polished concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Floor Products**]
b. [**AmeriPolish**]
c. [**ARDEX Americas**]
d. [**AWRC Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]

i. [**Moxie International**]
j. [**NewLook International, Inc.**]
k. [**Nox-Crete Products Group**]
l. [**PROSOCO, Inc**]
m. [**QuestMark**]
n. [**Vexcon Chemicals Inc.**]

2. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 POLISHED CONCRETE SURFACE FINISH REQUIREMENTS

A. Aggregate Exposure Class: [**Class A Cement Fines 85 to 95 percent fines; 5 to 15 percent fine aggregate**][**Class B Fine Aggregate 85 to 95 percent fine aggregate; 5 to 15 percent blend of fines and coarse aggregate**][**Class C Coarse Aggregate 10 to 20 percent cement fines and fine aggregates**].

B. Polish Concrete Appearance Levels: [**Level 1: Flat (Ground) up to 100-grit polish; DOI 0 to 9; Haze Reading less than 10**][**Level 2: Satin (Honed) up to 200- to 400-grit polish; DOI 10 to 39; Haze Reading less than 10; Reflective Sheen: Low to medium**][**Level 3: Polished (Polished Gloss up to 400- to 800-grit polish; DOI 40 to 69; Haze Reading less than 10; Reflective Sheen: Medium to high**][**Level 4: Highly Polished (Very High Gloss) 800-grit and higher polish; DOI 70 to 100; Haze Reading less than 10; Reflective Sheen: High to highest**][**Match design reference sample**].

C. Slip Resistance: Minimum Dynamic Coefficient of Friction (DCOF) of 0.42. Provide required slip resistance based on final gloss level and determined by the Concrete Polishing Council.

2.4 ACCESSORIES

A. Repair Materials: As recommended in writing by manufacturer to repair and fill cracks, and repair surfaces compatible with polishing materials.

B. Water: Potable.

C. Cleaning Agents: As recommended in writing by manufacturer.

2.5 POLISHING EQUIPMENT

A. Equipment and Supplies: Provide equipment and supplies, not limited to, the concrete grinding and concrete polisher equipment, tooling and polishing diamonds for the polished concrete finishing Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete substrates are acceptable for grinding, polishing and product installation as recommended by manufacturer.

B. Do not begin Work until unsatisfactory conditions have been addressed and corrected.

3.2 PREPARATION

A. Verify that concrete substrate preparation is in accordance with manufacturer's written instructions.

B. Clean surfaces free of dust, dirt and other contaminates incompatible with liquids applied products and polishing.

C. Clean and seal cracks as recommended by manufacturer.

D. Prepare, clean and fill joints with joint filler as recommended in writing by manufacturer.

E. Clean surface completely of any dust with cleaning solution as recommended in writing by manufacturer.

3.3 APPLICATION

A. Machine grind floor surfaces progressively to receive aggregate and polish appearance levels indicated to match approved mockup.

B. Scoring: Score decorative jointing in concrete surfaces **1/16 inch (1.6 mm)** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [**after**][**before**] staining.

1. Joint Width: [**3/8 inch (10 mm)**].

C. Apply penetrating stain densifier treatment for polished concrete in polishing sequence and in accordance with manufacturer's written instructions, allowing recommended drying time between successive coats.

D. Apply reactive color stain for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

E. Apply color dyes for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

F. Apply sealers to polished concrete in polishing sequence and in accordance with manufacturers' written instructions.

G. Continue progressively polishing to aggregate and polish appearance levels to match approved mockup for final finish appearance.

H. Visually inspect to remove defects and repolish areas that are defective. Repolish those areas that do not meet specified aggregate and polish levels per approved mockup.

I. Complete edges of floor finish that adjoins surrounding floor areas in a sharp and clean manner.

J. Neutralize and clean polished floor surfaces.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner**][**Engage**] a qualified testing and inspecting agency to perform tests at three random locations for areas up to **100 sq. ft. (465 sq. m)** and inspections and to submit reports.

B. Measure polish specular gloss level, DOI, and haze as specified; repolish if required to achieve Project requirements.

C. Verify aggregate exposure as specified. Machine surfaces if required to achieve Project requirements.

D. Verify compliance of slip resistance to comply with specified slip-resistance rating.

E. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Control and dispose of waste products produced by grinding and polishing operations.

B. Protect installed polished concrete surfaces from damage during construction in accordance with manufacturer's written instructions.

END OF SECTION 03 35 43 00

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Task	Specification	Specification Description
03 35 43 00	03 30 00 00	Cast-In-Place Concrete
03 35 63 00	03 30 00 00	Cast-In-Place Concrete
03 35 66 00	03 30 00 00	Cast-In-Place Concrete
03 35 83 00	03 30 00 00	Cast-In-Place Concrete
03 37 00 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 37 13 00 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-mix shotcrete.
2. Wet-mix shotcrete.

1.2 DEFINITIONS

A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.

B. Dry-Mix Shotcrete: Shotcrete with most of the mixing water added at nozzle.

C. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Require representatives of each entity directly concerned with shotcrete to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for shotcrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Shotcrete Installer.

2. Review methods and procedures related to shotcrete, but not limited to, the following:

   a. Qualification data, equipment, and facilities needed to make progress and avoid delays.
   b. Shotcrete finishes and finishing.
   c. Cold- and hot-weather shotcreting procedures.
   d. Curing procedures
   e. Construction joints.
   f. Forms and form-removal limitations.
   g. Reinforcement accessory installation.
   h. Shotcrete repair procedures.
   i. Protection of shotcrete.

3. Before submitting design mixtures, review each shotcrete design mixture and examine procedures for ensuring quality of shotcrete materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Design Mixtures: For each shotcrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. For predampened dry-mix mixtures, indicate amounts of mixing water to be added to the dry-mix materials before mixing and conveying through the delivery hose.

D. Shop Drawings: For shotcrete installation.

1. Include plans, elevations, sections, and support and anchor details.
2. Detail fabrication, bending, and placing of reinforcement; number and location of splices; and special reinforcement required for openings through shotcrete structures.
3. Detail formwork fabrication, assembly, and support.
4. Indicate locations of proposed construction joints.

E. Samples: For [**waterstops, approximately 24 inches (600 mm) long**][**and**][**each exposed product and for each color and finish specified, approximately 24 by 24 by 2 inches (600 by 600 by 50 mm) in size**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**testing agency**][**and**][**preconstruction testing service**].

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Form materials.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.

C. Preconstruction Test Reports: For shotcrete.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer employing nozzle operators for Project, each of whom [**attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests**][**is**

ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical Position][**is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical and Overhead Positions**][**is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position**][**and**][**is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions**] as appropriate to the required shotcrete work.

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

C. Standard: Comply with ACI 506.2, "Specification for Shotcrete," unless otherwise indicated.

D. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution, as directed by the Owner.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner**][**Engage**] a qualified testing agency to perform preconstruction testing on shotcrete.

1. Produce and test shotcrete test panels before shotcrete placement according to requirements in ACI 506.2 for each design mixture, shooting orientation, and nozzle operator. Produce test panels with dimensions of **24 by 24 inches (600 by 600 mm)** minimum and of average thickness of shotcrete, but not less than **3-1/2 inches (90 mm)**.
2. From each test panel, testing agency to obtain six test specimens: one set of three specimens unreinforced, and one set of three specimens reinforced. Agency will perform the following:

   a. Strength Testing: Test each set of unreinforced specimens for compressive strength according to ASTM C42/C42M.
   b. Core Grading: Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.[**Avoid damaging coatings on steel reinforcement.**]

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practical sizes to minimize number of joints.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60** **(Grade 420)**, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Galvanized Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

D. Plain-Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

E. Welded Wire Reinforcement: ASTM A1064/A1064M, [**plain, fabricated from as-drawn steel wire**][**plain, fabricated from galvanized-steel wire**][**deformed**], furnished in flat sheet.

F. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice" and as follows:

1. For uncoated reinforcement, use [**all-plastic**][**CRSI Class 1, plastic-protected**][**or**][**CRSI Class 2, stainless steel**] bar supports.
2. For zinc-coated reinforcement, use [**galvanized wire or dielectric-polymer-coated wire**][**or**][**all-plastic**] bar supports.

G. Reinforcing Anchors: ASTM A36/A36M, unheaded rods or ASTM A307, Grade A, hex-head bolts; carbon steel; and carbon-steel nuts.

1. Finish: [**Plain, uncoated**][**Hot-dip zinc coating, ASTM A153/A153M**].

H. Zinc Repair Material: ASTM A780/A780M, zinc-based solder, paint containing zinc dust, or sprayed zinc.

2.3 SHOTCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, [**Type I**][**or**][**Type III**]. Use only one brand and type of cement for Project.

1. Fly Ash: ASTM C618, Class C or Class F.
2. Slag Cement: ASTM C989/C989M, Grade 100 or Grade 120.
3. Silica Fume: ASTM C1240, amorphous silica.

B. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, portland-limestone**][**Type IT, ternary blended**] cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, from a single source, and as follows:

1. Combined Aggregate Size: ACI 506R or ASTM C1436, Grading [**No. 1**][**No. 2**] sieve analysis.
2. Deleterious Substances: As specified for [**fine aggregate**][**coarse-aggregate Class 3S**][**coarse-aggregate Class 3M**][**coarse-aggregate Class 1N**] according to ASTM C33/C33M.

D. Lightweight Aggregates: ASTM C330/C330M.

1. Combined Aggregate Size: ACI 506R, Grading [**No. 1**][**No. 2**] sieve analysis.

E. Water: Potable, complying with ASTM C94/C94M, and free from deleterious materials that may affect color stability, setting, or strength of shotcrete.

F. Carbon-Steel Fiber: ASTM A820/A820M, [**Type I, cold-drawn wire**][**or**][**Type II, cut sheet**], deformed.

1. Nominal Length: [**0.5 inch (13 mm)**][**1 inch (25 mm)**][**1.5 inches (38 mm)**].
2. Aspect Ratio: [**35 to 40**][**45 to 50**][**60 to 65**].

G. Synthetic Fiber: [**Monofilament**][**or**][**fibrillated**] polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C1116/C1116M, Type III, [**1 to 1.5 inches (25 to 38 mm)**][**1.5 to 2 inches (38 to 50 mm)**] long.

H. Ground Wire: High-strength steel wire, 0.8 to 1.0 mm in diameter.

I. Joint Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

J. Admixtures: ASTM C1141/C1141M, Class A (liquid) or Class B (nonliquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain no more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.

1. Accelerating Admixture, Conventional: ASTM C494/C494M, Type C or Type E.
2. Pozzolanic Admixture: Fly ash, slag cement, and silica fume as limited in "Portland Cement" Paragraph in this article.
3. Coloring Admixture: ASTM C979/C979M, synthetic mineral-oxide pigment or colored, water-reducing admixture, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
4. Air-Entraining Admixture: As limited in "Shotcrete Mixtures" Article.

2.4 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: [**Flat dumbbell without center bulb**][**Ribbed without center bulb**][**As indicated**].
2. Dimensions: [**4 inches by 3/16 inch thick (100 mm by 4.75 mm thick)**]; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: [**Flat dumbbell without center bulb**][**Ribbed without center bulb**][**As indicated**].
2. Dimensions: [**4 inches by 3/16 inch thick (100 mm by 4.75 mm thick)**]nontapered.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, **3/4 by 1 inch (19 by 25 mm)**.

D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free, hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete; **3/8 by 3/4 inch (10 by 19 mm)**.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** dry, or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Curing Compound: ASTM C309, Type 1, Class B; clear, [**waterborne**][**solvent-borne**], membrane-forming curing compound.

2.6 SHOTCRETE MIXTURES

A. Source Limitations for Shotcrete: Obtain each color, size, type, and variety of shotcrete material and shotcrete mixture from single manufacturer with resources to provide shotcrete of consistent quality in appearance and physical properties.

B. Design Mixtures: Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixture or field test data, or both.

C. Cementitious Materials Replacing Portland Cement: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

D. Cementitious Materials, Maximum Content: Limit use of [**fly ash**][**slag cement**][**and**][**silica fume**] to not exceed, in combination, [**25**] percent of portland cement by weight.

E. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by **ACI 301 (ACI 301M)**.

F. Admixtures: Use admixtures according to manufacturer's written instructions.

G. Coloring Admixture: Add coloring admixture to shotcrete mixture according to manufacturer's written instructions and to result in hardened shotcrete color consistent with approved mockup.

H. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

I. Shotcrete Mixture: Proportion mixture to provide shotcrete with the following properties:

1. Compressive Strength (28 Days): [**5000 psi (34.5 MPa)**][**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**].
2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having an air content before pumping of [**7**][**8**] percent with a tolerance of plus or minus 1-1/2 percent.
3. Carbon-Steel Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of [**50 lb/cu. yd. (30 kg/cu. m)**][**100 lb/cu. yd. (60 kg/cu. m)**].
4. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written

instructions, at a rate of [**1.5 lb/cu. yd. (0.90 kg/cu. m)**][**5 lb/cu. yd. (3 kg/cu. m)**].
5. Color: [**As indicated by manufacturer's designation**][**as directed by the Owner**].
6. Color of [**Flash**][**Finish**] Coat: [**As indicated by manufacturer's designation**][**as directed by the Owner**].

2.7 SHOTCRETE EQUIPMENT

A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.

B. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.

1. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
2. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.

C. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.8 BATCHING AND MIXING

A. Dry-Mix Process: Measure mixture proportions by weight batching according to ASTM C94/C94M or by volume batching complying with ASTM C685/C685M requirements.

1. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
2. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.

B. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**] and furnish batch ticket information.

1. Comply with ASTM C685/C685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Concrete and Masonry Substrates: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and **1/2 inch (13 mm)** deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces to saturated, surface-dry condition before shotcreting.

1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.

B. Earth Substrates: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.

C. Rock Substrates: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.[**Dampen surfaces to saturated, surface-dry condition before shotcreting.**]

D. Steel Substrates: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3.2 FORMS

A. Design, erect, support, brace, and maintain forms, according to **ACI 301 (ACI 301M)**, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.

1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.

B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

3.3 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.

C. Securely embed reinforcing anchors into existing substrates, located as required.

D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain minimum concrete cover.

E. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.

F. Install welded wire reinforcement in largest practical sheets on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A780/A780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

3.4 JOINTS

A. General: Construct joints at locations as directed by the Owner.

B. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.

C. Contraction Joints: Construct contraction joints in shotcrete using saw cuts **1/8-inch- (3-mm-)** wide by one-third of slab depth or joint-filler strips **1/4-inch- (6-mm-)** wide by one-third of shotcrete depth unless otherwise indicated.

1. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
2. Space joints at [**15 feet (4.5 m) o.c.**][**centers indicated**] horizontally and vertically.
3. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
4. Where shooting over an existing substrate joint, align new shotcrete joint with existing joint.

3.5 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

C. Prevent waterstop displacement during shotcrete application.

3.6 ALIGNMENT CONTROL

A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.7 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.8 APPLICATION

A. Apply shotcrete applied by [**dry-mix**][**or**][**wet-mix**] process and according to ACI 506.2.

B. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.

C. Moisten wood forms immediately before placing shotcrete where form coatings are not used.

D. Apply [**dry-mix shotcrete materials within 45 minutes after predampening**][**and**][**wet-mix shotcrete materials within 90 minutes after batching**].

E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.

1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
2. Remove and dispose of cuttings during the trimming or rodding process to prevent unconsolidated material from falling onto lower reinforcement.

F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.

G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.

H. Do not permit shotcrete to sag, slough, or dislodge.

I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.

J. Do not disturb shotcrete surfaces before beginning finishing operations.

K. Remove ground wires or other alignment-control devices after shotcrete placement.

L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.

M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by **ACI 117 (ACI 117M)**, increased by a factor of two.

N. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. Discontinue shotcreting when ambient temperature is **40 deg F (4.4 deg C)** and falling.
2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than **50 deg F (10 deg C)** and no more than **90 deg F (32 deg C)**.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

O. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305.1 when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:

1. Cool ingredients before mixing to maintain, at time of placement, shotcrete temperature below [**100 deg F (38 deg C) for dry mix**][**and**][**90 deg F (32 deg C) for wet mix**].
2. Reduce temperature of reinforcing steel and receiving surfaces below **100 deg F (38 deg C)** before shotcreting.

3.9 SURFACE FINISHES

A. General: Finish shotcrete according to descriptions in ACI 506R.

B. Natural Finishes:

1. Gun Finish: Natural undisturbed finish as sprayed.
2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.

C. Flash-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to **1/4-inch (6-mm)** coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve to provide a finely textured finish.

D. Flash-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to **1/4-inch (6-mm)** coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve, and apply [**wood-float**][**rubber-float**][**brush-float**][**steel-trowel**] finish.

E. Finish-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, **1/4 to 1 inch (6 to 25 mm)** thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve to provide a finish of uniform texture and appearance.

F. Finish-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, **1/4 to 1 inch (6 to 25 mm)** thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding **No. 4 (4.75-mm)** sieve, and apply [**wood-float**][**rubber-float**][**brush-float**][**steel-trowel**] finish.

3.10 CURING

A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.

B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.

C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Water-saturated absorptive covers or moisture-retaining covers. Lap and seal sides and ends of covers with **12-inch (300-mm)** lap over adjacent covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Apply curing compound to natural gun and flash-coat finishes at rate of **1 gal./100 sq. ft.**

(1 L/2.5 sq. m).

D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 FORM REMOVAL

A. Forms not supporting weight of shotcrete may be removed after curing for 24 consecutive hours at not less than **50 deg F (10 deg C)**, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.

1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Air Content: ASTM C173/C173M, volumetric method or ASTM C231/C231M, pressure method; one test for each compressive-strength test for each mixture of air-entrained, wet-mix shotcrete measured before pumping.

C. Shotcrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when **80 deg F (27 deg C)** and above, and one test for each set of compressive-strength specimens.

D. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mixture and for each workday or for every [**50 cu. yd. (38 cu. m)**] of shotcrete placed, whichever is less. Produce test panels with dimensions of **24 by 24 inches (600 by 600 mm)** minimum and of average thickness of shotcrete, but not less than **4-1/2 inches (115 mm)**. Testing agency will obtain sets of test specimens from each test panel.

1. Compressive Strength Testing: One set of three unreinforced specimens. Test each set of unreinforced specimens for compressive strength according to construction testing requirements in ACI 506.2.
2. Visual Core Grading: One set of three reinforced specimens. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

E. In-Place Shotcrete Testing: One set of three unreinforced cores for each mixture and for each workday or for every [**50 cu. yd. (38 cu. m)**] of shotcrete placed, whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C42/C42M. Do not cut steel reinforcement.

F. Strength of shotcrete will be considered satisfactory according to the following:

1. Specimen Cores: Mean compressive strength of each set of three unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
2. Specimen Cubes: Mean compressive strength of each set of three unreinforced cubes to equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

G. Shotcrete will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

3.13 REPAIRS

A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.

1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and **1/2 inch (13 mm)** deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
3. Dampen surfaces and apply new shotcrete.[**Match adjacent color and finish.**]

B. Repair core holes from in-place testing according to repair provisions in **ACI 301 (ACI 301M)**, except do not use shotcrete. Match adjacent color and finish.

3.14 CLEANING

A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03 37 13 00

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Task	Specification	Specification Description
03 37 13 00	03 30 00 00	Cast-In-Place Concrete
03 37 16 00	03 30 00 00	Cast-In-Place Concrete
03 37 16 00	03 11 16 00	Architectural Concrete

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SECTION 03 38 16 00 - UNBONDED POST-TENSIONED CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Post-tensioning tendons and accessories, including pocket formers, bar chairs, slab bolsters, and nonprestressed reinforcement required for installing post-tensioning tendons, including the following:
2. Post-tensioning tendons and accessories, including pocket formers, bar chairs, slab bolsters, and nonprestressed reinforcement required for installing post-tensioning tendons, including the following:

    a. Support bars.
    b. Backup bars and hairpins at anchorages.
    c. Hairpins at locations of horizontal curvature.
    d. Supplemental reinforcement at blockouts.

3. Post-tensioning operations, including stressing, recording tendon elongations and gage pressures, and finishing tendons.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for concrete formwork and nonprestressed steel reinforcement, except for nonprestressed reinforcement.
2. Section 032000 "Concrete Reinforcing" for nonprestressed steel reinforcement, except for nonprestressed reinforcement required for installing post-tensioning tendons.
3. Section 033000 "Cast-in-Place Concrete" for concrete.

1.2 DEFINITIONS

A. Strand Tail: Excess strand length extending past the anchorage device.

B. Stressing Pocket: Void formed by pocket former at stressing-end anchorage that provides required cover over wedges and strand tail.

C. Wedge Cavity: Cone-shaped hole in anchorage device designed to hold the wedges that anchor the strand.

1.3 COORDINATION

A. Attachments and Penetrations:

1. Attach permanent construction, such as curtain-wall systems, handrails, fire-protection equipment, lights, and security devices to the post-tensioned slab using embedded anchors.
2. Drilled anchors, power-driven fasteners, and core drilling for sleeves or other penetrations are not allowed unless, as directed by the Owner.
3. Form penetrations within [**18 inches (460 mm)**] of an anchorage with ASTM A53/A53M,

Schedule 40 steel pipe.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review procedures related to installation and stressing of post-tensioning tendons, including, but not limited to, the following:

a. Construction schedule and availability of materials, personnel, and equipment needed to make progress and avoid delays.
b. Storage of post-tensioning materials on-site.
c. Structural load limitations.
d. Coordination of post-tensioning installation drawings and nonprestressed reinforcing steel placing drawings.
e. Horizontal and vertical tolerances on tendons and nonprestressed reinforcement placement.
f. Marking and measuring of elongations.
g. Submittal of stressing records and requirements for tendon finishing.
h. Removal of formwork.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Post-tensioning coating.
2. Tendon sheathing.
3. Anchorage devices.
4. Tendon couplers.
5. Bar and tendon supports.
6. Pocket formers.
7. Sheathing repair tape.
8. Stressing-pocket patching material.
9. Encapsulation system.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.

10. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing tendon layout, installation procedures, and the following:

1. Installation drawings, including plans, elevations, sections, and details.
2. Numbers, arrangement, and designation of post-tensioning tendons.
3. Tendon profiles and method of tendon support, including chair heights and locations. Show tendon profiles at sufficient scale to clearly indicate all support points with their associated heights.
4. Details for horizontal curvature around openings and at anchorages.
5. Locations of anchorages and blockouts required for stressing.
6. Anchorage details, including bundled tendon flaring.
7. Tendon clearances around slab openings and penetrations.
8. Construction joint locations and pour sequence.
9. Details for corners and other locations where tendon layouts may conflict with one another or with nonprestressed reinforcing steel.
10. Locations of nonprestressed reinforcement required for installing post-tensioning tendons, including, but not limited to, the following:

    a. Support bars.
    b. Backup bars and hairpins at anchorages.
    c. Hairpins at locations of horizontal curvature.
    d. Supplemental reinforcement at blockouts.

11. Stressing procedures and jacking force to result in final effective forces used in determining number of tendons required.
12. Calculated elongations for each tendon.

D. Samples: For the following products:

1. Anchorages with **24 inches (610 mm)** of coated, sheathed strand.
2. Couplers with **24 inches (610 mm)** of coated, sheathed strand.
3. Components of the encapsulation system, unassembled and clearly identified.

E. Delegated Design Submittal: For post-tensioning system.

1. Include sealed design calculations prepared by a qualified structural engineer indicating method of elongation calculation, including values used for friction coefficients, anchorage seating loss, elastic shortening, creep, relaxation, and shrinkage.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**testing agency**]. Include resume of individual supervising installation and stressing of post-tensioning tendons.

B. Evaluation Reports: For each type of anchorage device and coupler, from ICC-ES:

C. Product Certificates: For each type of encapsulation system.

D. Mill Test Reports: Certified mill test reports for prestressing strand used on Project, indicating that strand is low relaxation and including the following:

1. Coil numbers or identification.
2. Breaking load.

3. Load at 1 percent extension.
4. Elongation at failure.
5. Modulus of elasticity.
6. Diameter and net area of strand.

E. Field quality-control reports.

F. Procedures Statement: Procedures for cutting excess strand tail and patching stressing pocket.

G. Stressing Jack Calibration: Calibration certificates for jacks and gages to be used on Project. Calibrate each jack-and-gage set as a pair.

H. Stressing Records: Submit the same day as stressing operations.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Fabricating plant certified by PTI according to procedures set forth in PTI's "Manual for Certification of Plants Producing Unbonded Single Strand Tendons."

B. Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 - Field Fundamentals course or has equivalent verifiable experience and knowledge, as directed by the Owner.

1. Superintendent to be trained by post-tensioning supplier in the operation of stressing equipment to be used on Project.

C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1. Testing Agency Inspector: Personnel performing field inspections and measuring elongations to have successfully completed PTI's Level 1 - Field Fundamentals course or to have equivalent verifiable experience and knowledge, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle post-tensioning materials according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain post-tensioning materials and equipment from single source.

1. Stressing jacks not provided by post-tensioning supplier must be calibrated and approved for use on Project by post-tensioning supplier.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design post-tensioned reinforcement.

B. Design structure to withstand the loads indicated according to governing codes, within limits and under conditions indicated.

C. Average Precompression:

1. Minimum Average Slab Precompression: [**125 psi (0.86 MPa)**][**200 psi (1.4 MPa)**].
2. Maximum Average Slab Precompression: [**300 psi (2.1 MPa)**][**500 psi (3.4 MPa)**].
3. Minimum Average Precompression in T-, L-, and Rectangular-Beam Cross Sections: [**200 psi (1.4 MPa)**].
4. Minimum Precompression in Slab Section Not Included in T- or L-Beam Section: [**100 psi (0.7 MPa)**].
5. Maximum Precompression in Transfer Girders: [**1000 psi (6.9 MPa)**]. Specify stage-stressing sequence to avoid overstress.

D. Comply with **ACI 318 (ACI 318M)** requirements unless more stringent requirements are indicated.

1. Limits on stresses at transfer of prestress and under service load.
2. Minimum bonded reinforcement.
3. Concrete cover over reinforcement.

E. Fire Resistance:

1. Design members such that thickness and concrete cover over reinforcement comply with the following:

a. Fire-resistance requirements of authorities having jurisdiction.
b. The following fire-resistance requirements:

1) Slabs: [**Two**] hours.
2) Beam: [**Two**] hours.

F. Deflection Limits, Including Creep and Shrinkage Effects, as Follows:

1. Total Dead Load: [**L/600**].
2. Total Dead Plus Live Load: [**L/360**].

G. Closure Strips: Locate closure strips at midspan and adjust tendon forces and profiles accordingly. Calculate moments in spans with closure strips assuming a continuous slab. Provide only nonprestressed reinforcement within closure strips. Design reinforcement in closure strip to carry ultimate moment at midspan.

2.3 PRESTRESSING TENDONS

A. ACI Publications: Comply with ACI 423.7 unless otherwise indicated.

B. Prestressing Strand: ASTM A416/A416M, **Grade 270 (Grade 1860)**, uncoated, seven-wire, low-relaxation, [**0.5-inch- (12.7-mm-)**][**0.6-inch- (15.2-mm-)**] diameter strand.

C. Post-Tensioning Coating: Compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties; chemically stable and nonreactive with prestressing strand, nonprestressed reinforcement, sheathing material, and concrete.

1. Minimum Coating Weight: [**2.5 lb (1.14 kg)** for **0.5-inch- (12.7-mm-)**][**3 lb (1.36 kg)** for **0.6-inch- (15.2-mm-)**] diameter strand per **100 feet (30 m)** of strand.
2. Completely fill annular space between strand and sheathing over entire tendon length with post-tensioning coating.

D. Tendon Sheathing:

1. Material: Polyethylene or polypropylene with a minimum density of **0.034 lb/cu. in. (0.9 g/cu. cm)**.
2. Minimum Thickness: [**0.050 inch (1.25 mm)**].
3. Continuous over length of tendon [**to provide watertight encapsulation of prestressing strand**][**and**][**between anchorages to prevent intrusion of cement paste or loss of coating for a nonencapsulated system**].

E. Anchorage and Coupler Assemblies: Assemblies of prestressing strand, wedges, and anchor or coupler complying with static and fatigue testing requirements and capable of developing 95 percent of actual breaking strength of strand.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**General Technologies, Inc.**]
   b. [**Hayes Specialty Machining, Ltd.**]
   c. [**Precision Sure-Lock, Inc.**]

2. Anchorage Bearing Stresses: Comply with ACI 423.7 for stresses at transfer load and service load.
3. Fixed-End Anchorage Assemblies: Plant fabricated with wedges seated at a load of not less than 80 percent and not more than 85 percent of breaking strength of strand.

F. Encapsulation System: Watertight encapsulation of prestressing strand consisting of the following:

1. Encapsulation Caps: Attached to anchorages with a positive mechanical connection and completely filled with post-tensioning coating.

   a. Encapsulation Caps for Fixed- and Stressing-End Anchorages: Designed to provide watertight encapsulation of wedge cavity. Sized to allow required extension of strand past the wedges.

      1) Attach encapsulation caps for fixed-end anchorages in fabricating plant.

   b. Encapsulation Caps at Intermediate Anchorages: Open to allow passage of strand.

2. Sleeves: Attached to anchorage with positive mechanical connection; overlapped a minimum of **4 inches (100 mm)** with sheathing and completely filled with post-tensioning coating.

2.4 NONPRESTRESSED STEEL BARS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**] percent.

B. Support Bars, Reinforcing Bars, and Hairpins:

1. Steel: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.
2. Low-Alloy Steel: ASTM A706/A706M, deformed.
3. Galvanized Steel: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

   a. Zinc Repair Material: ASTM A780/A780M, zinc-based solder, paint containing zinc dust, or sprayed zinc.

4. Epoxy-Coated Steel: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, ASTM A775/A775M epoxy coated with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

   a. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on bars and complying with ASTM A775/A755M. After fabricating bars, repair damaged areas according to ASTM D3963/D3963M.

C. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening tendons and tendon support bars in place. Manufacture bar supports, according to CRSI's "Manual of Standard Practice," from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. For uncoated bars, use [**all-plastic**][**CRSI Class 1 plastic-protected**][**CRSI Class 2 stainless steel**] bar supports.
2. For epoxy-coated bars, use [**CRSI Class 1A epoxy-coated or other dielectric-polymer-coated-wire**][**all-plastic**] bar supports.
3. For zinc-coated bars, use [**galvanized-wire or dielectric-polymer-coated-wire**][**all-plastic**] bar supports.

2.5 ACCESSORIES

A. Pocket Formers: Capable of completely sealing wedge cavity; sized to provide the required cover over the anchorage and allow access for cutting strand tail.

B. Anchorage Fasteners: [**Stainless**][**Galvanized**][**Uncoated**]-steel nails, wires, and screws used to attach anchorages to formwork.

C. Sheathing Repair Tape: Elastic, self-adhesive, moistureproof tape with minimum width of **2 inches (50 mm)**, in contrasting color to tendon sheathing; nonreactive with sheathing, coating, or prestressing steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**3M**]
   b. [**Adhesive Tape Products, Ltd**]
   c. [**Covalence Adhesives**]

2.6 PATCHING MATERIAL

A. Patching Material: One-component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead applications. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**Fox Industries, Inc.**]
c. [**Kaufman Products, Inc**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

PART 3 - EXECUTION

3.1 FORMWORK

A. Design formwork to support load redistribution that may occur during stressing operation. Ensure that formwork does not restrain elastic shortening, camber, or deflection resulting from application of prestressing force.

B. Do not remove forms supporting post-tensioned elements until tendons have been fully stressed and elongations, as directed by the Owner.

C. Do not place concrete in supported floors until tendons on supporting floors have been stressed and elongations, as directed by the Owner.

3.2 INSTALLATION OF NONPRESTRESSED STEEL REINFORCEMENT

A. Placement of nonprestressed steel reinforcement is specified in Section 032000 "Concrete Reinforcing." Coordinate placement of nonprestressed steel reinforcement with installation of post-tensioning tendons.

3.3 INSTALLATION OF TENDONS

A. Install tendons according to installation drawings and procedures stated in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

1. Tolerances: Comply with tolerances in ACI 423.7 for beams and slabs.

B. Tendon Supports: Provide continuous slab bolsters or bars supported on individual high chairs spaced at a maximum of **42 inches (1070 mm)** o.c. to ensure tendons remain in their designated positions during construction operations and concrete placement.

1. Support tendons as required to provide profiles shown on installation drawings. Position supports at high and low points and at intervals not exceeding **48 inches (1220 mm)**. Ensure that tendon profiles between high and low points are smooth parabolic curves.
2. Attach tendons to supporting chairs and reinforcement without damaging tendon sheathing.
3. Support slab tendons independent of beam reinforcement.

C. Maintain tendon profile within maximum allowable deviations from design profile as follows:

1. **1/4 inch (6.3 mm)** for member depth less than or equal to **8 inches (200 mm)**.
2. **3/8 inch (9.5 mm)** for member depth greater than **8 inches (200 mm)** and less than or equal to **24 inches (610 mm)**.
3. **1/2 inch (13 mm)** for member depth greater than **24 inches (610 mm)**.

D. Maintain minimum radius of curvature of 480-strand diameters for lateral deviations to avoid openings, ducts, and embedded items. Maintain a minimum of **2 inches (50 mm)** of separation between tendons at locations of curvature.

E. Limit tendon bundles to [**five**] tendons. Do not twist or entwine tendons within a bundle. Maintain a minimum distance of **12 inches (300 mm)** between center of adjacent bundles.

F. If tendon locations conflict with nonprestressed reinforcement or embedded items, tendon placement governs. Obtain the Owner approval before relocating tendons or tendon anchorages that interfere with one another, as directed by the Owner.

G. Deviations in horizontal spacing and location of slab tendons are permitted when required to avoid openings and inserts.

H. Installation of Anchorages:

1. Place anchorages at locations shown on approved installation drawings.
2. Do not switch fixed- and stressing-end anchorage locations.
3. Attach pocket formers, intermediate anchorages, and stressing-end anchorages securely to bulkhead forms. Install stressing-end and intermediate anchorages perpendicular to tendon axis.
4. Install tendons straight, without vertical or horizontal curvature, for a minimum of **12 inches (300 mm)** behind stressing-end and intermediate anchorages.
5. Embed intermediate anchorage devices at construction joints in first concrete placed at joint.
6. Minimum splice length in reinforcing bars at anchorages is **24 inches (600 mm)**. Stagger splices a minimum of **60 inches (1500 mm)**.
7. Place fixed-end anchorages in formwork at locations shown on installation drawings. Support anchorages firmly to avoid movement during concrete placement.
8. Remove loose encapsulation caps on fixed-end anchorages, refill with post-tensioning coating, and re-attach encapsulation caps to achieve a watertight enclosure.

I. Maintain minimum concrete cover as follows:

1. From Exterior Edge of Concrete to Wedge Cavity: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**].
2. From Exterior Edge of Concrete to Strand Tail: [**3/4 inch (19 mm)**].
3. From Exterior Edge of Concrete to Wedge-Cavity Cap: [**1 inch (25 mm)**].
4. Top, Bottom, and Edge Cover for Anchorages: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**].

J. Maintain minimum clearance of **6 inches (150 mm)** between tendons and openings.

K. Prior to concrete placement, mark tendon locations on formwork with spray paint.

L. Do not install sleeves within [**36 inches (914 mm)**] of anchorages after tendon layout has been inspected.

M. Do not install conduit, pipe, or embeds requiring movement of tendons after tendon layout has been inspected.

N. Do not use couplers unless location has been approved by the Owner, as directed by the Owner.

3.4 SHEATHING INSPECTION AND REPAIR

A. Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring post-tensioning coating and repairing or replacing tendon sheathing.

1. Ensure that sheathing is watertight and there are no air voids.
2. Follow tape repair procedures in PTI's "Field Procedures Manual for Unbonded Single Strand Tendons."

B. Maximum length of exposed strand behind anchorages is as follows:

1. Fixed End: [**12 inches (300 mm)**].
2. Intermediate and Stressing End: [**1 inch (25 mm)**].

a. Cover exposed strand with sheathing repair tape to prevent contact with concrete.

C. Immediately remove and replace tendons that have damaged strand.

3.5 CONCRETE PLACEMENT

A. Do not place concrete until placement of tendons and nonprestressed-steel reinforcement has been inspected by [**special inspector**][**testing agency**].

B. Provide as directed by the Owner and [**special inspector**][**testing agency**] a minimum of 48 hours' notice before concrete placement.

C. Ensure compaction of concrete around anchorages.

D. Ensure that position of tendons and nonprestressed-steel reinforcement do not change during concrete placement. Reposition tendons and nonprestressed-steel reinforcement moved during concrete placement to original location.

E. Ensure that method of concrete placement does not damage tendon sheathing. Do not support pump lines, chutes, or other concrete-placing equipment on tendons.

3.6 TENDON STRESSING

A. Calibrate stressing jacks and gages at start of project and at least every six months thereafter. Keep copies of calibration certificates for each jack-and-gage pair on Project site that are available for inspection. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.

B. Stress tendons only under supervision of a qualified post-tensioning superintendent.

C. Do not begin stressing operations until concrete compressive strength has reached [**3000 psi (20.7 MPa)**] as indicated by tests of field-cured cylinders.

D. Complete stressing within [**96**] hours of concrete placement.

E. If concrete has not reached required compressive strength, obtain the Owner approval to partially stress tendons and delay final stressing until concrete has reached required strength, as directed by the Owner.

F. Stage stress [**transfer girders**][**foundation mats**] according to schedule shown on the Contract Drawings.

G. If detensioning and restressing of tendon is required, discard wedges used in original stressing and provide new wedges.

H. Mark and measure elongations according to PTI's "Field Procedures Manual for Unbonded Single Strand Tendons." Measure elongations to closest [**1/8 inch (3.2 mm)**].

I. Submit stressing records within one day of completion of stressing. If discrepancies between measured and calculated elongations exceed plus or minus 7 percent, resolve these discrepancies, as directed by the Owner.

J. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and calculated and measured elongations agree within 7 percent.

K. If measured elongations deviate from calculated elongations by more than 7 percent, perform additional testing, restressing, strengthening, or replacing of affected elements, as directed by the Owner.

L. Stressing Records: Testing agency records the following information during stressing operations:

1. Name of Project.
2. Date of approved installation drawings used for installation and stressing.
3. Floor number and concrete placement area.
4. Date of stressing operation.
5. Weather conditions, including temperature and rainfall.
6. Name and signature of inspector.
7. Name of individual in charge of stressing operation.
8. Serial or identification numbers of jack and gage.
9. Date of jack-and-gage calibration certificates.
10. Gage pressure to achieve required stressing force according to supplied calibration chart.
11. Tendon identification mark.
12. Calculated tendon elongation.
13. Actual tendon elongation.
14. Actual gage pressure.

3.7 TENDON FINISHING

A. Do not cut strand tails or cover anchorages until stressing records have been reviewed, as directed by the Owner.

B. Cut strand tails as soon as possible after approval of elongations.

C. Cut strand tail between **1/2 and 3/4 inch (13 and 19 mm)** from wedges. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include the following:

1. Oxyacetylene flame.
2. Abrasive wheel.
3. Hydraulic shears.

4. Plasma cutting.

D. Install encapsulation caps and sleeves on intermediate anchorages within one day of stressing.

E. Cut strand tails and install encapsulation caps on stressing-end anchorages, as directed by the Owner.

F. Patch stressing pockets within one day of cutting strand tail. Clean inside surface of stressing pocket to remove laitance or post-tensioning coating before installing patching material. Finish patching material flush with adjacent concrete.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Before concrete placement, [**special inspector**][**testing agency**] will inspect the following for compliance with post-tensioning installation drawings and the Contract Documents:

   a. Location and number of tendons.
   b. Tendon profiles and cover.
   c. Installation of backup bars, hairpins, and other nonprestressed reinforcement shown on post-tensioning installation drawings.
   d. Installation of pocket formers and anchorage devices.
   e. Repair of damaged sheathing.
   f. Connections between sheathing and anchorage devices.

2. [**Special inspector**][**Testing agency**] will record tendon elongations during stressing.
3. [**Special inspector**][**Testing agency**] will immediately report deviations, as directed by the Owner.

B. Prepare test and inspection reports.

3.9 PROTECTION

A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade components.

B. Protect exposed components within one workday of their exposure during installation.

C. Prevent water from entering tendons during installation and stressing.

D. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.10 REPAIRS

A. Review repair procedures, as directed by the Owner.

B. Repairs requiring removal of concrete, review, as directed by the Owner.

END OF SECTION 03 38 16 00

Task	Specification	Specification Description
03 38 16 00	03 30 00 00	Cast-In-Place Concrete
03 39 00 00	03 30 00 00	Cast-In-Place Concrete
03 39 13 00	03 30 00 00	Cast-In-Place Concrete
03 39 13 00	03 11 16 00	Architectural Concrete
03 39 23 00	03 30 00 00	Cast-In-Place Concrete
03 39 23 23	03 30 00 00	Cast-In-Place Concrete

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SECTION 03 41 00 00 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast structural concrete.
2. Thin brick and accessories.
3. Stone materials and accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**concrete topping and**]placing connection anchors in concrete.
2. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
3. Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.
4. Section 071900 "Water Repellents" for water-repellent finish treatments.

1.2 DEFINITIONS

A. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, as directed by the Owner.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

   a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
   b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
   c. Third-party-verified Declare product label, designated "Red List Free."

d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.

4. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

D. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate separate face and backup mixture locations and thicknesses.
5. Indicate type, size, and length of welded connections by AWS standard symbols.
6. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
8. Include and locate openings larger than **10 inches (250 mm)**. Where additional structural support is required, include header design.
9. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
10. Indicate relationship of precast structural concrete units to adjacent materials.
11. Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.
12. Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.
13. Indicate estimated camber for precast floor slabs with concrete toppings.
14. Indicate shim sizes and grouting sequence.
15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

E. Samples:

1. For each type of finish indicated on exposed surfaces of precast structural concrete units with architectural finish, in sets of three, representative of finish, color, and texture variations expected; approximately **12 by 12 by 2 inches (300 by 300 by 50 mm)**.

   a. Where other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

2. Samples for each thin-brick unit required, showing full range of color and texture expected. Include Samples showing color and texture of joint treatment.

   a. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
   b. Grout Samples for Verification: Showing color and texture of joint treatment.

F. Delegated Design Submittals: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional

engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**][**testing agency**].

B. Welding certificates.

C. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Insulation.
6. Structural-steel shapes and hollow structural sections.
7. Thin-brick units and accessories.
8. Stone anchors and accessories.

D. Material Test Reports: For aggregates, by a qualified testing agency.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control[**and special inspection**] reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant as follows:

a. Group C, [**Category C1 - Precast Concrete Products (no prestressed reinforcement)**][**Category C2 - Prestressed Hollowcore and Repetitively Produced Products**][**Category C3 - Prestressed Straight Strand Structural Members**][**Category C4 - Prestressed Deflected Strand Structural Members**].
b. Group CA, [**Category C1A - Precast Concrete Products (no prestressed reinforcement)**][**Category C2A - Prestressed Hollowcore and Repetitively Produced Products**][**Category C3A - Prestressed Straight-Strand Structural Members**][**Category C4A - Prestressed Deflected-Strand Structural Members**].

B. Required Certified Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect [**Category S1 - Simple**][**Category S2 - Complex**] Structural Systems.

C. Installer Qualifications: An experienced precast concrete erector who has retained a "PCI-Certified Field

Auditor" to conduct a field audit of a project installed by erector in [**Category S1 - Simple**][**Category S2 - Complex**] Structural Systems and who can produce an Erectors' Post Audit Declaration, according to PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

D. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

E. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

G. Sample Panels: After sample approval and before fabricating precast structural concrete units with [**architectural finish**][**thin-brick facing**][**stone facing**], produce a minimum of [**two**] sample panels approximately [**16 sq. ft. (1.5 sq. m)**] in area, as directed by the Owner. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

1. Locate panels where indicated or, if not indicated, as directed by the Owner.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
3. After approval of repair technique, maintain one sample panel at fabricator's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample panels when directed.

H. Mockups: After sample panel approval but before production of precast structural concrete units with [**architectural finish**][**thin-brick facing**][**stone facing**], construct full-sized mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup as indicated on Drawings including [**sealants**] and precast structural concrete units with an architectural finish complete with anchors, connections, flashings, and joint fillers.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Stone Anchor Testing: Engage a qualified testing agency to perform preconstruction testing according to ASTM C1354/C1354M or ASTM E488, modified as follows:

1. Furnish test specimens, including stone anchors, that are representative of materials proposed for incorporation into the Work.
2. Anchorage Tests: Test **12 inches (300 mm)** square samples for[**each combination of**] stone variety, orientation of cut, finish, and anchor type proposed for use on Project. Test for shear and tensile strength of anchorage system.

1.8 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design precast structural concrete units[**including stone facing system**].

B. Design Standards: Comply with **ACI 318 (ACI 318M)** and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets prescriptive requirements of authorities having jurisdiction or has been calculated according to [**ACI 216.1 (ACI 216.1M)**][**PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"**] and is acceptable to authorities having jurisdiction.

D. Structural Performance:

1. Precast structural concrete units and connections to withstand design loads indicated within limits and under conditions indicated.
2. Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

a. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of **ACI 318 (ACI 318M)**.

1) Thermal Movements: Allow for in-plane thermal movements resulting from annual

ambient temperature changes of [**minus 18 to plus 120 deg F (minus 10 to plus 67 deg C)**][**120 deg F (67 deg C)**].

b. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

c. Vehicular Impact Loads: Design spandrel beams acting as vehicular barriers for passenger cars to resist a single [**6000-lbf (26.7-kN)**] load applied horizontally in any direction to the spandrel beam, with anchorages or attachments capable of transferring this load to the structure. Design spandrel beams assuming the load to act at a height of **18 or 27 inches (457 or 686 mm)** above the floor or ramp surface, whichever is more severe, on an area not to exceed **1 sq. ft. (0.0929 sq. m)**.

2.2 PRECAST STRUCTURAL CONCRETE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Coreslab Structures**]
2. [**GATE Precast Company**]
3. [**Wells Concrete**]

2.3 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**][**to match those used for precast concrete design reference sample**]. Furnish with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder, capable of temporarily delaying setting of newly placed concrete mixture to depth of reveal specified.

2.4 REINFORCING MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**] percent.

B. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Galvanized Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**],

deformed bars, with ASTM A767/A767M, Class II zinc coating and chromate treatment.[**Galvanize after fabrication and bending.**]

E. Epoxy-Coated Reinforcing Bars: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] epoxy coated, with less than 2 percent damaged coating in each **12-inch (300-mm)** bar length.

F. Steel Bar Mats: ASTM A184/A184M, fabricated from [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed bars, assembled with clips.

G. Plain-Steel Welded Wire Reinforcement: ASTM A185/A185M, fabricated from [**as-drawn steel**][**galvanized-steel**] wire into flat sheets.

H. Deformed-Steel Welded Wire Reinforcement: ASTM A497/A497M or ASTM A1064/A1064M, flat sheet.

I. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**], flat sheet, [**Type 1 bendable**][**Type 2 nonbendable**] coating.

J. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.5 PRESTRESSING TENDONS

A. Pretensioning Strand: [**ASTM A416/A416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, seven-wire**][**or**][**ASTM A886/A886M, Grade 270 (Grade 1860), indented, seven-wire**], low-relaxation strand.

B. Unbonded Post-Tensioning Strand: ASTM A416/A416M, **Grade 270 (Grade 1860)**, uncoated, seven-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

C. Post-Tensioning Bars: ASTM A722/A722M, uncoated high-strength steel bar.

2.6 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Portland Cement: ASTM C150/C150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

D. Supplementary Cementitious Materials:

1. Pozzolans: ASTM C618, Class C, F, or N with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C618, Class N.
3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

E. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33/C33M, with coarse aggregates complying with [**Class 5S**][**Class 5M**][**Class 4S**][**Class 4M**]. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.

   a. Gradation: [**Uniformly graded**][**Gap graded**][**To match design reference sample**].

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate to match approved finish sample.

F. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C330/C330M, with absorption less than 11 percent.

G. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

H. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

I. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

J. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing Admixture: ASTM C494/C494M, Type S.
8. Plasticizing and Retarding Admixture: ASTM C494/C494M, Type S.
9. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

2.7 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36/A36M.

B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Plate: ASTM A283/A283M, Grade C.

D. Malleable-Iron Castings: ASTM A47/A47M, Grade 32510 or Grade 35028.

E. Carbon-Steel Castings: ASTM A27/A27M, **Grade 60-30 (Grade 415-205)**.

F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M.

G. Carbon-Steel Structural Tubing: ASTM A500/A500M, Grade B or Grade C.

H. Wrought Carbon-Steel Bars: ASTM A675/A675M, **Grade 65 (Grade 450)**.

I. Deformed-Steel Wire or Bar Anchors: ASTM A496/A496M or ASTM A706/A706M.

J. Carbon-Steel Bolts and Studs: **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A563/A563M; and flat, unhardened steel washers, ASTM F844.

K. High-Strength Bolts, Nuts, and Washers:

1. ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

   a. Finish: [**Plain**][**Hot-dip zinc coating**][**Mechanically deposited zinc coating**].

2. ASTM F3125/F3125M, **Grade A490 (Grade A490M)**, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

L. Zinc-Coated Finish: For exterior steel items[**, steel in exterior walls,**] and items indicated for galvanizing, apply zinc coating by [**hot-dip process according to ASTM A123/A123M or ASTM A153/A153M**][**electrodeposition according to ASTM B633, SC 3, Types 1 and 2**].

1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

M. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply [**lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79**][**SSPC-Paint 25**] according to SSPC-PA 1.

N. Welding Electrodes: Comply with AWS standards.

O. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.8 STAINLESS STEEL CONNECTION MATERIALS

A. Stainless Steel Plate: ASTM A240/A240M or ASTM A666, Type 304, Type 316, or Type 201.

B. Stainless Steel Bolts and Studs: **ASTM F593, Alloy Group 1 or 2 (ASTM F738M, Grade A1 or A4)**, hex-head bolts and studs; **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or A4)** stainless

steel nuts; and flat, stainless steel washers.

1. Lubricate threaded parts of stainless steel bolts with an antiseize thread lubricant during assembly.

C. Stainless Steel-Headed Studs: ASTM A276/A276M, Alloy 304 or 316, with minimum mechanical properties of PCI MNL 116.

2.9 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units[**as recommended by precast fabricator for application**]:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D2240; minimum tensile strength **2250 psi (15.5 MPa)**, ASTM D412.
2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D2240; capable of supporting a compressive stress of **3000 psi (20.7 MPa)** with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.10 ACCESSORIES

A. Reglets Specified Elsewhere: Specified in Section 076200 "Sheet Metal Flashing and Trim."

B. Reglets: [**PVC extrusions,**][**Stainless steel, Type 302 or Type 304,**][**Copper,**] felt or fiber filled, or with face opening of slots covered.

C. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install structural precast concrete units.

2.11 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881/C881M, of type, grade, and class to suit requirements.

2.12 THIN BRICK AND ACCESSORIES

A. Thin Brick:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Endicott Clay Products Co**]
   d. [**General Shale, Inc.**]
   e. [**Glen-Gery Corporation**]

2. Thickness not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** thick, and as follows:

   a. Dimensional Tolerances: Plus **0 inch (0 mm)** or minus **1/16 inch (1.6 mm)** for any dimension **8 inches (203 mm)** or less and plus **0 inch (0 mm)** or minus **3/32 inch (2.4 mm)** for any dimension more than **8 inches (203 mm)**.
   b. Out-of-Square Tolerance: Plus or minus **1/16 inch (1.6 mm)**.
   c. Warpage Tolerance: Plus **0 inch (0 mm)** or minus **1/16 inch (1.6 mm)**.
   d. Variation of Shape from Specified Angle: Plus or minus one degree.
   e. Modulus of Rupture: Not less than **250 psi (1.7 MPa)** when tested according to ASTM C67/C67M.
   f. Tensile Bond Strength: Not less than **150 psi (1.0 MPa)** when tested before and after freeze-thaw test according to ASTM E488 as modified. Adhere a steel plate with a welded rod on a single thin-brick face with epoxy for each test.
   g. 24-Hour Cold-Water Absorption: Not more than 6 percent when tested according to ASTM C67/C67M.
   h. Freeze-Thaw Resistance: No detectable disintegration or separation after 300 freezing-and-thawing cycles when tested according to ASTM C666/C666M, Method B.
   i. Chemical Resistance: Tested according to ASTM C650 and rated "not affected."
   j. Efflorescence: Tested according to ASTM C67/C67M and rated "not effloresced."
   k. Surface Coating: Thin brick with colors or textures applied as coatings to withstand 50 cycles of freezing and thawing; ASTM C67/C67M with no observable difference in applied finish when viewed from **10 ft. (3 m)**.
   l. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

B. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Special Shapes: Include corners, edge corners, and end edge corners.

E. Face Size: [**2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long**][**2-1/4 inches (57 mm) high**

by 11-5/8 inches (295 mm) long][**3-5/8 inches (92 mm) high by 7-5/8 inches (194 mm) long**][**3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm) long**].

F. [**Where indicated to "match existing,"**] provide thin brick matching color, texture, and face size of existing adjacent brick work, as directed by the Owner.

G. Face Color and Texture: **as directed by the Owner**

H. Sand-Cement Mortar: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

I. Pointing Grout: Packaged, polymer-modified, sanded grout complying with ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bostik; Arkema**]
   b. [**C-Cure**]
   c. [**Custom Building Products**]
   d. [**DAP Products Inc.**]
   e. [**H.B. Fuller Construction Products Inc. / TEC**]
   f. [**Jamo Inc**]
   g. [**Laticrete International, Inc.**]
   h. [**MAPEI Corporation**]
   i. [**Parex, a Sika brand**]
   j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   k. [**Southern Grouts & Mortars, Inc**]
   l. [**Summitville Tiles, Inc.**]

2. Polymer Type: Acrylic resin in [**dry, redispersible form, packaged with other dry ingredients**][**liquid-latex form for adding packaged dry-grout mix**].
3. Colors: [**As indicated by manufacturer's designations**][**as directed by the Owner**].

2.13 STONE MATERIALS AND ACCESSORIES

A. Stone facing for precast structural concrete is specified in Section 044200 "Exterior Stone Cladding."

B. Anchors: Stainless steel, ASTM A276/A276M, Type 304 or Type 316, of temper and diameter required to support loads without exceeding allowable design stresses.

1. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.

C. Silicone, Nonstaining, S, NS, 25, NT, M: Chemically curing, elastomeric, single-component, nonsag, neutral-curing, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**The Dow Chemical Company**]
c. [**Tremco Incorporated**]

D. Urethane, S, NS, 25, T, M: Chemically curing, elastomeric, single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Sika Corporation**]
c. [**Tremco Incorporated**]

E. Epoxy Filler: ASTM C881/C881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.

1. Elastomeric Anchor Sleeve: **1/2 inch (13 mm)** long; 60 Shore, Type A durometer hardness; ASTM D2240.

F. Bond Breaker: [**Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick**][**Polyethylene sheet, ASTM D4397, 6 to 10 mils (0.15 to 0.25 mm) thick**].

2.14 INSULATED FLAT-WALL PANEL ACCESSORIES

A. Molded-Polystyrene Board Insulation: ASTM C578, [**Type XI, 0.70 lb/cu. ft. (12 kg/cu. m)**][**Type I, 0.90 lb/cu. ft. (15 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type IX, 1.80 lb/cu. ft. (29 kg/cu. m)**]; [**square**][**ship-lap**] edges; thickness as directed by the Owner.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type X, 1.30 lb/cu. ft. (21 kg/cu. m)**][**Type IV, 1.55 lb/cu. ft. (26 kg/cu. m)**][**Type VI, 1.80 lb/cu. ft. (29 kg/cu. m)**][**Type VII, 2.20 lb/cu. ft. (35 kg/cu. m)**][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m)**]; [**square**][**ship-lap**] edges; thickness as directed by the Owner

C. Polyisocyanurate Board Insulation: ASTM C591, [**Type I, 1.8 lb/cu. ft. (29 kg/cu. m)**][**Type II, 2.5 lb/cu. ft. (40 kg/cu. m)**][**Type III, 3.0 lb/cu. ft. (48 kg/cu. m)**] unfaced, thickness as directed by the Owner

D. Wythe Connectors: [**Glass-fiber-reinforced vinylester connectors**][**Polypropylene pin connectors**][**Stainless steel pin connectors**][**Bent galvanized reinforcing bars**][**Galvanized welded wire trusses**][**Galvanized bent wire connectors**][**Epoxy-coated carbon-fiber grid**][**Fiberglass trusses**] manufactured to connect wythes of precast concrete panels.

2.15 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
2. Limit use of fly ash to [**20**][**35**] percent replacement of portland cement by weight and ground granulated blast-furnace slag to [**20**][**50**] percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by **ACI 318 (ACI 318M)** or PCI MNL 116 when tested according to ASTM C1218/C1218M.

D. Normal-Weight Concrete Mixtures: Proportion [**face mixtures**][**face and backup mixtures**][**full-depth mixture**][**face and backup mixtures or full-depth mixtures, at fabricator's option**] by either laboratory trial batch or field test data methods according to ACI PRC-211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): **5000 psi (34.5 MPa)**.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: For structural precast concrete with an architectural finish, limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C642, except for boiling requirement.

F. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI PRC-211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): **5000 psi (34.5 MPa)**.
2. Unit Weight: Calculated equilibrium unit weight of **115 lb/cu. ft. (1842 kg/cu. m)**, plus or minus **3 lb/cu. ft. (48 kg/cu. m)**, according to ASTM C567/C567M.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

I. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.16 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing

and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces of structural precast concrete with an architectural finish that is exposed to view in the finished work.
2. Edge and Corner Treatment: Uniformly [**chamfered**][**radiused**].

2.17 THIN-BRICK FACINGS

A. Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.

B. Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.

C. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.

D. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of thin brick.

1. Tool joints to a [**slightly concave**][**V-**]shape when pointing grout is thumbprint hard.

E. Clean faces and joints of thin-brick facing.

2.18 STONE FACINGS

A. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of **3/4 inch (19 mm)** from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

1. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not more than **24 inches (600 mm)** o.c. around perimeter of stone facing panels with a minimum of four anchors per panel.

B. Fill anchor holes with [**sealant filler and install anchors**][**epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone**].

1. Install minimum **0.006-inch- (0.15-mm-)** thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
2. Install **1/8-inch (3-mm)** polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

2.19 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than **10 inches (250 mm)** in any dimension. Do not drill or cut openings or prestressing strand without the Owner approval, as directed by the Owner.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strand to maintain at least **3/4-inch (19-mm)** minimum concrete cover. Increase cover requirements for reinforcing steel to **1-1/2 inches (38 mm)** when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
5. Protect strand ends and anchorages with a minimum of **1-inch- (25-mm-)** thick, nonmetallic,

nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place face mixture to a minimum thickness after consolidation of the greater of **1 inch (25 mm)** or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

K. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

L. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

M. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

N. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

O. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116, as directed by the Owner.

2.20 CASTING INSULATED WALL PANELS

A. Cast, screed, and consolidate wythe supported by mold.

B. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.

C. Ensure bottom wythe and insulation layer are not disturbed after bottom wythe reaches initial set.

D. Cast, screed, and consolidate top wythe to meet required finish.

E. Maintain temperature below **150 deg F (65 deg C)** in bottom concrete wythe.

2.21 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

B. Thin-Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of thin bricks in a unit:

1. Alignment of Mortar Joints:

   a. Jog in Alignment: **1/8 inch (3 mm)**.
   b. Alignment with Panel Centerline: Plus or minus **1/8 inch (3 mm)**.

2. Variation in Width of Exposed Mortar Joints: Plus or minus **1/8 inch (3 mm)**.
3. Tipping of Individual Thin Bricks from the Panel Plane of Exposed Thin-Brick Surface: Plus **0 inch (0 mm)**; minus **1/4 inch (6 mm)** less than or equal to depth of form-liner joint.
4. Exposed Thin-Brick Surface Parallel to Primary Control Surface of Panel: Plus **1/4 inch (6 mm)**; minus **1/8 inch (3 mm)**.
5. Individual Thin-Brick Step in Face from Panel Plane of Exposed Thin-Brick Surface: Plus **0 inch (0 mm)**; minus **1/4 inch (6 mm)** less than or equal to depth of form-liner joint.

C. Stone Veneer-Faced Precast Structural Concrete Units:

1. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus **1/4 inch (6 mm)**.
2. Variation in Joint Width: **1/8 inch in 36 inches (3 mm in 900 mm)** or a quarter of nominal joint width, whichever is less.
3. Variation in Plane between Adjacent Stone Units (Lipping): **1/16-inch (1.6-mm)** difference between planes of adjacent units.

2.22 COMMERCIAL FINISHES

A. Commercial Grade: Remove fins and protrusions larger than **1/8 inch (3 mm)** and fill holes larger than **1/2 inch (13 mm)**. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to **3/16 inch (5 mm)**.

B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than **1/2 inch (13 mm)** caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than **1/4 inch (6 mm)** in width that occur more than once per **2 sq. in. (1300 sq. mm)**. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to **1/8 inch (3 mm)**.

C. Grade B Finish: Fill air pockets and holes larger than **1/4 inch (6 mm)** in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than **1/8 inch (3 mm)** in width that occur more than once per **2 sq. in. (1300 sq. mm)**. Grind smooth form offsets or fins larger than **1/8 inch (3 mm)**. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.

D. Grade A Finish: Repair surface blemishes and fill air holes with the exception of air holes **1/16 inch (1.6 mm)** in width or smaller, and form marks where the surface deviation is less than **1/16 inch (1.6 mm)**. Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.

E. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a

uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

F. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

G. Apply roughened surface finish according to **ACI 318** **(ACI 318M)** to precast concrete units that receive concrete topping after installation.

2.23 COMMERCIAL ARCHITECTURAL FINISHES

A. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform and straight. Finish exposed-face surfaces of precast concrete units to match approved [**design reference sample**][**sample panels**][**mockups**] and as follows:

1. Design Reference Sample: as directed by the Owner.
2. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
3. As-Cast-Surface Finish: Provide surfaces to match approved sample or mockup for acceptable surface, air voids, sand streaks, and honeycomb.
4. Textured-Surface Finish: Impart by form liners or inserts.
5. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
6. Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
7. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
8. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
9. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
10. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
11. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
12. Thin-Brick Facing: See "Thin-Brick Facings" Article.
13. Stone Facing: See "Stone Facings" Article.

2.24 SOURCE QUALITY CONTROL

A. Testing Agency: [**as directed by the Owner**] a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712.

1. Test and inspect self-consolidating concrete according to PCI TR-6.

C. Strength of precast structural concrete units is considered deficient if units fail to comply with **ACI 318**

(ACI 318M) requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores to be taken from units of suspect strength, from locations, as directed by the Owner.
2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator, as directed by the Owner. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to the Owner approval. The Owner reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted as directed by the Owner.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum **4.0-mil- (0.1-mm-)** thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780/A780M.
3. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
4. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:

a. Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
b. Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.

3. For slip-critical connections, use method and inspection procedure approved by as directed by

the Owner and coordinated with inspection agency.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Place grout end cap or dam in voids at ends of hollow-core slabs.
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator, as directed by the Owner.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**as directed by the Owner**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Erection of precast structural concrete members.

B. Testing Agency: [**as directed by the Owner**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to the Owner, as directed by the Owner.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units, as directed by the Owner.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of **20 ft. (6 m)**.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as directed by the Owner.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 41 00 00

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Task	Specification	Specification Description
03 41 16 00	03 41 00 00	Precast Structural Concrete
03 41 19 00	03 41 00 00	Precast Structural Concrete
03 41 23 00	03 41 00 00	Precast Structural Concrete
03 41 26 00	03 38 16 00	Unbonded Post-Tensioned Concrete
03 41 26 00	03 41 00 00	Precast Structural Concrete
03 41 33 00	03 41 00 00	Precast Structural Concrete
03 48 29 00	03 41 00 00	Precast Structural Concrete
03 48 46 00	03 41 00 00	Precast Structural Concrete
03 48 49 00	03 41 00 00	Precast Structural Concrete

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SECTION 03 51 13 00 - CEMENTITIOUS WOOD FIBER DECKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Monolithic cementitious wood-fiber plank units.
2. Composite cementitious wood-fiber plank units.
3. Cementitious wood-fiber tile units.
4. Subpurlins and grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include details at supports, reinforcement at openings, and attachment to other work.

C. Samples: Show texture, finish, and edge and end configurations of each type of cementitious wood-fiber unit, [**12 inches (305 mm)**][**24 inches (610 mm)**] long by width of unit.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For cementitious wood-fiber units, for tests performed by a qualified testing agency.

C. Evaluation Reports: For cementitious wood-fiber deck, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cementitious wood-fiber units from moisture.

B. Store units on elevated platforms at Project site in a dry, well-ventilated, covered space and stack according to manufacturer's written instructions.

C. Handle units to prevent chipping, breaking, cracking, staining, soiling, warping, or other physical damage. Discard damaged units at time of installation.

1.6 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit work to be performed according to manufacturers' written instructions and warranty requirements.

B. Protect cementitious wood-fiber deck from moisture during installation and while exposed to the weather until permanently covered with subsequent construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**50**][**450**] or less.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Noise Reduction Coefficient (NRC): [**NRC 0.55**][**NRC 0.60**][**NRC 0.65**][**NRC 0.70**][**NRC 0.75**][**NRC 0.80**]; ASTM C423.

D. Light Reflectance: 60 percent; ASTM E1349.

2.2 MONOLITHIC CEMENTITIOUS WOOD-FIBER PLANK UNITS

A. Monolithic Plank: Manufacturer's standard, tongue-and-groove-edged, cementitious wood-fiber units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Size: Manufacturer's standard width; length [**to span a minimum of two supports**][**as indicated**].
4. End Configuration: Square.
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Channel-Reinforced Monolithic Plank: Manufacturer's standard, tongue-and-groove-edged, cementitious wood-fiber planks with factory-installed, cold-formed, **0.060-inch- (1.5-mm-)** thick, galvanized-steel channel set in grooved edge; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Size: Manufacturer's standard width; length [**to span a minimum of two support spacings**][**as indicated**].
4. End Configuration: Square.

C. Concealed-Tee Monolithic Plank: Manufacturer's standard cementitious wood-fiber units, **3 inches (76 mm)** thick, with edges kerfed, back rabbeted, and beveled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Size: Manufacturer's standard width; length [**to span a minimum of two support spacings**][**as indicated**].
3. End Configuration: Square.
4. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.3 COMPOSITE CEMENTITIOUS WOOD-FIBER PLANK UNITS

A. Insulated Composite Plank Type IV XPS: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, ASTM C578, Type IV extruded-polystyrene insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: Manufacturer's standard width and of length indicated.
5. End Configuration: Square.
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Insulated Composite Plank Type I XPS: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, ASTM C578, Type I expanded-polystyrene insulation, and top layer of APA-rated oriented-strand-board

sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**5-1/4 inches (133 mm)**][**6-1/2 inches (165 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: Manufacturer's standard width and of length indicated.
5. End Configuration: Square.
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

C. Composite Nailable Surface Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**].
3. Size: Manufacturer's standard width and of length indicated.
4. End Configuration: Square.
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.4 CEMENTITIOUS WOOD-FIBER TILE UNITS

A. Monolithic Tile: Manufacturer's standard, rabbet-edged, cementitious wood-fiber units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**].
3. Size: [**24-inch (610-mm)**][**32-inch (813-mm)**][**48-inch (1219-mm)**] nominal width and of length indicated.

4. End Configuration: [**Square**][**Tongue and groove**].
5. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

B. Insulated Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base, ASTM C578, Type IV extruded-polystyrene insulation, and top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with DOC PS 2, **7/16 inch (11 mm)** thick; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]

2. Cementitious Wood-Fiber Tile Base Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**].
3. Insulation Thickness: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**][**7 inches (177 mm)**][**8 inches (202 mm)**].
4. Size: [**24-inch (610-mm)**][**32-inch (813-mm)**][**48-inch (1219-mm)**] nominal width and of length indicated.
5. End Configuration: [**Square**][**Tongue and groove**].
6. Finish: Manufacturer's standard [**natural**][**or**][**prime-painted**] finish.

2.5 SUBPURLINS AND GROUT

A. Bulb-Tee Subpurlins: Hot-rolled steel bulb tees, complying with ASTM A499, of length required to span three support spacings; shop painted with metal primer.

B. Gypsum Concrete Grout: Factory-packaged, gypsum concrete grout formulation recommended by cementitious wood-fiber unit manufacturer with a minimum compressive strength of **500 psi (3.45 MPa)**.

2.6 ACCESSORIES

A. Anchor Clips: Manufacturer's standard formed anchor clips of **0.0478-inch- (1.21-mm-)** thick minimum, galvanized-steel sheet, of type and configuration required for deck system indicated.

B. Screws: Manufacturer's recommended corrosion-resistant screw fasteners and washers, self-drilling, self-tapping, of length required for deck and structural framing indicated.

C. Nails: Manufacturer's recommended corrosion-resistant nails of size and length required for deck and structural framing indicated.

D. Adhesive: Manufacturer's recommended construction adhesive complying with APA AFG-01.

E. Filler Strips: Insulation strips, same as used in manufacture of insulated composite cementitious wood-fiber units.

F. Polyethylene Film: **0.004 inch (0.10 mm)** thick, complying with ASTM D4397.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structural support framing for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing cementitious wood-fiber deck.

1. Install fastenings [**according to manufacturer's written instructions unless otherwise indicated**][**as indicated**].

B. Deck Interruptions: Provide barrier seals or blocking at overhangs to form wind seals and at partitions and walls to form sound seals unless otherwise indicated.

3.3 ROOF DECK INSTALLATION

A. Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Mechanically fasten planks to supports and perimeter members.
4. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.

B. Concealed-Tee Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly [**nest tongue-and-groove**][**butt square**] end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Mechanically fasten planks to supports and perimeter members.
4. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
5. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.

C. Monolithic Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with **3/4-inch- (19-mm-)** long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.

1. Lay tile with rabbeted edges supported on subpurlins.
2. Lay tile with square-cut ends concealed [**and supported on cross subpurlins**][**over supporting purlins or beams**].

3. Lay tile with tongue-and-groove ends exposed in pattern indicated.
4. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.

D. Composite Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with **3/4-inch- (19-mm-)** long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.

1. Lay tile with rabbeted edges supported on subpurlins.
2. Lay tile with square-cut ends concealed [**and supported on cross subpurlins**][**over supporting purlins or beams**].
3. Lay tile with tongue-and-groove ends exposed in pattern indicated.
4. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top surface of cementitious wood-fiber base. Fill remainder of joint with filler strips of insulation.

3.4 FORM-DECK INSTALLATION

A. Plank Form Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.

1. Cut panels to provide starter units.
2. Continuously support plank edges and ends at perimeter of building and at openings in deck.
3. Cover exposed edges and ends of form planks with polyethylene film before pouring cast-in-place fill to prevent paste or mixing water from penetrating deck and seeping through to bottom face. Remove exposed film after cast-in-place fill has set.

B. Shoring: Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic.

1. Comply with **ACI 318 (ACI 318M)** and ACI 301 for design, installation, and removal of shoring and reshoring.

   a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

2. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 CLEANING AND PROTECTION

A. Protect top surfaces of deck from damage caused by construction operations.

B. Protect exposed bottom surfaces of deck from soiling and damage during handling and construction.

C. Clean exposed bottom surfaces of completed deck and touch up minor damage to surfaces, as directed by the Owner.

D. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that cementitious wood-fiber deck is without damage or deterioration at time of Substantial Completion.

E. Remove and replace deteriorated and damaged deck units.

END OF SECTION 03 51 13 00

SECTION 03 53 00 00 - CONCRETE TOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emery-aggregate concrete floor topping.
2. Iron-aggregate concrete floor topping.
3. Concrete floor topping for standard applications.
4. Decorative concrete floor topping.
5. Polishable concrete floor topping.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each concrete floor topping, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

B. Field quality-control reports[**by as directed by the Owner**].

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6 MOCKUPS

A. Build mockups [**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**to set quality standards for fabrication and installation**][**and**][**for preconstruction testing**].

1. Build mockups approximately **100 sq. ft. (9.3 sq. m)** in the location indicated or, if not indicated, as directed by the Owner.

B. Concrete floor topping mockups are to demonstrate typical joints where applicable, surface finish, bonding, texture, tolerances, and standard of workmanship.

1. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.

1. Place concrete floor topping only when ambient temperature and temperature of base slabs are between **50 and 86 deg F (10 and 30 deg C)**.

B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 CONCRETE FLOOR TOPPINGS

A. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**Laticrete International, Inc.**]
c. [**Metalcrete Industries**]
d. [**Vulcan Materials Company**]

2. Performance Criteria:

a. Set Time: ASTM C403/C403M.
b. Impact Resistance: ACI 544.2.
c. Flexural Strength: ASTM C78/C78M.
d. Abrasion Resistance: ASTM C944/C944M.

3. Compressive Strength Minimum (28 Days): [**10,000 psi (69 MPa)**]; ASTM C109/C109M.

B. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**Master Builders Solutions**]
   d. [**Metalcrete Industries**]
   e. [**Vulcan Materials Company**]

2. Performance Criteria:

   a. Set Time: ASTM C403/C403M.
   b. Impact Resistance: ACI 544.2.
   c. Flexural Strength: ASTM C78/C78M.
   d. Abrasion Resistance: ASTM C944/C944M.

3. Compressive Strength (28 Days): Minimum [**12,000 psi (83 MPa)**]; ASTM C109/C109M.

C. Concrete Floor Topping for Standard Applications: Non-industrial, cement-based self-leveling interior concrete topping or resurfacing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Performance Criteria:

   a. Application: Barrel mix or pump.
   b. Flow Time: Minimum 10 minutes.
   c. Initial Set: Not less than 10 minutes.
   d. Final Set: Not less than 45 minutes.
   e. Compressive Strength (28 Days): Minimum [**4,000 psi (27.58 MPa)**][**6,000 psi (41.37 MPa)**][**7,000 psi (48 MPa)**]; ASTM C109/C109M.

3. Materials:

   a. Normal-Weight Aggregate: ASTM C33/C33M. Provide from single source. Well-graded, washed gravel.
   b. Coloring: as directed by the Owner.
   c. Primer: As recommended by manufacturer.
   d. Sealer: As recommended by manufacturer.

4. Thickness: [**As indicated on Drawings**][**1/8 inch to 2 inches (3.175 mm to 50.8 mm)**][**1/4 inch to 2 inches (6.35 mm to 50.8 mm)**][**Up to 5 inches (127 mm) with aggregates**].

D. Decorative Concrete Floor Topping: Non-industrial cement-based self-leveling interior concrete topping as a decorative overlay or micro-topping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Performance Criteria:

   a. Abrasion Resistance: ASTM C779/C779M.
   b. Impact Strength: ASTM C805/C805M.

3. Co-efficient of Friction: ASTM C1679, materials meet levels of finish as recommended in writing by manufacturer.
4. Materials:

   a. Polymer-modified, cementitious, single-component topping.
   b. Coloring: as directed by the Owner.
   c. Primer: As recommended by manufacturer.
   d. Sealer: As recommended by manufacturer.

5. Thickness: [**As indicated on Drawings**][**1/16 inch to 2 inches (1.58 mm to 50.8 mm)**].

E. Polishable Concrete Floor Topping: Non-industrial, cement-based self-leveling interior concrete topping suitable to receive a mechanical polish process.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Laticrete International, Inc.**]
   c. [**Schonox HPS North America, Inc.**]
   d. [**Sika Corporation**]

2. Description: Polymer-modified cementitious single component topping.

   a. Coloring: Materials as recommended in writing by manufacturer, as directed by the Owner.
   b. Primer: As recommended in writing by manufacturer.
   c. Sealer: As recommended in writing by manufacturer.

3. Performance Criteria:

a. Compressive Strength (28 Days): Minimum [**6,000 psi (41.37 MPa)**][**7,000 psi (48 MPa)**]; ASTM C109/C109M.
b. Flexural Strength: Minimum **1,000 psi (70 kg/cm2)** at 28 days, ASTM C348.
c. Abrasion Resistance: ASTM D4060.
d. Tensile Strength: ASTM C1583/C1583M.

4. Thickness: [**As indicated on Drawings**][**3/8 inch to 2 inches (9.52 mm to 50.8 mm)**].

2.2 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq m)** when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 25 percent solids content, minimum.

2.3 RELATED MATERIALS

A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids [**epoxy resin with a Type A Shore durometer hardness of 80**][**aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95**] in accordance with ASTM D2240.

B. Joint-Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**or**][**ASTM D1752, cork or self-expanding cork**].

C. Portland Cement: ASTM C150/C150M, Type I or II.

D. Sand: ASTM C404, fine aggregate passing **No. 16 (1.18 mm)** sieve.

E. Water: Potable.

F. Acrylic-Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined by ASTM C219.

H. Bond-Breaker Membrane: ASTM D2178/D2178M, asphalt-glass felt, Type III, standard ply sheet.

I. Crack and Joint Repair:

1. Crack repair materials as recommended in writing by concrete topping manufacturer.
2. Joint sealant materials as recommended in writing by concrete topping manufacturer.

J. Epoxy Adhesive: ASTM C881/C881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

K. Power-Actuated Fasteners: Fastener systems with an evaluation report based on ICC-ES AC70.

L. Nonslip Aggregate Materials: As recommended in writing by concrete topping manufacturer.

M. Concrete Hardener and Dustproofer: Chemical clear liquid hardener which produces a dense, hard and dustproof concrete surface.

N. Moisture Control System: As required for Project, and as recommended in writing by manufacturer.

O. Low-Viscosity Rigid Polyurethane Crack and Joint Repair: As recommended in writing by manufacturer.

P. Semi-Rigid Joint Sealant: As recommended in writing by manufacturer.

Q. Topical Color: as directed by the Owner.

R. Resilient Emulsion: As recommended in writing by manufacturer.

S. Integral Color: as directed by the Owner. Pigment type as recommended in writing by manufacturer.

2.4 MIXING

A. Bonding Slurry:

1. Mix portland cement with water to a thick paint consistency.
2. Mix 1 part portland cement and [**1-1/2**][**2**][**2-1/2**] parts sand with water[**and an acrylic-bonding agent in accordance with manufacturer's written instructions**] to a thick paint consistency.

B. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer in accordance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Verify that base concrete slabs comply with scratch finish requirements specified in Section 033000 "Cast-in-Place Concrete."

C. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method in accordance with ASTM D4263.

D. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of **1/4 inch (6 mm)**.

1. Prepare and clean existing base slabs in accordance with concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
2. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.
3. Saw cut contraction and construction joints in existing concrete to a depth of **1/2 inch (13 mm)** and fill with semirigid joint filler.
4. To both sides of joint edges and at perimeter of existing base slab, [**mechanically remove a 4-inch- (100-mm-) wide and 0- to 1-inch- (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface**][**install concrete nails in manufacturer's recommended staggered pattern**].

B. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated on Drawings.

1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface unless otherwise indicated on Drawings.
2. Terminate full-width, joint-filler strips **1/2 inch (13 mm)** below topping surface where joint sealants are indicated, in accordance with Section 079200 "Joint Sealants."
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

C. Install power-actuated fasteners in accordance with written directions of floor topping manufacturer at perimeter of areas that are to receive floor topping, including both edges of locations where joints will be formed in floor topping.

D. Primers: Provide priming at locations indicated on Drawings, and as recommended in writing by manufacturer.

3.3 APPLICATION OF FLOOR TOPPING

A. Begin floor topping application in presence of manufacturer's technical representative.

B. Monolithic Floor Topping: After textured float finish is applied to fresh concrete of base slabs installed in accordance with Section 033000 "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.

C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of **1/16 to 1/8 inch (1.6 to 3 mm)**, without puddling. Place floor topping while slurry is still tacky.

D. Existing Concrete: Apply epoxy-bonding adhesive, mixed in accordance with manufacturer's written instructions, and scrub into dry base slabs to a thickness of **1/16 to 1/8 inch (1.6 to 3 mm)**, without puddling. Place floor topping while adhesive is still tacky.

E. Aggregate Concrete Topping: Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating, using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

F. Overlay or Micro-Topping: Apply in strict compliance with manufacturer's written installation instructions. Mix and spread material on to the surface with recommended squeegees and trowels.

G. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

a. Finish surfaces to specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15, and [**measure**][**notify independent testing agency to permit measurement**] within 24 hours in accordance with ASTM E1155 for a randomly trafficked floor surface.
b. Finish and measure surface, so gap at any point between surface and an unleveled freestanding **10-ft.- (3-m-)** long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed **1/4 inch (6 mm)**.

H. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as directed by the Owner.

1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

I. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Form joints in concrete floor topping over contraction joints in base slabs unless otherwise indicated.
2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than **1/2 inch (13 mm)** deep.

3.4 PROTECTING AND CURING

A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.

C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, in accordance with concrete floor topping manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with [**water**][**continuous water-fog spray**][**or**][**absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers**].
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof

tape.

3. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller in accordance with manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.5 JOINT FILLING

A. Prepare and clean contraction joints and install semirigid joint filler, in accordance with manufacturer's written instructions, once topping has fully cured.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.6 REPAIR

A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**as directed by the Owner will engage**][**Engage**] a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of completed applications of concrete floor toppings to take place in successive stages, in areas of extent and using methods as follows:

1. Sample Sets: At point of placement, a set of three molded-cube samples to be taken from the topping mix for the first **1000 sq. ft. (93 sq. m)**, plus one set of samples for each subsequent **5000 sq. ft. (464 sq. m)** of topping, or fraction thereof, but not less than six samples for each day's placement. Samples to be tested in accordance with ASTM C109/C109M for compliance with compressive-strength requirements.
2. Concrete floor topping to be tested for delamination by dragging a steel chain over the surface.
3. Concrete floor topping to be tested for compliance with surface flatness and levelness tolerances.

C. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 53 00 00

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Task	Specification	Specification Description
03 53 14 00	03 53 00 00	Concrete Topping
03 53 19 00	03 53 00 00	Concrete Topping

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SECTION 03 54 00 00 - GYPSUM CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-leveling, gypsum cement underlayment for application below interior floor coverings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum cement underlayment.
2. Reinforcement.
3. Primer.
4. Corrosion-resistant coating.
5. Surface sealer.
6. Sound control mat.

B. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Test Reports:

1. For fire-resistant ratings, from a qualified testing agency.
2. For STC-rated assemblies, from a qualified testing agency.
3. For IIC-rated assemblies, from a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.

1. Place gypsum cement underlayments only when ambient temperature and temperature of substrates are between **50 and 80 deg F (10 and 27 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

1. STC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

C. IIC-Rated Assemblies: For IIC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E492 and classified according to ASTM E989 by an independent testing agency.

1. IIC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

2.2 GYPSUM CEMENT UNDERLAYMENTS

A. Gypsum Cement Underlayment: Self-leveling, gypsum cement product that can be applied in minimum uniform thickness of [**1/8 inch (3 mm)**] to match adjacent floor elevations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arcosa Inc.**]
b. [**ARDEX Americas**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Hacker Industries, Inc.**]
e. [**MAPEI Corporation**]
f. [**Maxxon Corporation**]
g. [**Schonox HPS North America, Inc.**]
h. [**USG Corporation**]

2. Cement Binder: Gypsum or blended gypsum cement as defined by ASTM C219.
3. Compressive Strength: Not less than [**2500 psi (17.2 MPa)**][**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**] at 28 days when tested according to ASTM C472.
4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

B. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)**; or coarse sand as recommended by underlayment manufacturer.

1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.

C. Water: Potable and at a temperature of not more than **70 deg F (21 deg C)**.

D. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.

E. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

    a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    b. VOC Content: Provide coating with VOC content of 100 g/L or less.

F. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

   a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
   b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

   a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   b. VOC Content: Provide coating with VOC content of 100 g/L or less.

G. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

2.3 ACCESSORIES

A. Sound Control Mat: As required to meet STC and IIC ratings, manufactured by gypsum cement underlayment manufacturer.

1. Thickness: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**3/4 inch (19 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrate according to manufacturer's written instructions.

1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
2. Fill substrate voids to prevent underlayment from leaking.

B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test, ASTM F1869: Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**85**] percent relative humidity level measurement, or as recommended by gypsum cement underlayment manufacturer.

C. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.

1. Install underlayment reinforcement recommended in writing by manufacturer.

D. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

E. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond; prepare surfaces according to manufacturer's written instructions.

F. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

G. Sound Control [**Mat**][**and**][**Board**]: Install sound control materials according to manufacturer's written instructions.

1. Do not install mechanical fasteners that penetrate through the sound control materials.

3.3 INSTALLATION

A. Mix and install underlayment components according to manufacturer's written instructions.

1. Close areas to traffic during underlayment installation and for time period after installation recommended in writing by manufacturer.
2. Coordinate installation of components to provide optimum adhesion to substrate and between coats.
3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Install underlayment to produce uniform, level surface.

1. Install a final layer without aggregate to product surface.
2. Feather edges to match adjacent floor elevations.

D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during installation and curing processes.

E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

F. Apply surface sealer at rate recommended by manufacturer.

G. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 INSTALLATION TOLERANCES

A. Finish and measure surface, so gap at any point between gypsum cement underlayment surface and an unleveled, freestanding, **10-foot- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**][**3/16 inch (4.8 mm)**][**1/8 inch (3 mm)**][**1/8 inch (3 mm) and 1/16 inch (1.6 mm) in 2 feet (610 mm)**].

3.5 PROTECTION

A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 00 00

SECTION 03 54 16 00 - HYDRAULIC CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polymer-modified, self-leveling, hydraulic cement underlayment for application below interior floor coverings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Hydraulic cement underlayment.
2. Reinforcement.
3. Primer.
4. Corrosion-resistant coating.
5. Surface sealer.
6. Sound control mat.

B. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Test Reports:

1. For fire-resistant ratings, from a qualified testing agency.
2. For STC-rated assemblies, from a qualified testing agency.
3. For IIC-rated assemblies, from a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment

products required for this Project.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.

1. Place hydraulic cement underlayments only when ambient temperature and temperature of substrates are between **50 and 80 deg F (10 and 27 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

1. STC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

C. IIC-Rated Assemblies: For IIC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E492 and classified according to ASTM E989 by an independent testing agency.

1. IIC Rating: [**60**][**55**][**50**][**As indicated on Drawings**].

2.2 HYDRAULIC CEMENT UNDERLAYMENTS

A. Hydraulic Cement Underlayment: Polymer-modified, self-leveling, hydraulic cement product that can be applied in minimum uniform thickness of **1/4 inch (6 mm)** and that can be feathered at edges to match adjacent floor elevations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arcosa Inc.**]
b. [**ARDEX Americas**]
c. [**Atlas Construction Supply, Inc**]
d. [**CMP Specialty Products; a Bostik Brand**]
e. [**Combimix Inc.**]
f. [**Custom Building Products**]

g. [**Dayton Superior Corporation**]
h. [**Dependable, LLC**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H.B. Fuller Construction Products Inc. / TEC**]
k. [**Hacker Industries, Inc.**]
l. [**J.E. Tomes**]
m. [**KOSTER American Corporation**]
n. [**Lambert Corporation**]
o. [**Laticrete International, Inc.**]
p. [**MAPEI Corporation**]
q. [**Master Builders Solutions**]
r. [**Maxxon Corporation**]
s. [**Metalcrete Industries**]
t. [**Schonox HPS North America, Inc.**]
u. [**Silpro Corporation**]
v. [**US SPEC, Division of US MIX Company**]
w. [**USG Corporation**]
x. [**Uzin Utz North America, Inc.**]

2. Cement Binder: ASTM C150/C150M, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C219.
3. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at 28 days when tested according to ASTM C109/C109M.
4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

B. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)**; or coarse sand as recommended by underlayment manufacturer.

1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.

C. Water: Potable and at a temperature of not more than **70 deg F (21 deg C)**.

D. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.

E. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. VOC Content: Provide coating with VOC content of 100 g/L or less.

F. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

1. VOC Content: Provide coating with VOC content of 250 g/L or less.
2. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Low-Emitting Materials: Coating shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Material Emissions and Pollutant Control: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
b. VOC Content: Provide coating with VOC content of 250 g/L or less.

6. Emissions Requirements: Coating shall comply with either of the following:

a. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. VOC Content: Provide coating with VOC content of 100 g/L or less.

G. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

2.3 ACCESSORIES

A. Sound Control Mat: As required to meet STC and IIC ratings, manufactured by hydraulic cement underlayment manufacturer.

1. Thickness: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**3/4 inch (19 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of the Work.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrate according to manufacturer's written instructions.

1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
2. Fill substrate voids to prevent underlayment from leaking.

B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test, ASTM F1869: Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**85**] percent relative humidity level measurement, or as recommended by hydraulic cement underlayment manufacturer.

C. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.

1. Install underlayment reinforcement recommended in writing by manufacturer.

D. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

E. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond, and prepare surfaces according to manufacturer's written instructions.

F. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

G. Sound Control [**Mat**][**and**][**Board**]: Install sound control materials according to manufacturer's written instructions.

1. Do not install mechanical fasteners that penetrate through the sound control materials.

3.3 INSTALLATION

A. Mix and install underlayment components according to manufacturer's written instructions.

1. Close areas to traffic during underlayment installation and for time period after installation recommended in writing by manufacturer.
2. Coordinate installation of components to provide optimum adhesion to substrate and between coats.
3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Install underlayment to produce uniform, level surface.

1. Install a final layer without aggregate to product surface.
2. Feather edges to match adjacent floor elevations.

D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during installation and curing processes.

E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

F. Apply surface sealer at rate recommended by manufacturer.

G. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 INSTALLATION TOLERANCES

A. Finish and measure surface, so gap at any point between hydraulic cement underlayment surface and an unleveled, freestanding, **10-foot- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**][**3/16 inch (4.8 mm)**][**1/8 inch (3 mm)**][**1/8 inch (3 mm) and 1/16 inch (1.6 mm) in 2 feet (610 mm)**].

3.5 PROTECTION

A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 16 00

Task	Specification	Specification Description
03 54 16 00	03 54 00 00	Gypsum Cement Underlayment
03 61 16 00	01 22 00 00	No Specification Required
03 62 13 00	03 41 00 00	Precast Structural Concrete
03 62 16 00	03 41 00 00	Precast Structural Concrete
03 63 00 00	03 37 13 00	Shotcrete
03 64 23 00	03 41 00 00	Precast Structural Concrete
03 64 26 00	01 22 00 00	No Specification Required
03 81 00 00	02 41 19 13	Cutting and Patching
03 81 13 00	02 41 19 13	Cutting and Patching
03 81 16 00	02 41 19 13	Cutting and Patching

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SECTION 04 01 00 00 - MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Paint removers.
2. Cleaning materials.
3. Liquid strippable masking agent.

1.2 ALLOWANCES

A. Allowances for cleaning masonry are specified in Section 012100 "Allowances."

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 DEFINITIONS

A. Very Low-Pressure Spray: Under [**100 psi (690 kPa)**].

B. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

C. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

D. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to cleaning masonry, including, but not limited to, the following:

a. Scheduling a pre-mockup meeting.
b. Manufacturer's representative of cleaning materials to be present during testing for consultation.
c. Mockup locations.
d. Masonry types.
e. Soiling types.
f. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
g. Materials, material application, and sequencing.
h. Cleaning types and cleaning methods.
i. Quality-control program.

j. Review cleaning program.
k. Coordination with building occupants.

1.6 SEQUENCING AND SCHEDULING

A. Work Sequence: Perform masonry-cleaning Work in the following sequence:

1. Remove plant growth and any other biological growth.
2. Inspect for open mortar joints. Where repairs are required, delay further cleaning Work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint or graffiti.
4. Clean masonry surfaces.
5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units and joints in accordance with masonry repair Sections.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and application instructions.
2. Include test data substantiating that products comply with requirements.

B. Material certificates signed by manufacturer and Contractor certifying that each material complies with requirements.

C. Each type of chemical cleaning material.

D. Qualification data for firms and specialists to demonstrate their capabilities and experience. Include list of five completed projects with project names and references.

E. Cleaning Program:

1. Describe cleaning protocol, materials, methods, and equipment to be used.
2. Indicate protection of surrounding materials on people, vehicles, buildings, and site items.
3. Describe control method of runoff during operations.
4. Create written report of final cleaning methods and process used.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**paint-remover manufacturer**][**and**][**chemical-cleaner manufacturer**].

B. Preconstruction Test Reports: For cleaning materials and methods.

C. Cleaning program.

1.9 QUALITY ASSURANCE

A. Source of Materials: Obtain materials for masonry cleaning from a single source for each type of substrate required to ensure quality of cleaning.

B. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, who employs factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

C. Masonry-Cleaning Specialist Firms: A firm that provides masonry cleaning, including masonry cleaners that have been used for similar applications with successful results, and is manufacturer authorized for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

D. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, who employs factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.

1. If materials and methods other than those indicated are proposed for any phase of cleaning Work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.

1.10 MOCKUPS

A. Prepare mockups of cleaning on existing surfaces to evaluate and establish cleaning materials and processes. Consult cleaning manufacturer for project applications.

1. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].
2. Cleaning: Clean an existing area [**approximately 25 sq. ft. (2.3 sq. m)**][**as indicated**] for each type of masonry and surface condition.

   a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
   b. Consult with chemical cleaning product manufacturer to verify what products require pre-wetting of substrate before cleaner application.
   c. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.
   d. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage one or more chemical-cleaner[**and paint-remover**] manufacturers to perform preconstruction testing on masonry surfaces.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to Project in undamaged condition.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.13 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning Work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Clean masonry surfaces only when air temperature is **40 deg F (4 deg C)** and above and is predicted to remain so for at least seven days after completion of cleaning.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until masonry has thawed and dried out, but not less than seven days after completion of cleaning.
2. Hot-Weather Requirements: Protect unit masonry Work when temperature and humidity conditions produce excessive evaporation of water from masonry. Provide artificial shade and wind breaks and use cooled materials as required.

C. Refer to chemical cleaner manufacturer's recommendations for application techniques when hot-weather conditions exist.

PART 2 - PRODUCTS

2.1 PAINT REMOVERS

A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**EaCo Chem, Inc.**]

e. [**Hydroclean; Hydrochemical Techniques, Inc**]
f. [**PROSOCO, Inc**]
g. [**Shore Corporation**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming, alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**Dumond Chemicals, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation, for removing paint from masonry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**Hydroclean; Hydrochemical Techniques, Inc**]
c. [**PROSOCO, Inc**]
d. [**Shore Corporation**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation, for removing paint from masonry; containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

d. [**EaCo Chem, Inc.**]
e. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation, for removing paint coatings from masonry; containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dumond Chemicals, Inc**]
b. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

2.2 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **5 quarts (5 L)** of 5 percent sodium hypochlorite (bleach), and **15 quarts (15 L)** of hot water for every **5 gal. (20 L)** of solution required.

E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cathedral Stone Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]
c. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra**

cotta][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**Dumond Chemicals, Inc**]
   e. [**Hydroclean; Hydrochemical Techniques, Inc**]
   f. [**Price Research, Ltd. dba Charles Paint Research**]
   g. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

G. Mild-Acid Cleaner: Manufacturer's standard mild-acid cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

H. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**Dumond Chemicals, Inc**]
   e. [**EaCo Chem, Inc.**]
   f. [**Hydroclean; Hydrochemical Techniques, Inc**]

g. [**Price Research, Ltd. dba Charles Paint Research**]
h. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

I. One-Part Limestone Acidic Cleaner: Manufacturer's standard one-part acidic formulation for cleaning limestone.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**EaCo Chem, Inc.**]
d. [**Hydroclean; Hydrochemical Techniques, Inc**]
e. [**Price Research, Ltd. dba Charles Paint Research**]
f. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

J. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium- or sodium-hydroxide-based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**Hydroclean; Hydrochemical Techniques, Inc**]
d. [**Price Research, Ltd. dba Charles Paint Research**]
e. [**PROSOCO, Inc**]

2. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

K. Poultices Cleaners: Manufacturer's temporary cleaning coating designed to remove dirt and stains without water in its application or removal. Consult manufacturer for strength level to fit project masonry substrates.

1. Masonry Substrate: [**Clay masonry**][**Glazed masonry**][**Marble**][**Concrete masonry units**][**Stone veneer**][**Terra cotta**][**Glazed terra cotta**][**Slate**][**Stone**][**Limestone**][**Sandstone**][**Granite**][**Polished granite**][**Travertine**].

2.3 LIQUID STRIPPABLE MASKING AGENT

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]
c. [**PROSOCO, Inc**]

2.4 ACCESSORY MATERIALS

A. Retain materials of use based on the approval of a mockup.

1. Provide materials with previous effectiveness in performing the Work involved.

a. Include materials with minimal possibility of damaging exposed surfaces.
b. Materials with consistency of each application.
c. Materials that provide uniformity of the resulting overall appearance.

B. Do not use products or tools that could do the following:

1. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces.
2. Leave residue on surfaces.

C. Equipment: Provide equipment for controlled spray application of water and chemical cleaners.

1. For chemical cleaner spray applications, provide a low-pressure tank or chemical pump suitable for the chemical cleaner indicated, equipped with spray tip for cleaning method applications.

D. Natural bristles brushes only.

E. Wood scrappers.

F. Trowels.

G. Provide additional accessories applicable to project conditions, including tapes, sheets, etc., to suit Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate conditions with specialist present, for compliance with approved mockup requirements for cleaning type, methods, products, and other conditions affecting performance.

3.2 PREPARATION

A. General: Comply with each manufacturer's written instructions for protecting people, motor vehicles, surrounding buildings, masonry areas not to be cleaned, nonmasonry surfaces, landscaping, equipment, and other surfaces that could be injured or harmed by such Work.

1. Provide temporary protective covers over pedestrian walkway areas and at points of entrance and exit for people, motor vehicles, and equipment that must remain during duration of cleaning procedures.
2. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant.
3. Temporarily protect all open joints to prevent intrusion of washing waters into the wall structure or building interior.
4. Remove all extraneous items no longer in use on face of surface unless indicated to remain, as directed by the Owner.
5. Apply masking agents in accordance with manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
6. Neutralize alkaline and acid wastes before disposal where applicable.

B. Provide disposal of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Remove[**gutters and**] downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.3 APPLICATION OF PRELIMINARY CLEANING MATERIALS

A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods.

1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
2. Removing Biological Growth: Completely remove visible biological, moss, and shrub growth from masonry surfaces. Carefully remove biological growths, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and biological debris from open joints to whatever depth they occur.
3. Mold, Mildew, and Algae Removal:

   a. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
   b. Apply mold, mildew, and algae remover by brush[**or low-pressure spray**].
   c. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
   d. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove mold, mildew, and algae remover and soil.

B. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.4 APPLICATION OF PAINT REMOVER

A. Paint-Remover Application, General: Apply paint removers in accordance with paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

B. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Repeat process if necessary to remove all paint.
6. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
7. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
8. Remove asphalt and tar with [**solvent-type paste paint remover**].

    a. Apply paint remover only to asphalt and tar by brush without prewetting.
    b. Allow paint remover to remain on surface for 10 to 30 minutes.
    c. Repeat application if needed.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
8. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.

D. Paint Removal with Solvent-Type Paste Paint Remover: .

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats in accordance with manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.

4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.

E. Paint Removal with Covered, Solvent-Type Paste Paint Remover: .

1. Remove loose and peeling paint using [**low**][**medium**][**high**]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.

F. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.5 GENERAL APPLICATION OF CLEANING METHODS

A. Chemical Cleaning: Do not apply during winds of enough force to spread them to unprotected surfaces.

B. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**][**50 ft. (15 m)**], as directed by the Owner.

C. Proceed with cleaning in an orderly manner; work from [**bottom to top**][**top to bottom**] of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.

D. Use only those cleaning methods indicated for each masonry material and location.

1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.

   a. Equip units with pressure gages.
   b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
   c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
   d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
   e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.
   f. For steam application, use steam generator capable of delivering live steam at nozzle.

E. Poultices: Where needed, provide a paste or slurry made with absorbent material or powder-inert clay, such as kaolin or sepiolite, diatomaceous earth (fuller's earth), or cellulose products such as pulp cellulose or shredded paper that is mixed with a cleaning solution (a liquid reagent such as water, organic solvent, among others).

F. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces,

including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

G. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed in accordance with "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.

H. Remove minor stains (cuprous, ferrous, etc.) if any.

I. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.6 WATER-CLEANING TYPE

A. Water Application Methods:

1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least **6 inches (150 mm)** from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

B. Cold-Water Soak:

1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles of [**five minutes**] on and [**20 minutes**] off.
4. Continue spraying [**until surface encrustation has softened enough to permit its removal by water wash, as indicated by cleaning tests**][**for 72 hours**].
5. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

C. Cold-Water Wash: Use cold water applied by [**low**][**medium**][**high**]-pressure spray.

D. Hot-Water Wash: Use hot water applied by [**low**][**medium**][**high**]-pressure spray.

E. Steam Cleaning: Apply steam at very low pressures not exceeding [**30 psi (207 kPa)**][**80 psi (550 kPa)**]. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.

3.7 CHEMICAL-CLEANING TYPE

A. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces in accordance with chemical-cleaner manufacturer's written instructions; use brush[**or spray**] application.[**Do not spray apply at pressures exceeding 50 psi (345 kPa).**] Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

1. Consult with cleaning product manufacturer to verify what products require pre-wetting of substrate before cleaner application.

B. Dilute chemical cleaners with water when required to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

C. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.

1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.

D. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

E. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

F. Nonacidic Gel Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply gel cleaner in **1/8-inch (3-mm)** thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**].
4. Remove bulk of gel cleaner.
5. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

G. Nonacidic Liquid Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

H. Mild-Acid Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

I. Acidic Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of 2 to 3 minutes**].
4. Rinse with cold water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil. Rinse until all foaming, if any, stops and suds disappear.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

J. One-Part Limestone Chemical Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**].
4. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
5. Rinse with [**cold**][**hot**] water applied by medium-pressure spray to remove chemicals and soil.

K. Two-Part Chemical Cleaning: .

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply alkaline prewash cleaner to surface by brush or roller.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer unless otherwise indicated.
4. Rinse with [**cold**][**hot**] water applied by medium-pressure spray to remove chemicals and soil.
5. Apply acidic afterwash cleaner to surface[**in two applications**], while surface is still wet, using[**low-pressure spray equipment,**] deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended in writing by manufacturer unless otherwise indicated.
6. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil.[**Rinse until surface reaction value is between pH 5 and pH 9 according to pH-measuring paper, pen, or indicator solution.**]
7. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection, to perform preconstruction product testing, and provide on-site assistance as directed by the Owner. Have [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than [**once**][**twice**] to observing progress and quality of the work.

3.9 FINAL CLEANING

A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.

B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

C. Remove masking materials, leaving no residues that could trap dirt.

D. Clean landscaping areas of debris.

3.10 PROTECTION

A. Provide final protection and maintain conditions in a manner as directed by the Owner, which ensures cleaning Work without being soiled at time of substantial completion.

END OF SECTION 04 01 00 00

Task	Specification	Specification Description
04 01 20 00	04 01 00 00	Masonry Cleaning
04 01 20 41	04 01 00 00	Masonry Cleaning

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SECTION 04 01 20 51 - BRICK MASONRY REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry materials.
2. Mortar materials.
3. Manufactured repair materials.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 040110 "Masonry Cleaning" for cleaning and paint removal existing masonry.
3. Section 040120.64 "Brick Masonry Repointing" for repointing existing brickwork.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and sealant-joint preparation for repaired masonry.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed.

B. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**].

C. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.

D. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to the Owner or storage, as directed by the Owner.

E. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

F. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

G. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of bricks to freezing and thawing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to brick masonry repair including, but not limited to, the following:

a. Verify brick masonry repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Cleaning types and cleaning methods.
d. Quality-control program.
e. Review cleaning program.
f. Coordination with building occupants.
g. Protection and barriers for the public.

1.4 SEQUENCING AND SCHEDULING

A. Order sand[**and gray portland cement**] for colored mortar immediately after approval of [**Samples**][**mockups**]. Take delivery of and store at Project site enough quantity to complete Project.

B. Work Sequence: Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks in accordance with "Brick Masonry Patching" Article. Patch holes in mortar joints according to Section 040120.64 "Brick Masonry Repointing."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use.
3. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of replacement bricks on the structure, showing relation of existing and new or relocated units.
2. Show provisions for expansion joints or other sealant joints.
3. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
4. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of

each point of contact or anchorage.

C. Samples for Initial Selection: For the following:

1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, **6 inches (150 mm)** long by [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

   a. Have each set contain a close color range of at least [**three**][**six**] Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
   b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

2. Sand Types Used for Mortar: Minimum **8 oz. (240 mL)** of each in plastic screw-top jars.
3. Patching Compound: Submit sets of patching compound Samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.

   a. Have each set contain a close color range of at least [**three**][**six**] Samples of different mixes of patching compound that matches the variations in existing masonry when cured and dry.

4. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For the following:

1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
2. Each type of patching compound in the form of briquettes, at least **3 inches (75 mm)** long by **1-1/2 inches (38 mm)** wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
3. Accessories: Each type of accessory and miscellaneous support.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**brick masonry repair specialist**][**including field supervisors and workers**][**and**][**testing service**].

B. Preconstruction Test Reports: For [**existing bricks and mortar**][**and**][**replacement bricks**].

C. Quality-control program.

1.7 QUALITY ASSURANCE

A. Brick Masonry Repair Specialist Qualifications: Engage an experienced brick masonry repair firm to perform Work of this Section. Firm is to have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.

1. Field Supervision: Brick masonry repair specialist firm is to maintain experienced full-time supervisors on Project site during times that brick masonry repair work is in progress.

2. Brick Masonry Repair Workers: When bricks are being patched, at least one worker per crew should be trained and certified by manufacturer of patching compound to apply its products performing the work of brick repairs.

B. Brick-Cleaning Specialist Firms: A firm that provides masonry cleaning, including masonry cleaners that have been used for similar applications with successful results, and is manufacturer authorized for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

C. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

1.8 MOCKUPS

A. Prepare mockups of brick masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution, and for fabrication and installation, as directed by the Owner.

1. Masonry Repair: Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately **48 inches (1200 mm)** in least dimension. Construct sample areas in locations in existing walls, as directed by the Owner. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:

   a. Replacement: [**Four**] brick units replaced.
   b. Patching: Three small holes [**at least 1 inch (25 mm) in diameter**][**as directed**] for each type of brick indicated to be patched.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, as directed by the Owner.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on brick masonry as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Replacement Brick: Test each proposed type of replacement brick in accordance with sampling and testing methods in ASTM C67/C67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction).
3. Existing Brick: Test each type of existing brick indicated for replacement in accordance with testing methods in ASTM C67/67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [**five**] existing units from locations, as directed by the Owner. Take testing samples from these units.
4. Existing Mortar: Test in accordance with ASTM C1324, modified as directed by the Owner, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
5. Temporary Patch: As directed by the Owner, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver bricks to Project site strapped together in suitable packs or pallets or in heavy-duty cartons and protected against impact and chipping.

B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

E. Store sand where grading and other required characteristics can be maintained and contamination avoided.

F. Handle bricks to prevent overstressing, chipping, defacement, and other damage.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repair brick masonry only when air temperature is between **40 and 90 deg F (4 and 32 deg C)** and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements: Comply with the following procedures for masonry repair unless otherwise indicated:

1. When air temperature is below **40 deg F (4 deg C)**, heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between **40 and 120 deg F (4 and 49 deg C)**.
2. When mean daily air temperature is below **40 deg F (4 deg C)**, provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for seven days after repair.

D. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of **90 deg F (32 deg C)** and above unless otherwise indicated.

E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**brick units**][**cementitious mortar components**][**and**][**sand**] from single [**source**][**producer**][**or**][**manufacturer**].

B. For [**exposed masonry units**][**and**][**cementitious mortar components**], obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.3 MASONRY MATERIALS

A. Masonry Materials: Face brick, required to complete brick masonry repair work.

1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork and with physical properties [**within 10 percent of those determined from preconstruction testing of selected existing units.**][**as listed below:**]

a. Physical Properties: In accordance with ASTM C67/C67M.
b. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.

2. Brick Matching Architect's Sample: Units with colors, color variation within units, surface texture, and physical properties that match Architect's sample. Match existing units in size and shape, as directed by the Owner.

a. Physical Properties: In accordance with ASTM C67C67M.
b. For Architect's sample that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range rather than brick that matches an individual color within that range.

3. Special Shapes:

a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.

4. Tolerances as Fabricated: [**In accordance with tolerance requirements in ASTM C216, Type FBX**][**In accordance with tolerance requirements in ASTM C216, Type FBS**].

B. Building Brick: ASTM C62, of same vertical dimension as face brick, for masonry work concealed from view.

1. Grade SW where in contact with earth.
2. [**Grade SW or Grace MW**][**Grade SW, Grade MW, or Grade NW**] for concealed backup.

2.4 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white[**or gray, or both**] where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cemex S.A.B. de C.V.**]
b. [**Heidelberg Materials**]
c. [**Holcim (US) Inc**]
d. [**Quikrete; The QUIKRETE Companies, LLC**]

D. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Holcim (US) Inc**]

E. Mortar Sand: ASTM C144.

1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

G. Water: Potable.

2.5 MANUFACTURED REPAIR MATERIALS

A. Brick Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching brick masonry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cathedral Stone Products, Inc.**]
   b. [**Conproco Corporation**]
   c. [**Edison Coatings, Inc.**]

2. Use formulation that is vapor and water permeable (equal to or more than the brick), exhibits low shrinkage, has lower modulus of elasticity than bricks being repaired, and develops high bond strength to all types of masonry.
3. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
4. Formulate patching compound in colors and textures to match each brick being patched. Provide [**sufficient number of**][**no fewer than three**] colors to enable matching of the color, texture, and variation of each unit.

2.6 ACCESSORY MATERIALS

A. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of bricks, less the required depth of pointing materials unless removed before pointing.

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer in accordance with [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**].

1. Surface Preparation: Use coating requiring no better than [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**] surface preparation in accordance with manufacturer's literature or certified statement.
2. VOC Limit: Use coating with a VOC content of [**400 g/L (3.3 lb/gal.)**] or less.

D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could leave residue on surfaces.

2.7 MORTAR MIXES

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

B. Colored Mortar: Produce mortar of color required by using specified ingredients, as directed by the Owner.

1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mixes: Mix mortar materials in the following proportions:

1. Rebuilding (Setting) Mortar by Volume: ASTM C270, Proportion Specification, [**1 part portland cement, 1 part lime, and 6 parts sand**].
2. Rebuilding (Setting) Mortar by Type: ASTM C270, Proportion Specification, [**Type N**] unless otherwise indicated; with cementitious material limited to [**portland cement and lime**][**masonry cement**][**or**][**mortar cement**].
3. Rebuilding (Setting) Mortar by Property: ASTM C270, Property Specification, [**Type N**] unless otherwise indicated; with cementitious material limited to [**portland cement and lime**][**masonry cement**][**or**][**mortar cement**].
4. Pigmented, Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate conditions with specialist present, for compliance with approved mockup requirements for brick units, repair methods, products, and other conditions affecting performance of the Work.

3.2 PREPARATION

A. General: Comply with each manufacturer's written instructions for protecting people, motor vehicles, surrounding buildings, masonry areas not to be cleaned, nonmasonry surfaces, landscaping, equipment, and other surfaces that could be injured or harmed by such Work.

1. Provide temporary protective covers over pedestrian walkway areas and at points of entrance and exit for people, motor vehicles, and equipment that must remain during duration of repairing procedures.
2. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant.
3. Temporarily protect all open joints to prevent intrusion of washing waters into the wall structure or building interior.
4. Remove all extraneous items no longer in use on face of surface unless indicated to remain, as directed by the Owner.

3.3 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

3.4 MASONRY REPAIR, GENERAL

A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**][**50 ft. (15 m)**] away, as directed by the Owner.

3.5 ABANDONED ANCHOR REMOVAL

A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items [**no longer in use unless indicated to remain**][**indicated to be removed**].

1. Remove items carefully to avoid spalling or cracking masonry.
2. If an item cannot be removed without damaging surrounding masonry, review, as directed by the Owner. Do the following where directed:

   a. Cut or grind off item approximately [**3/4 inch (20 mm)**] beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
   b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace bricks.

3.6 BRICK REMOVAL AND REPLACEMENT

A. At locations indicated, remove bricks that are damaged, spalled, or deteriorated[**or are to be reused**]. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.

1. When removing single bricks, remove material from center of brick and work toward outside edges.

B. Support and protect remaining masonry that surrounds removal area.

C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.[**Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections.**]

D. Notify the Owner of unforeseen detrimental conditions, including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.

E. Remove in an undamaged condition as many whole bricks as possible.

1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.

2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
3. Store brick for reuse. Store off ground, on skids, and protected from weather.
4. Deliver cleaned brick not required for reuse to the Owner, as directed by the Owner.

F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.

G. Replace removed damaged brick with other removed brick in good condition, where possible, [**or with new brick**]matching existing brick. Do not use broken units unless they can be cut to usable size.

H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

1. Maintain joint width for replacement units to match existing joints.
2. Use setting buttons or shims to set units accurately spaced with uniform joints.

I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with enough mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C67/C67M initial rates of absorption (suction) of more than **30 g/30 sq. in. per min. (30 g/194 sq. cm per min.)** Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
2. Rake out mortar used for laying brick before mortar sets in accordance with Section 040120.64 "Brick Masonry Repointing." Point at same time as repointing of surrounding area.
3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.7 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify the Owner if steel is exposed during masonry removal. Where Architect determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Surface Preparation: Remove paint, rust, and other contaminants in accordance with [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**], as applicable to comply with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [**1/16 inch (1.6 mm)**], notify the Owner before proceeding.

3.8 BRICK MASONRY PATCHING

A. Patch the following bricks unless another type of repair or replacement is indicated:

1. Bricks indicated to be patched.
2. Bricks with holes.
3. Bricks with chipped edges or corners.[**Patch chipped edges or corners measuring more than 3/4 inch (19 mm) in least dimension.**]
4. Bricks with small areas of deep deterioration.[**Patch deep deteriorations measuring more than 3/4 inch (19 mm) in least dimension and more than 1/4 inch (6 mm) deep.**]

B. Remove and replace existing patches [**where indicated**][**unless otherwise indicated or as directed by the Owner**].

C. Patching Bricks:

1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least [**1/4 inch (6 mm)**] thick, but not less than recommended in writing by patching compound manufacturer.
2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of brick.
3. Mix patching compound in individual batches to match each unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
4. Rinse surface to be patched and leave damp, but without standing water.
5. Brush-coat surfaces with slurry coat of patching compound in accordance with manufacturer's written instructions.
6. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than **1/4 inch (6 mm)** or more than **2 inches (50 mm)** thick. Roughen surface of each layer to provide a key for next layer.
7. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of brick. Shape and finish surface before or after curing, as determined by testing, to best match existing brick.
8. Keep each layer damp for 72 hours or until patching compound has set.
9. Remove and replace patches with hairline cracks or that show separation from brick at edges, and those that do not match adjoining brick in color or texture.

3.9 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified testing agency to perform tests and inspections, as directed by the Owner. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed, as directed by the Owner.

C. Notify [**inspectors**][**and**][**the Owner**] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [**inspectors**][**and**][**the Owner**] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.11 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property.

B. Masonry Waste: Remove masonry waste and legally dispose of off the Owner property, as directed by the Owner.

END OF SECTION 04 01 20 51

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Task	Specification	Specification Description
04 01 20 51	03 01 30 00	Maintenance of Cast-in-Place Concrete
04 01 20 51	04 01 00 00	Masonry Cleaning
04 01 20 52	04 01 00 00	Masonry Cleaning

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SECTION 04 01 20 91 - BRICK MASONRY REPOINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mortar materials.
2. Mortar mixes.

B. Related Requirements:

1. Section 012100 "Allowances" for brick repointing allowances.
2. Section 012200 "Unit Prices" for brick repointing unit prices. Indicate the percentage, if any, by which actual quantities may deviate upward or downward from estimated quantities before the unit price may be adjusted by a change order.
3. Section 040110 "Masonry Cleaning" for cleaning and paint removal from both clay masonry and stone.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**] <**Insert range of values**>.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Review methods and procedures related to repointing brick masonry including, but not limited to, the following:

a. Verify brick masonry repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Quality-control program.
d. Coordination with building occupants.
e. <**Insert agenda items**>.

1.4 SEQUENCING AND SCHEDULING

A. Order sand[**and gray portland cement**] for pointing mortar immediately after approval of [**Samples**] [**mockups**]. Take delivery of and store at Project site enough quantity to complete Project.

B. Work Sequence: Perform brick masonry repointing Work in the following sequence, which includes Work specified in this and other Sections:

1. Remove plant growth.

2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks in accordance with Section 040120.63 "Brick Masonry Repair." Patch holes in mortar joints in accordance with "Repointing" Article.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use.
3. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of repointing work on the structure.
2. Show provisions for expansion joints or other sealant joints.
3. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.

C. Samples for Initial Selection: For the following:

1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches (150 mm) long by [**1/4 inch (6 mm)**] [**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

   a. Have each set contain a close color range of at least [**three**] [**six**] **<Insert number>** Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
   b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

2. Sand Type Used for Pointing Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
3. Sealant materials.
4. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For the following:

1. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches (150 mm) long by [**1/4 inch (6 mm)**] [**1/2 inch (13 mm)**] wide, set in aluminum or plastic channels.

    a. Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.

2. Sealant materials.
3. Accessories: Each type of accessory and miscellaneous support.

1.6 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For existing bricks and mortar.

B. Quality-control program.

C. Qualification Statements: For [**brick masonry repointing specialist**] [**field supervisors and workers**] [**and**] [**testing service**].

1.7 QUALITY ASSURANCE

A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. Firm is to have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.

    1. Field Supervision: Brick masonry repointing specialist firms are to maintain experienced full-time supervisors on Project site during times that brick masonry repointing work is in progress.

B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

1.8 MOCKUPS

A. Prepare mockups of brick masonry repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.

    1. Repointing: Rake out joints in two separate areas[**, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide**] [**as indicated on Drawings**] <**Insert dimensions**> for each type of repointing required, and repoint one of the areas.
    2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
    3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**Owner will engage**] [**Engage**] a qualified testing agency to perform preconstruction testing on masonry units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Existing Brick: Test each type of existing brick indicated for repointing in accordance with testing methods in ASTM C67/C67M for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [**five**] <**Insert number**> existing units from locations designated by Architect. Take testing samples from these units.
3. Existing Mortar: Test in accordance with ASTM C1324, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
4. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed in accordance with product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:

1. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
2. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for seven days after pointing.

D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white[**or gray, or both**] where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. Mortar Cement: ASTM C1329/C1329M.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

E. Mortar Sand: ASTM C144.

1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Water: Potable.

2.3 MORTAR MIXES

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

1. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.

B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's written approval.

1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mixes: Mix mortar materials in the following proportions:

1. Pointing Mortar by Volume: ASTM C270, Proportion Specification, [**1 part portland cement, 1 part lime, and 6 parts sand**] <**Insert proportions**>.[**Add mortar pigments to produce mortar colors required.**]
2. Pointing Mortar by Type: ASTM C270, Proportion Specification, [**Type N**] <**Insert Type**> unless otherwise indicated; with cementitious material limited to [**portland cement and lime**] [**masonry cement**] [**or**] [**mortar cement**].[**Add mortar pigments to produce mortar colors required.**]
3. Pointing Mortar by Property: ASTM C270, Property Specification, [**Type N**] <**Insert Type**> unless otherwise indicated; with cementitious material limited to [**portland cement and lime**] [**masonry cement**] [**or**] [**mortar cement**].[**Add mortar pigments to produce mortar colors required.**]

2.4 ACCESSORY MATERIALS

A. Sealant Materials:

1. Sealant manufacturer's standard elastomeric sealant(s) of base polymer and characteristics in accordance with applicable requirements in Section 079200 "Joint Sealants."

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

PART 3 - EXECUTION

3.1 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below pointing work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove[**gutters and**] downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.2 MASONRY REPOINTING, GENERAL

A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from [**20 ft. (6 m)**] [**50 ft. (15 m)**] <**Insert distance**> away by Architect.

3.3 REPOINTING

A. Rake out and repoint joints to the following extent:

1. All joints in areas indicated.
2. Joints indicated as sealant-filled joints.
3. Joints at locations of the following defects:

   a. Holes and missing mortar.
   b. Cracks that can be penetrated 1/4 inch (6 mm) or more by a knife blade 0.027 inch (0.7 mm) thick.
   c. Cracks [**1/16 inch (1.6 mm)**] [**1/8 inch (3 mm)**] <**Insert dimension**> or more in width and of any depth.
   d. Hollow-sounding joints when tapped by metal object.
   e. Eroded surfaces 1/4 inch (6 mm) deep or deeper.
   f. Deterioration to point that mortar can be easily removed by hand, without tools.
   g. Joints filled with substances other than mortar.

B. Do not rake out and repoint joints where not required.

C. Rake out joints as follows, in accordance with procedures demonstrated in approved mockup:

1. Remove mortar from joints to depth of [**joint width plus 1/8 inch (3 mm)**] [**2 times joint width**] [**2-1/2 times joint width**] [**not less than 1/2 inch (13 mm)**] [**not less than 3/4 inch (20 mm)**] [**and**] [**not less than that required to expose sound, unweathered mortar**] <**Insert requirement**>. Do not remove unsound mortar more than [**2 inches (50 mm)**] <**Insert dimension**> deep; consult Architect for direction.
2. Remove mortar from brick and other masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
3. Do not spall edges of brick or other masonry units or widen joints. Replace or patch damaged brick or other masonry units as directed by Architect.

D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.

E. Pointing with Mortar:

1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than [**3/8 inch (9 mm)**] <**Insert dimension**> until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than [**3/8 inch (9 mm)**] <**Insert dimension**>. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

F. Pointing with Sealant: Comply with Section 079200 "Joint Sealants" and as follows:

1. After raking out, keep joints dry and free of mortar and debris.
2. Clean and prepare joint surfaces.[**Prime joint surfaces unless sealant manufacturer recommends against priming.**] Do not allow primer to spill or migrate onto adjoining surfaces.
3. Fill sealant joints with specified joint sealant.

   a. Install cylindrical sealant backing beneath the sealant. Where space is insufficient for cylindrical sealant backing, install bond-breaker tape.
   b. Install sealant using only proven installation techniques that ensure that sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.
   c. Install sealant as recommended in writing by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:

      1) Fill joints to a depth equal to joint width, but not more than 1/2 inch (13 mm) deep or less than 1/4 inch (6 mm) deep.

   d. Tool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant from surfaces adjacent to joint.
   e. Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

G. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.4 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify [**inspectors**] [**and**] [**Architect's Project representatives**] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [**inspectors**] [**and**] [**Architect's Project representatives**] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 04 01 20 91

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Task	Specification	Specification Description
04 01 20 91	04 01 00 00	Masonry Cleaning
04 01 50 00	04 01 00 00	Masonry Cleaning
04 01 50 52	04 01 00 00	Masonry Cleaning
04 05 13 26	04 20 00 00	Unit Masonry
04 05 16 26	04 20 00 00	Unit Masonry
04 05 19 13	04 20 00 00	Unit Masonry
04 05 19 16	04 20 00 00	Unit Masonry
04 05 23 13	04 20 00 00	Unit Masonry
04 05 23 16	01 22 00 00	No Specification Required
04 05 23 16	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 04 20 00 00 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Clay masonry units.
3. Structural clay facing tile.
4. Fireplace and chimney lining units.
5. Lintels
6. Mortar and grout materials
7. Reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Accessories.
11. Mortar and grout mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Cast-stone trim in unit masonry.
2. Stone trim units in unit masonry.
3. Steel lintels in unit masonry.
4. Steel shelf angles for supporting unit masonry.
5. Cavity wall insulation adhered to masonry backup.

C. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 019119.43 "Exterior Enclosure Commissioning."
3. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail or channel slots for masonry-veneer anchors.
4. Section 042300 "Glass Unit Masonry" for glass block.
5. Section 042613 "Masonry Veneer" for unit masonry set as veneer.
6. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
7. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
8. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
9. Section 047200 "Cast Stone Masonry" for cast stone trim units.
10. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
11. Section 071900 "Water Repellents" for water repellents topically applied to unit masonry assemblies.
12. Section 072100 "Thermal Insulation" for cavity wall insulation.
13. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
14. Section 089516 "Wall Vents" for wall vents (brick vents).
15. Section 096313 "Brick Flooring" for interior brick flooring.
16. Section 096313.35 "Chemical-Resistant Brick Flooring" for chemical-resistant, interior brick flooring.
17. Section 097519 "Stone Trim" for interior stone window stools.
18. Section 321400 "Unit Paving" for exterior unit masonry paving.

19. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Exposed: Weather-exposed side of a constructed wall.

C. Reinforced Masonry: Masonry containing reinforcing steel within grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI PRC 315R. [**Indicate elevations of reinforced walls.**]
3. Lintel design and types required.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored Mortar: Full range of manufacturer's standard colors.
12. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.
13. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .

8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored mortar.
12. Weep/cavity vents.
13. Special Masonry Shapes: One of each unique shape.
14. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
15. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
16. Cavity drainage material.
17. Accessories embedded in masonry.

E. Delegated Design Submittals: For [**masonry anchors and ties**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only.

B. Material Certificates: For each type of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**] .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M [**or a list of addresses of buildings in Project's area where proposed brick has been used**

successfully and with a history of durability] .

e. For masonry units [**used in structural masonry**] , include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used within CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar [**and grout**] . Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Qualification Statements: For testing agency.

E. Delegated Design Engineer Qualifications: For [**masonry anchors and ties**].

F. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.
3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.

5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities, as directed by the Owner.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] . [**See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.**]

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**][**exterior wall**] mockup.
    b. Include lower corner of window opening [**framed with stone trim**] at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
    c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include wall substrate and cavity materials, veneer anchors, flashing [**cavity drainage material**], and weep holes in exterior masonry-veneer wall mockup.
    e. Include specified unit masonry on one face of interior unit masonry wall mockup.

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (610 mm)** down both sides of walls, and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of **24 inches (610 mm)** down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**][**or**][**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Masonry to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

B. Provide [**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 402/602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide [**square-edged**][**bullnose**] units for outside corners unless otherwise indicated.

D. CMUs: ASTM C90, [**normal weight**][**medium weight**][**lightweight**][**unless otherwise indicated**] .

1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Architectural CMUs: ASTM C90, [**normal-weight**][**medium-weight**][**lightweight**] architectural units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Angelus Block Co., Inc.**]
   b. [**Echelon Masonry, an Oldcastle APG brand**]
   c. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**] [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

F. Prefaced CMUs: ASTM C90, lightweight, with manufacturer's standard smooth resinous facing complying with ASTM C744.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Echelon Masonry, an Oldcastle APG brand**]
   b. [**York Building Products**]

2. Composition: [**Hollow**][**Solid**] units.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.6-mm-)** wide returns of facing to create **1/4-inch- (6.2-mm-)** wide mortar joints with modular coursing.
4. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

G. Acoustical CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] sound-absorbing units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Echelon Masonry, an Oldcastle APG brand**]
   c. [**RPG Acoustical Systems, Inc.**]
   d. [**Sound Seal**]

2. Surface Characteristics: [**Slotted**][**Textured**] .
3. Cavity Fill: [**Fibrous filler**][**Galvanized steel septum**][**Unfilled**] .

4. Sound Transmission Classification (STC): In accordance with ASTM E90 and ASTM E413.
5. Noise Reduction Coefficient (NRC): In accordance with ASTM C423 and ASTM E795.

H. Rigid, Cellular Thermal Insulation CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units containing rigid, specially shaped, molded-polystyrene insulation complying with ASTM C578, Type I, designed for installing in cores of CMUs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Concrete Block Insulating Systems**]
   b. [**Echelon Masonry, an Oldcastle APG brand**]
   c. [**Shelter Enterprises Inc.**]
   d. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

I. Low-Carbon CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units with low embodied carbon.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CarbonBuilt**]
   b. [**CarbonCure**]
   c. [**CarbonKind**]
   d. [**CarbonX**]
   e. [**Pozzotive (Glenwood Mason Supply)**]

2. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
3. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

J. Concrete Building Brick: ASTM C55, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches**

(70 mm)][3-5/8 inches (92 mm)] high by 7-5/8 inches (194 mm) long.

K. Concrete Facing Brick: ASTM C1634, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]
   e. [**Westbrook Concrete Block Co., Inc.**]

2. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by [2-1/4 inches (57 mm)][2-3/4 inches (70 mm)][3-5/8 inches (92 mm)] high by [7-5/8 inches (194 mm)][11-5/8 inches (295 mm)][15-5/8 inches (397 mm)] long.
3. Texture: [**Smooth-face**][**Split-face**][**Ground-face**] finish. [**Match Architect's samples**].
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

L. Concrete Masonry Unit Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

   a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 CLAY MASONRY UNITS

A. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Regional Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications [**where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels**][**requiring brick of size, form, color, and texture on exposed surfaces that cannot be**

produced by sawing][**where shapes produced by sawing would result in sawed surfaces being exposed to view**] .

D. Hollow Clay Facing Brick: ASTM C652, Grade [**SW**][**MW**] , Type [**HBA**][**HBB**][**HBX**][**HBS**] , Class [**H40V**][**H60V**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]
   e. [**Endicott Clay Products Co**]
   f. [**General Shale, Inc.**]
   g. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

E. Solid Clay Facing Brick: ASTM C216, Grade [**SW**][**MW**] , Type [**FBX**][**FBS**][**FBA**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Boral Bricks, Inc; Boral Limited**]
   e. [**Echelon Masonry, an Oldcastle APG brand**]
   f. [**Endicott Clay Products Co**]
   g. [**General Shale, Inc.**]
   h. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

F. Solid Building Brick: ASTM C62, Grade [**SW**][**MW**][**NW**] .

1. Size (Actual Dimensions): [**3-1/2 inches (89 mm) wide by 2-1/4 inches (57 mm) high by 7-1/2 inches (190 mm) long**][**or**][**3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long**] .
2. Application: Use for concealed brick unless otherwise indicated.

G. Glazed Brick: ASTM C1405, Grade [**S**][**SS**] , Class [**Exterior**][**Interior**] , Division [**Solid**][**H40V**][**H60V**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Belden Brick Company (The)**]
   b. [**Elgin Butler Company**]
   c. [**Glen-Gery Corporation**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**11-5/8 inches (295 mm)**] long.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and provide Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Application: Use where [**brick is exposed unless otherwise**] indicated.
5. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
6. [**Where indicated to "match existing,"**] provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

2.6 STRUCTURAL CLAY FACING TILE

A. General: Provide solid, multicored, or hollow units, with shape and direction of cores optional unless

otherwise indicated.

1. Where reinforced masonry is indicated, provide multicored units designed for use in reinforced, grouted masonry, either with vertical cores and with webs notched to receive horizontal reinforcement, or with horizontal cores and with holes in bed shells for placement of grout and to receive vertical reinforcement.
2. Where indicated for exterior applications, provide units recommended by manufacturer for exterior use in Project's location.
3. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated, including applications that cannot be produced by sawing standard units.

    a. Provide [**bullnose**][**square-edged**] units for outside corners unless otherwise indicated.
    b. Provide coved internal corners.
    c. Provide recessed, coved base units.

4. Where direct application of plaster is indicated or where bonded to backup masonry, provide units with rough, combed, or scored faces.

B. Glazed Structural Clay Facing Tile: ASTM C126, Grade [**S**][**SS**] .

1. Sizes: [**6P Series with actual face dimensions of 3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm)**][**6T Series with actual face dimensions of 5 inches (127 mm) high by 11-11/16 inches (297 mm)**][**4W Series (8-Square) with actual face dimensions of 7-5/8 inches (194 mm) high by 7-5/8 inches (194 mm)**][**4S Series with actual face dimensions of 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm)**][**8W Series with actual face dimensions of 7-5/8 inches (194 mm) high by 15-5/8 inches (397 mm)**] long by widths indicated.
2. Width: Manufactured to dimensions [**5/16 inch (8 mm)**][**3/8 inch (10 mm)**] less than nominal dimensions.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Provide special units glazed on ends and tops, as well as faces for corners, jambs, sills, pilasters, columns, and other applications indicated, where glazed units are exposed on other surfaces and faces.
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**].
6. [**Where shown to "match existing,"**] provide glazed structural clay facing tile matching color range, texture, and size of existing adjacent glazed structural clay facing tile.

C. Unglazed Structural Clay Facing Tile: ASTM C212, Type [**FTX**][**FTS**] , Class [**Standard**][**Special-Duty**] .

1. Number of Faces: Single faced [**where only one finished face is exposed when units are installed; double faced, where both finished faces are exposed when units are installed**] .
2. Size: [**As indicated**][**Match existing**] .

2.7 FIREPLACE AND CHIMNEY LINING UNITS

A. Firebox Brick: ASTM C1261, size required to produce lining thickness indicated.

B. Clay Flue Lining Units: ASTM C315.

2.8 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density

classification; and with reinforcing bars indicated. [**Provide lintels with net-area compressive strength of not less than that of CMUs.**][**Provide lintels with net-area compressive strength as indicated.**]

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete" and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FERO Corporation**]
b. [**Halfen USA, Inc.**]
c. [**Hohmann & Barnard, Inc**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
3. Carbon Steel: ASTM A1008/A1008M [**with ASTM A153/A153M, Class B coating**] .

2.9 MORTAR AND GROUT MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide mortar and grout materials to achieve performance requirements as specified in mortar and grout mixes.

D. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

E. Hydrated Lime: ASTM C207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]

H. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

I. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

J. Colored Mortar: Packaged blend made from [**portland cement-lime mix**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]

3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]
5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

K. Preblended Dry Mortar Mix: Packaged blend complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**Quikrete; The QUIKRETE Companies, LLC**]
3) [**Sakrete; CRH Americas, Oldcastle APG**]
4) [**SPEC MIX, LLC**]

b. Dry Mortar Mix Materials: Made from [**portland cement-lime mix**][**masonry cement**][**or**][**mortar cement**] , sand, [**mortar pigments,**][**water repellent admixture**] .

2. Preblended Dry Masonry Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**SPEC MIX, LLC**]

L. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

M. Aggregate for Grout: ASTM C404.

N. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or prefaced masonry units (and approved for use by manufacturer of units); in color indicated or, if not otherwise indicated, as directed by the Owner.

O. Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C199 test; or an equivalent product acceptable to authorities having jurisdiction.

P. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with [**ASTM C494/C494M, Type C**][**ASTM C1384**] , and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**GCP Applied Technologies Inc.**]

Q. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACM Chemistries**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**GCP Applied Technologies Inc.**]
   d. [**Master Builders Solutions**]

R. Water: Potable.

2.10 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold or lock more securely reinforcing bars in center of cells. Units are formed from minimum **0.148-inch (3.77-mm)** diameter steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

C. Masonry-Joint Reinforcement: ASTM A951/A951M.

1. Interior Walls: [**Mill-**][**Hot-dip**] galvanized carbon steel.
2. Exterior Walls: [**Hot-dip galvanized carbon**][**Stainless**] steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
5. Wire Size for Veneer Ties: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than **16 inches (406 mm)** o.c.
7. Provide in lengths of not less than **10 ft. (3 m)**[**with prefabricated corner and tee units**] .

D. Masonry-Joint Reinforcement for Single-Wythe Masonry:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Hohmann & Barnard, Inc**]
    c. [**Wire-Bond**]

2. Type: Ladder [**or truss**] with single pair of side rods.

E. Masonry-Joint Reinforcement for Multiwythe Masonry:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

2. Ladder type with one side rod at each face shell of hollow masonry units more than **4 inches (102 mm)** wide, plus [**one side rod**][**two side rods**] at each wythe of masonry **4 inches (102 mm)** wide or less.
3. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least **5/8-inch (16-mm)** cover on outside face.
4. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of

backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of **1/16 inch (1.6 mm)** and maximum vertical adjustment of **1-1/4 inches (32 mm)**. Size ties to extend at least halfway through facing wythe but with at least **5/8-inch (16-mm)** cover on outside face. [**Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.**]

F. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single **0.187-inch- (4.76-mm-)** diameter, [**hot-dip galvanized carbon**][**stainless**] steel continuous wire.

2.11 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
8. Stainless Steel Bars: ASTM A276 or ASTM A666/A666M, Type 304.

C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0336-inch- (0.85-mm-) thick steel sheet, galvanized after fabrication**][**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0312-inch- (0.79-mm-) thick, stainless steel sheet**][**0.0625-inch- (1.59 mm-) thick, stainless steel sheet**] .

D. Individual Wire Ties: Rectangular units with closed ends and not less than **4 inches (100 mm)** wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than **2 inches (51 mm)** long for masonry constructed from solid units.
2. Where wythes [**do not align**][**are of different materials**] , use adjustable ties with pintle-and-eye connections having a maximum adjustment of **1-1/4 inches (32 mm)**.
3. Wire: Fabricate from [**3/16-inch- (4.76-mm-)**][**1/4-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.**]

E. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3GEN Masonry Products, Inc.**]

2. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]

F. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: [**Dovetail**][**Channel**] tabs for inserting into [**dovetail**][**channel**] slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

   a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from [**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0785-inch- (1.99 mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] with [**dovetail**][**channel**] tabs for inserting into slots in concrete.

   a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick galvanized sheet may be used at interior walls unless otherwise indicated.

G. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (10-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [**steel, hot-dip galvanized after fabrication**][**stainless steel**] .

H. Rigid Anchors: Fabricate from steel bars [**1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**][**bent to configuration indicated**] .

1. Corrosion Protection: [**Hot-dip galvanized to comply with ASTM A153/A153M**][**Epoxy coating 0.020 inch (0.51 mm) thick**][**Rust-inhibitive paint**] .

I. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf (445 N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.6 mm).
2. Fabricate sheet metal anchor sections and other sheet metal parts from [**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] .

3. Fabricate wire ties from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized-steel**][**stainless steel**] wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie with seismic accessories [**and washer at face of insulation**] .

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**FERO Corporation**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**PROSOCO, Inc**]
        5) [**Wire-Bond**]

6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

    b. Seismic: Provide seismic tie, clip, and continuous wire in veneer.

7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match

thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Heckmann Building Products, Inc.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**TruFast; a brand of Altenloh, Brinck & Co. US, Inc.**]
6) [**Wire-Bond**]

b. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
c. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with wingnut or clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]

b. Fastener Configuration: Single-barrel screw with [**wingnut head**][**thermally resistant wingnut head**][**thermally resistant clip**] .
c. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
d. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

11. Masonry-Veneer Anchors; Seismic-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting leg with slotted hole for vertical leg of seismic pintle tie. Tie is rib-stiffened, sheet metal bent plate with down-turned leg to fit in anchor slot and with

integral tabs to hold continuous wire in veneer.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

12. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.
13. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless steel shank.

2.12 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3GEN Masonry Products, Inc.**]
b. [**Cheney Flashing Company**]
c. [**Hohmann & Barnard, Inc**]
d. [**Keystone Flashing Company, Inc**]
e. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**][**or**][**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with sawtooth ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.

9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
10. Fabricate metal drip edges from stainless steel. Extend at least **3 inches (76 mm)** into wall and **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
11. Fabricate metal sealant stops from stainless steel. Extend at least **3 inches (76 mm)** into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.
12. Fabricate metal expansion-joint strips from [**stainless steel**][**copper**] to shapes indicated.
13. Solder metal items at corners.

B. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper-Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Advanced Building Products Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**STS Coatings, Inc.**]
      4) [**Wire-Bond**]
      5) [**York Manufacturing, Inc**]

   b. Sheet Weight: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .
   c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Asphalt-Coated Copper Flashing: Copper sheet coated with flexible asphalt.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Hohmann & Barnard, Inc**]
      2) [**Wire-Bond**]

   b. Sheet Weight: [**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .

3. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**3GEN Masonry Products, Inc.**]

2) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**STS Coatings, Inc.**]
6) [**Wire-Bond**]
7) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

4. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**STS Coatings, Inc.**]
4) [**VaproShield LLC**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

5. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

6. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl

rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

7. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Hyload; IKO Industries, Inc.**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **40 mils (1.0 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **25 mils (0.64 mm)** thick, with a **15-mil- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

8. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Carlisle Coatings & Waterproofing Inc**]
2) [**Elevate; Amrize Building Envelope LLC**]
3) [**Heckmann Building Products, Inc.**]
4) [**Hohmann & Barnard, Inc**]
5) [**Wire-Bond**]

b. Thickness: **40 mils (1.0 mm)**.

C. Drainage Plane Flashing: Provide flashing materials as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3GEN Masonry Products, Inc.**]
   b. [**Mortar Net Solutions**]
   c. [**STS Coatings, Inc.**]
   d. [**York Manufacturing, Inc**]

2. Fabrication: [**Stainless steel**][**Copper**][**Rubberized asphalt**][**Elastomeric membrane**] and drainage membrane to shapes indicated [**including weep tabs, termination bar, and drip edge**] .

   a. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
   b. Copper: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**] thick.
   c. Rubberized Asphalt: [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.
   d. Elastomeric Membrane: [**EPDM complying with ASTM D4637/D4637M**][**PVC**][**PVC with Elvaloy Kee**][**TPO**] , [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.

3. Fabricate continuous flashings in sections **60 inches (1524 mm)** long, minimum.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Mortar Net Solutions**]

E. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

F. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

G. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

H. Termination Bars for Flexible Flashing:

1. Material: [**Aluminum**][**Stainless steel**][**Rigid PVC**]
2. Size: [**0.075 by 1 inch (1.90 by 25 mm)**][**1/8 by 1 inch (3.2 by 25 mm)**][**1/8 by 1-1/8 inch (3.2 by 29 mm)**] .

I. Termination Bars for Flexible Flashing, Flanged:

1. Material: [**Stainless steel sheet 0.019 by 1-1/2 inches (0.48 by 38 mm)**][**Aluminum sheet 0.064 by 1-1/2 inches (1.63 by 38 mm)**] .
2. Fabricate with a **3/8-inch (10-mm)** flange at top [**and bottom**] .

2.13 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**][**or**][**PVC**] .

B. Preformed Control-Joint Gaskets: Made from [**styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805**][**or**][**PVC, complying with ASTM D2287, Type PVC-65406**] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vents: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, **1/4 to 3/8 inch (6.4 to 10 mm)** in diameter, in length required to produce **2-inch (51-mm)** exposure on exterior and **18 inches (457 mm)** in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by **4 inches (102 mm)** long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, **3/8 by 1-1/2 by 3-1/2 inches (10 by 38 by 89 mm)** long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Advanced Building Products Inc.**]
        3) [**Heckmann Building Products, Inc.**]
        4) [**Hohmann & Barnard, Inc**]
        5) [**Mortar Net Solutions**]
        6) [**Wire-Bond**]

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe; in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**CavClear; a division of Archovations, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color, as directed by the Owner.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Williams Products, Inc.**]
3) [**Wire-Bond**]

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Size: Strips [**full depth of cavity**][**3/4 inch (19 mm) thick**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] and [**10 inches (254 mm)**][**16 inches (406 mm)**] high.
c. Surface Drainage: [**Dovetail-shaped notches**][**Dimpled surface**] that prevents clogging with mortar droppings.

2. Rainscreen Drainage Mat:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**CavClear; a division of Archovations, Inc.**]

3) [**Keene Building Products**]
4) [**Maxxon Corporation**]
5) [**Mortar Net Solutions**]
6) [**Wire-Bond**]

b. Size: Sheets or strips not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] thick and installed to full height of cavity.
c. Surface Drainage: Provide additional strips **4 inches (102 mm)** high at weep holes and thick enough to fill entire depth of cavity to prevent weep holes from clogging with mortar.

F. Masonry Cell Fill: [**Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)**][**Lightweight-Aggregate Fill: ASTM C331/C331M**][**Foamed-in-place masonry cell fill**] .

G. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

2.14 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Provide the following types of mortar for applications stated unless another type is indicated [**or needed to provide required compressive strength of masonry**] .

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use [**Type M**][**Type S**][**Type N**] .
3. For mortar parge coats, use [**Type S**][**or**][**Type N**] .
4. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored mortar cement**] .

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints, as directed by the Owner.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints, as directed by the Owner.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, [**Table 1**][**or**][**paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)**] .
3. Provide grout with a slump of [**8 to 11 inches (203 to 279 mm)**][**10 to 11 inches (254 to 279 mm)**] as measured in accordance with ASTM C143/C143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. [**Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).**]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**stack bond**][**one-third running bond**][**Flemish bond**][**English bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] . Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-In Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout **24 inches (610 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Rigid, Cellular Thermal Insulation, CMUs: Install molded-polystyrene insulation units into masonry unit cells before laying units.

J. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of hollow CMUs solidly around plastic tubes of anchors, and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors [**48 inches (1219 mm)**] o.c. unless otherwise indicated.

3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. General: Lay masonry units as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Hollow Clay Facing Brick: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Solid Masonry Units: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

D. Structural Clay Facing Tiles: Lay units as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with **1/4- to 3/8-inch- (6.4- to 10-mm-)** thick joints.

E. Firebox Brick: Set units in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately **1/8 inch (3.2 mm)**. Tool joints smooth on surfaces exposed to fire or smoke.

F. Clay Flue Lining Units: Install units to comply with ASTM C1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar **1/16 to 1/8 inch (1.6 to 3.2 mm)** thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.

G. Trim Units: Set [**stone**][**cast-stone**] trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

H. Rake out mortar joints at [**prefaced CMUs**][**glazed brick**][**and**][**glazed structural clay facing tile**] to a

uniform depth of **1/4 inch (6.4 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

I. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

J. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

K. Cut joints flush where indicated to receive [**waterproofing**][**cavity wall insulation**][**air barriers**] unless otherwise indicated.

3.6 INSTALLATION OF COMPOSITE MASONRY

A. Bond wythes of composite masonry together [**using one of the following methods**][**as follows**] :

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [**4.5 sq. ft. (0.42 sq. m)**][**2.67 sq. ft. (0.25 sq. m)**][**1.77 sq. ft. (0.16 sq. m)**] of wall area spaced not to exceed [**36 inches (914 mm)**][**24 inches (610 mm)**][**16 inches (406 mm)**] o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (914 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.

a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than [**8 inches (200 mm)**][**12 inches (300 mm)**] clear horizontally and **16 inches (400 mm)** clear vertically.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

1. Structural Clay Facing Tile: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at [**exterior walls, except cavity walls**][**and**][**interior walls and partitions**] .

D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are indicated at juncture, bond walls together as follows:

1. Provide individual wire ties not more than [**8 inches (203 mm)**][**16 inches (406 mm)**] o.c.
2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than [**24 inches (610 mm)**][**48 inches (1219 mm)**] o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 INSTALLATION OF CAVITY WALLS

A. Bond wythes of cavity walls together as follows:

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [**4.5 sq. ft. (0.42 sq. m)**][**2.67 sq. ft. (0.25 sq. m)**][**1.77 sq. ft. (0.16 sq. m)**] of wall area spaced not to exceed [**36 inches (914 mm)**][**24 inches (610 mm)**][**16 inches (406 mm)**] o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (914 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.

   a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
   b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

   a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
   b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .
   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] to allow for differential movement regardless of whether bed joints align.

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than [**8 inches (203 mm)**][**12 inches (305 mm)**] clear horizontally and **16 inches (406 mm)** clear vertically.
4. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Parge cavity face of backup wythe in a single coat approximately **3/8 inch (10 mm)** thick. Trowel face of parge coat smooth.

E. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately **12 inches (305 mm)** o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 INSTALLATION OF ANCHORED MASONRY VENEERS

A. Masonry-veneer anchors to comply with the following requirements:

1. Fasten [**screw-attached**][**and**][**seismic**] anchors [**through sheathing to wall framing**][**and**][**to concrete and masonry backup**] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [**tie sections**][**connector sections and continuous wire**] in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each [**2.67 sq. ft. (0.25 sq. m)**][**3.5 sq. ft. (0.33 sq. m)**] of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.

B. Provide not less than [**2 inches (51 mm)**][**1 inch (25 mm)**] of airspace between back of masonry veneer and face of [**sheathing**][**insulation**] .

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.9 INSTALLATION OF MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (152 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings [**in addition to continuous reinforcement**] .

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at [**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 INSTALLATION OF ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**2 inches (51 mm)**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (914 mm)** o.c. horizontally.

3.11 INSTALLATION OF CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Indicate locations of joints on Drawings. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint **4 inches (102 mm)** in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**] for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than [**3/8 inch (10 mm)**] .

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 INSTALLATION OF LINTELS

A. Provide lintel types where indicated on Drawings and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are indicated without structural steel or other supporting lintels.

B. Provide minimum bearing of **8 inches (203 mm)** at each jamb unless otherwise indicated.

3.13 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. [**Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.**]

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and through inner wythe to within **1/2 inch (13 mm)** of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately **2 inches (51 mm)** on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and **1-1/2 inches (38 mm)** into the inner wythe. [**Form 1/4-inch (6.4-mm) hook in edge of flashing embedded in inner wythe.**]
4. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under [**water-resistive barrier**][**air barrier**] , lapping at least **4 inches (102 mm)**. [**Fasten upper edge of flexible flashing to sheathing through termination bar.**]
5. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] and turn ends up not less than **2 inches (51 mm)** to form end dams.
6. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
7. Install metal [**drip edges**][**and**][**sealant stops**] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Single-Wythe CMU Flashing System: Install in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

3.14 INSTALLATION OF WEEP/CAVITY VENTS

A. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use [**specified weep/cavity vents**][**or**][**open-head joints**] to form weep holes.

2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
4. Space weep holes formed from [**plastic tubing**][**or**][**wicking material**] **16 inches (406 mm)** o.c.
5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

B. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches (51 mm)**, to maintain drainage.

1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than **24 inches (610 mm)** above top of pea gravel.

C. Cavity Drainage Material: Place in [**cavities**][**airspace behind veneers**] to comply with configuration requirements for cavity drainage material in "Accessories" Article.

D. Install cavity vents in head joints in exterior wythes at spacing indicated. Use [**specified weep/cavity vent**][**or**][**open-head joints**] to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.15 INSTALLATION OF REIINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than [**60 inches (1524 mm)**][**12.67 ft. (3.86 m)**] .

3.16 INSTALLATION OF MASONRY CELL FILL

A. Loose-Fill Insulation: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

B. Lightweight-Aggregate Fill: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

C. Foamed-in-Place Masonry Cell Fill: Drill holes in mortar bed joints at spacing as indicated in writing by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with [**Level 2**][**Level 3**] in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each **5000 sq. ft. (464 sq. m)** of wall area or portion thereof.

E. Concrete Masonry Units: Test each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Clay Masonry Units: Test each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

G. Mortar Aggregates: Ratio test (Proportion Specification) for each mix provided, in accordance with ASTM C780.

H. Mortar: Test each mix provided in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

I. Grout: Test each mix provided in accordance with ASTM C1019.

J. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [**7 days and at**] 28 days.

3.18 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch (19 mm)**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/8 inch per foot (3.2 mm per 305 mm)**. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.19 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.20 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in TEK 08-04A.
7. Clean masonry with a proprietary acidic masonry cleaner applied in accordance with manufacturer's written instructions.

3.21 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (102 mm)** in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (457 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken masonry units not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 20 00 00

SECTION 04 20 00 00A - MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clay masonry units.
2. Concrete masonry units.
3. Mortar materials.
4. Ties and anchors.
5. Embedded flashing.
6. Accessories.
7. Mortar mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Cast-stone trim in masonry veneer.
2. Stone trim units in masonry veneer.
3. Steel lintels in masonry veneer.
4. Steel shelf angles for supporting masonry veneer.

C. Related Requirements:

1. Section 019119.43 "Exterior Enclosure Commissioning."
2. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail slots or channel slots for masonry-veneer anchors.
3. Section 034100 "Precast Structural Concrete" for thin brick veneer.
4. Section 034500 "Precast Architectural Concrete" for thin brick veneer.
5. Section 042000 "Unit Masonry" for multi-wythe masonry veneer assemblies.
6. Section 042200 "Concrete Unit Masonry" for full-size, single-wythe CMU assemblies.
7. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
8. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
9. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
10. Section 047200 "Cast Stone Masonry" for cast-stone trim units.
11. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural-steel frame.
12. Section 071900 "Water Repellents" for water repellents applied to masonry veneer assemblies.
13. Section 072500 "Weather Barriers" for weather barriers part of masonry veneer assemblies.
14. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
15. Section 092900 "Gypsum Board" for exterior backer board part of masonry veneer assemblies.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Exposed: Weather-exposed side of a constructed wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Thin Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Thin CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Colored Mortar: Full range of manufacturer's standard colors.
9. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.
10. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Thin Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Thin CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Special Masonry Shapes: One of each unique shape.
9. Colored Mortar: Full range of manufacturer's standard colors.
10. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
11. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
12. Weep/cavity vents.
13. Cavity drainage material.
14. Accessories embedded in masonry.

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and include source of aggregates.

1. Submittal is for information only.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**] .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M [**or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability**] .

2. Integral water repellent used in decorative CMUs.
3. Cementitious Materials: Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, Dry Mortar Mixes: Include description of type and proportions of ingredients.
6. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.

D. Qualification Statements: For testing agency.

E. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed masonry veneer construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.
3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] .

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed masonry veneer construction**][**typical exterior wall**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] high by full thickness, including face and backup wythes and accessories.

   a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**] mockup.
   b. Include lower corner of window opening [**framed with stone trim,**] at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
   c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
   d. Include wall substrate and cavity materials, veneer anchors, flashing [**cavity drainage material**] , and weep holes in exterior masonry-veneer wall mockup.

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If the units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (610 mm)** down face of veneer, and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace masonry veneer damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**][**or**][**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MASONRY VENEER, GENERAL

A. Masonry Standard: Comply with TMS 402/602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CLAY MASONRY UNITS

A. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Regional Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications [**where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels**][**requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing**][**where shapes produced by sawing would result in sawed surfaces being exposed to view**] .

D. Hollow Clay Facing Brick: ASTM C652, Grade [**SW**][**MW**] , Type [**HBX**][**HBS**][**HBA**] , Class H40V.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]
e. [**Endicott Clay Products Co**]
f. [**General Shale, Inc.**]
g. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**As selected by Architect**] .

E. Solid Clay Facing Brick: ASTM C216, Grade [**SW**][**MW**] , Type [**FBX**][**FBS**][**FBA**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Boral Bricks, Inc; Boral Limited**]
   e. [**Echelon Masonry, an Oldcastle APG brand**]
   f. [**Endicott Clay Products Co**]
   g. [**General Shale, Inc.**]
   h. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**As selected by Architect**] .

9. Solid Building Brick: ASTM C62, Grade [**SW**][**MW**][**NW**] .

F. Glazed Brick: ASTM C126, Grade [**S**][**SS**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Belden Brick Company (The)**]
   b. [**Elgin Butler Company**]
   c. [**Glen-Gery Corporation**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**11-5/8 inches (295 mm)**] long.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Application: Use where [**brick is exposed unless otherwise indicated**][**indicated**] .
5. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
6. [**Where indicated to "match existing,"**] provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

G. Thin Brick: ASTM C1088, Grade [**Exterior**][**Interior**] , Type [**TBA**][**TBS**][**TBX**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Elgin Butler Company**]
   c. [**General Shale, Inc.**]
   d. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Thin brick with colors or textures applied as coatings to withstand 50 cycles of freezing and thawing; ASTM C67/C67M, with no observable difference in applied finish when viewed from **10 ft. (3 m)**.
5. Size (Actual Dimensions): [**3/8 inches (10 mm)**][**1/2 inches (13 mm)**][**9/16 inches (14 mm)**][**5/8 inches (16 mm)**][**3/4 inches (19 mm)**][**1 inches (25 mm)**][**1-5/8 inches (41 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-3/16 inches (71 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**8-1/2 inches (216 mm)**][**9-1/2 inches (241 mm)**][**9-5/8 inches (244 mm)**][**11-5/8 inches (295 mm)**][**15-5/8 inches (397 mm)**][**19-1/4 inches (489 mm)**] long.
6. Installation Method: [**Thinset**][**Thickset**][**Modular panels systems**] .
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.

8. Color and Texture: [**Match Architect's samples**][**As selected by Architect**] .

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

D. Architectural CMUs: ASTM C90. [**normal weight**][**medium weight**][**lightweight**] architectural veneer units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Angelus Block Co., Inc.**]
b. [**Echelon Masonry, an Oldcastle APG brand**]
c. [**York Building Products**]

2. Size (Actual Dimensions): [**3-5/8 inches (92 mm) wide by 3-5/8 inches (92 mm) high by 15-5/8 inches (397 mm) long**] .
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**][**Match Architect's samples**] .
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

E. Thin CMUs: ASTM C1877 and TMS 402/602 Ch. 13.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Angelus Block Co., Inc.**]

2. Size (Actual Dimensions): **1-5/8 inches (41 mm)** wide by [**3-5/8 inches (92 mm)**][**7-5/8 inches (193 mm)**] high by [**15-5/8 inches (397 mm) long**].

3. Pattern and Texture: [**Standard pattern, smooth finish**][**Match Architect's samples**] .
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

F. Concrete Facing Brick: ASTM C1634, [**normal weight**][**medium weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]
   e. [**Westbrook Concrete Block Co., Inc.**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**] high by [**7-5/8 inches (194 mm)**][**11-5/8 inches (295 mm)**][**15-5/8 inches (397 mm)**] long.
3. Texture: [**Smooth-face**][**Split-face**][**Ground-face**] finish. [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

G. Concrete Masonry Unit Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

   a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 MORTAR MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

D. Hydrated Lime: ASTM C207, Type S.

E. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

F. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]

G. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

H. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

I. Colored Mortar: Packaged blend made from [**portland cement-lime mix**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]
5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

J. Preblended Dry Mortar Mix: Packaged blend complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**Quikrete; The QUIKRETE Companies, LLC**]
3) [**Sakrete; CRH Americas, Oldcastle APG**]
4) [**SPEC MIX, LLC**]

b. Dry Mortar Mix Materials: Made from [**portland cement-lime mix**][**masonry cement**][**or**][**mortar cement**] sand, [**mortar pigments**][**water repellent admixture**] .

2. Preblended Dry Masonry Cement Mortar Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]

2) [**SPEC MIX, LLC**]

K. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

L. Latex Additive: Manufacturer's standard emulsion, serving as replacement for part or all of gauging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BASF**]
   b. [**Custom Building Products**]
   c. [**Euclid Chemical**]
   d. [**H.B. Fuller Construction Products Inc. / TEC**]
   e. [**Laticrete International, Inc.**]
   f. [**MAPEI Corporation**]

M. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture, complying with [**ASTM C494/C494M, Type C**][**ASTM C1384**] , and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**GCP Applied Technologies Inc.**]

N. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACM Chemistries**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**GCP Applied Technologies Inc.**]
   d. [**Master Builders Solutions**]

O. Water: Potable.

2.6 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .

C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0336-inch- (0.85-mm-) thick, steel sheet, galvanized after fabrication**][**0.0635-inch- (1.61-mm-) thick, steel sheet, galvanized after fabrication**][**0.0312-inch- (0.79-mm-) thick, stainless steel sheet**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**] .

D. Adjustable Anchors for Connecting to Structural-Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.4-mm-)** diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: [**Dovetail**][**Channel**] tabs for inserting into [**dovetail**][**channel**] slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick, steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick, steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

   a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after**

fabrication][**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] with [**dovetail**][**channel**] tabs for inserting into dovetail slots in concrete.

a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized sheet may be used at interior walls unless otherwise indicated.

F. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a **100 lbf (445 N)** load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of **1/16 inch (1.6 mm)**.
2. Fabricate sheet metal anchor sections and other sheet metal parts from [**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] .
3. Fabricate wire ties from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie [**and washer at face of insulation**] .

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**FERO Corporation**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**PROSOCO, Inc**]
      4) [**Wire-Bond**]

6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Heckmann Building Products, Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**Quality Steel and Wire LLC**]
      4) [**Wire-Bond**]

   b. Seismic: Provide seismic tie, clip, and continuous wire in veneer.

7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and

base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Quality Steel and Wire LLC**]
4) [**Wire-Bond**]

8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**PROSOCO, Inc**]
4) [**TRUFAST Walls**]
5) [**Wire-Bond**]

b. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
c. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with wingnut or clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]

b. Fastener Configuration: Single-barrel screw with [**wingnut head**][**thermally resistant wingnut head**][**thermally resistant clip**] .
c. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
d. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

11. Masonry-Veneer Anchors; Seismic-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting leg with slotted hole for vertical leg of seismic pintle tie. Tie is rib-stiffened, sheet metal bent plate with down-turned leg to fit in anchor slot and with integral tabs to hold continuous wire in veneer.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

12. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.
13. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon steel drill point and 300 Series stainless steel shank.

2.7 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cheney Flashing Company**]
b. [**Hohmann & Barnard, Inc**]
c. [**Keystone Flashing Company, Inc**]
d. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**][**or**][**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not

exceeding 12 ft. (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.

5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6.4 mm) to form a stop for retaining sealant backer rod.
9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least 3 inches (76 mm) into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
10. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
11. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6.4 mm) to form a stop for retaining sealant backer rod.
12. Fabricate metal expansion-joint strips from [**stainless steel**][**copper**] to shapes indicated.
13. Solder metal items at corners.

B. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Advanced Building Products Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**STS Coatings, Inc.**]
      4) [**Wire-Bond**]
      5) [**York Manufacturing, Inc**]

   b. Sheet Weight: [3 oz./sq. ft. (0.9 kg/sq. m)][5 oz./sq. ft. (1.5 kg/sq. m)][7 oz./sq. ft. (2 kg/sq. m)] .
   c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum 2-mil (0.05-mm) thick stainless steel sheet, bonded to a layer of polymeric fabric.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
      2) [**Hohmann & Barnard, Inc**]

3) [**PROSOCO, Inc**]
4) [**STS Coatings, Inc.**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

3. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil (0.05-mm)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**STS Coatings, Inc.**]
3) [**VaproShield LLC**]
4) [**Wire-Bond**]
5) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

4. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

5. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Viaflex**]
6) [**Wire-Bond**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

6. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Hyload; IKO Industries, Inc.**]
3) [**Mortar Net Solutions**]
4) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **40 mils (1.0 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **25 mils (0.64 mm)** thick, with a **15-mil- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

7. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Carlisle Coatings & Waterproofing Inc**]
2) [**Elevate; Amrize Building Envelope LLC**]
3) [**Heckmann Building Products, Inc.**]
4) [**Hohmann & Barnard, Inc**]
5) [**Wire-Bond**]

b. Thickness: **40 mils (1.0 mm)**.

C. Drainage Plane Flashing: Provide flashing materials as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Mortar Net Solutions**]
b. [**STS Coatings, Inc.**]
c. [**York Manufacturing, Inc**]

2. Fabrication: [**Stainless steel**][**Copper**][**Rubberized asphalt**][**Elastomeric membrane**] and drainage membrane to shapes indicated [**including weep tabs, termination bar, and drip edge**] .

   a. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
   b. Copper: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**] thick.
   c. Rubberized Asphalt: [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.
   d. Elastomeric Membrane: [**EPDM, complying with ASTM D4637/D4637M**][**PVC**][**PVC with Elvaloy Kee**][**TPO**] , [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.

3. Fabricate continuous flashings in sections **60 inches (1524 mm)** long, minimum.
4. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

D. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

E. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

G. Termination Bars for Flexible Flashing:

1. Material: [**Aluminum**][**Stainless steel**][**Rigid PVC**] .
2. Size: [**0.075 by 1 inch (1.90 by 25 mm)**][**1/8 by 1 inch (3.2 by 25 mm)**][**1/8 by 1-1/8 inch (3.2 by 29 mm)**] .

H. Termination Bars for Flexible Flashing, Flanged:

1. Material: [**Stainless steel sheet 0.019 by 1-1/2 inches (0.48 by 38 mm)**][**Aluminum sheet 0.064 by 1-1/2 inches (1.63 by 38 mm)**] .
2. Fabricate with a **3/8-inch (10-mm)** flange at top [**and bottom**] .

2.8 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**][**or**][**PVC**] .

B. Weep/Vent Products: Use the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, **1/4 to 3/8 inch (6.4 to 10 mm)** in diameter, in length required to produce **2-inch (51-mm)** exposure on exterior and **18 inches (457 mm)** in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by **4 inches (102 mm)** long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, **3/8 by 1-1/2 by 3-1/2 inches (10 by 38 by 89 mm)** long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Advanced Building Products Inc.**]
      2) [**Heckmann Building Products, Inc.**]
      3) [**Hohmann & Barnard, Inc**]
      4) [**Mortar Net Solutions**]
      5) [**Wire-Bond**]

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe; in color selected from manufacturer's standard.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**CavClear; a division of Archovations, Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**Keene Building Products**]
      4) [**Mortar Net Solutions**]

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Hohmann & Barnard, Inc**]

2) [**Williams Products, Inc.**]
3) [**Wire-Bond**]

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Size: Strips [**full depth of cavity**][**3/4 inch (19 mm) thick**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] and [**10 inches (254 mm)**][**16 inches (406 mm)**] high.
c. Surface Drainage: [**Dovetail-shaped notches**][**Dimpled surface**] that prevents clogging with mortar droppings.

2. Rainscreen Drainage Mat:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**CavClear; a division of Archovations, Inc.**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]

b. Size: Sheets or strips not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] thick and installed to full height of cavity.
c. Surface Drainage: Provide additional strips **4 inches (102 mm)** high at weep holes and thick enough to fill entire depth of cavity to prevent weep holes from clogging with mortar.

D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer for thermal bridging. Component and anchor size and spacing engineered by manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FERO Corporation**]
b. [**Halfen USA, Inc.**]
c. [**Hohmann & Barnard, Inc**]

E. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

F. Modular Panel System: Manufacturer's approved modular panels designed for adhering thin brick units or mechanically securing thin brick to the panel with attachment hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Tabs Wall Systems, LLC**]

2. Panel Type: Use [**Metal, G90 galvanized steel 0.018 inch (0.46 mm) thick, structural Grade 33 steel**][**Composite made of polypropylene and fiberglass**] .

G. Expanded Metal Lath: **3.4 lb/sq. yd. (1.8 kg/sq. m)**, self-furring, diamond-mesh lath complying with ASTM C847. Fabricate from structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G60 (Z180)**.

H. Woven-Wire Lath: ASTM C1032/C1032M, fabricated into **1-1/2-inch (38-mm)** hexagonal-shaped mesh with minimum **0.0510-inch- (1.3-mm-)** diameter, galvanized-steel wire.

I. Welded-Wire Lath: ASTM C933, fabricated into **2-by-2-inch (50-by-50-mm)** mesh with minimum **0.0625-inch- (1.6-mm-)** diameter, galvanized-steel wire.

J. Lath Attachment Devices and Fasteners: Corrosion-resistant material and type required by ASTM C1063 for installations indicated.

K. Weep Screed: Fabricated from hot-dip galvanized steel sheet ASTM A653/ASTMA653M, **G60 (Z180)** zinc coating.

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Masonry Veneer: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Use Type N unless another type is indicated.

1. For masonry below grade or in contact with earth, use [**Type M**][**Type S**] .

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored mortar cement**] .

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample, as directed by the Owner.
4. Application: Use pigmented mortar for exposed mortar joints.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.
2. Application: Use colored-aggregate mortar for exposed mortar joints.

F. Thinset Mortar: Polymer-modified, thinset mortar per ANSI A118.4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install all accessories in accordance with manufacturer's written instructions.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Select and arrange units for exposed masonry veneer to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. [**Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).**]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**stack bond**][**one-third running bond**][**Flemish bond**][**English bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. Lay masonry units with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells.

1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.

B. Hollow Clay Facing Brick: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Solid Masonry Units: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

D. Trim Units: Set [**stone**][**cast-stone**] trim units in full bed of mortar with full vertical joints.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness

unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

3.6 INSTALLATION OF ANCHORED MASONRY VENEERS

A. Masonry-veneer anchors to comply with the following requirements:

1. Fasten [**screw-attached**][**and**][**seismic**] anchors [**through sheathing to wall framing**][**and**][**to concrete and masonry backup**] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [**tie sections**][**connector sections and continuous wire**] in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each [**2.67 sq. ft. (0.25 sq. m)**][**3.5 sq. ft. (0.33 sq. m)**] of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.

B. Provide not less than [**2 inches (51 mm)**][**1 inch (25 mm)**] of airspace between back of masonry veneer and face of [**sheathing**][**insulation**] .

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.7 INSTALLATION OF THE ANCHORING OF MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**2 inches (51 mm)**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (914 mm)** o.c. horizontally.

3.8 INSTALLATION OF ADHERED THIN BRICK VENEER

A. Thickset Method:

1. Mechanically fasten metal lath or mesh securely to substrate per manufacturer's written instructions.
2. Apply scratch coat and then bond coat over prepared lath or mesh.
3. Set thin brick into mortar bed, ensuring full coverage on back of thin brick units.

4. Maintain consistent spacing, coursing, joint width, and alignment.

B. Thinset Method:

1. Apply thinset latex-modified mortar to backer board as recommended in writing by manufacturer with notched trowel.
2. Set thin brick, pressing firmly into mortar for full bond.
3. Maintain consistent spacing, coursing, joint width, and alignment.

C. Modular Panel Systems:

1. General: Follow manufacturers' modular panel systems written instructions for the following:

   a. Mortar: Type N or latex modified.

2. Panels and Adhesive: Per panel manufacturer's written instructions.
3. Interior Applications:

   a. Install, secure and prepare modular panels per manufacturer's written instructions.
   b. Provide polymer-modified mortar as recommended in writing by thin brick manufacturer.
   c. Trowel the mortar onto the panel and expose the coursing on the modular panel.
   d. Back face of thin brick must be dry and clean, free of dirt, oil, or any other foreign contaminant.
   e. Apply a uniform layer of mortar to the entire back surface of each thin brick with notched trowel immediately prior to setting.
   f. Place thin veneer on the panel leg and bag in joints with Type N or Type S mortar.
   g. Strike joints using a joint profile tool.

4. Exterior Applications:

   a. Install, secure and prepare modular panels per manufacturer's written instructions.
   b. Back face of thin brick must be dry and clean, free of dirt, oil, or any other foreign contaminant.
   c. Where applicable, insert thin brick into panel grooves, rails, or tabs to support and align thin brick courses.
   d. Where panel requires mortar method installation, trowel the scratch coat onto the panel and expose the coursing on the modular panel.
   e. Thin brick to be applied within 10 minutes after thinset adhesive has been applied and before film begins to form on the thinset adhesive.
   f. Lay thin brick in course pattern as indicated on Drawings.
   g. Leave a uniform **3/8- to 1/2-inch (9.5- to 12.7-mm)** gap at openings to allow for movement joint installation.
   h. Keep areas intended to receive sealant clean of thin brick, adhesive, and other materials during construction.
   i. Place thin brick on the panel leg and bag in joints with Type N or Type S mortar.
   j. Strike joints using a joint profile tool.
   k. Do not allow masonry units to bridge movement joints in substrate.

3.9 INSTALLATION OF ADHERED THIN CMU VENEER

A. General: Construct thin CMU in compliance with TMS 402/602.

B. Mechanically fasten metal lath or mesh securely to moisture-resistant substrate per manufacturer's written instructions.

C. Apply ANSI A118.4 mortar scratch coat over prepared lath or mesh.

D. Horizontally score mortar surface while plastic to form mechanical key.

E. Brush neat portland cement paste onto both the scratch coat surface and the back of the thin CMU unit completely.

F. Maintain consistent spacing, coursing, joint width, and alignment.

G. Press, tap veneer units into place, and bed firmly to achieve **3/8-inch (9-mm)** minimum to **1-1/4-inch (302-mm)** maximum mortar behind the units after setting.

H. Ensure full continuous contact without gaps behind the veneer units.

I. Tool joints with a round jointer when mortar is thumbprint hard for uniform appearance.

J. Remove and clean excess mortar promptly.

K. Grout the joints only after there is sufficient cure time of installing thin CMU units, when mild contact will not break the bonding.

L. Extra precaution should be taken while raking the joints to desired depth so the surface of the thin CMU is undamaged. Clean off remaining grout debris on the thin CMU surface with a dry, soft-bristled brush.

M. See thin CMU manufacturer's written instructions on cleaning and maintenance. Do not use harsh chemicals for cleaning, such as muriatic acid, or abusive tools, such as wire brushes to clean the surface.

3.10 INSTALLATION OF EXPANSION JOINTS

A. General: Install expansion-joint materials in masonry veneer as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.

B. Form expansion joints as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint **4 inches (102 mm)** in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**] for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than [**3/8 inch (10 mm)**] .

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 INSTALLATION OF OFFSET ANGLE SUPPORTS

A. Provide offset angle supports where indicate and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are indicated without structural steel or other supporting lintels.

B. Provide minimum bearing of **8 inches (203 mm)** at each jamb unless otherwise indicated.

3.12 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. [**Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.**]

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under [**water-resistive barrier**][**air barrier**] , lapping at least **4 inches (102 mm)**. [**Fasten upper edge of flexible flashing to sheathing through termination bar.**]
3. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] and turn ends up not less than **2 inches (51 mm)** to form end dams.
4. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
5. Install metal [**drip edges**][**and**][**sealant stops**] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

3.13 INSTALLATION OF WEEP/CAVITY VENTS

A. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use [**specified weep/cavity vents**][**or**][**open-head joints**] to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
4. Space weep holes formed from [**plastic tubing**][**or**][**wicking material**] **16 inches (406 mm)** o.c.

5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

B. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

C. Install vents in head joints in exterior wythes at spacing indicated. Use [**specified weep/cavity vent products**][**or**][**open-head joints**] to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with Level 2 in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Testing Prior to Construction: One set of tests.

D. Clay Masonry Units: Test each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

E. Concrete Masonry Units: Test each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregates: Ratio test (proportion specification) for each mix provided, in accordance with ASTM C780.

G. Mortar: Test each mix provided, in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

3.15 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.16 CLEANING

A. In-Progress Cleaning: Clean masonry veneer as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied in accordance with manufacturer's written instructions.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of masonry veneer work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (102 mm)** in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (457 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken masonry units not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, as directed by the Owner.

END OF SECTION 04 20 00 00A

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Task	Specification	Specification Description
04 21 00 00	04 20 00 00a	Masonry Veneer
04 21 13 00	04 20 00 00	Unit Masonry
04 21 13 00	04 20 00 00a	Masonry Veneer
04 21 19 00	04 20 00 00	Unit Masonry
04 21 19 00	04 20 00 00a	Masonry Veneer
04 21 26 00	04 20 00 00	Unit Masonry
04 21 26 00	04 20 00 00a	Masonry Veneer
04 21 29 00	04 20 00 00	Unit Masonry
04 21 29 00	04 20 00 00a	Masonry Veneer

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SECTION 04 22 00 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Lintels.
3. Mortar and grout materials.
4. Reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Accessories.
8. Mortar and grout mixes.

B. Products Installed, but Not Furnished, under This Section:

1. Precast architectural concrete trim in concrete unit masonry.
2. Glass unit masonry in concrete unit masonry.
3. Brick veneer in concrete unit masonry.
4. Cast-stone trim in concrete unit masonry.
5. Steel lintels in concrete unit masonry.
6. Steel shelf angles for supporting concrete unit masonry.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail slots for masonry anchors.
2. Section 034500 "Precast Architectural Concrete" for precast concrete trim.
3. Section 042300 "Glass Unit Masonry" for glass block.
4. Section 042613 "Masonry Veneer" for unit masonry set as veneer.
5. Section 047200 "Cast Stone Masonry" for cast stone trim units.
6. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
7. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles.
8. Section 071900 "Water Repellents" for water repellents applied to surface of unit masonry assemblies.
9. Section 072119 "Foamed-in-Place Insulation" for foam insulation installed in CMU cores.
10. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
11. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

C. Exposed: Weather-exposed side of a constructed wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI PRC 315R. [**Indicate elevations of reinforced walls.**]
3. Lintel design and types required.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Colored Mortar: Full range of manufacturer's standard colors.
4. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.

D. Samples for Verification: For each type and color of the following:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Colored mortar.
4. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
5. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.

E. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
2. Type III Environmental Product Declaration (EPD): For each product.
3. Type III Environmental Product Declaration (EPD): For each product.
4. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.
5. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**][**documentation of carbon-reduction methods**] .
b. For masonry units [**used in structural masonry**] , include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used in CMUs, if not surface treated.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

B. Mix Designs: For each type of mortar [**and grout**] . Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

C. Qualification Statements: For testing agency.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 402/602.

E. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1200 mm)**][**60 inches (1500 mm)**] long by [**36 inches (900 mm)**][**48 inches (1200 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.

3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] .

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1200 mm)**][**60 inches (1500 mm)**][**72 inches (1800 mm)**][**96 inches (2400 mm)**] long by [**36 inches (900 mm)**][**48 inches (1200 mm)**][**60 inches (1500 mm)**][**72 inches (1800 mm)**] high by full thickness, including face and backup wythes and accessories.

   a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**][**exterior wall**] mockup.
   b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
   c. Include through-wall flashing installed for a **24-inch (600-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof

sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (600 mm)** down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**] [**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Provide [**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 402/602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 CONCRETE UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, [**use the equivalent thickness method for masonry units in accordance with Tech Note TEK 07-01D**][**units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction**] .

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide [**square-edged**][**bullnose**] units for outside corners unless otherwise indicated.

D. CMUs: ASTM C90, [**normal weight**][**medium weight**][**lightweight**][**unless otherwise indicated**] .

1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less-than-nominal dimensions.
2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Architectural CMUs: ASTM C90, [**normal-weight**][**medium-weight**][**lightweight**] architectural units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Angelus Block Co., Inc.**]
b. [**Echelon Masonry, an Oldcastle APG brand**]
c. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less-than-nominal dimensions.
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**] . [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

F. Prefaced CMUs: ASTM C90, lightweight, with manufacturer's standard smooth resinous facing complying with ASTM C744.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Echelon; an Oldcastle APG brand**]
   b. [**York Building Products**]

2. Composition: [**Hollow**][**Solid**] units.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
4. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

G. Acoustical CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] sound-absorbing units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Acme Brick Company**]
   b. [**Echelon; an Oldcastle APG brand**]
   c. [**RPG Acoustical Systems, Inc.**]
   d. [**Sound Seal**]

2. Surface Characteristics: [**Slotted**][**Textured**] .
3. Cavity Fill: [**Fibrous filler**][**Galvanized steel septum**][**Unfilled**].
4. Sound Transmission Classification (STC): minimum as measured [**by an independent, accredited NVLAP facility**] in accordance with ASTM E90 and ASTM E413.
5. Noise Reduction Coefficient (NRC): In accordance with ASTM C423 and ASTM E795.

H. Rigid, Cellular Thermal Insulation CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units containing rigid, specially shaped, molded-polystyrene insulation complying with ASTM C578, Type I, designed for installing in cores of CMUs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Concrete Block Insulating Systems**]

b. [**Echelon Masonry, an Oldcastle APG brand**]
c. [**Shelter Enterprises Inc.**]
d. [**York Building Products**]

2. Size: Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

I. Low-Carbon CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units with low embodied carbon.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CarbonBuilt**]
b. [**CarbonCure**]
c. [**CarbonKind**]
d. [**CarbonX**]
e. [**Pozzotive (Glenwood Mason Supply)**]

2. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
3. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

J. Concrete Building Brick: ASTM C55, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**] high by **7-5/8 inches (194 mm)** long.

K. CMU Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. [**Provide lintels with net-area compressive strength of not less than that of CMUs.**][**Provide lintels with net-area compressive strength as indicated.**]

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete" and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**, cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**, cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide mortar and grout materials to achieve performance requirements as specified in mortar and grout mixes.

D. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

E. Hydrated Lime: ASTM C207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]

j. [**Sakrete; CRH Americas, Oldcastle APG**]

H. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Lafarge North America Inc.**]

I. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

J. Colored Mortar: Packaged blend made from [**portland cement-lime mix lime**] [**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]

5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments does not exceed 10 percent of portland cement by weight.
5. Pigments does not exceed 5 percent of [**masonry cement**] [**mortar cement**] by weight.

K. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

L. Aggregate for Grout: ASTM C404.

M. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or prefaced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

N. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**GCP Applied Technologies Inc.**]

O. Water-Repellent Mortar Admixture: Liquid water-repellent admixture added to mortar, intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACM Chemistries**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]

P. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch (3.77-mm)** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Heckmann Building Products, Inc.**]
   b. [**Hohmann & Barnard, Inc**]
   c. [**Wire-Bond**]

C. Masonry-Joint Reinforcement: Ladder type complying with ASTM A951/A951M.

1. Interior Walls: [**Mill-**][**Hot-dip**] galvanized carbon steel.
2. Exterior Walls: [**Hot-dip galvanized carbon**][**Stainless**] steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
5. Spacing of Cross Rods: Not more than **16 inches (406 mm)** o.c.
6. Provide in lengths of not less than **10 ft. (3 m)**[**, with prefabricated corner and tee units**] .

2.8 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into masonry but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Mill Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M commercial steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6-mm-)** diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.35-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be**

used at interior walls unless otherwise indicated.]

D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

   a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, hot-dip galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.35-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized carbon steel wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 12.7 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.075-inch- (1.90 mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.078-inch- (1.98-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] with dovetail tabs for inserting into dovetail slots in concrete.

   a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized sheet may be used at interior walls unless otherwise indicated.

E. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (9.5-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [**steel, hot-dip galvanized after fabrication**][**stainless steel**] .

F. Rigid Anchors: Fabricate from steel bars [**1-1/2 inches (38 mm) wide by 1/4 inch (6 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**][**bent to configuration indicated**] .

1. Corrosion Protection: [**Hot-dip galvanized to comply with ASTMA 153/A153M**][**Epoxy coating 0.020 inch (0.51 mm) thick**][**Rust-inhibitive paint**] .

2.9 EMBEDDED FLASHING

A. Embedded Flashing Applications: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing [**with a drip edge**][**with a sealant stop**][**or flexible flashing with a metal drip edge**][**or elastomeric thermoplastic flashing with a drip edge**][**or flexible flashing with a metal sealant stop**] .
4. Where flashing is fully concealed, use [**metal flashing**] [**flexible flashing**] .

B. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual":

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Cheney Flashing Company**]
    b. [**Hohmann & Barnard, Inc**]
    c. [**Keystone Flashing Company, Inc**]
    d. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**] [**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2400 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6 mm)** to form a stop for retaining sealant backer rod.
9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.

C. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper-Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**Advanced Building Products Inc.**]
        2) [**Hohmann & Barnard, Inc**]
        3) [**STS Coatings, Inc.**]
        4) [**Wire-Bond**]
        5) [**York Manufacturing, Inc**]

    b. Sheet Weight: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .
    c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Asphalt-Coated Copper Flashing: Copper sheet coated with flexible asphalt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

b. Sheet Weight: [**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .

3. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
2) [**Hohmann & Barnard, Inc**]
3) [**PROSOCO, Inc**]
4) [**STS Coatings, Inc.**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

4. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**STS Coatings, Inc.**]
3) [**VaproShield LLC**]
4) [**Wire-Bond**]
5) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

5. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

6. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Wire-Bond**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

7. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Hohmann & Barnard, Inc**]
2) [**Hyload; IKO Industries, Inc.**]
3) [**Mortar Net Solutions**]
4) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **0.040 inch (1.02 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **0.025 inch (0.64 mm)** thick, with a **0.015-inch- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

8. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Carlisle Coatings & Waterproofing Inc**]
      2) [**Elevate; Amrize Building Envelope LLC**]
      3) [**Heckmann Building Products, Inc.**]
      4) [**Hohmann & Barnard, Inc**]
      5) [**Wire-Bond**]

   b. Thickness: **40 mils (1.0 mm)**.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      a. [**Mortar Net Solutions**]

E. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

F. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

   1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
   2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
   3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

G. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**] [**PVC**] .

B. Preformed Control-Joint Gaskets: Made from [**styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805**] [**PVC, complying with ASTM D2287, Type PVC-65406**] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   b. [**EaCo Chem, Inc.**]
   c. [**PROSOCO, Inc**]

E. Masonry-Cell Fill: [**Loose-fill insulation, perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)**][**Lightweight-aggregate fill, ASTM C331/C331M**][**Foamed-in-place masonry cell fill**] .

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**] [**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Provide the following types of mortar for applications stated unless another type is indicated [**or needed to provide required compressive strength of masonry**] .

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use [**Type M**][**Type S**][**Type N**] .
3. For mortar parge coats, use [**Type S**] [**Type N**] .
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**] .

1. Pigments does not exceed 10 percent of portland cement by weight.
2. Pigments does not exceed 5 percent of [**masonry cement**] [**mortar cement**] by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints, as directed by the Owner.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints as directed by the Owner.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, [**Table 1**] [**paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)**] .
3. Provide grout with a slump of [**8 to 11 inches (200 to 280 mm)**][**10 to 11 inches (250 to 280 mm)**] as measured in accordance with ASTM C143/C143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow

units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Exposed Masonry: Mix units to produce uniform blend of colors and textures.

E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

F. Temperature Control: Perform temperature-sensitive construction procedures while masonry Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within **10 deg F (6 deg C)**.

1. 40 to 32 Deg F (4 to 0 Deg C):

   a. Mortar: Heat mixing water to produce mortar temperature between **40 and 120 deg F (4 and 49 deg C)**.
   b. Grout: Follow normal masonry procedures.

2. 32 to 25 Deg F (0 to Minus 4 Deg C):

   a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**; maintain temperature of mortar on boards above freezing.
   b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.

3. 25 to 20 Deg F (Minus 4 to 7 Deg C):

   a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**; maintain temperature of mortar on boards above freezing.
   b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.
   c. Heat both sides of walls under construction using salamanders or other heat sources.
   d. Use windbreaks or enclosures when wind is in excess of 15 mph.

4. 20 Deg F (Minus 7 Deg C) and Below:

   a. Mortar: Heat mixing water and sand to produce mortar temperatures between **40 and 120 deg F (4 and 49 deg C)**.
   b. Grout: Heat grout materials to **90 deg F (32 deg C)** to produce in-place grout temperature of **70 deg F (21 deg C)** at end of workday.
   c. Masonry Units: Heat masonry units so that they are above **20 deg F (minus 7 deg C)** at time of laying.
   d. Provide enclosure and auxiliary heat to maintain an air temperature of at least **40 deg F (4 deg C)** for 24 hours after laying units.

5. Do not heat water for mortar and grout to above **160 deg F (71 deg C)**.

G. Masonry Protection: Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.

1. 40 to 32 Deg F (4 to 0 Deg C): Protect masonry from rain or snow for at least 24 hours by

covering with weather-resistive membrane.
2. 32 to 25 Deg F (0 to Minus 4 Deg C): Completely cover masonry with weather-resistive membrane for at least 24 hours.
3. 25 to 20 Deg F (Minus 4 to 7 Deg C): Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
4. 20 Deg F (Minus 7 Deg C) and Below: Except as otherwise indicated, maintain masonry temperature above 32 deg F (0 deg C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to **40 deg F (4 deg C)** for 48 hours.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, or **1/2 inch (13 mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, or **1/2 inch (13 mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6 mm in 3 m)** or **1/2 inch (13 mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)**.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (9 mm)** or minus **1/4 inch (6 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses

and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [**2 inches (50 mm)**][**4 inches (100 mm)**] . Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout **24 inches (600 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Rigid, Cellular Thermal Insulation, CMUs: Install molded-polystyrene insulation units into masonry unit cells before laying units.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of hollow CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors [**48 inches (1200 mm)**] o.c. unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."
5. Joint Sealants: Comply with ASTM C1193 for use of joint sealants, including acoustic sealants as applicable to materials, applications and Project conditions.
6. Penetration Firestopping: Install penetration firestopping systems for Project applications to comply with manufacturer's written installation instructions.

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are

not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Where applicable, set masonry trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Prefaced CMUs: Rake out mortar joints at units to a uniform depth of **1/4 inch (6 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 INSTALLATION OF MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (150 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings [**in addition to continuous reinforcement**] .

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at [**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 INSTALLATION OF ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (915 mm)** o.c. horizontally.

3.8 INSTALLATION OF CONTROL JOINTS

A. General: Install control joint materials in CMUs as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.

B. Locate control joints. [**See Drawings**][**Comply with CMU-TEC-009-25**] .

C. Form control joints in CMUs as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 INSTALLATION OF LINTELS

A. Install lintels over openings as indicated.

B. Provide concrete or formed-in-place masonry lintels where shown and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are shown without structural steel or other supporting lintels. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

C. Install loose steel over openings [**.**][**as follows:**][**See Drawings.**]

1. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

D. Lintels at Fire-Rated Openings: Provide fire-rated masonry required or steel lintels with applied fireproofing in thickness required to maintain fire rating of wall or partition rating.

3.10 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. At lintels, extend flashing a minimum of **6 inches (150 mm)** into masonry at each end. At heads and sills, extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.
3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than **1-1/2 inches**

(38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

4. Install metal [**drip edges**][**and**][**sealant stops**] with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 INSTALLATION OF REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than [**60 inches (1500 mm)**][**12.67 ft. (3.86 m)**] .

3.12 INSTALLATION OF MASONRY-CELL FILL

A. Loose-Fill Insulation: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

B. Lightweight-Aggregate Fill: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

C. Foamed-In-Place Masonry Cell Fill: Drill holes in mortar bed joints at spacing as indicated in writing by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.

B. Inspections: Special inspections in accordance with [**Level 2**][**Level 3**] in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces, grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each **5000 sq. ft. (464.5 sq. m)** of wall area or portion thereof.

E. Concrete Masonry Units: Test for each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregates: Ratio test (Proportion Specification) for each mix provided, in accordance with ASTM C780.

G. Mortar: Test for each mix provided, in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

H. Grout: Test for each mix provided, in accordance with ASTM C1019.

I. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [**7 days and at**] 28 days.

J. Fire-Resistance-Rated Construction: Where applicable, inspect fire-rated CMU construction to determine compliance with construction documents per building code compliance.

3.14 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch (19 mm)**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/8 inch per ft. (3 mm per 300 mm)**. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.15 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.16 CLEANING

A. In-Progress Cleaning: Clean unit masonry as Work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid-strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in TEK 08-04A.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (100 mm)** in each dimension.
2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (450 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose as directed by the Owner.

END OF SECTION 04 22 00 00

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Task	Specification	Specification Description
04 22 00 00	04 20 00 00a	Masonry Veneer
04 22 23 00	04 22 00 00	Concrete Unit Masonry
04 22 23 00	04 20 00 00a	Masonry Veneer
04 22 23 13	04 20 00 00	Unit Masonry
04 22 23 13	04 22 00 00	Concrete Unit Masonry
04 22 23 13	04 20 00 00a	Masonry Veneer
04 22 23 23	04 20 00 00	Unit Masonry
04 22 23 23	04 22 00 00	Concrete Unit Masonry
04 22 23 23	04 20 00 00a	Masonry Veneer
04 22 23 26	04 20 00 00	Unit Masonry
04 22 23 26	04 22 00 00	Concrete Unit Masonry
04 22 23 26	04 20 00 00a	Masonry Veneer
04 22 23 29	04 20 00 00	Unit Masonry
04 22 23 29	04 22 00 00	Concrete Unit Masonry
04 22 23 29	04 20 00 00a	Masonry Veneer
04 22 23 31	04 20 00 00	Unit Masonry
04 22 23 31	04 22 00 00	Concrete Unit Masonry
04 22 23 31	04 20 00 00a	Masonry Veneer

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SECTION 04 23 00 00 - GLASS UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass block.
2. Mortar materials.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for [**steel frames**][**and**][**loose steel lintels**] at glass unit masonry assemblies.

1.2 SEQUENCING AND SCHEDULING

A. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Fabrication and installation details for [**glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement, and expansion strips**][**and**][**glass-block panel systems**][**and**][**glass-block grid systems**]. Include accessories where indicated.

C. Samples for Initial Selection: [**Manufacturer's actual glass-block units**][**glass-block grid material**][**and**][**joint materials involving color selection**].

D. Samples for Verification:

1. [**Glass-block units**][**glass-block grid material**][**and**][**joint materials involving color selection**].
2. Panels consisting of four full-size glass-block units with [**glass-block grid**][**mortar**][**and**][**sealant**] joints.

   a. Provide Samples for each form, pattern, and color of glass block and color of joint material indicated or selected by Architect, as directed by the Owner.

E. Delegated Design Submittals: For installed products, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Research Reports: For post-installed anchors, from ICC-ES.

B. Qualification Statements: For professional engineer.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical [**exterior**][**and**][**interior**] panel, **48 by 48 inches (1200 by 1200 mm)** in size.
2. Build mockup of typical [**exterior wall area**][**and**][**interior partition**] containing glass unit masonry assembly as shown on Drawings.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store glass block in unopened cartons on elevated platforms, under cover, and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store glass-block grid materials in unopened cartons in an enclosed, dry location.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are **40 deg F (5 deg C)** or higher.

1. Maintain temperature in installation areas at **40 deg F (5 deg C)** or above for 48 hours after installing.
2. Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or when joint substrates are wet.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For glass block, obtain[**each type and pattern of**] glass block from single source from single

manufacturer.

B. For accessory materials, obtain each [**cementitious material**][**admixture**][**and**][**accessory component**] from single source from single manufacturer[**and each aggregate from single source or producer**].

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glass-block grid systems, including attachment to building construction.

B. Structural Performance: Glass-block grid systems, including attachment to building construction, to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Loads: As indicated on Drawings.

C. Glass-Block Panels - General:

1. Non-load bearing, isolated within opening glass fiber or white polyethylene foam expansion strips at jambs and head.
2. Head and Jamb Channels: Size and material as recommended by manufacturer for glass-block units selected. Provide bond breaker as recommended by manufacturer at sill where required by glass-block panel design.

2.3 FIRE-RATED GLASS UNIT MASONRY

A. Assemblies are listed by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 257.

2.4 GLASS BLOCK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Seves Glass Block, Inc.**]

B. Glass Unit Masonry: .

1. Sizes, General: Provide manufacturer's standard sizes unless indicated as custom.
2. Square Glass-Block Size: [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**7-3/4 inches (197 mm)**][**12.99 inches (33 cm)**] square by [**3-1/8 inches (79 mm)**][**4.72 inches (12 cm)**] thick.
3. Other Glass-Block Size: [**13 inches (33 cm)**][**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by **3-1/8 inches (79 mm)** thick.
4. Glass Unit Masonry Patterns:

a. Pattern:

1) Smooth, undistorted inner and outer faces.

2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other, and smooth outer faces.
4) Linear prismatic design, horizontal on one inner face, vertical on other, and smooth outer faces.
5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
6) As indicated by manufacturer's designation.
7) Manufacturer's standard decorative pattern to match Architect's sample, as directed by the Owner.
8) As selected by Architect from manufacturer's full range.

5. Glass Color: [**Colorless**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].
6. Edge-Coating Color: [**White**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

   a. Provide one color throughout for each pattern indicated.
   b. Provide multiple colors as indicated for each size and pattern.

7. [**45**][**60**][**90**]-minute fire rating complying with NFPA 257.
8. High-Performance, Prefabricated, Panel Glass-Block System:

   a. Hurricane Resistant: [**Complies with large missile impact test ASTM E1886 and ASTM 1996**][**Tested to Florida and Dade County approval protocols TAS 201, TAS 202, and TAS 203**][**Window Size and Design Pressure Rating: As recommended by manufacturer**].
   b. Tornado Resistant: [**Complies with ASTM E330**][**Air pressure test as recommended by manufacturer**].
   c. Blast Resistant: [**Complies with GSA and UFC 04-0110-01 blast glass standards**].
   d. Security and Detention: [**ANSI Z97.1**][**16 CFR 1201**].

9. Performance Requirements:

   a. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**][**0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.43 W/sq. m x K)**].
   b. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of [**0.40**][**0.30**][**0.27**].
   c. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   d. Sound Transmission Class (STC): Rated for not less than [**43**][**48**][**50**][**53**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

10. Special Shapes and Finishing Units: .

    a. Corner-Block Sizes and Shapes: Manufacturer's standard units designed to form [**90**][**45**][**22.5**]-degree corners when joined with straight units of same height.
    b. End-Block Size and Shape: [**7-1/2 inches (19 cm)**][**7-3/4 inches (95 by 197 mm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.

c. Curved-Block Size and Shape: [**7-1/2 inches (19 cm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.
d. Radius-Block Sizes and Shapes: End unit with top matching finished end and with rounded finished corner in manufacturer's standard size to match end units.

11. Graphic-Applied Glass Block: .

a. Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [**6 inches (152 mm) square by 1 inch (25 mm)**][**4-3/4 inches (120 mm) square by 1-9/16 inches (40 mm)**][**6-5/16 inches (160 mm) square by 1-3/16 inches (30 mm)**][**7-1/2 inches (190 mm) square by 1-15/16 inches (50 mm)**][**7-1/2 inches (190 mm) square by 2-3/4 inches (70 mm)**][**7-7/8 inches (200 mm) square by 7/8 inch (22 mm)**][**7-7/8 inches (200 mm) square by 1-15/16 inches (50 mm)**][**4-5/8 inches (117 mm) in diameter by 2-3/8 inches (60 mm)**] thick, actual size.

12. Solar Glass Block: .

a. Glass Block for Solar Wall Tubes: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface.
b. Size: [**8 inches (20 mm) square**][**8 by 16 inches (20 by 40 mm)**].

2.5 GLASS-BLOCK PAVERS

A. Horizontal Block and Glass-Pavers: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [**4.33 inches (11 cm) square by 2.36 inches (6 cm)**][**5.57 inches (14 cm) square by 1.96 inches (5 cm)**][**5.57 inches (14 cm) square by 4.33 inches (11 cm)**][**6.29 inches (16 cm) square by 1.18 inches (3 cm)**][**7.48 inches (19 cm) square by 2.75 inches (7 cm)**][**7.48 inches (19 cm) square by 3.15 inches (8 cm)**][**7.48 inches (19 cm) square by 3.93 inches (10 cm)**][**7.87 inches (20 cm) square by 0.78 inch (2 cm)**].

B. Glass-Paver Round Blocks: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [**4.33 inches (11 cm) in diameter by 2.36 inches (6 cm)**][**7.48 inches (19 cm) in diameter by 1.96 inches (5 cm)**][**7.48 inches (19 cm) in diameter by 3.93 inch (10 cm)**] thick.

C. Horizontal Glass-Pavers, Fire-Resistant: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [**7.48 inches (19 cm) square by 3.12 inches (8 cm)**][**7.48 inches (19 cm) square by 6.29 inches (16 cm)**] thick.

1. [**45**][**60**][**90**]-minute fire rating complying with NFPA 257.

D. Horizontal Glass-Pavers, Historical Design: . Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; [**2.7 inches (7 cm) square by 1.88 inches (4.8 cm)**][**3.54 inches (9 cm) square by 0.74 inch (1.9 cm)**][**3.54 inches (9 cm) square by 0.98 inch (2.5 cm)**] thick.

E. Horizontal Glass-Solar-Powered (Photovoltaic) Pavers: . Transparent, colorless, half-shell glass block, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface.

1. Round: **4.33 inches (11 cm)** in diameter by **2.36 inches (6 cm)** thick.
2. Square: **4.33 inches (11 cm)** square by **2.36 inches (6 cm)** thick.
3. Performance: Internal lithium battery (LiFePO4 3.2v) and high-luminosity LED diodes (3000-3500MCD).
4. Light Color: Cool white.

5. Service Life: 50,000 hours.

2.6 PREFABRICATED GLASS-BLOCK PANELS AND WINDOWS

A. Glass Unit Masonry: .

1. Sizes, General: Provide manufacturer's standard sizes unless indicated as custom.
2. Square Glass-Block Size: [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**] square by **3-7/8 inches (98 mm)** thick.
3. Other Glass-Block Size: [**3-3/4 inches (95 mm)**][**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by [**5-3/4 inches (146 mm)**][**7-3/4 inches (197 mm)**][**11-3/4 inches (299 mm)**] by **3-7/8 inches (98 mm)** thick.
4. Glass Unit Masonry Patterns:

   a. Pattern:

      1) Smooth, undistorted inner and outer faces.
      2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
      3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other, and smooth outer faces.
      4) Linear prismatic design, horizontal on one inner face, vertical on other, and smooth outer faces.
      5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
      6) As indicated by manufacturer's designation.
      7) Manufacturer's standard decorative pattern to match Architect's sample, as directed by the Owner.
      8) As selected by Architect from manufacturer's full range.

5. Glass Color: [**Color**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].
6. Edge-Coating Color: [**Color**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

   a. Provide one color throughout for each pattern indicated.
   b. Provide multiple colors as indicated for each size and pattern.

B. Special Shapes and Finishing Units: .

1. Corner-Block Sizes and Shapes: Manufacturer's standard units designed to form [**90**][**45**][**22.5**]-degree corners when joined with straight units of same height.
2. End-Block Size and Shape: [**7-1/2 inches (19 cm)**][**7-3/4 inches (95 by 197 mm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.
3. Curved-Block Size and Shape: [**7-1/2 inches (19 cm)**] square by [**3-7/8 inches (98 mm)**][**3-1/8 inches (79 mm)**] thick.
4. Radius-Block Sizes and Shapes: End unit with top matching finished end and with rounded finished corner in manufacturer's standard size to match end units.
5. Glass-Block Window Vents:

   a. Vinyl sash windows.
   b. Vinyl air vents.
   c. Vinyl dryer vents.

2.7 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II. Provide natural color or white cement as required to produce mortar color indicated.

1. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cemex S.A.B. de C.V.**]
b. [**Heidelberg Materials**]
c. [**Holcim (US) Inc**]

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

F. Colored Cement Product: Packaged blend made from [**portland cement and hydrated lime**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Heidelberg Materials**]
2) [**Holcim (US) Inc**]

2. Colored Masonry Cement:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Cemex S.A.B. de C.V.**]
2) [**Heidelberg Materials**]
3) [**Holcim (US) Inc**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of masonry cement by weight.

G. Aggregate: ASTM C144, with 100 percent passing **No. 8 (2.36-mm)** sieve.

1. For [**pointing mortar**][**and**][**joints narrower than 1/4 inch (6 mm)**], use aggregate graded with 100 percent passing **No. 16 (1.18-mm)** sieve.
2. White Aggregates: Natural white sand or crushed white stone.
3. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

H. Dry Water-Repellent Admixture: Dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACM Chemistries**]
b. [**GCP Applied Technologies Inc.**]
c. [**Master Builders Solutions**]

I. Liquid Water-Repellent Admixture: Liquid polymeric water-repellent mortar admixture that does not reduce flexural bond strength of mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACM Chemistries**]
b. [**GCP Applied Technologies Inc.**]
c. [**Master Builders Solutions**]

J. Water: Potable.

2.8 GLASS UNIT MASONRY ACCESSORIES

A. Aluminum Perimeter Channels: Two-piece aluminum channel.

1. Sizes: As recommended by manufacturer.
2. Finish: [**Mill**][**Anodized clear**][**Anodized bronze**][**Powder coating**].

B. Mortarless Glass-Block Grid System: Custom glass-block grid system for windows and walls.

1. Finish: As selected from manufacturer's standard finishes and colors.

C. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A951/A951M in straight lengths of not less than **10 ft. (3 m)**, and as follows:

1. Interior Walls: Hot-dip galvanized, carbon steel wire.
2. Exterior Walls: [**Hot-dip galvanized, carbon**][**Stainless**] steel wire.
3. Wire Size: W1.7 or **0.148-inch (3.8-mm)** diameter.
4. Width: [**2 inches (50 mm)**][**1-5/8 inches (40 mm)**].
5. Spacing of Cross Rods: Not more than **16 inches (407 mm)** apart.

D. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, **0.0359 inch (0.9 mm)** by **1-3/4 inches (44 mm)** wide by **24 inches (600 mm)** long, hot-dip galvanized after fabrication to comply with ASTM A153/A153M.

E. Mortarless Installation System: System of [**aluminum**][**or**][**plastic**] perimeter framing, anchors, and spacers designed for installing glass block with sealant-filled joints.

F. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.

G. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

H. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M or ASTM D1227/D1227M.

I. Mineral-Fiber Expansion Strips: Comply with requirements of fire-rated assembly listing and glass-block manufacturer.

1. Use for fire-rated assemblies.

J. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; **3/8 inch (9 mm)** thick by [**4 inches (100 mm)**][**3-1/2 inches (89 mm)**][**2-1/2 inches (63 mm)**] wide.

1. Use plastic-foam expansion strips for[**fire-rated and**] non-fire-rated assemblies.

K. Sealants: Manufacturer's standard elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants."

1. Silicone: Nonstaining, S, NS, 50, NT .
2. Urethane: S, NS, 25, NT .
3. Sealant shall have a VOC content of 250 g/L or less.
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

L. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Section 079200 "Joint Sealants."

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, or antifreeze compounds unless otherwise indicated.

1. Do not use calcium chloride in mortar.
2. For mortar in exterior panels, use water-repellent admixture in accordance with admixture manufacturer's written instructions.
3. For pointing mortar in exterior panels, use water-repellent admixture in accordance with admixture manufacturer's written instructions.
4. Limit cementitious materials in mortar to portland cement and lime.

B. Mortar for Glass Unit Masonry Assemblies:

1. Provide mortar, mixed in accordance with glass-block manufacturer's listing with testing and inspecting agency, for fire-resistance rating indicated.
2. Comply with ASTM C270, Proportion Specification for Type S mortar.

a. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.

C. Pigmented Mortar: Use colored cement product[**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**].

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of masonry cement by weight.
3. Mix to match Architect's sample, as directed by the Owner.

D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine sills, jambs, and heads surrounding glass unit masonry assemblies, with Installer present, for

compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF GLASS BLOCK WITH MORTAR

A. General: Install masonry units in accordance with manufacturer's written instructions.

1. Where applicable, fasten frames and anchors or clips securely to surrounding construction.
2. Shim starting track as needed to make it level.
3. Arrange coursing pattern to provide consistent joint work throughout.

B. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.

C. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] exposed joint widths unless otherwise indicated.

D. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:

1. Vertical Spacing of Panel Reinforcement for Exterior Panels: [**Every other course, but not more than 16 inches (407 mm) o.c., starting with first course above sill**][**As indicated on Drawings**].
2. Vertical Spacing of Panel Reinforcement for Interior Panels: [**Not more than 16 inches (407 mm) o.c.**][**As indicated on Drawings**].
3. Do not bridge expansion joints with panel reinforcement.
4. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
5. Lap panel reinforcement not less than **6 inches (150 mm)** if more than one length is necessary.
6. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place, and covering with upper half of mortar bed.

E. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least **12 inches (300 mm)** into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:

1. For in-place unit masonry assemblies and concrete, attach panel anchors with **1/4-inch- (6-mm-)** diameter, bolt-size post-installed anchors, two per panel anchor.
2. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.
3. For steel members, attach panel anchors with **1/4-inch- (6-mm-)** diameter through bolts and nuts or bolts in tapped holes in steel members.

F. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.

G. Use [**plastic spacers**][**or**][**temporary wedges**] in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.

1. If temporary wedges are used, remove them after mortar has set and fill voids with mortar.

H. Keep expansion joints free of mortar.

I. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.

1. If temporary wedges are used, remove them before raking out and pointing joints.
2. Point joints at [**exterior face**][**both faces**] of exterior panels with mortar.
3. Point joints at [**exterior face**][**both faces**] of exterior panels with sealant.
4. Point joints at both faces of exterior and interior panels with sealant.

J. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than **3/8 inch (10 mm)** thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

1. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.

K. Point joints by filling with sealant to comply with requirements in Section 079200 "Joint Sealants."

L. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.

M. Install sealant at jambs, heads, mullions, and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Section 079200 "Joint Sealants."

N. Construction Tolerances: Set glass block to comply with the following tolerances:

1. Variation from Plumb: For vertical lines and surfaces, do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**, **3/8 inch in 20 ft. (9 mm in 6 m)**, **or 1/2 inch in 40 ft. (12 mm in 12 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, **or 3/8 inch in 40 ft. (9 mm in 12 m)**] or more.
2. Variation from Level: For bed joints and other conspicuous lines, do not exceed **1/8 inch in 10 ft. (3 mm in 3 m)**, **1/4 inch in 20 ft. (6 mm in 6 m)**, or **1/2 inch in 40 ft. (12 mm in 12 m)** or more.
3. Variation of Location in Plan: For location of elements in plan, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)**.
4. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus **1/16 inch (1.5 mm)**.
5. For faces of adjacent exposed units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)**.

3.3 INSTALLATION OF GLASS BLOCK WITH SEALANT

A. General: Install mortarless glass-block systems in accordance with manufacturer's written instructions.

1. Fasten frames and anchors or clips securely to surrounding construction.
2. Shim starting track as needed to make it level.
3. Adhere glass block to starting track and spacers with silicone sealant.

B. After glass blocks are installed, apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

3.4 CLEANING

A. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants, and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.

B. Remove excess sealants with commercial solvents in accordance with sealant manufacturer's written instructions. Exercise care not to damage sealant in joints.

C. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently[**to eliminate dried mortar particles and aggregate**].

END OF SECTION 04 23 00 00

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Task	Specification	Specification Description
04 23 00 00	04 20 00 00a	Masonry Veneer
04 23 13 00	04 20 00 00	Unit Masonry
04 23 13 00	04 23 00 00	Glass Unit Masonry
04 23 13 00	04 20 00 00a	Masonry Veneer
04 41 00 00	04 42 00 00	Exterior Stone Cladding

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SECTION 04 42 00 00 - EXTERIOR STONE CLADDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone panels set with individual anchors.
2. Stone panels mechanically anchored on steel trusses.
3. Stone panels mechanically anchored on steel strongback frames.
4. Stone panels mechanically anchored on steel stud frames.
5. Stone panels mechanically anchored (field installed) on a metal-grid system.
6. Stone panels set in architectural precast concrete.
7. Stone panels glazed into aluminum curtain-wall framing system.
8. Stone trim units, including [**bands**][**copings**][**sills**][**jambs**][**and**][**soffits**].
9. Stone units with carving or inscriptions.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for installing [**inserts**][**and**][**weld plates**] in concrete for anchoring stone cladding.
2. Section 034500 "Precast Architectural Concrete" for casting stone panels in architectural precast concrete units.
3. Section 042000 "Unit Masonry" [**for installing inserts in unit masonry for anchoring stone cladding**][**and**][**for stone trim in unit masonry walls**].
4. Section 054000 "Cold-Formed Metal Framing" for steel stud frames supporting stone cladding.
5. Section 079200 "Joint Sealants" for sealing joints in stone cladding system with elastomeric sealants.
6. Section 084413 "Glazed Aluminum Curtain Walls" for installing stone panels in aluminum curtain-wall systems.
7. Section 096340 "Stone Flooring" for dimension stone used as paving and flooring.
8. Section 097513 "Stone Wall Facing" for dimension stone applied as paneling on building interiors.

1.2 DEFINITIONS

A. Definitions contained in ASTM C119 apply to this Section.

B. IBC: International Building Code.

C. Stone Cladding Assembly: An exterior wall covering system consisting of stone panels[**and trim**] together with anchors, [**backup structure,**][**secondary weather barrier (sheathing),**][**mortar,**][**adhesives,**] fasteners, and sealants used to secure the stone to the building structure and to produce a weather-resistant covering.

1. Backup structure includes [**steel trusses**][**steel strongback frames**][**steel stud frames**][**metal-grid system**][**and**][**miscellaneous steel framing required to secure stone to the building structure**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each[**variety of stone,**] stone accessory, and manufactured product.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Show fabrication and installation details for stone cladding assembly, including dimensions and profiles of stone units.

1. Show locations and details of joints both within stone cladding assembly and between stone cladding assembly and other construction.
2. Include details of [**mortar joints**][**sealant joints**][**and**][**mortar joints pointed with sealant**].
3. Show locations and details of anchors[**and backup structure**].
4. Show direction of veining, grain, or other directional pattern.
5. Include large-scale shaded elevations and details of decorative surfaces and inscriptions.

D. Samples for Initial Selection: For joint materials involving color selection.

E. Stone Samples for Verification: Sets for each variety, color, and finish of stone required; not less than **12 inches (300 mm)** square.

1. Sets consist of at least [**two**][**three**][**four**][**five**] Samples, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.

F. Colored Pointing Mortar Samples for Verification: For each color required. Make Samples using same sand and mortar ingredients to be used on Project.

G. Sealant Samples for Verification: For each type and color of joint sealant required.

H. Delegated Design Submittal: For stone cladding assembly.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Material Test Reports:

1. Stone Test Reports: For[**each**] stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous [**five**][**three**] years.
2. For metal components, by a qualified testing agency, indicating chemical and physical properties of metal.
3. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer complying with requirements in Section 079200 "Joint Sealants" and indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

D. Preconstruction test reports.

E. Source quality-control reports.

F. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone cladding assemblies similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: A firm or individual experienced in installing stone cladding assemblies similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to [**AWS D1.1/D1.1M, "Structural Welding Code - Steel**][**AWS D1.2/D1.2M, "Structural Welding Code - Aluminum**][**AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel**][**and**][**AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel**]."

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical exterior wall area [**as shown on Drawings**][**not less than 72 inches (1800 mm) long by 48 inches (1200 mm) high**][**not less than 15 feet (4.5 m) long by 10 feet**

(3 m) **high**].

a. Include typical components, attachments to building structure, and methods of installation.
b. Include window opening with stone [**returns**][**trim**].
c. Include typical carved surface.
d. Include sealant-filled joint complying with requirements in Section 079200 "Joint Sealants."
e. Include an area that has been damaged and repaired.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Stone Testing Service: [**The Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing.

1. Retesting of materials that fail to meet specified requirements is done at Contractor's expense.
2. Furnish test specimens that are representative of materials proposed for incorporation into the Work.
3. Physical Property Tests: For[**each**] stone variety proposed for use on Project, tested for compliance with physical property requirements, other than abrasion resistance, according to referenced ASTM standards.
4. Flexural Strength Tests: For[**each combination of**] stone variety, thickness, orientation of cut, and finish, proposed for use on Project, tested according to ASTM C880/C880M, in both wet and dry conditions.
5. Anchorage Tests: For[**each combination of**] stone variety, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C1354/C1354M.
6. Anchoring System Mockup Test: For stone anchoring system, tested according to ASTM C1201/C1201M, Procedure B, with a maximum test load equal to 3 times the design load. Build laboratory mockup at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site. Mockup consists of one panel in size.

B. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

C. Preconstruction Field Testing of Sealants: Before installing joint sealants, field test their adhesion to joint substrates according to Section 079200 "Joint Sealants."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

C. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

1.10 FIELD CONDITIONS

A. Protect stone cladding during erection by doing the following:

1. Cover tops of stone cladding installation with nonstaining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of **24 inches (600 mm)** down both sides and hold securely in place.
2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.
3. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
4. Protect sills, ledges, and projections from mortar and sealant droppings.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace stone cladding damaged by frost or freezing conditions. Comply with cold-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

C. Hot-Weather Requirements: Comply with hot-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

D. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below **40 deg F (5 deg C)** or when joint substrates are wet.

1.11 COORDINATION

A. Coordinate installation of inserts that are to be embedded in concrete or masonry, flashing reglets, and similar items to be used by stone cladding Installer for anchoring, supporting, and flashing of stone cladding assembly. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.

B. Time delivery and installation of stone cladding to avoid extended on-site storage and to coordinate with work adjacent to stone cladding.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Stone: Obtain[**each variety of**] stone[**regardless of finish,**] from single quarry[**whether specified in this Section or in another Section of the Specifications,**] with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.
2. Make quarried blocks available for examination by Architect or as directed by the Owner.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

C. Source Limitations for Other Materials: Obtain each type of stone accessory[**sealant,**] and other material from single manufacturer for each product.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stone cladding assembly.

B. General: Design stone anchors and anchoring systems according to ASTM C1242.

1. Stone anchors withstand not less than two times the weight of the stone cladding in both compression and tension.

C. Structural Performance: Stone cladding assembly withstands the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Wind Loads: As indicated.
2. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.

D. Seismic Performance: Stone cladding assembly withstands the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

F. Horizontal Building Movement (Interstory Drift): Allow for maximum horizontal building movement equal to quotient resulting from dividing floor-to-floor height at any floor by 400.

G. Shrinkage and Creep: Allow for progressive vertical shortening of building frame equal to in **10 feet (3 m)**.

H. Safety Factors for Stone: Design stone cladding assembly to withstand loads indicated without exceeding stone's allowable working stress determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:

1. Safety Factor for Granite: [**3**].
2. Safety Factor for Oolitic Limestone: [**8**].
3. Safety Factor for Dolomitic Limestone: [**6**].
4. Safety Factor for Marble: [**5**].
5. Safety Factor for Quartz-Based Stone: [**6**].
6. Safety Factor for Serpentine: [**6**].
7. Safety Factor for Slate: [**5**].
8. Safety Factor for Travertine: [**8**].

9. Safety Factor for Concentrated Stresses: [**4**][**for granite**][**and**][**10**][**for stone varieties other than granite**].

I. Design stone anchors[**and backup structure**] to withstand loads indicated without exceeding allowable working stresses established by the following:

1. For Structural Steel: AISC 360.
2. For Cold-Formed Steel: AISI's "North American Specification and Commentary for the Design of Cold-Formed Steel Structural Members."
3. For Cold-Formed Stainless Steel: ASCE/SEI 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."
4. For Aluminum: AA ADM-1, "The Aluminum Design Manual."
5. For Cast-in-Place and Postinstalled Fasteners in Concrete: One-fourth of tested capacity when installed in concrete with compressive strength indicated.
6. For Postinstalled Fasteners in Masonry: One-sixth of tested capacity when installed in masonry units indicated.

J. Limit deflection in each prefabricated assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to not more than [**1/720**] of assembly's clear span or the following, whichever is smaller:

1. **1/16 inch (1.5 mm)**, measured in plane of wall.
2. **1/4 inch (6 mm)**, measured perpendicular to wall.

K. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. [**Concrete fabrication and erection tolerances are specified in Section 033000 "Cast-in-Place Concrete."**][**Structural-steel fabrication and erection tolerances are specified in Section 051200 "Structural Steel Framing."**]

L. Provision for Deflection of Building Structure:

1. Deflection Due to Weight of Stone Cladding Assembly: Allow for [**1/4-inch (6-mm)**] vertical deflection in **20-foot (6-m)** span of structural members supporting stone cladding assembly.
2. Live Load Deflection: Allow for [**1/4-inch (6-mm)**] vertical deflection, in **20-foot (6-m)** span of structural members supporting stone cladding assembly, due to live loads imposed on building's structural frame after stone installation.

M. Corrosion and Staining Control: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Materials do not stain exposed surfaces of stone and joint materials.

2.3 GRANITE

A. Material Standard: Comply with ASTM C615/C615M.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials

are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: Uniform, [**fine**][**medium**]-grained, [**white**][**pink**][**gray**][**black**] stone[**without veining**].

H. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

I. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

J. Finish: [**Polished**][**Honed**][**Thermal**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.4 LIMESTONE

A. Material Standard: Comply with ASTM C568/C568M.

1. Classification: [**I Low-Density**][**II Medium-Density**][**II Medium-Density except as follows: absorption, 5 percent by weight maximum; density, 150 lb/cu. ft. (2400 kg/cu. m) minimum; compressive strength, 8000 psi (55 MPa) minimum; and modulus of rupture 800 psi (5.5 MPa) minimum**][**III High-Density**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: [**Dolomitic**][**Oolitic**][**Shell**] limestone.

H. Varieties and Sources: Indiana limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.

1. Indiana Limestone Grade and Color: [**Select, buff**][**Select, gray**][**Standard, buff**][**Standard, gray**][**Rustic, buff**][**Rustic, gray**][**Variegated**], according to grade and color classification established by ILI.

I. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

J. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

K. Finish: [**Smooth finish**][**Sand rubbed**][**Machine tooled, four bats per 1 inch (25 mm)**][**Machine tooled, six bats per 1 inch (25 mm)**][**Machine tooled, eight bats per 1 inch (25 mm)**][**As indicated**][**Match Architect's sample**][**matching standard ILI finish**].

L. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

M. Thickness: Not less than [**1-1/4 inches (32 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.5 MARBLE

A. Material Standard: Comply with ASTM C503/C503M, [**Classification I Calcite**][**Classification II Dolomite**][**Group A**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: Uniform, fine- to medium-grained, [**white**] stone with only slight veining.

H. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

I. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

J. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.6 QUARTZ-BASED STONE

A. Material Standard: Comply with ASTM C616/C616M, [**Classification I Sandstone**][**Classification II Quartzitic Sandstone**][**Classification III Quartzite**][**except for minimum free silica content**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Finish: [**Sand rubbed**][**Natural cleft**][**Thermal**][**As indicated**][**Match Architect's sample**].

H. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

I. Thickness: Not less than [**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.7 SERPENTINE

A. Material Standard: Comply with ASTM C1526, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to

determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

H. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

I. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

J. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.8 SLATE

A. Material Standard: Comply with ASTM C629/C629M, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Description: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**] slate with a fine, even grain[**and unfading color,**] from clear, sound stock.

H. Finish: [**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**].

I. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

J. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] unless otherwise indicated.

2.9 TRAVERTINE

A. Material Standard: Comply with ASTM C1527/C1527M, [**Classification I Exterior**][**Classification II Interior**].

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Cut: [**Vein**][**Fleuri**].

1. Orientation of Veining: [**Horizontal**][**Vertical**][**As indicated**].

H. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

I. Filling: Fill pores on faces of stone with cementitious filler of color [**selected by Architect**][**matching Architect's sample**].

J. Finish: [**Polished**][**Honed**][**As indicated**][**Match Architect's sample**].

K. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

L. Thickness: Not less than [**1 inch (25 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.

2.10 OTHER STONE

A. Material Standards:

1. Maximum Absorption per ASTM C97/C97M.
2. Minimum Compressive Strength per ASTM C170/C170M.
3. Minimum Flexural Strength per ASTM C880/C880M.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

D. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Finish: [**Polished**][**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**].

H. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

I. Thickness: Not less than [**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] unless otherwise indicated.

2.11 FRAMING FOR BACKUP STRUCTURE

A. [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: For framing members in contact with stone, fabricate from same material and finish specified for anchors. For framing members not in contact with stone, comply with requirements indicated below:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M or ASTM A992/A992M, minimum thickness of **3/16 inch (5 mm)**.
2. Steel Tubing: ASTM A500/A500M or ASTM A513/A513M, minimum thickness of **3/16 inch (5 mm)**.
3. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-4, made from [**galvanized steel complying with ASTM A653/A653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness**][**steel sheet complying with ASTM A1008/A1008M, structural steel, Grade 33 (Grade 230), not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A123/A123M**].

B. Steel Stud Frames: Galvanized-steel wall framing complying with Section 054000 "Cold-Formed Metal Framing."

1. Secondary Weather Barrier (Sheathing): Galvanized-steel sheet complying with ASTM A653/A653M, commercial steel, coating designation **G90 (Z275)**.

C. Metal-Grid Systems: Manufacturer's standard integrated system that combines metal struts, fittings, fasteners, and stone anchors and is engineered expressly for mechanically installing stone cladding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Canaren Inc**]
b. [**Hohmann & Barnard, Inc**]
c. [**Meadow Burke**]

2. Struts: Cold-formed metal channels with continuous slot complying with MFMA-4, of size and shape required for application indicated, made from [**galvanized steel complying with ASTM A653/A653M, with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness**][**steel sheet complying with ASTM A1008/A1008M, not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A123/A123M**].
3. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach struts to building structure, by method indicated or selected, and stone anchors to struts, as well as to prevent galvanic corrosion. Fabricate components in contact with stone from same material specified for anchors.
4. Stone Anchors: Shapes and sizes standard with system manufacturer, complying with "Anchors and Fasteners" Article.

2.12 ANCHORS AND FASTENERS

A. Fabricate anchors[**including shelf angles,**] from stainless steel, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**]; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A276, [**Type 304**][**Type 316**].

B. Fabricate shelf angles for limestone from hot-dip galvanized steel, ASTM A36/A36M for materials and ASTM A123/A123M for galvanizing.

C. Fabricate anchors, including shelf angles, from extruded aluminum, **ASTM B221 (ASTM B221M)**, alloy and temper as required to support loads imposed without exceeding allowable design stresses, but not less than strength and durability properties of Alloy 6063-T6.

D. Cast-in-Place Concrete Inserts: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel, with capability to sustain, without failure, a load equal to 4 times the loads imposed as determined by testing per ASTM E488/E488M, conducted by a qualified independent testing agency. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.

E. Postinstalled Anchor Bolts for Concrete and Masonry: [**Chemical anchors**][**torque-controlled expansion anchors**][**or**][**undercut anchors**] made from stainless steel components complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Alloy Group A1 or A4)** for bolts and nuts; ASTM A240/A240M, ASTM A276, or ASTM A666, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.

1. For [**stainless steel**][**and**][**aluminum**], use annealed stainless steel bolts, nuts, and washers; for bolts, **ASTM F593 (ASTM F738M)**; and for nuts, **ASTM F594 (ASTM F836M)**, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].
2. For [**galvanized-steel shelf angles**][**and**][**backup structure**], use carbon-steel bolts, nuts, and washers; for bolts, **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; for nuts, **ASTM A563 (ASTM A563M)**, Grade A; and for washers, **ASTM F436 (ASTM F436M)**; all hot-dip or mechanically zinc coated.

G. Weld Plates for Installation in Concrete: Comply with Section 055000 "Metal Fabrications."

2.13 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction, natural color or white as required to produce mortar color indicated.

1. Low-Alkali Cement: Portland cement for use with limestone contains no more than 0.60 percent total alkali when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Pigments have a record of satisfactory performance in mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Davis Colors**]
b. [**Lanxess Corporation**]
c. [**Solomon Colors Inc.**]

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime.

E. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 10 percent of portland cement by weight.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heidelberg Materials**]
b. [**Holcim (US) Inc**]
c. [**Lafarge North America Inc.**]

F. Aggregate: ASTM C144; except for [**joints narrower than 1/4 inch (6 mm)**][**and**][**pointing mortar**], 100 percent pass **No. 16 (1.18-mm)** sieve.

1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.

G. Water: Potable.

2.14 STONE ACCESSORIES

A. Setting Shims: Strips of [**resilient plastic**][**or**][**vulcanized neoprene, Type A Shore durometer hardness of 50 to 70**], nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

B. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.

C. Concealed Sheet Metal Flashing: Fabricated from[**zinc-tin, alloy-coated**] stainless steel in thicknesses indicated, but not less than **0.0156 inch (0.4 mm)** thick, and complying with Section 076200 "Sheet Metal Flashing and Trim."

D. Cementitious Dampproofing[**for Limestone**]: Cementitious formulation recommended by ILI and nonstaining to stone; compatible with joint sealants and noncorrosive to anchors and attachments.

E. Weep and Vent Tubes: [**Medium-density polyethylene tubing, 1/4-inch (6-mm) OD**][**Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm)**], of length required to extend from exterior face of stone to cavity behind.

F. Cellular Plastic Weep Hole/Vents: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

G. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

H. Wicking Material: Absorbent rope, made from [**cotton**][**or**][**UV-resistant synthetic fiber**], **1/4 to 3/8 inch (6 to 10 mm)** in diameter, of length required to produce **2-inch (50-mm)** exposure on exterior and **18 inches (450 mm)** in cavity between wythes.

I. Sealants for Joints in Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants" and do not stain stone:

1. Silicone: Nonstaining, [**S, NS, 100/50, NT**][**S, NS, 50, NT**][**S, NS, 100/50, T, NT**][**M, NS, 50, NT**].
2. Urethane: [**S, NS, 25, NT**][**S, NS, 100/50, T, NT**][**M, NS, 50, NT**][**M, NS, 50, T, NT**][**M, NS, 25, T, NT**].
3. Joint-Sealant Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range of colors**][**Match color of stone**].

J. Preformed Joint Seals: Preformed [**silicone**][**foam**] joint seals that comply with applicable requirements in Section 079100 "Preformed Joint Seals" and do not stain stone.

K. Sealant for Filling Kerfs: [**Same sealant used for joints in stone cladding.**][**Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants" and that do not stain stone:**]

1. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adfast**]
2) [**GE Construction Sealants; Momentive Performance Materials Inc.**]

3) [**May National Associates, Inc.; a subsidiary of Sika Corporation**]
4) [**Pecora Corporation**]
5) [**The Dow Chemical Company**]
6) [**Tremco Incorporated**]

2. Urethane, M, NS, 25, T, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Bostik; Arkema**]
2) [**LymTal International, Inc.**]
3) [**Master Builders Solutions**]
4) [**Sika Corporation**]

2.15 FABRICATION OF STONE

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
3. For marble, serpentine, and travertine, comply with recommendations in MIA's "Dimension Stone - Design Manual VII."

B. Control depth of stone and back check to maintain minimum clearance of [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.

E. Finish exposed faces and edges of stone[**except sawed reveals,**] to comply with requirements indicated for finish and to match approved samples[**and mockups**].

F. Quirk-miter corners unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

G. Cut stone to produce uniform joints [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**] wide and in locations indicated.

H. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

I. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

1. Produce moldings and molded edges with machines that use abrasive shaping wheels made to reverse contour of molding shape.

J. Carve and cut [**inscriptions**][**and**][**decorative surfaces**]. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

K. Abrasively etch [**inscriptions**][**and**][**decorative surfaces**].

L. Laser etch [**inscriptions**][**and**][**decorative surfaces**].

M. Clean backs of stone to remove rust stains, iron particles, and stone dust.

N. Inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

2.16 FABRICATION OF BACKUP STRUCTURE

A. Fabrication of [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: Fabricate in shop to comply with AISC 303.

1. Weld shop connections to comply with applicable provisions of AWS D1.1/D1.1M.
2. Fabricate joints to exclude water or to permit its escape to building exterior, at locations where water could accumulate because of condensation or other causes.
3. Hot-dip galvanize backup structure after fabrication to comply with ASTM A123/A123M.

B. Fabrication of Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Weld secondary weather barrier (sheathing) to outside face of steel stud frames. Use continuous welds at all four edges of sheets to provide continuous weather seal.
2. Clean welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

2.17 SHOP-PAINTED STEEL FINISHES

A. Shop-Painted Steel Finishes: Paint uncoated steel backup structure before delivering to Project site to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cloverdale Paint**]
b. [**Coronado Paint; Benjamin Moore & Co.**]
c. [**Dulux (formerly ICI Paints); a brand of AkzoNobel**]
d. [**Frazee Paint; Comex Group**]

e. [**General Paint**]
f. [**Sherwin-Williams Company (The)**]
g. [**SICO; PPG Architectural Coatings**]

B. Surface Preparation: After fabricating steel items, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Apply one coat of fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#76.[**After primer has dried, apply one coat of exterior alkyd enamel complying with MPI#96 of a different color than primer.**]

D. Apply two-coat, high-performance coating system consisting of epoxy zinc-rich primer, complying with MPI#20 and topcoat of high-build epoxy coating, complying with MPI#108.

2.18 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated. Do not use calcium chloride.
2. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

B. Portland Cement-Lime Setting Mortar: Comply with ASTM C270, Proportion Specification, [**Type S.**][**Type N.**][**for types of mortar indicated below:**]

1. Set granite with Type S mortar.
2. Set limestone with Type N mortar.
3. Set marble with Type S mortar.
4. Set quartz-based stone with [**Type S**][**Type N**] mortar.
5. Set serpentine with Type S mortar.
6. Set slate with Type S mortar.
7. Set travertine with Type N mortar.
8. Backparge travertine with Type O mortar.

C. Pointing Mortar: Comply with ASTM C270, Proportion Specification, [**Type S**][**Type N**][**Type O**][**for types of mortar indicated**]. Provide pointing mortar mixed to match Architect's sample and complying with the following:

1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
2. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
3. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
4. Point granite with [**Type S**][**Type N**] mortar.
5. Point limestone with [**Type N**][**Type O**] mortar.
6. Point marble with [**Type N**][**Type O**] mortar.
7. Point quartz-based stone with [**Type N**][**Type O**] mortar.
8. Point serpentine with [**Type N**][**Type O**] mortar.
9. Point slate with Type N mortar.
10. Point travertine with [**Type N**][**Type O**] mortar.

2.19 SOURCE QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform source quality-control testing.

1. Retesting of materials that fail to meet specified requirements is done at Contractor's expense.
2. Furnish test specimens [**randomly selected**][**selected by testing agency**] from same blocks as actual materials proposed for incorporation into the Work.
3. Flexural Strength Tests: ASTM C880/C880M, performed on specimens of same thickness, orientation of cut, and finish as installed stone. One set of test specimens is required to be tested for every [**10,000 sq. ft. (1000 sq. m)**][**5000 sq. ft. (500 sq. m)**][**3000 sq. ft. (300 sq. m)**], but not fewer than two sets for each stone variety.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive stone cladding and conditions under which stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone cladding.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone cladding.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BACKUP STRUCTURE

A. Installing [**Steel Trusses**][**Strongback Frames**][**and**][**Miscellaneous Steel Framing**]: Comply with AISC 303 and install to accommodate construction tolerances specified.

1. Maintain erection of backup structure within tolerances in AISC 303.
2. For prefabricated units to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Install by [**welding to steel weld-plates anchored in concrete**][**bolting to inserts cast into concrete**][**or**][**bolting to structural-steel frame**].
4. Clean welds, bolted connections, and abraded areas immediately after erection.

   a. Repair galvanizing to comply with ASTM A780/A780M.
   b. Apply paint to exposed areas using same material as used for shop painting.

B. Installing Steel Stud Frames: Install [**by welding to steel weld-plates anchored in concrete**][**by welding to structural-steel frame**][**by bolting to structural-steel frame**] to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Install steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding **1/16 inch (1.5 mm)** and no variation in position exceeding **1/8 inch (3 mm)**.
2. For prefabricated frames to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Clean welds, bolted connections, and abraded areas immediately after erection. Repair galvanizing to comply with ASTM A780/A780M.

C. Installing Metal-Grid Systems: Comply with manufacturer's written instructions to provide integrated system that combines metal struts, fittings, fasteners, and stone anchors.

1. Fasten struts by bolting to [**inserts in concrete**][**or**][**steel angle clips bolted to steel framing**].
2. Fasten stone supports and anchors by bolting to struts.
3. Shim and adjust struts and stone supports and anchors to provide grid that is level, plumb, and true to line with no variation in plane or alignment exceeding **1/16 inch (1.5 mm)** and no variation in position exceeding **1/8 inch (3 mm)**.

3.3 INSTALLATION OF STONE CLADDING, GENERAL

A. Before setting stone, clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Coat limestone with dampproofing to extent indicated below:

1. Stone at Grade: Beds, joints, and back surfaces to at least **12 inches (300 mm)** above finish-grade elevations.
2. Stone Extending Below Grade: Beds, joints, back surfaces, and face surfaces below grade.
3. Allow dampproofing to cure before setting dampproofed stone. Do not damage or remove dampproofing while handling and setting stone.

C. Parge back of travertine panels with mortar not less than **3/8 inch (10 mm)** thick.

D. Execute stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.

1. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.

E. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.

F. Set stone to comply with requirements indicated. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with uniform joints of widths indicated, and with edges and faces aligned according to established relationships and indicated tolerances.

G. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.

1. Sealing expansion and other joints is specified in Section 079200 "Joint Sealants."
2. Keep expansion joints free of mortar and other rigid materials.

H. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water, to divert water to building exterior. Extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.

I. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.

1. Place weep holes in joints where moisture may accumulate, including at base of cavity walls and above shelf angles and flashing. Locate weep holes at intervals not exceeding **24 inches (600 mm)**. Use [**weep and vent tubes**][**plastic weep hole/vents**][**or**][**wicking material**].
2. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not

exceeding **20 feet (6 m)** vertically. Locate vents in joints at intervals not exceeding **60 inches (1500 mm)** horizontally. Use [**weep and vent tubes**][**or**][**plastic weep hole/vents**].

3.4 INSTALLATION OF MECHANICALLY ANCHORED STONE CLADDING

A. Set stone cladding with mechanical anchors without mortar unless otherwise indicated.

B. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C1242.

C. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.

D. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

3.5 INSTALLATION OF STONE CLADDING WITH MORTAR

A. Set stone cladding with mortar and mechanical anchors [**where indicated**][**unless otherwise indicated**].

B. Set stone in full bed of mortar with head joints filled unless otherwise indicated.

1. Use setting buttons of adequate size, in sufficient quantity, and of thickness required to maintain uniform joint width and to prevent mortar from extruding. Hold buttons back from face of stone a distance at least equal to width of joint, but not less than depth of pointing materials.
2. Do not set heavy units or projecting courses until mortar in courses below has hardened enough to resist being squeezed out of joint.
3. Support and brace projecting stones until wall above is in place and mortar has set.
4. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

C. Fill space between back of stone units and backup wall solidly with mortar or grout.

D. Embed ends of sills in mortar; leave remainder of joint open until final pointing.

E. Rake out joints for pointing with mortar to depths of not less than **1/2 inch (12 mm)**. Rake joints to uniform depths with square bottoms and clean sides.

F. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply first layer of pointing mortar in layers not more than **3/8 inch (10 mm)** until a uniform depth is formed.

G. Point stone joints by placing pointing mortar in layers not more than **3/8 inch (10 mm)**. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

H. Tool joints with a round jointer having a diameter **1/8 inch (3 mm)** larger than width of joint, when pointing mortar is thumbprint hard.

I. Rake out mortar from sealant-pointed joints to depths required for sealant and sealant backing, but not less than **1/2 inch (12 mm)**. Rake joints to uniform depths with square bottoms and clean sides.

J. Set the following stone cladding with unfilled head joints for installing joint sealants:

1. Cornices.
2. Copings.
3. Sills.
4. Belt and other projecting courses.

3.6 INSTALLATION OF JOINT-SEALANTS

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.7 INSTALLATION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (10 mm in 6 m)**, or **1/2 inch in 40 feet (12 mm in 12 m)** or more. For external corners, corners and jambs within **20 feet (6 m)** of an entrance, expansion joints, and other conspicuous lines, do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **3/8 inch in 40 feet (10 mm in 12 m)** or more.

B. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **3/8 inch (10 mm)** maximum.

C. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (12 mm in 12 m)** or more.

D. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus **1/4 inch (6 mm)**.

E. Variation in Joint Width: Do not vary from average joint width more than plus or minus **1/8 inch (3 mm)** or a quarter of nominal joint width, whichever is less. For joints within **60 inches (1500 mm)** of each other, do not vary more than **1/8 inch (3 mm)** or a quarter of nominal joint width, whichever is less from one to the other.

F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed **1/16-inch (1.5-mm)** difference between planes of adjacent units.

3.8 ADJUSTING AND CLEANING

A. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and stone cladding that does not match approved samples[**and mockups**]. Damaged stone may be repaired if the Owner approves methods and results.

B. Replace damaged or defective work in a manner that results in stone cladding's matching approved samples[**and mockups**], complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone cladding as work progresses.[**Remove mortar fins and smears before tooling joints.**] Remove excess sealant and smears as sealant is installed.

D. Final Cleaning: Clean stone cladding no fewer than six days after completion of pointing and sealing,

using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

END OF SECTION 04 42 00 00

Task	Specification	Specification Description
04 42 43 00	04 42 00 00	Exterior Stone Cladding
04 43 16 00	01 22 00 00	No Specification Required
04 43 16 00	04 42 00 00	Exterior Stone Cladding
04 51 00 00	04 20 00 00	Unit Masonry

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SECTION 04 72 00 00 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall panels[**with engraved inscriptions**].
2. Trim units.
3. Decorative elements.
4. Mortar materials.
5. Accessories.

B. Related Requirements:

1. Section 034500 "Precast Architectural Concrete."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

D. Samples for Initial Selection: For colored mortar.

E. Samples for Verification:

1. For each color and texture of cast stone required, [**4 inches (100 mm) square**] in size.
2. For each trim shape required, [**4 inches (100 mm)**] in length.
3. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project.[**Label Samples to indicate types and amounts of pigments used.**]

F. Full-Size Samples: For each [**color**][**texture**][**engraving**][**and**][**shape**] of cast stone unit required.

1. Make available for Architect's review at Project site[**or at manufacturing plant, if acceptable to Architect**].
2. Make Samples from materials to be used for units used on Project[**immediately before beginning production of units for Project**].
3. Approved Samples may be installed in the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**][**and**][**testing agency**].

1. Include copies of material test reports, indicating compliance of cast stone with ASTM C1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364.

1. Provide test reports based on testing within previous six months.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by [**CSI**][**or**][**APA**][**or**][**PCI for Group A, Category AT**].

B. Furnish cast stone for installation in mockups specified in [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects[**and to set quality standards for materials and execution**].

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone[**with unit masonry work**] to avoid delaying the Work[**and to minimize the need for on-site storage**].

B. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units if required, using dollies with wood supports.
2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.6 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Cast Stone: Obtain cast stone units from single source from single manufacturer.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

2.2 CAST STONE MATERIALS

A. General: Comply with ASTM C1364.

B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast stone textures and colors.

E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures as directed by the Owner.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
3. Air-Entraining Admixture: ASTM C260/C260M.[**Add to mixes for units exposed to the exterior**

at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.]

4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.

G. Reinforcement:

1. Deformed steel bars complying with ASTM A615/A615M, **Grade 40 (Grade 280)**. Use galvanized or epoxy-coated reinforcement when covered with less than **1-1/2 inches (38 mm)** of cast stone material.

   a. Epoxy Coating: ASTM A775/A775M.
   b. Galvanized Coating: ASTM A767/A767M.

2. Plain-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
3. Galvanized-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
4. Fiber Reinforcement: ASTM C1116/C1116M.

H. Embedded Anchors and Other Inserts: Fabricated from [**stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 304**][**stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 316**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

2.3 CAST STONE UNITS

A. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Cast stone units shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Cast stone units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Cast Stone Units: Comply with ASTM C1364.

1. Units are manufactured using the [**manufacturer's selected**][**vibrant dry tamp**][**wet-cast**][**machine-made**] method.
2. Wall Panels: [**Sizes as indicated on Drawings**].

a. Engravings: As indicated on Drawings.

3. Trim units including [**window sills**][**lintels**][**surrounds**][**mullions**][**copings**][**cornices**][**wall caps**][**belt courses**][**water tables**][**quoins**][**keystones**][**items as indicated on Drawings**].
4. Decorative elements including [**pilasters**][**column covers**][**medallions**][**balustrades**][**steps**][**steps and risers**][**bollards**][**benches**][**curbing**][**fountains**][**items as indicated on Drawings**].

G. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

H. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than **1/8 inch (3 mm)**.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater, but in no case by more than **1/4 inch (6 mm)**.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than **1/8 inch (3 mm)** on formed surfaces of units and **3/8 inch (10 mm)** on unformed surfaces.

I. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 percent relative humidity and temperature of **100 deg F (38 deg C)** for 12 hours or **70 deg F (21 deg C)** for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

a. No fewer than five days at mean daily temperature of **70 deg F (21 deg C)** or above.
b. No fewer than seven days at mean daily temperature of **50 deg F (10 deg C)** or above.

J. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

K. Colors and Textures: [**Match Architect's samples**][**Match existing units**][**as directed by the Owner**].

2.4 MORTAR MATERIALS

A. Provide mortar materials that comply with [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

B. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Aggregate for mortar and grout[**cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

H. Hydrated Lime: ASTM C207, Type S.

I. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

J. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Argos USA LLC**]
   b. [**Cemex S.A.B. de C.V.**]
   c. [**Fairborn Cement Company**]
   d. [**Federal White Cement, Ltd.**]
   e. [**Heidelberg Materials**]
   f. [**Holcim (US) Inc**]
   g. [**Lafarge North America Inc.**]
   h. [**Lehigh White Cement Company**]
   i. [**Quikrete; The QUIKRETE Companies, LLC**]
   j. [**Sakrete; CRH Americas, Oldcastle APG**]

K. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Davis Colors**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**Lanxess Corporation**]
   d. [**Solomon Colors Inc.**]

L. Colored Cement Products: Packaged blend made from [**portland cement and hydrated**

lime][**masonry cement**][**or**][**mortar cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Argos USA LLC**]
      2) [**Heidelberg Materials**]
      3) [**Holcim (US) Inc**]

2. Colored Masonry Cement:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Argos USA LLC**]
      2) [**Cemex S.A.B. de C.V.**]
      3) [**Fairborn Cement Company**]
      4) [**Heidelberg Materials**]
      5) [**Holcim (US) Inc**]
      6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

M. Preblended Dry Mortar Mix: Packaged blend made from [**portland cement and hydrated lime**][**masonry cement**][**or**][**mortar cement**], sand, [**mortar pigments,**][**water repellents,**] and admixtures and complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
      2) [**Quikrete; The QUIKRETE Companies, LLC**]
      3) [**Sakrete; CRH Americas, Oldcastle APG**]
      4) [**SPEC MIX, LLC**]

2. Preblended Dry Masonry Cement Mortar Mix:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**SPEC MIX, LLC**]

N. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

O. Water: Potable.

2.5 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from [**Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**Type 316 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

B. Dowels: **1/2-inch- (12-mm-)** diameter round bars, fabricated from [**Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**Type 316 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666**][**steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M**].

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

2.6 MORTAR MIXES

A. Comply with requirements in [**Section 042000 "Unit Masonry"**][**Section 042613 "Masonry Veneer"**] for mortar mixes.

B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent

agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.

C. Comply with ASTM C270, Proportion Specification.

1. For setting mortar, use [**Type S**][**Type N**].
2. For pointing mortar, use [**Type N**][**Type O**].

D. Preblended dry mortar mix complying with ASTM C1714/C1714M and capable of producing mortar strength as indicated in ASTM C270.

1. For setting mortar, use [**Type S**][**Type N**].
2. For pointing mortar, use [**Type N**][**Type O**].

E. Pigmented Mortar: Use colored cement product[**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products**].

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample, as directed by the Owner.
4. Application: Use pigmented mortar for exposed mortar joints.

F. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample, as directed by the Owner.
2. Application: Use colored-aggregate mortar for exposed mortar joints.

2.7 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast stone units according to ASTM C1364.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

A. Set cast stone as indicated in TMS 604.

B. Install cast stone units to comply with requirements in [**Section 042000 "Unit Masonry."**][**Section 042613 "Masonry Veneer."**]

C. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

D. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

E. Set units in full bed of mortar with full head joints unless otherwise indicated.

1. Set units with joints [**1/4 to 3/8 inch (6 to 10 mm)**][**3/8 to 1/2 inch (10 to 13 mm)**] wide unless otherwise indicated.
2. Build anchors and ties into mortar joints as units are set.
3. Fill dowel holes and anchor slots with mortar.
4. Fill collar joints solid as units are set.
5. Build concealed flashing into mortar joints as units are set.
6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
7. Keep joints at shelf angles open to receive sealant.

F. Rake out joints for pointing with mortar to depths of not less than **3/4 inch (19 mm)**. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

G. Point mortar joints by placing and compacting mortar in layers not greater than **3/8 inch (10 mm)**. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

H. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

I. Rake out joints for pointing with sealant to depths of not less than **3/4 inch (19 mm)**. Scrub faces of units to remove excess mortar as joints are raked.

J. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."

1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

K. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.

1. Keep joints free of mortar and other rigid materials.
2. Build in compressible foam-plastic joint fillers where indicated.
3. Form joint of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**].
4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated in TMS 604.

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

C. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

D. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

E. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

F. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**].

G. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

H. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**], [**3/8 inch in 20 ft. (10 mm in 6 m)**][**1/4 inch in 20 ft. (6 mm in 6 m)**], or **1/2 inch (12 mm)** maximum.

B. Variation from Level: Do not exceed [**1/4 inch in 10 ft. (6 mm in 3 m)**][**1/8 inch in 10 ft. (3 mm in 3 m)**], [**3/8 inch in 20 ft. (10 mm in 6 m)**][**1/4 inch in 20 ft. (6 mm in 6 m)**], or **1/2 inch (12 mm)** maximum.

C. Variation in Joint Width: Do not vary joint thickness more than **1/8 inch in 36 inches (3 mm in 900 mm)** or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than **1/16 inch (1.5 mm)**, except where variation is due to warpage of units within tolerances specified.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved the Owner.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain the Owner approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by methods described in Cast Stone Institute Technical Bulletin #39.
6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 04 72 00 00

Task	Specification	Specification Description
04 72 00 00	03 41 00 00	Precast Structural Concrete
04 72 00 00	04 20 00 00	Unit Masonry

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SECTION 05 01 70 51 - DECORATIVE METAL CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes decorative metal cleaning as follows:

1. Cleaning metal.
2. Removing paint
3. Removing corrosion.
4. Priming for repainting.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal refinishing specialist.

B. Preconstruction Test Reports: For [**chemical cleaning of**][**and**][**paint removal from**] decorative metal.

1.6 QUALITY ASSURANCE

A. Decorative Metal Cleaning Specialist Qualifications: A qualified decorative metal cleaning specialist. Cleaning specialist shall be experienced in using mechanical and chemical methods on the types of

metal surfaces indicated.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.61 "Decorative Metal Repair"**][**Section 050170.63 "Decorative Metal Refinishing"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal cleaning processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.

1. Cleaning: Prepare an area [**approximately 2 sq. ft. (0.2 sq. m)**][**as indicated on Drawings**] for each process on each type of metal indicated for treatment.
2. Approval of mockups does not constitute approval of deviations from the Contract
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency or one or more [**chemical-cleaner**][**and**][**paint-remover**] manufacturers to perform preconstruction testing on each type of metal.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal cleaning only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials, including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

E. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.2 PAINT REMOVERS

A. Alkaline-Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from metals, and containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**EaCo Chem, Inc.**]

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from metal, and containing no methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Dumond Chemicals, Inc**]

C. Solvent-Type-Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from metals.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**Shore Corporation**]

D. Low-Odor, Solvent-Type-Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable

solvent-type paste, gel, or foamed emulsion formulation for removing paint from metals; and containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Cathedral Stone Products, Inc.**]
   c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
   d. [**Dumond Chemicals, Inc**]
   e. [**EaCo Chem, Inc.**]

E. Covered, Solvent-Type-Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry; and containing no methanol or methylene chloride.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dumond Chemicals, Inc**]

2.3 MISCELLANEOUS MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Price Research, Ltd. dba Charles Paint Research**]

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces; and that will easily come off entirely, including adhesive.

C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
b. Leave an unintended residue on surfaces.

2.4 FERROUS METAL PRIMERS

A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free, universal primer, compatible with[**firmly adhered existing paint and**] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry-film thickness.

B. Finish Primer: Primer complying with applicable requirements in [**Section 090190.52 "Maintenance Repainting"**] for finish painting of primed metal.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL CLEANING, GENERAL

A. Execution of the Work: In cleaning items, disturb them as minimally as possible and as follows:

1. Remove deteriorated coatings and corrosion.
2. Sequence work to minimize time before protective coatings are reapplied.
3. Clean items in place unless otherwise indicated.

B. Mechanical Coating Removal: Use gentle methods, such as scraping and wire brushing, that will not abrade metal substrate.

C. Repaint: Where indicated, prepare painted decorative metal by [**cleaning surface, removing less than firmly adhered existing paint, sanding edges smooth,**][**removing existing paint**] and priming for painting as specified.

3.3 CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure where needed to produce cleaning effect established by mockup.

D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of two to three minutes**].
4. Nonferrous Metals: Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.
6. Repeat cleaning procedure where needed to produce cleaning effect established by mockup. Do not repeat more than once.

E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**, leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**, leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold-water, low-pressure spray to remove residue**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from surface.
2. Pressure and distance from surface as established by mockup.

G. Chemical Rust Removal:

1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

H. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.4 PAINT REMOVAL

A. General: Use only those paint-removal methods indicated for each type of decorative metal.

1. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

   a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
   b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.

2. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gages.
   b. Unless otherwise indicated, hold spray nozzle at least **6 inches (152 mm)** from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous

strokes to produce uniform coverage.

c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with cone-shaped spray.

d. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.

e. For high-pressure water-spray application, use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.

f. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

B. Paint Removal with Alkaline-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
8. For spots of remaining paint, apply alkaline-paste paint remover according to "Paint Removal with Alkaline-Paste Paint Remover" Paragraph above.

D. Paint Removal with Solvent-Type-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

E. Paint Removal with Covered, Solvent-Type-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

3.5 PRIMING

A. Repair Primer: Apply immediately after completing a repair.

B. Finish Primer: Apply as soon after cleaning as possible.

3.6 DECORATIVE METAL CLEANING SCHEDULE

A. Treatment for Decorative Railing [**DMR-1**]: Wrought-iron railing and gate.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Alkaline-paste paint remover**][**Covered or skin-forming alkaline paint remover**][**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint remover**][**Covered, solvent-type paint remover**].
3. Repairs: As specified in Section 050170.61 "Decorative Metal Repair."
4. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

B. Treatment of Decorative Railing [**DMR-2**]: Cast-iron balustrade.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Alkaline-paste paint remover**][**Covered or skin-forming alkaline paint remover**][**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint remover**][**Covered, solvent-type-paste paint remover**].
3. Rust Removal: [**Chemical**][**Mechanical**].
4. Repair: As specified in Section 050170.61 "Decorative Metal Repair."
5. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

C. Treatment of Decorative Railing [**DMR-3**]: Bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Repair: As specified in Section 050170.61 "Decorative Metal Repair."
4. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail**].

D. Treatment for Bronze Grille [**DMG-#**]: Strip paint and coat grille.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint**

remover][**Covered, solvent-type-paste paint remover**].

3. Protective Coating: As specified in [**Section 050170.63 "Decorative Metal Refinishing."**]

END OF SECTION 05 01 70 51

SECTION 05 01 70 61 - DECORATIVE METAL REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metal repairs as follows:

   a. Repairing metal and replacing damaged and missing components in place.
   b. Removing metal for shop repair and replacement of components; reinstalling repaired metal.
   c. Painting steel uncovered during the Work.
   d. Installing wood rails supported by or attached to decorative metal railings or brackets.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 057000 "Decorative Metal" for new decorative metal construction.
3. Section 057300 "Decorative Metal Railings" for new decorative handrails and railings.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**]

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
2. Include field-verified dimensions and the following:

a. Identification of each new metal item and component and its location on the structure in annotated plans and elevations.
b. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
c. Provisions for sealant joints if required.

C. Samples for Initial Selection: For the following:

1. Each type of decorative metal item and component with applied finishes.
2. Sealant materials.
3. Accessories to verify color selection.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:

1. Each type of new material to be used for replacing existing or missing decorative metal; **6 inches (150 mm)** long in least dimension or whole item.
2. Fittings and brackets.
3. Each type of exposed connection between components. Show method of finishing components at connections.
4. Each type of exposed finish prepared on metal of the same alloy to be used for the Work of this Section; **6 inches (150 mm)** long in least dimension.
5. Sealant materials.
6. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.

E. Delegated-Design Submittal: For [**structural performance of repaired railings, handrails, and anchors**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal repair specialist.

B. Evaluation Reports: For post-installed structural anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Decorative Metal Repair Specialist Qualifications: A qualified decorative metal fabrication and repair specialist. Experience installing and finishing new decorative metalwork is insufficient experience for repairing decorative metal.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.63 "Decorative Metal Refinishing"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal repair processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are inconspicuous.

1. Replacing Cast-Metal Components: [**Two**] cast-iron [**handrail brackets**][**and**][**grilles**] replaced with exact duplicates.
2. Replacing Cut-Out Metal Items: [**Two**] cut-out bronze-plate [**wall registers**] replaced with exact duplicates.

3. Repairing Wrought Handrail and Railing: [**3 feet (1 m)**] of wrought-iron handrail and railing. [**Patch indentations and reconnect fractures by filling, welding, brazing, or applying new metal material**].
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal repairs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design post-installed structural anchors.

B. Structural Performance: [**Railings**][**and**][**handrails**], including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
2. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

2.2 METAL MATERIALS

A. General: Provide decorative metal materials made of the alloys, forms, and types that match existing metals and have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.

B. Source Limitation for Replacement Cast Materials: Obtain castings for decorative metal repair from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.

C. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use

and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:

1. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.
2. Extruded Structural Pipe and Tubes: ASTM B429/B429M, Alloy 6063-T6.
3. Drawn General-Purpose Seamless Tubes: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.
4. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
5. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
6. Castings: ASTM B26/B26M, Alloy A356-T6.

D. Copper Alloys, Bronze: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze, 57 percent copper and 40 percent zinc).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper and 40 percent zinc).
3. Seamless Pipe: ASTM B43, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
4. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
5. Composition Bronze Castings: ASTM B62, Alloy UNS No. C83600 ("85-5-5-5" is the common trade name; 85 percent copper and 5 percent each of tin, lead, and zinc).
6. Sand Castings: ASTM B584, Alloy UNS No. C86500 (No. 1 manganese bronze, 58 percent copper, 39 percent zinc, 1 percent manganese, and small amounts of other metals).

E. Copper Alloys, Brass: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B249/B249M, Alloy UNS No. C36000 (free-cutting brass, 60 percent copper, 36 percent zinc, and small amounts of other metals).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
3. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
4. Sand Castings: ASTM B584, Alloy UNS No. C85200 (high-copper yellow brass, 72 percent copper, 24 percent zinc, and small amounts of other metals).

F. Stainless Steel: Grade designated below for each form required:

1. Tubing: ASTM A554, [**Grade MT-304**][**Grade MT-316**].
2. Pipe: ASTM A312/A312M, [**Grade TP304**][**Grade TP316**].
3. Castings: ASTM A743/A743M, [**Grade CF8 or CF20**][**Grade CF8M**].
4. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Flat Bar: ASTM A666, [**Type 304**][**Type 316**].
6. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**].

G. Steel: Standard and grade designated below for each form required:

1. Tubing: Cold formed, ASTM A500/A500M.
2. Steel Plate, Shapes, and Bars: ASTM A36/A36M.
3. Steel Bars: Mild steel; ASTM A29/A29M, Grade 1010.
4. Steel Sheet: ASTM A1008/A1008M, cold-rolled commercial steel sheet; matte finish; suitable for exposed applications.

H. Cast Iron: Standard designated below for each type of casting:

1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.

I. Wrought Iron: [**Mild steel; ASTM A29/A29M, Grade 1010**]; hand worked or machine forged to the form indicated.

2.3 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

E. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

F. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29**].

1. Surface Preparation: Use coating requiring no better than [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**] surface preparation according to manufacturer's literature or certified statement.
2. VOC Limit: Use coating with a VOC content of [**400 g/L (3.3 lb/gal.)**] or less.

2.4 FASTENERS

A. Fasteners: Fasteners of the same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.

1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
2. Use concealed fasteners for interconnecting decorative metal components and for attaching them to other work unless exposed fasteners are [**unavoidable**][**or**][**the existing fastening method**].
3. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
4. Finish heads of exposed fasteners to match finish of metal fastened unless otherwise indicated.

B. Anchors, General: Use bolt heads of same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal anchored.

C. Post-Installed Structural Anchors: Fastener systems; with working capacity greater than or equal to the

design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Uses: Securing [**railings**][**and**][**handrails**] to concrete.
2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

D. Post-Installed Nonstructural Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Wood Rails: Hardwood rails of species and profile [**matching design reference sample**][**matching existing**][**as indicated on Drawings**], complying with [**Section 064013 "Exterior Architectural Woodwork."**][**Section 064023 "Interior Architectural Woodwork."**].

B. Welding Electrodes and Filler Metal: Select according to AWS specifications for metal alloy welded; use metal type and alloy as recommended in writing by producer of metal to be welded or filled and as required for color match, strength, and compatibility in fabricated items.

C. Brazing Rods for Copper-Alloy Components: Type and alloy as recommended in writing by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

D. Brazing Rods for Cast-Iron Components: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for strength and compatibility in fabricated items.

E. Metal-Patching Compound: Two-part, polyester-resin metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated because of corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated**], provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior use.

H. Sealant Materials:

1. Provide manufacturer's standard, elastomeric [**single-component, nonsag, neutral-curing silicone**][**single-component, nonsag urethane**] sealant complying with applicable requirements in Section 079200 "Joint Sealants."
2. Colors: Provide colors of exposed sealants to match colors of metals in which sealant is placed unless otherwise indicated.

I. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Building Restoration Products, Inc.**]
   b. [**Price Research, Ltd. dba Charles Paint Research**]

J. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

K. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

   a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
   b. Leave an unintended residue on surfaces.

2.6 METAL FABRICATION

A. Metal Fabricators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allen Architectural Metals, Inc**]
   b. [**Alloy Casting Co., Inc.**]
   c. [**Antique Cast Iron, LLC**]
   d. [**Architectural Iron Company, Inc.**]
   e. [**Brandywine Forge**]
   f. [**f2 Industries**]
   g. [**Heritage Cast Iron USA**]
   h. [**Historical Arts & Casting, Inc**]
   i. [**King Architectural Metals**]

j. [**Olek Lejbzon & Co.**]
k. [**Postville Blacksmith Shop**]
l. [**Robinson Iron**]
m. [**Schiff Architectural Detail**]
n. [**Wiemann Metalcraft**]

B. Fabricate repairs of decorative metal items and components in sizes and profiles to match existing decorative metal, with accurate curves, lines, and angles. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

C. Provide uniform, neat seams with minimum exposure of welds, brazing, solder, and sealant.

D. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.

E. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.

F. Castings: Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

1. Finish castings to match existing decorative metalwork.
2. Replacement Casting for Handrail Bracket: Duplicate existing handrail bracket on the cast-iron railing of first-floor stairs in the lobby. Make molds from this bracket to create new cast-iron brackets.

2.7 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

2.9 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**]

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.10 FERROUS METAL FINISHES

A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free universal primer, compatible with[**firmly adhered existing paint and**] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Finish Primer: Primer complying with applicable requirements in [**Section 090190.52 "Maintenance Repainting"**] for finish painting of primed existing metal.

C. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning,

pretreatment, application, and minimum dry film thickness.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

D. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REPAIR, GENERAL

A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In repairing items, disturb remaining existing work as minimally as possible and as follows:

1. Stabilize decorative metal to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
2. Remove deteriorated coatings and corrosion.
3. Sequence work to minimize time before protective coatings are reapplied.
4. Repair items where stabilization is insufficient to stop progress of deterioration.
5. Repair items in place where possible.
6. Replace or reproduce items where indicated or scheduled.
7. Install temporary protective measures to stabilize decorative metal that is indicated to be repaired later.

C. Mechanical Coating Removal: Use gentle methods, such as scraping and wire brushing, that will not abrade metal substrate.

D. Repair Decorative Metal Item: Match existing materials and features.

1. Repair decorative metals by patching, piecing-in, splicing, or otherwise reinforcing metals with new metal matching existing metal.

E. Replace Decorative Metal Component: Where indicated, duplicate and replace items with new metal matching existing metal.

1. Replace heavily deteriorated or missing parts or features of decorative metal with compatible materials, using surviving prototypes to create patterns or molds for duplicate replacements.

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being cleaned. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gages.
   b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
   c. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
   d. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

E. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold-water, low-pressure spray to remove residue**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from surface.
2. Pressure and distance from surface as established by mockup.

F. Chemical Rust Removal:

1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

G. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.4 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal work as required in Section 024119 "Selective Demolition" for specific requirements relating to selectively demolishing construction, including decorative metal removal for repair or reinstallation elsewhere.

B. Defects in Painted Metal Surfaces: Repair nonload-bearing defects in existing metal surfaces, including dents and gouges more than [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**] deep or [**1/2 inch (13 mm)**][**1 inch (25 mm)**] across, and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners. Prime iron and steel surfaces immediately after repair to prevent flash rusting.

C. Reinstalling [**Railing**][**and**][**Fence**] Posts: After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave **1/8-inch (3-mm)** buildup sloped away from post.

D. Anchoring Wood Rails: Secure wood rails to metal subrail or brackets from bottom of wood rail as indicated on Drawings. Make fastener heads flush to metal surface.

E. Installing Sealant:

1. After metal reinstallation, keep joints to receive sealant dry and free of debris.
2. Clean and prepare joint surfaces according to Section 079200 "Joint Sealants."[**Prime joint surfaces unless sealant manufacturer recommends against priming.**] Do not allow primer to spill or migrate onto adjoining surfaces.
3. Fill sealant joints with specified joint sealant as recommended in writing by sealant manufacturer and according to Section 079200 "Joint Sealants" and the following:

   a. Install sealant using only proved installation methods that ensure sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding metal.
   b. Do not allow sealant to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces, particularly rough or sculptural textures. Promptly remove excess and spillage of sealant as the work progresses. Clean adjoining surfaces by means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

4. Cure sealant according to Section 079200 "Joint Sealants."

3.5 PRIMING

A. Repair Primer: Apply immediately after completing a repair.

B. Finish Primer: Apply as soon after cleaning as possible.

3.6 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify Architect if steel is exposed during metal removal. Where Architect determines that the steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Surface Preparation: Remove paint, rust, and other contaminants according to [**SSPC-SP 2, "Hand Tool Cleaning,"**][**SSPC-SP 3, "Power Tool Cleaning,"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"**] as applicable to comply with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [**1/16 inch (1.6 mm)**], notify Architect before proceeding, as directed by the Owner.

3.7 DECORATIVE METAL REPAIR SCHEDULE

A. Treatment for Decorative Railing [**DMR-1**]: Wrought-iron railing and gate.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repairs: Repair railing and replace missing components with hand-worked [**steel bars**][**wrought iron**].

   a. Apply repair primer immediately after repair.

4. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]
5. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]

B. Treatment of Decorative Railing [**DMR-2**]: Cast-iron balustrade.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Rust Removal: [**Chemical**][**Mechanical**].
4. Repair: [**Patch with new material by filling, welding, brazing, or applying new metal material with fasteners**].

   a. Apply repair primer immediately after repair.

5. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

C. Treatment of Decorative Railing [**DMR-3**]: Bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repair: [**Splice new material into deteriorated section**].
4. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail**].

D. Treatment of Decorative Railing and Handrail [**DMRH-1**]: Deteriorated bronze handrail on cast-iron railing.

1. Repair: Replace broken cast-iron railing components and repaint railing. Replace entire, deteriorated bronze handrail with shop-fabricated aluminum handrail.
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Railing Finish: Paint as specified in [**Section 090190.52 "Maintenance Repainting."**]

   a. Color: [**As indicated by manufacturer's designations**][**Matching design reference sample**][**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Handrail Finish:

   a. Aluminum Finish: [**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Anodized color matching design reference sample**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**].
   b. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's**

designations][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**].

5. Finish Treatment:

   a. Protective Coating: As specified in Section 050170.63 "Decorative Metal Refinishing."
   b. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

END OF SECTION 05 01 70 61

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SECTION 05 01 70 63 - DECORATIVE METAL REFINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes refinishing bare decorative metal surfaces as follows:

1. Refinishing metal in place.
2. Removing metal for shop refinishing; reinstalling refinished metal.
3. Integral metal finishes.
4. Clear protective coatings.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 099423 "Gilding" for gilding on metalwork.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of refinishing work.
2. Include field-verified dimensions.

C. Samples for Initial Selection: For the following:

1. A range of each type of exposed finish prepared on metal of the same alloy matching existing metal.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise

indicated, finished as required for use in the Work:

1. Each type of exposed finish prepared on metal of the same alloy matching existing metal; **6 inches (150 mm)** long in least dimension.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal refinishing specialist.

1.6 QUALITY ASSURANCE

A. Decorative Metal Refinishing Specialist Qualifications: A qualified decorative metal refinishing specialist.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.61 "Decorative Metal Repair"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal refinishing processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.

1. Waxing Bronze: Wax a cleaned area [**approximately 2 sq. ft. (0.2 sq. m)**][**as indicated on Drawings**] of [**each type of**] bronze [**sculpture**][**paneling**][**and**][**hardware**].
2. Refinishing Decorative Metal: Refinish [**one**] decorative for each type of metal indicated to be refinished.
3. Repairing Decorative Metal Finish: Repair finish of [**one**] decorative for each type of metal finish indicated to be repaired.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal refinishing only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials, including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

E. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

2.2 PROTECTIVE COATING MATERIALS

A. Wax Coating: Inert, high-melting-point wax or wax blend, consisting primarily of [**carnauba**][**or**][**microcrystalline petroleum**] wax[**and no solvents**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BWC Company, Inc. (The)**]
b. [**Fisher Scientific; part of Thermo Fisher Scientific**]
c. [**Real Milk Paint Co.**]
d. [**TALAS**]

B. Organic Coating: Clear, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of methyl methacrylate copolymer with benzotriazole UV inhibitor.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**StanChem, Inc.**]
    b. [**TALAS**]

C. Copper-Alloy Corrosion Inhibitor: Solution of [**1**][**to**][**3**] percent benzotriazole in water.

2.3 MISCELLANEOUS MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Building Restoration Products, Inc.**]
    b. [**Price Research, Ltd. dba Charles Paint Research**]

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

    a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
    b. Leave an unintended residue on surfaces.

2.4 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

A. Unfinished: No applied finish; only preparatory cleaning.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

2.6 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.7 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.

2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REFINISHING, GENERAL

A. Refinishing Appearance Standard: Refinished surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In refinishing items, disturb remaining existing work as minimally as possible and as follows:

1. Remove dirt and corrosion.
2. Sequence work to minimize time before protective coatings are reapplied.
3. Refinish items in place where possible and according to required appearance.

C. Refinish Decorative Metal Item: Remove existing metal finishes on item unless otherwise indicated[**including integral polished and patinated finishes,**] and reapply them.

D. Repair Finish of Decorative Metal Item: Restore areas of deteriorated or missing finish on item and blend restored finish with existing, adjacent finish[**including integral polished and patinated finishes**].

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gages.
   b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
   c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
   d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
   e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of two to three minutes**]
4. Nonferrous Metals: Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.

E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove**

residue].

F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold water, low-pressure spray to remove residue.**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from the surface.
2. Pressure and distance from surface as established by mockup.

3.4 PROTECTIVE COATING

A. Protective Hot-Wax Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply wax coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being waxed.
2. Preheat surface to about **212 deg F (100 deg C)**; hot enough to melt the wax and remove water vapor and other gases within metal surface, but not hot enough to boil the wax or ignite solvents if any.
3. Apply uniform wax coating to surface, ensuring that wax coverage is complete, including recesses.[**Apply second wax coating following the same process.**]
4. Inspect surface and repair holidays by reheating and applying more wax.
5. Buff waxed surface to a slight shine with a lint-free cloth after wax has cooled to a hazy appearance.

B. Protective Organic Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply organic coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being coated.
2. Apply two uniform coats by air-spray method according to manufacturer's written instructions, with interim drying between coats.
3. Apply coating to a total dry film thickness of **1 mil (0.025 mm)**.
4. Protect coated surface from contamination until fully cured.

3.5 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal, repair, and reinstallation work as required in Section 024119 "Selective Demolition" and Section 050170.61 "Decorative Metal Repair."

3.6 DECORATIVE METAL REFINISHING SCHEDULE

A. Treatment of Decorative Handrail [**DMR-#**] : Tarnished bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed**

finish, lacquered, on handrail].

B. Treatment for Bronze Statue Finish [**DMS-#**]: Clean, repair patina finish, and coat statue.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Finish Repair: Selectively patinate the [**nose**][**foot**][**and**][**previous metal repairs**] to match the rest of the statue.
4. Protective Coating: Protective [**hot-wax**][**organic**] coating.

END OF SECTION 05 01 70 63

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Task	Specification	Specification Description
05 05 19 00	05 50 00 00	Metal Fabrications
05 05 21 00	05 12 00 00	Structural Steel Framing
05 05 23 00	01 22 00 00	No Specification Required
05 05 23 00	05 12 00 00	Structural Steel Framing
05 05 23 00	05 50 00 00	Metal Fabrications

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SECTION 05 12 00 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Bolts and connectors.
3. Rods.
4. Forged-steel structural hardware.
5. Slide bearings.
6. Shrinkage-resistant grout.
7. Prefabricated building columns.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
4. [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**][**and**][**Section 099600 "High-Performance Coatings"**] for painting requirements.
5. [**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)"**][**and**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for painting requirements.
6. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A6/A6M with flanges thicker than **1-1/2 inches (38 mm)**.
2. Welded built-up members with plates thicker than **2 inches (50 mm)**.
3. Column base plates thicker than **2 inches (50 mm)**.

D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint [**whether prequalified or qualified by testing**][**qualified by testing**] , including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittals: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data [**signed and sealed by the qualified professional engineer responsible for their preparation**] .

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Health Product Declaration (HPD): For each product.

12. Health Product Declaration (HPD): Provide HPD.

13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

14. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

15. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

16. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

17. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

18. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent

(100 ppm) and certification expiration date.

19. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For specified shop and field welding.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Test Reports: For structural-steel materials, including chemical and physical properties.

D. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

E. Source Quality Control Reports: For structural-steel framing.

F. Field Quality Control Reports: For specified tests and inspections.

G. Qualification Statements: For [**Installer**][**fabricator**][**shop-painting applicators**][**professional engineer**][**testing agency**] .

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, [**Category ACSE**][**Category CSE**] .

C. Shop-Painting Applicator Qualifications: Qualified in accordance with AISC's Sophisticated Paint [**Endorsement P1**][**Endorsement P2**][**Endorsement P3**] or to SSPC-QP 3.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided the Owner’s testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.

2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.

a. Select and complete connections using [**schematic details indicated**][**and**][**ANSI/AISC 360**] .
b. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

C. Moment Connections: [**Type PR, partially**][**Type FR, fully**] restrained.

D. Construction: [**Moment frame**][**Braced frame**][**Shear wall system**][**Combined system of moment frame and braced frame**][**Combined system of moment frame and shear walls**][**Combined system of braced frame and shear walls**][**Combined system of moment frame, braced frame, and shear**

walls] .

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes: [**ASTM A992/A992M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

C. Channels, Angles, M-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

D. Channels, Angles, S-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

E. Plate and Bar: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**] .

F. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, **50 ksi (345 MPa)**.

G. Cold-Formed Hollow Structural Sections: [**ASTM A500/A500M, Grade B**][**ASTM A500/A500M, Grade C**][**ASTM A1085/ASTMA1085M**] structural tubing.

H. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.

I. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: [**Standard**][**Extra strong**][**Double-extra strong**] .
2. Finish: [**Black**][**Galvanized**][**Black except where indicated to be galvanized**] .

J. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

K. Steel Forgings: ASTM A668/A668M.

L. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A490 (Grade A490M)**, Type 1, heavy-hex steel structural bolts [**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**] ; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex

carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 490-1 (Type 10.9-1)**, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Hot-dip zinc coating**][**Mechanically deposited zinc coating**][**Hot-dip or mechanically deposited zinc coating**] .
2. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with [**mechanically deposited zinc coating**][**mechanically deposited zinc coating, baked epoxy-coated**] finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**][**round**] head assemblies, consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**][**Mechanically deposited zinc coating**] .

E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A36/A36M**] .

1. Configuration: [**Straight**][**Hooked**] .
2. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
5. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

B. Headed Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**] , straight.

1. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
4. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

C. Threaded Rods: [**ASTM A36/A36M**][**ASTM A193/A193M, Grade B7**][**ASTM A354, Grade BD**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**] .

1. Nuts: **ASTM A63 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Washers: [**ASTM F436 (ASTM F436M), Type 1, hardened**][**ASTM A36/A36M**] carbon steel.
3. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

2.5 FORGED-STEEL STRUCTURAL HARDWARE

A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.

B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 SLIDE BEARINGS

A. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Amscot Structural Products Corp.**]
b. [**Fluorocarbon Company Limited**]
c. [**GRM Custom Products**]
d. [**R.J. Watson Bridge & Structural Engineered Systems**]

2. Mating Surfaces: [**PTFE and PTFE**][**PTFE and mirror-finished stainless steel**] .
3. Coefficient of Friction: Not more than [**0.03**][**0.04**][**0.05**][**0.06**][**0.10**][**0.12**] .
4. Design Load: Not less than [**2000 psi (13.7 MPa)**][**5000 psi (34 MPa)**][**6000 psi (41 MPa)**] .

5. Total Movement Capability: [**2 inches (50 mm)**] .

2.7 PRIMER

A. Steel Primer:

1. Comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**][**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**][**Section 099114 "Exterior Painting (MPI Standards)," Section 099124 "Interior Painting (MPI Standards)," and Section 099601 "High-Performance Coatings (MPI Standards)."**]

2. SSPC-Paint 23, latex primer.

3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: [**MPI#26**][**MPI#80**][**MPI#134**] .

1. Etching Cleaner: MPI#25, for galvanized steel.

2. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**][**ASTM A780/A780M**] .

2.8 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.9 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, [**mechanically thermal cut,**] or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with [**SSPC-SP 1**][**SSPC-SP 2**][**SSPC-SP 3**] .

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than **10 inches (250 mm)** o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. [**Do not thermally cut bolt holes or enlarge holes by burning.**]
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.10 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.11 PREFABRICATED BUILDING COLUMNS

A. Prefabricated Building Column : Consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Black Rock Fireproof Column, a division of United Steel**]
   b. [**Dean Lally LLC / FireTrol Columns**]

2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

   a. Fire-Resistance Rating: [**Four hours**][**Three hours**][**Two hours**][**As indicated on Drawings**] .

2.12 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize [**lintels**][**shelf angles**][**and**][**welded door frames**] attached to structural-steel frame and located in exterior walls.

2.13 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches (50 mm)**.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces [**unless indicated to be painted**] .
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner [**or in accordance with SSPC-SP 16**] .

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of **1.5 mils (0.038 mm)**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Bolted Connections: Inspect [**and test**] shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.

    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

    1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

    1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION OF STRUCTURAL-STEEL FRAMING

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Rods: [**Snug-tighten**][**Pretension**] anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Shrinkage-Resistant Grout: Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. [**Comply with manufacturer's written installation instructions for grouting.**]

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection [**unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M**], as directed by the Owner.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs [**where indicated**] , back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

C. Touchup Priming: Cleaning and touchup priming are specified in [**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

3.7 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect [**and test**] bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

   a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

   b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 05 12 00 00

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Task	Specification	Specification Description
05 12 23 00	05 12 00 00	Structural Steel Framing
05 12 23 00	05 40 00 00	Cold-Formed Metal Framing
05 12 23 00	05 50 00 00	Metal Fabrications
05 13 00 00	05 12 00 00	Structural Steel Framing
05 13 00 00	05 50 00 00	Metal Fabrications
05 14 13 00	01 22 00 00	No Specification Required
05 15 16 00	05 50 00 00	Metal Fabrications
05 15 16 00	05 70 00 00	Decorative Metal
05 15 19 00	05 70 00 00	Decorative Metal

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SECTION 05 21 00 00 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel joists and joist girders.
2. Primers.
3. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Certificates: For each type of bolt.

D. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

E. Field quality control reports.

F. Qualification Statements: For [**manufacturer**] [**Erector**] [**testing agency**].

G. Delegated Design Engineer Qualifications: For steel joist framing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications[**.**"][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Erector Qualifications: An experienced Erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Welding Qualifications: Qualify field-welding procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications[**.**"][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.7 SEQUENCING

A. Deliver steel bearing plates to be built into [**cast-in-place concrete**] [**and**] [**masonry**] construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design steel joist framing.

B. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use [**ASD; data are given at service-load level**] [**LRFD; data are given at factored-load level**].
2. Design special joists to withstand design loads with live-load deflections no greater than the following:

   a. Floor Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.
   b. Roof Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.

2.2 STEEL JOISTS AND JOIST GIRDERS

A. K-Series Steel Joist: Manufactured steel joists of type indicated in accordance with "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: [**K-series steel joists**] [**and**] [**KCS-type K-series steel joists**].
2. K-Series Steel Joist Substitutes: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Provide holes in chord members for connecting and securing other construction to joists.
4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends as indicated on Drawings, complying with SJI's "Specifications."
6. Do not camber joists.
7. Camber joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**]
8. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

B. Long-Span Steel Joist: Manufactured in accordance with "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. Joist Type: [**LH-series long-span steel joists**] [**and**] [**DLH-series long-span steel joists**].
2. End Arrangement: [**Underslung**] [**Square**].
3. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
4. Provide holes in chord members for connecting and securing other construction to joists.
5. Camber long-span steel joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

C. Composite Steel Joist: Manufactured in accordance with "Standard Specifications for Composite Steel Joists, CJ-Series" in SJI's "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," with steel-angle top- and bottom-chord members and parallel top chord, and with [**underslung**] [**square**] ends.

1. Camber composite steel joists [**as indicated on Drawings**]

D. Joist Girders: Manufactured in accordance with "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. End Arrangement: [**Underslung**] [**Underslung with bottom-chord extensions**] [**Square**].

2. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
3. Provide holes in chord members for connecting and securing other construction to joist girders.
4. Camber joist girders [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

A. Primer:

1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
2. Provide shop primer that complies with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

2.4 STEEL JOIST ACCESSORIES

A. Bridging:

1. Provide bridging anchors and number of rows of [**horizontal**] [**or**] [**diagonal**] bridging of material, size, and type required by SJI's "Specifications"[**and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice"**] for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Detail and fabricate in accordance with SJI's "Specifications[**.**"][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.
3. Fabricate as indicated on Drawings and in accordance with SJI's "Specifications[**.**"][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. [**Shop prime paint**] [**Hot-dip zinc coat in accordance with ASTM A123/A123M**].

C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
2. Finish: [**Plain, uncoated**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

E. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH (Grade 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**] [**ASTM A780/A780M**].

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by [**hand-tool cleaning, SSPC-SP 2**] [**or**] [**power-tool cleaning, SSPC-SP 3**].

B. Do not prime paint joists and accessories[**to receive sprayed fire-resistive materials**].

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

D. Shop priming of joists and joist accessories is specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STEEL JOISTS AND JOIST GIRDERS

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Specifications[**,**"][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice,"**] joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel [**bearing plates**] [**and**] [**framework**]. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists[**, bearing plates,**] [**abutting structural steel,**] and accessories.

   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds in accordance with AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 05 21 00 00

Task	Specification	Specification Description
05 21 19 00	05 21 00 00	Steel Joist Framing

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SECTION 05 31 00 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Health Product Declaration (HPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.
b. Acoustical roof deck.

2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Qualification Statements: For [**welding personnel**][**and**][**testing agency**].

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

B. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

C. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and [**Class 1-60**][**Class 1-75**][**Class 1-90**] windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]
11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Valley Joist**]
14. [**Verco Decking, Inc.; a Nucor company**]
15. [**Vulcraft Group; Division of Nucor Corp.**]
16. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type NR, narrow rib**][**Type IR, intermediate rib**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.3 ACOUSTICAL ROOF DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**DACS, Inc.**]
5. [**Epic Metals Corporation**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**Roof Deck, Inc**]
9. [**Vulcraft Group; Division of Nucor Corp.**]

B. Fabrication of Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-

inhibitive primer.

a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0358 inch (1.20/0.91 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
12. Acoustical Perforations: [**Deck units with manufacturer's standard perforated vertical webs**][**Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck**].
13. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.

    a. Factory install sound-absorbing insulation into cells of cellular deck.

14. Acoustical Performance: NRC [**0.65**][**0.75**][**0.80**][**0.85**][**0.90**], tested in accordance with ASTM C423.

2.4 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]

11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Verco Decking, Inc.; a Nucor company**]
14. [**Vulcraft Group; Division of Nucor Corp.**]
15. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard [**gray**][**or**][**white**] baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**] zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thickness: [**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].

2.5 ELECTRIFIED CELLULAR FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cordeck**]
2. [**HH Robertson**]

B. Source Limitations for Electrified Cellular Floor Deck: Obtain cellular floor-deck units and compatible electrical components, such as preset inserts, activation kits, afterset inserts, service fittings, header ducts, and trench header ducts, from single manufacturer.

C. Fabrication of Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with SDI C. Fabricate deck to the minimum section properties, width of panel, number, and area of cells per panel indicated.

1. Cellular Deck Type: [**Composite**][**Noncomposite**].
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0358/0.0598 inch (0.91/1.52 mm)**][**0.0474/0.0358**

inch (1.20/0.91 mm)][0.0474/0.0474 inch (1.20/1.20 mm)][0.0474/0.0598 inch (1.20/1.52 mm)][0.0598/0.0474 inch (1.52/1.20 mm)][0.0598/0.0598 inch (1.52/1.52 mm)].

6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
7. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

2.6 NONCOMPOSITE FORM DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**New Millennium Building Systems, LLC**]
9. [**OEG Building Materials Inc**]
10. [**Roof Deck, Inc**]
11. [**Valley Joist**]
12. [**Verco Decking, Inc.; a Nucor company**]
13. [**Vulcraft Group; Division of Nucor Corp.**]
14. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite deck panels used as a form to comply with SDI NC, with the minimum section properties indicated, and with the following:

1. Uncoated Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum.
2. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with[**top and**] underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
4. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

5. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
6. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
7. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
8. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.7 NONCOMPOSITE VENTED FORM DECK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Marlyn Steel Decks, Inc.**]
4. [**Miami Metal Deck**]
5. [**New Millennium Building Systems, LLC**]
6. [**Roof Deck, Inc**]
7. [**Verco Decking, Inc.; a Nucor company**]
8. [**Vulcraft Group; Division of Nucor Corp.**]
9. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Vented Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite deck panels used as a form to comply with SDI NC, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**] zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
4. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
5. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
6. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
7. Vent Slot Area: Manufacturer's standard vent slots providing [**1-1/2**] percent open area.

2.8 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10 (4.8-mm)** minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, not less than **0.0359-inch (0.91-mm)** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, of same material and finish as deck, and of thickness and profile [**indicated**][**recommended by SDI standards for overhang and slab depth**].

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**] thick, with factory-punched hole of **3/8-inch (9.5-mm)** minimum diameter.

J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

K. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck. For drains, cut holes in the field.

L. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck, with **3-inch- (76-mm-)** wide flanges and [**level**][**sloped**] recessed pans of **1-1/2-inch (38-mm)** minimum depth. For drains, cut holes in the field.

M. Galvanizing Repair Paint: [**ASTM A780/A780M**][**SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight**].

N. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches (38 mm)** long, and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds [**18 inches (460 mm) apart, maximum**][**12 inches (300 mm) apart in Zone 1 and 6 inches (150 mm) apart in Zones 2 and 3, based on roof-area definitions in FM Global Loss Prevention Data Sheet 1-28**][**as indicated**].
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or [**18 inches (460 mm)**][**36 inches (1 m)**], and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:

1. End Joints: [**Lapped 2 inches (50 mm) minimum**][**Butted**][**Lapped 2 inches (50 mm) minimum or butted at Contractor's option**].

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and [**weld**][**mechanically fasten**] flanges to top of deck. Space [**welds**][**mechanical fasteners**] not more than **12 inches (300 mm)** apart with at least one [**weld**][**fastener**] at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and [**weld**][**or**][**mechanically fasten**].

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. [**Weld**][**or**][**mechanically fasten**] to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 INSTALLATION OF FLOOR DECK

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing:

a. Weld edge ribs of panels at each support. Space additional welds an average of **16 inches (400 mm)** apart, but not more than **18 inches (460 mm)** apart.
b. Space and locate welds as indicated.

3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches (1 m)**, and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of [**1-1/2 inches (38 mm)**], with end joints as follows:

1. End Joints: [**Lapped**][**Butted**][**Lapped or butted at Contractor's option**].

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from [**all-cellular units**][**alternating cellular units with noncellular composite units**][**units indicated**].

1. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Section 260539 "Underfloor Raceways for Electrical Systems" with installation of electrified cellular metal floor deck.

G. Install piercing hanger tabs at [**14 inches (355 mm)**] apart in both directions, within **9 inches (228 mm)** of walls at ends, and not more than **12 inches (305 mm)** from walls at sides unless otherwise indicated.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on [**both surfaces**][**top surface**] of prime-painted deck immediately after installation, and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

   a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

   a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.

C. Prepare test and inspection reports.

END OF SECTION 05 31 00 00

Task	Specification	Specification Description
05 31 13 00	05 31 00 00	Steel Decking
05 31 23 00	05 31 00 00	Steel Decking
05 31 33 00	05 31 00 00	Steel Decking
05 36 00 00	05 31 00 00	Steel Decking

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SECTION 05 40 00 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-formed steel framing.
2. Load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Vertical deflection clips, exterior.
5. Interior non-load-bearing wall framing.
6. Vertical deflection clips, interior.
7. Floor joist framing.
8. Roof-rafter framing.
9. Soffit framing.
10. Sill sealer gasket/termite barrier.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, within height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For cold-formed steel framing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List

Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For shop or field welding.

B. Product Certificates: For each type of code-compliance certification for studs and track.

C. Product Test Reports: For each listed product, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**] .

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports:

1. For nonstandard cold-formed steel framing [**post-installed anchors**][**and**][**power-actuated fasteners**] , from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

E. Qualification Statements: For testing agency.

F. Delegated Design Engineer Qualifications: For cold-formed steel framing.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by International Accreditation Service (IAS) to IAS AC98 criteria for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency [**, or in-house testing with calibrated test equipment,**] indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with the product-certification program of [**the Steel Framing Industry Association**][**the Steel Stud Manufacturers Association**][**the Supreme Steel Framing System Association**] .

D. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 for one- and two-family dwellings.

F. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: [**As indicated on Drawings**] .
2. Deflection Limits: Design framing systems to withstand [**design loads**] without deflections greater than the following:

   a. Load-Bearing Wall Framing:

      1) Exterior: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
      2) Interior: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.

   b. Exterior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
   c. Interior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.
   d. Floor Joist Framing: Vertical deflection of [**1/360**][**1/480**] for live loads and l/240 for total loads of the span.
   e. Roof-Rafter Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the horizontally projected span for live loads.
   f. Ceiling Joist Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of **120 deg F (67 deg C)**.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

   a. Upward and downward movement of [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch**

(25 mm)][1-1/2 inches (38 mm)] .

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] .

D. Seismic Performance: Cold-formed steel framing to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7 and AISI S400**] .

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Product iQ" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

F. Sound-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 COLD-FORMED METAL FRAMING

A. Cold-Formed Steel Framing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**CEMCO; California Expanded Metal Products Co.**]
c. [**ClarkDietrich**]
d. [**Consolidated Fabricators Corp.; Building Products Division**]
e. [**CRACO Mfg., Inc.**]
f. [**Design Shapes in Steel**]
g. [**Formetal Co. Inc. (The)**]
h. [**Jaimes Industries, Inc.**]
i. [**Marino\WARE**]
j. [**MBA Metal Framing**]
k. [**Mill Steel Framing; Mill Steel Company**]
l. [**MRI Steel Framing, LLC**]
m. [**Olmar Supply, Inc**]
n. [**Quail Run Building Materials, Inc.**]
o. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
p. [**State Building Products, Inc**]
q. [**Steel Construction Systems; Stone Group of Companies**]
r. [**Steel Network, Inc. (The)**]
s. [**Steeler, Inc**]
t. [**Super Stud Building Products Inc.**]
u. [**TELLING Industries**]
v. [**The Mill Steel Co**]
w. [**US Frame Factory**]

2. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of

preconsumer recycled content not less than 25 percent.

3. Framing Members, General: Comply with [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] for conditions indicated.
4. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

   a. Grade: [**ST33H (ST230H)**][**ST50H (ST340H)**][**As required by structural performance**] .

   b. Coating: [**G60 (Z180)**, **A60 (ZF180)**, **AZ50 (AZM150)**, **or GF30 (ZGF90)**][**G90 (Z275) or equivalent**] .

5. Steel Sheet for Vertical Deflection Drift Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

   a. Grade: [**33 (230)**][**50 (340)**, **Class 1**][**As required by structural performance**].
   b. Coating: **G90 (Z275)**.

2.3 LOAD-BEARING WALL FRAMING

A. Steel Studs, Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**] .
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] .

C. Steel Box or Back-to-Back Headers, Load-Bearing Wall: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**] .

D. Steel Single- or Double-L Headers, Load-Bearing Wall: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Top Flange Width: [**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-**

1/2 inches (63 mm)] .

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Exterior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [0.0329 inch (0.84 mm)][0.0428 inch (1.09 mm)][0.0538 inch (1.37 mm)][0.0677 inch (1.72 mm)][0.0966 inch (2.45 mm)][0.1180 inch (2.997 mm)] .

2. Flange Width: [1-3/8 inches (35 mm)][1-5/8 inches (41 mm)][2 inches (51 mm)][2-1/2 inches (63 mm)].

B. Steel Track, Exterior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [0.0329 inch (0.84 mm)][0.0428 inch (1.09 mm)][0.0538 inch (1.37 mm)][0.0677 inch (1.72 mm)][0.0966 inch (2.45 mm)][0.1180 inch (2.997 mm)][**Matching steel studs**] .
2. Flange Width: [1-1/4 inches (32 mm)].

C. Vertical Deflection Clips, Exterior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Marino\WARE**]
e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
f. [**Simpson Strong-Tie Co., Inc.**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]

2. Clip Type: [**Bypass**][**Head**].

D. Single Deflection Track, Exterior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [0.0428 inch (1.09 mm)][0.0538 inch (1.37 mm)][0.0677 inch (1.72 mm)][0.0966 inch (2.45 mm)][0.1180 inch (2.997 mm)].
2. Flange Width: [1 inch (25 mm) **plus the design gap for one-story structures**][**and**][1 inch (25 mm) **plus twice the design gap for other applications**].

E. Drift Clips, Exterior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Interior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Interior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**].
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**] .

C. Vertical Deflection Clips, Interior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**AllSteel & Gypsum Products, Inc.**]
   b. [**ClarkDietrich**]
   c. [**CRACO Mfg., Inc.**]
   d. [**Marino\WARE**]
   e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
   f. [**Simpson Strong-Tie Co., Inc.**]
   g. [**Steeler, Inc**]

2. Clip Type: [**Bypass**][**Head**] .

D. Single Deflection Track, Interior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].
2. Flange Width: [**1 inch (25 mm) plus the design gap for one-story structures**][**and**][**1 inch (25 mm) plus twice the design gap for other applications**].

E. Drift Clips, Interior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 FLOOR JOIST FRAMING

A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, [**unpunched**][**punched with standard holes**][**punched with enlarged service holes**] with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

B. Steel Rim Joist Track: Manufacturer's standard U-shaped steel rim joist track, of web depths indicated, unpunched or punched at joist spacing, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel joists**].

2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**], minimum.

2.7 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.8 SOFFIT FRAMING

A. Exterior Soffit Framing: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.9 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic-coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.

2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.10 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process in accordance with ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, [**Grade 36**][**Grade 55**] , threaded carbon steel bolts, carbon-steel nuts, and flat, hardened-steel washers.

1. Bolt Type: [**Hex-headed bolts**][**Headless, hooked bolts**][**Headless bolts, with encased end threaded**]
2. Zinc Coating: [**Hot-dip process in accordance with ASTM A153/A153M, Class C**][**Mechanically deposition according to ASTM B695, Class 50**] .

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction.

1. Acceptance Criteria: [**ICC-ES AC01**][**ICC-ES AC193**][**ICC-ES AC58**][**ICC-ES AC308**] as appropriate for the substrate
2. Uses: Securing cold-formed steel framing to structure.

3. Type: [**Torque-controlled expansion anchor**][**Torque-controlled adhesive anchor**][**adhesive anchor**] .

4. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.

5. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ISO 3506-1)**.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.11 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: [**ASTM A780/A780M**][**MIL-P-21035B**][**SSPC-Paint 20**] .

B. Cement Grout: Portland cement, ASTM C476, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, **1/4 inch (6 mm)** thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum **68-mil (1.7-mm)** nominal thickness, self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Polyguard Products, Inc.**]

2. Physical Properties:

   a. Peel Adhesion: **17.0 lb/in (2.9 N/mm)** of width when tested in accordance with ASTM D412.
   b. Low-Temperature Flexibility: Pass at **minus 25 deg F (minus 32 deg C)** when tested in accordance with ASTM D146/D146M.
   c. Water Vapor Permeance: **0.05 perm (0.44 ng/Pa x s x sq. m)** maximum when tested in accordance with ASTM E96/E96M, Method B.
   d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.12 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, in accordance with AISI S240 and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install in accordance with Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, in accordance with Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Spacing: Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of **1/8 inch (3 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or track to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch (6 mm)** to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Sill Sealer Gasket: Install at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

E. Sill Sealer Gasket/Termite Barrier: Install in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION OF COLD-FORMED STEEL FRAMING

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing in accordance with ASTM C1007, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding **1/16 inch (1.6 mm)**.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install in accordance with Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

A. Install continuous top and bottom track sized to match studs. Align track accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: [**As indicated on Shop Drawings**].

B. Squarely seat studs against top and bottom track, with gap not exceeding **1/8 inch (3 mm)** between the end of wall-framing member and the web of track.

1. Fasten both flanges of studs to top and bottom track.
2. Space studs as follows:

a. Stud Spacing: [12 inches (305 mm)][16 inches (406 mm)][19.2 inches (488 mm)][24 inches (610 mm)][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs in accordance with AISI S240, Section C3.5.2. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
2. Install track and jack studs above and below wall openings. Anchor track to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically [48 inches (1220 mm)][**as indicated on Drawings**][**as indicated on Shop Drawings**]. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed in accordance with manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom track. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting

structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Single Deflection Track, Exterior: Install and anchor to building structure.
2. Vertical Deflection Clips, Exterior: Connect to [**bypassing**][**infill**] studs and anchor to building structure.
3. Drift Clips, Exterior: Connect to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel U-channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while

providing lateral support.

1. Single Deflection Track, Interior: Install and anchor to building structure.
2. Vertical Deflection Clips, Interior: Connect to studs and anchor to building structure.
3. Drift Clips, Interior: Connect to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 INSTALLATION OF FLOOR JOIST FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated [**on Shop Drawings**] .

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing as indicated on Shop Drawings.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than **2 inches (51 mm)** from abutting walls, and as follows:

1. Joist Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Bridging: Install bridging at intervals indicated [**on Shop Drawings**] . Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.8 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.9 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Testing: the Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports, as directed by the Owner.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect, as directed by the Owner.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00 00

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Task	Specification	Specification Description
05 41 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 13 00	05 40 00 00	Cold-Formed Metal Framing
05 42 23 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	01 22 00 00	No Specification Required
05 43 00 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	05 50 00 00	Metal Fabrications
05 45 00 00	05 40 00 00	Cold-Formed Metal Framing
05 45 13 00	05 40 00 00	Cold-Formed Metal Framing
05 45 16 00	05 40 00 00	Cold-Formed Metal Framing

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SECTION 05 50 00 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Alternating tread devices.
6. Metal ships' ladders and pipe crossovers.
7. Metal floor plate.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim.
11. Metal bollards.
12. Vehicular barrier cable systems.
13. Pipe and downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Cast-iron wheel guards.
16. Metal downspout boots.
17. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Prefabricated building columns.
6. Slotted channel framing.
7. Manufactured metal ladders.
8. Alternating tread devices.
9. Metal ships' ladders and pipe crossovers.
10. Metal bollards.
11. Vehicular barrier cable systems.
12. Pipe and downspout guards.
13. Abrasive metal nosings, treads, and thresholds.
14. Cast-iron wheel guards.
15. Metal downspout boots.

B. Shop Drawings: Show fabrication and installation details.[**Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.**] Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Elevator machine beams, hoist beams, and divider beams.
3. Steel shapes for supporting elevator door sills.
4. Steel girders for supporting wood frame construction.
5. Steel pipe columns for supporting wood frame construction.
6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Alternating tread devices.
10. Metal ships' ladders and pipe crossovers.
11. Metal floor plate and supports.
12. Elevator pit sump covers.
13. Structural-steel door frames.
14. Miscellaneous steel trim including [**steel angle corner guards**][**steel edgings**][**and**][**loading-dock edge angles**].
15. Metal bollards.
16. Loose steel lintels.
17. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded [**nosing**][**and**][**tread**].

D. Delegated Design Submittals: For [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**].

B. Structural Performance of Aluminum Ladders: Ladders[**, including landings,**] are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Comply with applicable railing loadings in Section 055213 "Pipe and Tube Railings."

D. Vehicular Barrier Cable Systems: Design vehicular barrier cable systems to resist a single [**6000-lbf (28.7-kN)**] service load and [**10,000-lbf (47.9-kN)**] ultimate load applied horizontally in any direction to the cable system, with anchorages or attachments capable of transferring this load to the structure. Limit deflection to **18 inches (457 mm)**. Design is to assume loads are applied at a height of [**18 inches (457 mm)**] above the floor or ramp surface on an area not to exceed **1 sq. ft. (0.09 sq. m)**.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles**

(800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

I. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].

J. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

K. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

L. Rolled-Stainless Steel Floor Plate: ASTM A793.

M. Abrasive-Surface Floor Plate: Steel plate [**with abrasive granules rolled into surface**][**or**][**with abrasive material metallically bonded to steel**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**IKG**]
   b. [**Ohio Gratings, Inc**]
   c. [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

2. Source Limitations: Obtain floor plate from single source from single manufacturer.

N. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

O. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

P. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

Q. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.

1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

R. Steel Prestressing Strand: ASTM A416/A416M, **Grade 270 (Grade 1860)**, low-relaxation, seven-wire, with **0.9-lb/sq. ft. (4.39-kg/sq. m)** zinc coating.

1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.

S. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: [**1-5/8 by 1-5/8 inches (41 by 41 mm)**][**As indicated**].
2. Galvanized Steel: ASTM A653/A653M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**], with **G90 (Z275)** coating; [**0.108-inch (2.8-mm)**][**0.079-inch (2-mm)**][**0.064-inch (1.6-mm)**] nominal thickness.
3. Cold-Rolled Steel: ASTM A1008/A1008M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**]; [**0.0966-inch (2.5-mm)**][**0.0677-inch (1.7-mm)**][**0.0528-inch (1.35-mm)**] minimum thickness; [**unfinished**][**coated with rust-inhibitive, baked-on, acrylic enamel**][**hot-dip galvanized after fabrication**].

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

U. Aluminum Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

V. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

W. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

X. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

Y. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

Z. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

AA. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

BB. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening [**aluminum**][**stainless steel**][**or**][**nickel silver**].
2. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3, (ASTM A563M, Class 10S3)** heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, **ASTM F593 (ISO 3506-1)**; with hex nuts, **ASTM F594 (ASTM F836M)**; and, where indicated, flat washers; Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches (41 by 22 mm)** by length indicated with anchor straps or studs not less than **3 inches (75 mm)** long at not more than **8 inches (200 mm)** o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)**.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing[**and contour of welded surface matches that of adjacent surface**].

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated.

Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes [**indicated**][**recommended by partition manufacturer**] with attached bearing plates, anchors, and braces as [**indicated**][**recommended by partition manufacturer**]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
2. Drill or punch girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at **24 inches (600 mm)** o.c.

E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide **1/2-inch (12.7-mm)** baseplates with four **5/8-inch (16-mm)** anchor bolts and **1/4-inch (6.4-mm)** top plates.

F. Galvanize miscellaneous framing and supports where indicated.

G. Prime miscellaneous framing and supports with [**zinc-rich primer**][**primer specified in Section 099600 "High-Performance Coatings"**] where indicated.

2.7 PREFABRICATED BUILDING COLUMNS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Black Rock Fireproof Column, a division of United Steel**]
2. [**Dean Lally LLC / FireTrol Columns**]

B. Source Limitations: Obtain prefabricated building column from single source from single manufacturer.

C. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

D. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: [**4 hours**][**3 hours**][**2 hours**][**As indicated**].

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive **3/4-inch (19-mm)** bolts, spaced not more than **6 inches (150 mm)** from ends and **24 inches (600 mm)** o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches (50 mm)** larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize[**and prime**] shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:

1. Comply with ANSI A14.3[**, except for elevator pit ladders**].
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails [**16 inches (406 mm)**][**18 inches (457 mm)**] apart unless otherwise indicated.
2. Siderails: Continuous, [**3/8-by-2-1/2-inch (9.5-by-64-mm)**][**1/2-by-2-1/2-inch (12.7-by-64-mm)**] steel flat bars, with eased edges.
3. Rungs: [**3/4-inch- (19-mm-) diameter**][**3/4-inch- (19-mm-) square**][**1-inch- (25-mm-) diameter**][**1-inch- (25-mm-) square**], steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**IKG**]
      2) [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating,

supported by steel angles. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**] in least dimension.

9. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted steel brackets.
10. Galvanize[**and prime**][**exterior**]ladders, including brackets.
11. Prime [**exterior**]ladders, including brackets and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

C. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Halliday Products**]
   b. [**Kattsafe**]
   c. [**O'Keeffe's Inc.**]
   d. [**Precision Ladders, LLC**]
   e. [**Royalite Manufacturing, Inc.**]
   f. [**Thompson Fabricating, LLC**]
   g. [**UPNOVR, Inc.**]

2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
3. Space siderails [**16 inches (406 mm)**][**18 inches (457 mm)**] apart unless otherwise indicated.
4. Siderails: Continuous extruded-aluminum channels or tubes, not less than **2-1/2 inches (64 mm)** deep, **3/4 inch (19 mm)** wide, and **1/8 inch (3.2 mm)** thick.
5. Rungs: Extruded-aluminum tubes, not less than **3/4 inch (19 mm)** deep and not less than **1/8 inch (3.2 mm)** thick, with ribbed tread surfaces.
6. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
7. Provide platforms as indicated fabricated from [**pressure-locked aluminum bar grating**][**or**][**extruded-aluminum plank grating**], supported by extruded-aluminum framing. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**] in least dimension.
8. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted aluminum brackets.
9. Provide minimum **72-inch- (1830-mm-)** high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.10 ALTERNATING TREAD DEVICES

A. Alternating Tread Devices: Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Lapeyre Stair Inc.**]
   b. [**Precision Ladders, LLC**]

2. Tread depth is not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **9-1/2 inches (241 mm)**.
3. Tread depth is not to be less than **8-1/2 inches (216 mm)** exclusive of nosing or less than **10-1/2 inches (267 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **8 inches (203 mm)**.
4. Fabricate from [**steel**][**stainless steel**][**aluminum**] and assemble by welding or with stainless steel fasteners.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.11 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal [**ships' ladders**][**and**][**pipe crossovers**] where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads are not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)** including the nosing, and riser height is not to be more than **9-1/2 inches (241 mm)**.
2. Fabricate [**ships' ladders**][**and**][**pipe crossovers**], including railings from [**steel**][**stainless steel**][**aluminum**].
3. Fabricate treads[**and platforms**] from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**] in least dimension.
4. Fabricate treads[**and platforms**] from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.12 METAL FLOOR PLATE

A. Fabricate from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate of thickness indicated below:

1. Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**5/16 inch (8 mm)**][**3/8 inch (9.5 mm)**][**As indicated**].

B. Provide grating sections where indicated, fabricated from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide [**steel**][**stainless steel**][**aluminum**] angle supports as indicated.

D. Include [**steel**][**stainless steel**][**aluminum**] angle stiffeners, and fixed and removable sections as indicated.

E. Provide flush [**steel**][**stainless steel**][**aluminum**] bar drop handles for lifting removable sections, one at each end of each section.

2.13 ELEVATOR PIT SUMP COVERS

A. Fabricate from [**1/8-inch (3.2-mm)**][**3/16-inch (4.8-mm)**][**rolled-steel**][**abrasive-surface**] floor plate with four **1-inch- (25-mm-)** diameter holes for water drainage and for lifting.

B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide steel angle supports unless otherwise indicated.

2.14 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch (16-by-38-mm)** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches (250 mm)** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize[**and prime**][**exterior**]steel frames.

D. Prime [**exterior**]steel frames with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.15 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize[**and prime**][**exterior**]miscellaneous steel trim.

D. Prime [**exterior**]miscellaneous steel trim with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.16 METAL BOLLARDS

A. Fabricate metal bollards from [**Schedule 80 steel pipe**][**Schedule 40 steel pipe**][**Schedule 80 stainless steel, No. 4/180-grit finish**][**1/4-inch (6.4-mm) wall-thickness rectangular steel tubing**][**steel shapes, as indicated**].

1. Cap bollards with **1/4-inch- (6.4-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate with [**flat**][**sloped**][**domed**] top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate bollards with **3/8-inch- (9.5-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] baseplates for bolting to concrete slab. Drill baseplates at all four corners for **3/4-inch (19-mm)** anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel [**pipe**][**or**][**tubing**] with **1/4-inch- (6.4-mm-)** thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than **8 inches (200 mm)** deep and **3/4 inch (19 mm)** larger than OD of bollard.

D. Fabricate internal sleeves for removable bollards from Schedule 80 [**steel**][**stainless steel**] pipe or **1/4-inch (6.4-mm)** wall-thickness [**steel**][**stainless steel**] tubing with an OD approximately **1/16 inch (1.5 mm)** less than ID of bollards. Match drill sleeve and bollard for **3/4-inch (19-mm)** [**steel**][**stainless steel**] machine bolt.

E. Prime steel bollards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.17 VEHICULAR BARRIER CABLE SYSTEMS

A. Vehicular Barrier Cable Systems: Of diameter required by performance requirements, but not less than **1/2-inch- (12-mm-)** diameter, [**zinc-coated steel wire rope**][**stainless steel wire rope**][**zinc-coated steel prestressing strand**] with turnbuckles, toggles, machine swage terminals, and other fittings and accessories for securing to structural columns and walls and for tightening barrier cable.

2.18 PIPE AND DOWNSPOUT GUARDS

A. Fabricate [**pipe**][**downspout**] guards from **3/8-inch- (9.5-mm-)** thick by **12-inch- (300-mm-)** wide, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch (50-mm)** clearance between pipe and pipe guard. Drill each end for two **3/4-inch (19-mm)** anchor bolts.

B. Galvanize[**and prime**] steel [**pipe**][**downspout**] guards.

C. Prime steel [**pipe**][**downspout**] guards with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.19 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze (leaded red or semired brass)**][**nickel silver (leaded nickel bronze)**], with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Safety Tread Co., Inc**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Barry Pattern & Foundry Co., Inc**]
   d. [**Safe-T-Metal Company, Inc.**]
   e. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Cross-hatched nosings, **4 inches (100 mm)** wide, with **1/4-inch- (6-mm-)** thick **1-inch (25-mm)** lip, for casting into concrete.
4. Cross-hatched nosings, **1-1/2 inches (38-mm)** wide, **3/8-inch- (9.5-mm-)** thick **1-1/2 inch (38-mm)** lip, for casting into concrete.
5. Cross-hatched Treads: Full depth of tread with **3/4-by-3/4-inch (19-by-19-mm)** nosing, for application over bent plate treads or existing stairs.
6. Fluted-Saddle-Type Thresholds: **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with tapered edges.
7. Fluted-Interlocking or -Hook-Strip Thresholds: **5 inches (125 mm)** wide by **5/8 inch (16 mm)** high, with tapered edge.
8. Thresholds: Plain-stepped- (stop-) type units, **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with **1/2-inch (12-mm)** step.

B. Extruded Units: [**Aluminum**][**Bronze**], with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Safety Tread Co., Inc**]
   b. [**Amstep Products**]
   c. [**Armstrong Products, Inc**]
   d. [**Balco; a CSW Industrials Company**]
   e. [**Nystrom, Inc.**]
   f. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
4. Provide solid-abrasive-type units without ribs.

5. Nosings:

   a. Square-back units, [**1-7/8 inches (48 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] wide, for casting into concrete steps.
   b. Beveled-back units, [**3 inches (75 mm)**][**4 inches (100 mm)**] wide with **1-3/8-inch (35-mm)** lip, for surface mounting on existing stairs.
   c. Two-piece units, **3 inches (75 mm)** wide, with subchannel for casting into concrete steps.

6. Treads: [**Square**][**Beveled**]-back units, full depth of tread with **1-3/8-inch (35-mm)** lip, for application over existing stairs.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Drill for mechanical anchors and countersink. Locate holes not more than **4 inches (100 mm)** from ends and not more than **12 inches (300 mm)** o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.

   1. Provide two rows of holes for units more than **5 inches (125 mm)** wide, with two holes aligned at ends and intermediate holes staggered.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.20 CAST-IRON WHEEL GUARDS

A. Provide wheel guards made from cast-iron, **3/4-inch- (19-mm-)** thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

B. Prime cast-iron wheel guards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.21 METAL DOWNSPOUT BOOTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**J.R. Hoe & Sons Inc.**]
   2. [**Neenah Foundry Company**]

B. Source Limitations: Obtain downspout boots from single source from single manufacturer.

C. Provide downspout boots made from cast [**iron**][**aluminum**] in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

   1. Outlet: [**Vertical, to discharge into pipe**][**Horizontal, to discharge into pipe**][**At 35 degrees from horizontal, to discharge onto splash block or pavement**].

D. Prime cast-iron downspout boots with [**zinc-rich primer.**][**primer specified in Section 099600 "High-**

Performance Coatings."]

2.22 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize bearing and leveling plates.

C. Prime plates with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.23 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches (200 mm)** unless otherwise indicated.

C. Galvanize[**and prime**] loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.24 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.25 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.26 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items[**not indicated to be galvanized**] unless they are to be embedded in

concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting"**][**primers specified in Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.27 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for [**ceiling-hung toilet partitions**][**operable partitions**][**overhead doors**][**and**][**overhead grilles**] securely to, and rigidly brace from, building structure.

C. Anchor shelf angles securely to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**].

D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLATION OF SHELF ANGLES

A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.5 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.6 INSTALLATION OF ALTERNATING TREAD DEVICES

A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.

3.7 INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.

B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

3.8 INSTALLATION OF METAL FLOOR PLATE

A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.9 INSTALLATION OF ELEVATOR PIT SUMP COVERS

A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.10 INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.11 INSTALLATION OF MISCELLANEOUS STEEL TRIM

A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.12 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**]. Provide four **3/4-inch (19-mm)** bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least **4 inches (100 mm)** in concrete.

C. Anchor bollards in concrete [**with pipe sleeves preset and anchored into concrete**][**in formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of bollard**]. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Anchor internal sleeves for removable bollards in [**concrete by inserting in pipe sleeves preset into concrete**][**formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve**]. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward internal sleeve.

F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

G. Place removable bollards over internal sleeves and secure with **3/4-inch (19-mm)** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. The Owner furnishes padlocks.

H. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.13 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

A. Install vehicular barrier cable systems at locations indicated, mounted at heights indicated on Drawings above the parking surface. Anchor [**wire ropes**][**steel prestressing strand**] to structural columns and walls and tension to withstand vehicle loading as specified in "Performance Requirements" Article with no cable tensioned less than **3000 lbf (13.3 kN)**. Do not displace supporting components.

3.14 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

A. Provide pipe guards at exposed vertical pipes in [**parking garage**][**at locations indicated on Drawings**] where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four **3/4-inch (19-mm)** bolts at each pipe guard. Mount pipe guards with top edge **26 inches (660 mm)** above driving surface.

3.15 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.16 INSTALLATION OF CAST-IRON WHEEL GUARDS

A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.17 INSTALLATION OF METAL DOWNSPOUT BOOTS

A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.

B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.18 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.19 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 50 00 00

SECTION 05 51 13 00 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with [**concrete-filled**][**precast concrete**][**precast terrazzo**][**epoxy-resin-filled**][**and**][**abrasive-coating-finished, formed-metal**] treads.
2. [**Steel tube**]railings and guards attached to metal stairs.
3. [**Steel tube**]handrails attached to walls adjacent to metal stairs.
4. Railing gates at the level of exit discharge.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs[**, railings, and guards**].

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts,[**blocking for attachment of wall-mounted handrails,**] and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Perforated metal.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Prefilled metal-pan-stair treads.
5. Abrasive nosings.
6. Shop primer products.
7. Nonslip-aggregate concrete finish.
8. Abrasive-coating finish to formed-metal stairs.
9. Precast concrete treads.
10. Precast terrazzo treads.
11. Epoxy-resin-filled stair treads.

12. Handrail wall brackets.
13. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.
5. Indicate profile and dimensions of precast terrazzo treads.
6. Indicate profile and dimensions of epoxy-resin-filled treads.

D. Samples for Verification: For each type and finish of [**nosing**][**precast terrazzo tread**][**epoxy-resin-filled tread**].

E. Delegated Design Submittal: For stairs, [**railings and guards,**][**precast terrazzo treads,**][**epoxy-resin-filled treads**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, [**railings and guards,**][**precast terrazzo treads,**][**epoxy-resin-filled treads**], including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

a. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

D. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Steel Tubing for Railings and Guards: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

D. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M,[**either commercial steel, Type B, or**] structural steel, **Grade 25 (Grade 170)**, unless another grade is required by design loads; exposed.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M,[**either commercial steel, Type B, or**] structural steel, **Grade 30 (Grade 205)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project

site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Galvanized Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating,[**either commercial steel, Type B, or**] structural steel, **Grade 33 (Grade 230)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Expanded-Metal, Carbon Steel: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 1 (uncoated).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

7. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

I. Perforated Metal, Uncoated: Cold-rolled steel sheet, ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

J. Perforated Metal, Galvanized Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

K. Perforated Metal, Aluminum Sheet: **ASTM B209 (ASTM B209M)**, [**0.125 inch (3.18 mm)**][**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

L. Woven-Wire Mesh, Steel: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Woven-Wire Mesh, Aluminum: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch- (4.1-mm-)** diameter, aluminum wire complying with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

N. Welded-Wire Mesh: [**Diamond**][**Square**] pattern, **2-inch (50-mm)** welded-wire mesh, made from **0.236-inch (6.0-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

O. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

P. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

Q. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

R. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze**][**nickel silver**], with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Safety Tread Co., Inc**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Barry Pattern & Foundry Co., Inc**]
   d. [**Ecoglo, Inc.**]
   e. [**Granite State Casting Co**]
   f. [**Safe-T-Metal Company, Inc.**]

g. [**TrueNorth Steel**]
h. [**Wooster Products Inc**]

2. Configuration: Cross-hatched units, [**3 inches (75 mm)**][**4 inches (100 mm)**] wide without lip.

B. Extruded Units: [**Aluminum**][**Bronze**] units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Safety Tread Co., Inc**]
b. [**Amstep Products**]
c. [**Armstrong Products, Inc**]
d. [**Balco; a CSW Industrials Company**]
e. [**Ecoglo, Inc.**]
f. [**Granite State Casting Co**]
g. [**Nystrom, Inc.**]
h. [**UPNOVR, Inc.**]
i. [**Wooster Products Inc**]

2. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
3. Provide solid-abrasive units without ribs.
4. Nosings, Square-Back Units: [**1-7/8 inches (48 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] wide, without lip.
5. Nosings, Two-Piece Units: **3 inches (75 mm)** wide, with subchannel for casting into concrete.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

E. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.4 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated[**and capable of withstanding design loads**].

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Handrail Wall Brackets: [**Cast nickel-silver,**][**Cast aluminum,**][**Cast bronze,**][**Cast stainless steel,**] center of rail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from face of wall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Julius Blum & Co., Inc.**]
b. [**The Wagner Companies**]

B. Welding Electrodes: Comply with AWS requirements.

C. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Zinc-Rich Primer: Comply with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

F. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish system indicated.

G. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

I. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

J. Prefilled Concrete Treads:

1. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with minimum 28-day compressive strength of **3000 psi (20 MPa)** and maximum aggregate size of **1/2 inch (13 mm)** unless otherwise indicated.
2. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
3. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, [**steel,**][**galvanized steel,**] **6 by 6 inches (152 by 152 mm)**, W1.4 by W1.4, unless otherwise indicated on Drawings.

   a. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

4. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening welded-wire reinforcement in place.

   a. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.

K. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.6 PRECAST CONCRETE TREADS

A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of **5000 psi (35 MPa)** and a total air content of not less than 4 percent or more than 6 percent.

B. Reinforcement: Galvanized, welded-wire reinforcement, **2 by 2 inches (50 by 50 mm)** by **0.062-inch-(1.6-mm-)** diameter steel wire; comply with ASTM A1064/A1064M, except for minimum wire size.

2.7 PRECAST TERRAZZO TREADS

A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Wausau Tile, Inc.**]

2. Epoxy Resin Matrix: Manufacturer's standard recommended for use indicated.
3. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.

a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.

4. Reinforcement: ASTM A615/A615M, **Grade 60 (Grade 420)** bars, as required by unit size, profile, and thickness.
5. Abrasive Inserts: **1/2-inch- (13-mm-)** wide, silicon carbon/epoxy mixture.

   a. Provide three inserts, **1/2 inch (13 mm)** apart, with first insert located **1 inch (25 mm)** from nosing at adjacent stair riser locations.

6. Color: As selected by Architect from manufacturer's standard color selections, as directed by the Owner.
7. Finish: Honed.
8. Surface Sealer: Slip- and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 8; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.8 EPOXY-RESIN-FILLED TREADS

A. Epoxy-Resin-Filled Treads: **3/8-inch- (9.5-mm-)** thick, epoxy resin with **8000-psi (55 158-kPa)** compressive strength; set on steel subtread.

   1. Color: As selected by Architect from manufacturer's standard color selections, as directed by the Owner.

2.9 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts,[**railings and guards,**] clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

   1. Join components by welding unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs[**, railings, and guards**] in shop to greatest extent possible.

   1. Disassemble units only as necessary for shipping and handling limitations.
   2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

   1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
   2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 - No evidence of welded joint**][**Finish #2 - Completely sanded joint with some undercutting and pinholes okay**][**Finish # 3 - Partially dressed weld with spatter removed**][**Finish # 4 - Good quality, uniform undressed weld with minimal splatter**].

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that will be exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.10 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for [**Architectural**][**Commercial**][**Service**] Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of [**steel plates**][**or**][**steel channels**][**or**][**steel rectangular tubes**][**as indicated on Drawings**].

   a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
   b. Provide closures for exposed ends of channel and rectangular tube stringers.
   c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Platforms: Construct of [**steel plate**][**or**][**steel channel**][**or**][**steel rectangular tube**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

   a. Provide closures for exposed ends of channel and rectangular tube framing.
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.[**If using bolts, fabricate and join so bolts are not exposed on finished surfaces.**]
4. Where stairs are enclosed by gypsum board[**shaft-wall**] assemblies, provide hanger rods or struts to support landings from floor construction above or below.

   a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel

sheet of thickness needed to comply with performance requirements, but not less than **0.067 inch (1.7 mm)**.

1. Fabricate treads and landing subplatforms of exterior stairs so finished walking surfaces slope to drain.
2. Steel Sheet, Uncoated: [**Cold**][**Hot**]-rolled steel sheet[**unless otherwise indicated**].
3. Galvanized Steel Sheet: Galvanized steel sheet[**, where indicated**].
4. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
5. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
6. Shape metal pans to include nosing integral with riser.
7. Attach abrasive nosings to risers.
8. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
9. Provide epoxy-resin-filled treads, reinforced with glass fibers, with non-slip-concrete aggregate finish to tread surface.
10. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than **0.097 inch (2.5 mm)**.

1. Steel Sheet: Uncoated, hot-rolled steel sheet unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.11 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Comply with applicable requirements in [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] top and bottom rails and **1-1/2-inch- (38-mm-)** square posts.
2. Picket Infill: [**1/2-inch- (13-mm-)**][**3/4-inch- (19-mm-)**][**round**][**square**] pickets spaced to prohibit the passage of a **4-inch (100-mm)** diameter sphere.
3. Expanded-Metal Infill: Expanded-metal panels edged with U-shaped channels made from steel sheet and not less than **0.043 inch (1.1 mm)** thick. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**vertical**].
4. Perforated-Metal Infill: Perforated-metal panels edged with U-shaped channels made from metal sheet, of same metal as perforated metal, and not less than **0.043 inch (1.1 mm)** thick. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**][**as indicated on Drawings**].
5. Mesh Infill: [**Woven**][**Welded**]-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)**

steel channel frames. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].

6. Intermediate Rails Infill: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] intermediate rails spaced less than [**12 inches (305 mm)**][**21 inches (533 mm)**] clear.
7. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with [**cam-type, self-closing**][**spring**] hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

   a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 - No evidence of a welded joint**][**Finish #2 - Completely sanded joint, some undercutting and pinholes are okay**][**Finish #3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**] as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.
2. By bending[**or by inserting prefabricated elbow fittings**].
3. By flush bends[**or by inserting prefabricated flush-elbow fittings**].
4. By radius bends of radius indicated[**or by inserting prefabricated elbow fittings of radius indicated**].
5. By inserting prefabricated [**elbow fittings**][**flush-elbow fittings**][**elbow fittings of radius indicated**].

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

1. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

4. Provide type of bracket [**with flange tapped for concealed anchorage to threaded hanger bolt**][**with predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.12 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs.

Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

G. Install precast concrete treads with adhesive supplied by manufacturer.

H. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by [**welding**][**or**][**bolting**] to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

C. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as[**required to comply with performance requirements.**][**follows:**]

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**]wood backing between studs. Coordinate with stud installation to locate backing members.
e. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
f. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.4 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 51 13 00

Task	Specification	Specification Description
05 51 13 00	05 50 00 00	Metal Fabrications
05 51 13 00	05 71 13 00	Fabricated Metal Spiral Stairs

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SECTION 05 51 19 00 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal grating stairs.
2. Steel railings and guards.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs[**railings, and guards**].

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts,[**blocking for attachment of wall-mounted handrails,**] and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Gratings.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Shop primer products.
5. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

D. Delegated Design Submittal: For stairs[**railings, and guards**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs[**railings, and guards**], including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**].

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

a. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

D. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Aluminum Bars for Grating Treads: **ASTM B221 (ASTM B221M)** extruded aluminum, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.
3. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

G. Steel Tubing for Railings and Guards: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Provide galvanized finish for exterior installations and where indicated.

H. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
3. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
4. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
5. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Provide galvanized finish for exterior installations and where indicated.

J. Woven-Wire Mesh, Steel: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Woven-Wire Mesh, Aluminum: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch- (4.1-mm-)** diameter, aluminum wire complying with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

L. Welded-Wire Mesh: [**Diamond**][**Square**] pattern, **2-inch (50-mm)** welded-wire mesh, made from **0.236-inch (6.0-mm)** nominal-diameter steel wire complying with ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

N. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.3 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated[**and capable of withstanding design loads**].

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

D. Zinc-Rich Primer: Comply with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs[**railings, and guards**] in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish # 3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**].

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that are exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class,

unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel [**plates**][**or**][**channels**].

   a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
   b. Provide closures for exposed ends of channel stringers.
   c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Construct platforms and tread supports of steel [**plate**][**or**][**channel**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

   a. Provide closures for exposed ends of channel framing.
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.
4. Where stairs are enclosed by gypsum board[**shaft-wall**] assemblies, provide hanger rods or struts to support landings from floor construction above or below.

   a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from [**welded steel**][**or**][**pressure-locked steel**][**pressure-locked aluminum**] grating with [**1-1/4-by-3/16-inch (32-by-5-mm) bearing bars at 15/16 inch (24 mm) o.c.**][**1-by-3/16-inch (25-by-5-mm) bearing bars at 11/16 inch (17 mm) o.c.**][**1-by-1/8-inch (25-by-3-mm) bearing bars at 7/16 inch (11 mm) o.c.**] and crossbars at **4 inches (100 mm)** o.c.
2. Fabricate treads and platforms from [**welded steel**][**or**][**pressure-locked steel**][**pressure-locked aluminum**] grating with openings in gratings no more than [**5/16 inch (8 mm)**][**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

   a. Surface: [**Plain**][**Serrated**].
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**][**Mill**].

3. Fabricate grating treads with [**rolled-steel floor plate**][**cast-abrasive**] nosing and with steel angle or steel plate carrier at each end for stringer connections.

   a. Secure treads to stringers with bolts.

4. Fabricate grating platforms with nosing matching that on grating treads.

   a. Secure grating to platform framing [**by welding**][**with bolts**].

D. Risers: [**Open**][**Solid**].

E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.

1. Material and Finish: Steel plate to match finish of other steel items.
2. Fabricate to dimensions and details indicated.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] top and bottom rails and **1-1/2-inch- (38-mm-)** square posts.
2. Picket Infill: [**1/2-inch- (13-mm)**][**3/4-inch (19-mm)**][**round**][**square**] pickets spaced to prohibit the passage of a **4-inch (100-mm)** diameter sphere.
3. Mesh Infill: [**Woven**][**Welded**]-wire mesh [**crimped**][**welded**] into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** steel channel frames. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].
4. Intermediate Rails Infill: [**1-5/8-inch- (41-mm-) diameter**][**1-1/2-inch- (38-mm-) square**] intermediate rails spaced less than [**12 inches (305 mm)**][**21 inches (533 mm)**] clear.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

   a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #3 - Partially dressed weld with spatter removed**][**Finish #4 - Good quality, uniform undressed weld with minimal splatter**] as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.
2. By bending[**or by inserting prefabricated elbow fittings**].
3. By flush bends[**or by inserting prefabricated flush-elbow fittings**].
4. By radius bends of radius indicated[**or by inserting prefabricated elbow fittings of radius indicated**].
5. By inserting prefabricated [**elbow fittings**][**flush-elbow fittings**][**elbow fittings of radius indicated**].

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.

1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

1. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
4. Provide type of bracket [**with flange tapped for concealed anchorage to threaded hanger bolt**][**with predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**][**minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:**]

1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interior Stairs:

a. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
b. SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.

a. Clean bottom surface of baseplates.
b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
c. After stairs have been positioned and aligned, tighten anchor bolts.
d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by [**welding**][**or**][**bolting**] to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as[**required to comply with performance requirements.**][**follows:**]

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**]wood backing between studs. Coordinate with stud installation to locate backing members.
e. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
f. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.4 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 51 19 00

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Task	Specification	Specification Description
05 51 19 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 51 13 00	Metal Pan Stairs
05 51 19 00	05 71 13 00	Fabricated Metal Spiral Stairs
05 51 33 13	05 50 00 00	Metal Fabrications
05 51 33 13	05 52 13 00	Pipe And Tube Railings
05 51 33 16	05 50 00 00	Metal Fabrications
05 51 33 23	05 50 00 00	Metal Fabrications
05 51 33 23	05 52 13 00	Pipe And Tube Railings

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SECTION 05 52 13 00 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.
2. Aluminum railings.
3. Stainless steel railings.

B. Related Requirements:

1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.
2. Section 057300 "Decorative Metal Railings" for ornamental railings fabricated from pipes and tubes and guard-infill metals.
3. Section 096900 "Access Flooring" for railings included with access flooring.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For products involving selection of color, texture, or design [**, including mechanical finishes**] .

D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

   a. Show method of [**connecting**][**and**][**finishing**] members at intersections.

E. Delegated Design Submittals: For railings, including analysis data signed and sealed by the qualified

professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For shop or field welding.

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

E. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

F. Qualification Statements: For [**delegated design professional engineer**][**testing agency**] .

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch (38-mm)** clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

A. Steel Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hollaender Mfg. Co.**]
b. [**Kee Safety, Inc.**]
c. [**Trex Commercial Products, Inc.**]
d. [**TrueNorth Steel**]
e. [**VIVA Railings, LLC**]
f. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of

preconsumer recycled content not less than 25 percent.

4. Tubing: [**ASTM A500/A500M (cold formed)**][**ASTM A513/A513M, Type 5**] .

5. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

   a. Provide galvanized finish for exterior installations and where indicated.

6. Plates, Shapes, and Bars: ASTM A36/A36M.
7. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
8. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**] , Class 1 (uncoated).

   a. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

9. Perforated-Metal Infill Panels, Steel:

   a. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel, Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

   b. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

10. Woven-Wire Mesh Infill Panels, Steel:

    a. Weave Type: Wove, intermediate crimp.
    b. Pattern: [**Diamond**][**Square**] .
    c. Mesh Size: **2-inch (50-mm)**.
    d. Wire: **0.134-inch- (3.42-mm-)** diameter steel wire complying with **ASTM A510 (ASTM A510M)**.

2.4 ALUMINUM RAILINGS

A. Aluminum Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATR Technologies, Inc.**]
   b. [**CraneVeyor Corp**]
   c. [**Hollaender Mfg. Co.**]
   d. [**Julius Blum & Co., Inc.**]
   e. [**Kane Innovations, Inc.**]
   f. [**Kattsafe**]
   g. [**Kee Safety, Inc.**]
   h. [**Moultrie Rail Systems**]
   i. [**Superior Aluminum Products, Inc**]

j. [**Thompson Fabricating, LLC**]
k. [**TimberTech, AZEK Building Products; The AZEK Company LLC**]
l. [**Trex Commercial Products, Inc.**]
m. [**Tri Tech, Inc.**]
n. [**Tubular Specialties Manufacturing, Inc.**]
o. [**Tuttle, a Dant Clayton Division**]
p. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

4. Extruded Bars and Tubing: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

5. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

   a. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

6. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.

7. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
8. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
9. Castings: ASTM B26/B26M, Alloy A356.0-T6.
10. Perforated Metal Infill Panels, Aluminum:

    a. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6, [**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

11. Woven-Wire Mesh Infill Panels, Aluminum:

    a. Weave Type: Woven, intermediate crimp.
    b. Pattern: [**Diamond**][**Square**] .
    c. Mesh Size: **2 inches (50 mm)**.
    d. Wire: **0.162-inch- (4.1-mm-)** diameter aluminum wire complying with ASTM B211/B211M, Alloy 6061-T94.

2.5 STAINLESS STEEL RAILINGS

A. Stainless Steel Railing:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CraneVeyor Corp**]
   b. [**Julius Blum & Co., Inc.**]
   c. [**Kane Innovations, Inc.**]
   d. [**Stainless Fabricators, Inc**]
   e. [**Trex Commercial Products, Inc.**]
   f. [**Tri Tech, Inc.**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

h. [**Tuttle, a Dant Clayton Division**]
i. [**VIVA Railings, LLC**]
j. [**Wagner Companies (The); R&B Wagner, Inc.**]

2. Source Limitations: Obtain each type of railing from single source from single manufacturer.

3. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316L**] .
4. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316L**] .

5. Castings: ASTM A743/A743M, [**Grade CF 8 or CF 20**][**Grade CF 8M or CF 3M**] .
6. Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**] .
7. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**] , Class 3 (corrosion-resistant steel), made from stainless steel sheet, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] .

   a. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

8. Perforated Metal Infill Panels, Stainless Steel:

   a. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**] , [**0.062 inch (1.59 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

9. Woven-Wire Mesh Infill Panels: Stainless Steel:

   a. Weave Type: Woven, intermediate crimp.
   b. Pattern: [**Diamond**][**Square**] .
   c. **Mesh Size:2 inches (50 mm)**.
   d. Wire: **0.141-inch- (3.57-mm-)** diameter stainless steel wire complying with ASTM A580/A580M, [**Type 304**][**Type 316**] .

2.6 FASTENERS

A. Fastener Materials:

1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for zinc coating.

2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
3. Aluminum Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
4. Stainless Steel Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.

5. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction [**and capable of withstanding design loads**] .

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to

other work, unless otherwise indicated.

2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

3. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction.

1. Acceptance Criteria: [**ICC-ES AC193**][**ICC-ES AC308**] .

2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.7 MISCELLANEOUS MATERIALS

A. Handrail Brackets:

1. Material: [**Cast iron**][**Cast aluminum**][**Cast stainless steel**][**Cast nickel-silver**] .
2. Center of Handrail: [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from [**face of railing**][**wall**] .

B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

1. For [**aluminum**][**and**][**stainless steel**] railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

G. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

H. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

I. Intermediate Coats and Topcoats: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

J. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

K. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

L. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.

M. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

N. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated on Drawings**] , provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.8 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage [**, but not less than that required to support structural loads**] .

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water.

1. Provide weep holes where water may accumulate.
2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with [**welded**][**nonwelded**] connections unless otherwise indicated.

H. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards.

Provide with [**cam-type, self-closing**][**spring**] hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

I. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Finish #1 welds; ornamental quality with no evidence of a welded joint**][**Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay**][**Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed**] .

J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

K. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

L. Directional Changes:

1. Form changes in direction as detailed on Drawings.
2. Form changes in direction [**by bending**][**by inserting prefabricated elbow fittings**] .
3. Form changes in direction [**by flush bends**][**by inserting prefabricated flush-elbow fittings**] .
4. Form changes in direction [**by radius bends of radius indicated**][**by inserting prefabricated elbow fittings of radius indicated**] .
5. Form changes in direction by bending to smallest radius that will not result in distortion of railing member.

M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.

2. Coordinate anchorage devices with supporting structure.

R. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.

1. Provide socket covers designed and fabricated to resist being dislodged.
2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

T. Expanded-Metal Infill Panels: Fabricate infill panels from expanded-metal sheet of same metal as railings.

1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than **0.043 inch (1.1 mm)** thick.
2. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**] .

U. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal.

1. Material: [**Steel**][**Galvanized steel**][**Aluminum**][**Stainless steel**][**Same metal as railings in which they are installed**] .
2. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than **0.043 inch (1.1 mm)** thick.
3. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**][**as indicated on Drawings**] .

V. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** metal channel frames.

1. Fabricate wire mesh and frames from same metal as railings in which they are installed.
2. Orient wire mesh with [**diamonds vertical**][**diamonds perpendicular to top rail**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**][**as indicated on Drawings**] .

W. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.9 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize [**exterior**][**indicated**] steel railings, including hardware, after fabrication.
2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.

4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as

weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner [**and as follows**] .

1. Comply with SSPC-SP 16.

D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3.**][**SSPC-SP 3.**][**requirements indicated below:**]

1. Exterior Railings: SSPC-SP 6/NACE No. 3.
2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
3. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
4. Other Railings: SSPC-SP 3.

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**][**primers specified in Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**][**primers specified in Section 099601 "High-Performance Coatings (MPI Standards)" are**] indicated.

2. Do not apply primer to galvanized surfaces.

G. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.10 ALUMINUM FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Mill Finish: AA-M12, nonspecular as fabricated.

C. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41**][**AA-M12C22A31**] .

D. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44**][**AA-M12C22A32/A34**] .

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**] as directed by the Owner.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

G. Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

I. Single-Coat Superior Performance FEVE Organic Finish: Single-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish, complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

J. Two-Coat Superior Performance FEVE Organic Finish: Two-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Pipe and Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.

2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.

3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**] as directed by the Owner.

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480, No. 4.

2. High-Luster Finish: ASTM A480/A480M, No. 7.

3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION OF PIPE AND TUBE RAILINGS, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

5. Set posts plumb within a tolerance of **1/16 inch in 3 ft. (2 mm in 1 m)**.

6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 ft, (6 mm in 3.5 m)**.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending **2 inches (50 mm)** beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**anchoring cement**] , mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**anchoring cement**] , mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**] .

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**] .

E. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:

1. Steel Railings: Weld flanges to post and bolt to metal supporting surfaces.
2. Aluminum Railings: Attach posts as indicated on Drawings, using fittings designed and

engineered for this purpose.
3. Stainless Steel Railings: Weld flanges to post and bolt to supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to concrete and masonry with [**sleeves concealed within**][**flanges connected to**][**brackets on underside of rails connected to**] railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and [**welded to railing ends**][**connected to railing ends, using nonwelded connections**] .

C. Attach handrails to walls with wall brackets [**, except where end flanges are used**] . Provide brackets with [**1-1/2-inch (38-mm)**] clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**] .
2. Locate brackets as indicated on Drawings or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets [**and railing end flanges**] to building construction.

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**] wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

E. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop

paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

3.7 CLEANING

A. Clean [**aluminum**][**and**][**stainless steel**] by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 52 13 00

Task	Specification	Specification Description
05 52 13 00	05 50 00 00	Metal Fabrications

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SECTION 05 53 00 00 - EXPANDED METAL GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expanded metal gratings.
2. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87**

kN/sq. m).
4. Walkways and Elevated Platforms Used as Exits: Uniform load of **100 lbf/sq. ft. (4.79 kN/sq. m)**.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **8000 lbf (35.60 kN)**, whichever produces the greater stress.
6. Limit deflection to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 EXPANDED METAL GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Grating**]
2. [**AMICO, a Gibraltar Industries company**]
3. [**Central Expanded Metal, Inc.**]
4. [**Grating Pacific, Inc.**]
5. [**Nucor Grating; a Nucor company**]

B. Provide expanded metal gratings in material, finish, style, size, thickness, weight, and type indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Material: [**Steel**][**Stainless steel**][**Aluminum**].
2. Steel Finish: [**Unfinished, oiled**][**Shop primed**][**Galvanized**].
3. Stainless Steel Finish: Mill finish, as fabricated.
4. Aluminum Finish: Mill finish, as fabricated.
5. Style Designation for Steel: [**4.27 lb**][**3/4 number 9**].
6. Style Designation for Stainless Steel: [**1-1/2 number 9**][**3/4 number 9**].
7. Size for Aluminum: [**2 lb**][**3/4 0.188**][**1-1/2 0.125**].
8. Type: [**I, expanded**][**II, expanded and flattened**].

2.3 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors **24 inches (600 mm)** o.c. and provide minimum anchor units in the form of steel straps **1-1/4 inches (32 mm)** wide by **1/4 inch (6 mm)** thick by **8 inches (200 mm)** long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.4 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; **ASTM F593 (ISO 3506-1)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion**][**or**][**chemical**] anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.6 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)** coating.

E. Expanded Metal Carbon Steel: ASTM F1267, Class 1.

F. Expanded Metal Galvanized Steel: ASTM F1267, Class 2, Grade A.

G. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

H. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

I. Expanded Metal Stainless Steel: ASTM F1267, Class 3, made from stainless steel sheet, ASTM A240/A240M, [**Type 304**][**Type 316L**].

2.7 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.8 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Fit exposed connections accurately together to form hairline joints.

D. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion

resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

F. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with bars having a thickness not less than overall grating thickness at contact points.

G. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than **1/8 inch (3 mm)** thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.9 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames, and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

3.2 INSTALLATION OF EXPANDED METAL GRATINGS

A. Comply with manufacturer's written instructions for installing gratings.

B. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.

C. Attach removable units to supporting members by bolting at **6-inch (150-mm)** intervals.

D. Attach nonremovable units to supporting members by welding unless otherwise indicated. Space welds at **6-inch (150-mm)** intervals.

E. Attach aluminum units to steel supporting members by bolting at **6-inch (150-mm)** intervals.

F. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings

immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 00 00

SECTION 05 53 13 00 - BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055119 "Metal Grating Stairs" for grating treads and landings of steel-framed stairs.
3. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including [**manufacturers' published load tables**][**analysis data signed and sealed by the qualified professional engineer responsible for their preparation**].

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87**

kN/sq. m).
4. Walkways and Elevated Platforms Used as Exits: Uniform load of **100 lbf/sq. ft. (4.79 kN/sq. m)**.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **8000 lbf (35.60 kN)**, whichever produces the greater stress.
6. Limit deflection to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 METAL BAR GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Grating**]
2. [**BarnettBates Corporation**]
3. [**Borden Metal Products (Canada) Limited**]
4. [**Grating Pacific, Inc.**]
5. [**Grupo Metelmex, S.A. de C.V.**]
6. [**IKG**]
7. [**MLP Steel Company; Laurel Steel Products Division**]
8. [**Neenah Foundry Company**]
9. [**Nucor Grating; a Nucor company**]
10. [**Ross Technology Company**]
11. [**Seidelhuber Metal Products; Brodhead Steel**]

B. Metal Bar Grating Standards: Comply with [**NAAMM MBG 531**][**and**][**NAAMM MBG 532**].

C. Welded Steel Grating:[**MBG-#.**]

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**][**1-3/8 inches (35 mm)**][**1-7/8 inches (48 mm)**][**2-3/8 inches (60 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark W-11-4 (1 x 3/16) STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark W-15-4 (1 x 1/8) STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark W-19-4 (1-1/4 x 3/16) STEEL: **1-1/4-by-3/16-inch (32-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark W-19-4 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark W-19-4 (2 x 1/4) STEEL: **2-by-1/4-inch (51-by-6.4-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
10. Grating Mark W-30-4 (5 x 3/8) STEEL: **5-by-3/8-inch (127-by-9.5-mm)** bearing bars at **1-7/8**

inches (60 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
11. Grating Mark: As indicated.
12. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
13. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

D. Pressure-Locked Steel Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-11-4 (1 x 3/16) STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-15-4 (1-1/4 x 1/8) STEEL: **1-1/4-by-1/8-inch (32-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark P-19-4 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark: As indicated.
9. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
10. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

E. Riveted Steel Grating:[**MBG-#.**]

1. Bearing Bar Spacing: [**3/4 inch (19 mm)**][**1-1/8 inches (29 mm)**][**2-5/16 inches (59 mm)**], clear.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Rivet Spacing: [**3-1/2 inches (89 mm)**][**5 inches (127 mm)**][**7 inches (178 mm)**] o.c. along bearing bar.
5. Grating Mark R-12-3-1/2 (1 x 1/8) STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars with **3/4-inch (19-mm)** clear space between bearing bars, and rivets at **3-1/2 inches (89 mm)** o.c. along bearing bar.
6. Grating Mark R-18-7 (1-1/2 x 3/16) STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars with **1-1/8-inch (29-mm)** clear space between bearing bars, and rivets at **7 inches (178 mm)** o.c. along bearing bar.
7. Grating Mark R-37-5 (4 x 1/4) STEEL: **4-by-1/4-inch (102-by-6.4-mm)** bearing bars with **2-5/16-inch (59-mm)** clear space between bearing bars, and rivets at **5 inches (127 mm)** o.c. along bearing bar.
8. Grating Mark R-37-5 (5 x 3/8) STEEL: **5-by-3/8-inch (127-by-9.5-mm)** bearing bars with **2-5/16-inch (59-mm)** clear space between bearing bars, and rivets at **5 inches (127 mm)** o.c. along bearing bar.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-**

oxide aggregate in an epoxy-resin adhesive][**As indicated**].

11. Steel Finish: [**Shop primed**][**Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface**].

F. Pressure-Locked, Stainless Steel Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**][**1-3/8 inches (35 mm)**][**1-7/8 inches (48 mm)**][**2-3/8 inches (60 mm)**] o.c.
2. Bearing Bar Depth: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-11-4 (1 x 3/16) STAINLESS STEEL: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-15-2 (1 x 1/8) STAINLESS STEEL: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **2 inches (51 mm)** o.c.
7. Grating Mark P-19-4 (1-1/2 x 3/16) STAINLESS STEEL: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark P-30-4 (3 x 3/8) STAINLESS STEEL: **3-by-3/8-inch (76-by-9.5-mm)** bearing bars at **1-7/8 inches (48 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Serrated**][**Knurled**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
11. Finish: [**Mill finish**][**Abrasive blasted**][**Electropolished**].

G. Pressure-Locked, Rectangular-Bar Aluminum Grating:[**MBG-#.**] Fabricated by [**pressing rectangular flush-top crossbars into slotted bearing bars**][**or**][**swaging crossbars between bearing bars**].

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17.5 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**] o.c.
2. Bearing Bar Depth: [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**As required to comply with structural performance requirements**].
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-7-4 (1 x 1/8) ALUMINUM: **1-by-1/8-inch (25-by-3.2-mm)** bearing bars at **7/16 inch (11 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-11-4 (1 x 3/16) ALUMINUM: **1-by-3/16-inch (25-by-4.8-mm)** bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
7. Grating Mark P-15-4 (1-1/2 x 3/16) ALUMINUM: **1-1/2-by-3/16-inch (38-by-4.8-mm)** bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark P-19-4 (2 x 3/16) ALUMINUM: **2-by-3/16-inch (51-by-4.8-mm)** bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
9. Grating Mark: As indicated.
10. Traffic Surface: [**Plain**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
11. Aluminum Finish: [**Mill finish**][**Class I, clear, anodized finish**].

H. Pressure-Locked, Aluminum I-Bar Grating:[**MBG-#.**] Fabricated by swaging crossbars between bearing bars.

1. Bearing Bar Spacing: [**7/16 or 1/2 inch (11 or 13 mm)**][**11/16 inch (17 mm)**][**15/16 inch (24 mm)**][**1-3/16 inches (30 mm)**] o.c.
2. Bearing Bar Depth: [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**][**As required to comply with structural performance requirements**].
3. Bearing Bar Flange Width: **1/4 inch (6.4 mm)**.
4. Crossbar Spacing: [**2 inches (51 mm)**][**4 inches (102 mm)**] o.c.
5. Grating Mark P-11-4 (1 I-Bar) ALUMINUM: **1-inch (25-mm)** I-bar bearing bars at **11/16 inch (18 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
6. Grating Mark P-15-2 (1 I-Bar) ALUMINUM: **1-inch (25-mm)** I-bar bearing bars at **15/16 inch (24 mm)** o.c., and crossbars at **2 inches (51 mm)** o.c.
7. Grating Mark P-19-4 (1-1/2 I-Bar) ALUMINUM: **1-1/2-inch (38-mm)** I-bar bearing bars at **1-3/16 inches (30 mm)** o.c., and crossbars at **4 inches (102 mm)** o.c.
8. Grating Mark: As indicated.
9. Traffic Surface: [**Plain**][**Grooved**][**Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive**][**As indicated**].
10. Aluminum Finish: [**Mill finish**][**Class I, clear, anodized finish**].

2.3 GRATING FRAMES AND SUPPORTS

A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors **24 inches (600 mm)** o.c. and provide minimum anchor units in the form of steel straps **1-1/4 inches (32 mm)** wide by **1/4 inch (6 mm)** thick by **8 inches (200 mm)** long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.4 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**, and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; **ASTM F593 (ISO 3506-1)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**, and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion**][**or**][**chemical**] anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

D. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

E. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

F. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)** coating.

G. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

H. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

2.7 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.8 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.

2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars **3/16 inch (4.8 mm)** or less in thickness and spaced **15/16 inch (24 mm)** or more o.c., with each clip designed and fabricated to fit over two bearing bars.
3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars **3/16 inch (4.8 mm)** or less in thickness and spaced less than **15/16 inch (24 mm)** o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish threaded bolts with nuts and washers for securing grating to supports.
6. Furnish self-drilling fasteners with washers for securing grating to supports.
7. Grating Clamps: Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Kee Safety, Inc.**]
        2) [**Lindapter International**]
        3) [**LNA Solutions, a Kee Safety company**]

H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

I. Do not notch bearing bars at supports to maintain elevation.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I.

2.10 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames, and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial**

Blast Cleaning."][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 INSTALLATION OF METAL BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 13 00

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Task	Specification	Specification Description
05 53 13 00	01 22 00 00	No Specification Required
05 53 13 00	05 50 00 00	Metal Fabrications
05 53 13 00	05 53 00 00	Expanded Metal Gratings

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SECTION 05 53 16 00 - PLANK GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed-metal plank gratings.
2. Extruded-aluminum plank gratings.
3. Grating frames and supports.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Formed-metal plank gratings.
2. Extruded-aluminum plank gratings.
3. Paint products.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including [**manufacturers' published load tables**][**analysis data signed and sealed by the qualified professional engineer responsible for their preparation**].

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.

10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Mill Certificates: Signed by manufacturers of stainless steel sheet certifying that products furnished comply with requirements.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Welding certificates.

E. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.6/D1.6M.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of **125 lbf/sq. ft. (6.00 kN/sq. m)** or concentrated load of **2000 lbf (8.90 kN)**, whichever produces the greater stress.

2. Floors for Heavy Manufacturing: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **3000 lbf (13.40 kN)**, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of **60 lbf/sq. ft. (2.87 kN/sq. m)**.
4. Walkways and Elevated Platforms Used as Exits: Uniform load of **100 lbf/sq. ft. (4.79 kN/sq. m)**.
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of **250 lbf/sq. ft. (11.97 kN/sq. m)** or concentrated load of **8000 lbf (35.60 kN)**, whichever produces the greater stress.
6. Limit deflection to [**L/360**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: 1.5.

2.2 FORMED-METAL PLANK GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMICO, a Gibraltar Industries company**]
2. [**Atkore Unistrut**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Grating Pacific, Inc.**]
5. [**IKG**]
6. [**Metalex**]
7. [**Nucor Grating; a Nucor company**]

B. C-Shaped Channels: Rolled from heavy sheet metal of thickness indicated, and punched in serrated diamond shape to produce raised slip-resistant surface and drainage holes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**IKG**]
d. [**Metalex**]
e. [**Nucor Grating; a Nucor company**]

2. Channel Width: [**4-3/4 inches (121 mm)**][**7 inches (178 mm)**][**9-1/2 inches (241 mm)**][**11-3/4 inches (298 mm)**][**18-3/4 inches (476 mm)**][**24 inches (610 mm)**][**As indicated**][**As required to comply with structural performance requirements**].
3. Channel Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**As indicated**][**As required to comply with structural performance requirements**].
4. Material: [**0.074-inch- (1.9-mm-) thick steel sheet, shop primed**][**0.104-inch- (2.65-mm-) thick steel sheet, shop primed**][**0.079-inch- (2.0-mm-) thick, hot-dip galvanized-steel sheet**][**0.108-inch- (2.8-mm-) thick, hot-dip galvanized-steel sheet**][**0.074-inch- (1.9-mm-) thick steel sheet, hot-dip galvanized after fabrication**][**0.104-inch- (2.65-mm-) thick steel sheet, hot-dip galvanized after fabrication**][**0.062-inch- (1.6-mm-) thick, stainless steel sheet**][**0.078-inch- (2.0-mm-) thick, stainless steel sheet**][**0.080-inch- (2.0-mm-) thick aluminum sheet**][**0.100-**

inch- (2.5-mm-) **thick aluminum sheet**].

2.3 EXTRUDED-ALUMINUM PLANK GRATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMICO, a Gibraltar Industries company**]
2. [**IKG**]
3. [**Ohio Gratings, Inc**]
4. [**Seidelhuber Metal Products; Brodhead Steel**]

B. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Type: Extruded-aluminum planks approximately **6 inches (152 mm)** wide with multiple flanges approximately **1.2 inches (30 mm)** o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
2. Depth: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As required to comply with structural performance requirements**].
3. Perforations: [**None**][**Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered**][**19/32 inch (15 mm) square, with adjacent rows aligned**].
4. Finish: Mill finish, as fabricated.

2.4 GRATING FRAMES AND SUPPORTS

A. Frames and Supports: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors **24 inches (600 mm)** o.c. and provide minimum anchor units in the form of steel straps **1-1/4 inches (32 mm)** wide by **1/4 inch (6.4 mm)** thick by **8 inches (200 mm)** long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.
2. Interior[**, where indicated**].

2.5 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; **ASTM F593 (ISO 3506-1)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.6 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.7 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, **Grade 30 (Grade 205)**.

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 33 (Grade 230)**, with **G90 (Z275)**

coating.

E. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, [**Type 304**][**Type 316L**].

F. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

2.8 ALUMINUM

A. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

C. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

D. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 5052-H32.

2.9 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Fit exposed connections accurately together to form hairline joints.

C. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: **4 inches (100 mm)** unless otherwise indicated.

E. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.

1. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

F. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than **1/8 inch (3.2 mm)** thick to the cut ends. Divide panels into

sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.10 ALUMINUM FINISHES

A. Class I, Clear Anodic Finish: AA-M12C22A41 complying with AAMA 611.

2.11 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings, frames and supports[**not indicated to be galvanized**] unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 INSTALLATION OF METAL PLANK GRATINGS

A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

B. Attach removable units to supporting members by bolting at every point of contact.

C. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.

D. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

3.3 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 16 00

Task	Specification	Specification Description
05 53 16 00	05 53 00 00	Expanded Metal Gratings
05 54 00 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 51 13 00	Metal Pan Stairs
05 55 13 00	05 71 13 00	Fabricated Metal Spiral Stairs
05 55 16 00	05 50 00 00	Metal Fabrications
05 55 16 00	05 51 13 00	Metal Pan Stairs
05 55 16 00	05 71 13 00	Fabricated Metal Spiral Stairs
05 56 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 58 00 00 - HEATING_COOLING UNIT COVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heating-cooling unit enclosures.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for heating-cooling unit enclosures.

C. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

D. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For heating-cooling unit enclosures. Show dimensions of heating-cooling units, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For [**fabricator**][**organic-coating applicator**][**and**][**powder-coating applicator**].

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing heating-cooling unit enclosures similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups of typical heating-cooling unit enclosures as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver heating-cooling unit enclosures wrapped in protective coverings or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with heating-cooling unit enclosures by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design heating-cooling unit enclosures.

B. Structural Performance: Heating-cooling unit enclosures shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Live Loads: **100 lbf/sq. ft. (4.8 kN/sq. m)** or a concentrated load of **300 lbf (1.3 kN)** on an area of **4 sq. in. (26 sq. cm)**, whichever produces the greater stress.

2.2 HEATING-COOLING UNIT ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airflex Industrial, Inc.**]
2. [**ARSCO Metals LLC**]
3. [**Barker Metalcraft**]
4. [**HVAC Custom Enclosure Co., LLC**]
5. [**Wenig Company (The)**]

B. Fabricate heating-cooling unit enclosures from metal of type and thickness indicated below:

1. Galvanized-Steel Sheet:

a. Framing: [**0.108 inch (2.74 mm)**][**Thickness required to comply with performance requirements**].
b. Sills and Stools: [**0.079 inch (2.01 mm)**][**Thickness required to comply with performance requirements**].
c. Front Panels and Bases: [**0.064 inch (1.63 mm)**].
d. Concealed Panels and Trim: [**0.040 inch (1.02 mm)**].
e. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

2. Steel Sheet:

a. Framing: [**0.105 inch (2.66 mm)**][**Thickness required to comply with performance requirements**].
b. Sills and Stools: [**0.075 inch (1.90 mm)**][**Thickness required to comply with performance requirements**].
c. Front Panels and Bases: [**0.060 inch (1.52 mm)**].
d. Concealed Panels and Trim: [**0.036 inch (0.91 mm)**].
e. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

C. Weld seams and connections unless otherwise indicated or unless other methods are necessary for access to heating and cooling equipment.

D. Incorporate stiffeners or laminated backing using noncombustible materials as needed for strength and rigidity.

1. Fill space between stiffeners with sound-deadening insulation attached to face sheet with insulation adhesive unless otherwise indicated.
2. Coat concealed faces of metal panels more than **6 inches (150 mm)** wide with a heavy coating of sound-deadening mastic applied at the minimum rate of **20 sq. ft./gal. (0.5 sq. m/L)**.

E. Provide louvers and grilles of size, type, and materials indicated.

1. For removable grilles, use modular units with recessed openings formed into surfaces of enclosures and without blank filler panels between grilles, so face panels and stools are continuous. Fabricate removable grilles and openings to precise tolerances to produce well-fitted assemblies free of warp or rattle, with grilles supported continuously along parallel edges and with tops flush with top of enclosure.

F. Incorporate removable tops and fronts where indicated or needed for access to heating-cooling units and to piping, ductwork, controls, and electrical service, with panels and openings as follows:

1. Fabricate with a fitting tolerance of not less than **1/32 inch (0.8 mm)** and not more than **1/16 inch (1.6 mm)** at each edge, with face of panels flush with adjoining fixed surfaces of enclosure.
2. Form panels for easy removal without interfering with adjoining construction or furniture. Hold panels in place with concealed clips and hardware that prevent warp and rattle.

G. Incorporate hinged access panels in enclosures for access to heating-cooling unit controls, as either separate elements or integrated with grille openings, as indicated or needed.

H. Coordinate construction, configuration, and dimensions of enclosures with those of heating-cooling units. Provide support for heating-cooling units and controls where indicated. Provide blind knockouts and supports for piping, ductwork, control lines, electrical conduit, and wiring where indicated or needed.

I. Locate fixed surfaces of enclosure to coincide precisely with window mullions and partition system terminations. Provide closures at ends of units, at recessed openings in base of units, and at other

locations where needed to conceal unfinished wall or floor surfaces, piping, conduit, ductwork, or heating-cooling units.

1. Provide built-in partitions (bulkheads) within enclosures between heating-cooling units, located to coincide with mullions and partition system terminations. Seal partitions to faces of enclosures with compressible gaskets or mastic sealing tape, and cover both sides of partitions with sound-deadening insulation attached to partitions with insulation adhesive.

2.3 SHEET METAL

A. Fabricate units from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel or forming steel.

C. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, with steel sheet substrate complying with ASTM A1008/A1008M, commercial steel, exposed**].

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in heating-cooling unit enclosures; as recommended in writing by heating-cooling unit enclosure manufacturer.

1. ASTM D1056, Type 1, Class A, and grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, and release paper protected.

B. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

C. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless[**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Sound-Deadening Materials:

1. Insulation: Unfaced mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Isolation Coating: Manufacturer's standard [**alkali-resistant coating**][**bituminous paint**][**epoxy coating**].

2.5 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Shop Primers: Comply with [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

D. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble heating-cooling unit enclosures in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of heating-cooling unit enclosures with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (1 mm)** and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor heating-cooling unit enclosures to adjoining construction.

F. Provide support framing, mounting, and attachment clips; splice sleeves; fasteners; and accessories needed to install heating-cooling unit enclosures.

G. Where welding is indicated, weld joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

2.7 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Siliconized-Polyester Coating: After cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.8 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-

SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of heating-cooling unit enclosures.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place heating-cooling unit enclosures level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install heating-cooling unit enclosures.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses.

E. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings."**]

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of heating-cooling unit enclosures from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 58 00 00

Task	Specification	Specification Description
05 58 16 00	05 58 00 00	Heating_Cooling Unit Covers
05 58 16 00	05 70 00 00	Decorative Metal
05 58 16 00	05 75 00 00	Decorative Formed Metal
05 58 23 00	05 58 00 00	Heating_Cooling Unit Covers
05 59 65 00	01 22 00 00	No Specification Required
05 59 65 00	05 70 00 00	Decorative Metal

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SECTION 05 70 00 00 - DECORATIVE METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative window security bars.
2. Decorative mechanical grilles and frames.
3. Custom door pulls.
4. Combination hall push-button stations.
5. Metal reveals at wood paneling.
6. Cast-metal rosettes at marble joints.

B. Related Requirements:

1. Section 057300 "Decorative Metal Railings" for decorative metal railings.
2. Section 057500 "Decorative Formed Metal" for decorative metal items made from sheet metal.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

E. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

F. Samples for Verification: For each type of exposed finish.

1. Sections of linear shapes.
2. Full-size Samples of castings and forgings.

a. For custom castings, submit finished Samples showing ability to reproduce detail[**, cast-metal color,**] and quality of finish.[**Samples may be of similar previous work.**]

3. Samples of [**welded**][**and**][**brazed**] joints showing quality of workmanship[**and color matching of materials**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**].

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Installer Qualifications: Fabricator of products.

C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

C. Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Tubing: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.

E. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 3003-H14**][**Alloy 5005-H32**][**Alloy 6061-T6**].

F. Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.3 COPPER AND COPPER ALLOYS

A. Fabricate products from alloys indicated and temper to suit application and forming methods but with

strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2.4 BRONZE

A. Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

B. Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

C. Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C23000 (red brass, 85 percent copper).

D. Castings: [**ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

E. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

2.5 BRASS

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

B. Seamless Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C26000 (cartridge brass, 70 percent copper).

C. Castings: ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

D. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

2.6 NICKEL SILVER

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

B. Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

2.7 COPPER

A. Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

B. Castings: ASTM B824, with a minimum of 99.9 percent copper.

C. Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 STAINLESS STEEL

A. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**][**Grade MT 316L**].

B. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**][**Grade TP 316L**].

C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**][**Grade CF 8M or Grade CF 3M**].

D. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

E. Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

F. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**][**Type 316L**].

G. Wire Rope and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carl Stahl DecorCable, Inc.**]
   b. [**Esmet, Inc.**]
   c. [**Feeney Inc.**]
   d. [**Hayn Enterprises, LLC**]
   e. [**Johnson, C. Sherman, Co., Inc**]
   f. [**Ronstan International Inc**]
   g. [**Seco South, Inc.**]

2. Wire Rope: [**1-by-19**][**7-by-7**][**7-by-19**] wire rope made from wire complying with ASTM A492, Type 316.
3. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain without failure a load equal to minimum breaking strength of wire rope with which they are used.

2.9 STEEL AND IRON

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513, Type 5 (mandrel drawn)**].

C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

D. Plates, Shapes, and Bars: ASTM A36/A36M.

E. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M unless otherwise indicated.

F. Steel Sheet, Cold Rolled: ASTM A1008/A1008M, either commercial steel or structural steel, exposed.

2.10 TITANIUM

A. Strip, Sheet, and Plate: ASTM B265, Grade 1.

B. Bars: ASTM B348, Grade 1.

2.11 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Items: [**Aluminum**][**Type 304 stainless steel**][**Type 316 stainless steel**] fasteners.
2. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, muntz metal (Alloy 280) fasteners where exposed**].
3. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, brass (Alloy 260 or 360) fasteners where exposed**].
4. Stainless Steel Items: [**Type 304**][**Type 316**] stainless steel fasteners.
5. Titanium Items: [**Type 304**][**Type 316**] stainless steel fasteners.
6. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless steel fasteners where exposed.
7. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
8. Dissimilar Metals: [**Type 304**][**Type 316**] stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5 unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.12 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

F. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

G. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

H. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

I. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer complying with MPI#26**][**Vinyl wash primer complying with MPI#80**][**Water-based galvanized metal primer complying with MPI#134**].

J. Intermediate Coats and Topcoats for Steel: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

K. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.

L. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.

M. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.13 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.
3. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes.
2. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to

weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop [**welding**][**and**][**brazing**]. [**Weld**][**and**][**braze**] behind finished surfaces without distorting or discoloring exposed side. Clean exposed [**welded**][**and**][**brazed**] joints of flux, and dress exposed and contact surfaces.

1. Where [**welding**][**and**][**brazing**] cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Type 1 Welds: no evidence of a welded joint**][**Type 2 Welds: completely sanded joint, some undercutting and pinholes okay**][**Type 3 Welds: partially dressed weld with spatter removed**][**Type 4 Welds: good quality, uniform undressed weld with minimal splatter**].

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.14 FABRICATION OF DECORATIVE WINDOW SECURITY BARS

A. Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.

B. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

C. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.

1. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
2. Fabricate anchorage devices that are capable of withstanding loads indicated.

2.15 DECORATIVE MECHANICAL GRILLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Architectural Grille**]
2. [**Beaux-Arts Classic Products**]
3. [**DLSS Manufacturing**]
4. [**H&K Perforating LLC**]
5. [**Precision Metal Fabricators, Inc.**]
6. [**Reggio Register Company, Inc.**]
7. [**Register & Grille Mfg. Co., Inc.**]

B. Fabricate decorative grilles from perforated [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.

1. Form perforations to match existing grilles.
2. Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

C. Drill and countersink grilles for mounting screws at **2 inches (50 mm)** from corners and at **10 inches (250 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

D. Fabricate grille frames from extruded [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] of profiles and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates [**welded**][**brazed**] to back of frames.

1. Secure grilles in frames with **0.5-inch- (12-mm-)** long [**welds**][**brazing**] along perimeter of grilles at **4 inches (100 mm)** o.c.
2. Provide frame profiles to match existing frames.
3. Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

E. Drill and countersink frames for mounting screws at **4 inches (100 mm)** from corners and at **16 inches (400 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

2.16 FABRICATION OF CUSTOM DOOR PULLS

A. Fabricate custom door pulls from [**brass**][**bronze**][**stainless steel**] bar stock of profile indicated, fabricated to shapes indicated.

1. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces.
2. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile.
3. Drill and tap door pulls to receive through bolts for attachment to doors.

B. Fabricate backing plates for custom door pulls from **1/8-inch (3.2-mm)** [**brass**][**bronze**][**stainless steel**] sheet.

1. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal.
2. Drill and countersink holes where indicated for screws and bolts.

C. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

2.17 FABRICATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Fabricate units of [**brass**][**bronze**][**stainless steel**] to comply with details indicated. Coordinate with elevator signal equipment to provide integrated, closely fitted assemblies.

1. Fabricate faceplates from **1/8-inch- (3.2-mm-)** thick sheet with edges beveled at a 45-degree

angle for one-half thickness of metal.

2. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal **4-inch (100-mm)** wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are **10 by 10 by 3-1/2 inches (250 by 250 by 90 mm)** in depth.
3. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of **1/16 inch (1.6 mm)** with engraving painted red. Make signs **5 inches (125 mm)** wide by **8 inches (200 mm)** high.
4. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station[**, card reader,**] and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

2.18 FABRICATION OF METAL REVEALS

A. Fabricate metal reveals for wood paneling from [**3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze**][**3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless steel**][**3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium**] channels.

1. Drill for mounting screws **6 inches (150 mm)** from ends of channels and not more than **24 inches (600 mm)** o.c.
2. Locate mounting screws at same heights for all channels.
3. Provide [**black-finished,**]hex-socket, wafer-head screws for mounting reveals.

2.19 FABRICATION OF CAST-METAL ROSETTES

A. Fabricate cast-metal rosettes to design indicated from [**aluminum**][**brass**][**bronze**][**nickel silver**]. Drill and tap castings for threaded mounting studs.

1. Provide custom castings to match design indicated.
2. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as directed by the Owner.
3. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

2.20 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.21 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**, with color matching Architect's sample**].

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[**, with color matching Architect's sample**].

L. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

M. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air dried; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with blackening and buffing matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.23 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.
2. Directional Satin Finish: ASTM A480/A480M, No. 4.
3. Dull Satin Finish: ASTM A480/A480M, No. 6.
4. High Luster Finish: ASTM A480/A480M, No. 7.
5. Mirror Finish: ASTM A480/A480M, No. 8.

E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

F. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

G. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.

1. Product: Subject to compliance with requirements, provide INCO colored stainless steel finish as developed and licensed by International Nickel Co., Ltd.
2. Color: [**Match Architect's sample**][**As selected by Architect from finisher's full range**].

2.24 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

C. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

D. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated ferrous-metal surfaces with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting."**][**primers specified in Section 099123 "Interior Painting."**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-**

Performance Coatings" are] indicated.
2. Do not apply primer to galvanized surfaces.

E. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Powder-Coat Finish, Nongalvanized: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Powder-Coat Finish, Galvanized: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.25 TITANIUM FINISHES

A. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLATION OF DECORATIVE WINDOW SECURITY BARS

A. Fasten security bar frames to concrete and masonry walls with cast-in-place or post-installed anchors. Peen exposed threads of anchors to prevent removal of security bars.

3.4 INSTALLATION OF DECORATIVE MECHANICAL GRILLES

A. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.

1. Secure to framing and blocking with specified fasteners.
2. On marble, brick, and other solid surfaces, secure with wood screws in plastic plugs.

3.5 INSTALLATION OF DECORATIVE-METAL-CLAD, HOLLOW-METAL DOORS AND FRAMES

A. Install doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.6 INSTALLATION OF CUSTOM DOOR PULLS

A. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head [**wood**][**self-tapping metal**] screws and secure pulls through doors and backing plates with oval-head machine screws.

3.7 INSTALLATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components. Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

3.8 INSTALLATION OF METAL REVEALS AT WOOD PANELING

A. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

3.9 INSTALLATION OF CAST-METAL ROSETTES AT MARBLE JOINTS

A. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a **3/4-inch- (19-mm-)** round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.

1. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

3.10 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

E. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

F. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

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SECTION 05 71 00 00 - DECORATIVE METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes decorative metal stairs.

B. Related Requirements:

1. Section 057113 "Fabricated Metal Spiral Stairs."
2. Section 093013 "Ceramic Tiling" for ceramic-tile treads and landings.
3. Section 096340 "Stone Flooring" for stone treads and landings.
4. Section 096400 "Wood Flooring" for wood treads and landings.
5. [**Section 096613 "Portland Cement Terrazzo Flooring"**][**Section 096623 "Resinous Matrix Terrazzo Flooring"**] for field-cast terrazzo treads and landings.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Shop primer products.
2. Precast concrete treads.
3. Precast terrazzo treads.
4. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means

of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

D. Samples for Verification: For each type and finish of tread.

E. Delegated Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs,[**and railings,**] including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**][**L/720**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Steel Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

D. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M,[**either commercial steel, Type B, or**] structural steel, **Grade 25 (Grade 170)**, unless another grade is required by design loads; exposed.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M,[**either commercial steel, Type B, or**] structural steel, **Grade 30 (Grade 205)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

G. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating,[**either commercial steel, Type B, or**] structural steel, **Grade 33 (Grade 230)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

H. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

I. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

J. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

L. Titanium Sheet: ASTM B265, Grade 1.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Aluminum Sheet: Flat sheet complying with **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

N. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

O. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

P. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

Q. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

R. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze**][**nickel silver**], with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Safety Tread Co., Inc**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Barry Pattern & Foundry Co., Inc**]
   d. [**Granite State Casting Co**]
   e. [**Safe-T-Metal Company, Inc.**]
   f. [**TrueNorth Steel**]
   g. [**Wooster Products Inc**]

2. Configuration: Cross-hatched units, [**3 inches (75 mm)**][**4 inches (100 mm)**] wide without lip.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Extruded Units: [**Aluminum**][**Bronze**] units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Safety Tread Co., Inc**]
b. [**Amstep Products**]
c. [**Armstrong Products, Inc**]
d. [**Balco; a CSW Industrials Company**]
e. [**Ecoglo, Inc.**]
f. [**Granite State Casting Co**]
g. [**Nystrom, Inc.**]
h. [**UPNOVR, Inc.**]
i. [**Wooster Products Inc**]

2. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
3. Provide solid-abrasive units without ribs.
4. Nosings: Square-back units, [**1-7/8 inches (48 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] wide, without lip.
5. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.4 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

D. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

D. Zinc-Rich Primer: Complying with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)** unless otherwise indicated.

I. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

J. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, [**steel,**][**galvanized steel,**] **6 by 6 inches (152 by 152 mm)**, W1.4 by W1.4, unless otherwise indicated on Drawings.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.
2. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

L. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.6 PRECAST CONCRETE TREADS

A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of **5000 psi (35 MPa)** and a total air content of not less than 4 percent or more than 6 percent.

B. Reinforcement: Galvanized, welded-wire reinforcement, **2 by 2 inches (50 by 50 mm)** by **0.062-inch-(1.6-mm-)** diameter steel wire; comply with ASTM A1064/A1064M, except for minimum wire size.

2.7 PRECAST TERRAZZO TREADS

A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Wausau Tile, Inc.**]

2. Epoxy Resin Matrix: Manufacturer's standard, recommended for use indicated.
3. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.

   a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
   b. 24-Hour Absorption Rate: Less than 0.75 percent.
   c. Dust Content: Less than 1.0 percent by weight.

4. Reinforcement: ASTM A615/A615M, **Grade 60 (Grade 420)** bars, as required by unit size, profile, and thickness.
5. Abrasive Inserts: **1/2-inch- (13-mm-)** wide, alundum oxide/epoxy mixture.

   a. Provide three inserts, **1/2 inch (13 mm)** apart, with first insert located **1 inch (25 mm)** from nosing at adjacent stair riser locations.

6. Color: As selected from manufacturer's standard color selections.
7. Finish: Honed.
8. Surface Sealer: Slip and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 12; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.8 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.

2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.

2.9 FABRICATION OF STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of [**steel plates**][**steel channels**][**steel plates or channels**][**steel tubes**][**as indicated on Drawings**].

a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
b. Provide closures for exposed ends of [**channel**][**tube**] stringers.
c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Platforms: Construct of steel [**plate**][**channel**][**plate or channel**][**rectangular tube**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

a. Provide closures for exposed ends of [**channel**][**tube**] framing.
b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.[**If using bolts, fabricate and join so bolts are not exposed on finished surfaces.**]

C. Subtreads, Risers, and Subplatforms:

1. Fabricate subtreads and subplatforms of steel [**plates**][**shapes indicated on Drawings**].
2. Form subtreads, risers, and subplatforms to configurations indicated from [**uncoated, cold-rolled steel sheet**][**uncoated, hot-rolled steel sheet**][**galvanized steel sheet**][**of thickness needed**

to comply with performance requirements, but not less than 0.075 inch (1.9 mm) thick][**of thickness indicated on Drawings**].

3. Weld subtreads to stringers.

    a. Locate welds on top of subtreads where they will be concealed by finished treads.

4. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads.

    a. Weld subplatforms to platform framing.
    b. Locate welds on top of subplatforms where they will be concealed by finished flooring.
    c. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.10 STAIR RAILINGS

A. Comply with applicable requirements in Section 057300 "Decorative Metal Railings."

1. Connect posts to stair framing by direct welding unless otherwise indicated.

2.11 FINISHES

A. Finish metal stairs after assembly.

B. Steel Galvanized Finish: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Steel Shop Prime Finish:

1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**]
2. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

    a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

D. Aluminum Finishes:

1. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.
2. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

    a. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].

E. Stainless Steel Finishes:

1. Stainless Steel Tubing Finishes:

a. 180-Grit Polished Finish: Uniform, directionally textured finish.
b. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
c. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**].

2. Stainless Steel Sheet and Plate Finishes:

a. Directional Satin Finish: ASTM A480/A480M, No. 4.
b. High Luster Finish: ASTM A480/A480M, No. 7.
c. Mirror Finish: ASTM A480/A480M, No. 8.

F. Bronze Finishes:

1. Statuary Conversion Coating over Satin Finish: CDA M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**, with color matching Architect's sample**].
2. Statuary Conversion Coating over Satin Finish, Lacquered: CDA M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air dried, as specified below)[**, with color matching Architect's sample**]:

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

3. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Brass Finishes:

1. Buffed Finish, Lacquered: CDA M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Copper Finishes:

1. As Fabricated: CDA M12 (Matte finish as fabricated).
2. Buffed Finish: CDA M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: CDA M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: CDA M32 (Mechanical Finish: directionally textured, medium satin).

5. Fine-Matte Finish: CDA M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: CDA M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

7. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

8. Medium-Satin Finish, Lacquered: CDA M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

9. Fine-Matte Finish, Lacquered: CDA M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLING METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

    1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

G. Install precast concrete treads with adhesive supplied by manufacturer.

H. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 71 00 00

Task	Specification	Specification Description
05 71 00 00	05 70 00 00	Decorative Metal

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SECTION 05 71 13 00 - FABRICATED METAL SPIRAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fabricated metal spiral stairs with steel central-supporting columns, radiating treads, and railings.

B. Related Requirements:

1. Section 062023 "Interior Finish Carpentry" for wood treads.
2. Section 096513 "Resilient Base and Accessories" for resilient treads.
3. Section 096816 "Sheet Carpeting" for carpeting treads.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for fabricated metal spiral stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate fabricated metal spiral stairs with finish flooring materials.

1.3 ACTION SUBMITTALS

A. Product Data: For fabricated metal spiral stairs, including railings. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for components.

B. Shop Drawings: For fabricated metal spiral stairs and railings. Include plans, elevations, sections, details, attachments to other work, and field measurements.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Samples for Verification: For the following products, in manufacturer's standard sizes:

1. Treads.
2. Metal with painted finish.
3. Railing members.

E. Delegated Design Submittal: For fabricated metal spiral stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content

and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with fabricated metal spiral stairs by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabricated metal spiral stairs from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated metal spiral stairs and railings.

B. Structural Performance of Stairs: Fabricated metal spiral stairs are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Uniform Load: [**40 lbf/sq. ft. (1.92 kN/sq. m)**][**100 lbf/sq. ft. (4.79 kN/sq. m)**].
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Railing Loads: Stairs are to withstand stresses resulting from railing loads in addition to loads specified above.
5. Deflection: Limit deflection of treads, landings, and framing members to [**L/360**] but not to exceed [**1/4 inch (6 mm)**].

C. Structural Performance of Railings: Railings are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Handrails and Top Rails of Guards:

   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Fabricated metal spiral stairs are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

2.3 SPIRAL STAIRS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accent Stairs; ADPG, LLC**]
2. [**Boston Stair**]
3. [**Couturier Iron Craft, Inc.**]
4. [**Custom Iron**]
5. [**Duvinage LLC**]
6. [**Goddard Manufacturing**]
7. [**Innovative Metalcraft, LLC**]
8. [**Iron Shop (The)**]
9. [**Mylen Stairs**]
10. [**Salter Spiral Stair**]
11. [**Stairways Inc.**]
12. [**Steptoe & Wife Antiques Ltd**]

B. Center Column: [**Steel**][**or**][**aluminum**] pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.

C. Treads, Cast Metal: Cast [**aluminum**][**iron**] treads[**and platforms**] with integral frames, legs, and hubs.

1. Provide treads[**and platforms**] with abrasive surfaces.

D. Treads, Metal Bar Grating: Steel-bar grating treads[**and platforms**] with welded hubs and as follows:

1. Radial grating treads.
2. [**Abrasive**][**Rolled-steel, floor-plate**] nosings.
3. Straight flanges and welded-on legs.
4. Tapered flanges without legs.

E. Treads, Formed Metal Plate: Formed [**steel-**][**aluminum-**]plate treads[**and platforms**], welded to hubs or center column, and as follows:

1. Straight flanges and welded-on legs.
2. Tapered flanges without legs.
3. Pan treads without legs.
4. One-piece treads and risers, [**with**][**without**] legs.
5. Rolled-steel, floor-plate wearing surfaces.
6. Aluminum-alloy, rolled tread-plate wearing surfaces.
7. Smooth steel-plate wearing surfaces.
8. Rubber wearing surfaces.
9. Plywood subtread for covering with finish flooring specified in another Section.

F. Treads, Metal Framed: Steel-framed treads[**and platforms**], welded to hubs or center column, and without legs; wearing surface as follows:

1. Cast iron with integral abrasive.
2. Smooth steel plate with integral abrasive.
3. Wood.
4. Plywood insert for covering with finish flooring specified in another Section.

G. Railings: Uniformly bent to spiral shape[**, and continuing at top to form guardrail around floor opening**].

1. Space balusters less than [**4 inches (102 mm)**][**4-3/8 inches (111 mm)**], clear.
2. Space balusters to provide one baluster per tread, and less than [**21 inches (533 mm)**][**30 inches (762 mm)**], clear.
3. Space intermediate rails less than [**4 inches (101 mm)**][**4-3/8 inches (111 mm)**][**21 inches (533 mm)**], clear.
4. Locate bottom rail so that a [**6-inch- (152-mm-)**]diameter sphere cannot pass between the stair and rail.
5. Hand Rail:

   a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
   b. Steel of shape and size indicated.
   c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
   d. Extruded bronze of shape and size indicated.
   e. Wood of shape and size indicated.

6. Top Rail:

   a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
   b. Steel of shape and size indicated.
   c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
   d. Extruded bronze of shape and size indicated.
   e. Wood of shape and size indicated.

7. Balusters:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. [**1/2-inch- (13-mm-) OD**][**5/8-inch- (16-mm-) OD**] round steel [**bars**][**tubing**].
   c. [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (19-mm-)**] square steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round aluminum tubing.

8. Intermediate Rails:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. Steel pipe[**or round tubing**] same size as top rail.
   c. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] round aluminum tubing.
   e. Round aluminum tubing same size as top rail.

2.4 MATERIALS

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Brackets, Flanges, and Anchors: Same metal and finish as supported item unless otherwise indicated.

D. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

E. Steel Bars for Grating Treads and Platforms: ASTM A36/A36M or ASTM A1011/A1011M.

F. Wire Rod for Grating Crossbars: ASTM A510/A510M.

G. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or Grade D.

H. Steel Pipe Columns: ASTM A53/A53M, Schedule 40. Provide Schedule 80 for columns larger than **NPS 4 (DN 100)** and where required to support loads.

I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

J. Steel Tubing: Either cold-formed steel tubing complying with ASTM A500/A500M or mandrel-drawn mechanical tubing complying with ASTM A513, Type 5.

K. Iron Castings: Either gray iron complying with ASTM A48/A48M or malleable iron complying with ASTM A47/A47M unless otherwise indicated or required by structural loads.

L. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

M. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

N. Aluminum Pipe and Structural Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

O. Extruded-Aluminum Tubing: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

P. Aluminum Castings: ASTM B26/B26M, Alloy 319.0-F.

Q. Extruded-Bronze Handrails: ASTM B455, Alloy UNS No. C38500 (architectural bronze).

R. Seamless Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

S. Seamless Brass Tubing: ASTM B135/B135M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).

T. Stainless Steel Tubing: ASTM A554, Grade MT 304.

U. Stainless Steel Sheet: Sheet, Strip, Plate, and Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

V. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316**][**Type 316L**].

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: For connecting stair components and for anchoring stairs to other construction, select fasteners of type, grade, and class required to produce connections capable of withstanding design loadings.

1. For aluminum, provide fasteners fabricated from Type 304 stainless steel.
2. For stainless steel, provide fasteners fabricated from Type 304 stainless steel.
3. For steel and cast iron, use plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
4. For exterior locations, provide fasteners fabricated from Type 304 stainless steel.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

C. Lacquer for Brass and Bronze: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products.

1. Product: Subject to compliance with requirements, provide "Incralac" developed by International Copper Research Corporation.

D. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

E. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with finish paint systems indicated.

F. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.

G. Shop Primer for Aluminum: Primer formulated for use over aluminum and compatible with finish paint systems indicated.

H. Wood for Stair Treads, Handrails, and Platforms: Laminated red oak, sanded to 120-grit smoothness. Apply uniform coat of manufacturer's standard clear sealer.

I. Rubber Wearing Surfaces: Manufacturer's standard, **1/4-inch- (6-mm-)** thick, molded-rubber covering in pattern and color indicated or, if not indicated, as selected by Architect from manufacturer's standard colors and patterns.

2.6 FABRICATION

A. Assemble fabricated metal spiral stairs in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form work true to line and level with accurate angles and surfaces.

D. Fabricate connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

E. Cut, reinforce, drill, and tap as needed to receive hardware, screws, and similar items.

F. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. Finish exposed welds to comply with NOMMA Guideline 1, "Joint Finishes," for [**Finish #1 -No evidence of a welded joint**][**Finish #2 - Completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - Partially dressed weld with spatter removed**].
5. Finish exposed surfaces smooth and blended and, except for fillet welds, so welded surface matches contours of adjoining surfaces.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL AND IRON FINISHES

A. Galvanized Finish: Hot-dip galvanize fabricated metal spiral stairs and railings after fabrication to comply with ASTM A123/A123M.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6 (WAB)/NACE WAB-3, "Commercial Blast Cleaning."**][**SSPC-SP 7 (WAB)/NACE WAB-4, "Brush-off Blast Cleaning."**]

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter; treat with etching cleaner [**or**][**in accordance with SSPC-SP 16**].

D. Apply shop primer to prepared surfaces of handrails and railing components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

2.8 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color:

a. [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
b. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (cleaned with inhibited chemicals; acid chromate-fluoride-phosphate conversion coating; shop primer).

1. Apply shop primer with a minimum dry film thickness of **1.5 mils (0.04 mm)**.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.9 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.10 BRASS AND BRONZE FINISHES

A. Buffed Finish: Mirror polished, buffed finish.

B. Lacquered Buffed Finish: Mirror polished, buffed finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: Directionally textured, medium satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.

1. Color Match: Match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where needed for securing fabricated metal spiral stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws, and other connectors as required.

B. Assemble fabricated metal spiral stair components to comply with manufacturer's written instructions, with each component aligned and in correct relation to each other, securely anchored to supporting column and adjacent structure.

C. Do not cut, alter, or drill stair components in the field that do not fit properly. Return components that do not fit to manufacturer for adjustment.

D. Install fabricated metal spiral stairs accurately in location, alignment, and elevation; level and plumb; and in accordance with manufacturer's written instructions.

E. Install fabricated metal spiral stairs by welding to steel structure or to weld plates cast into concrete unless otherwise indicated.

F. Field Welding:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

3.2 REPAIR

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material.

B. For galvanized surfaces, clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

1. Paint repaired areas with same material used for shop painting.

3.3 PROTECTION

A. Protect finished tread surfaces during construction by covering with **1/2-inch- (13-mm-)** thick, plywood secured with plastic strapping or another nonmarring fastening method.

END OF SECTION 05 71 13 00

Task	Specification	Specification Description
05 71 13 00	05 70 00 00	Decorative Metal
05 71 13 00	05 71 00 00	Decorative Metal Stairs

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SECTION 05 73 00 00 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum decorative railings.
2. Copper-alloy decorative railings.
3. Stainless steel decorative railings.
4. Steel and iron decorative railings.

B. Related Requirements:

1. Section 055213 "Pipe and Tube Railings" for nonornamental railings fabricated from pipes and tubes.
2. Section 057313 "Glazed Decorative Metal Railings."
3. Section 061000 "Rough Carpentry" for wood blocking for anchoring railings.
4. [**Section 064013 "Exterior Architectural Woodwork"**][**Section 064023 "Interior Architectural Woodwork"**] for wood railings.

1.2 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of decorative metal railings assembled from standard components.
2. Illuminated rails.
3. Stainless steel cable and cable fittings.
4. Expanded metal infill panels.
5. Perforated metal infill panels.
6. Woven-wire mesh infill panels.
7. Fasteners.
8. Post-installed anchors.
9. Handrail brackets.
10. Wood rails.

11. Lacquer for copper alloys.
12. Shop primer.
13. Intermediate coats and topcoats.
14. Bituminous paint.
15. Nonshrink, nonmetallic grout.
16. Anchoring cement.
17. Metal finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

1. For illuminated railings, include wiring diagrams and roughing-in details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters
2. Illuminated railing.
3. Fittings, end caps, and brackets.
4. Welded connections.
5. Brazed connections.
6. Cable and cable hardware and connections.
7. Assembled Sample of railing system, made from full-size components, including top rail, post, [**illuminated**] handrail, and guard infill. Sample need not be full height.

a. Show method of [**connecting**][**and**][**finishing**] members at intersections.

F. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**delegated design professional engineer**][**testing agency**].

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

F. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable

to authorities having jurisdiction.

G. Preconstruction test reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups as shown on Drawings.
2. Build mockups for each form and finish of railing, consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made [**the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**][**by Contractor**]. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings in accordance with ASTM E894 and ASTM E935.
3. Notify Architect [**seven**] days in advance of the dates and times when laboratory mockups will be tested, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.3 ALUMINUM DECORATIVE RAILINGS

A. Aluminum Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Structures & Design**]
b. [**Architectural Iron Designs, Inc.**]
c. [**ATR Technologies, Inc.**]
d. [**AZEK Building Products, Incorporated**]
e. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
f. [**CraneVeyor Corp**]
g. [**Feeney Inc.**]

h. [**Greco; CSW Industrials Inc.**]
i. [**HDI Railings**]
j. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
k. [**Hollaender Mfg. Co.**]
l. [**Julius Blum & Co., Inc.**]
m. [**Kane Innovations, Inc.**]
n. [**Knotwood US LLC**]
o. [**Livers Bronze Co.**]
p. [**Promenaid**]
q. [**Regal Ideas, Inc.**]
r. [**Seco South, Inc.**]
s. [**Superior Aluminum Products, Inc**]
t. [**Thompson Fabricating, LLC**]
u. [**Trex Commercial Products, Inc.**]
v. [**Tri Tech, Inc.**]
w. [**Tuttle, a Dant Clayton Division**]
x. [**VIVA Railings, LLC**]
y. [**Wagner Companies (The); R&B Wagner, Inc.**]
z. [**Wylie Metals**]

2. Source Limitations: Obtain aluminum decorative railing components from single source from single manufacturer.

B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

C. Extruded Bars and Shapes, Including Extruded Tube: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

D. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

E. Drawn Seamless Tube: ASTM B210/B210M, Alloy 6063-T832.

F. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 5005-H32**][**Alloy 6061-T6**].

G. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

H. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].

h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Stainless Steel Cable and Cable Fittings for Aluminum Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]
f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4 by 1 inch (6.4 by 25.4 mm)**, predrilled.

J. Castings: ASTM B26/B26M, Alloy A356.0-T6.

K. Perforated Metal Infill Panels: Aluminum sheet, **ASTM B209 (ASTM B209M)**, Alloy 6061-T6, [**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8-inch (9.5-mm) o.c. in staggered rows**].

L. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch (4.1-mm)** nominal diameter aluminum wire complying with ASTM B211/B211M, Alloy 6061-T94.

2.4 COPPER-ALLOY DECORATIVE RAILINGS

A. Copper-Alloy Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Iron Designs, Inc.**]
b. [**CraneVeyor Corp**]
c. [**Julius Blum & Co., Inc.**]
d. [**Lavi Industries**]
e. [**Livers Bronze Co.**]
f. [**Tri Tech, Inc.**]
g. [**Wagner Companies (The); R&B Wagner, Inc.**]
h. [**Wylie Metals**]

2. Source Limitations: Obtain copper and copper alloy decorative metal railing components from single source from single manufacturer.

B. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness of not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars, and of not less than Temper H55 (light drawn) for tube and pipe.

C. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

D. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

E. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

F. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

G. Bronze Seamless Tube: ASTM B135/B135M, Alloy UNS C23000 (red brass, 85 percent copper).

H. Brass Seamless Tube: ASTM B135/B135M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

I. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

J. Bronze Castings: [**Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

K. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

L. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.

M. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

N. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

O. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

P. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

Q. Stainless Steel Cable and Cable Fittings for Copper-Alloy Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]
f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

2.5 STAINLESS STEEL DECORATIVE RAILINGS

A. Stainless Steel Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGS Stainless Inc.**]
b. [**Architectural Iron Designs, Inc.**]
c. [**Atlantis Rail Systems**]
d. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
e. [**CraneVeyor Corp**]
f. [**Greco; CSW Industrials Inc.**]
g. [**HDI Railings**]
h. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
i. [**Hollaender Mfg. Co.**]
j. [**Julius Blum & Co., Inc.**]
k. [**Kane Innovations, Inc.**]
l. [**Lavi Industries**]
m. [**Livers Bronze Co.**]
n. [**Morse Industries**]
o. [**P&P Artec, Inc.**]
p. [**Seco South, Inc.**]
q. [**Trex Commercial Products, Inc.**]
r. [**Tri Tech, Inc.**]
s. [**Tuttle, a Dant Clayton Division**]

t. [**VIVA Railings, LLC**]
u. [**Wagner Companies (The); R&B Wagner, Inc.**]
v. [**Wylie Metals**]

2. Source Limitations: Obtain stainless steel decorative railing components from single source from single manufacturer.

B. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**][**Grade MT 316L**].

C. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**][**Grade TP 316L**].

D. Castings: ASTM A743/A743M, [**Grade CF 8 or CF 20**][**Grade CF 8M or CF 3M**].

E. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

F. Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

G. Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316**][**Type 316L**].

H. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].
h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Stainless Steel Cable and Cable Fittings for Stainless Steel Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGS Stainless Inc.**]
b. [**Bergen Cable Technology, LLC**]
c. [**Carl Stahl DecorCable, Inc.**]
d. [**Esmet, Inc.**]
e. [**Feeney Inc.**]

f. [**Hayn Enterprises, LLC**]
g. [**HDI Railings**]
h. [**Johnson, C. Sherman, Co., Inc**]
i. [**Loos & Co. Inc.**]
j. [**Morse Industries**]
k. [**Ronstan International Inc**]
l. [**Seco South, Inc.**]
m. [**Trex Commercial Products, Inc.**]
n. [**Ultra-tec; The Cable Connection**]
o. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

J. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 3 (corrosion-resisting steel), made from stainless steel sheet complying with ASTM A666, [**Type 304**][**Type 316**].

1. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

K. Perforated Metal Infill Panels: Stainless steel sheet, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**], [**0.062 inch (1.59 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

L. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal diameter stainless steel wire complying with ASTM A580/A580M, [**Type 304**][**Type 316**].

2.6 STEEL AND IRON DECORATIVE RAILINGS

A. Steel and Iron Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Iron Designs, Inc.**]
b. [**HDI Railings**]
c. [**Indital USA**]
d. [**Lawler Foundry Corporation**]
e. [**Livers Bronze Co.**]
f. [**Olin Metal Works**]
g. [**Regency Railings**]
h. [**Trex Commercial Products, Inc.**]
i. [**Tri Tech, Inc.**]

j. [**VIVA Railings, LLC**]
k. [**Wagner Companies (The); R&B Wagner, Inc.**]
l. [**Wiemann Metalcraft**]

2. Source Limitations: Obtain steel decorative railing components from single source from single manufacturer.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M, Type 5**].

D. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

E. Plates, Shapes, and Bars: ASTM A36/A36M.

F. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

G. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].
h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Stainless Steel Cable and Cable Fittings for Steel and Iron Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]

f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

I. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 1 (uncoated).

1. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

J. Perforated Metal Infill Panels:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].
2. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

K. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal diameter steel wire complying with ASTM A510/A510M.

2.7 FASTENERS

A. Fastener Materials:

1. Aluminum Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
2. Copper-Alloy (Bronze) Railing Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; muntz metal (Alloy 280) fasteners where exposed**].
3. Copper-Alloy (Brass) Railing Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed**].
4. Stainless Steel Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
5. Ungalvanized-Steel Railing Components: Plated-steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for electrodeposited zinc coating where concealed; Type 304 stainless steel fasteners where exposed.
6. Hot-Dip Galvanized-Steel Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
7. Dissimilar Metal Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
8. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction[**and capable of withstanding design loads**].

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**][**exposed fasteners are the standard fastening method for railings indicated**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593 and nuts, ASTM F594.

2.8 MISCELLANEOUS MATERIALS

A. Handrail Brackets: [**Cast-aluminum,**][**Cast-bronze,**][**Cast-brass,**][**Cast-copper,**][**Cast-nickel-silver,**][**Cast stainless steel,**][**Cast-iron**] center of handrail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from [**face of railing**][**wall**].

1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
3. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.
4. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

B. Wood Rails:

1. Clear, straight-grained hardwood rails secured to [**recessed**][**exposed**] metal subrail.

a. Species: [**Ash**][**Cherry**][**Red oak**][**Teak**][**Walnut**][**White oak**].
b. Finish: [**Manufacturer's standard**][**Transparent polyurethane**][**Penetrating oil**][**Acrylic impregnated**].
c. Staining: [**None**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
d. Profile: [**Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius**][**Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius**][**Round, 2-inch (50-mm) diameter**][**As indicated on Drawings**].

2. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
5. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**]

certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

6. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
7. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."

C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For [**aluminum**][**and**][**stainless steel**] railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

D. Brazing Rods: For copper-alloy railings, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

E. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.

F. Etching Cleaner for Galvanized Metal: Compatible with coating system specified.

G. Galvanizing Repair Paint: High-zinc-dust-content paint compatible with coating system specified.

H. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

I. Epoxy Zinc-Rich Primer: Compatible with topcoat.

J. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer**][**Vinyl wash primer**][**Water-based galvanized metal primer**].

K. Intermediate Coats and Topcoats: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

L. Epoxy Intermediate Coat: Compatible with primer and topcoat.

M. Polyurethane Topcoat: Compatible with undercoat.

N. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

O. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

P. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated on Drawings**], provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.9 FABRICATION

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[**, but not less than that required to support structural loads**].

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water.

1. Provide weep holes where water may accumulate.
2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with [**welded**][**or**][**mechanical**] connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.

I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

J. Brazed Connections: Connect copper and copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. At exposed connections, finish exposed surfaces smooth and blended, so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.

K. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.

1. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

2. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

L. Form changes in direction as follows:

1. As detailed.
2. [**By bending**][**or**][**by inserting prefabricated elbow fittings**].
3. [**By flush bends**][**or**][**by inserting prefabricated flush-elbow fittings**].
4. [**By radius bends of radius indicated**][**or**][**by inserting prefabricated elbow fittings of radius indicated**].
5. By bending to smallest radius that will not result in distortion of railing member.

M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other Work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry Work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
2. Coordinate anchorage devices with supporting structure.

R. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.

1. Provide socket covers designed and fabricated to resist being dislodged.
2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

T. Stainless Steel Cable Guard Infill: Fabricate cable guard infill assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment, so maximum amount is available for tensioning cable.
2. Tag cable assemblies and fittings to identify installation locations and orientations for coordinated installation.

U. Expanded-Metal Infill Panels: Fabricate infill panels from [**aluminum**][**stainless steel**][**steel**] expanded-metal sheet[**unless otherwise indicated**].

1. Edge panels with U-shaped channels made from same metal as infill; not less than **0.043 inch (1.1 mm)** thick.
2. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**].

V. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from [**aluminum**][**stainless steel**][**steel**][**galvanized steel**][**same metal as railings in which they are installed**].

1. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than **0.043 inch (1.1 mm)** thick.
2. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**].

W. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** metal channel frames.

1. Fabricate wire mesh and frames from [**aluminum**][**stainless steel**][**steel**][**unless otherwise indicated**].
2. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].

X. Toe Boards: Where indicated on Drawings, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.10 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.11 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34,**

Class II, 0.010 mm] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performing Organic Finish, Three-Coat (Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Superior-Performing Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605, containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605, containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and

apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.12 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: Buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: Directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: Directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: Nondirectional finish, fine matte).

F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: Buffed, smooth specular; Coating: Clear organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: Directionally textured, fine satin; Mechanical Finish: Directionally textured, hand rubbed; Coating: Clear organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: Directionally textured, medium satin; Coating: Clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: Nondirectional finish, fine matte; Coating: Clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: Directionally textured, fine satin; Chemical Finish: Conversion coating, sulfide)[**, with color matching Architect's sample**].

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: Directionally textured, uniform; Chemical Finish: Nonetched cleaned, degreased; Chemical Finish: Conversion coating, ammonium sulfate)[**, with**

color matching Architect's sample].

2.13 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High-Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.14 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize[**exterior**] steel and iron railings, including hardware, after fabrication.
2. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
3. Comply with ASTM A123/A123M for hot-dip galvanized railings.
4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
6. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner[**and as follows:**]

1. Comply with SSPC-SP 16.

D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3.**][**SSPC-SP 7/NACE No. 4.**][**requirements indicated below:**]

1. Exterior Railings: SSPC-SP 6/NACE No. 3.

2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
3. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
4. Other Railings: SSPC-SP 7/NACE No. 4.

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with [**primers specified in Section 099113 "Exterior Painting"**][**primers specified in Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.
2. Do not apply primer to galvanized surfaces.

G. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Powder-Coat Finish for Uncoated Ferrous Metal: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3.
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Powder-Coat Finish for Galvanized Metal: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3 m)**.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of [**aluminum**][**and**][**copper alloys**] that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending **2 inches (50 mm)** beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**].

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**].

E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.
2. For copper-alloy railings, attach posts as indicated, using fittings designed and engineered for this purpose.
3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
4. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to concrete and masonry with [**sleeves concealed within**][**flanges connected to**][**brackets on underside of rails connected to**] railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and [**welded to railing ends**][**or**][**connected to railing ends, using nonwelded connections**].

C. Attach handrails to walls with wall brackets[**, except where end flanges are used**]. Provide brackets with [**1-1/2-inch (38-mm)**] clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**].
2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets[**and railing end flanges**] to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into[**fire-retardant-treated**] wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.
6. For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with

SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

3.7 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made [the Owner][**from the testing and inspecting allowance, as authorized by Change Orders**].

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894 and ASTM E935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory, as directed by the Owner.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.8 CLEANING

A. Clean [**aluminum**][**and**][**stainless steel**] by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Clean [**wood rails**][**and**][**plastic handrail caps**] by wiping with a damp cloth and then wiping dry.

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.9 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00

SECTION 05 73 00 00A - GLAZED DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glazed decorative metal railings.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring railings.

1.2 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor and exterior deck areas and for pedestrian guidance and support, visual separation, or wall protection.

1.3 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data:

1. Metal railings assembled from standard components.
2. Glass products.
3. Glazing cement and accessories for structural glass railings.
4. Sealant and accessories for structural glass railings.
5. Fasteners.
6. Wood rails.
7. Lacquer for copper alloys.
8. Shop primer.
9. Bituminous paint.
10. Nonshrink, nonmetallic grout.
11. Anchoring cement.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Base channel.
3. Each type of glass and glass edge required.
4. Fittings and brackets.
5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, [**structural glass balusters,**][**and**][**glass-infill panels**]. Show method of finishing members at intersections. Samples need not be full height.

F. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**].

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.

D. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1. For glazed decorative metal railings.
2. For post-installed anchors.

E. Preconstruction test reports.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups as indicated on Drawings.
2. Build mockups for each form and finish of glass-infill panel railing consisting of two posts, top rail, handrail, glass-infill panel, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
3. Build mockups for each form and finish of structural glass railing consisting of top rail, structural glass, base channel, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made [**as directed by the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**][**by Contractor**]. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
3. Notify Architect [**seven**] days in advance of the dates and times when laboratory mockups will be tested, as directed by the Owner.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65, or minimum ultimate tensile strength divided by 1.95.
2. Copper Alloys: 60 percent of minimum yield strength.
3. Stainless Steel: 60 percent of minimum yield strength.
4. Steel: 72 percent of minimum yield strength.
5. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA CW-12, "Structural Properties of Glass."

C. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Structural Glass Railings and Glass-Infill Panels:

   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.

3. For structural glass railings, support each section of top rail [**and handrail**]by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.

   a. Support top rail [**and handrail**]ends such that railings remains in place if end glass panel fails.

D. Wind Loads: For exterior glazed decorative metal railings, capable of withstanding the following wind loads in accordance with the IBC and ASTM E1300:

1. Wind Load: [**As indicated on Drawings**].

E. Windborne-Debris-Impact Resistance: Exterior glazed decorative metal railings passing ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For exterior glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For exterior glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 GLAZED DECORATIVE METAL RAILINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ATR Technologies, Inc.**]
2. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
3. [**CraneVeyor Corp**]
4. [**Glass Vice USA**]
5. [**Greco; CSW Industrials Inc.**]
6. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
7. [**Hollaender Mfg. Co.**]
8. [**Julius Blum & Co., Inc.**]
9. [**Livers Bronze Co.**]
10. [**Morse Industries**]
11. [**Southwest Metalsmiths, Inc.**]
12. [**TACO Metals Inc.**]

13. [**Trex Commercial Products, Inc.**]
14. [**Tri Tech, Inc.**]
15. [**Tuttle, a Dant Clayton Division**]
16. [**VIVA Railings, LLC**]
17. [**Wagner Companies (The); R&B Wagner, Inc.**]

B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.

C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.

D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.4 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Extruded Bars and Shapes, Including Extruded Tube: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

D. Drawn Seamless Tubing: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.

E. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 5005-H32**][**Alloy 6061-T6**].

F. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.5 STAINLESS STEEL

A. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**].

B. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**].

C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**][**Grade CF 8M or Grade CF 3M**].

D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, [**Type 304**][**Type 316**].

E. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**].

2.6 STEEL AND IRON

A. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

2.7 COPPER ALLOYS

A. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.

B. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

C. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

D. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

E. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

F. Bronze Seamless Tube: ASTM B135/B135M Alloy UNS C23000 (red brass, 85 percent copper).

G. Brass Seamless Tube: ASTM B135/B135M Alloy UNS C26000 (cartridge brass, 70 percent copper).

H. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

I. Bronze Castings: [**Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

J. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

K. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.

L. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

M. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

N. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

O. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 GLASS AND GLAZING PRODUCTS, GENERAL

A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA/GANA Publications: [**"GANA Laminated Glazing Reference Manual" and**]"GANA Glazing Manual."

B. Safety Glazing: Glazing is to comply with 16 CFR 1201, Category II.

C. Safety Glazing Labeling: Permanently mark glass with certification label of [**the SGCC**][**the SGCC or another certification agency acceptable to authorities having jurisdiction**][**or**][**manufacturer**]. Label is to indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

D. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

E. Low-Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

F. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

G. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.

H. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

I. Ceramic-Coated Glass: Heat-strengthened float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.

J. Bent Glass: ASTM C1464, [**Kind BFT (bent, tempered)**][**Kind BHS, (bent, heat strengthened)**][**Kind BL, (bent, laminated)**].

K. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

L. Sealant and Accessories for Structural Glass Railings: Sealant, gaskets, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

M. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.9 GLASS HANDRAILS AND GUARDS

A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.

1. Glass Color: [**Clear**][**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Thickness for Structural Glass Balusters: As required by structural loads, but not less than [**12.0**][**19.0**] mm.
3. Thickness for Glass-Infill Panels: As required by structural loads, but not less than [**6.0**][**10.0**] mm.
4. Glass Thickness: As indicated on Drawings.

B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.

1. Construction: Laminate glass with [**polyvinyl butyral interlayer**][**or**][**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Kind: [**LHS (laminated heat strengthened)**][**LT (laminated tempered)**][**As indicated**].
4. Glass Color: Inner-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**]; outer-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**].
5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**], applied to [**inner**][**outer**] glass ply.
6. Interlayer Color: [**Clear**][**Blue-green**][**Bronze light**][**Gray**].
7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match**][**Provide**].
8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**][**8.0**] mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**3.0**][**4.0**][**5.0**] mm each.

C. Windborne-Debris-Impact-Resistant Laminated Glass Guards: ASTM C1172, Type II with two plies of glass bonded together with an interlayer.

1. Construction: Laminate glass with [**polyvinyl butyral interlayer**][**or**][**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: [**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Kind: [**LHS (laminated heat strengthened)**][**LT (laminated tempered)**][**As indicated**].
4. Glass Color: Inner-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**]; outer-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**].
5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**] applied to [**inner**][**outer**] glass ply.
6. Interlayer Color: [**Clear**][**Blue-green**][**Bronze light**][**Gray**].
7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match**][**Provide**].
8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**][**8.0**][**10**] mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**4.0**][**5.0**] mm each.

2.10 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Components: [**Type 304**][**Type 316**] stainless steel fasteners.
2. Stainless Steel Components: [**Type 304**][**Type 316**] stainless steel fasteners.
3. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; muntz metal (Alloy 280) fasteners where exposed**].
4. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed**].

5. Dissimilar Metals: [**Type 304**][**Type 316**] stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated[**and capable of withstanding design loads**].

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**][**exposed fasteners are the standard fastening method for railings indicated**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts; **ASTM F594 (ASTM F836M)**.

2.11 MISCELLANEOUS MATERIALS

A. Handrail Brackets: [**Cast aluminum,**][**Cast stainless steel,**][**Cast bronze,**][**Cast brass,**][**Cast copper,**][**Cast nickel-silver,**] center of rail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from face of structural glass balusters.

B. Wood Rails:

1. Clear, straight-grained hardwood rails secured to [**recessed**][**exposed**] metal subrail.

a. Species: [**Ash**][**Cherry**][**Red oak**][**Walnut**][**White oak**].
b. Finish: [**Manufacturer's standard**][**Transparent polyurethane**][**Penetrating oil**][**Acrylic impregnated**].
c. Staining: [**None**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
d. Profile: [**Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius**][**Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius**][**Round, 2-inch (50-mm) diameter**][**As indicated**].

2. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
5. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
6. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

7. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

C. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.

D. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Anchoring Cement: [**At exterior locations**][**and**][**where indicated**] provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.12 FABRICATION OF METAL RAILINGS

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[**, but not less than that required to support structural loads**].

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

H. Form changes in direction as follows:

1. As detailed.

2. [**By bending**][**or**][**by inserting prefabricated elbow fittings**].
3. [**By flush bends**][**or**][**by inserting prefabricated flush-elbow fittings**].
4. [**By radius bends of radius indicated**][**or**][**by inserting prefabricated elbow fittings of radius indicated**].
5. By bending to smallest radius that will not result in distortion of railing member.

I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

J. Close exposed ends of hollow railing members with prefabricated end fittings.

K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

M. For railing posts set in concrete, provide [**steel**][**stainless steel**] sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

2.13 FABRICATION OF GLASS PANELS AND BALUSTERS

A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

B. Glass-Infill Panels: Provide [**tempered**][**laminated, heat-strengthened**][**laminated, tempered**] glass-infill panels[**for both straight and curved sections**].

1. Edge Finish: [**Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces**].

C. Structural Glass Balusters: Provide [**tempered**][**laminated, heat-strengthened**][**laminated, tempered**] structural glass balusters[**for both straight and curved sections**].

1. Edge Finish: [**Grind smooth and flat polish exposed edges of glass, including those at open joints, to produce smooth, square edges with glass edge finishes**].
2. Factory-bond structural glass balusters to aluminum base and top-rail channels in railing manufacturer's plant using [**glazing cement**][**sealant**] to comply with manufacturer's written instructions[**, unless field glazing is standard with manufacturer**].
3. Fabricate structural glass balusters to maintain equal length glass widths and uniform spacing of [**1/2 inch (13 mm)**] between glass balusters.

2.14 METAL FINISH REQUIREMENTS, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.15 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performing Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Superior-Performing Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.16 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.17 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM/NOMMA 500, "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide.

1. Color: Match Architect's sample, as directed by the Owner.

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[**, with color matching Architect's sample**], as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.

B. Windborne-Debris Resistance: Anchor glazed decorative metal railings to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris-resistance testing.

C. Perform cutting, drilling, and fitting required for installing metal railings.

1. Fit exposed connections together to form tight, hairline joints.

2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of metal railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (5 mm in 3 m)**.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of [**aluminum**][**and**][**copper alloys**] that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with [**shop primer**][**bituminous paint**].

E. Adjust railings before anchoring to ensure matching alignment at abutting joints.

F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 METAL RAILING CONNECTIONS

A. Nonwelded Connections:

1. Use mechanical or adhesive joints for permanently connecting railing components.
2. Use wood blocks and padding to prevent damage to railing members and fittings.
3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated, but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches (50 mm)** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches (150 mm)** of post.

3.3 METAL ANCHORING POSTS

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted in sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**].

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**].

E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions,

connected to posts and to metal supporting members as follows:

1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.4 INSTALLATION OF GLASS BALUSTERS

A. Structural Glass Railings:

1. Install assembly to comply with railing manufacturer's written instructions.
2. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass balusters[**if glass was bonded to base and top-rail channels in factory**].
3. For field-assembled balusters, attach base channel to building structure, insert glass in base channel, and bond with [**glazing cement**][**sealant**].

    a. Support glass balusters in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.
    b. Fill remaining space in base channel with [**glazing cement**][**sealant**] for uniform support of glass.

4. Adjust spacing of glass balusters so gaps between balusters are equal before securing in position.
5. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

B. Post-Supported Railings with Glass-Infill Panels:

1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made [**as directed by the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**].

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements, as directed by the Owner.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced

or additional work with specified requirements.

3.6 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.

B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

D. Clean wood rails by wiping with a damp cloth and then wiping dry.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00A

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Task	Specification	Specification Description
05 73 00 00	05 70 00 00	Decorative Metal
05 73 00 00	05 75 00 00	Decorative Formed Metal
05 73 23 00	05 70 00 00	Decorative Metal
05 73 23 00	05 73 00 00	Decorative Metal Railings
05 73 23 00	05 73 00 00a	Glazed Decorative Metal Railings
05 73 23 00	05 75 00 00	Decorative Formed Metal

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SECTION 05 75 00 00 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Beam wraps.
2. Closures and trim.
3. Decorative-metal-clad doors and frames.
4. Escalator enclosures.
5. Filler panels.
6. Lighting coves.
7. Metal base.
8. Mullion cladding.
9. Pipe system covers.
10. Pockets for window treatment.
11. Window stools.

B. Related Requirements:

1. Section 057000 "Decorative Metal" for decorative items made primarily from plate, bars, extrusions, tubes, castings, and other forms of metal, but which may include sheet metal components.
2. Section 076100 "Sheet Metal Roofing" for items made of formed metal for roofing.
3. Section 076200 "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
4. Section 077100 "Roof Specialties" for items made of formed metal for parapets and copings.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

F. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For [**Installer**][**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**][**and**][**professional engineer**].

C. Mill Certificates: Signed by stainless steel manufacturers certifying that products furnished comply with requirements.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**mirrorlike stainless steel finish**][**and**][**statuary conversion coating copper-alloy finish**] to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units.

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type

indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Installer Qualifications: Fabricator of products.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For decorative metal items, obtain each color, grade, finish, type, and variety of metal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design decorative formed metal, including attachment to building construction.

B. Structural Performance: Decorative formed metal items, including anchors and connections, are to withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind Loads on Exterior Items: [**As indicated on Drawings**][**20 lbf/sq. ft. (957 Pa)**][**30 lbf/sq. ft. (1436 Pa)**].

C. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, are

to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: 1.0.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2.3 SHEET METAL

A. General: Fabricate products from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Aluminum Sheet: Flat sheet complying with **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

D. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel or forming steel.

E. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, with steel sheet substrate complying with ASTM A1008/A1008M, commercial steel, exposed**].

F. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness.

G. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper).

H. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

I. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

J. Titanium Sheet: ASTM B265, Grade 1.

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain [**airtight**][**weathertight**]; as recommended in writing by decorative formed metal manufacturer.

1. ASTM D1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.

B. Sealants, Exterior: Elastomeric sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

C. Sealants, Interior: Nonsag, paintable sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

D. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

E. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

F. Structural Anchors: For applications indicated to comply with certain design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

G. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

H. Anchor Materials:

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

J. Backing Materials: Provided or recommended by decorative formed metal manufacturer.

K. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal, will prevent telegraphing and oil-canning, and is compatible with substrate and noncombustible after curing.

L. Isolation Coating: Manufacturer's standard [**alkali-resistant coating**][**bituminous paint**][**epoxy coating**].

2.5 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Product formulated to remove grease and oil residue from metal surfaces and provide a clean, lightly etched surface to promote adhesion of coatings.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible

with paints specified to be used over it.

C. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

D. Shop Primers: Comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

E. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

F. Epoxy Zinc-Rich Primer: Compatible with topcoat.

G. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer**][**Vinyl wash primer**][**Water-based galvanized metal primer**].

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (1 mm)** and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

1. Use welding and brazing procedures that will blend with and not cause discoloration of metal

being joined.

2.7 BEAM WRAPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Industrial Louvers Inc.**]
3. [**Metal Sales & Service, Inc.**]
4. [**MM Systems Corporation**]
5. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
6. [**Southwest Metalsmiths, Inc.**]

B. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Steel Sheet: [**0.060 inch (1.52 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

C. Fabricate with calk stop angle to retain backer rod and sealant.

2.8 CLOSURES AND TRIM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction[**with weathertight joints at exterior installations**].

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance**

organic coating][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.

C. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.

D. Drill and tap holes needed for securing closures and trim to other surfaces.

E. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.

F. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.9 DECORATIVE-METAL-CLAD DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Dawson Metal Co., Inc**]
   2. [**InKan Limited**]
   3. [**Krieger Specialty Products Company**]

B. Laminate metal sheets, of type and thickness indicated below, to faces of [**hollow-metal doors and frames**][**and**][**elevator entrances**] where indicated. Use adhesive that will fully bond metal to metal and that will prevent telegraphing and oil-canning.

   1. Bronze Sheet: [**0.040 inch (1.02 mm)**].

      a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish, lacquered**].

   2. Brass Sheet: [**0.040 inch (1.02 mm)**].

      a. Finish: [**Buffed**][**Hand-rubbed**] finish lacquered.

   3. Stainless Steel Sheet: [**0.038 inch (0.95 mm)**].

      a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Titanium Sheet: [**0.025 inch (0.64 mm)**].

   a. Finish: [**Dull**][**Bright**] matte.

2.10 ESCALATOR ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.

1. Stainless Steel Sheet: [**0.062 inch (1.59 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2. Bronze Sheet: [**0.081 inch (2.05 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

2.11 FILLER PANELS

A. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as [**partitions**][**mullions**] unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.

1. Galvanized-Steel Sheet: [**0.064 inch (1.63 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

2. Steel Sheet: [**0.060 inch (1.52 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.

C. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use **1-inch- (25-mm-)** square material, unless otherwise indicated, set approximately **1/4 inch (6 mm)** into channeled edge of filler panel.

D. Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.

E. Do not mechanically fasten filler panels to mullions.

2.12 LIGHTING COVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Gordon Inc.**]
3. [**Hi-Tech Metals, Inc**]
4. [**MM Systems Corporation**]
5. [**Pittcon Industries**]

B. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Fabricate light coves with [**hairline butt joints**][**tapered edges for taping and spackling**].
5. Provide [**mitered corners, factory welded with backplates**][**factory endcaps**].
6. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

2.13 METAL BASE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form metal base from metal of type and thickness indicated below:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.14 MULLION CLADDING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.15 PIPE SYSTEM COVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ARSCO Metals LLC**]
2. [**JG Innovations, Inc.**]

B. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.

1. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance**

organic coating][**Powder coat**].

2. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

2.16 POCKETS FOR WINDOW TREATMENT

A. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.

C. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

2.17 WINDOW STOOLS

A. Form window stools from metal of type and thickness indicated below, with end closures:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**1.3 mm**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Bronze Sheet: [**0.051 inch (1.29 mm)**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

B. Weld seams at end closures.

C. Braze seams at end closures.

D. Apply sound-deadening [**insulation**][**mastic**] to underside of window stools.

2.18 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

D. Finish [**items indicated on Drawings**] after assembly.

E. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.19 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

   1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
   2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

   1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

   1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.20 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.21 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

D. Directional Satin Finish: No. 4.

E. Dull Satin Finish: No. 6.

F. Satin, Reflective, Directional Polish: No. 7.

G. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

H. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.23 COPPER-ALLOY FINISHES

A. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

B. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

E. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**with color matching Architect's sample**].

F. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air dried, as specified below)[**with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.24 TITANIUM FINISHES

A. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective

covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

F. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

G. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.3 ADJUSTING AND CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 75 00 00

Task	Specification	Specification Description
05 75 00 00	05 70 00 00	Decorative Metal

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Task	Specification	Specification Description
06 01 40 91	08 71 00 00	Door Hardware
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 23 00	06 13 00 00	Heavy Timber Construction
06 05 73 13	01 22 00 00	No Specification Required
06 05 73 33	06 10 00 00	Rough Carpentry
06 05 73 33	06 13 00 00	Heavy Timber Construction

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SECTION 06 10 00 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Wood-preservative-treated lumber.
3. Fire-retardant-treated lumber.
4. Dimension lumber framing.
5. Miscellaneous lumber.
6. Plywood backing panels.
7. Metal framing anchors.

B. Related Requirements:

1. Section 061533 "Wood Patio Decking" for elevated decks, including support framing.
2. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment.
3. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.
4. Section 064013 "Exterior Architectural Woodwork" for exterior wood stairs and railings.
5. Section 064023 "Interior Architectural Woodwork" for interior wood stairs and railings.
6. Section 313116 "Termite Control" for site application of borate treatment to wood framing.

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than **2 inches nominal (38 mm actual)** size in least dimension.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** size or greater but less than **5 inches nominal (114 mm actual)** size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. SBX: An inorganic boron used to prevent termites and fungal decay.

E. Lumber grading agencies, and abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber indicated to receive a stained or natural finish, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**] .
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**] unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Wood-Preservative-Treated Lumber by Pressure Process: AWPA U1, use categories as follows:

1. UC1, Interior/Dry: Interior construction continuously protected from weather or other sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood furniture.
   e. Wood millwork.

2. UC2, Interior/Damp: Interior construction protected from weather, but may be subject to sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood millwork.
   e. Wood flooring.

3. UC3A, Above Ground, Protected (Commodity Specification A): Coated wood products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include [**all rough carpentry.**][**the following items:**]

   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
   c. Wood siding and trim.

4. UC3A, Above Ground, Protected (All Other Commodity Specifications): Wood products in exterior

construction not in contact with ground, exposed to all weather cycles but either coated and installed in a manner that prevents prolonged wetting, or fully protected from liquid water by building design and construction. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood floor plates that are installed over concrete slabs-on-grade.
d. Wood siding and trim.
e. Wood sheathing.

5. UC3B, Above Ground, Exposed (Commodity Specification A): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including intermittent wetting, but with sufficient air circulation for wood to dry. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood decking, railings, and joists and beams for decks that are not critical to the performance and safety of the entire system/construction and that are in locations easily accessible for maintenance, repair, or replacement.

6. UC3B, Above Ground, Exposed (All Other Commodity Specifications): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.

7. UC4A, Ground Contact, General Use (Commodity Specification A): Non-critical wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, and wood products not in contact with ground but with ground contact-type hazards or that are critical or hard to replace. Include [**all rough carpentry.**][**the following items:**]

a. Wood framing members that are less than **6 inches (152 mm)** above the ground.
b. Joists and beams when they are difficult to maintain, repair, or replace and are critical to the performance and safety of the entire system/construction.

8. UC4A, Ground Contact, General Use (All Other Commodity Specifications): Non-critical wood products in contact with ground and exposed to all weather cycles, normal exposure conditions. Include [**all rough carpentry.**][**the following items:**]

a. Wood fence, deck, and guardrail posts.
b. Wood utility poles.

9. UC4B, Ground Contact, Heavy Duty (Commodity Specification A): Critical or difficult-to-replace wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, high decay potential, and saltwater splash. Include [**all rough carpentry.**][**the following items:**]

a. Wood foundations.

10. UC4C, Ground Contact, Extreme Duty (Commodity Specification A): Critical structural wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, severe environments, and extreme decay potential. Include [**all rough carpentry.**][**the following items:**]

    a. Wood foundation piling.

11. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. [**Do not use inorganic boron (SBX) for sill plates.**]
12. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
13. After treatment, redry [**boards**][**dimension lumber**] to 19 percent maximum moisture content.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**] .

D. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft. (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment is not to promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when

tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber is to be tested in accordance with ASTM D5664 and design value adjustment factors are to be calculated in accordance with ASTM D6841. [**For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.**]

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. [**Kiln-dry plywood after treatment to maximum moisture content of 15 percent.**]

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by testing agency**] .

E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
7. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Application: [**All interior partitions**][**Interior partitions not indicated as load bearing**] .
3. Species:

a. Hem-fir (north); NLGA.
b. Southern pine or mixed southern pine; SPIB.
c. Spruce-pine-fir; NLGA.
d. Hem-fir; WCLIB, or WWPA.
e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
f. Northern species; NLGA.
g. Eastern softwoods; NeLMA.
h. Western woods; WCLIB or WWPA.

B. Load-Bearing Partitions by Grade:

1. Grade: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .

2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .
3. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.
    e. Spruce-pine-fir; NLGA.
    f. Douglas fir-south; WWPA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-larch (north); NLGA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Machine Stress-Rated (MSR) Lumber Partitions:

1. Grade: Any species of MSR dimension lumber with a grade of not less than [**2400f-2.0E**][**2100f-1.8E**][**1650f-1.5E**].
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

D. Load-Bearing Partitions by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

E. Ceiling Joists:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Douglas fir-larch (north); NLGA.
    e. Southern pine or mixed southern pine; SPIB.
    f. Spruce-pine-fir; NLGA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-south; WWPA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
    j. Northern species; NLGA.
    k. Eastern softwoods; NeLMA.
    l. Western woods; WCLIB or WWPA.

F. Joists, Rafters, and Other Framing by Grade:

1. Grade: [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.

e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

G. Joists, Rafters, and Other Framing by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

H. Exposed Framing: Hand-select material [**indicated to receive a stained or natural finish**] for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

1. Species and Grade:

a. As indicated above for load-bearing construction of same type.
b. Hem-fir (north); [**Select Structural**][**No. 1**] grade; NLGA.
c. Southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
d. Douglas fir-larch; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
e. Mixed southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
f. Spruce-pine-fir; [**Select Structural**][**No. 1**] grade; NLGA.
g. Douglas fir-south; [**Select Structural**][**No. 1**] grade; WWPA.
h. Hem-fir; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
i. Douglas fir-larch (north); [**Select Structural**][**No. 1**] grade; NLGA.
j. Spruce-pine-fir (south); [**Select Structural**][**No. 1**] grade; NeLMA, WCLIB, or WWPA.
k. Eastern hemlock-balsam fir or eastern hemlock-tamarack; [**Select Structural**][**No. 1**] grade; NeLMA.
l. Beech-birch-hickory; [**Select Structural**][**No. 1**] grade; NeLMA.
m. Northern red oak; [**Select Structural**][**No. 1**] grade; NeLMA.
n. Redwood; [**Clear Heart Structural**][**Clear Structural**][**Select Structural**][**No. 1**] grade; RIS.
o. Mixed oak; [**Select Structural**][**No. 1**] grade; NeLMA.
p. Mixed maple; [**Select Structural**][**No. 1**] grade; NeLMA.
q. Western cedars; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.

2.5 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. Dimension Lumber Items:

1. Grade: [**Construction or No. 2**][**Standard, Stud, or No. 3**] .
2. Species: [**Any species.**][**Any of the following species:**][**The following species:**]

   a. Hem-fir (north); NLGA.
   b. Mixed southern pine or southern pine; SPIB.
   c. Spruce-pine-fir; NLGA.
   d. Hem-fir; WCLIB or WWPA.
   e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
   f. Western woods; WCLIB or WWPA.
   g. Northern species; NLGA.
   h. Eastern softwoods; NeLMA.

C. Utility Shelving:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade:

   a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; [**Premium or No. 2 Common (Sterling)**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
   b. Mixed southern pine or southern pine; No. [**1**][**2**] grade; SPIB.
   c. Hem-fir or hem-fir (north); [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NLGA, WCLIB, or WWPA.
   d. Spruce-pine-fir (south) or spruce-pine-fir; [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.

D. Concealed Boards:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade: [**Any of the following:**][**The following:**]

   a. Mixed southern pine or southern pine; No. [**2**][**3**] grade; SPIB.
   b. Hem-fir or hem-fir (north); [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NLGA, WCLIB, or WWPA.
   c. Spruce-pine-fir (south) or spruce-pine-fir; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
   d. Eastern softwoods; No. [**2**][**3**] Common grade; NeLMA.
   e. Northern species; No. [**2**][**3**] Common grade; NLGA.
   f. Western woods; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; WCLIB or WWPA.

E. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.

F. Wood Blocking: For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

G. Wood Furring: For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1.

1. Grade: [**Exterior, A-C**][**Exterior, C-C Plugged**][**Exposure 1, C-D Plugged**][**, fire-retardant treated**] .
2. Thickness: As indicated on the drawings or, if not indicated, not less than [**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal thickness.

2.7 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**][**of Type 304 stainless steel**] .
2. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**][**ICC-ES AC58**][**ICC-ES AC193**][**or**][**ICC-ES AC308**] as appropriate for the substrate.

2.8 ACCESSORIES

A. Metal Framing Anchors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MiTek Industries, Inc.**]
   b. [**Simpson Strong-Tie Co., Inc.**]
   c. [**Tamlyn**]

2. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.
3. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

   a. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**] .
   b. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**] .
   c. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**] .

4. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, **1-1/2 inches (38 mm)** wide by **0.050 inch (1.3 mm)** thick. [**Tie fastens to side of rafter or truss, face of top plates, and side of stud below.**]
5. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, **2-1/4 inches (57 mm)** wide by **0.062 inch (1.6 mm)** thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
6. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, **1-1/4 inches (32 mm)** wide by **0.050 inch (1.3 mm)** thick by **36 inches (914 mm)** long.
7. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.

    a. Bolt Diameter: [**5/8 inch (15.8 mm)**][**3/4 inch (19 mm)**] .
    b. Width: [**2-1/2 inches (64 mm)**][**3-3/16 inches (81 mm)**] .
    c. Body Thickness: [**0.108 inch (2.8 mm)**][**0.138 inch (3.5 mm)**] .
    d. Base Reinforcement Thickness: [**0.108 inch (2.8 mm)**][**0.239 inch (6.1 mm)**] .

8. Wall Bracing:

    a. T-shaped bracing made for letting into studs in saw kerf, **1-1/8 inches (29 mm)** wide by **9/16 inch (14 mm)** deep by **0.034 inch (0.85 mm)** thick with hemmed edges.
    b. Angle bracing made for letting into studs in saw kerf, **15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm)** thick with hemmed edges.

9. Materials: Unless otherwise indicated, fabricate from the following materials:

    a. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.

        1) Use for interior locations unless otherwise indicated.

    b. Heavy-Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

        1) Use for wood-preservative-treated lumber and where indicated.

    c. Stainless steel bars and shapes complying with ASTM A276/A276M.

        1) Stainless Steel: Type [**304**][**316**] .
        2) Use for exterior locations and where indicated.

B. Sill-Sealer Gasket:

1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; **1-inch (25-mm)** nominal thickness, compressible to **1/32 inch (0.8 mm)**; selected from manufacturer's standard widths to suit width of sill members indicated.
2. Closed-cell neoprene foam, **1/4 inch (6.4 mm)** thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Sill-Sealer Gasket and Termite Barrier: Self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface**

conditioner that complies with VOC limits of authorities having jurisdiction] .

D. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch (0.6 mm)**.

1. Compound Material: [**Butyl rubber**][**or**][**rubberized asphalt**] .

E. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

F. Water-Repellent Preservative: Formulation containing 3-iodo-2-propynyl butylcarbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION OF ROUGH CARPENTRY, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate [**furring,**] nailers, blocking, [**grounds,**] and similar supports to comply with requirements for attaching other construction.

C. Plywood Backing Panels: Install backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. [**Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.**]

D. Metal Framing Anchors: Install anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Sill-Sealer Gasket: Install gasket to form continuous seal between sill plates and foundation walls.

F. Sill-Sealer Gasket and Termite Barrier: Install gasket and termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than **16 inches (406 mm)** o.c.

I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than **96 inches (2438 mm)** o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than **96 inches (2438 mm)** o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and **2-inch nominal (38-mm actual)** thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than **100 sq. ft. (9.3 sq. m)** and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than **20 ft. (6 m)** o.c.

J. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

K. Field Application of Preservative Treatment: Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

L. Flexible Flashing: Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in ICC's "International Building Code" (IBC).
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF ROOFING NAILERS

A. Install roofing nailers where indicated on Drawings and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with

other work involved.

B. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

C. Securely attach roofing nailers to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with SPRI ED-1, Tables A6 and A7.

3.3 INSTALLATION OF WOOD BLOCKING

A. Install wood blocking where indicated on Drawings and where required for [**screeding or**] attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches (38 mm)** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.4 INSTALLATION OF WOOD FURRING

A. Install wood furring level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal- (19-by-63-mm actual-)** size furring [**horizontally**][**and**][**vertically**] at [**24 inches (610 mm)**][**600 mm**] o.c.

C. Furring to Receive Gypsum Board or Plaster Lath: Install **1-by-2-inch nominal- (19-by-38-mm actual-)** size furring vertically at [**16 inches (406 mm)**][**400 mm**] o.c.

3.5 INSTALLATION OF WALL AND PARTITION FRAMING

A. General: Provide single bottom plate and double top plates using members of **2-inch nominal (38-mm actual)** thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions [**and for load-bearing partitions where framing members bearing on partition are located directly over studs**] . Fasten plates to supporting construction unless otherwise indicated.

1. For exterior walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
2. For interior partitions and walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**][**2-by-3-inch nominal- (38-by-64-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
3. Provide continuous horizontal blocking at midheight of partitions more than **96 inches (2438 mm)** high, using members of **2-inch nominal (38-mm actual)** thickness and of same width as wall or partitions.

B. Construct corners and intersections with three or more studs [**, except that two studs may be used for interior non-load-bearing partitions**] .

C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.

1. For non-load-bearing partitions, provide double-jamb studs and headers not less than **4-inch nominal (89-mm actual)** depth for openings **48 inches (1200 mm)** and less in width, **6-inch nominal (140-mm actual)** depth for openings **48 to 72 inches (1200 to 1800 mm)** in width, **8-inch nominal (184-mm actual)** depth for openings **72 to 120 inches (1800 to 3000 mm)** in width, and not less than **10-inch nominal (235-mm actual)** depth for openings **10 to 12 ft. (3 to 3.6 m)** in width.
2. For load-bearing walls, provide double-jamb studs for openings **60 inches (1500 mm)** and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated [**or, if not indicated, in accordance with Table R602.7(1) or Table R602.7(2), as applicable, in ICC's "International Residential Code for One- and Two-Family Dwellings"**] .

D. Provide diagonal bracing in [**exterior walls, at both walls of each external corner**][**walls, at locations indicated on Drawings**] , at 45-degree angle, full-story height unless otherwise indicated. Use [**1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs**][**metal wall bracing, let into studs in saw kerf**] .

3.6 INSTALLATION OF FLOOR JOIST FRAMING

A. General: Install floor joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists as follows:

1. Where supported on wood members, by [**toe nailing or by**] using metal framing anchors.
2. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.

B. Fire Cuts: At joists built into masonry, bevel cut ends **3 inches (76 mm)** and do not embed more than **4 inches (102 mm)**.

C. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

D. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than one-third depth of joist; do not locate closer than **2 inches (50 mm)** from top or bottom.

E. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at ends of joists unless nailed to header or band.

F. Lap members framing from opposite sides of beams, girders, or partitions not less than **4 inches (102 mm)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

G. Anchor members paralleling masonry with **1/4-by-1-1/4-inch (6.4-by-32-mm)** metal strap anchors spaced not more than **96 inches (2438 mm)** o.c., extending over and fastening to three joists. Embed anchors at least **4 inches (102 mm)** into grouted masonry with ends bent at right angles and extending **4 inches (102 mm)** beyond bend.

H. Provide solid blocking between joists under jamb studs for openings.

I. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.

1. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.

J. Provide bridging of type indicated below, at intervals of **96 inches (2438 mm)** o.c., between joists.

1. Diagonal wood bridging formed from bevel-cut, **1-by-3-inch nominal- (19-by-64-mm actual-)** size lumber, double-crossed and nailed at both ends to joists.
2. Steel bridging installed to comply with bridging manufacturer's written instructions.

3.7 INSTALLATION OF CEILING JOIST AND RAFTER FRAMING

A. Ceiling Joists: Install with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.

1. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate, and nail to first joist or anchor with framing anchors or metal straps. Provide **1-by-8-inch nominal- (19-by-184-mm actual-)** size or **2-by-4-inch nominal- (38-by-89-mm actual-)** size stringers spaced **48 inches (1200 mm)** o.c. crosswise over main ceiling joists.

B. Rafters: Notch to fit exterior wall plates and [**toe nail or**] use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.

1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against valley rafters.
2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against hip rafter.

C. Provide collar beams (ties) as indicated or, if not indicated, provide **1-by-6-inch nominal- (19-by-140-mm actual-)** size boards between every third pair of rafters, but not more than **48 inches (1219 mm)** o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.

D. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.8 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00

Task	Specification	Specification Description
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 16 00	01 22 00 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry

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SECTION 06 13 00 00 - HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Timber.
2. Round wood poles.
3. Preservative-treated wood material.
4. Timber connectors.
5. Miscellaneous materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with heavy timber framing.
2. Section 061516 "Wood Roof Decking."
3. Section 061800 "Glued-Laminated Construction."

1.2 DEFINITIONS

A. Timbers: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

B. Poles: Round wood members, called either "poles" or "posts" in the referenced standards.

C. Inspection agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.
3. NLGA: National Lumber Grades Authority.
4. SPIB: Southern Pine Inspection Bureau (The).
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**and**][**timber connectors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For timber connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.

3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: For heavy timber framing. Show layout, dimensions of each member, and details of connections.

D. Samples: Not less than [**5 inches (127 mm)**][**7 inches (178 mm)**][**9 inches (229 mm)**] wide by **24 inches (600 mm)** long, showing the range of variation to be expected in appearance, including surface texture, of wood products.[**Apply a coat of penetrating sealer to Samples.**]

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For timbers specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber-grading agency for exposed timber not marked with grade stamp.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of materials to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 WOOD MATERIALS, GENERAL

A. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

I. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

J. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 TIMBER

A. Comply with DOC PS 20 and with grading rules of lumber-grading agencies certified by ALSC's Board of Review as applicable.

1. Factory mark each item of timber with grade stamp of grading agency.
2. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that are not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.

B. Timber Species and Grade:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**Select Structural**][**No. 1**][**No. 2**], NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**Select Structural**][**No. 1**][**No. 2**], WCLIB.
3. Douglas fir-larch or Douglas fir-larch (North); [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
4. Hem-fir or hem-fir (North); [**Select Structural**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
5. Southern pine; [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2 Dense**][**No. 2**], SPIB.
6. [**Beech-birch-hickory**][**Mixed maple**][**Mixed oak**][**Northern red oak**][**Red maple**][**Red oak**][**White oak**]; [**Select Structural**][**No. 1**][**No. 2**], NeLMA.
7. [**Mixed hardwoods**][**Mixed oak**][**Red oak**][**White oak**]; [**Select Dimension**][**Common Dimension**][**Sound Square Edge**], NHLA.

C. Structural Properties: Provide any species and grade that, for moisture content provided, complies with required structural properties.

1. Allowable Stress Ratings for 12-Inch Nominal (286-mm Actual) Depth: [**Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa)**][**Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa)**][**As indicated on Drawings**].

D. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing[**or provide timber that is unseasoned at time of dressing but with 19 percent maximum moisture content at time of installation**].

E. Dressing: Provide [**dressed timber (S4S)**][**timber that is rough sawn (Rgh)**] unless otherwise indicated.

2.3 ROUND WOOD POLES

A. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.4 PRESERVATIVE-TREATED WOOD MATERIAL

A. Pressure-treat materials with waterborne preservative according to AWPA U1; Use Category UC2[**for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or

chromium.

1. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.

E. After treatment, redry materials to 19 percent maximum moisture content.

F. Mark treated materials with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For exposed items indicated to receive a stained or natural finish, [**mark each piece on surface that is not exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

G. Application: [**Treat all heavy timber framing unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Sills and similar members in contact with masonry or concrete.
2. Timber framing members less than **18 inches (460 mm)** above grade.

2.5 TIMBER CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Halfen USA, Inc.**]
2. [**Simpson Strong-Tie Co., Inc.**]
3. [**USP Structural Connectors**]

B. Fabricate beam seats from [**steel**][**stainless steel**] with [**0.239-inch (6-mm)**][**3/16-inch (5-mm)**][**3/8-inch (9.5-mm)**] bearing plates, **3/4-inch- (19-mm-)** diameter-by-**12-inch- (300-mm-)** long deformed bar anchors, and **0.239-inch (6-mm)** side plates.

C. Fabricate beam hangers from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** stirrups and **0.239-inch (6-mm)** top plates.

D. Fabricate strap ties from [**steel**][**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**][**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

E. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

F. Provide bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; provide nuts complying with **ASTM A563 (ASTM A563M)**; and, where indicated, provide flat washers.

G. Provide stainless steel bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM F593,**

Alloy Group 1 or 2 (ASTM F738M, Grade A1 or A4); provide nuts complying with ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or A4); and, where indicated, provide flat washers.

H. Provide shear plates, [2-5/8 inches (66.7 mm)][4 inches (102 mm)] in diameter, complying with ASTM D5933.

I. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel plate, sheet, and strip complying with ASTM 240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Stainless steel flat bars complying with ASTM A666, [**Type 304**][**Type 316**].
6. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**][**Type 316**].

J. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.

K. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.6 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.7 FABRICATION

A. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.

B. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.

C. Predrill for fasteners and assembly of units.

D. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Coat crosscuts with end sealer.

F. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit except for treated wood where the treatment included a water repellent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Erect heavy timber framing true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Install horizontal and sloping members with crown edge up, and provide not less than **4 inches (102 mm)** of bearing on supports. Provide continuous members unless otherwise indicated; tie together over supports with metal strap ties if not continuous.
2. Handle and temporarily support heavy timber framing to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide **1/2-inch (13-mm)** clearance at tops, sides, and ends of members built into masonry, and bevel cut ends **3 inches (76 mm)**; do not embed more than **4 inches (102 mm)** unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

D. Fitting: Fit members by cutting and restoring exposed surfaces to match specified surfacing.

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat crosscuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

3.2 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber framing if repairs are not approved by Architect, as directed by the Owner.

END OF SECTION 06 13 00 00

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Task	Specification	Specification Description
06 13 23 00	06 13 00 00	Heavy Timber Construction

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SECTION 06 15 00 00 - WOOD ROOF DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-sawn wood roof decking.
2. Glued-laminated wood roof decking.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with wood roof decking.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For glued-laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of wood roof decking.

1.3 INFORMATIONAL SUBMITTALS

A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL

A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 SOLID-SAWN WOOD ROOF DECKING

A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.

B. Roof Decking Species:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), hem-fir, hem-fir (North), southern pine, spruce pine-fir (North), western hemlock, or western hemlock (North).
2. [**Alaska cedar**][**Balsam fir**][**Douglas fir-larch or Douglas fir-larch (North)**][**Eastern spruce**][**Hem-fir or hem-fir (North)**][**Southern pine**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**4 by 6**].

D. Roof Decking Grade:

1. [**Select(ed)**][**Commercial**] Decking.
2. [**Dense Standard**][**Dense Select**][**Select**][**Dense Commercial**][**Commercial**] Decking.
3. [**Select(ed) Decking or Select Dex**][**Commercial Decking or Commercial Dex**].

E. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.

F. Moisture Content: Provide wood roof decking with [**15**][**19**] percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

2.3 GLUED-LAMINATED WOOD ROOF DECKING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Structural Wood Systems; A Division of Harrison Industries**]

B. Face Species: [**Alaska cedar**][**Douglas fir-larch or Douglas fir-larch (North)**][**Ponderosa pine**][**Southern pine**][**Western cedars or western cedars (North)**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**3 by 8**][**4 by 6**][**4 by 8**][**5 by 6**][**5 by 8**].

D. Roof Decking Configuration: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.

E. Face Grade:

1. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
2. Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stains, end slits, skips, roller splits, and planer burns are not allowed.
3. Service: Face knot holes, stains, end splits, skips, roller splits, planer burns, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.

F. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

I. Laminating Adhesive: Wet-use type complying with ASTM D2559.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat wood roof decking in accordance with AWPA U1; Use Category UC2.

1. For laminated roof decking, treat lumber before gluing.

B. Preservative Chemicals: [**Inorganic boron (SBX)**][**Acceptable to authorities having jurisdiction and containing no arsenic or chromium**].

1. For exposed items indicated to receive a stained or natural finish, use products that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with

application of indicated finishes.

E. After treatment, redry materials to [**15**][**19**] percent maximum moisture content.

F. After dressing and fabricating roof decking, apply [**inorganic boron**][**copper naphthenate**] in accordance with AWPA M4 to surfaces cut to a depth of more than **1/16 inch (1.5 mm)**.

2.5 ACCESSORY MATERIALS

A. Fasteners for Solid-Sawn Roof Decking: Provide fastener size and type complying with AITC 112 for thickness of deck used.

B. Fasteners for Glued-Laminated Roof Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated roof decking.

C. Nails: Common; complying with ASTM F1667, Type I, Style 10.

D. Spikes: Round; complying with ASTM F1667, Type III, Style 3.

E. Fastener Material: Hot-dip galvanized steel.

F. Bolts for Anchoring Roof Decking to Walls: Carbon steel; complying with **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers[**, all hot-dip zinc coated**].

G. Installation Adhesive: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.

H. Sealants: Latex, complying with applicable requirements in Section 079200 "Joint Sealants" and recommended by sealant manufacturer and manufacturer of substrates for intended application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**May National Associates, Inc.; a subsidiary of Sika Corporation**]
c. [**Pecora Corporation**]
d. [**Permathane; a Holcim brand**]
e. [**Tremco Incorporated**]

I. Penetrating Sealer: Clear sanding sealer complying with Section 099300 "Staining and Transparent Finishing" and compatible with topcoats specified for use over it.

2.6 FABRICATION

A. Shop Fabrication: Where preservative-treated roof decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.

B. Predrill roof decking for lateral spiking to adjacent units to comply with AITC 112.

C. Seal Coat: After fabricating and surfacing roof decking, apply a saturation coat of penetrating sealer[**in fabrication shop**].

D. Apply indicated finish materials to comply with Section 099300 "Staining and Transparent Finishing" in fabrication shop.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install solid-sawn wood roof decking to comply with AITC 112.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].

B. Install laminated wood roof decking to comply with manufacturer's written instructions.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].
2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.

   a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
   b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
   c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
   d. Use 30d tongue nails in bottom tongue and **3/8-inch (10-mm)** face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.

3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at **30 inches (750 mm)** o.c. and within **12 inches (300 mm)** of the end of each unit. Stagger nailing **15 inches (380 mm)** in adjacent courses.

   a. Use 6d nails for 2-by-6 and 2-by-8 roof decking.
   b. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
   c. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
   d. Use 16d nails for 5-by-6 and 5-by-8 roof decking.

4. Glue adjoining roof decking courses together by applying a **3/8-inch (10-mm)** bead of adhesive to the top of tongues, according to research/evaluation report.

C. Anchor wood roof decking, where supported on walls, with bolts as indicated.

D. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

1. For solid-sawn roof decking, use inorganic boron (SBX).
2. For laminated roof decking, use copper naphthenate.

E. Apply joint sealant to seal roof decking at exterior walls at the following locations:

1. Between roof decking and supports located at exterior walls.
2. Between roof decking and exterior walls that butt against underside of roof decking.
3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.3 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect, as directed by the Owner.

3.4 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.

B. If, despite protection, [**inorganic boron (SBX)-treated**] roof decking becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 15 00 00

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SECTION 06 15 00 00A - WOOD PATIO DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood decking.
2. Wood stair treads.
3. Wood railings.
4. Wood benches.
5. Plastic decking.

B. Related Requirements:

1. Section 072500 "Weather Barriers" for flexible flashing used with patio decking.
2. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing used with patio decking.

1.2 DEFINITIONS

A. Boards: Lumber of less than **2 inches nominal (38 mm actual)** in thickness and **2 inches nominal (38 mm actual)** or greater in width.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** or greater but less than **5 inches nominal (114 mm actual)** in least dimension.

C. Timber: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**plastic decking**][**and**][**metal framing anchors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For [**plastic decking**][**and**][**metal framing anchors**]. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point

of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: For plastic decking, not less than **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of decking, including surface texture.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

C. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products.
2. Plastic decking.
3. Expansion anchors.
4. Metal framing anchors.
5. Decking fasteners.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Handle and store plastic lumber to comply with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**].
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**].
3. Timber. [**19 percent**][**No limit**].

2.2 WOOD DECKING

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Decking:

1. [**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.

2. [**Deck Heart or Construction Heart**][**Deck Common or Construction Common**] redwood; RIS.

C. Radius-Edged Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.

10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

D. S4S Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

a. Clear[**one face; small pin knots and worm holes allowed on back face**].
b. Sound; small pin knots, worm holes, and fixed knots allowed.
c. All heart[**one face**].
d. Straight grained and parallel cut.
e. Free of heart centers.
f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
g. No discoloration.

2.3 WOOD STAIR TREADS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Radius-Edged Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.
10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

C. Half-Round or Rounded-Edged Nosing Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B stepping**][**Near Rift B & B stepping**][**B & B stepping**]; SPIB.

D. S4S Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

a. Clear[**one face; small pin knots and worm holes allowed on back face**].
b. Sound; small pin knots, worm holes, and fixed knots allowed.
c. All heart[**one face**].
d. Straight grained and parallel cut.

e. Free of heart centers.
f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
g. No discoloration.

2.4 WOOD RAILINGS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Railing Members:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

C. Railing Boards:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, B & B finish; SPIB.

D. Radius-Edged Railing Boards: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.5 WOOD BENCHES

A. Dimension Lumber for Benches:

1. [**Select Structural**][**No. 1**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

B. Boards for Benches:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B finish**][**Near Rift B & B finish**][**B & B finish**]; SPIB.

C. Radius-Edged Boards for Benches: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.6 DIMENSION LUMBER FRAMING

A. Deck and Stair Framing:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

   a. Hem-fir (North); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Mixed southern pine; SPIB.
   e. Spruce-pine-fir; NLGA.
   f. Douglas fir-south; WWPA.
   g. Hem-fir; WCLIB or WWPA.
   h. Douglas fir-larch (North); NLGA.
   i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

2. Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

2.7 POSTS

A. Dimension Lumber Posts: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

1. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
2. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
3. Mixed southern pine; SPIB.
4. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
5. Northern species; NLGA.
6. Eastern softwoods; NeLMA.
7. Western woods; WCLIB or WWPA.

B. Timber Posts:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**No. 1**][**No. 2**]; NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**No. 1**][**No. 2**]; WCLIB.
3. Southern pine; [**No. 1**][**No. 2**]; SPIB.

C. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.8 PRESERVATIVE-TREATED LUMBER

A. Pressure treat boards and dimension lumber with waterborne preservative in accordance with AWPA U1; Use Category UC3b[**for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Pressure treat timber with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

C. Pressure treat poles with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

D. Preservative Chemicals: Acceptable to authorities having jurisdiction.

1. Do not use chemicals containing arsenic or chromium [**except for timber posts**][**except for poles**].

E. Use process[**for boards and dimension lumber**] that includes water-repellent treatment.

F. Use process[**for boards and dimension lumber**] that does not include water repellents or other substances that might interfere with application of indicated finishes.

G. After treatment, redry [**boards**][**dimension lumber**][**timber**][**and**][**poles**] to 19 percent maximum moisture content.

H. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, [**mark each piece on surface that will not be exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

I. Application: [**Treat all wood unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Framing members[**less than 18 inches (460 mm) above grade**].
2. Sills and ledgers.
3. Members in contact with masonry or concrete.
4. Posts.
5. Round wood poles.
6. Decking.
7. Stair treads.

2.9 PLASTIC DECKING

A. Plastic Lumber, General: Products acceptable to authorities having jurisdiction with current model code evaluation reports that show compliance with building code in effect for Project for indicated type of construction.

1. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, are not to be less than design loads and spans indicated.

B. Composite Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Fiberon**]
    c. [**Green Bay Decking, LLC**]
    d. [**Midwest Manufacturing**]
    e. [**MoistureShield; Oldcastle APG, Inc., CRH Americas, Inc.**]
    f. [**NewTechWood America, Inc.**]
    g. [**TimberTech, AZEK Building Products; The AZEK Company LLC**]
    h. [**Trex Company, Inc.**]
    i. [**UFP Construction; a UFP Industries Company**]

2. Decking Standard: [**ICC-ES AC109**][**or**][**ICC-ES AC174**].
3. Decking Size: [**7/8 by 5-1/2 inches (22 by 140 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**1-1/4 by 6 inches (32 by 152 mm) actual**][**1-3/8 by 3-1/2 inches (35 by 89 mm) actual**][**1-3/8 by 5-1/2 inches (35 by 140 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**].
4. Configuration: Provide product with grooved edges designed for fastening with concealed decking fasteners.
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

C. All-Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from high-density polyethylene (HDPE), PVC, polystyrene, or cellular PVC with no cellulose fiber.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Genova Products, Inc.**]
    c. [**Interplast Group, Ltd.**]
    d. [**L.B. Plastics, Inc.**]
    e. [**Re-Plast Products, Inc.**]
    f. [**RENEW Plastics, a division of N.E.W. Plastics Corp**]
    g. [**Veka Inc.**]
    h. [**Westech**]

2. Decking Standard: ICC-ES AC174.
3. Decking Size: [**1 by 6 inches (25 by 152 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**2 by 4 nominal, 1-1/2 by 3-1/2 inches (38 by 89 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**][**1-5/8 by 5-3/4 inches (41 by 146 mm) actual**].
4. Configuration: Provide product with [**grooved edges designed for fastening with concealed decking fasteners**][**or**][**tongue-and-groove edges designed for concealed fastening**].
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.10 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Use [**stainless steel**][**fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**] unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.
3. For [**plastic**][**wood**] decking, use stainless steel fasteners[**where fasteners are exposed to view**].
4. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Carbon-Steel Bolts: **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers all hot-dip zinc coated.

F. Stainless Steel Bolts: **ASTM F593, Alloy Group 1 or 2 (ASTM F738M, Grade A1 or Grade A4)**; with **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4)** hex nuts and, where indicated, flat washers.

G. Postinstalled Anchors: Stainless steel, [**chemical**][**or**][**torque-controlled expansion**] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance with ASTM E488 conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or Grade A4)**.

2.11 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Tamlyn**]
2. [**USP Structural Connectors**]

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those [**indicated on Drawings**][**of products of manufacturers listed**]. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, [**G60 (Z180)**][**G90 (Z270)**][**G185 (Z550)**] coating designation.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

E. Joist Hangers: U-shaped, with **2-inch- (50-mm-)** long seat and **1-1/4-inch- (32-mm-)** wide nailing flanges at least 85 percent of joist depth.

1. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

F. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

1. Strap Width: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

G. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.

H. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

1. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].
3. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**].

2.12 CONCEALED DECKING FASTENERS

A. Deck Splines: Corrosion-resistant metal or plastic splines that fit in grooves routed into the sides of decking material and are fastened to deck framing with screws. Splines provide uniform spacing of decking material.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Grabber Construction Products, Inc.**]
b. [**Ipe Clip Fastener Company Inc. (The)**]
c. [**M. M. Products, Inc.**]
d. [**Titan Metal Werks, Inc.**]

B. Deck Clips: Black-oxide-coated, stainless steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**FastenMaster; a division of OMG, Inc.**]

C. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy-powder-coated, hot-dip galvanized steel or stainless steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Grabber Construction Products, Inc.**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Prime wood[**indicated to be painted**], including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Section 099113 "Exterior Painting."

C. Stain wood[**indicated to be stained**], including both faces and edges. Cut to required lengths and stain ends. Comply with requirements in Section 099300 "Staining and Transparent Finishing."

3.3 INSTALLATION, GENERAL

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.

C. Install wood decking[**and stair treads**] with crown up (bark side down).

D. Install plastic lumber to comply with manufacturer's written instructions.

E. Secure decking to framing with [**deck splines**][**deck clips**][**deck tracks**][**or**][**screws**].

F. Install metal framing anchors to comply with manufacturer's written instructions.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

I. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Apply copper naphthenate field treatment to comply with AWPA M4, to cut surfaces of preservative-treated lumber.

K. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES AC70 for power-driven fasteners.
2. "Fastening Schedule" in ICC's International Building Code.
3. "Fastener Schedule for Structural Members" and "Alternate Attachments" in ICC's International Residential Code for One- and Two-Family Dwellings.

L. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.

3.4 INSTALLATION OF ELEVATED DECK JOIST FRAMING

A. General: Install joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.

B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

C. Lap members framing from opposite sides of beams or girders not less than **4 inches (102 mm,)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

D. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at intervals of **96 inches (2438 mm)** o.c., between joists.

3.5 INSTALLATION OF STAIRS

A. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:

1. Stringer Size: **2 by 12 inches nominal (38 by 286 mm actual)**, minimum.
2. Notching: Notch stringers to receive treads, risers, and supports; leave at least **3-1/2 inches (89 mm)** of effective depth.
3. Stringer Spacing: At least three stringers for each **36-inch (914-mm)** clear width of stair.

B. Provide stair framing with no more than[**3/16-inch (4.7-mm)** **variation between adjacent treads and risers and no more than**] **3/8-inch (9.5-mm)** variation between largest and smallest treads and risers within each flight.

C. Treads and Risers: Secure by gluing and [**nailing**][**screwing**] to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages[**and finish with bullnose edge**].

3.6 INSTALLATION OF RAILINGS

A. Balusters: Fit to railings, [**glue, and**][**nail**][**screw**] in place. Countersink fastener heads, fill flush, and sand filler.

B. Newel Posts: Secure to stringers and risers with [**through bolts**][**lag screws**][**countersunk-head wood screws and glue**].

C. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts[**and glue**].

END OF SECTION 06 15 00 00A

Task	Specification	Specification Description
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	06 15 00 00	Wood Roof Decking
06 15 13 00	06 15 00 00a	Wood Patio Decking

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SECTION 06 16 00 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring.
6. Underlayment.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.
2. Section 072500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.2 DEFINITIONS

A. ABAA: The Air Barrier Association of America.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical

data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
4. Product Data: For installation adhesives, indicating VOC content.
5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer [**including list of ABAA-certified installers and supervisors employed by Installer, who work on Project**][**and**][**testing and inspecting agency**] .

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.
4. Air-barrier and water-resistant glass-mat gypsum sheathing.
5. Power-driven fasteners.

E. Field Quality Control Reports: For specified tests and inspections.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer is to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and is to employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing meeting the requirements as follows:

    a. Independent agency, qualified in accordance with ASTM E329 for testing indicated, and certified by ABAA.

C. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.7 MOCKUPS

A. Build mockups to set quality standards for materials and execution [**and for preconstruction testing**], as directed by the Owner .

1. Build integrated mockups of exterior wall assembly [**as indicated on Drawings**][**150 sq. ft. (14 sq. m)**] , incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.

    a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
    b. Include junction with roofing membrane [**building corner condition,**][**and**][**foundation wall intersection**] .
    c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved, as directed by the Owner.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on field mockups, as directed by the Owner.

B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies are to comply with performance requirements, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization with detection liquids**] .
2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .
3. Notify Architect [**seven**] days in advance of the dates and times when mockups will be tested, as directed by the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [**tie-ins to installed waterproofing**][**tie-ins to other installed air barriers**] , and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD STRUCTURAL PANEL PRODUCTS

A. General: Wood structural panels include plywood, mat-formed (nonveneer) panels such as oriented strand board, and composite panels, which are veneer-faced panels with mat-formed cores.

B. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Certified Wood: Verify the following wood products are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

D. Certified Wood: Verify the following wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

E. Certified Wood: Verify the following wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

F. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on Drawings.

G. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative-Treated Plywood by Pressure Process: AWPA U1, use categories as follows:

1. UC2, Interior/Damp: For interior construction not in contact with ground but may be subject to moisture.
2. UC3B, Above Ground, Exposed: For exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting.
3. UC4A, Ground Contact: For wood panels in contact with ground and exposed to all weather cycles, normal exposure conditions.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: [**Treat all plywood unless otherwise indicated**][**Treat items indicated on Drawings**][**and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing**] .

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft.** **(3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment must not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated on Drawings.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood is to be tested in accordance with ASTM D5516 and design value adjustment factors are to be calculated in accordance with ASTM D6305. Span ratings after treatment are to be not less than span ratings specified. [**For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) are to be not less than span ratings specified.**]

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: [**Treat all plywood unless otherwise indicated.**][**Treat plywood indicated on Drawings, and the following:**]

1. Roof [**and wall**] sheathing within **48 inches (1220 mm)** of [**fire**][**party**] walls.
2. Roof sheathing.
3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

A. Plywood Sheathing, Walls:

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**] .
3. Nominal Thickness: Not less than [**11/32 inch (8.7 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Walls:

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**] .
3. Nominal Thickness: Not less than [**5/16 inch (7.9 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Edge and End Configuration: [**V-shaped, tongue-and-groove long edges; square ends**][**Square**] .
4. Size: [**24 by 96 inches (610 by 2438 mm) for horizontal**][**48 by 96 inches (1219 by 2438 mm) for vertical**][**48 by 108 inches (1219 by 2743 mm) for vertical**][**600 by 2400 mm for horizontal**][**1200 by 2400 mm for vertical**][**1200 by 2750 mm for vertical**] installation.

D. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Continental Building Products Inc.**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Georgia-Pacific Gypsum LLC**]
   b. [**Tremco Commercial Sealants and Waterproofing, part of Tremco CPG**]
   c. [**USG Corporation**]

2. Thickness: **5/8 inch (15.9 mm)** thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.
4. Edges: Square.
5. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
6. Air Permeance: Maximum [**0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa)**] pressure difference when tested in accordance with ASTM E2178.
7. Vapor Permeance: Minimum [**20 perms (580 ng/Pa x s x sq. m)**] when tested in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.
8. Sheathing Assembly Air Leakage: Maximum [**0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa)**] when tested in accordance with ASTM E2357.
9. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
10. UV Resistance: Can be exposed to sunlight for [**30**][**90**][**180**] days in accordance with manufacturer's written instructions.
11. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

F. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] .

G. Cementitious Backer Units, Walls: ASTM C1325, Type A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C-Cure**]
   b. [**Custom Building Products**]
   c. [**FinPan, Inc.**]
   d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

H. Fiberboard Sheathing: ASTM C208, Type IV, cellulosic fiberboard sheathing with square edges.

1. Grade: [**1 (Regular)**][**2 (Structural)**] .
2. Thickness: [**1/2 inch (13 mm)**][**25/32 inch (20 mm)**] .

I. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**DiversiFoam Products**]
   b. [**HydroBlok**]
   c. [**Kingspan Insulation LLC**]
   d. [**Owens Corning**]
   e. [**The Dow Chemical Company**]

2. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

J. Foil-Faced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings are to have a flame-spread index of

25 or less when tested individually.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Coatings & Waterproofing Inc**]
   c. [**Elevate; Amrize Building Envelope LLC**]
   d. [**Hunter Panels; a Carlisle Company**]
   e. [**Rmax, A Business Unit of Sika Corporation**]
   f. [**The Dow Chemical Company**]

2. Thickness: [**7/16 inch (11.1 mm)**][**1/2 inch (13 mm)**][**5/8 inch (15.9 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

2.6 ROOF SHEATHING

A. Plywood Sheathing, Roofs :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Roofs :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

2.7 PARAPET SHEATHING

A. Plywood Sheathing, Parapets :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Parapets :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

C. Glass-Mat Gypsum Roof Boards, Parapets: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

D. Cementitious Backer Units, Parapets: ASTM C1325, Type A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C-Cure**]
   b. [**Custom Building Products**]
   c. [**FinPan, Inc.**]
   d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

2.8 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
   c. [**Hunter Panels; a Carlisle Company**]
   d. [**Johns Manville; a Berkshire Hathaway company**]
   e. [**Rmax, A Business Unit of Sika Corporation**]
   f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .

B. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type II,

Class 1, with DOC PS 2, Exposure 1 oriented strand board adhered to spacers on one face.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
   c. [**Hunter Panels; a Carlisle Company**]
   d. [**Johns Manville; a Berkshire Hathaway company**]
   e. [**Rmax, A Business Unit of Sika Corporation**]
   f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .
4. Spacers: Wood furring strips or blocks not less than **3/4 inch (19 mm)** thick and spaced not more than [**12 inches (300 mm)**][**16 inches (400 mm)**][**24 inches (600 mm)**] o.c.

2.9 SUBFLOORING

A. Plywood Combination Subfloor-Underlayment :

1. Classification: DOC PS 1, [**Exterior, Structural I, C-C Plugged**][**Exterior, C-C Plugged**][**Exposure 1, Structural I, Underlayment**][**Exposure 1, Underlayment**] single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: Fully sanded face.

B. Oriented-Strand-Board Combination Subfloor-Underlayment :

1. Classification: DOC PS 2, Exposure 1 single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: [**Fully sanded**][**Resin-impregnated overlay**] face.

C. Plywood Subflooring :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] single-floor panels or sheathing.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

D. Oriented-Strand-Board Subflooring :

1. Classification: DOC PS 2, Exposure 1 [**Structural I sheathing**][**single-floor panels or sheathing**] .
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**][**60/32**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

2.10 UNDERLAYMENT

A. General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than **1/4 inch (6.4 mm)** over smooth subfloors and not less than **3/8 inch (9.5 mm)** over board or uneven subfloors.

B. Plywood Underlayment for Resilient Flooring :

1. Classification: DOC PS 1, [**Exterior A-C**][**Exterior B-C**][**Exterior, C-C Plugged**][**Exposure 1 Underlayment**] with fully sanded face.

C. Plywood Underlayment for Ceramic Tile :

1. Classification: DOC PS 1, Exterior, C-C Plugged, not less than **5/8-inch (15.9-mm)** nominal thickness.

D. Plywood Underlayment for Carpet :

1. Classification: DOC PS 1, [**Exterior, C-C Plugged**][**Exposure 1, Underlayment**][**Interior, Underlayment**] .

E. Particleboard Underlayment : ANSI A208.1, [**Grade PBU**][**Grade M-2**] .

1. Verify particleboard is made without urea formaldehyde.
2. Verify particleboard has formaldehyde emission rates not greater than 0.09 ppm when tested in accordance with ASTM D6007 or ASTM E1333.

F. Hardboard Underlayment : ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.11 MISCELLANEOUS MATERIALS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacturer.

1. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**][**of Type 304 stainless steel**] .
2. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended in writing by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than **0.0329 inch (0.835 mm)** thick, use screws that comply with ASTM C1002.
2. For steel framing from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

H. Sealant for Paper-Surfaced and Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended in writing by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

I. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended in writing by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum **2 inches (50 mm)** wide, **10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m)**, of type recommended in writing by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

J. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended in writing by sheathing manufacturer for sealing joints and penetrations in sheathing.

K. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with [**APA AFG-01**][**ASTM D3498**] that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in the ICC's "International Building Code."
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate [**wall**][**parapet**][**and**][**roof**] sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF WOOD STRUCTURAL PANELS

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Combination Subfloor-Underlayment:

a. [**Glue and nail**][**Nail**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

2. Subflooring:

a. [**Glue and nail**][**Nail**][**Nail or staple**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

3. Wall and Roof Sheathing:

a. [**Nail**][**Nail or staple**] to wood framing. [**Apply a continuous bead of glue to framing members at edges of wall sheathing panels.**]
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

4. Underlayment:

a. [**Nail**][**Nail or staple**] to subflooring.

b. Space panels **1/32 inch (0.8 mm)** apart at edges and ends.
c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to wood framing with [**nails**][**or**][**screws**] .
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
3. Install panels with a **3/8-inch (9.5-mm)** gap where non-load-bearing construction abuts structural elements.
4. Install panels with a **1/4-inch (6.4-mm)** gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.4 INSTALLATION OF AIR-BARRIER AND WATER-RESISTANT GLASS-MAT GYPSUM SHEATHING

A. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.

1. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install transition strip on roofing membrane or base flashing, so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate.

B. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

D. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [**transition strip**][**preformed silicone extrusion**] , so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate. Maintain **3 inches (75 mm)** of full contact over solid bearing to perimeter frames, with not less than **1 inch (25 mm)** of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

E. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.

F. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

G. Seal top of through-wall flashings to sheathing with an additional **6-inch- (150-mm-)** wide transition strip.

H. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

I. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending **6 inches (150 mm)** beyond repaired areas in strip direction.

3.5 INSTALLATION OF CEMENTITIOUS BACKER UNITS

A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.6 INSTALLATION OF FIBERBOARD SHEATHING

A. Comply with ASTM C846 and with manufacturer's written instructions.

B. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails [**or galvanized staples**] ; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least **3/8 inch (9.5 mm)** from edges and ends.

C. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow **1/8-inch (3-mm)** open space between edges

and ends of adjacent units. Stagger horizontal joints if any.

D. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

3.7 INSTALLATION OF FOAM-PLASTIC SHEATHING

A. Comply with manufacturer's written instructions.

B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

3.8 INSTALLATION OF PARTICLEBOARD UNDERLAYMENT

A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.

1. Fastening Method: [**Glue and nail**][**Nail**][**Nail or staple**] underlayment to subflooring.

3.9 INSTALLATION OF HARDBOARD UNDERLAYMENT

A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.

1. Fastening Method: [**Nail**][**Nail or staple**] underlayment to subflooring.

3.10 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. [**Inspections may include the following:**]

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
3. Termination mastic has been applied on cut edges.
4. Strips and transition strips have been firmly adhered to substrate.
5. Compatible materials have been used.
6. Transitions at changes in direction and structural support at gaps have been provided.
7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization using detection liquids**] .
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 06 16 00 00

Task	Specification	Specification Description
06 16 23 00	06 10 00 00	Rough Carpentry
06 16 23 00	06 16 00 00	Sheathing
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	06 16 00 00	Sheathing
06 16 43 00	06 10 00 00	Rough Carpentry
06 16 43 00	06 16 00 00	Sheathing
06 17 13 00	06 10 00 00	Rough Carpentry
06 17 13 00	06 18 00 00	Glued-Laminated Construction
06 17 23 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 18 00 00	Glued-Laminated Construction

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SECTION 06 17 53 00 - SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Preservative-treated lumber.
3. Fire-retardant-treated lumber.

1.2 ALLOWANCES

A. Provide wood truss bracing under the Metal-Plate-Connected Truss Bracing Allowance as specified in Section 012100 "Allowances."

1.3 DEFINITIONS

A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For [**wood-preservative-treated lumber,**][**fire-retardant-treated lumber,**] metal-plate connectors, metal truss accessories, and fasteners.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification from treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.

5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.

D. Delegated Design Submittals: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**metal connector-plate manufacturer**][**professional engineer**][**and**][**fabricator**].

B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated lumber.
2. Fire-retardant-treated wood.
3. Metal-plate connectors.
4. Metal truss accessories.

1.6 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that [**participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction**][**and**][**is certified for chain of custody by an FSC-accredited certification body**].

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

D. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

E. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

F. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

G. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Metal-plate-connected wood trusses are to be capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection under Design Loads:

a. Roof Trusses: Vertical deflection of [**1/180**][**1/240**][**1/360**] of span.
b. Floor Trusses: Vertical deflection of [**1/360**][**1/480**][**1/600**] of span.

C. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.

D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

G. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

H. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

J. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

K. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

L. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

M. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

N. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 WOOD PRODUCTS

A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.

3. Provide dressed lumber, S4S.
4. Provide dry lumber with [**15**][**19**] percent maximum moisture content at time of dressing.

B. Minimum Chord Size for Roof Trusses: [**2 by 6 inches nominal (38 by 140 mm actual) for top chords**][**2 by 6 inches nominal (38 by 140 mm actual) for bottom chords**][**2 by 6 inches nominal (38 by 140 mm actual) for both top and bottom chords**].

C. Minimum Specific Gravity for Top Chords: [**0.50**].

D. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

2.3 PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2[**for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed trusses indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

D. Application: Treat [**all trusses unless otherwise indicated**][**trusses where indicated on Drawings**].

2.4 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201 at 92 percent relative humidity. Use for interior locations

where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber is to be tested in accordance with ASTM D5664, and design value adjustment factors is to be calculated in accordance with ASTM D6841.[**For enclosed roof framing and framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.**]

C. Kiln-dry lumber after treatment to a maximum moisture content of [**15**][**19**] percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed trusses and bracing indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

E. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat [**all trusses unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Floor trusses.
2. Roof trusses.

2.5 METAL CONNECTOR PLATES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpine, a division of ITW Inc.**]
2. [**Cherokee Metal Products, Inc.; Masengill Machinery Company**]
3. [**Eagle Metal Products**]
4. [**MiTek Industries, Inc.**]

B. Fabricate connector plates to comply with TPI 1.

C. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G60 (Z180)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], and not less than **0.035 inch (0.88 mm)** thick.

1. Use for exterior locations[**, wood-preservative-treated lumber,**][**fire-retardant treated lumber,**] and where indicated.

2.6 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
2. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**][**of Type 304 stainless steel**].

B. Nails, Brads, and Staples: ASTM F1667.

2.7 METAL FRAMING ANCHORS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Allowable design loads, as published by manufacturer, are to comply with or exceed those [**indicated**][**of products of manufacturers listed**]. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

1. Use for exterior locations and where indicated.

F. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, **1-1/2 inches (38 mm)** wide by **0.050 inch (1.3 mm)** thick.[**Tie fastens to one side of truss, top plates, and side of stud below.**]

G. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall studs

below, **2-1/4 inches (57 mm)** wide by **0.062 inch (1.6 mm)** thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.

H. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, **1-1/4 inches (32 mm)** wide by **0.050 inch (1.3 mm)** thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

I. Floor Truss Hangers: U-shaped hangers, full depth of floor truss, with **1-3/4-inch- (44-mm-)** long seat; formed from metal strap **0.062 inch (1.6 mm)** thick with tabs bent to extend over and be fastened to supporting member.

J. Roof Truss Bracing/Spacers: U-shaped channels, **1-1/2 inches (38 mm)** wide by **1 inch (25 mm)** deep by **0.040 inch (1.0 mm)** thick, made to fit between two adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

K. Drag Strut Connectors: Angle clip with one leg extended for fastening to the side of girder truss.

1. Angle clip is **3 by 3 by 0.179 by 8 inches (76 by 76 by 4.55 by 203 mm)** with extended leg **8 inches (203 mm)** long. Connector has galvanized finish.
2. Angle clip is **3 by 3 by 0.239 by 10-1/2 inches (76 by 76 by 6.07 by 267 mm)** with extended leg **10-1/2 inches (267 mm)** long. Connector has painted finish.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 92 percent zinc dust by weight.

2.9 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.10 SOURCE QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform special inspections, as directed by the Owner.

1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.

2. Provide special inspector with access to places where wood trusses are being fabricated to perform inspections.

B. Correct deficiencies in Work that special inspections indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses [**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**][**as indicated**]; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.

1. Anchor trusses to girder trusses as indicated.

I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install bracing to comply with Section 061000 "Rough Carpentry."
2. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

L. Replace wood trusses that are damaged or do not comply with requirements.

1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, as directed by the Owner.

3.2 REPAIRS AND PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate

solution by spraying to comply with EPA-registered label.

B. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

C. Repair damaged galvanized coatings on exposed surfaces in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform special inspections to verify that temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package, as directed by the Owner.

END OF SECTION 06 17 53 00

SECTION 06 18 00 00 - GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural glued-laminated timber.
2. Timber connectors.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with structural glued-laminated timber.
2. Section 061300 "Heavy Timber Construction" for framing using [**timbers**][**and**][**round wood poles**].
3. Section 061516 "Wood Roof Decking" for glued-laminated wood roof decking.

1.2 DEFINITIONS

A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on lumber, adhesives, fabrication, and protection.
2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
3. For connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For laminating adhesives, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For laminating adhesives, indicating compliance with requirements for low-emitting materials.
6. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
7. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.

C. Shop Drawings:

1. Show layout of structural glued-laminated timber system and full dimensions of each member.
2. Indicate species and laminating combination.

3. Include large-scale details of connections.

D. Samples: Full width and depth, **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of structural glued-laminated timber[**including variations due to specified treatment**].

1. Apply specified factory finish to three sides of half length of each Sample.

E. Delegated Design Submittal: For structural glued-laminated timber and timber connectors.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in ANSI A190.1.

B. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.

C. Research/Evaluation Reports: For [**structural glued-laminated timber**][**and**][**timber connectors**], from ICC-ES.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: [**An AITC- or APA-EWS-licensed firm**][**certified for chain of custody by an FSC-accredited certification body**].

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with provisions in AITC 111.

B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality

Requirements," to design structural glued-laminated timber and connectors.

B. Structural Performance: Structural glued-laminated timber and connectors are to withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in ANSI 117 or determined according to ASTM D3737 and acceptable to authorities having jurisdiction.

C. Seismic Performance: Structural glued-laminated timber and connectors are to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 STRUCTURAL GLUED-LAMINATED TIMBER

A. General: Provide structural glued-laminated timber that complies with ANSI A190.1 and ANSI 117 or research/evaluation reports acceptable to authorities having jurisdiction.

1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
2. Provide structural glued-laminated timber made from single species.
3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
4. Provide structural glued-laminated timber made with wet-use adhesive complying with ANSI A190.1.
5. Adhesives: Do not use adhesives that contain urea formaldehyde.
6. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesives: Do not use adhesives that contain urea formaldehyde.
9. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Species and Grades for Structural Glued-Laminated Timber:

1. [**Alaska cedar**][**Douglas fir-larch**][**Southern pine**][**Any species**] in grades needed to comply with "Performance Requirements" Article.
2. [**Alaska cedar**][**Douglas fir-larch**][**Southern pine**][**Any species**] that complies with [**structural properties**][**combination symbols**][**beam stress classifications**] indicated.

M. Species and Grades: For [**beams**][**and**][**purlins**].

1. Species and Beam Stress Classification: [**Ponderosa pine, 16F-1.3E**][**Alaska cedar, 20F-1.5E**][**Eastern spruce, 20F-1.5E**][**Any species, 20F-1.5E**][**Any species, 24F-1.7E**][**Douglas fir-larch, 24F-1.8E**][**Southern pine, 24F-1.8E**][**Douglas fir-larch or southern pine, 24F-1.8E**][**Southern pine, 30F-2.1E**].
2. Lay-up: [**Balanced**][**Either balanced or unbalanced**].

N. Species and Grades for Arches:

1. Species and Beam Stress Classification: [**Alaska cedar, 20F-1.5E**][**Eastern spruce, 20F-1.5E**][**Any species, 20F-1.5E**][**Any species, 24F-1.7E**][**Douglas fir-larch, 24F-1.8E**][**Southern pine, 24F-1.8E**][**Douglas fir-larch or southern pine, 24F-1.8E**].
2. Lay-up: [**Balanced**][**Either balanced or unbalanced**].
3. Species and Combination Symbol: [**Alaska cedar, 20F-V13 WS**][**Douglas fir-larch, 24F-V8 WS**][**Southern pine, 24F-V5 SP**][**Alaska cedar, 20F-V12 WS**][**Douglas fir-larch, 24F-V4 WS**][**Southern pine, 24F-V3 SP**].

O. Species and Grades for [**Columns**][**and**][**Truss Members**]:

1. Species and Combination Symbol: [**Alaska cedar, 70**][**Douglas fir-larch, 1**][**Douglas fir-larch, 3**][**Southern pine, 47**][**Southern pine, 50**].

P. Appearance Grade: [**Premium**][**Architectural**][**Industrial**][**Framing**], complying with AITC 110.

1. For Premium and Architectural appearance grades, fill voids as required by AITC 110.[**For Premium appearance grade, use clear wood inserts, of matching grain and color, for filling voids and knot holes more than 1/4 inch (6 mm) wide.**]

2.3 PRESERVATIVE TREATMENT

A. Preservative Treatment: Where preservative-treated structural glued-laminated timber is indicated, comply with AWPA U1, Use [**Category 1**][**Category 2**][**Category 3A**][**Category 3B**][**Category 4A**].

1. Use preservative solution without[**water repellents or**] substances that might interfere with application of indicated finishes.
2. Do not incise structural glued-laminated timber or wood used to produce structural glued-laminated timber.

B. Preservative:[**One of the following:**]

1. Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
2. Pentachlorophenol in light petroleum solvent.
3. Copper naphthenate in a light petroleum solvent.
4. Ammoniacal zinc copper arsenate (ACZA) in a water solution.
5. Chromated copper arsenate (CCA) in a water solution.
6. Ammoniacal copper quat Type A (ACQ-C) in a water solution.
7. Propiconazole tebuconazole imidacloprid (PTI) in a water emulsion.

C. After dressing members, apply a copper naphthenate field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than **1/16 inch (1.5 mm)**.

2.4 TIMBER CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Simpson Strong-Tie Co., Inc.**]
2. [**USP Structural Connectors**]

B. Fabricate beam seats from [**steel**][**stainless steel**] with [**0.239-inch (6-mm)**][**3/16-inch (5-mm)**][**3/8-inch (9.5-mm)**] bearing plates, **3/4-inch- (19-mm-)** diameter-by-**12-inch- (300-mm-)** long deformed bar anchors, and **0.239-inch (6-mm)** side plates.

C. Fabricate arch base shoes from [**steel**][**stainless steel**] with **1-inch (25-mm)** baseplates and **3/8-inch (9.5-mm)** side plates.

D. Fabricate beam hangers from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** stirrups and **0.239-inch (6-mm)** top plates.

E. Fabricate hinge connectors from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** side plates and [**3/4-inch (19-mm)**][**1-inch (25-mm)**] top and bottom plates.

F. Fabricate strap ties from [**steel**][**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**][**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

G. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

H. Provide bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; nuts complying with **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

I. Provide shear plates, [**2-5/8 inches (66.7 mm)**][**4 inches (102 mm)**] in diameter, complying with ASTM D5933.

J. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel flat bars complying with ASTM A666, [**Type 304**][**Type 316**].
5. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**][**Type 316**].
6. Stainless steel plate, sheet, and strip complying with ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

K. Finish steel assemblies and fasteners with rust-inhibitive primer, **2-mil (0.05-mm)** dry film thickness.

L. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.5 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.6 FABRICATION

A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

1. Dress exposed surfaces as needed to remove planing and surfacing marks.

B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.

C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

D. End-Cut Sealing: Immediately after end cutting each member to final length[**and after preservative treatment**], apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit[**except for preservative-treated wood where treatment included a**

water repellent].

2.7 FACTORY FINISHING

A. Clear Finish: Manufacturer's standard, resistant to mildew and fungus.

1. Water repellent.
2. Film-forming two-coat, [**varnish**][**urethane**].

B. Semitransparent Stain Finish: Manufacturer's standard oil-based stain, resistant to mold and fungus.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

C. Solid-Color Stain Finish: Manufacturer's standard [**oil-based**][**latex**] penetrating stain, resistant to mildew and fungus.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Painted Finish: Acrylic latex system.

1. Prime Coat: Stain blocking primer as recommended by topcoat manufacturer.
2. Intermediate Coat: Matching topcoat.
3. Topcoat: High-performance architectural coating, [**low sheen**][**eggshell**][**satin**][**semigloss**].
4. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide **1/2-inch (13-mm)** clearance at tops, sides, and ends of members built into masonry; bevel cut ends **3 inches (76 mm)**; and do not embed more than **4 inches (102 mm)** unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements

for shop fabrication.

D. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing[**and finishing**].

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat cross cuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

   a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
   b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

3.3 ADJUSTING

A. Repair damaged surfaces[**and finishes**] after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect, as directed by the Owner.

3.4 PROTECTION

A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.

1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 06 18 00 00

Task	Specification	Specification Description
06 18 13 00	06 18 00 00	Glued-Laminated Construction
06 18 16 00	06 10 00 00	Rough Carpentry
06 18 16 00	06 18 00 00	Glued-Laminated Construction

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SECTION 06 20 00 00 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior trim.
2. Paneling.
3. Shelving and clothes rods.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view and for framing exposed to view.
2. Section 064023 "Interior Architectural Woodwork" for shop-fabricated carpentry.
3. Section 099123 "Interior Painting" or Section 099124 "Interior Painting (MPI Standards)" for priming and backpriming of interior finish carpentry.

1.2 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

C. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.

B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.

C. Samples for Verification:

1. For each species and cut of lumber and panel products with nonfactory-applied finish, with half of exposed surface finished; **50 sq. in. (300 sq. cm)** for lumber and **8 by 10 inches (200 by 250 mm)** for panels.
2. For foam-plastic moldings, with half of exposed surface finished; **50 sq. in. (300 sq. cm)**.
3. For each finish system and color of lumber and panel products with factory-applied finish, **50 sq. in. (300 sq. cm)** for lumber and **8 by 10 inches (200 by 250 mm)** for panels.

D. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

3. Chain-of-Custody Qualification Data: For manufacturer and vendor.

4. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation criteria.

5. Product Data: For installation adhesives, indicating VOC content.

6. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

7. Laboratory Test Reports: For installation adhesives, indicating compliance with VOC emissions evaluation criteria.

8. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

9. Product Data for Cradle-to-Cradle Certification:

   a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

   b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

   c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

10. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

11. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List

Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

12. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.

1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
2. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Regional Materials: Verify the following wood products are manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

1. Interior trim.

2. Fire-rated interior door [**and sidelight**] frames.
3. Interior [**plywood**][**hardboard**][**board**] paneling.
4. Shelving [**and clothes rods**] .
5. Interior [**stairs**][**and**][**railings**] .

B. Regional Materials: Verify the following wood products are manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

1. Interior trim.
2. Fire-rated interior door [**and sidelight**] frames.
3. Interior [**plywood**][**hardboard**][**board**] paneling.
4. Shelving [**and clothes rods**] .
5. Interior [**stairs**][**and**][**railings**] .

C. Certified Wood: Verify the following wood products are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

1. Interior trim.
2. Fire-rated interior door [**and sidelight**] frames.
3. Interior [**plywood**][**hardboard**][**board**] paneling.
4. Shelving [**and clothes rods**] .
5. Interior [**stairs**][**and**][**railings**] .

D. Certified Wood: Verify the following wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

1. Interior trim.
2. Fire-rated interior door [**and sidelight**] frames.
3. Interior [**plywood**][**hardboard**][**board**] paneling.
4. Shelving [**and clothes rods**] .
5. Interior [**stairs**][**and**][**railings**] .

E. Certified Wood: Verify the following wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Interior trim.
2. Fire-rated interior door [**and sidelight**] frames.
3. Interior [**plywood**][**hardboard**][**board**] paneling.
4. Shelving [**and clothes rods**] .
5. Interior [**stairs**][**and**][**railings**] .

F. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

G. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.

2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

H. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece [**or omit grade stamp and provide certificates of grade compliance issued by grading agency**] .

I. Softwood Plywood: DOC PS 1.

J. Hardboard: ANSI A135.4.

K. MDF: ANSI A208.2, [**Grade 130**].

L. Particleboard: ANSI A208.1, [**Grade M-2**][**Grade M-2-Exterior Glue**] .

M. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with ISO 4586-3, Grade VGS.

1. Color: [**White**][**Black**][**Gray**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category [**UC1**][**UC2**] .

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent, respectively.

2. Preservative Chemicals: Acceptable to authorities having jurisdiction [**and containing no arsenic or chromium**] .
3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
4. Do not use material that is warped or does not comply with requirements for untreated material.
5. Mark lumber with treatment-quality mark of an inspection agency approved by the ALSC's Board of Review.

a. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**] .

6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

7. Application: [**Where indicated on Drawings**][**All interior lumber and plywood**].

2.3 INTERIOR TRIM

A. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade:

a. Eastern white pine; NeLMA or NLGA [**C Select**][**D Select**][**Finish or 1 Common**][**Premium or 2 Common**] .
b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [**C Select (Choice)**][**D Select (Quality)**][**1 Common (Colonial)**][**2 Common (Sterling)**] .

c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [**C Select (Choice)**][**D Select (Quality)**][**Finish or 1 Common (Colonial)**][**Premium or 2 Common (Sterling)**] .
d. White woods; WWPA [**C Select**][**D Select**][**1 Common**][**2 Common**] .
e. Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA [**Superior or C & Btr**][**Prime or D**] finish.
f. Southern pine; SPIB [**B & B**][**C & Btr**] finish.
g. Western red cedar; NLGA, WCLIB, or WWPA [**Clear Heart**][**Grade A**][**Grade B**] .

2. Maximum Moisture Content: [**19**][**15**] percent [**with at least 85 percent of shipment at 12 percent or less**] .
3. Finger Jointing: [**Allowed**][**Not allowed**] .
4. Face Surface: [**Surfaced (smooth)**][**Saw textured**] .

B. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade: [**Red oak**][**White maple**][**Alder**][**Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar**]; NHLA [**Clear**][**A Finish**][**B Finish**] .

2. Maximum Moisture Content: [**13**][**10**][**9**] percent.
3. Finger Jointing: Not allowed.
4. Gluing for Width: [**Allowed**][**Not allowed**][**Use for lumber trim wider than 6 inches (150 mm)**] .
5. Veneered Material: [**Allowed**][**Not allowed**][**Use for lumber trim wider than 6 inches (150 mm)**] .
6. Face Surface: [**Surfaced (smooth)**][**Saw textured**] .
7. Matching: Selected for compatible grain and color.

C. Lumber Trim for Opaque Finish (Painted Finish):

1. Species and Grade:

a. Eastern white pine; NeLMA or NLGA [**D Select**][**Finish or 1 Common**][**Premium or 2 Common**] .
b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [**D Select (Quality)**][**1 Common (Colonial)**][**2 Common (Sterling)**] .

c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [**D Select (Quality)**][**Finish or 1 Common (Colonial)**][**Premium or 2 Common (Sterling)**] .
d. White woods; WWPA [**D Select**][**1 Common**][**2 Common**] .
e. Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA [**Superior or C & Btr**][**Prime or D**] finish.
f. Spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA [**1 Common**][**2 Common**] .
g. Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or

yellow poplar; NHLA [**A Finish**][**B Finish**] .

2. Maximum Moisture Content for Softwoods: [**19**][**15**] percent [**with at least 85 percent of shipment at 12 percent or less**] .

3. Maximum Moisture Content for Hardwoods: [**13**][**10**][**9**] percent.
4. Finger Jointing: [**Allowed**][**Not allowed**] .
5. Face Surface: [**Surfaced (smooth)**][**Saw textured**] .
6. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.

D. Softwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings. Made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."

1. Species: [**Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**][**Southern pine**][**Western red cedar**][**Douglas fir**].

2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
3. Finger Jointing: Not allowed.
4. Matching: Selected for compatible grain and color.

5. Base Pattern: [**WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee**][**WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch**][**WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge**][**WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee**][**WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge**] base.
6. Shoe-Mold Pattern: [**WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round**][**WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round**][**WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee**] shoe mold.
7. Casing Pattern: [**WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell**][**WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge**][**WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge**] casing.
8. Mull-Casing Pattern: [**WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge**][**WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose**][**WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge**] casing.
9. Stop Pattern: [**WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch**][**WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee**][**WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose**] stop.
10. Chair-Rail Pattern: WM 297, **11/16-by-3-inch (17-by-76-mm)** chair rail.

E. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings made to patterns included in MMPA's "HWM/Series Hardwood Moulding Patterns."

1. Species: [**Red oak**][**White maple**][**Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar**].
2. Maximum Moisture Content: 9 percent.
3. Finger Jointing: Not allowed.
4. Matching: Selected for compatible grain and color.
5. Optional Material: Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.

6. Base Pattern: [**HWM 633, 7/16-by-3-1/4-inch (11-by-83-mm) ogee**][**HWM 713, 7/16-by-3-1/4-inch (11-by-83-mm) ranch**][**HWM 753, 7/16-by-3-1/4-inch (11-by-83-mm) beaded-edge**][**WM 620, 7/16-by-4-1/4-inch (11-by-108-mm) ogee**] base.
7. Shoe-Mold Pattern: [**HWM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round**][**HWM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round**][**HWM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee**] shoe mold.
8. Casing Pattern: [**HWM 328, 1/2-by-2-1/4-inch (13-by-57-mm) clamshell**][**HWM 366, 1/2-by-2-**

1/4-inch (13-by-57-mm) **featheredge**][**HWM 376,** 1/2-by-2-1/4-inch (13-by-57-mm) **beaded-edge**] casing.

9. Mull-Casing Pattern: [**HWM 989,** 3/16-by-2-inch (5-by-51-mm) **square-edge**][**HWM 988,** 3/8-by-1-1/2-inch (9.5-by-38-mm) **featheredge**][**HWM 987,** 3/8-by-2-inch (9.5-by-51-mm) **featheredge**] casing.
10. Stop Pattern: [**HWM 856,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **ranch**][**HWM 946,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **ogee**][**HWM 886,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **bullnose**] stop.
11. Chair-Rail Pattern: HWM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

F. Moldings for Opaque Finish (Painted Finish): Made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."

1. Softwood Moldings: MMPA WM 4, P grade.

   a. Species: [**Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**].

   b. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.

2. Hardwood Moldings: MMPA WM 4, P-grade.

   a. Species: [**Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar**].
   b. Maximum Moisture Content: 9 percent.

3. Finger Jointing: [**Allowed**][**Not allowed**] .
4. Optional Material: Primed MDF.

5. Base Pattern: [**WM 623,** 9/16-by-3-1/4-inch (14-by-83-mm) **ogee**][**WM 713,** 9/16-by-3-1/4-inch (14-by-83-mm) **ranch**][**WM 753,** 9/16-by-3-1/4-inch (14-by-83-mm) **beaded-edge**][**WM 620,** 9/16-by-4-1/4-inch (14-by-108-mm) **ogee**][**WM 750,** 9/16-by-4-1/4-inch (14-by-108-mm) **beaded-edge**] base.
6. Shoe-Mold Pattern: [**WM 129,** 7/16-by-11/16-inch (11-by-17-mm) **quarter-round**][**WM 126,** 1/2-by-3/4-inch (13-by-19-mm) **quarter-round**][**WM 131,** 1/2-by-3/4-inch (13-by-19-mm) **ogee**] shoe mold.
7. Casing Pattern: [**WM 327,** 11/16-by-2-1/4-inch (17-by-57-mm) **clamshell**][**WM 366,** 11/16-by-2-1/4-inch (17-by-57-mm) **featheredge**][**WM 376,** 11/16-by-2-1/4-inch (17-by-57-mm) **beaded-edge**] casing.
8. Mull-Casing Pattern: [**WM 957,** 3/8-by-1-3/4-inch (9.5-by-44-mm) **beaded-edge**][**WM 973,** 3/8-by-1-3/4-inch (9.5-by-44-mm) **bullnose**][**WM 983,** 3/8-by-1-3/4-inch (9.5-by-44-mm) **featheredge**] casing.
9. Stop Pattern: [**WM 856,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **ranch**][**WM 946,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **ogee**][**WM 886,** 3/8-by-1-3/8-inch (9.5-by-35-mm) **bullnose**] stop.
10. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

G. PVC-Wrapped Moldings: MMPA WM 2 and made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Nickell Moulding Company, Inc.**]
   b. [**Zamma Corporation**]

2. Base Pattern: [**WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee**][**WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch**] base.
3. Shoe-Mold Pattern: [**WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round**][**WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round**] shoe mold.
4. Casing Pattern: [**WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell**][**WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge**] casing.
5. Mull-Casing Pattern: [**WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose**][**WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge**] casing.
6. Stop Pattern: [**WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch**][**WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose**] stop.
7. Chair-Rail Pattern: WM 297, **11/16-by-3-inch (17-by-76-mm)** chair rail.

8. Colors, Textures, and Grain Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. Foam-Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces are not to be shaped after molding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Architectural Mall, Inc**]
   b. [**Carter Millwork**]
   c. [**Chemcrest Inc.; a division of Foamcore**]
   d. [**Diamond Mfg., Inc.**]
   e. [**Focal Point Products**]
   f. [**Fypon LLC**]
   g. [**Melton Classics Inc.**]
   h. [**Vintage Mouldings Manufacturing Ltd.**]
   i. [**Worthington Millwork, LLC.**]

2. Density: Not less than **20 lb/cu. ft. (320 kg/cu. m)**.
3. Flame-Spread Index: Not more than [**75**] when tested in accordance with ASTM E84.
4. Thickness: Not more than **1/2 inch (12.7 mm)**.
5. Width: Not more than **8 inches (204 mm)**.

6. Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] as directed by the Owner.

2.4 PANELING

A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Chesapeake Plywood LLC**]
   b. [**Holland Southwest International**]
   c. [**Houston Plywood Industry, Inc.**]

2. Face Veneer Species and Cut: [**Rotary-cut white birch**][**Plain-sliced red oak**][**Plain-sliced hickory**].
3. Veneer Matching: [**Random match**][**Selected for similar color and grain**] .
4. Backing Veneer Species: [**Same species as face veneer**][**Any hardwood compatible with face species**] .
5. Construction: Veneer core.
6. Thickness: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**][**5/16 inch (7.9 mm)**][**7/16 inch (11 mm)**] .

7. Panel Size (Imperial): [**48 by 96 inches (1219 by 2438 mm)**][**48 by 120 inches (1219 by 3048 mm)**] .
8. Panel Size (Metric): [**1200 by 2400 mm**][**1200 by 3000 mm**] .
9. Glue Bond: Type II (interior).

10. Face Pattern: Manufacturer's standard [**V**][**channel**] -grooved pattern, with grooves at edges, center, and third points of panels, and at other locations to provide pattern resembling random-width boards.

11. Finish: [**Manufacturer's standard, transparent, UV-resistant, protective finish**][**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Hardboard Paneling: Interior factory-finished hardboard paneling complying with ANSI A135.5.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Chesapeake Plywood LLC**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Marlite, Inc.**]

2. Thickness: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**1/4 inch (6.4 mm)**] .

3. Finish: [**Class I**][**Class II**] .

4. Surface-Burning Characteristics: As follows, tested in accordance with ASTM E84:

   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.

5. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

C. Board Paneling, MMPA: Interior wood-board paneling complying with MMPA WM 9.

1. Species: [**Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**][**Southern pine**][**Western red cedar**][**Figured red gum**].

2. Grade: [**Clear No. 1**][**Clear No. 2**][**Knotty No. 1**][**Knotty No. 2**][**Finger jointed**] .

3. Maximum Moisture Content: [**15 percent with at least 85 percent of shipment at 12 percent or**

less][**9 percent**] .

4. Pattern: [**V-joint, tongue and groove, PT 82**][**Beaded ceiling, PT 85**][**Beveled-edge channel, shiplapped, PT 82**][**As indicated on Drawings**] .

5. Net Coverage Width: Not less than [**5-1/16 inches (128 mm)**][**6-3/4 inches (171 mm)**][**8-3/4 inches (222 mm)**] .

D. Board Paneling:

1. Species and Grade:

a. Eastern white pine; NeLMA or NLGA [**C Select**][**D Select**][**Finish or 1 Common**][**Premium or 2 Common**] .
b. Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA [**C Select (Choice)**][**D Select (Quality)**][**1 Common (Colonial)**][**2 Common (Sterling)**] .

c. Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [**C Select (Choice)**][**D Select (Quality)**][**Finish or 1 Common (Colonial)**][**Premium or 2 Common (Sterling)**] .
d. Southern pine; SPIB [**B & B**][**C & Btr**][**No. 2**] Paneling.
e. Western red cedar; NLGA, WCLIB, or WWPA [**Clear Heart**][**Grade A**][**Grade B**] .

2. Maximum Moisture Content: [**19**][**15**] percent [**with at least 85 percent of shipment at 12 percent or less**] .
3. Pattern:

a. V-joint, tongue and groove, [**NeLMA EWP 4**][**SPIB SPP 54**][**or**][**WWPA WP 4**] .
b. Pickwick, tongue and groove, [**NeLMA EWP 2**][**SPIB SPP 52**][**or**][**WWPA WP 2**] .
c. Rounded-edge channel groove, tongue and groove, [**SPIB SPP 60**][**or**][**WWPA WP 6**] .
d. Edge and center bead, tongue and groove, [**NeLMA E & CB**][**or**][**WWPA E & CB Ceiling**] .

4. Net Coverage Width: Not less than [**5-1/16 inches (128 mm)**][**6-3/4 inches (171 mm)**][**8-3/4 inches (222 mm)**] .

2.5 SHELVING AND CLOTHES RODS

A. Shelving : [**Exposed**][**Closet**][**Utility**] shelving, made from [**the following material**][**one of the following materials**] , **3/4 inch (19 mm)** thick:

1. Particleboard with [**radiused and filled**][**or**][**solid-wood**] front edge.
2. MDF with [**radiused**][**or**][**solid-wood**] front edge.
3. MDO softwood plywood with solid-wood edge.
4. Melamine-faced particleboard with [**radiused and filled**][**applied-PVC**] front edge.
5. Wood boards as specified above for [**lumber trim for opaque**][**softwood lumber trim for transparent**][**hardwood lumber trim for transparent**] finish.

6. Softwood Boards:

a. Kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA [**C Select (Choice)**][**D Select (Quality)**][**Finish or 1 Common (Colonial)**][**Premium or 2 Common (Sterling)**] .
b. Kiln-dried Douglas fir-larch, Douglas fir south, or hem-fir; SPIB [**Superior or C & Btr**][**Prime or D**] finish; NLGA, WCLIB, or WWPA; or southern pine; [**B & B**][**C**] finish.

B. Shelf Cleats: [**3/4-by-3-1/2-inch (19-by-89-mm) boards**][**3/4-by-5-1/2-inch (19-by-140-mm) boards**][**3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods**] , as specified above for [**shelving**][**lumber trim for opaque finish**][**softwood lumber trim for transparent finish**][**hardwood lumber trim for transparent finish**] .

C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A&M Hardware, Inc.**]
   b. [**EPCO, Engineered Products Co.**]
   c. [**Knape & Vogt Manufacturing Company**]

D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A&M Hardware, Inc.**]
   b. [**Centerline Brackets; Centerline Steel, LLC**]
   c. [**EPCO, Engineered Products Co.**]
   d. [**Knape & Vogt Manufacturing Company**]

E. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; [**powder-coat-finished**][**brass-finished**][**zinc-plated**] steel.

F. Adjustable Shelf Brackets: BHMA A156.9, B04112; [**powder-coat-finished steel**][**brass-finished steel**][**zinc-plated steel**][**bronze-anodized aluminum**][**black-anodized aluminum**][**natural aluminum**] .

G. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; [**powder-coat-finished**][**brass-finished**][**zinc-plated**] steel.

H. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; [**powder-coat-finished**][**brass-finished**][**zinc-plated**] steel.

I. Wood Clothes Rods: **1-1/2-inch- (38-mm-)** diameter, clear, kiln-dried [**hardwood**][**Douglas fir or southern pine**] .

J. Metal Clothes Rods: **1-5/16-inch- (33-mm-)** diameter, [**aluminum tubes**][**chrome-plated-steel tubes**][**color-coated-steel tubes**][**stainless steel tubes**][**chrome-plated-steel telescoping tubes with end brackets for mounting on shelf cleats**] .

K. Wood Rod Flanges: Clear, kiln-dried, [**Douglas fir or southern pine**][**eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**][**red oak**][**white maple**][**aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar**] turnings [**with clear finish**] .

L. Metal Rod Flanges: [**Aluminum**][**Chrome-plated steel**][**Stainless steel**] .

2.6 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended in writing by manufacturer for general carpentry use.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

4. Verify adhesive complies with VOC emissions evaluation criteria.

5. Verify adhesives have a VOC content of [**30**] g/L or less.

C. Installation Adhesive for Foam-Plastic Moldings: Product recommended in writing for indicated use by foam-plastic molding manufacturer.

1. Verify adhesives have a VOC content of [**50**] g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

D. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.

1. Verify adhesives have a VOC content of [**50**] g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

E. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended in writing for indicated use by adhesive manufacturer.

1. Verify adhesives have a VOC content of [**70**] g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

2.7 FABRICATION

A. General: Back out or kerf backs of the following members, except those with ends exposed in finished work:

1. Interior standing and running trim, except shoe and crown molds.
2. Wood-board paneling.

B. Ease edges of lumber less than **1 inch (25 mm)** in nominal thickness to **1/16-inch (1.5-mm)** radius and edges of lumber **1 inch (25 mm)** or more in nominal thickness to **1/8-inch (3-mm)** radius.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours [**unless longer conditioning is recommended in writing by manufacturer**] .

3.3 INSTALLATION OF INTERIOR FINISH CARPENTRY, GENERAL

A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.

1. Use concealed shims where necessary for alignment.
2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended in writing by manufacturer.
3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
4. Install to tolerance of **1/8 inch in 96 inches (3 mm in 2438 mm)** for level and plumb. Install adjoining interior finish carpentry with **1/32-inch (0.8-mm)** maximum offset for flush installation and **1/16-inch (1.5-mm)** maximum offset for reveal installation.
5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 INSTALLATION OF INTERIOR TRIM

A. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.

1. Do not use pieces less than **24 inches (610 mm)** long, except where necessary.
2. Stagger joints in adjacent and related standing and running trim.
3. [**Cope**][**Miter**] at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
4. Use scarf joints for end-to-end joints.
5. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

6. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
7. Install trim after gypsum-board joint finishing operations are completed.
8. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
9. Fasten to prevent movement or warping.
10. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 INSTALLATION OF PANELING

A. Hardwood Veneer Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels.

1. Leave **1/4-inch (6-mm)** gap to be covered with trim at top, bottom, and openings.
2. Install with uniform tight joints between panels.
3. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners.
4. Space fasteners and adhesive as recommended in writing by panel manufacturer.
5. Conceal fasteners to greatest practical extent.

6. Arrange panels with grooves and joints over supports.

   a. Fasten to supports with nails of type and at spacing recommended in writing by panel manufacturer.
   b. Use fasteners with prefinished heads matching groove color.

B. Hardboard Paneling: Install in accordance with manufacturer's written instructions.

1. Leave **1/4-inch (6-mm)** gap to be covered with trim at top, bottom, and openings.
2. Butt adjacent panels with moderate contact.
3. Use fasteners with prefinished heads matching paneling color.

4. Wood Stud or Furring Substrate: Install with **1-inch (25-mm)** annular-ring shank hardboard nails.
5. Plaster or Gypsum-Board Substrate: Install with **1-5/8-inch (41-mm)** annular-ring shank hardboard nails.
6. Nailing: Space nails **4 inches (100 mm)** o.c. at panel perimeter and **8 inches (200 mm)** o.c. at intermediate supports unless otherwise required by manufacturer.

C. Board Paneling, MMPA: Install in accordance with manufacturer's written instructions.

1. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.

2. Install in full lengths without end joints.
3. Stagger end joints in random pattern to uniformly distribute joints on each wall.

4. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
5. Install with uniform end joints. Locate end joints only over furring or blocking.
6. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards.
7. Install with uniform tight joints between boards.

8. Fasten paneling by face nailing, setting nails, and filling over nail heads.
9. Fasten paneling with trim screws, set below face and filled.
10. Fasten paneling by blind nailing through tongues.

11. Fasten paneling with paneling system manufacturer's concealed clips.
12. Fasten paneling to gypsum wallboard with panel adhesive.

D. Board Paneling: Install in accordance with manufacturer's written instructions.

1. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.

2. Install in full lengths without end joints.
3. Stagger end joints in random pattern to uniformly distribute joints on each wall.

4. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
5. Install with uniform end joints. Locate end joints only over furring or blocking.
6. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards.
7. Install with uniform tight joints between boards.

8. Fasten paneling by face nailing, setting nails, and filling over nail heads.
9. Fasten paneling with trim screws, set below face and filled.
10. Fasten paneling by blind nailing through tongues.
11. Fasten paneling with paneling system manufacturer's concealed clips.
12. Fasten paneling to gypsum wallboard with panel adhesive.

3.6 INSTALLATION OF SHELVING AND CLOTHES RODS

A. Cut shelf cleats at ends of shelves about **1/2 inch (13 mm)** less than width of shelves and sand exposed ends smooth.

1. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled.
2. Space fasteners not more than **16 inches (400 mm)** o.c. [**Use two fasteners at each framing member or fastener location for cleats 4 inches nominal (89 mm actual) in width and wider.**]

3. Apply a bead of multipurpose construction adhesive to back of shelf cleats before installing.
4. Remove adhesive that is squeezed out after fastening shelf cleats in place.

B. Install shelf brackets in accordance with manufacturer's written instructions, spaced not more than [**32 inches (800 mm)**][**36 inches (900 mm)**] o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

C. Install standards for adjustable shelf supports in accordance with manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than **12 inches (300 mm)** o.c.

D. Install standards for adjustable shelf brackets in accordance with manufacturer's written instructions, spaced not more than **36 inches (900 mm)** o.c. and within **6 inches (150 mm)** of ends of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

E. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled.

1. Install shelves, fully seated on cleats, brackets, and supports.

2. Fasten shelves to cleats with finish nails or trim screws, set flush.

3. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.

F. Install rod flanges for rods as indicated.

1. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
2. Install rods in rod flanges.

3.7 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements.

1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

B. Adjust joinery for uniform appearance.

3.8 CLEANING

A. Clean interior finish carpentry on exposed and semiexposed surfaces.

B. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.9 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 20 00 00

Task	Specification	Specification Description
06 22 00 00	06 20 00 00	Interior Finish Carpentry
06 22 13 00	06 20 00 00	Interior Finish Carpentry
06 25 00 00	06 20 00 00	Interior Finish Carpentry
06 25 16 00	06 20 00 00	Interior Finish Carpentry

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SECTION 06 41 00 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood-veneer-faced casework for transparent finish.
2. Wood-veneer-faced casework for opaque finish.
3. Plastic-laminate-clad casework.
4. Wood materials.
5. Glass.
6. Casework hardware.
7. Accessories.
8. Shop finishing.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud-framing required for anchoring cabinets.
3. [**Section 123616 "Metal Countertops."**][**Section 123619 "Wood Countertops."**][**Section 123623.13 "Plastic-Laminate-Clad Countertops."**][**Section 123640 "Stone Countertops."**][**Section 123661 "Simulated Stone Countertops."**]

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

B. Coordinate wood species, veneer, cut, grade, matching, finishing, and other requirements with [**wood doors**][**wood paneling**] as specified in [**Section 064216 "Flush Wood Paneling."**][**Section 081416 "Flush Wood Doors."**][**Section 123553.19 "Wood Laboratory Casework."**]

C. Hardware Coordination: Distribute copies of approved hardware schedule specified in [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review locations and method of attachment of backing required for casework installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include panel material description and finish.
2. Include glazing.
3. Include accessories.
4. Include hardware.
5. Include shop finishing.

B. Shop Drawings:

1. Plans, elevations, sections, and attachment details.

   a. Show large-scale details.
   b. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   c. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
   d. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.

2. Apply AWI's Quality Certification Program (hereafter AWI QCP) label to Shop Drawings.

C. Samples for Initial Selection: For each exposed product and for each color and finish specified, in manufacturer's standard size.

D. Samples for Verification: Provide a minimum of three samples showing the full range of color and/or grain to be expected in the finished work, for the following.

1. Lumber for Transparent Finish: Not less than **8 inches (200 mm)** long by **3/4 inch (19 mm)** thick, and as wide as practical, for each species and cut, finished on one side and one edge.
2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished cabinets. Samples to show the full range of color and grain to be expected.
3. Veneer Panel for Transparent Finish: **8 by 8 inches (200 mm by 200 mm)** by **1/4 inch (6.4 mm)**, representative of and selected from flitches to be used for transparent-finished casework.
4. Lumber and Panel Products with Shop-Applied Opaque Finish: Not less than **8 inches (200 mm)** long by **3/4 inches (19 mm)** thick, and as wide as practical, for each species and cut for lumber and **8 by 10 inches (200 by 250 mm)** for panels, for each finish system and color.

   a. Finish [**entire**][**one-half of**] exposed surface.

5. Plastic Laminates: **8 by 8 inches (200 by 200 mm)**, for each type, color, pattern, and surface finish required.

   a. Provide one Sample applied to core material with specified edge material applied to one edge.

6. Thermally Fused Laminate (TFL) Panels: **8 by 10 inches (200 by 250 mm)**, for each color, pattern, and surface finish.

   a. Provide edgebanding on one edge.

7. Corner Pieces:

   a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, **18 inches (450 mm)** high by **18 inches (450 mm)** wide by **6 inches (150 mm)** deep.
   b. Miter joints for standing trim.

8. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Product Data: Verify compliance with requirements for Forest Stewardship Council U.S. (FSC).
4. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
5. Product Data: For installation adhesives, indicating VOC content.
6. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
8. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.5 INFORMATIONAL SUBMITTALS

A. Test Reports: Valid AWI "Performance Quality Test Report" indicating compliance with specified ANSI/AWI 0641 Structural Performance Duty Level.

B. Certification Reports:

1. Provide [**labels**][**certificates**] from AWI QCP indicating woodwork [**complies**][**and installation comply**] with requirements of aesthetic grade and duty level specified.

   a. Project has been registered with AWI as AWI QCP Number.
   b. Register the Work of this Section with AWI's Quality Certification Program.

2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of the Contract Documents in addition to those of the referenced quality standard.

C. Product Certificates: For[**each type of product.**][**the following:**]

1. Composite wood products.
2. Thermally fused laminate (TFL) panels.
3. Glass.
4. Adhesives.

D. Field quality control reports.

E. Qualification Statements: For [**manufacturer**][**Installer**].

1.6 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI QCP Certificate.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

B. Installer Qualifications: [**Manufacturer of products**][**Licensed participant in AWI QCP**].

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical architectural cabinets as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.10 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 45**][**30 and 55**][**43 and 65**] percent during the remainder of the construction period.

C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unless otherwise indicated, comply with ANSI/AWI 0641 for duty level and grade of architectural cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide [**labels**][**certificates**] from AWI QCP indicating that woodwork [**complies**][**and installation comply**] with requirements of aesthetic grade and duty level specified.

2.2 WOOD-VENEER-FACED CASEWORK FOR TRANSPARENT FINISH

A. Architectural Woodwork Institute (AWI) Standard:

1. Structural Performance Duty Level: [**1**][**2**][**3**][**4**][**As indicated on Drawings**].
2. Aesthetic Performance Grade: [**Premium**][**Custom**][**Economy**][**As indicated on Drawings**].
3. Product Data: Verify materials were fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
4. Product Data: Verify materials were fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.
5. Certified Wood: Verify wood products are certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.
6. Certified Wood: Verify wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
7. Certified Wood: Verify wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
8. Verify adhesives have a VOC content of [**30**] g/L or less.

B. Casework Construction Type: [**Frameless**][**Face frame**].

C. Door and Drawer-Front:

1. Design: [**Flush panel**][**Stile and rail**].
2. Style: [**Flush overlay**][**Reveal overlay**][**Flush inset**].

   a. Reveal Dimension: [**1/2 inch (13 mm)**][**As determined by hinge type and clearance**][**As indicated on Drawings**].

D. Exposed Exterior Surfaces:[**As indicated on Drawings.**]

1. Species: [**Red oak**][**White oak**][**White ash**][**White birch**][**Select white maple**][**As indicated on Drawings**].
2. Cut: [**Plain sliced/plain sawn**][**Rift cut/rift sawn**][**Quarter cut/quarter sawn**].
3. Grain Direction: [**Vertically for drawer fronts, doors, and fixed panels**][**Horizontally for drawer fronts, doors, and fixed panels**][**Vertically for doors and fixed panels, horizontally for drawer fronts**][**As indicated on Drawings**].
4. Veneer Matching:

   a. Matching of Veneer Leaves: [**Book**][**Slip**][**Random**] match.
   b. Veneer Matching within Panel Face: [**Running**][**Balance**][**Center-balance**] match.
   c. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
   d. Blueprint Matching: Match veneers on casework[**wall paneling,**][**doors**] in room indicated on Drawings.

5. Edgeband: [**Solid wood**][**Veneer**] matching exposed surfaces.

E. Exposed Interior Surfaces:[**As indicated on Drawings.**]

1. Species: [**Match exposed exterior surfaces**][**Red oak**][**White oak**][**White ash**][**White birch**][**Select white maple**][**As indicated on Drawings**].
2. Cut: [**Match exposed exterior surfaces**][**Plain sliced/plain sawn**][**Rift cut/rift sawn**][**Quarter cut/quarter sawn**].
3. Veneer Matching: Match exposed exterior surfaces.
4. Edgeband: [**Solid wood**][**Veneer**][**Match exposed exterior surfaces**].

F. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [**Same species wood veneer panel indicated for exposed surfaces**][**Thermally fused laminate (TFL) panels**][**High-pressure decorative laminate (HDPL)**][**Compatible species to that indicated for exposed surfaces, stained to match**].
2. Drawer Subfronts, Backs, and Sides: [**Solid-hardwood lumber, same species indicated for exposed surfaces**][**Solid-hardwood lumber, stained to match species indicated for exposed surfaces**][**Solid birch or maple hardwood lumber**][**Seven- or nine-ply hardwood plywood with no internal voids**][**Thermally fused laminate (TFL) panels**].
3. Drawer Bottoms: [**Hardwood plywood**][**Thermally fused laminate (TFL) panels**].
4. Shelves: [**Adjustable**][**Fixed**].

   a. Loading Capacity: [**40 lb/sq. ft**][**50 lb/sq. ft**].

5. Edgeband: [**Wood veneer compatible for color and grain of exposed surfaces**][**PVC or polyester**][**Match exposed surfaces**].

2.3 WOOD-VENEER-FACED CASEWORK FOR OPAQUE FINISH

A. Architectural Woodwork Institute (AWI) Standard:

1. Structural Performance Duty Level: [**1**][**2**][**3**][**4**][**As indicated on Drawings**].
2. Aesthetic Performance Grade: [**Premium**][**Custom**][**Economy**][**As indicated on Drawings**].
3. Product Data: Verify materials were fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
4. Product Data: Verify materials were fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.
5. Certified Wood: Verify wood products are certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.
6. Certified Wood: Verify wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
7. Certified Wood: Verify wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
8. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde

Emissions from Composite Wood Products," or are made with no added formaldehyde.

9. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

10. Verify adhesives have a VOC content of [**30**] g/L or less.

B. Casework Construction Type: [**Frameless**][**Face frame**].

C. Door and Drawer-Front:

1. Design: [**Flush panel**][**Stile and rail**].
2. Style: [**Flush overlay**][**Reveal overlay**][**Flush inset**].

   a. Reveal Dimension: [**1/2 inch (13 mm)**][**As determined by hinge type and clearance**][**As indicated on Drawings**].

D. Exposed Exterior Surfaces: [**Any closed-grain hardwood suitable for opaque finish**][**Medium-density fiberboards (MDF)**][**Medium-density overlay (MDO)**].

1. Edgeband: [**Solid wood**][**Veneer**] matching exposed surfaces.

E. Exposed Interior Surfaces: [**Any closed-grain hardwood suitable for opaque finish**][**Medium-density fiberboards (MDF)**][**Medium-density overlay (MDO)**].

1. Edgeband: [**Solid wood**][**Veneer**][**Match exposed exterior surfaces**].

F. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [**Match materials indicated for exposed surfaces**][**Thermally fused laminate (TFL) panels**].
2. Drawer Sides and Backs: [**Solid birch or maple hardwood lumber**][**Seven- or nine-ply hardwood plywood with no interior voids**][**Thermally fused laminate (TFL) panels**].
3. Drawer Bottoms: [**Hardwood plywood**][**Thermally fused laminate (TFL) panels**].
4. Shelves: [**Fixed**][**Adjustable**].

   a. Loading Capacity: [**40 lb/sq. ft**][**50 lb/sq. ft**].

5. Edgeband:

   a. Edges of Veneer Panels: [**Solid wood**][**Veneer**][**Veneer tape**] compatible for color and grain of exposed surfaces.
   b. Edges of Thermally Fused Laminate (TFL) Panels: [**PVC or ABS, 0.018-inch (0.460-mm) minimum thickness**][**PVC, 3.0 mm thick**].

2.4 PLASTIC-LAMINATE-CLAD CASEWORK

A. Architectural Woodwork Institute (AWI) Standard:

1. Structural Performance Duty Level: [**1**][**2**][**3**][**4**][**As indicated on Drawings**].

2. Aesthetic Performance Grade: [**Premium**][**Custom**][**Economy**][**As indicated on Drawings**].
3. Product Data: Verify materials were fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
4. Product Data: Verify materials were fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.
5. Certified Wood: Verify wood products are certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.
6. Certified Wood: Verify wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
7. Certified Wood: Verify wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
8. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
9. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

10. Verify adhesives have a VOC content of [**30**] g/L or less.

B. Casework Construction Type: [**Frameless**][**Face frame**].

C. Door and Drawer-Front:

1. Design: [**Flush panel**][**Stile and rail**].
2. Style: [**Flush**][**Reveal**] overlay.

    a. Reveal Dimension: [**1/2 inch (13 mm)**][**As determined by hinge type and clearance**][**As indicated on Drawings**].

D. High-Pressure Decorative Laminate (HDPL): ISO 4586-3, grades as indicated or, if not indicated, as required by quality standard.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABET Inc.**]
    b. [**Formica Corporation**]
    c. [**Laminart LLC**]
    d. [**Pionite; a Panolam Industries International, Inc. brand**]
    e. [**Wilsonart LLC**]

E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.
2. Match Architect's sample, as directed by the Owner.
3. As selected by Architect from laminate manufacturer's full range in the following categories:

   a. Solid colors, [**gloss**][**matte**] finish.
   b. Solid colors with core same color as surface, [**gloss**][**matte**] finish.
   c. Wood grains, [**gloss**][**matte**] finish.
   d. Patterns, [**gloss**][**matte**] finish.

F. Exposed Exterior Surfaces:

1. Plastic-Laminate Grade: [**HGP**][**HGS**][**VGS**].
2. Pattern Direction: [**Vertically for drawer fronts, doors, and fixed panels**][**Horizontally for drawer fronts, doors, and fixed panels**][**As indicated on Drawings**].
3. Edgebanding: [**High-pressure decorative laminate (HDPL)**][**PVC or ABS, 0.018-inch (0.460-mm) minimum thickness**][**PVC, 3.0 mm thick**].

G. Exposed Interior Surfaces: [**High-pressure decorative laminate (HDPL) the same color and pattern as exposed exterior surfaces**][**Thermally fused laminate (TFL) the same color and pattern as exterior surfaces**].

1. Edgebanding: [**High-pressure decorative laminate (HDPL)**][**PVC or ABS, 0.018-inch (0.460-mm) minimum thickness**][**PVC, 3.0 mm thick**].

H. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: [**High-pressure decorative laminate (HDPL) cabinet liner Grade CLS, ISO 4586-3**][**Thermally fused laminate (TFL) panels**].
2. Drawer Sides and Backs: [**Solid-hardwood lumber**][**Seven- or nine-ply plywood with no internal voids**][**Thermally fused laminate (TFL) panels with PVC or polyester edgebanding**].
3. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate (HDPL), ISO 4583-3, grade to match exposed surface.
4. Drawer Bottoms: [**Hardwood plywood**][**Thermally fused laminate (TFL) panels**].
5. Shelves: [**Fixed**][**Adjustable**].

   a. Loading Capacity: [**40 lb/sq. ft**][**50 lb/sq. ft**].

6. Edgebanding: [**High-pressure decorative laminate (HDPL)**][**PVC or ABS, 0.018-inch (0.460-mm) minimum thickness**][**PVC, 3.0 mm thick**].

2.5 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than **3 inches (75 mm)** wide.
2. Wood Moisture Content:

   a. Non-Climate-Controlled Environments: [**7 to 12**][**9 to 15**][**10 to 15**] percent.
   b. Climate-Controlled Environments: [**4 to 9**][**6 to 10**][**8 to 13**] percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
4. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

5. Medium-Density Fiberboard (MDF): ANSI A208.2, [**Grade 130**].
6. Particleboard (Medium Density): ANSI A208.1, [**Grade M-2**][**Grade M-2-Exterior Glue**].
7. Softwood Plywood: DOC PS 1[**medium-density overlay**].
8. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
9. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper[**and complying with requirements of AWI 300**].

2.6 GLASS

A. Float Glass for Cabinet Doors: ASTM C1036, Type I, [**Class 1 (clear)**][**Class 2 or 3 (tinted)**], Quality-Q3.

1. Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**].
2. Tint Color: [**Blue-green**][**Bronze**][**Green**][**Gray**].

B. Tempered Float Glass for Cabinet Doors: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), complying with ANSI Z97.1.

1. Door Inserts: Type I, [**Class 1 (clear)**][**Class 2 or 3 (tinted)**], Quality-Q3.

    a. Thickness: [**6.0 mm**].
    b. Tint Color: [**Blue-green**][**Bronze**][**Green**][**Gray**].

2. Frameless Sliding Doors: Type I, [**Class 1 (clear)**][**Class 2 or 3 (tinted)**], Quality-Q3.

    a. Thickness: [**6.0 mm**].
    b. Tint Color: [**Blue-green**][**Bronze**][**Green**][**Gray**].
    c. Unframed Glass Doors: Grind smooth and polish exposed edges and corners.

C. Laminated Glass for Cabinet Doors: ASTM C1172, Type II, complying with ANSI Z97.1.

1. Thickness: [**6.0 mm**].
2. Tint Color: [**Blue-green**][**Bronze**][**Green**][**Gray**].

D. Mirror Glass for Cabinet Doors: ASTM C1503, Mirror [**Select**][**Glazing**], Quality-Q3.

1. Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**].

E. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Section 088113 "Decorative Glass Glazing."

F. Tempered Float Glass for Cabinet Shelves: ASTM C1048, Kind FT, Condition A, Type I, [**Class 1 (clear)**][**Class 2 or 3 (tinted)**], Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.

1. Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**].
2. Tint Color: [**Blue-green**][**Bronze**][**Green**][**Gray**].

2.7 CASEWORK HARDWARE

A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

B. Hinges:

1. Butt Hinges: **2-3/4-inch (70-mm)**, Grade 1 five-knuckle steel hinges made from **0.095-inch- (2.4-mm-)** thick metal, and as follows:

a. Semi-Concealed Hinges, Back Mounted, for Flush Doors: ANSI/BHMA A156.9, B01361.
b. Semi-Concealed Hinges, Back Mounted, for Overlay Doors: ANSI/BHMA A156.9, B01511.

2. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, [**95-110**][**115-140**][**160-180**] degrees of opening[**self-closing**][**with integral soft-close damper**].

C. Pulls and Knobs:

1. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011, **3-inch (75-mm)** centers.
2. Wire Pulls: Back mounted, [**solid metal**][**plastic**], [**4 inches (100 mm) long, 5/16 inch (8 mm) in diameter**][**5 inches (127 mm) long, 5/16 inch (8 mm) in diameter**].
3. Back-Mounted Knobs: ANSI/BHMA A156.9, B02041.

D. Catches and Latches:

1. Magnetic Catches: ANSI/BHMA A156.9, B03141.
2. Push-in Magnetic Catches: ANSI/BHMA A156.9, B03132.
3. Roller Catches, Double Rollers: ANSI/BHMA A156.9, B03072.
4. Ball Friction Catches: ANSI/BHMA A156.9, B03013.

E. Shelf Rests and Standards:

1. Adjustable Shelf Standards and Supports: [**ANSI/BHMA A156.9, B04071; with shelf rests, B04081**][**ANSI/BHMA A156.9, B04102; with shelf brackets, B04112**].
2. Shelf Rests: ANSI/BHMA A156.9, B04013; [**metal**][**plastic**][**two-pin plastic with shelf hold-down clip**].

F. Drawer Slides: ANSI/BHMA A156.9.

1. Standard Duty (Grade 1 and Grade 2): [**Side mount**][**Undermount**][**and extending under bottom edge of drawer**].
2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): [**Side mount**][**Undermount**].

a. Type: [**Full**][**Full overtravel**][**Partial**] extension.
b. Material: [**Aluminum**][**Epoxy-coated polymer**][**Galvanized-steel ball-bearing**][**Stainless steel**][**Zinc-plated ball-bearing**] slides.
c. Motion Feature: [**Push to open**][**soft close dampener**][**self-closing mechanism**].

3. Drawer Types:

a. Pencil drawers not more than **3 inches (75 mm)** high and not more than **24 inches (600 mm)** wide provide [**50 lb (22.7 kg)**] load capacity.
b. General-purpose drawers more than **3 inches (75 mm)** high, but not more than **6 inches (150 mm)** high and not more than **24 inches (600 mm)** wide, provide [**75 lb (34 kg)**] load capacity.
c. File drawers more than **6 inches (150 mm)** high or more than **24 inches (600 mm)** wide provide [**100 lb (45 kg)**] load capacity.
d. Lateral file drawers more than **6 inches (150 mm)** high and more than **24 inches (600 mm)**, but not more than **30 inches (762 mm)** wide, provide [**150 lb (68 kg)**] load capacity.
e. Lateral file drawers more than **6 inches (150 mm)** high and more than **30 inches (762 mm)** wide provide [**200 lb (90.7 kg)**] load capacity.
f. Computer keyboard tray provides [**75 lb (34 kg)**] load capacity.

G. Tracks for Sliding Glass Doors: [**Surface**][**Recessed**] mounting, ANSI/BHMA A156.9, B07063; [**plastic**][**aluminum**].

H. Locks for Drawer and Hinged-Doors: [**Cylindrical (cam)**][**Mortise**] type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.

1. Provide a minimum of two keys per lock and six master keys.
2. Provide locks [**where indicated**][**on every door and drawer**].

I. Door Bumpers: Manufacturer's standard self-adhering clear silicone pads.

J. Hardware Finish:

1. Exposed Hardware: Provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

a. Dark, Oxidized, Satin Bronze, Oil Rubbed: ANSI/BHMA 613 for bronze base; ANSI/BHMA 640 for steel base.
b. Bright Brass, Clear Coated: ANSI/BHMA 605 for brass base; ANSI/BHMA 632 for steel base.
c. Bright Brass, Vacuum Coated: ANSI/BHMA 723 for brass base; ANSI/BHMA 729 for zinc-coated-steel base.
d. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
e. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
f. Bright Chromium Plated: ANSI/BHMA 625 for brass or bronze base; ANSI/BHMA 651 for steel base.
g. Satin Stainless Steel: ANSI/BHMA 630.

2. Concealed Hardware: Manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.8 ACCESSORIES

A. Grommets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Doug Mockett & Company, Inc.**]
   b. [**Hafele America Co.**]
   c. [**W.W. Grainger, Inc.**]

2. Wire-Management Grommets: Circular, grommets and matching caps with slot for wire passage.

   a. Finish: [**Metal**][**Molded plastic**].
   b. Outside Diameter: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].
   c. Color: [**Brushed, nickel plated**][**Polished, chrome plated**][**Black, epoxy coated**][**Brown**][**Black**].

3. Power/Data Grommets: UL-listed [**recessed**][**pop-up**] grommet.

   a. Power Outlets: [**Two**][**Three**][**Five**].
   b. USB Charger: [**Type A**][**Type B**][**1 Dual**].

4. Paper Slot Grommet: [**12 inches (305 mm)**][**17 inches (432 mm)**] long by **1-3/4 inches (45 mm)** wide by **1 inch (25 mm)** deep; molded-plastic, paper-slot liner with **1/4 inch (6.4 mm)** lip.

   a. Color: [**Brown**][**Black**].

2.9 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease sharp edges and corners.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

   1. Notify Architect seven days in advance of dates and times architectural cabinet fabrication will be complete, as directed by the Owner.
   2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

D. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in NGA's "GANA Glazing Manual."

1. For glass in wood frames, secure glass with removable stops.
2. For exposed glass edges, polish and grind smooth.

2.10 SHOP FINISHING

A. Finish architectural cabinets at manufacturer's shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Shop-finish transparent-finished architectural cabinets at manufacturer's shop as specified in this Section. See Section 099123 "Interior Painting" for field finishing of opaque-finished architectural cabinets.

C. Drawings indicate items that are required to be shop finished. Finish these items at manufacturer's shop as specified in this Section. See [**Section 099123 "Interior Painting"**][**Section 099300 "Staining and Transparent Finishing"**] for field finishing of architectural cabinets.

D. Shop Priming: Shop apply the prime coat including backpriming, if any, for[**transparent-finished**] items specified to be field finished. See [**Section 099123 "Interior Painting"**][**Section 099300 "Staining and Transparent Finishing"**] for material and application requirements.

E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural cabinets, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

F. Transparent Finish:

1. Aesthetic Performance Grade: [**Premium**][**Custom**][**Economy**][**Same as item to be finished**].
2. Finish System: [**TR-1, lacquer, nitrocellulose**][**TR-2A, lacquer, post-catalyzed**][**TR-2B, lacquer, pre-catalyzed**][**TR-3, latex acrylic, water-based**][**TR-4, varnish, conversion**][**TR-5, oil, synthetic penetrating**][**TR-6, polyurethane, catalyzed**][**TR-7, acrylic crosslinking, water-based**][**TR-8, acrylated epoxy, polyester, or urethane, UV-cure**][**TR-9, UV curable, water-based**][**TR-10, vinyl, catalyzed**][**TR-11, polyurethane, water-based**][**TR-12, polyester, catalyzed**].
3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
4. Staining: [**None required**][**Match approved sample for color**][**Match Architect's sample**].
5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
6. Filled Finish for Open-Grain Woods:[**After staining, apply wash-coat sealer and allow to dry.**] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
7. Sheen: [**Flat, 15-30**][**Satin, 31-45**][**Semigloss, 46-60**][**Gloss, 61-100**] gloss units measured on 60-degree gloss meter per ASTM D523.

G. Opaque Finish:

1. Aesthetic Performance Grade: [**Premium**][**Custom**][**Economy**][**Same as item to be finished**].
2. Finish System: [**OP-1, lacquer, nitrocellulose**][**OP-2A, lacquer, post-catalyzed**][**OP-2B, lacquer, pre-catalyzed**][**OP-3, latex acrylic, water-based**][**OP-4, varnish, conversion**][**OP-5, oil, synthetic penetrating**][**OP-6, polyurethane, catalyzed**][**OP-7, acrylic crosslinking, water-based**][**OP-8, acrylated epoxy, polyester, or urethane, UV-cure**][**OP-9, UV curable, water-based**][**OP-10, vinyl, catalyzed**][**OP-11, polyurethane, water-based**][**OP-12, polyester, catalyzed**].

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
4. Sheen: [**Flat, 15-30**][**Satin, 31-45**][**Semigloss, 46-60**][**Gloss, 61-100**] gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.
2. Verify size and locations of cutouts for appliances, special equipment, sinks, plumbing, and other items to be mounted in or adjacent to casework.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.3 INSTALLATION OF CASEWORK

A. Install casework to comply with requirements of the structural and aesthetic performance specified.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Install cabinets level, plumb, and true in line to a tolerance of **1/8 inch in 96 inches (3 mm in 2400 mm)** using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Maintain veneer sequence matching of cabinets with transparent finish.

D. Anchor cabinets in accordance with AWI requirements or tested method to anchors or blocking built in or directly attached to framing or substrates.

1. Install cabinets to comply with seismic requirements as indicated on Drawings.

E. Shop Finishes: Touch up finishing after installation of architectural cabinets. Fill nail holes with matching filler.

1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

a. Use filler matching finish of items being installed.

F. Field Finishing: See [**Section 099123 "Interior Painting"**][**Section 099300 "Staining and Transparent Finishing"**] for finishing of installed architectural cabinets.

3.4 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that casework, including installation, complies with requirements of ANSI/AWI 0620 for the specified grade.

1. AWI QCP Inspector to prepare and submit inspection report.

3.5 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where impossible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware and other moving parts to function smoothly.

C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION 06 41 00 00

SECTION 06 41 13 00 - RESIDENTIAL CABINETS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for residential cabinets. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by Owner.

System Description

2. Performance Requirements:
   a. Comply with test procedures and required performances of ANSI/KCMA A161.1.
      1) Tests: Performed on standard 760 mm (30 inch) wall and base cabinets.
   b. Drawers and Drawer Hardware for HUD Severe Use: Apply 330 N (75 pound) point load to exterior edge of drawer extended 150 mm (6 inches) from its closed position for period of 15 minutes.
      1) Successful Test: No failure in any part of drawer assembly or operating system and drawer remain operable with no mechanical interference with any part of cabinet assembly.

Submittals

3. Product Data: Submit product data for cabinets and countertops.
4. Shop Drawings: Submit Shop Drawings for cabinets and countertops for each type of kitchen.
5. Samples: Submit samples of following for selection:
   a. Wood veneers with stain finishes.
   b. Plastic laminate patterns and colors.
6. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written certification that cabinets and countertops meet or exceed specified requirements.

Quality Assurance

7. Certifications:
   a. Cabinets: Continuously tested, certified and display label or seal of Kitchen Cabinet Manufacturer's Association (KCMA) or Southern California Association of Cabinet Manufacturers Association in accordance with ANSI Z34.1.
      1) HUD Severe Use Cabinets: Bear KCMA Certification Seal and additional label indicating conformance to HUD Severe Use specifications.
      2) Normal/Elderly Use: Bear KCMA Certification Seal.
8. Regulatory Requirements: Comply with following:
   a. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing - regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).

4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).

9. Mock-ups:
   a. Install mock-up of cabinets and countertops in kitchen as part of kitchen renovation mock-up.
   b. Install mock-up of cabinets and countertops in bathroom as part of bathroom renovation mock-up.
   c. Locations: As directed.
   d. Approved Mock-up: Standard for rest of work.
   e. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

10. Packing, Shipping, Handling, and Unloading:
    a. Do not deliver cabinets until building or storage area is enclosed and sufficiently dry to prevent damage from excessive changes in moisture content.
    b. Protect casework and equipment from damage during delivery, storage, installation and subsequent building operations.

Scheduling

11. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Project Conditions

12. Field Measurements: Field measure spaces to receive cabinets before beginning fabrication.
    a. Cabinets: Conform to building lines and neatly fitted around openings, pipes, and other obstructions.

PRODUCTS

Normal/Elderly Use Cabinets

13. Cabinets: Standard size factory manufactured, assembled and finished for normal/elderly and severe use as scheduled. Comply with:
    a. HUD Minimum Property Standards for Housing, Paragraph 611-1.
    b. ANSI/KCMA A161.1.
14. Cabinet Construction: Hardwood face frames and reveal overlay construction.
    a. Base and Wall Cabinets: Same construction and same appearance.
15. Cabinet Materials:
    a. Plywood: ANSI/HPMA HP and PS 1.
    b. Particleboard, ANSI A208.1, medium density.
    c. Pressure Treated Lumber: AWPA C2.
    d. Cabinet Hardware: ANSI/BHMA AI 56.9.
       1) Cabinet Hardware: Finishing requirements of ANSI/BHMA A156, corrosion resisting.
16. Vanity Cabinets: Sizes as indicated.
    a. Size if Not Indicated: 460 mm (18 inches) to 610 mm (24 inches) wide and 410 mm (16 inches) to 530 mm (21 inches) deep.
17. Cabinet Finish: Comply with ANSI/KCMA A161.1 finish test and performance requirements.
    a. Exposed Surfaces and Interior of Cabinet: Factory finished consisting of stain, sealer and top coal, lightly sanded between application.
       1) Sealer and Top Coats: Oven dried.
       2) Stain Color: Selected from manufacturer's standard colors.
    b. Toe Kick: Painted as directed.
    c. Alternate Finish: High-pressure Decorative Laminates (HPDL) may be supplied in lieu of finish described above.
       1) HPDL: Comply with NEMA LD 3, Type GP 28, 0.7 mm (0.028 inch) thickness.
18. Fillers and Molding: Use scribe mould and fillers to assure accurate job fit.
    a. Molding and Fillers: Outside corners, scribes, cove molding, and trim molding.

b. Fillers: Include comer base fillers, base fillers, and wall fillers.
c. Cove Molding: Hardwood.
d. Finish: Match cabinet finish.

19. Joint Sealant: Mildew resistant one-component silicone; FS TT-S-001543A, Class A; ASTM C 920, Type S, Grade NS. Class 25, Uses NT, G, and A.
    a. Color: As selected from manufacturer's standard line.

HUD Severe Use Cabinets

20. Wall and Base Cabinets: Comply with requirements under Cabinets - General above.
    a. Construct to produce sturdy and rigid construction.
    b. Wall and Base Cabinets and Countertops: Constructed of solid lumber and/or exterior grade plywood with wood veneer core.
        1) Particleboard, flakeboard, fiberboard, or hardboard not allowed.
    c. Base Cabinets:
        1) Parts Touching Floor: Pressure treated solid lumber.
        2) Provide integral toe space of minimum 75 mm (3 inches) by 75 mm (3 inches).
        3) Toe Kicks: 19.1 mm (3/4 inch) net thickness, pressure treated solid lumber.
21. Face Frames: 19.1 mm (3/4 inches) net thick kiln dried solid hardwood, free of knots and selected for light uniform color suitable for stain finish.
    a. Frames: Mortised and tenoned, dovetailed or doweled. glued and stapled under pressure and filled and sanded.
    b. Vertical End Members (Stiles): Minimum 38 mm (1-1/2 inch) net width.
    c. Vertical Center Members between Doors and Drawers (Mulls): Minimum 50 mm (2 inches) net width.
    d. Horizontal Members (Rails): 44 mm (1-3/4 inches) net width.
    e. Stiles and Top and Bottom Rails: Dadoed to receive ends, bottoms and tops.
22. Doors and Door Hardware:
    a. Doors: 19.1 mm (3/4 inch) thick 7-ply A-D grade exterior hardwood plywood with no more than one veneer joint on face.
    b. Edges: Reversed shaped to form continuous finger grip around sides.
    c. Edges: Filled and sanded smooth prior to finish.
    d. Edges: May be treated with hot foil transfer.
    e. Edges: May be covered with 9.5 mm (3/8 inch) by 19.1 mm (3/4 inch) reverse shaped hardwood bands.
    f. Acceptable Hardwoods: Beech, birch, maple or oak suitable for stain finish.
    g. Hinges: Manufacturer's standard heavy duty with self closing feature, face mount or semi concealed type.
23. Drawers and Drawer Hardware:
    a. Fronts Construction and Finish: Same as doors.
    b. Sides and Backs: Minimum 17.4 mm (11/16 inch) net thickness Grade C solid lumber with sides dovetailed or mortised and tenoned into fronts.
    c. Backs: Dadoed into sides.
    d. Bottoms: Minimum 6.4 mm (1/4 inch) softwood or hardwood exterior plywood let into front, sides and back.
    e. Drawer Parts: Glued and nailed or stapled together.
    f. Mount drawers on metal side rails with 34 kg (75 pound) loading capacity.
    g. Cabinet Members or Guides: Attached at rear to 19.1 mm (3/4 inch) solid lumber hanging rail or 12.7 mm (1/2 inch) solid lumber or plywood block which is attached to 19.1 mm (3/4 inch) solid lumber hanging rail by use of metal rear mount brackets or by continuous wraparound method.
24. Installation Cleats: Minimum 19.1 mm (3/4 inch) by 89 mm (3-1/2 inches) net thickness S4S, Grade C, kiln dried solid lumber, dadoed to receive bottoms and tops.
    a. Provide two horizontal members running full length of cabinet at top and bottom.
    b. Base Cabinets with Drawers: Side mount drawer slide bracket(s) rigidly attached to 12.7 mm (1/2 inch) thick plywood or wood block which is rigidly attached to top cleat. See "Drawers" paragraph above for alternate mounting.

25. End Panels:
    a. Exposed End Panels: Minimum 2-2 Grade, 12.7 mm (1/2 inch) thick 5-ply exterior hardwood plywood, selected for light uniform color.
    b. Ends Not Exposed : May be 12.7 mm (1/2 inch) exterior softwood plywood, Grade A-D, with Grade A side to inside of cabinet.
    c. Ends: Dadoed minimum of 6 mm (1/4 inch) deep to receive shelves, bottoms and tops.
    d. Ends: Let into dado in face frame.
    e. Base Cabinet End Panels: Stop 89 mm (3-1/2 inches) above floor and supported by 19.1 mm (3/4 inch) by 89 mm (3-1/2 inch) pressure treated solid lumber member.
26. Shelves and Wall Cabinet Bottoms: 12.7 mm (1/2 inch) thick Grade 2-2 exterior hardwood plywood or Grade A-D exterior softwood plywood with wood banded front edge or 19.1 mm (3/4 inch) net thickness solid lumber.
    a. Shelves: Let into dadoes of end panels and braced behind mulls.
    b. Bottoms: Let into (rabbet or dado, manufacturer's choice) ends, cleats and front frames.
    c. Shelves and Bottoms: Glued and stapled.
    d. Optional Adjustable Shelves: 19.1 mm (3/4 inch) thick Grade 2-2 exterior hardwood plywood of Grade A-D exterior softwood plywood with wood banded front edge or 19.1 mm (3/4 inch) net thickness solid lumber.
        1) Shelves: Support as necessary to comply with shelf deflection provisions of ANSI/KCMA A161.1.
        2) Shelves: When loaded at 73.3 kg/sq. m (15 PSF) for seven days shall not deflect more than 1.6 mm (1/16 inch) per 305 mm (linear foot) between supports.
        3) Maximum Deflection: 6.4 mm (1/4 inch) between supports.
27. Backs: Provide on cabinets (optional on sink bases depending on job conditions).
    a. Backs: Minimum 6.4 mm (1/4 inch) thick Grade 2-2 exterior hardwood plywood or A-D grade exterior softwood plywood.
    b. Backs: Securely glued and stapled to ends, 89 mm (3-1/2 inch) cleats and shelves of cabinet.
    c. Backs: May be let into dado of ends and cleats or may be applied flush with ends and cleats.
28. Base Bottoms: 12.7 mm (1/2 inch) thick Grade 2-2 exterior hardwood plywood or A-C Grade exterior softwood plywood.
    a. Bottoms: Let into (rabbet or dado, manufacturer's choice) end panels, front rails and installation cleats.
    b. Bottom: Supported by 19.1 mm (3/4 inch) net thickness pressure treated solid lumber braces 610 mm (24 inches) OC running front to rear of cabinet and resting on finished floor.

Countertops

29. Plastic Laminate Countertops: ANSI A161.2.
    a. Type: Post-formed with integral backsplashes.
        1) Front Edges: No-drip.
        2) Backsplashes: Minimum 100 mm (4 inches) high with cove beveled molding with Type A curved top and scribe edge.
        3) Provide backsplashes at juncture of countertop with back and side walls.
    b. Materials: High pressure plastic laminated to 19.1 mm (3/4 inch) thick exterior plywood.
        1) Particleboard, flakeboard, fiberboard, or hardboard not allowed.
    c. Plastic Laminate: NEMA LD 3,Type PF42, 1.1 mm. (0.042 inch) thickness.
        1) Colors, patterns, finishes as selected from manufacturer's standard offering.
    d. Perimeter of Bottom of Countertops and Sink Cut-outs: Sealed with varnish.
30. Cultured Marble Countertops: ANSI Z124.3 and HUD UM 73a.
    a. Cast in molds with integral lavatory bowls to achieve required shape and configuration in coordination with vanity cabinets and plumbing trim.
    b. Integral Lavatory Bowls: Recessed oval shape.
    c. Holes for Plumbing Trim: Coordinate with Division 15 Section "Plumbing."

d. Provide radius corners and edges.
e. Backsplashes: Provide where counters meet walls including at back and at sides.
f. Finish: Polished.

Metal Grease Splash Material

31. Stainless Steel: AISI Type 304, nonmagnetic sheets, free of buckles, waves, and surface imperfections, No. 4 polished finish on exposed surfaces, 24 gage, sanded edges.

Wall Cabinet Soffit Material

32. Gypsum Board or Plaster.
33. Wood:
    a. Exposed Wood Soffit Face: 6.4 mm (1/4 inch) 3-ply birch-faced cabinet grade plywood.
    b. Blocking: Hemlock-Fir No. 2.

Source Quality Control

34. Testing: Performed under Third Party Administrator who is in compliance with ANSI Z34.1.

EXECUTION

Examination

35. Site Verification of Conditions:
    a. Existing Conditions: Examine spaces to verity that they are ready to receive cabinets and countertops.
    b. Verify grounds, blocking and supports for proper location and support of cabinets before beginning installation. Verify location of mechanical and electrical rough-ins to assure proper match with installed equipment.
    c. Survey each kitchen and bath to verify dimensions for cabinets and countertops.

Preparation

36. Protection: Protect adjacent elements from damage and disfiguration.
    a. Repair or replace damaged elements.
37. Remove and dispose of existing cabinets and countertops.

Installation

38. General: Deliver, uncrate, place in proper location and assemble cabinets and countertops in accordance with manufacturer's recommendations and approved Shop Drawings.
39. Cabinets: Set cabinets accurately in place, level, and plumb.
    a. Maintain distance between bottom of wall cabinets and top of countertop between 380 and 455 mm (15 and 18 inches).
    b. Scribe and secure to floor and walls.
    c. Provide connecting and attaching devices, closures, and trim members as required for complete installation.
    d. Install items complete and adjust moving parts to operate smoothly.
    e. Wall Cabinets: Hang from masonry walls or secure directly to wall studs.
    f. Scribe and closely fit casework to adjacent work.
    g. Vanity Cabinet: Seal joint between cabinets and walls with joint sealant.
40. Countertops: Secure to casework and walls with concealed fasteners.
    a. Plastic Laminate Post-Formed Countertops: Miter inside corner joints. a. Seal cut edge of plywood at sink opening with spar varnish.
    b. Seal joints between countertops and walls with joint sealant.
41. Sinks, Lavatories, and Trim: Provided and installed under Division 15 Section “Plumbing.”
42. Metal Grease Splash: Install on wall full width of range from top of range to bottom of range hood. Secure to wall with appropriate rounded head fasteners at perimeter.
43. Wall Cabinet Soffits:
    a. Gypsum Board or Plaster.

b. Wood: Provide plywood soffit with backup blocking above cabinets where existing drywall drop soffit does not exist.
   1) Blocking: Provide blocking required to secure drop soffit plywood material in its intended location above new wall cabinets.
   2) Plywood Facing: Trim butt edge conditions with solid wood strip pieces to match. Trim comer conditions with solid wood premilled comer to match. Secure facing materials with fine finish nails and fill nail holes.
   3) Finish to match cabinet finish.

Adjusting And Cleaning

44. Adjusting: Adjust and lubricate moving parts to operate smoothly.
45. Cleaning: Comply with requirements of Detailed Scope of Work.

END OF SECTION 06 41 13 00

Task	Specification	Specification Description
06 41 13 00	06 41 00 00	Architectural Wood Casework
06 41 93 00	06 41 00 00	Architectural Wood Casework
06 41 93 00	08 71 00 00	Door Hardware

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SECTION 06 42 16 00 - FLUSH WOOD PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flush wood paneling (wood-veneer wall surfacing).
2. Fire-retardant-treated materials.
3. Installation materials.

B. Related Requirements:

1. Section 057000 "Decorative Metal" for metal reveals at wood paneling.
2. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing paneling that is concealed within other construction before paneling installation.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that paneling can be installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.

7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
12. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
13. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
14. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
15. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
16. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
17. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
18. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
19. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
20. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
21. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
22. Product Data: For installation adhesives, indicating VOC content.
23. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For flush wood paneling.

1. Include plans, elevations, sections, and attachment details.
2. Show details full size.
3. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
4. For paneling produced from premanufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes.
5. For paneling veneered in fabrication shop, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
6. Apply [**AWI Quality Certification**][**WI Certified Compliance**] Program label to Shop Drawings.

D. Samples: For each exposed product and for each color and finish specified, in manufacturer's or fabricator's standard size.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For the following:

1. Lumber for Transparent Finish: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**][**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.
2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished paneling.
3. Veneer-Faced Panel Products for Transparent Finish: [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**][**12 by 24 inches (300 by 600 mm)**], for each species and cut. Include at least one face-veneer seam and finish as specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**].

B. Product Certificates: For each type of product.

C. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**][**WI Certified Compliance Program**].

D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Shop Certification: [**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

C. Installer Qualifications: [**Fabricator of products**][**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical paneling as shown on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver paneling until painting and similar operations that might damage paneling have been completed in installation areas. Store paneling in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install paneling until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install paneling until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 55**][**43 and 70**][**17 and 50**] percent during the remainder of the construction period.

C. Field Measurements: Where paneling is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings.

Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support paneling by field measurements before being enclosed/concealed by construction and indicate measurements on Shop Drawings.

D. Established Dimensions: Where paneling is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of paneling [**wood-veneer-faced architectural cabinets**][**ornamental woodwork**][**wood trim**][**wood frames**][**wood doors faced with veneers from same flitches as paneling**].

2.2 PANELING, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of flush wood paneling (wood-veneer wall surfacing) indicated for construction, finishes, installation, and other requirements.

1. Provide inspections of fabrication and installation together with labels and certificates from [**AWI**][**WI**] certification program indicating that woodwork complies with requirements of grades specified.
2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.3 FLUSH WOOD PANELING (WOOD-VENEER WALL SURFACING)

A. Grade: [**Premium**][**Custom**][**Economy**].

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

E. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

F. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

G. Wood Species and Cut: [**White oak, rift sliced**][**Select white ash, plain sliced**][**Sycamore, plain sliced**][**Cherry, plain sliced**][**Butternut, plain sliced**][**Avodire, quarter sliced**].

H. Veneer Matching Method:

1. Adjacent Veneer Leaves: [**Book**][**Slip**][**Pleasing (Random)**] match.
2. Within Panel Face: [**Running**][**Balance**][**Center-balance**] match.
3. Adjacent Veneer Leaves and within Panel Face: Slip, center-balance, or book match.

I. Panel-Matching Method:

1. No matching is required between adjacent panels. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
2. [**Premanufactured panel sets used full width**][**Premanufactured panel sets selectively reduced in width**][**Made-to-order, sequence-matched panels**][**Made-to-order, blueprint-matched panels and components**] within each separate area.

   a. See Section 011000 "Summary" for requirements concerning flitches reserved by Architect.

J. Vertical Panel-Matching Method: [**Continuous end match; veneer leaves of upper panels are continuations of veneer leaves of lower panels**][**Architectural end book match; veneer leaves are individually book matched from lower panels to upper panels**][**Architectural end slip match; veneer leaves are individually slip matched from lower panels to upper panels**][**Panel end book match; panels are book matched from lower panels to upper panels**][**Panel end slip match; panels are slip matched from lower panels to upper panels**].

K. Panel Core Construction: [**Hardwood veneer-core plywood**][**Particleboard or MDF**][**Fire-retardant particleboard or fire-retardant MDF**].

1. Thickness: [**3/4 inch (19 mm)**][**As indicated on Drawings**].

L. Exposed Panel Edges: [**Inset solid-wood or wood-veneer matching faces**][**Legs of metal channels forming reveals**][**Applied solid-wood banding 11/16 inch (18 mm) thick by depth of panels**][**Applied bronze flat bars 1/16 inch (1.6 mm) thick by depth of panels**].

M. Panel Reveals: [**Matte black plastic laminate**][**Bronze sheet**][**Stainless steel sheet**][**Bronze channels, 1 by 1 by 1/8 inch (25.4 by 25.4 by 3.2 mm) thick**][**Stainless steel channels, 1 by 1 by 1/16 inch (25.4 by 25.4 by 1.6 mm) thick**].

N. Fire-Retardant-Treated Paneling: Panels are to consist of wood-veneer and fire-retardant particleboard or fire-retardant, medium-density fiberboard (MDF). Panels are to have a flame-spread index of [**25**][**75**] or less and a smoke-developed index of 450 or less per ASTM E84, and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.

O. Assemble panels by gluing and concealed fastening.

2.4 MATERIALS

A. Materials, General: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

B. Wood Moisture Content: [**5 to 10**][**8 to 13**][**4 to 9**] percent.

C. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. MDF: ANSI A208.2, [**Grade 130**].
7. Particleboard (Medium Density): ANSI A208.1, [**Grade M-2**][**Grade M-2-Exterior Glue**].
8. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

D. Adhesives: Do not use adhesives that contain urea formaldehyde.

E. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

G. Adhesives: Do not use adhesives that contain urea formaldehyde.

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of paneling.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arauco North America**]
   b. [**Timber Products, Inc.**]

2. For panels **3/4 inch (19 mm)** thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, **1600 psi (11 MPa)**; modulus of elasticity, **300,000 psi (2070 MPa)**; internal bond, **80 psi (550 kPa)**; and screw-holding capacity on face and edge, **250 and 225 lbf (1100 and 1000 N)**, respectively.
3. For panels **13/16 to 1-1/4 inches (20 to 32 mm)** thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, **1300 psi (9 MPa)**; modulus of elasticity, **250,000 psi (1720 MPa)**; linear expansion, 0.50 percent; and screw-holding capacity on

face and edge, **250 and 175 lbf (1100 and 780 N)**, respectively.

D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Roseburg**]

2.6 INSTALLATION MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: [**Softwood or hardwood lumber**][**Fire-retardant-treated softwood lumber**], kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

C. Installation Adhesive: Product recommended by panel fabricator for each substrate for secure anchorage.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.7 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Arrange paneling in shop or other suitable space in proposed sequence for examination by Architect, as directed by the Owner. Mark units with temporary sequence numbers to indicate position in proposed layout.

1. Lay out one elevation at a time if approved by Architect.
2. Notify Architect seven days in advance of the date and time when layout will be available for viewing.
3. Provide lighting of similar type and level as that of final installation for viewing layout unless otherwise approved by Architect.
4. Rearrange paneling as directed by Architect until layout is approved.
5. Do not trim end units and other nonmodular-size units to less than modular size until after Architect's approval of layout.[**Indicate trimming by masking edges of units with nonmarking material.**]
6. Obtain Architect's approval of layout before start of assembly. Mark units and Shop Drawings with assembly sequence numbers based on approved layout.

C. Complete fabrication, including assembly, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times paneling fabrication will be complete, as directed by the Owner.

D. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.8 SHOP FINISHING

A. General: Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Shop Priming: Shop apply the prime coat including backpriming, if any, for[**transparent-finished**] paneling specified to be field finished. See Section 099300 "Staining and Transparent Finishing" for material and application requirements.

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing paneling, as applicable to each unit of work.

1. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of paneling.

D. Transparent Finish:

1. Grade: [**Premium**][**Custom**][**Economy**][**Same as item to be finished**].
2. Finish: System - [**1, nitrocellulose lacquer**][**2, precatalyzed lacquer**][**3, postcatalyzed lacquer**][**4, water-based latex acrylic**][**5, conversion varnish**][**6, synthetic penetrating oil**][**7, catalyzed vinyl**][**8, water-based crosslinking acrylic**][**9, UV curable acrylated epoxy, polyester, or urethane**][**10, water-based UV curable**][**11, catalyzed polyurethane**][**12, water-based polyurethane**][**13, catalyzed polyester**].
3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
4. Staining: [**None required**][**Match approved sample for color**][**Match Architect's sample**].
5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
6. Filled Finish for Open-Grain Woods:[**After staining, apply wash-coat sealer and allow to dry.**] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
7. Sheen: [**Flat, 15-30**][**Satin, 31-45**][**Semigloss, 46-60**][**Gloss, 61-100**] gloss units measured on

60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition paneling to humidity conditions in installation areas.

B. Before installing paneling, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install paneling to comply with quality standard grade of paneling to be installed.

B. Install paneling level, plumb, true in line, and without distortion. Shim as required with concealed shims. Install level and plumb to a tolerance of **1/8 inch in 96 inches (3 mm in 2400 mm)**. Install with no more than **1/16 inch in 96-inch (1.6 mm in 2400-mm)** vertical cup or bow and **1/8 inch in 96-inch (3 mm in 2400-mm)** horizontal variation from a true plane.

1. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding [**1/32 inch (0.8 mm)**][**1/16 inch (1.5 mm)**].

C. Anchor paneling to supporting substrate with [**concealed panel-hanger clips**][**splined connection strips**][**blind nailing**].

1. Do not use face fastening unless [**covered by trim**][**otherwise indicated**].

D. Complete finishing work specified in this Section to extent not completed at shop or before installation of paneling. Fill nail holes with matching filler where exposed.

1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

E. See Section 099300 "Staining and Transparent Finishing" for final finishing of installed paneling.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective paneling, where possible, to eliminate defects. Where not possible to repair, replace paneling. Adjust for uniform appearance.

B. Clean paneling on exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 42 16 00

SECTION 06 42 19 00 - PLASTIC-LAMINATE-FACED WOOD PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced wood paneling.

B. Related Requirements:

1. Section 057000 "Decorative Metal" for metal reveals at plastic-laminate-faced wood paneling.
2. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing paneling that is concealed within other construction before paneling installation.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that paneling can be installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-faced wood paneling.

B. Product Data Submittals: For each product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point

of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.

7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
12. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
13. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
14. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
15. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
16. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
17. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
18. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
19. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
20. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
21. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
22. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
23. Product Data: For installation adhesives, indicating VOC content.
24. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

D. Shop Drawings: For plastic-laminate-faced wood paneling.

1. Include plans, elevations, sections, and attachment details.
2. Show details full size.
3. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
4. Apply [**AWI Quality Certification**][**WI Certified Compliance**] Program label to Shop Drawings.

E. Samples: For each exposed product and for each color and texture specified, in manufacturer's or fabricator's standard size.

F. Samples for Initial Selection: For each type of plastic laminate.

G. Samples for Verification: For each type of exposed laminate, [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**].

1. Provide one Sample applied to core material[**and with specified edge material applied to one edge**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator**].

B. Product Certificates: For each type of product.

C. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**][**WI Certified Compliance Program**].

D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Shop Certification: [**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

B. Installer Qualifications: [**Fabricator of products**][**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of [**typical paneling as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver paneling until painting and similar operations that might damage paneling have been completed in installation areas. Store paneling in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install paneling until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install paneling until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 55**][**43 and 70**][**17 and 50**] percent during the remainder of the construction period.

C. Field Measurements: Where paneling is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support paneling by field measurements before being enclosed/concealed by construction and indicate measurements on Shop Drawings.

D. Established Dimensions: Where paneling is indicated to fit to other construction, establish dimensions

for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PANELING, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-faced wood paneling (decorative laminate surfacing) indicated for construction, finishes, installation, and other requirements.

1. Provide inspections including installation together with labels and certificates from [**AWI**][**WI**] certification program indicating that woodwork complies with requirements of grades specified.
2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.2 PLASTIC-LAMINATE-FACED WOOD PANELING

A. Grade: [**Premium**][**Custom**][**Economy**].

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

E. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

F. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed surfaces complying with the following requirements, as directed by the Owner:

1. As indicated by manufacturer's designations.
2. Match Architect's samples.
3. As selected by Architect from laminate manufacturer's full range in the following categories:

   a. Solid colors, [**gloss**][**matte**] finish.
   b. Solid colors with core same color as surface, [**gloss**][**matte**] finish.
   c. Wood grains, [**gloss**][**matte**] finish.
   d. Patterns, [**gloss**][**matte**] finish.

4. Grain Direction: [**Vertical**][**Horizontal**].

H. Panel Core: [**Particleboard or MDF**][**Fire-retardant particleboard or fire-retardant MDF**].

1. Thickness: [**3/4 inch (19 mm)**][**As indicated on Drawings**].

I. Exposed Panel Edges: [**Plastic-laminate matching faces**][**Legs of metal channels forming reveals**][**Applied solid-wood banding 11/16 inch (18 mm) thick by depth of panels**][**Applied bronze flat bars 1/16 inch (1.6 mm) thick by depth of panels**].

J. Panel Reveals: [**Matte black plastic laminate**][**Bronze sheet**][**Stainless steel sheet**][**Bronze channels, 1 by 1 by 1/8 inch (25.4 by 25.4 by 3.2 mm) thick**][**Stainless steel channels, 1 by 1 by 1/16 inch (25.4 by 25.4 by 1.6 mm) thick**].

K. Adhesives for Bonding Plastic Laminate: [**Type I, waterproof type**][**Type II water-resistant type**] as selected by fabricator to comply with requirements .

1. Adhesive for Bonding Edges: Hot-melt adhesive[**or adhesive specified above for faces**].

L. Fire-Retardant-Treated Paneling: Panels are to consist of fire-retardant plastic laminate and fire-retardant particleboard or fire-retardant, medium-density fiberboard (MDF). Panels are to have a flame-spread index of [**25**][**75**] or less and a smoke-developed index of 450 or less per ASTM E84, and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.

M. Assemble panels by gluing and concealed fastening.

2.3 MATERIALS

A. Materials, General: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

B. Wood Moisture Content: [**5 to 10**][**8 to 13**][**4 to 9**] percent.

C. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. MDF: ANSI A208.2, [**Grade 130**].
7. Particleboard (Medium Density): ANSI A208.1, [**Grade M-2**][**Grade M-2-Exterior Glue**].

2.4 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of paneling.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of

25 or less per ASTM E84.

1. For panels **3/4 inch (19 mm)** thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, **1600 psi (11 MPa)**; modulus of elasticity, **300,000 psi (2070 MPa)**; internal bond, **80 psi (550 kPa)**; and screw-holding capacity on face and edge, **250 and 225 lbf (1100 and 1000 N)**, respectively.
2. For panels **13/16 to 1-1/4 inches (20 to 32 mm)** thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, **1300 psi (9 MPa)**; modulus of elasticity, **250,000 psi (1720 MPa)**; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, **250 and 175 lbf (1100 and 780 N)**, respectively.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arauco North America**]
   b. [**Timber Products, Inc.**]

D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Roseburg**]

2.5 INSTALLATION MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: [**Softwood or hardwood lumber**][**Fire-retardant-treated softwood lumber**], kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

C. Installation Adhesive: Product recommended by panel fabricator for each substrate for secure anchorage.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of

Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.6 FABRICATION

A. Complete fabrication, including assembly, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times paneling fabrication will be complete, as directed by the Owner.

B. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition paneling to humidity conditions in installation areas.

B. Before installing paneling, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install paneling to comply with quality standard grade of paneling to be installed.

B. Install paneling level, plumb, true in line, and without distortion. Shim as required with concealed shims. Install level and plumb to a tolerance of **1/8 inch in 96 inches (3 mm in 2400 mm)**. Install with no more than **1/16 inch in 96-inch (1.6 mm in 2400-mm)** vertical cup or bow and **1/8 inch in 96-inch (3 mm in 2400-mm)** horizontal variation from a true plane.

1. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding [**1/32 inch (0.8 mm)**][**1/16 inch (1.5 mm)**].

C. Anchor paneling to supporting substrate with [**concealed panel-hanger clips**][**splined connection strips**][**blind nailing**]. Do not use face fastening unless [**covered by trim**][**otherwise indicated**].

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective paneling, where possible, to eliminate defects. Where not possible to repair, replace paneling. Adjust for uniform appearance.

B. Clean paneling on exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

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SECTION 06 44 00 00 - ORNAMENTAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior ornamental woodwork for transparent finish.
2. Exterior ornamental woodwork for opaque finish.
3. Interior ornamental woodwork for transparent finish.
4. Interior ornamental woodwork for opaque finish.
5. Wood furring, blocking, shims, and hanging strips for installing ornamental woodwork items that are not concealed within other construction.
6. Shop priming of exterior ornamental woodwork.
7. Shop priming of interior ornamental woodwork.
8. Shop finishing of exterior ornamental woodwork.
9. Shop finishing of interior ornamental woodwork.

B. Related Requirements:

1. [**Section 061000 "Rough Carpentry"**][**Section 061052 "Miscellaneous Rough Carpentry"**] for wood furring, blocking, shims, and hanging strips required for installing ornamental woodwork that are concealed within other construction before ornamental woodwork installation.
2. Section 062013 "Exterior Finish Carpentry" for exterior carpentry exposed to view that is not specified in this Section.
3. Section 062023 "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior ornamental woodwork can be supported and installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Composite wood products.
2. Fire-retardant-treated materials.
3. Finishing materials and processes.
4. Wood-Preservative Treatment:

   a. Include data and warranty from chemical-treatment manufacturer and certification by

treating plant that treated materials to comply with requirements.
   b. Indicate type of preservative used and net amount of preservative retained.
   c. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

5. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials to comply with requirements.
6. Waterborne Treatments: For products receiving a waterborne treatment, Include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
12. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
13. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
14. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
15. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
16. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
17. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
18. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
19. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
20. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
21. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: Show location of each item, including the following:

1. Dimensioned plans, elevations, and sections.
2. Attachment devices, and other components.
3. Show [**large-scale**][**full-size**] details.

4. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
5. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
6. Apply [**AWI Quality Certification**][**WI Certified Compliance**] Program label to Shop Drawings.

D. Samples: For each exposed product and for each shop-applied color and finish specified.

1. Size:

a. Panel Products: **12 inches by 12 inches (300 mm by 300 mm)**.
b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**][**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

E. Samples for Initial Selection: For each type of shop-applied exposed finish.

1. Size:

a. Panel Products: **12 inches by 12 inches (300 mm by 300 mm)**.
b. Lumber Products: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**][**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.

F. Samples for Verification:

1. Lumber for Exterior Wood-Stain Finish: Not less than **5 inches (125 mm)** wide by **12 inches (300 mm)** long, for each species, with one-half of exposed surface finished.
2. Lumber for Transparent Finish: Not less than [**5 inches (125 mm) wide by 12 inches (300 mm) long**][**5 inches (125 mm) wide by 24 inches (600 mm) long**], for each species and cut, finished on one side and one edge.
3. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished ornamental woodwork.
4. Lumber and Panel Products with Shop-Applied Opaque Finish: **5 inches (125 mm)** wide by **12 inches (300 mm)** long for lumber and [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**] for panels, for each finish system and color, with[**one-half of**] exposed surface finished.

a. Finish [**entire**][**one-half of**] exposed surface.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**ornamental woodwork manufacturer**][**and**][**Installer**].

B. Product Certificates: For [**each type of product.**][**the following:**]

1. Composite wood products.
2. Adhesives.

C. Evaluation Reports: For [**wood-preservative-treated**][**and**][**fire-retardant-treated**] wood materials, from ICC-ES.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI Quality Certification Program**][**WI Certified Compliance Program**] certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**].

B. Installer Qualifications: [**Manufacturer of products**][**and**][**Licensed participant in AWI's Quality Certification Program**][**Licensed participant in WI's Certified Compliance Program**].

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution, as directed by the Owner.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with Architectural Woodwork Standards, Section 2.

B. Do not deliver interior ornamental woodwork until painting and similar operations that could damage woodwork have been completed in installation areas.

C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1. Handle and store fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Weather Limitations for Exterior Work: Proceed with installation of exterior ornamental woodwork only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish is to be applied without exposure to rain, snow, or dampness.

B. Environmental Limitations for Interior Work without Humidity Control: Do not deliver or install interior ornamental woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupancy for the remainder of the construction period.

C. Environmental Limitations for Interior Work with Humidity Control: Do not deliver or install interior ornamental woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 55**][**43 and 70**][**20 and 50**] percent during the remainder of the construction period.

D. Field Measurements: Where ornamental woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.

E. Established Dimensions: Where ornamental woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 ORNAMENTAL WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of ornamental woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide [**labels**][**and**][**certificates**] from [**AWI**][**WI**] certification program indicating that woodwork[**including installation,**] complies with requirements of grades specified.

a. Contractor is to register the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 800-345-0991.

2. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and Architectural Woodwork Standards.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 EXTERIOR ORNAMENTAL WORK FOR TRANSPARENT FINISH

A. Exterior ornamental work for transparent finish includes the following:

1. Balustrades.
2. Columns.
3. Cupolas.
4. Pediment heads.
5. Pilasters.

B. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**].

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry

Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

K. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

L. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

M. Wood Species: [**Teak**][**African mahogany**][**All-heart redwood**][**Western red cedar**][**Ponderosa pine or sugar pine**].

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than **3 inches (76 mm)** wide.

N. Wood Moisture Content: [**9 to 15**][**10 to 15**][**7 to 12**] percent.

2.3 EXTERIOR ORNAMENTAL WORK FOR OPAQUE FINISH

A. Exterior ornamental work for opaque finish includes the following:

1. Balustrades.
2. Columns.
3. Cupolas.
4. Pediment heads.
5. Pilasters.

B. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**].

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

K. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

L. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

M. Wood Species: [**All-heart redwood**][**Western red cedar**][**Ponderosa pine**][**Ponderosa pine or sugar pine**][**Eastern white pine, sugar pine, or western white pine**][**Any closed-grain hardwood**][**Softwood plywood**].

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than **3 inches (76 mm)** wide.

N. Wood Moisture Content: [**9 to 15**][**10 to 15**][**7 to 12**] percent.

2.4 INTERIOR ORNAMENTAL WORK FOR TRANSPARENT FINISH

A. Interior ornamental work for transparent finish includes the following:

1. Altar.
2. Balustrades.
3. Columns.
4. Grilles.
5. Judge's bench.
6. Lectern.
7. Mantels.
8. Pediment heads.
9. Pilasters.
10. Pulpit.
11. Witness stand.

B. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**].

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site

from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

K. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

L. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

M. Wood Species and Cut:[**Match species and cut indicated for other types of transparent-finished ornamental woodwork located in same area of building unless otherwise indicated.**]

1. Species: [**Red oak**][**White oak**][**White ash**][**Hickory**].
2. Cut: [**Plain sliced/plain sawn**][**Rift cut/rift sawn**][**Quarter cut/quarter sawn**][**Any cut**].

N. Wood Moisture Content: [**5 to 10**][**8 to 13**][**4 to 9**] percent.

2.5 INTERIOR ORNAMENTAL WORK FOR OPAQUE FINISH

A. Interior ornamental work for opaque finish includes the following:

1. Altar.
2. Balustrades.
3. Columns.
4. Grilles.
5. Lectern.
6. Mantels.
7. Pediment heads.
8. Pilasters.
9. Pulpit.

B. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**].

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

K. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

L. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

M. Wood Species: [**Any closed-grain hardwood**][**Eastern white pine, sugar pine, or western white pine**].

N. Wood Moisture Content: [**5 to 10**][**8 to 13**][**4 to 9**] percent.

2.6 WOOD MATERIALS

A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of ornamental woodwork and quality grade specified, as directed by the Owner.

B. Composite Wood Products: Products shall be made without urea formaldehyde.

C. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

E. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

F. Composite Wood Products: Products shall be made without urea formaldehyde.

1. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.7 PRESERVATIVE-TREATED WOOD MATERIALS

A. Preservative-Treated Wood Materials: Provide with water-repellent preservative treatment complying with AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).

1. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC)[**combined with a compatible EPA registered insecticide**].
2. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. Extent of Preservative Treated Wood Materials: Treat [**exterior ornamental woodwork indicated on Drawings**][**exterior ornamental woodwork unless otherwise indicated on Drawings**][**interior ornamental woodwork in contact with concrete or masonry**].

1. Items fabricated from the following wood species need not be treated:

a. [**Redwood**][**All-heart redwood**].
b. [**Western red cedar**][**All-heart western red cedar**].
c. White oak.
d. African mahogany.
e. Honduras mahogany.
f. Ipe.
g. Dark red meranti.
h. Teak.

2.8 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of Architectural Woodwork Standards for the grade specified. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

1. For exterior applications, use materials that comply with testing requirements after being subjected to accelerated weathering in accordance with ASTM D2898.
2. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
3. For items indicated to receive a stained, transparent or natural finish, use organic resin chemical formulation.
4. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
5. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arauco North America**]
   b. [**Timber Products, Inc.**]

2. For panels **3/4 inch (19 mm)** thick and less, comply with ANSI A208.1 for Grade M-2, except for the following minimum properties: modulus of rupture, **1600 psi (11 MPa)**; modulus of elasticity, **300,000 psi (2070 MPa)**; internal bond, **80 psi (550 kPa)**; and screw-holding capacity on face and edge, **250 and 225 lbf (1100 and 1000 N)**, respectively.
3. For panels **13/16 to 1-1/4 inches (20 to 32 mm)** thick, comply with ANSI A208.1 for Grade M-1, except for the following minimum properties: modulus of rupture, **1300 psi (9 MPa)**; modulus of elasticity, **250,000 psi (1720 MPa)**; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, **250 and 175 lbf (1100 and 780 N)**, respectively.

D. Fire-Retardant Fiberboard: Medium-density fiberboard (MDF) panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Roseburg**]

2.9 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Use [**stainless steel**][**fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329/F2329M**] unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.
3. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Carbon-Steel Bolts: ASTM A307 with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers all hot-dip zinc coated.

F. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4)** hex nuts and, where indicated, flat washers.

G. Postinstalled Anchors: Stainless steel, [**chemical**][**or**][**torque-controlled expansion**] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance with ASTM E488/E488M conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or Grade A4)**.

2.10 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, Hanging Strips, and Nailers: Softwood or hardwood lumber[**pressure-preservative treated**][**fire-retardant treated**], kiln dried to less than 15 percent moisture content.

1. Wood-Preservative Treatment: By pressure process, AWPA U1; Use Category UC3b.

a. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
b. Preservative Chemicals: Acceptable to authorities having jurisdiction[**and containing no arsenic or chromium**].
c. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.

2. Fire-Retardant Treatment: Complying with requirements; provide [**where indicated on Drawings**].

B. Adhesives: Do not use adhesives that contain urea formaldehyde.

C. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Adhesives: Do not use adhesives that contain urea formaldehyde.

F. Adhesives: Do not use adhesives that contain urea formaldehyde.

G. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.11 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate ornamental woodwork to dimensions, profiles, and details indicated.

1. Ease edges to radius indicated for the following:

a. Edges of Solid-Wood (Lumber) Members: **1/16 inch (1.5 mm)** unless otherwise indicated.
b. Edges of Rails and Similar Members More Than **3/4 Inch (19 mm)** Thick: **1/8 inch (3 mm)**.

C. Complete fabrication, including assembly[**and finishing**], to maximum extent possible before shipment to Project site.

1. Disassemble components only as necessary for shipment and installation.
2. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
3. Notify Architect seven days in advance of the dates and times ornamental woodwork fabrication will be complete, as directed by the Owner.

4. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.

    a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
    b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.12 SHOP PRIMING

A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing ornamental woodwork, as applicable to each unit of work.

B. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of ornamental woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

C. Exterior Ornamental Woodwork for Opaque Finish: Shop prime all surfaces with one coat of wood primer specified in Section 099113 "Exterior Painting."

D. Exterior Ornamental Woodwork for Transparent Finish:

    1. Shop seal surfaces to be concealed.
    2. Shop seal exposed surfaces with stain (if specified), other required pretreatments, and first coat of finish as specified in Section 099300 "Staining and Transparent Finishing."

E. Interior Ornamental Woodwork for Opaque Finish: Shop prime with one coat of wood primer specified in Section 099123 "Interior Painting."

    1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

F. Interior Ornamental Woodwork for Transparent Finish: Shop seal with stain (if required), other required pretreatments, and first coat of finish as specified in Section 099300 "Staining and Transparent Finishing."

    1. Backpriming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork.[**Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.**]

2.13 SHOP FINISHING

A. Finish ornamental woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Shop finish transparent-finished ornamental woodwork at fabrication shop as specified in this Section. Refer to [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for field finishing opaque-finished ornamental woodwork.

C. Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**and**][**Section 099300 "Staining and Transparent Finishing"**] for field finishing ornamental

woodwork not indicated to be shop finished.

D. Transparent Finish for Exterior Items: Comply with Section 099300 "Staining and Transparent Finishing."

E. Opaque Finish for Exterior Items: Comply with Section 099113 "Exterior Painting."

F. Transparent Finish for Interior Items:

1. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**][**Same as item to be finished**].
2. Finish System - 1: Lacquer, Nitrocellulose.
3. Finish System - 2: Lacquer, Pre Catalyzed.
4. Finish System - 3: Lacquer, Post Catalyzed.
5. Finish System - 4: Latex Acrylic, Water-Based.
6. Finish System - 5: Varnish, Conversion.
7. Finish System - 6: Oil, Synthetic Penetrating.
8. Finish System - 7: Vinyl, Catalyzed.
9. Finish System - 8: Acrylic Cross Linking, Water-Based.
10. Finish System - 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
11. Finish System - 10: UV curable, Water-Based.
12. Finish System - 11: Polyurethane, Catalyzed.
13. Finish System - 12: Polyurethane, Water-Based.
14. Finish System - 13: Polyester, Catalyzed.
15. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
16. Staining: [**None required**][**Match approved sample for color**][**Match Architect's sample**].
17. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
18. Filled Finish for Open-Grain Woods:[**After staining, apply wash-coat sealer and allow to dry.**] Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
19. Sheen: [**Flat, 8-14**][**Satin, 15-25**][**Satin Gloss, 26-49**][**Semigloss, 50-70**][**Gloss, 71-90**] gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

G. Opaque Finish for Interior Items:

1. Architectural Woodwork Standards Grade: [**Premium**][**Custom**][**Economy**][**Same as item to be finished**].
2. Finish System - 1: Lacquer, Nitrocellulose.
3. Finish System - 2: Lacquer, Pre Catalyzed.
4. Finish System - 3: Lacquer, Post Catalyzed Lacquer.
5. Finish System - 4: Latex Acrylic, Water-Based.
6. Finish System - 5: Varnish, Conversion.
7. Finish System - 7: Vinyl, Catalyzed.
8. Finish System - 8: Acrylic Cross Linking, Water-Based.
9. Finish System - 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
10. Finish System - 10: UV Curable, Water-Based.
11. Finish System - 11: Polyurethane, Catalyzed.
12. Finish System - 12: Polyurethane, Water-Based.
13. Finish System - 13: Polyester, Catalyzed.
14. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
15. Sheen: [**Flat, 8-14**][**Satin, 15-25**][**Satin Gloss, 26-49**][**Semigloss, 50-70**][**Gloss, 71-90**] gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition ornamental woodwork to average prevailing humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.

B. Before installing ornamental woodwork, examine shop-fabricated work for completion, and complete work as required, including removing packing and backpriming concealed surfaces.

3.2 INSTALLATION

A. Grade: Install ornamental woodwork to comply with same grade as item to be installed.

B. Assemble ornamental woodwork, and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install ornamental woodwork level, plumb, true in line, and without distortion.

1. Shim as required with concealed shims.
2. Install level and plumb to a tolerance of **1/8 inch in 96 inches (3 mm in 2400 mm)**.

D. Scribe and cut ornamental woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Preservative-Treated Wood: Where cut or drilled, treat cut ends and drilled holes in accordance with AWPA M4.

F. Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

G. Anchor ornamental woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails[**or finishing screws**] for exposed fastening, countersunk and filled flush with ornamental woodwork.
3. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.
4. For shop-finished items, use filler matching finish of items being installed.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.4 REPAIR

A. Repair damaged and defective ornamental woodwork, where possible, to eliminate functional and visual

defects[**and to result in interior ornamental woodwork being in compliance with requirements of Architectural Woodwork Standards for the specified grade**].

B. Where not possible to repair, replace defective Work.

C. Shop Finish: Touch up finishing work specified in this Section after installation of ornamental woodwork.

1. Fill nail holes with matching filler where exposed.
2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

D. Field Finish: See [**Section 099123 "Interior Painting"**][**and**][**Section 099300 "Staining and Transparent Finishing"**] for final finishing of installed ornamental woodwork not indicated to be shop finished.

END OF SECTION 06 44 00 00

Task	Specification	Specification Description
06 44 39 00	06 44 00 00	Ornamental Woodwork
06 46 13 00	06 20 00 00	Interior Finish Carpentry
06 46 19 00	01 22 00 00	No Specification Required
06 46 19 00	06 20 00 00	Interior Finish Carpentry

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SECTION 06 74 13 00 - FIBERGLASS REINFORCED GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber-reinforced plastic gratings.
2. Grating frames and supports.

1.2 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For glass-fiber-reinforced plastic gratings.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated Design Submittal: For gratings, including [**manufacturer's published load tables**] [**analysis data signed and sealed by the qualified professional engineer responsible for their preparation**].

1.4 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform load of 125 lbf/sq. ft. (6.00 kN/sq. m) or concentrated load of 2000 lbf (8.90 kN), whichever produces the greater stress.
2. Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 3000 lbf (13.40 kN), whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m).

4. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m).
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 8000 lbf (35.60 kN), whichever produces the greater stress.
6. Limit deflection to [**L/360**] or 1/4 inch (6.4 mm), whichever is less.

C. Seismic Performance: Gratings are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

1. Component Importance Factor: 1.5.

2.2 GLASS-FIBER-REINFORCED PLASTIC GRATINGS

A. Molded Glass-Fiber-Reinforced Gratings: Bar gratings made by placing glass-fiber strands that have been saturated with thermosetting plastic resin in molds in alternating directions to form interlocking bars without voids and with a high resin content.

1. Configuration: [**1-1/2-inch- (38-mm-) square mesh, 1 inch (25 mm) thick**] [**1-1/2-inch- (38-mm-) square mesh, 1-1/4 inches (32 mm) thick**] [**1-1/2-inch- (38-mm-) square mesh, 1-1/2 inches (38 mm) thick**] [**2-inch- (51-mm-) square mesh, 2 inches (51 mm) thick**] [**1-1/2-inch- (38-mm-) square mesh, thickness as required to comply with structural performance requirements**] [**As required to comply with structural performance requirements**].
2. Weight: [**2.5 lb/sq. ft. (12.2 kg/sq. m)**] [**2.7 lb/sq. ft. (13.2 kg/sq. m)**] [**3.2 lb/sq. ft. (15.6 kg/sq. m)**] [**3.5 lb/sq. ft. (17.1 kg/sq. m)**] [**3.7 lb/sq. ft. (18.1 kg/sq. m)**] [**4.1 lb/sq. ft. (20.0 kg/sq. m)**] [**5.0 lb/sq. ft. (24.4 kg/sq. m)**].
3. Resin: [**Polyester**] [**Vinylester**].

   a. Flame-Spread Index: 25 or less when tested in accordance with ASTM E84.
   b. USDA Acceptance: Accepted for food-processing applications.

4. Color: [**Beige**] [**Gray**] [**Green**] [**Orange**] [**Yellow**] [**Manufacturer's standard**].
5. Traffic Surface: [**Plain, meniscus**] [**Applied abrasive finish**] [**As indicated**].

B. Pultruded Glass-Fiber-Reinforced Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.

1. Configuration: [**I4010; 1-inch (25-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open)**] [**I6010; 1-inch (25-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open)**] [**I4015; 1-1/2-inch (38-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open)**] [**I6015; 1-1/2-inch (38-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open)**] [**T3320; 2-inch (51-mm) T-bars spaced 1-1/2 inches (38 mm) o.c. (33 percent open)**] [**T5020; 2-inch (51-mm) T-bars spaced 2 inches (51 mm) o.c. (50 percent open)**] [**As required to comply with structural performance requirements**].
2. Weight: [**2.35 lb/sq. ft. (11.5 kg/sq. m)**] [**2.83 lb/sq. ft. (13.8 kg/sq. m)**] [**3.10 lb/sq. ft. (15.1 kg/sq. m)**] [**3.41 lb/sq. ft. (16.6 kg/sq. m)**] [**4.10 lb/sq. ft. (20.0 kg/sq. m)**] [**4.13 lb/sq. ft. (20.2 kg/sq. m)**].
3. Resin Type: [**Polyester**] [**Vinylester**].

   a. Flame-Spread Index: 25 or less when tested in accordance with ASTM E84.
   b. USDA Acceptance: Accepted for food-processing applications.

4. Color: [**Beige**] [**Gray**] [**Green**] [**Orange**] [**Yellow**] [**Manufacturer's standard**].
5. Traffic Surface: [**Plain, grooved**] [**Applied abrasive finish**] [**As indicated**].

2.3 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**] [**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ISO 898-1, Property Class 4.6); with hex nuts, ASTM A563/A563M; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts, and, where indicated, flat washers; ASTM F593 (ISO 3506-1) for bolts and ASTM F594 (ISO 3506-1) for nuts, Alloy [**Group 1 (A1)**] [**Group 2 (A4)**].

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563/A563M; and, where indicated, flat washers.

E. Post-Installed Anchors: [**Torque-controlled expansion anchors**] [**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components are zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: ASTM F593 (ISO-3506-1) for bolts and ASTM F594 (ISO 3506-1) for nuts, Alloy [**Group 1 (A1)**] [**Group 2 (A4)**].

2.4 FABRICATION

A. Shop Assembly: Shop fabricate grating sections to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form gratings from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

F. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

2.5 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings: Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, use shapes made from same resin as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

3.2 INSTALLATION OF GLASS-FIBER-REINFORCED PLASTIC GRATINGS

A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless steel anchor clips and hold-down devices for bolted connections.

END OF SECTION 06 74 13 00

Task	Specification	Specification Description
06 74 13 00	05 53 13 00	Bar Gratings

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SECTION 07 01 50 19 - PREPARATION FOR REROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes:

1. Full roof tear-off.
2. Partial roof tear-off.
3. Temporary roofing.
4. Roof re-cover preparation.
5. Base flashing removal.
6. Fastener pull-out testing.
7. Disposal.

B. Related Requirements:

1. Section 011000 "Summary" for use of premises and for phasing requirements.
2. Section 015000 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.

1.2 DEFINITIONS

A. EPS: Molded (expanded) polystyrene.

B. Full Roof Tear-off: Removal of existing roofing system down to existing [**roof deck**][**concrete fill**].

C. OSB: Oriented strand board.

D. Partial Roof Tear-off: Removal of selected components and accessories from existing roofing system.

E. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

F. Roof Re-Cover Preparation: Existing roofing system is to remain and be prepared for new roof installed over it.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:

a. Reroofing preparation, including roofing system manufacturer's written instructions.

b. Temporary protection requirements for existing roofing system components that are to remain.
c. Existing roof drains and roof drainage during each stage of reroofing, and roof-drain plugging and plug removal.
d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.
e. Existing roof deck conditions requiring Architect notification.
f. Existing roof deck removal procedures and the Owner notifications.
g. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
h. Structural loading limitations of roof deck during reroofing.
i. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.
j. HVAC shutdown and sealing of air intakes.
k. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
l. Asbestos removal and discovery of asbestos-containing materials.
m. Governing regulations and requirements for insurance and certificates if applicable.
n. Existing conditions that may require Architect notification before proceeding, as directed by the Owner.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Temporary Roofing Submittal: Product data and description of temporary roofing system.

1. If temporary roof remains in place, include surface preparation requirements needed to receive permanent roof, and submit a letter from roofing manufacturer stating acceptance of the temporary roof and that its inclusion does not adversely affect the new roofing system's resistance to fire and wind [**or specified special warranty**][**or its FM Approvals rating**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Include certificate that Installer is approved by warrantor of existing roofing system.
2. Include certificate that Installer is licensed to perform asbestos abatement.

B. Field Test Reports: Fastener pull-out test report.

C. Photographs or Video: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations.

1. Submit before Work begins.

D. Landfill Records: Indicate receipt and acceptance of [**demolished roofing materials and**] hazardous wastes, such as asbestos-containing materials, by a landfill facility licensed to accept them.

1.6 CLOSEOUT SUBMITTALS

A. Certified statement from [**Manufacturer**] stating that existing roof warranty has not been affected by

Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: [**Approved by warrantor of existing roofing system to work on existing roofing**][**licensed to perform asbestos abatement in the state or jurisdiction where Project is located**].

B. Regulatory Requirements:

1. Comply with governing EPA notification regulations before beginning roofing removal.
2. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.8 FIELD CONDITIONS

A. Existing Roofing System: [**Built-up asphalt**][**Built-up coal-tar**][**APP-modified bituminous**][**SBS-modified bituminous**][**EPDM**][**CSPE**][**KEE**][**PVC**][**TPO**][**APP-modified bituminous protected membrane**][**SBS-modified bituminous protected membrane**][**Fluid-applied protected membrane**][**Coated foamed**] roofing.

B. the Owner [**will**][**will not**] occupy portions of building immediately below reroofing area.

1. Conduct reroofing so the Owner's operations are not disrupted.
2. Provide the Owner with not less than [**72**] hours' written notice of activities that may affect the Owner's operations.
3. Coordinate work activities daily with the Owner so the Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
4. Before working over structurally impaired areas of deck, notify the Owner to evacuate occupants from below affected area.

   a. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Conditions existing at time of inspection for bidding will be maintained by the Owner as far as practical.

1. A roof moisture survey of existing roofing system is available for Contractor's reference.
2. The results of an analysis of test cores from existing roofing system are available for Contractor's reference.
3. Construction Drawings[**and Project Manual**] for existing roofing system are provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.

F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

G. Hazardous Materials:

1. It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work, as directed by the Owner.

   a. Hazardous materials will be removed by the Owner before start of the Work.
   b. Existing roof will be left no less watertight than before removal.

2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner.
3. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.
   c. Coordinate reroofing preparation with hazardous material remediation to prevent water from entering existing roofing system or building.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by [**Manufacturer**].

1. Notify warrantor before proceeding with the Work.
2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.

   a. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 TEMPORARY PROTECTION MATERIALS

A. EPS Insulation: ASTM C578.

B. Plywood: DOC PS 1, Grade CD, Exposure 1.

C. OSB: DOC PS 2, Exposure 1.

2.2 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are Contractor's responsibilities.

B. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

C. Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-

fiber sheet.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt-impregnated, glass-fiber felt.

E. Asphalt Primer: ASTM D41/D41M.

F. Roofing Asphalt: ASTM D312/D312M, Type III or IV.

G. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approvals' RoofNav.

2.3 INFILL AND REPLACEMENT MATERIALS

A. Use infill materials matching existing roofing system materials unless otherwise indicated.

1. Infill materials are specified in [**Section 075113 "Built-up Asphalt Roofing"**][**Section 075116 "Built-up Coal Tar Roofing"**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing"**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing"**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing"**][**Section 075416 "Keytone Ethylene Ester (KEE) Roofing"**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing"**][**Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing"**] unless otherwise indicated.

B. Steel deck is specified in Section 053100 "Steel Decking."

C. Wood blocking, curbs, and nailers are specified in Section 061000 "Rough Carpentry."

D. Plywood roof sheathing is specified in Section 061600 "Sheathing."

E. Parapet Sheathing:

1. ASTM C1177/C1177M or ASTM C1278/C1278M water-resistant gypsum substrate; [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**] thick.
2. [**Pressure-preservative**][**Exterior fire-retardant**]-treated plywood wall sheathing, [**19/32 inch (15 mm)**] thick, complying with Section 061600 "Sheathing."

F. Fasteners: Factory-coated steel fasteners with metal or plastic plates listed in FM Approvals' RoofNav, and acceptable to new roofing system manufacturer.

2.4 AUXILIARY REROOFING MATERIALS

A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of [**existing and**]new roofing system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Protect existing roofing system that is not to be reroofed.

2. Loosely lay **1-inch- (25-mm-)** minimum thick, EPS insulation over existing roofing in areas not to be reroofed.

    a. Loosely lay **15/32-inch (12-mm)** plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of **1 inch (25 mm)**.

3. Limit traffic and material storage to areas of existing roofing that have been protected.
4. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
5. Comply with requirements of existing roof system manufacturer's warranty requirements.

B. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.

C. Shut off rooftop utilities and service piping before beginning the Work.

D. Test existing roof drains to verify that they are not blocked or restricted.

1. Immediately notify Architect of any blockages or restrictions, as directed by the Owner.

E. Coordinate with the Owner to shut down air-intake equipment in the vicinity of the Work.

1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

F. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

G. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.

1. Prevent debris from entering or blocking roof drains and conductors.

    a. Use roof-drain plugs specifically designed for this purpose.
    b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.

    a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 ROOF TEAR-OFF

A. Notify the Owner each day of extent of roof tear-off proposed for that day[**and obtain authorization to proceed**].

B. Lower removed roofing materials to ground and onto lower roof levels, using dust-tight chutes or other acceptable means of removing materials from roof areas.

C. Remove aggregate ballast from roofing.[**Store aggregate ballast for reuse in manner not to exceed structural loading limitations of roof deck.**]

D. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing using a power broom.

E. Remove pavers and accessories from roofing.

1. Store and protect pavers and accessories for reuse in manner not to exceed structural loading limitations of roof deck.
2. Discard cracked pavers.

F. Remove ballast, protection mat, and EPS insulation from protected roofing membrane.

1. Discard EPS insulation that is damaged or exceeds [**8 lb/cu. ft. (128 kg/cu. m)**].
2. Store EPS insulation for reuse and protect it from physical damage.
3. Store ballast for reuse in manner not to exceed structural loading limitations of roof deck.

G. Full Roof Tear-off: [**Where indicated on Drawings, remove**][**Remove**] existing roofing and other roofing system components down to the existing [**roof deck**][**concrete fill**].

1. Remove [**substrate board**][**vapor retarder**][**roof insulation**][**cover board**].
2. Remove base flashings and counter flashings.
3. Remove perimeter edge flashing and gravel stops.
4. Remove copings.
5. Remove expansion-joint covers.
6. Remove flashings at pipes, curbs, mechanical equipment, and other penetrations.
7. Remove roof drains indicated on Drawings to be removed.
8. Remove wood blocking, curbs, and nailers.
9. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry.

   a. Remove unadhered bitumen, unadhered felts, and wet felts.

10. Remove excess asphalt from steel deck.

    a. A maximum of **15 lb/100 sq. ft. (0.72 kg/sq. m)** of asphalt is permitted to remain on steel decks.

11. Remove fasteners from deck[**or cut fasteners off slightly above deck surface**].

H. Partial Roof Tear-off: [**Where indicated on Drawings, remove**][**Remove**] existing roofing down to [**existing cover board**][**existing insulation**] and immediately check for presence of moisture.

1. [**Engage**][**the Owner will engage**] a qualified testing agency to perform the following test:

   a. Coordinate with the Owner's testing agency to schedule times for tests and inspections immediately after removal.

2. Survey exposed substrate that is to remain using infrared color thermography according to ASTM C1153.

   a. Prepare survey report of initial scan indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.

3. Survey exposed substrate that is to remain using electrical capacitance/impedance testing according to ASTM D7954/D7954M.

   a. Prepare survey report indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.

4. Survey exposed substrate that is to remain using nuclear hydrogen detection testing according to SPRI/RCI NT-1.

    a. Prepare survey report indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.

5. Remove wet or damp materials below existing roofing and above deck, as directed by the Owner.
6. Inspect wood blocking, curbs, and nailers for deterioration and damage.

    a. If wood blocking, curbs, or nailers have deteriorated, immediately notify the Owner.

7. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry.

    a. Remove unadhered bitumen, unadhered felts, and wet felts.

8. Remove excess asphalt from steel deck that is exposed by removal of wet or damp materials.

    a. A maximum of **15 lb/100 sq. ft. (0.72 kg/sq. m)** of asphalt is permitted to remain on steel decks.

9. Remove fasteners from deck[**or cut fasteners off slightly above deck surface**].

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify the Owner.

    1. Do not proceed with installation until directed by the Owner.

C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify the Owner.

    1. Do not proceed with installation until directed by the Owner.

D. Provide additional deck securement as indicated on Drawings.

E. Replace steel deck as indicated on Drawings.

F. Replace steel deck as directed by the Owner.

G. Prepare and paint steel deck surface.

    1. Painting and preparation for painting is specified in Section 099113 "Exterior Painting."

H. Replace plywood roof sheathing as indicated on Drawings.

I. Replace plywood roof sheathing as directed by the Owner.

3.4 INFILL MATERIALS INSTALLATION

A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.

1. Installation of infill materials is specified in [**Section 075113 "Built-up Asphalt Roofing."**][**Section 075116 "Built-up Coal Tar Roofing."**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing."**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing."**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing."**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing."**][**Section 075416 "Keytone Ethylene Ester (KEE) Roofing."**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing."**][**Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing."**]
2. Installation of wood blocking, curbs, and nailers is specified in Section 061000 "Rough Carpentry."

B. Install new roofing patch over roof infill area.

1. If new roofing is installed the same day tear-off is made, roofing patch is not required.

3.5 TEMPORARY ROOFING

A. Install approved temporary roofing over area to be reroofed.

B. Install temporary roofing over area to be reroofed.

1. [**Install two glass-fiber felts**][**Mechanically fasten base sheet and install a glass-fiber felt**], lapping each sheet **19 inches (483 mm)** over preceding sheet.
2. Embed glass-fiber felt in a solid mopping of hot roofing asphalt applied within equiviscous temperature range.
3. Glaze-coat completed surface with hot roofing asphalt.

C. Remove temporary roofing before installing new roofing.

D. Prepare temporary roof to receive new roofing [**according to approved temporary roofing proposal**][**by patching and repairing temporary roofing**].

1. Restore temporary roofing to watertight condition.
2. Obtain approval for temporary roof substrate from roofing manufacturer and Architect before installing new roof, as directed by the Owner.

3.6 ROOF RE-COVER PREPARATION

A. Remove blisters, ridges, buckles,[**mechanically attached roofing fastener buttons projecting above roofing,**] and other substrate irregularities from existing roofing that inhibit new recover boards from conforming to substrate.

1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.
2. Scarify surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards.
3. Broom clean existing substrate.
4. Coordinate with the Owner’s inspector to schedule times for tests and inspections.
5. Verify that existing substrate is dry.

a. Spot check substrates with an electrical capacitance moisture-detection meter.

6. Remove materials that are wet or damp.

B. Remove blisters, ridges, buckles,[**mechanically attached roofing fastener buttons projecting above roofing,**] and other substrate irregularities from existing roofing that inhibit new [**recover boards**][**roofing**] from conforming to substrate.

1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.
2. Shave surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new [**recover boards**][**roofing**].
3. Broom clean existing substrate.
4. Coordinate with the Owner's inspector to schedule times for tests and inspections.
5. Verify that existing substrate is dry before proceeding with installation.

a. Spot check substrates with an electrical capacitance moisture-detection meter.

6. Remove materials that are wet and damp.

C. Remove blisters and areas of roofing not fully adhered.

D. Remove[**mechanically attached roofing fastener buttons projecting above roofing and other**] substrate irregularities that inhibit new recover boards from conforming to substrate.

1. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing with a power broom.
2. Clean substrate of contaminants, such as dirt, debris, oil, and grease, that can affect adhesion of coated foamed roofing.
3. Power vacuum the existing roof surface.

a. If recommended by foam manufacturer, prime dried surface at recommended rate with recommended primer.

4. Scarify surface of coated polyurethane roofing as necessary to achieve a suitable substrate for new roofing.
5. Verify that surface is dry by pressing litmus paper to surface areas most likely to retain moisture, such as shaded areas and low spots.

a. If paper changes color, surface is too wet to apply foam.

6. Build up isolated low spots on existing roofing with sprayed foam specified in Section 075700 "Coated Foamed Roofing" to prevent ponding.

3.7 BASE FLASHING REMOVAL

A. Remove existing base flashings.

1. Clean substrates of contaminants, such as asphalt, sheet materials, dirt, and debris.

B. Do not damage metal counterflashings that are to remain.

1. Replace metal counterflashings damaged during removal with counterflashings [**of same metal,**

weight or thickness, and finish as existing.][**specified in Section 076200 "Sheet Metal Flashing and Trim."**][**specified in Section 077100 "Roof Specialties."**]

C. Inspect parapet sheathing, wood blocking, curbs, and nailers for deterioration and damage.

1. If parapet sheathing, wood blocking, curbs, or nailers have deteriorated, immediately notify the Owner.

D. Remove existing parapet sheathing and replace with new parapet sheathing to comply with Section 061600 "Sheathing."

1. If parapet framing, wood blocking, curbs, or nailers have deteriorated, immediately notify the Owner.

E. As directed by the Owner, replace parapet framing, wood blocking, curbs, and nailers to comply with [**Section 054000 "Cold-Formed Metal Framing."**][**Section 061000 "Rough Carpentry."**]

3.8 FASTENER PULL-OUT TESTING

A. [**Perform**][**Retain independent testing and inspecting agency to conduct**] fastener pull-out tests according to SPRI FX-1, and submit test report to [**Architect**][**roofing manufacturer**] before installing new roofing system, as directed by the Owner.

1. Obtain [**Architect's**][**roofing manufacturer's**] approval to proceed with specified fastening pattern, as directed by the Owner.

a. [**Architect**][**Roofing manufacturer**] may furnish revised fastening pattern commensurate with pull-out test results, as directed by the Owner.

3.9 DISPOSAL

A. Collect demolished materials and place in containers.

1. Promptly dispose of demolished materials.
2. Do not allow demolished materials to accumulate on-site.
3. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off the Owner's property, as directed by the Owner.

END OF SECTION 07 01 50 19

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Task	Specification	Specification Description
07 01 50 81	07 51 13 00	Built-Up Asphalt Roofing
07 01 50 81	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 01 70 00	07 51 13 00	Built-Up Asphalt Roofing
07 01 70 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 01 70 00	07 62 00 00	Sheet Metal Flashing And Trim
07 01 70 00	07 71 00 00	Roof Specialties
07 05 13 00	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 05 13 00	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 05 13 00	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 05 13 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 11 13 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied, cut-back-asphalt dampproofing.
2. Cold-applied, emulsified-asphalt dampproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.
2. [**Section 042000 "Unit Masonry"**] [**Section 042200 "Concrete Unit Masonry"**] for mortar parge coat on masonry surfaces.
3. [**Section 071326 "Self-Adhering Sheet Waterproofing"**] [**Section 071353 "Elastomeric Sheet Waterproofing"**] [**Section 071354 "Thermoplastic Sheet Waterproofing"**] [**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**] [**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed in accordance with to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide [**protection course**] [**drainage panels**] auxiliary materials recommended in writing by manufacturer of primary materials.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products are to comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.

B. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered[**or nonfibered**].

2.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D1227/D1227M, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D1227/D1227M, Type II, Class 1.

C. Brush and Spray Coats: ASTM D1227/D1227M, Type III, Class 1.

2.5 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with each other and with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D41/D41M.

C. Emulsified-Asphalt Primer: ASTM D1227/D1227M, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

D. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.

E. Patching Compound: [**Epoxy or latex-modified repair mortar**] [**Asbestos-free fibered mastic**] of type recommended in writing by dampproofing manufacturer.

2.6 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

1. Thickness: Nominal [**1/8 inch (3 mm)**] [**1/4 inch (6 mm)**] [**1/8 inch (3 mm) for vertical applications; 1/4 inch (6 mm) elsewhere**].
2. Adhesive: Rubber-based solvent type recommended in writing by dampproofing manufacturer for protection course type.

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6 mm), with a compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

E. Smooth-surfaced roll roofing complying with ASTM D6380/D6380M, Class S, Type III.

2.7 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel acceptable to dampproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, with or without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

2.8 INSULATION DRAINAGE PANELS

A. Insulation Drainage Panels:

1. Comply with Section 072100 "Thermal Insulation" for insulation drainage panels.
2. Unfaced or geotextile-faced, extruded-polystyrene board insulation in accordance with ASTM C578, Type IV, 25-psi (173-kPa), or Type VI, 40-psi (276-kPa), minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with dampproofing manufacturer's written application instructions. Provide clean, dust-free, and dry substrates for dampproofing.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections[**; cover with asphalt-coated glass fabric**].

3.3 INSTALLATION OF BITUMINOUS DAMPPROOFING, GENERAL

A. Comply with dampproofing manufacturer's written application instructions for cure time between coats and drying time before backfilling unless otherwise indicated.

1. Apply dampproofing to provide continuous plane of protection.

2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior [**concrete**] [**masonry**] [**single-wythe masonry**] walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 INSTALLATION OF COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply [**two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

B. Unparged Masonry Foundation Walls: Apply [**primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**primer and one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.5 INSTALLATION OF COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply [**two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m)**] [**one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m)**].

B. Unparged Masonry Foundation Walls: Apply [**primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat**] [**primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m)**] [**primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m)**].

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Masonry Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Masonry Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

H. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

I. Interior Face of Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.6 INSTALLATION OF PROTECTION COURSE

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
2. Install protection course [**on same day**] [**within 24 hours**] of dampproofing installation (while coating is tacky) to ensure adhesion.

3.7 INSTALLATION OF DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Install panels over completed-and-cured dampproofing, with geotextile facing away from wall substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. Install [**thermal insulation specified in Section 072100 "Thermal Insulation,"**] [**protection course**] before installing drainage panels.

B. Insulation Drainage Panels: Install panels over completed-and-cured dampproofing. Use adhesive or another method that does not penetrate dampproofing. Cut and fit panels to within 3/4 inch (19 mm) of projections and penetrations.

1. Ensure that drainage channels are aligned and free of obstructions.

3.8 PROTECTION

A. Protect installed drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

B. Correct dampproofing that does not comply with requirements; repair substrates and reapply dampproofing.

END OF SECTION 07 11 13 00

Task	Specification	Specification Description
07 11 13 00	07 14 16 00	Cold Fluid-Applied Waterproofing
07 11 19 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 13 13 00	07 11 13 00	Bituminous Dampproofing

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SECTION 07 13 53 00 - ELASTOMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric sheet waterproofing.
2. Accessory waterproofing system materials.
3. Protection course.
4. Molded-sheet drainage panels.
5. Electronic leak-detection (ELD) materials.
6. Plaza-deck pavers.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
5. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.

1.2 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**][**under-slab vapor retarders**][**under-slab insulation**][**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. Review transitions within waterproofing system and between waterproofing and adjacent air barrier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance

properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For the following products:

1. **8-by-8-inch (200-by-200-mm)** square of waterproofing and flashing sheet.
2. **4-by-4-inch (100-by-100-mm)** square of drainage panel.
3. Plaza-deck paver, [**4-by-4-inch (100-by-100-mm) square**][**full sized**], in each color and texture required.
4. Paver pedestal assembly.

D. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer.

B. Field quality control reports.

C. Sample warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**][**approved**] by waterproofing manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including[**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**][**As indicated on Drawings**].
b. Description: Each type of [**wall**][**deck**][**plaza**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed

Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: [**10**][**20**] years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, [**on warranty form at end of this Section,**] signed by Installer, covering Work of this Section, for warranty period of [**two**] years.

1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, [**plaza-deck pavers**][**including paver pedestal assembly**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**][**drainage panels**] from [**same manufacturer as waterproofing membrane**][**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers [**and paver pedestals**] from single source from single manufacturer.

2.2 ELASTOMERIC SHEET WATERPROOFING

A. EPDM Rubber Sheet: ASTM D6134/D6134M, Type I, **60-mil- (1.5-mm-)** thick flexible sheet, unreinforced, formed from EPDM.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Coatings & Waterproofing Inc**]

2.3 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatibility with one another and with sheet waterproofing.

1. Furnish liquid-type accessory materials that comply with VOC limits of authorities having jurisdiction.

B. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or **60-mil- (1.5-mm-)** thick, uncured EPDM, as required by manufacturer.

C. Exposed Sheet Flashing: **60-mil- (1.5-mm-)** thick EPDM, cured or uncured, as required by manufacturer.

D. Bonding Adhesives: For bonding waterproofing sheets and sheet flashings to substrates and projections.

E. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.

1. Butyl Gum Tape: **30-mil- (0.76-mm-)** thick by **6-1/4-inch- (160-mm-)** wide, uncured butyl with polyethylene release film.

F. Lap Sealant: Single-component sealant.

G. In-Seam Sealant: Single-component sealant.

H. Water-Cutoff Mastic: Butyl mastic sealant.

I. Waterproofing and Sheet-Flashing Accessories: Sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.

J. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately **1 inch (25 mm)** wide, prepunched, with fasteners.

2.4 PROTECTION COURSE

A. Protection course material of type and thickness as recommended in writing by waterproofing manufacturer for each Project condition.

2.5 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding **No. 70 (0.21-mm)** sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Hydrotech, Inc.**]
b. [**Carlisle Coatings & Waterproofing Inc**]
c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
d. [**GCP Applied Technologies Inc.**]
e. [**ISI Building Products**]
f. [**Polyguard Products, Inc.**]
g. [**Urethane Polymers International, Inc. (UPI)**]

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding **No. 70 (0.21-mm)** sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Hydrotech, Inc.**]
b. [**Carlisle Coatings & Waterproofing Inc**]
c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
d. [**GCP Applied Technologies Inc.**]
e. [**Hyload; IKO Industries, Inc.**]
f. [**ISI Building Products**]
g. [**Polyguard Products, Inc.**]
h. [**Soprema, Inc.**]
i. [**Urethane Polymers International, Inc. (UPI)**]
j. [**W. R. Meadows, Inc**]

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.43-mm)** sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GCP Applied Technologies Inc.**]

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than

[2.8 gpm per ft. (35 L/min. per m)].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Hydrotech, Inc.**]
    b. [**Carlisle Coatings & Waterproofing Inc**]
    c. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
    d. [**Hyload; IKO Industries, Inc.**]
    e. [**Polyguard Products, Inc.**]
    f. [**Soprema, Inc.**]
    g. [**Urethane Polymers International, Inc. (UPI)**]
    h. [**W. R. Meadows, Inc**]

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [9 to 17 gpm per ft. (112 to 211 L/min. per m)] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GCP Applied Technologies Inc.**]
    b. [**ISI Building Products**]
    c. [**Polyguard Products, Inc.**]

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve; and with a vertical flow rate through the core of [21 to 82 gpm per ft. (261 to 1018 L/min. per m)] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**][**of** 21 gpm per ft. (261 L/min. per m)]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Coatings & Waterproofing Inc**]
    b. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
    c. [**W. R. Meadows, Inc**]

2.6 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.7 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**][**Concrete**][**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**][**Limestone**][**Marble**][**Quartz-based stone**][**Slate**][**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**] minimum compressive strength, ASTM C140/C140M; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance in accordance with ASTM C67/C67M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Coatings & Waterproofing Inc**]
b. [**Hanover Architectural Products**]
c. [**Hastings Pavement Company, LLC**]
d. [**Roofblok Limited**]
e. [**Sunny Brook Pressed Concrete, Co.**]
f. [**Tile Tech Pavers**]
g. [**Wausau Tile, Inc.**]
h. [**Westile Roofing Products; an Oldcastle company**]

2. Thickness: [**2 inches (51 mm)**][**2-3/8 inches (60 mm)**].
3. Face Size: [**12 inches (305 mm) square**][**12 by 24 inches (305 by 610 mm)**][**18 inches (457 mm) square**][**24 inches (610 mm) square**][**As indicated**].
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of **3 inches (75 mm)** wide by **0.031 inch (0.8 mm)** thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**][**as named below**], including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Envirospec, Inc.**]
    b. [**Hanover Architectural Products**]
    c. [**Roofblok Limited**]
    d. [**Sunny Brook Pressed Concrete, Co.**]
    e. [**Wausau Tile, Inc.**]
    f. [**Westile Roofing Products; an Oldcastle company**]

2. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations and other conditions affecting performance of waterproofing.

    1. Verify that concrete substrate has cured and aged for minimum time recommended in writing by waterproofing manufacturer.
    2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written installation instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.

F. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.4 INSTALLATION OF ELASTOMERIC SHEET WATERPROOFING

A. Fully Adhered Elastomeric Sheet Waterproofing:

1. Install fully adhered sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions and in accordance with recommendations in ASTM D6134/D6134M.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to substrates at required rate and allow it to partially dry.
4. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
5. Install fully adhered sheets and accessory materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
7. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.

    a. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

B. Partially Adhered Elastomeric Sheet Waterproofing:

1. Install partially adhered sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to the following areas of substrates and to each sheet at required rate and allow it to partially dry:

    a. Upper 25 percent of length of each sheet and **18 inches (457 mm)** around perimeter of each sheet.

4. Firmly adhere sheets to substrate. Do not apply bonding adhesive to splice area of sheet.
5. Install partially adhered sheets and accessory materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

C. Compartmented, Loosely Laid Elastomeric Sheet Waterproofing:

1. Install compartmented, loosely laid sheets over entire area to receive waterproofing in accordance with manufacturer's written installation instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply continuous beads of water-cutoff mastic, of size recommended in writing by waterproofing

manufacturer, to substrates in a **60-by-60-inch (1500-by-1500-mm)** grid pattern before installing sheet.

4. Apply sheets with side laps shingled with slope of deck where possible.
5. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.
6. Install compartmented, loosely laid sheets and accessory materials to tie into existing waterproofing.
7. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

D. Cement Splice: Clean splice areas, apply splicing cement and in-seam sealant, and firmly roll side and end laps of overlapping sheets in accordance with manufacturer's written instructions to produce a splice not less than **6 inches (150 mm)** wide and to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.

E. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets in accordance with manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.

F. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with waterproofing manufacturer's written installation instructions.

G. Form wall flashings using exposed sheet flashing.

H. Extend deck sheet waterproofing to form wall flashings.

1. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
2. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal edges of sheet-flashing terminations.

I. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.

J. Terminate and seal top of sheet flashings[**with mechanically anchored termination bars**].

3.5 INSTALLATION OF PROTECTION COURSE

A. Install protection course over waterproofing membrane in accordance with manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.

1. Molded-sheet drainage panels may be used in place of a separate protection course for vertical applications when approved by waterproofing manufacturer.

3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.7 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations. Adjust for final level and slope of paved surfaces.

C. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to vary no more than **1/16 inch (1.6 mm)** in elevation between adjacent pavers and no more than **1/16 inch (1.6 mm)** from surface plane elevation of individual paver.

E. Limit variation in paving installation to within [**1/4 inch in 10 ft. (6 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of Contractor.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report.
2. Notify the Owner 48 hours in advance of date and time of inspection.
3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed waterproofing from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 13 53 00

SECTION 07 14 13 00 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot fluid-applied rubberized asphalt waterproofing.
2. Accessory waterproofing system materials.
3. Protection course.
4. Molded-sheet drainage panels.
5. Insulation drainage panels.
6. Electronic leak detection (ELD) materials.
7. Plaza-deck pavers.

B. Related Requirements:

1. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
2. Section 075556 "Fluid-Applied Protected Membrane Roofing" for hot fluid-applied rubberized asphalt roofing system.
3. Section 079100 "Preformed Joint Seals" for foundation-wall expansion joints that interface with waterproofing.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
6. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for plaza expansion-joint assemblies that interface with waterproofing.
7. Section 221423 "Storm Drainage Piping Specialties" for plaza-deck drains.
8. Section 321400 "Unit Paving" for plaza-deck pavers set on setting beds.
9. Section 334600 "Subdrainage" for molded-sheet drainage panel.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not breakdown, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength complying with requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**] [**under-slab vapor retarders**] [**under-slab insulation**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
2. Review transitions within waterproofing system and between waterproofing and adjacent air barrier.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings:

1. Indicate locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, expansion-joint conditions, tie-ins with adjoining waterproofing, and other termination conditions.
3. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported plaza-deck pavers.

C. Samples: For the following materials:

1. Drainage panel, 4 by 4 inch (100 by 100 mm).
2. Plaza-deck paver, [**4 by 4 inch (100 by 100 mm)**] [**full sized**].
3. Paver pedestal assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**Installer**] [**testing agency**].

B. Field quality control reports.

C. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockups for each typical waterproofing installation including [**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**] [**As indicated on Drawings**].
b. Description: Each type of [**wall**] [**deck**] [**plaza**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials in accordance with manufacturer's written instructions.

B. Remove and replace materials that cannot be applied within their stated shelf life.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to frozen, damp, or wet substrates, or when temperature is below 0 deg F (minus 18 deg C).
2. Do not apply waterproofing when snow, rain, fog, or mist are present, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.11 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection boards**] [**drainage panels**] [**pedestals and pavers on plaza decks**].
2. Pavers Warranty: Pavers must not dish or warp, nor crack, split, or disintegrate in freeze-thaw conditions.
3. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

B. Installer's Special Warranty: Submit warranty [**on warranty form at end of this Section,**] signed by Installer, covering the Work of this Section, for warranty period of [**two**] years from date of Substantial Completion.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection boards**] [**drainage panels**] [**pedestals and pavers on plaza decks**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**] [**molded-sheet drainage panels**] [**insulation drainage panels**] from [**same manufacturer as waterproofing membrane**] [**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers [**and paver pedestal assembly**] from single source from single manufacturer for consistent quality in appearance and physical properties.

2.2 HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. Single-Component Waterproofing: [**Reinforced**] [**Unreinforced**]; 100 percent solids rubberized asphalt membrane.

1. Flow: 1/8 inch (3.2 mm) maximum at 140 deg F (60 deg C) in accordance with ASTM D5329.
2. Flash Point: Not less than 500 deg F (260 deg C) and not less than 77 deg F (25 deg C) above the manufacturer's maximum recommended application temperature in accordance with ASTM D92.
3. Water-Vapor Permeance: 0.027 perm in accordance with ASTM E96/E96M, Procedure E.
4. Crack Bridging Capability: No cracking, splitting, or loss of adhesion in accordance with ASTM C1305/C1305M.

2.3 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

B. Asphalt Primer: ASTM D41/D41M.

C. Elastomeric Sheet Flashing: Manufacturer's standard uncured neoprene flashing sheet.

1. Adhesive: Manufacturer's standard contact adhesive.

D. SBS-Modified Bituminous Sheet Flashing: ASTM D6164/D6164M, Grade G, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, [**white**] [**gray**] [**tan**].

1. Backer Sheet: ASTM D6164/D6164M, Grade S, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3.2 mm) thick; with stainless steel anchors.

F. Reinforcing Fabric: Manufacturer's standard fiberglass mesh or spun-bonded polyester fabric.

2.4 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

1. Thickness: Nominal [**1/8 inch (3.2 mm)**] [**1/4 inch (6.4 mm)**] [**1/8 inch (3.2 mm) for vertical applications; 1/4 inch (6.4 mm) elsewhere**].

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6.4 mm), with compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

2.5 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of

[**9 to 17 gpm per ft. (112 to 211 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve; and with a vertical flow rate through the core of [**21 to 97 gpm per ft. (261 to 1197 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**] [**of 21 gpm per ft. (261 L/min. per m)**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

2.6 INSULATION DRAINAGE PANELS

A. Unfaced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

B. Geotextile-Faced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.

C. Unfaced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

D. Geotextile-Faced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.

E. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

F. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.

G. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

H. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven geotextile filter fabric.

I. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) minimum density, 40 psi (276 kPa) minimum compressive strength, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [**3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**] [**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

2.7 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.8 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**] [**Concrete**] [**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**] [**Limestone**] [**Marble**] [**Quartz-based stone**] [**Slate**] [**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**] [**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**] [**6500 psi (45 MPa)**] minimum compressive strength when tested in accordance with ASTM C140/C140M; absorption not greater than 5 percent when tested in accordance with ASTM C140/C140M; and no breakage and maximum 1 percent mass loss, freeze-thaw resistance, when tested in accordance with ASTM C67/C67M.

1. Thickness: [**2 inches (51 mm)**] [**2-3/8 inches (60 mm)**] .
2. Face Size: [**12 inches (305 mm) square**] [**12 by 24 inches (305 by 610 mm)**] [**18 inches (457 mm) square**] [**24 inches (610 mm) square**] [**As indicated**] .
3. Color and Texture: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
4. Provide pavers with holes or slots to permit rain flowing across plaza to drain through grate into roof drains.

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of 3 inches (75 mm) wide by 0.031 inch (0.8 mm) thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**] [**as named below**], including [**fixed-height**] [**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3.2 mm)**] [**3/16 inch (5 mm)**] [**1/8 to 3/16 inch (3.2 to 5 mm)**].

1. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period as recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits as recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates in accordance with waterproofing manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Coordinate with the Owner for impact to air-intake equipment in the vicinity of the Work. Cover or filter air-intake louvers before proceeding with work that could affect indoor air quality or that could activate smoke detectors in the ductwork.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

3.4 TREATMENT OF JOINTS AND CRACKS

A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**]. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.

1. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks, or

joints and cracks exceeding 1/8 inch (3.2 mm) thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied rubberized asphalt over elastomeric sheet.

2. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3.2 mm) thick, and beyond roof drains and penetrations.

   a. Apply second layer of hot fluid-applied rubberized asphalt over reinforcing fabric.

B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches (150 mm) on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied rubberized asphalt over elastomeric sheet.

3.5 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.6 INSTALLATION OF SHEET FLASHING

A. Install sheet flashing at terminations of waterproofing membrane in accordance with manufacturer's written instructions.

B. Prime substrate with asphalt primer.

C. Install sheet flashing and adhere to deck and wall substrates in a layer of hot rubberized asphalt.

D. Bond modified bituminous flashing sheet to substrate as follows:

   1. Adhere SBS-modified bituminous[**backer sheet and**] flashing sheet to substrate in a layer of hot fluid-applied rubberized asphalt, or torch apply APP-modified bituminous flashing sheet to substrate as standard with manufacturer.

E. Extend sheet flashing up walls or parapets a minimum of 8 inches (200 mm) above plaza-deck pavers and 6 inches (150 mm) onto deck to be waterproofed.

F. Install termination bars and mechanically fasten to top of sheet flashing at terminations and perimeter of waterproofing.

3.7 INSTALLATION OF HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. General: Apply waterproofing in accordance with manufacturer's written instructions.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate at manufacturer's recommended rate and allow it to dry.

D. Heat rubberized asphalt in accordance with manufacturer's written instructions.

1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.

E. Unreinforced Waterproofing Membrane Applications: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, [**180-mil (4.5-mm) minimum thickness**] [**180-mil (4.5-mm) average thickness, but not less than 125 mils (3.2 mm) thick**].

F. Reinforced Waterproofing Membrane Applications: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils (2.3 mm); embed reinforcing fabric, overlapping sheets 2 inches (50 mm); spread another 125-mil- (3.2-mm-) thick layer to provide a uniform, reinforced, seamless membrane 215 mils (5.5 mm) thick.

G. Cure waterproofing, taking care to prevent contamination and damage to membrane.

3.8 INSTALLATION OF PROTECTION COURSE

A. Cover waterproofing with protection course with overlapped joints before membrane is subject to [**backfilling**] [**construction or vehicular traffic**].

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.9 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with waterproofing manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing.

B. Molded-Sheet Collector-Panel System: Install in accordance with waterproofing manufacturer's written instructions. Connect to piped subdrainage system specified in Section 334600 "Subdrainage."

3.10 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panel in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panel in accordance with manufacturer's written instructions. Stagger end joints and tightly abut board insulation.

3.11 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations in accordance with manufacturer's written installation instructions. Adjust for final level and slope of paved surfaces.

C. [**Loosely lay pavers on pedestals**] [**Seat pavers on pedestals and install bolted plate in accordance with manufacturer's written installation instructions**], maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.

E. Limit variation in paving installation to within [**1/4 inch in 10 ft. (6.4 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing agency to verify thickness of waterproofing during application for each [**600 sq. ft. (56 sq. m)**] of installed waterproofing or part thereof.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain 2 inches (50 mm) of clearance from top of base flashing.
b. Flood each area for [**24**] [**48**] [**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing system manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.
2. Notify the Owner 48 hours in advance of date and time of inspection.
3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing system from damage and wear during remainder of construction period.

B. Protect installed [**protection course**] [**drainage panels**] from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where material is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 14 13 00

SECTION 07 14 16 00 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyether waterproofing.
2. Polyurethane waterproofing.
3. Polymer rubber gel waterproofing.
4. Rubber waterproofing.
5. Cold-applied rubberized asphalt waterproofing.
6. Latex waterproofing.
7. Accessory waterproofing system materials.
8. Protection course.
9. Molded-sheet drainage panels.
10. Insulation drainage panels.
11. Electronic leak-detection (ELD) materials.
12. Plaza-deck pavers.

B. Related Requirements:

1. Section 071800 "Traffic Coatings" for exposed, fluid-applied membrane with an integral wearing surface.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior expansion-joint assemblies that interface with waterproofing.
5. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.
6. Section 221423 "Storm Drainage Piping Specialties" for plaza-deck drains.
7. Section 321400 "Unit Paving" for plaza-deck pavers set on setting beds.
8. Section 334600 "Subdrainage" for molded-sheet drainage panels.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength complying with requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill[**other waterproofing systems**] [**under-slab vapor retarders**] [**under-slab insulation**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations in waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements, including, but not limited to, the following:

a. Surface preparation specified in other Sections.
b. Minimum concrete curing period.
c. Forecasted weather conditions.
d. Special details and sheet flashings.
e. Repairs.
f. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings:

1. Indicate locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, expansion-joint conditions, tie-ins with adjoining waterproofing, and other termination conditions.
3. Include setting drawings indicating layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For the following materials:

1. Cured sample of waterproofing membrane on suitable rigid substrate, 8 by 8 inches (200 by 200 mm).
2. Flashing sheet, 8 by 8 inches (200 by 200 mm).
3. Membrane-reinforcing fabric, 8 by 8 inches (200 by 200 mm).
4. Drainage panel, 4 by 4 inches (100 by 100 mm).
5. Plaza-deck paver, [**4 by 4 inches (100 by 100 mm)**] [**full sized**].
6. Paver pedestal assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**testing agency**].

B. Field quality control reports.

C. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockup for each typical waterproofing installation, including [**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**] [**As indicated on Drawings**].
b. Description: Each type of [**wall**] [**deck**] [**plaza deck**] installation.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials in accordance with manufacturer's written instructions.

B. Remove and replace materials that cannot be applied within their stated shelf life.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to frozen, damp, or wet substrates, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
2. Do not apply waterproofing when snow, rain, fog, or mist are present, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.11 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection course**] [**drainage panels**] [**pedestals and pavers on plaza decks**].
2. Pavers Warranty: Pavers must not dish or warp, nor crack, split, or disintegrate in freeze-thaw conditions.
3. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

B. Installer's Special Warranty: Submit warranty [**on warranty form at end of this Section,**] signed by Installer, covering the Work of this Section, for warranty period of [**two**] years from date of Substantial Completion.

1. Warranty includes leak remediation, including repair, removal, and replacement of [**protection course**] [**drainage panels**] [**pedestals and pavers on plaza decks**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Waterproofing System: Obtain waterproofing materials [**protection course**] [**molded-sheet drainage panels**] [**insulation drainage panels**] from [**same manufacturer as waterproofing membrane**] [**manufacturer approved by waterproofing membrane manufacturer**].

B. Plaza-Deck Paving: Obtain plaza-deck pavers[**and paver pedestal assembly**] from single source from single manufacturer for consistent quality in appearance and physical properties.

2.2 POLYETHER WATERPROOFING

A. STPE Waterproofing: Single-component, silyl-terminated polyether[**complying with ASTM C836/C836M**].

1. Tensile Strength: 900 psi (6.2 MPa) minimum; ASTM D638.
2. Elongation at Break: 300 percent minimum; ASTM D638.
3. Water Vapor Permeance: 0.1 perm (5.7 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
4. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

2.3 POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: [**ASTM C836/C836M**] [**coal-tar free**].

B. Single-Component, Reinforced, Modified Polyurethane Waterproofing: [**ASTM C836/C836M**] [**coal-tar free**].

C. Two-Component, Polyurethane Waterproofing:[**ASTM C836/C836M.**]

D. Two-Component, Reinforced, Polyurethane Waterproofing:[**ASTM C836/C836M.**]

E. PUMA Waterproofing: Two-component, polyurethane methacrylate; ASTM C1305/C1305M.

1. Tensile Strength: 900 psi (6.2 MPa) minimum; ASTM D638.
2. Elongation at Break: 400 percent minimum; ASTM D638.
3. Water Vapor Permeance: 0.003 perm (0.172 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.

F. PMMA Waterproofing: Two-component, polymethyl methacrylate; ASTM C836/C836M, reinforced with polyester fleece layer.

1. Thickness: Not less than 90 mils; ASTM D5147/D5147M (Section 6).
2. Elongation at Peak Load: Average 35%; ASTM D5147/D5147M (Section 7).
3. Tear Strength: Not less than 90 lbf (0.4 kN); ASTM D5147/D5147M (Section 8).
4. Low-Temperature Flexibility: Minus 4 deg F (minus 20 deg C); ASTM D5147/D5147M (Section 12).

2.4 POLYMER RUBBER GEL WATERPROOFING

A. Single-Component, Polymer-Modified Rubber Gel (PRG) Waterproofing: Spray-applied, composite system composed of non-Newtonian thixotropic, noncuring, flexible, self-healing polymer rubberized bituminous emulsion, polyethylene sheet membrane, and other proprietary ancillary components.

1. Solids Content: 99 percent minimum; ASTM D1353/D1353M.
2. Puncture Resistance: Minimum 90 lb.; ASTM D1709.
3. Hardness: Minimum 100; ASTM C836/C836M.
4. Tensile Strength: Minimum 50 lb., ASTM D412.
5. Elongation Percentage: Minimum 300; ASTM C1135.
6. Adhesion to Concrete: Rating of 1 (Excellent); ASTM D412.
7. Water Vapor Permeance: 0.005 perm, maximum, ASTM E96/E96M.

B. Single-Component, Polymer-Modified Rubber Gel (PRG) Injection Restorative Membrane Waterproofing System: Elastomeric, noncuring, flexible, self-healing, chemical-resistant polymer rubberized bituminous emulsion formulated for repairing and restoring damaged waterproofing membrane systems.

1. Solids Content: Minimum 75 percent; ASTM D1353/D1353M.
2. Viscosity at Application: Minimum 150,000 cP; ASTM D2196.

2.5 RUBBER WATERPROOFING

A. Single-Component, Rubber Waterproofing: ASTM C836/C836M; solvent based; coal-tar free.

1. Hydrostatic-Head Resistance: 69.3 ft. (21.1 m) minimum; [**ASTM C1306/C1306M**] [**ASTM E154/E154M**].

B. Two-Component, Rubber Waterproofing: ASTM C836/C836M; coal-tar free.

1. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

C. Two-Component, Reinforced, Rubber Waterproofing: ASTM C836/C836M; coal-tar free.

1. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

2.6 COLD-APPLIED RUBBERIZED ASPHALT WATERPROOFING

A. Single-Component, Rubberized Asphalt Waterproofing: [**ASTM C836/C836M**] water-based, polymer-modified rubberized asphalt waterproofing.

1. Elongation at Break: 360 percent minimum; ASTM D412.
2. Water Vapor Permeance: 0.03 perm (1.72 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
3. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

B. Single-Component, Reinforced, Rubberized Asphalt Waterproofing: [**ASTM C836/C836M**]water-based, polymer-modified rubberized asphalt waterproofing.

1. Elongation at Break: 360 percent minimum; ASTM D412.
2. Water Vapor Permeance: 0.03 perm (1.72 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
3. Hydrostatic-Head Resistance: [**200 ft. (60 m)**] of water, minimum; ASTM D5385/D5385M.

C. Two-Component, Rubberized Asphalt Waterproofing: Water-based, polymer-modified rubberized asphalt.
1. Elongation at Break: 360 percent minimum; ASTM D412.

2.7 LATEX WATERPROOFING

A. Latex-Based Waterproof Coating with Biocide:

1. Hydrostatic Pressure Resistance: [**10 psi (69 kPa)**] [**12 psi (83 kPa)**] [**15 psi (103 kPa)**] [**20 psi (140 kPa)**] minimum; ASTM D7088.
2. Resistance to Wind-Driven Rain: [**98 mph (44 m/s)**] [**140 mph (63 m/s)**] minimum; ASTM D6904.

2.8 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

B. Primer: Liquid [**waterborne**] [**solvent-borne**] primer as recommended in writing for substrate by waterproofing manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner as recommended in writing for substrate by waterproofing manufacturer.

D. Sheet Flashing: Manufacturer's standard flashing sheet.

1. Adhesive: Manufacturer's standard contact adhesive.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3.2 mm) thick; with stainless steel anchors.

F. Reinforcing Fabric: Manufacturer's standard fiberglass mesh or spun-bonded polyester fabric.

G. Detailing Seam Tape: Manufacturer's standard detailing tape.

H. Joint Sealant: [**Single-component**] [**Multicomponent**] polyurethane sealant, compatible with waterproofing; [**ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck applications; Use NT exposure**] [**as specified in Section 079200 "Joint Sealants"**]; and as recommended in writing by waterproofing manufacturer for substrate and joint conditions.

I. Backer Rod: Closed-cell polyethylene foam.

2.9 PROTECTION COURSE

A. Protection Course, Asphaltic: ASTM D6506/D6506M; semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners:

1. Thickness: Nominal [**1/8 inch (3.2 mm)**] [**1/4 inch (6.4 mm)**] [**1/8 inch (3.2 mm) for vertical applications; 1/4 inch (6.4 mm) elsewhere**].

B. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**both sides**] with plastic film, nominal thickness 1/4 inch (6.4 mm), with compressive strength of not less than 8 psi (55 kPa) when tested in accordance with ASTM D1621/D1621M, and maximum water absorption by volume of 0.6 percent when tested in accordance with ASTM C272/C272M.

C. Protection Course, Extruded-Polystyrene Board Insulation, Unfaced: ASTM C578, Type X, 1/2 inch (13 mm) thick.

D. Protection Course, Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

2.10 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a needle-punched nonwoven-geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core and a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

D. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-

plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43 mm) sieve, laminated to one side of the core, without a polymeric film bonded to the other side; and with a horizontal flow rate through the core of not less than [**2.8 gpm per ft. (35 L/min. per m)**].

E. Molded-Sheet Collector-Panel System with Polymeric Film: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 17 gpm per ft. (112 to 211 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

F. Molded-Sheet Collector-Panel System Wrapped with Geotextile: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; wrapped with a nonwoven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425 mm) sieve; and with a vertical flow rate through the core of [**21 to 97 gpm per ft. (261 to 1197 L/min. per m)**] and a minimum horizontal, in-plane flow rate [**as indicated on Drawings**] [**of 21 gpm per ft. (261 L/min. per m)**]. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system.

2.11 INSULATION DRAINAGE PANELS

A. Unfaced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

B. Geotextile-Faced, Wall-Insulation Drainage Panels, Type IV: ASTM C578, 25 psi (173 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven-geotextile filter fabric.

C. Unfaced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation; fabricated with shiplapped or channel edges and with one side having grooved drainage channels.

D. Geotextile-Faced, Wall-Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven-geotextile filter fabric.

E. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

F. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VI: ASTM C578, 40 psi (276 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven-geotextile filter fabric.

G. Unfaced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; unfaced extruded-polystyrene board insulation, fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

H. Geotextile-Faced, Plaza-Deck, Insulation Drainage Panels, Type VII: ASTM C578, 60 psi (414 kPa) minimum compressive strength; extruded-polystyrene board insulation, fabricated with tongue-and-groove edges, with one side having grooved drainage channels, and faced with manufacturer's standard, nonwoven-geotextile filter fabric.

I. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) minimum density, 40 psi (276 kPa) minimum compressive strength, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [**3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**] [**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by waterproofing membrane manufacturer.

1. Conductive medium to be located directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within waterproofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 PLAZA-DECK PAVERS

A. Plaza-Deck Pavers: [**Brick**] [**Concrete**] [**Asphalt-block**] pavers specified in Section 321400 "Unit Paving."

B. Stone Plaza-Deck Pavers: [**Granite**] [**Limestone**] [**Marble**] [**Quartz-based stone**] [**Slate**] [**Travertine**] pavers specified in Section 321400 "Unit Paving."

C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [**square edged**] [**with top edges beveled 3/16 inch (5 mm)**], manufactured for use as plaza-deck pavers; [**7500 psi (52 MPa)**] [**6500 psi (45 MPa)**] minimum compressive strength when tested in accordance with ASTM C140/C140M; absorption not greater than 5 percent when tested in accordance with ASTM C140/C140M; and no breakage and maximum 1 percent mass loss, freeze-thaw resistance, when tested in accordance with ASTM C67/C67M.

1. Thickness: [**2 inches (50 mm)**] [**2-3/8 inches (60 mm)**].
2. Face Size: [**12 inches (305 mm) square**] [**12 by 24 inches (305 by 610 mm)**] [**18 inches (457 mm) square**] [**24 inches (610 mm) square**] [**As indicated**].
3. Color and Texture: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Provide pavers with holes or slots to permit rain flowing across plaza to drain through grate into roof drains.

D. Plaza-Deck Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of 3 inches (75 mm) wide by 0.031 inch (0.8 mm) thick with stainless steel anchors.

E. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**] [**as named below**], including [**fixed-height**] [**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3.2 mm)**] [**3/16 inch (5 mm)**] [**1/8 to 3/16 inch (3.2 to 5 mm)**].

1. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period as recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits as recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with waterproofing manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Coordinate with the Owner for impact to air-intake equipment in the vicinity of the Work. Cover or filter air-intake louvers before proceeding with work that could affect indoor air quality or that could activate smoke detectors in the ductwork.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

3.4 TREATMENT OF JOINTS AND CRACKS

A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**]. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.

1. Comply with ASTM C1193 for joint-sealant installation.
2. Apply bond breaker on sealant surface, beneath preparation strip.
3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches (150 mm) wide along each side of joint. Apply waterproofing in two separate applications and embed a joint-reinforcing strip in first preparation coat.

B. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.

1. Extend sheet flashings for [**4 inches (100 mm)**] onto perpendicular surfaces and items penetrating substrate.

3.5 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under waterproofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with waterproofing manufacturer's written installation instructions.

3.6 INSTALLATION OF COLD FLUID-APPLIED WATERPROOFING

A. General: Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in [**ASTM C898/C898M**] [**ASTM C1471/C1471M**].

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate at manufacturer's recommended rate and allow it to dry.

D. Unreinforced Waterproofing Membrane Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a minimum dry film thickness of [**60 mils (1.5 mm)**] [**90 mils (2.25 mm)**] [**120 mils (3 mm)**] .
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

E. Reinforced Waterproofing Membrane Applications: Mix materials and apply waterproofing by roller, notched squeegee, trowel, or other suitable application method.

1. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced

membrane free of entrapped gases and pinholes, with an average dry film total thickness of [**70 mils (1.8 mm)**] [**80 mils (2 mm)**] [**90 mils (2.3 mm)**] [**120 mils (3 mm)**].

2. Apply reinforced waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

F. Cure waterproofing, taking care to prevent contamination and damage to membrane.

3.7 INSTALLATION OF PROTECTION COURSE

A. Cover waterproofing with protection course with butted joints before membrane is subject to [**backfilling**] [**construction or vehicular traffic**].

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.8 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with waterproofing manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing.

B. Molded-Sheet Collector-Panel System: Install in accordance with waterproofing manufacturer's written instructions. Connect to piped subdrainage system specified in Section 334600 "Subdrainage."

3.9 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panels in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.10 INSTALLATION OF PLAZA-DECK PAVERS

A. Install pavers in accordance with manufacturer's written instructions.

B. Install paver pedestals and accessories to required elevations. Adjust for final level and slope of paved surface.

C. [**Loosely lay pavers on pedestals**] [**Seat pavers on pedestals and install bolted plate in accordance with manufacturer's written installation instructions**], maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paver assembly. Align joint patterns parallel in each direction.

1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.

D. Install pavers to vary no more than 1/16 inch (1.6 mm) in elevation between adjacent pavers and no more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.

E. Limit variation in paver installation to within [**1/4 inch in 10 ft. (6.4 mm in 3 m)**] of surface plane in any direction; noncumulative.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections:

1. Testing agency to verify thickness of waterproofing during application for each [**600 sq. ft. (56 sq. m)**] of installed waterproofing or part thereof.

B. Perform the following tests before overlying construction is placed:

1. ELD Testing: Testing agency surveys entire horizontal waterproofed area and flashings to locate discontinuities in the system assembly using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until waterproofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each completed horizontal waterproofed area for leaks, in accordance with recommendations in ASTM D5957. Install temporary containment assemblies, plug, or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain 2 inches (50 mm) of clearance from top of base flashing.
b. Flood each area for [**24**] [**48**] [**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of Contractor.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Manufacturer's Field Service: Engage a [**full-time**] site representative qualified by waterproofing system manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.
2. Notify the Owner 48 hours in advance of date and time of inspection, as directed by the Owner.

3. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.

D. Additional Tests and Inspections:

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
2. Waterproofing system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing system from damage and wear during remainder of construction period.

B. Protect installed [**protection course**] [**drainage panels**] from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where material is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 14 16 00

SECTION 07 16 13 00 - POLYMER MODIFIED CEMENT WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Prepackaged, polymer-modified cement waterproofing.
2. Field-mixed, polymer-modified cement waterproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**concrete slabs serving as protective topping for waterproofing and**]the finishing of concrete walls and slabs to receive waterproofing.
2. Section 099726 "Cementitious Coatings" for polymer-modified cementitious coatings used primarily for decorative purposes.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemically Compatible: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength, complying with specified performance requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation Work, including other waterproofing systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

B. Samples for Initial Selection: For each type of exposed product.

1. Include Samples of available color selection.

C. Samples for Verification: For each type of exposed waterproofing indicated, in manufacturer's standard sizes.

D. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statement: For Applicator.

B. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Entity that employs applicators and supervisors who are trained[**and approved**] by waterproofing manufacturer in applying polymer-modified cement waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Take necessary precautions to keep products clean, dry, and free of damage.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit polymer-modified cement waterproofing to be applied in accordance with manufacturer's written instructions.

B. Proceed with waterproofing work only after installation of pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at **40 deg F (4.4 deg C)** or above for at least 48 hours before, during work, and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 PREPACKAGED, POLYMER-MODIFIED CEMENT WATERPROOFING

A. Negative-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with [**water**][**polymer admixture**] to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists negative-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**AQUAFIN, Inc**]
   c. [**ChemMasters, Inc**]
   d. [**EDCO Products Inc.**]
   e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   f. [**Five Star Products, Inc.**]
   g. [**Gemite Products Inc., a W.R. Meadows company**]
   h. [**International Chem-Crete, Inc.**]
   i. [**Master Builders Solutions**]
   j. [**Metalcrete Industries**]
   k. [**Sakrete; CRH Americas, Oldcastle APG**]
   l. [**Sika Corporation**]
   m. [**SpecChem, LLC**]
   n. [**Specco Industries, Inc**]
   o. [**United Gilsonite Laboratories (UGL)**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. Potable Water Containment: Products of this Section must be certified to NSF 61 for use with potable water.
6. Color: [**White**][**Gray**][**Match Architect's samples**][**As selected by Architect from full range**][**As indicated in a color schedule**], as directed by the Owner.
7. VOC Content: [**100**] g/L or less.
8. Low-Emitting Materials: Verify interior coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. VOC Content: [**100**] g/L or less.
10. Low-Emitting Materials: Verify VOC emissions of interior coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
11. VOC Emissions: Verify interior coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Positive-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with [**water**][**polymer admixture**] to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**AQUAFIN, Inc**]
   c. [**Conproco Corporation**]
   d. [**Damtite Waterproofing, Inc.**]
   e. [**EDCO Products Inc.**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Five Star Products, Inc.**]
   h. [**Gemite Products Inc., a W.R. Meadows company**]
   i. [**International Chem-Crete, Inc.**]
   j. [**Master Builders Solutions**]
   k. [**Metalcrete Industries**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Sika Corporation**]
   n. [**SpecChem, LLC**]
   o. [**Specco Industries, Inc**]
   p. [**United Gilsonite Laboratories (UGL)**]
   q. [**Wall Firma, Inc**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance

with ASTM C109/C109M.

4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. Color: [**White**][**Gray**][**Match Architect's samples**][**As selected by Architect from full range**][**As indicated in a color schedule**], as directed by the Owner.

2.2 FIELD-MIXED, POLYMER-MODIFIED CEMENT WATERPROOFING

A. Admixture for Field Mixing: Manufacturer's standard polymer admixture for mixing with portland cement and sand to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists [**positive**][**negative**]-side hydrostatic pressure and has properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**United Gilsonite Laboratories (UGL)**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.
4. Flexural Strength: Minimum [**710 psi (4.8 MPa)**] at 28 days when tested in accordance with ASTM C348.
5. VOC Content: [**100**] g/L or less.
6. Low-Emitting Materials: Verify interior coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. VOC Content: [**100**] g/L or less.
8. Low-Emitting Materials: Verify VOC emissions of interior coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. VOC Emissions: Verify interior coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 ACCESSORY MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections, and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and

recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Portland Cement: ASTM C150/C150M, Type I.

E. Slurry-Coat Sand: ASTM C144.

F. Trowel-Coat Sand: ASTM C33/C33M, fine aggregate.

G. Water: Potable.

2.4 MIXES

A. Prepackaged, Polymer-Modified Cement Waterproofing: Add prepackaged dry ingredients to mixing liquid in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

B. Field-Mixed, Polymer-Modified Cement Waterproofing: Add polymer admixture to portland cement and sand in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Confirm water stops and other primary joint seals have been installed in concrete joints.

C. Confirm waterproofing thickness to be applied to substrate face locations will not interfere with required operating and service clearances for elevators and other equipment to be installed within pits.

D. Proceed with application only after unsatisfactory conditions have been corrected.

E. Notify the Owner in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure[**to confine spraying operation and**] to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks **1/16 inch (1.6 mm)** wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum **1 inch (25 mm)** deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of **1/16 inch (1.6 mm)**.

3. Clean clay masonry surfaces in accordance with ASTM D5703.
4. Concrete Joints: Clean reveals.

3.3 APPLICATION OF POLYMER-MODIFIED CEMENT WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water[**for several hours**] and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

a. Onto columns integral with treated walls.
b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**][**48 inches (1200 mm) for masonry**].
c. Onto exterior walls and onto both exterior and interior columns, for a height of **12 inches (300 mm)**, where floors, but not walls, are treated.
d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**][**pipe chases**][**pits**][**sumps**][**similar offsets and features**].

3. Number of Coats: [**Number required for specified water permeability**][**Two**][**Three**].

a. Coating Thickness: Maximum application thickness of [**47 mils (1.2 mm)**][**60 mils (1.5 mm)**] per coat for total thickness [**as required for specified water permeability**][**of 100 mils (2.5 mm)**][**of 120 mils (3.0 mm)**].
b. Apply first coat as a slurry with brush or roller, and apply subsequent coats with brush, roller, spray, or trowel.
c. Vigorously work first coat onto the substrate, forcing the material into surface voids. Apply each subsequent coat into full contact with previous coat.
d. Allow manufacturer's recommended time between coats. Dampen surface between coats.

B. Final Coat Finish: [**Smooth troweled**][**Brushed**][**Textured**].

C. Curing:

1. Air-cure waterproofing for not less than [**five**] days immediately after application and prior to being placed in service.
2. Moist-cure waterproofing for not less than [**three**] days immediately after application has set, followed by air drying prior to being placed in service unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

3.5 PROTECTION AND CLEANING

A. Protect surfaces from hot, dry, and windy weather conditions. Prevent rapid drying through manufacturer-approved methods.

END OF SECTION 07 16 13 00

SECTION 07 16 16 00 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Crystalline waterproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete slabs serving as protective topping for waterproofing and the finishing of concrete walls and slabs to receive waterproofing.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemically Compatible: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength, complying with specified performance requirements when in contact with another material.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation Work, including other waterproofing systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

B. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statement: For [**Applicator**][**testing agency**].

B. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Field quality-control reports.

D. Sample warranties.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Entity that employs applicators and supervisors who are trained[**and approved**] by waterproofing manufacturer in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.8 MOCKUPS

A. Build mockups to set quality standards for materials and execution.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Store materials in dry environment at a temperature above **45 degrees F (7 degrees C)**.

C. Do not use materials stored for more than 24 months from date of manufacture.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be applied in accordance with manufacturer's written instructions and warranty requirements.

B. Proceed with waterproofing work only after installation of pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

1.11 WARRANTY

A. Manufacturer's Material Warranty: Manufacturer agrees to replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes replacement of waterproofing system.
2. Warranty Period: [**Five**][**Ten**] years from date of Substantial Completion.

B. Applicator's Special Warranty: Submit warranty signed by Applicator, to replace waterproofing that fails to remain watertight within specified warranty period covering Work of this Section.

1. Warranty includes leak remediation, and coverage for failure to meet specified requirements, including defects caused by faulty workmanship.
2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Crystalline Waterproofing: Prepackaged, [**gray**][**white**]-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties complying with or exceeding the criteria specified below.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**AQUAFIN, Inc**]
c. [**ChemMasters, Inc**]
d. [**Conproco Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Gemite Products Inc., a W.R. Meadows company**]
g. [**International Chem-Crete, Inc.**]
h. [**IPA Systems, Inc.**]
i. [**KOSTER American Corporation**]
j. [**Kryton International, Inc.**]
k. [**Master Builders Solutions**]

l. [**Penetron USA, Inc.**]
m. [**Sika Corporation**]
n. [**Tremco Incorporated**]
o. [**Xypex Chemical Corporation**]

2. Water Permeability: Maximum [**zero for water at 30 ft. (9 m)**] when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum [**4000 psi (27.6 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.
4. Self-Sealing: Autogenous crack sealing of treated concrete for cracks with width of **0.02 inch (0.5 mm)** or greater when subjected to hydrostatic pressure of **65 psi (0.44 MPa)**.
5. Sulfate Resistance: The waterproofing treatment must improve concrete resistance to sulfates by reducing permeability without affecting compressive strength; performance to be verified by independent testing.
6. Potable Water Containment: Products of this Section must be certified to NSF 61 for use with potable water.

2.2 ACCESSORY MATERIALS

A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Water: Potable.

2.3 MIXES

A. Crystalline Waterproofing: Add prepackaged dry ingredients to water in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure[**to confine spraying operation and**] to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks **1/16 inch (1.6 mm)** wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum **1 inch (25 mm)** deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of **1/16 inch (1.6 mm)**.

3. Concrete Joints: Clean reveals.

3.3 APPLICATION OF CRYSTALLINE WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

a. Onto columns integral with treated walls.
b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**][**48 inches (1200 mm) for masonry**].
c. Onto exterior walls and onto both exterior and interior columns, for a height of **12 inches (300 mm)**, where floors, but not walls, are treated.
d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**][**pipe chases**][**pits**][**sumps**][**similar offsets and features**].

3. Number of Coats: [**Number required for specified water permeability**][**Two**][**Three**].
4. Application Method: Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
5. Dampen surface between coats.

B. Final Coat Finish: [**Smooth**][**Brushed**][**Spray textured**].

C. Curing: Moist-cure waterproofing for [**three**] days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

END OF SECTION 07 16 16 00

SECTION 07 16 19 00 - METAL OXIDE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-oxide waterproofing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 033000 "Cast-in-Place Concrete" for concrete slabs serving as protective topping for waterproofing and the finishing of concrete walls and slabs to receive waterproofing.
3. Section 042000 "Unit Masonry" for cleaning of unit masonry walls to receive waterproofing.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill [**other waterproofing systems**] [**underslab vapor retarders**] [**underslab insulation**] [**subdrainage systems**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review waterproofing requirements including, but not limited to, the following:

a. Minimum concrete curing period.
b. Forecasted weather conditions.
c. Repairs.
d. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Applicator [**and testing agency**].

B. Manufacturer Certificates: For each type of waterproofing, patching, and plugging material.

C. Product Test Reports: For tests performed by manufacturer and witnessed by a qualified testing agency.

1. Iron content of metallic waterproofing.
2. Oxidizing agent content of metallic waterproofing.

D. Field quality control reports.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm that employs applicators and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under submittals and to set quality standards for application.

1. Build mockup of typical [**vertical**] [**horizontal**] surfaces [**as shown on Drawings**].

a. Size: [**100 sq. ft. (9.29 sq. m) in size**].

2. Visually and physically examined for bonding and loose materials by waterproofing material manufacturer.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.

B. Store in dry locations, at the temperature recommended in writing by the manufacturer, with adequate ventilation and handle in a manner to prevent damage or contamination.

C. Remove and replace materials that cannot be applied within their stated shelf life.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit metal-oxide waterproofing to be performed in accordance with manufacturer's written instructions and warranty requirements.

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Metal-Oxide Waterproofing: A product specifically formulated for waterproofing concrete and masonry substrates and containing pulverized iron and a chemical oxidizing agent to cause the iron particles to oxidize and grow in size in the presence of water.

2.2 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by metal-oxide waterproofing manufacturer for intended use and compatibility with one another and with waterproofing.

B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

D. Portland Cement: ASTM C150/C150M, Type I.

E. Sand: ASTM C144.

F. Aggregate for Protective Coat: ASTM C33/33M.

G. Water: Potable.

H. Sealant: Polyurethane foam.

2.3 MIXES

A. Metal-Oxide Coats: Add metal-oxide waterproofing compound and other mix components, if any, to water in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency for each coat.

B. Measure, batch, and mix portland cement and sand in the proportion of [**1:2-1/2**] and water. Blend together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Confirm water stops and other primary joint seals have been installed in concrete joints.

C. Proceed with application only after unsatisfactory conditions have been corrected.

D. Notify Architect in writing of active leaks or defects that would affect system performance, as directed by the Owner.

E. Confirm waterproofing thickness to be applied to substrate face locations will not interfere with required operating and service clearances for elevators and other equipment installed within pits.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks 1/16 inch (1.6 mm) wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch (25 mm) deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces in accordance with ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution in accordance with ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning in accordance with ASTM D4259.

2. Clean concrete unit masonry surfaces in accordance with ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

3. Clean clay masonry surfaces in accordance with ASTM D5703.
4. Concrete Joints: Clean reveals.

3.3 APPLICATION OF METAL-OXIDE WATERPROOFING

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water and maintain damp condition in accordance with manufacturer's written instructions until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

    a. Onto columns integral with treated walls.
    b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of [**24 inches (600 mm) for cast-in-place concrete**] [**48 inches (1200 mm) for masonry**].
    c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
    d. Onto every substrate in areas indicated for treatment, including [**pipe trenches**] [**pipe chases**] [**pits**] [**sumps**] [**and similar offsets and features**].

3. Number of Metal-Oxide Coats: Applying two or more coats required for specified water permeability.
4. Application Method: Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids. Brush each subsequent coat into full contact with previous coat.
5. Dampen surface between coats.
6. Allow each coat to set for maximum 24 hours between coats.

B. Wall and Columns Protection Coat: Immediately after metal-oxide coats have set, apply protection coat on walls and columns to a minimum thickness of [**1/8 inch (3 mm)**].

    1. Finish: [**Smooth**] [**Brushed**] [**Textured**].

C. Floors Protective Topping: Immediately after metal-oxide coats have set, apply floor topping to a thickness of [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**].

    1. Finish: [**Smooth**] [**Brushed**].

D. Curing: Moist-cure waterproofing for [**three**] days immediately after installation has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

END OF SECTION 07 16 19 00

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SECTION 07 17 00 00 - BENTONITE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextile/bentonite sheets.
2. Composite bentonite membrane.
3. Protection course.
4. Molded-sheet drainage panels.
5. Insulation drainage panels.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for forms and waterstops.
2. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.
5. Section 312000 "Earth Moving" for excavating and backfilling.
6. Section 315000 "Excavation Support and Protection" for permanent below-grade support systems that receive blindside waterproofing.

1.2 DEFINITIONS

A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.

B. Chemical Compatibility: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.

1.3 COORDINATION

A. Coordinate the Work of this Section with adjacent concrete foundation work, including fill[**, other waterproofing systems**] [**, under-slab vapor retarders**] [**, under-slab insulation**] [**and**] [**subdrainage systems**].

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

C. Coordinate formwork and form bracing requirements for blindside sheet waterproofing. Coordinate restrictions on use of form ties and other components as necessary to eliminate or minimize penetrations through blindside sheet waterproofing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
b. Include manufacturer's written installation instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, air barrier, and other termination conditions.

C. Samples: For each of the following products, in sizes indicated:

1. Waterproofing: 6 inches (150 mm) square.
2. Protection Course: 6 inches (150 mm) square.
3. Molded-Sheet Drainage Panels: 6 inches (150 mm) square.
4. Insulation Drainage Panels: 6 inches (150 mm) square.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates: For each type of waterproofing material.

B. Preconstruction Test Reports: For water samples taken at Project site along with recommendations resulting from these tests.

C. Field quality control reports.

D. Sample warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that employs installers and supervisors who are trained and [**certified**] [**approved**] by waterproofing manufacturer.

1.8 MOCKUPS

A. Build mockups to verify selections made under samples and set quality standards for application.

1. Build mockup of installation on typical [**vertical**] [**and**] [**horizontal**] surfaces [**as indicated on Drawings**].

a. Size: [**10 sq. ft. (0.9 sq. m) in size**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in factory-sealed and -labeled packaging. Handle and store following manufacturer's instructions, recommendations, and material safety data sheets. Protect from construction operation-related damage and damage from weather, excessive temperatures, and prolonged sunlight.

B. Do not double-stack pallets during shipping or storage. Protect waterproofing materials from moisture, excessive temperatures, and sources of ignition. Provide cover, top, and all sides, for materials stored on-site, allowing for adequate ventilation.

C. Remove damaged material from site and dispose of in accordance with applicable regulations.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing on ground water.

1. Obtain water samples from Project site at approximate locations where waterproofing will be installed and test for acids, alkalis, brine, or other contaminants that may inhibit performance of waterproofing materials.
2. Comply with waterproofing manufacturer's written instructions for testing.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed in accordance with manufacturer's written instructions and warranty requirements.

1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
2. Do not place bentonite clay products in panel or composite form on damp surfaces unless such practice is approved in writing by manufacturer.

1.12 WARRANTY

A. Special Warranty: Manufacturer [**and Installer**] agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain bentonite waterproofing system from single source from single manufacturer. Obtain accessory products used with bentonite waterproofing, including waterstops specified in Section 033000 "Cast-in-Place Concrete" from sources acceptable to bentonite waterproofing manufacturer.

2.2 GEOTEXTILE/BENTONITE SHEETS

A. Geotextile/Bentonite Sheet: Minimum of 1.10 lb/sq. ft. (5.37 kg/sq. m) of granular sodium bentonite between two layers of polypropylene geotextile fabric, one woven and one nonwoven, needle punched.

1. Grab Tensile Strength: [**95 lbf (422 N)**] in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.

B. Contaminant-Resistant Geotextile/Bentonite Sheet: Minimum of 1.10 lb/sq. ft. (5.37 kg/sq. m) of contaminant-resistant granular sodium bentonite, specially formulated for use in saltwater or contaminated ground water, between two layers of polypropylene geotextile fabric, one woven and one nonwoven, needle punched.

1. Grab Tensile Strength: [**95 lbf (422 N)**] in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.

C. Polyethylene-Lined Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. (4.8 kg/sq. m) of granular sodium bentonite between two layers of geotextile fabric.

1. Grab Tensile Strength: 95 lbf (422 N) in accordance with ASTM D4632.
2. Puncture Resistance: 100 lbf (445 N) in accordance with ASTM D4833.
3. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

D. Contaminant-Resistant Polyethylene-Lined Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. (4.8 kg/sq. m) of contaminant-resistant granular sodium bentonite clay granules, specially formulated for use in saltwater or contaminated ground water, between two layers of geotextile fabric.

1. Grab Tensile Strength: 120 lbf (530 N) in accordance with ASTM D4632.
2. Puncture Resistance: 140 lbf (620 N) in accordance with ASTM D4833.
3. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

2.3 COMPOSITE BENTONITE MEMBRANE

A. Composite Bentonite Membrane: Manufacturer's standard membrane consisting of a geomembrane liner bonded to a layer of bentonite.

1. Puncture Resistance: 155 lbf (689 N) in accordance with ASTM E154.
2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

B. Composite Bentonite Membrane with Protective Facing: Manufacturer's standard membrane consisting of geomembrane liner bonded to a layer of bentonite clay granules with a spun polypropylene facing.

1. Puncture Resistance: 155 lbf (689 N) in accordance with ASTM E154.

2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

C. Contaminant-Resistant Composite Bentonite Membrane: Manufacturer's standard membrane consisting of polyethylene geomembrane bonded to a layer of bentonite.

1. Puncture Resistance: 112 lbf (498 N) in accordance with ASTM E154.
2. Vapor Permeance: 0.03 perm (0.172 ng/Pa x s x sq. m) in accordance with ASTM E96/E96M.

2.4 ACCESSORY WATERPROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by bentonite waterproofing manufacturer for intended use and compatibility with one another and with waterproofing.

B. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 (0.85 mm) sieve.

C. Bentonite Mastic: Bentonite compound of trowelable consistency, specifically formulated for application at joints and penetrations.

D. Bentonite Tubes: Manufacturer's standard 2-inch- (50-mm-) diameter, water-soluble tube containing approximately 1.5 lb/ft. (2.2 kg/m) of granular bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.

E. Metal Termination Bars: Manufacturer's standard aluminum or stainless steel bars with upper flange to receive sealant.

F. Plastic Protection Sheet: Polyethylene sheeting in accordance with ASTM D4397; thickness as recommended in writing by waterproofing manufacturer to suit application but at least 6 mils (0.15 mm) thick.

G. Cement Grout Patching Material: Grout mix compatible with substrate being patched and recommended in writing by waterproofing manufacturer.

H. Masonry Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch- (13- or 25-mm-) diameter washers under fastener heads.

I. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Section 079200 "Joint Sealants."

J. Tapes: Waterproofing manufacturer's recommended waterproof tape for joints between sheets, membranes, or panels.

K. Adhesive: Waterproofing manufacturer's water-based adhesive used to secure waterproofing to both vertical and horizontal surfaces.

2.5 PROTECTION COURSE

A. Protection course material of type and thickness as recommended in writing by waterproofing manufacturer for each Project condition.

2.6 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel acceptable to dampproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, with or without a polymeric film bonded to the other side; and with a vertical flow rate through the core of [**9 to 21 gpm per ft. (112 to 261 L/min. per m)**].

2.7 INSULATION DRAINAGE PANELS

A. Insulation Drainage Panels:

1. Comply with Section 072100 "Thermal Insulation" for insulation drainage panels.
2. Unfaced or geotextile-faced, extruded-polystyrene board insulation in accordance with ASTM C578, Type IV, 25 psi (173 kPa), or Type VI, 40 psi (276 kPa), minimum compressive strength; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations and other conditions affecting performance of bentonite waterproofing.

B. Examine bentonite materials before installation. Reject materials that have been prematurely exposed to moisture.

C. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions.

B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material in accordance with manufacturer's written instructions.

C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch (3 mm), honeycomb areas, and other defects with bentonite mastic or cement grout patching material in accordance with manufacturer's written instructions.

D. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch

(3 mm) wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar in accordance with manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

A. Prepare substrates, voids, cracks, and cavities; and install waterproofing and accessories in accordance with manufacturer's written instructions.

1. Before installing, verify the correct side of waterproofing that faces substrate surface.
2. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane in accordance with manufacturer's details in preparation for bentonite tubes and mastic.
3. Apply bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
4. Prime concrete substrates. Primer may be omitted on concrete surfaces that comply with manufacturer's written requirements for dryness, surface texture, and freedom from imperfections.

B. Apply bentonite tubes continuously on footing against base of wall to be waterproofed.

C. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts.

D. Install protection course before backfilling or placing overburden when recommended in writing by waterproofing manufacturer.

3.4 INSTALLATION OF GEOTEXTILE/BENTONITE SHEETS

A. Install a continuous layer of waterproofing sheets directly against surface to be waterproofed. Lap ends and edges a minimum of 4 inches (100 mm) on horizontal and vertical substrates unless otherwise indicated. Stagger end joints between sheets a minimum of 24 inches (600 mm). Fasten seams by stapling to adjacent sheet or nailing to substrate.

B. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.

1. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.

C. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally against wall. Secure with masonry fasteners spaced in accordance with manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.

D. Termination at Grade:

1. Extend waterproofing sheets to within [**12 inches (300 mm)**] of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
2. Fasten top edge of waterproofing sheets to wall and protect top edge with sheet metal counterflashing. Cover waterproofing with a lapped course of plastic protection sheets if backfilling does not proceed immediately.

E. Excavation Support and Protection (Permanent Shoring): Encase tieback heads, rods, nuts, and plates in accordance with waterproofing manufacturer's written instructions for each configuration.

1. Install a layer of waterproofing sheets, with ends and edges lapped and nailed to shoring. Cover waterproofing with plastic protection sheets if needed for protection from precipitation; remove plastic sheets before placing concrete.
2. Inspect and repair waterproofing after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

3.5 INSTALLATION OF COMPOSITE BENTONITE MEMBRANE

A. Install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches (100 mm) unless otherwise indicated. Stagger end joints between membranes a minimum of 24 inches (600 mm). Seal joints with permanent seam tape or heat-welded for gas barrier.

B. Below Structural Slabs-on-Grade: Apply waterproofing membrane with polyethylene side down, and staple ends and edges.

1. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
2. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.

C. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches (100 mm).

D. Concrete Walls: Apply mastic to form continuous 3/4-inch (19-mm) cant or fillet at intersection of footings and walls.

1. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches (150 mm) onto the footing. Lap membrane ends and edges a minimum of 2 inches (50 mm).
2. Secure membrane to wall.
3. Apply mastic to form continuous 3/4-inch (19-mm) layer around penetrations.
4. Termination at Grade: Extend waterproofing membrane to within [**12 inches (300 mm)**] of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

E. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback heads, rods, nuts, and plates in accordance with waterproofing manufacturer's written instructions for each configuration. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.

1. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped minimum of 4 inches (100 mm) and nailed to shoring.
2. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

F. Horizontal Roofs, Plazas, and between Slabs: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped a minimum of 3 inches (75 mm).

1. Apply mastic to form continuous 3/4-inch (19-mm) cant or fillet at intersection of horizontal and vertical substrates. Extend waterproofing membrane to top of curb or to a minimum of 6 inches (150 mm) above plane of waterproofing; secure with manufacturer's recommended tape.
2. Clean overlap area and apply waterproof tape, rolling the exposed edge to seal to membrane below.
3. Turn edges up and seal to vertical surfaces.

3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels in accordance with manufacturer's written instructions. Use adhesives or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.7 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation units in adhesive or tape applied in accordance with manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panels in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

1. Engage a factory-authorized service representative to test and inspect completed waterproofing installation before covering with other construction and provide written report stating that installation complies with manufacturer's written instructions.

a. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.

2. Engage a [**full-time**] site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect, as directed by the Owner.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 PROTECTION, REPAIR, AND CLEANING

A. Do not permit traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Correct deficiencies in waterproofing or remove waterproofing that does not comply with requirements; repair substrates and reapply waterproofing.

END OF SECTION 07 17 00 00

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Task	Specification	Specification Description
07 17 13 00	07 17 00 00	Bentonite Waterproofing

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SECTION 07 18 00 00 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Traffic coatings and pavement markings for the following applications:

1. Pedestrian traffic.
2. Vehicular traffic.
3. Equipment-room floor.

B. Related Requirements:

1. Section 071900 "Water Repellents" for penetrating and film-forming water repellents applied on traffic-bearing surfaces.
2. Section 096723 "Resinous Flooring" for fluid-applied, [**decorative**][**general-use commercial**][**general-use industrial**][**high-performance**] resinous flooring that does not serve as a waterproofing membrane with integral wearing surface.
3. Section 096766 "Fluid-Applied Athletic Flooring" for fluid-applied, resinous flooring for athletic activity areas.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: Traffic coatings and pavement markings for the following applications:

1. Pedestrian traffic.
2. Vehicular traffic.
3. Equipment-room floor.

B. Product Data Submittals: For each product.

1. Include installation instructions and details, material descriptions, dry- or wet-film thickness requirements, and finish.

C. Sustainable Design Submittals:

1. Product Data: For coatings, indicating VOC content.
2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
3. Product Test Reports: For traffic coatings, documentation indicating the Solar Reflectance properties.

D. Shop Drawings: For traffic coatings.

1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other

termination conditions that are not included in manufacturer's product data.

2. Include plans showing layout of pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For each type of exposed finish, prepared on rigid backing.

1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of traffic coating.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build mockup for each traffic coating and substrate to receive traffic coatings.
2. Size: [**200 sq. ft. (18.5 sq. m)**] of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below **40 deg F (5 deg C)**, when relative humidity exceeds 85 percent, or when temperatures are less than **5 deg F (3 deg C)** above dew point.

1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.

B. Do not install traffic coating until items that penetrate membrane have been installed.

C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of [**40 deg F (4.4 deg C) for oil-based materials**][**50 deg F (10 deg C) for water-based materials**], and not exceeding **95 deg F (35 deg C)**.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Adhesive or cohesive failures.
b. Abrasion or tearing failures.
c. Surface crazing or spalling.
d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain traffic coatings from single source from single manufacturer.

B. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.

C. Obtain pavement-marking paint from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 TRAFFIC COATINGS

A. Traffic Coating : Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for [**pedestrian traffic**][**vehicular traffic**][**equipment-room floor**] service condition; according to ASTM C957/C957M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Polymer Technology Corp.**]
b. [**Crossfield Products Corp**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Gaco; Holcim Building Envelope**]
e. [**GCP Applied Technologies Inc.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
h. [**Insl-X Products; Benjamin Moore & Co.**]
i. [**Key Resin Company**]
j. [**LymTal International, Inc.**]
k. [**Master Builders Solutions**]
l. [**Neogard; Hempel Group**]
m. [**Pacific Polymers; a Holcim brand**]
n. [**Pecora Corporation**]
o. [**POLY-CARB; Olin Corporation**]
p. [**Polycoat Products**]
q. [**PPG Paints; PPG Industries, Inc.**]
r. [**Sherwin-Williams Company (The)**]
s. [**Soprema, Inc.**]
t. [**Tremco Incorporated**]
u. [**Urethane Polymers International, Inc. (UPI)**]

B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.

1. Material: [**Epoxy**][**Polyurethane**].

C. Preparatory and Base Coats: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**].

D. Intermediate Coat: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**], measured excluding aggregate.
2. Aggregate Content: [**As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated**][**Not less than 8 to 10 lb/100 sq. ft. (3.9 to 4.9 kg/10 sq. m)**][**To refusal**].

E. Topcoat: [**Polyurethane**][**Aromatic urethane**][**Aliphatic urethane**][**Aromatic urethane with UV inhibitors**][**epoxy**].

1. Thicknesses: Minimum [**dry-**][**wet-**]film thickness [**as recommended in writing by manufacturer for substrate and service conditions indicated**], measured excluding aggregate.
2. Aggregate Content: [**As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated**][**As required to achieve slip-resistant finish**][**8 to 10 lb/100 sq. ft. (3.9 to 4.9 kg/10 sq. m)**][**To refusal**].
3. Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**].

F. Aggregate: [**Manufacturer's standard aggregate for each use indicated**][**Uniformly graded, washed silicon carbide sand**][**Uniformly graded, washed silica sand**][**Uniformly graded, washed flint shot silica**][**Walnut shell granules**][**Aluminum-oxide grit**] of particle sizes, shape, and minimum hardness

recommended in writing by traffic-coating manufacturer.

G. Fire-Test-Response Characteristics: Provide traffic-coating materials with the fire-test-response characteristics as determined by testing identical products according to test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.

1. [**Class A**][**Class B**][**Class C**] roof covering according to ASTM E108.

H. Energy Star Listing: Provide traffic coating that is listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products.

I. Energy Performance: Provide traffic coating with an initial Solar Reflectance Index of [**not less than 0.70**] and emissivity of [**not less than 0.75**] when tested according to CRRC-1.

J. VOC Content, LEED 2009: [**250**] g/L or less.

K. Low-Emitting Materials, LEED 2009: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

L. VOC Content, LEED v4: [**100**] g/L or less.

M. Low-Emitting Materials, LEED v4: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

N. VOC Content: [**100**] g/L or less.

O. Low-Emitting Materials: VOC emissions of interior coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

P. VOC Content: [**100**] g/L or less.

Q. Low-Emitting Materials: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

R. VOC Emissions: Interior coatings shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ACCESSORY MATERIALS

A. Joint Sealants: [**As specified in Section 079200 "Joint Sealants."**][**ASTM C920.**].

B. Sheet Flashing: Nonstaining [**sheet material recommended in writing by traffic-coating**

manufacturer][**uncured neoprene sheet**][**cured neoprene sheet**].

1. Thickness: Minimum [**60 mils (1.5 mm)**][**50 mils (1.3 mm)**].

C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.

D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

2.5 PAVEMENT MARKINGS

A. Pavement-Marking Paint Specified Elsewhere: Comply with Section 321723 "Pavement Markings."

B. Pavement-Marking Paint:

1. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, [**Type N**][**Type F**][**Type S**]; colors complying with FS TT-P-1952.
2. MPI #32 Alkyd Traffic Marking Paint.
3. Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than [**three**][**45**] minutes.
4. MPI #97 Latex Traffic Marking Paint.
5. Color: [**White**][**Yellow**][**Blue**][**As indicated**].

C. Glass Beads: [**AASHTO M 247, Type 1**][**FS TT-B-1325, Type 1A**].

D. VOC Content: [**150**] g/L or less.

E. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. VOC Content: [**100**] g/L or less.

G. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. VOC Content: [**100**] g/L or less.

I. Low-Emitting Materials: VOC emissions of interior paints shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

J. VOC Content: [**100**] g/L or less.

K. Low-Emitting Materials: Interior paints shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

L. VOC Emissions: Interior paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor

recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.

B. Verify that substrates are visibly dry and free of moisture.

1. Test for moisture according to ASTM D4263.
2. Test for moisture content by [**measuring with an electronic moisture meter**][**method recommended in writing by traffic-coating manufacturer**].

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after substrate construction and penetrating work have been completed.
2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
3. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Clean and prepare substrates according to ASTM C1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.

B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.

1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.

C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.

D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.

E. Concrete Substrates: [**Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D4259.**]Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
2. Remove concrete fins, ridges, and other projections.
3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release

agents, and other incompatible materials that might affect coating adhesion.

4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D4258.

3.3 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C1127 and manufacturer's written instructions.

B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.

C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.

D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.

1. Comply with recommendations in ASTM C1193 for joint-sealant installation.

B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.5 INSTALLATION OF TRAFFIC COATINGS

A. Apply traffic coating according to ASTM C1127 and manufacturer's written instructions.

B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.

C. Start traffic-coating application in presence of manufacturer's technical representative.

D. Verify that wet-film thickness of each coat complies with requirements every [**100 sq. ft. (9 sq. m)**].

E. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.

F. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.

G. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.6 INSTALLATION OF PAVEMENT MARKINGS

A. Do not apply pavement-marking paint for striping and other markings until layout, colors, and placement have been verified with Architect and traffic coating has cured.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply pavement-marking paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges. Apply at manufacturer's recommended rates for a minimum wet-film thickness of **15-mils (0.4-mm)**.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet pavement-marking paint at a rate of **6 lb/gal. (0.72 kg/L)**.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform the following field tests and inspections:

1. Materials Testing:

a. Samples of material delivered to Project site ae to be taken, identified, sealed, and certified in presence of [**the Owner and**]Contractor.
b. Testing agency must perform tests for characteristics specified, using applicable referenced testing procedures.
c. Testing agency must verify thickness of coatings during traffic-coating application for each [**600 sq. ft. (56 sq. m)**] of installed traffic coating or part thereof.

2. Electronic Leak-Detection Testing:

a. Testing agency must test [**each deck area**][**each deck area indicated for testing on Drawings**] for leaks using an electronic leak-detection method that locates discontinuities in the traffic-coating membrane.
b. Testing agency must perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.
c. Testing agency must create a conductive electronic field over the area of traffic coating to be tested and electronically determine locations of discontinuities or leaks, if any, in the traffic coating.
d. Testing agency must provide survey report indicating locations of discontinuities, if any.

B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.

1. Notify the Owner 48 hours in advance of date and time of inspection.

C. Waterproofing will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 PROTECTING AND CLEANING

A. Protect traffic coatings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 18 00 00

Task	Specification	Specification Description
07 18 13 00	07 18 00 00	Traffic Coatings
07 18 16 00	07 18 00 00	Traffic Coatings

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SECTION 07 19 00 00 - WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrating water repellents.
2. Film-forming water repellents.
3. MPI-approved water repellents.

B. Related Requirements:

1. Section 030130 "Maintenance of Cast-in-Place Concrete" for high-build penetrating polymer sealers for exterior traffic surfaces.
2. Section 042000 "Unit Masonry" for integral water-repellent admixture for unit masonry assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's printed statement of VOC content.
2. Include manufacturer's standard colors.
3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
4. Include printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies water repellents approved by MPI, with the proposed product highlighted.

B. Samples: For each type[**and color**] of water repellent and substrate indicated, **12 by 12 inches (300 by 300 mm)** in size, with specified water-repellent treatment applied to half of each Sample.

C. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Applicator**][**testing agency**].

B. Product Certificates: For each type of water repellent.

C. Preconstruction Test Reports: For water-repellent-treated substrates.

D. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."

1.6 MOCKUPS

A. Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects[**, for preconstruction testing,**] and to set quality standards for materials and execution.

1. Locate mockups [**where indicated on Drawings**][**on masonry sample panels**][**on existing surfaces where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**], as directed by the Owner.

a. Size: [**10 sq. ft. (0.93 sq. m)**][**25 sq. ft. (2.3 sq. m)**] each.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing of water repellents on [**field mockups**][**manufacturer's standard substrate assemblies**][**on existing substrate assemblies**].

1. In addition to verifying performance requirements, use mockups to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
2. Propose changes to materials and methods to suit Project.
3. Notify Architect [**seven**] days in advance of the dates and times when mockups will be tested, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **35 deg F (2 deg C)** and not more than **110 deg F (44 deg C)**, in accordance with manufacturer's written instructions.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Protect materials from direct sunlight.

1.9 FIELD CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied in accordance with manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than 28 days.
2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. Ambient temperature is above **40 deg F (4.4 deg C)** and below **100 deg F (37.8 deg C)** and will remain so for 24 hours.
4. Substrate is not frozen and substrate-surface temperature is above **40 deg F (4.4 deg C)** and below **100 deg F (37.8 deg C)**.
5. Rain or snow is not predicted within 24 hours.
6. Not less than [**24 hours**][**seven days**] have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which [**manufacturer**][**and**][**Applicator**] agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water repellents must meet the following performance requirements as determined by [**preconstruction**]testing on[**manufacturer's standard**] substrates representing those indicated for this Project.

B. Water Absorption: Minimum [**80**][**90**] percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested in accordance with the following:

1. Cast-in-Place Concrete: ASTM C642.
2. Precast Concrete: ASTM C642.
3. Cast Stone: ASTM C1195.
4. Concrete Masonry Units: ASTM C140/C140M.
5. Clay Brick: ASTM C67/C67M.
6. Natural Stone: ASTM C97/C97M.
7. Portland Cement Plaster (Stucco): ASTM D6532.

C. Water-Vapor Transmission: Comply with one or both of the following:

1. Maximum [**10**] percent reduction in water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM E96/E96M.
2. Minimum [**80**] percent water-vapor transmission of treated compared to untreated specimens, in accordance with ASTM D1653.

D. Water Penetration and Leakage through Masonry: Minimum [**90**] percent reduction in leakage rate of

treated compared to untreated specimens, in accordance with ASTM E514/E514M.

E. Durability: Maximum [**5**] percent loss of water-repellent performance after 2500 hours of weathering in accordance with ASTM G154 compared to water-repellent-treated specimens before weathering.

2.2 PENETRATING WATER REPELLENTS

A. Penetrating Low-VOC Silane Water Repellent: Clear, containing [**20**][**40**][**100**] percent or more active content of [**modified**]silane; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Concrete Sealers USA**]
e. [**Dayton Superior Corporation**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Evonik Corporation**]
h. [**Foxfire Enterprises, Inc.**]
i. [**Ghostshield**]
j. [**LymTal International, Inc.**]
k. [**Master Builders Solutions**]
l. [**Nox-Crete Products Group**]
m. [**Pecora Corporation**]
n. [**PPG Paints; PPG Industries, Inc.**]
o. [**Price Research, Ltd. dba Charles Paint Research**]
p. [**PROSOCO, Inc**]
q. [**Specco Industries, Inc**]
r. [**Textured Coatings of America, Inc**]
s. [**Tnemec Company, Inc.**]
t. [**W. R. Meadows, Inc**]

B. Penetrating Silane Water Repellent: Clear, containing [**20**][**40**][**100**] percent or more active content of [**modified**]silane; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Evonik Corporation**]
g. [**Fox Industries, Inc.**]

h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**LymTal International, Inc.**]
j. [**Master Builders Solutions**]
k. [**Nox-Crete Products Group**]
l. [**Pecora Corporation**]
m. [**PPG Paints; PPG Industries, Inc.**]
n. [**Price Research, Ltd. dba Charles Paint Research**]
o. [**PROSOCO, Inc**]
p. [**Specco Industries, Inc**]
q. [**Textured Coatings of America, Inc**]
r. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
s. [**Tnemec Company, Inc.**]

C. Penetrating Low-VOC Siloxane Water Repellent: Clear, containing [**10**][**12**] percent or more active content of [**modified**]siloxane; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cathedral Stone Products, Inc.**]
b. [**Concrete Sealers USA**]
c. [**Conproco Corporation**]
d. [**Dayton Superior Corporation**]
e. [**Evonik Corporation**]
f. [**Fabrikem Manufacturing Ltd.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**PPG Paints; PPG Industries, Inc.**]
i. [**Price Research, Ltd. dba Charles Paint Research**]
j. [**RainGuard Professional**]
k. [**SaverSystems**]
l. [**Specco Industries, Inc**]
m. [**Textured Coatings of America, Inc**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**United Gilsonite Laboratories (UGL)**]

D. Penetrating Siloxane Water Repellent: Clear, containing [**10**][**12**] percent or more active content of [**modified**]siloxane; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Conproco Corporation**]
b. [**Dayton Superior Corporation**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**Evonik Corporation**]
e. [**Fabrikem Manufacturing Ltd.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**PPG Paints; PPG Industries, Inc.**]

h. [**Price Research, Ltd. dba Charles Paint Research**]
i. [**PROSOCO, Inc**]
j. [**SaverSystems**]
k. [**Specco Industries, Inc**]
l. [**Textured Coatings of America, Inc**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]

E. Penetrating Low-VOC Silane/Siloxane-Blend Water Repellent: Clear, containing [**10**][**12**] percent or more active content of silane and siloxane blend with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**AWRC Corporation**]
c. [**Cathedral Stone Products, Inc.**]
d. [**Chemical Products Industries, Inc**]
e. [**Conproco Corporation**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**Evonik Corporation**]
h. [**Fabrikem Manufacturing Ltd.**]
i. [**Fox Industries, Inc.**]
j. [**Foxfire Enterprises, Inc.**]
k. [**Ghostshield**]
l. [**Karnak Corporation**]
m. [**Kryton International, Inc.**]
n. [**Laticrete International, Inc.**]
o. [**LymTal International, Inc.**]
p. [**Master Builders Solutions**]
q. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
r. [**Pecora Corporation**]
s. [**PPG Paints; PPG Industries, Inc.**]
t. [**Price Research, Ltd. dba Charles Paint Research**]
u. [**PROSOCO, Inc**]
v. [**RainGuard Professional**]
w. [**SaverSystems**]
x. [**Sika Corporation**]
y. [**Symons; a Brand of Dayton Superior Corporation**]
z. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
aa. [**Tnemec Company, Inc.**]
bb. [**United Gilsonite Laboratories (UGL)**]
cc. [**V-Seal Concrete Sealers & Specialty Coatings**]
dd. [**Wacker Chemical Corporation**]

F. Penetrating Silane/Siloxane-Blend Water Repellent: Clear, containing [**10**][**12**] percent or more active content of silane and siloxane blend with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Fabrikem Manufacturing Ltd.**]
e. [**Fox Industries, Inc.**]
f. [**Karnak Corporation**]
g. [**Kryton International, Inc.**]
h. [**Laticrete International, Inc.**]
i. [**LymTal International, Inc.**]
j. [**Master Builders Solutions**]
k. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
l. [**Pecora Corporation**]
m. [**PPG Paints; PPG Industries, Inc.**]
n. [**Price Research, Ltd. dba Charles Paint Research**]
o. [**PROSOCO, Inc**]
p. [**RainGuard Professional**]
q. [**SaverSystems**]
r. [**Sika Corporation**]
s. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
t. [**Tnemec Company, Inc.**]
u. [**Wacker Chemical Corporation**]

G. Penetrating Low-VOC Siliconate Water Repellent: Clear, methyl siliconate water repellent with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Concrete Sealers USA**]
b. [**Ghostshield**]
c. [**Moxie International**]
d. [**PROSOCO, Inc**]

H. Penetrating Water and Oil Repellent: Clear, oleophobic water repellent; with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Chemical Products Industries, Inc**]
c. [**ChemMasters, Inc**]
d. [**Concrete Sealers USA**]
e. [**Evonik Corporation**]
f. [**Ghostshield**]
g. [**Laticrete International, Inc.**]
h. [**Master Builders Solutions**]
i. [**PROSOCO, Inc**]
j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]

I. Penetrating Water Repellent and Corrosion Inhibitor: Clear, containing [**100**] percent or more active content of modified [**silane**][**siloxane**] water repellent and corrosion inhibitor, with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**ChemMasters, Inc**]
c. [**Ghostshield**]

J. Penetrating Water Repellent for Calcareous Stone: Clear, modified silane with ethyl silicate, specially formulated for limestone and marble.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Chemical Technologies, Inc**]
b. [**Evonik Corporation**]
c. [**PROSOCO, Inc**]

K. Penetrating Water Repellent Concentrate: Concentrated [**siloxane**][**silane**], for field dilution.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Chemical Products Industries, Inc**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Evonik Corporation**]
d. [**LymTal International, Inc.**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**PROSOCO, Inc**]

2.3 FILM-FORMING WATER REPELLENTS

A. Film-Forming Low-VOC Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Professional Products of Kansas, Inc.**]

b. [**Specco Industries, Inc**]
c. [**United Gilsonite Laboratories (UGL)**]

B. Film-Forming Silicone Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Professional Products of Kansas, Inc.**]
b. [**Specco Industries, Inc**]

C. Film-Forming Water Repellent for Masonry: [**Clear**][**Pigmented**], consisting of resins, acrylics, polymers, with 600 g/L or less of VOCs; for masonry block or brick.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
b. [**PPG Paints; PPG Industries, Inc.**]
c. [**SaverSystems**]
d. [**Textured Coatings of America, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Film-Forming Low-VOC Modified Acrylic Water Repellent: [**Clear**][**Pigmented**], breathing coating of acrylic resin, which may be enhanced with silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ghostshield**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Nox-Crete Products Group**]
d. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Specco Industries, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Film-Forming Modified Acrylic Water Repellent: [**Clear**][**Pigmented**], breathing coating of acrylic resins, which may be enhanced silane and siloxane resins; in a waterborne, solvent-borne, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 600 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
   b. [**Nox-Crete Products Group**]
   c. [**OKON; a Rust-Oleum brand; a subsidiary of RPM International, Inc.**]
   d. [**PPG Paints; PPG Industries, Inc.**]
   e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
   f. [**Specco Industries, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 MPI-APPROVED WATER REPELLENTS

A. Water Repellent, Clear (Paintable); MPI #34: Penetrating, clear water-repellent coating, for use on interior or exterior masonry, brick, and concrete surfaces, and that can be recoated with conventional paints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cloverdale Paint**]
   b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   c. [**PPG Paints; PPG Industries, Inc.**]
   d. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
   e. [**United Gilsonite Laboratories (UGL)**]

2. VOC Content: [**600 g/L or less**][**400 g/L or less**][**150 g/L or less**][**Less than 51 g/L**].
3. MPI Green Performance Standard: [**GPS-1**][**GPS-2**].

B. Water Repellent, Clear (Not Paintable); MPI #117: Penetrating, silicone-oil type, clear water-repellent for interior or exterior masonry block or brick, not intended for recoating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Behr Paint Company (Behr Process LLC)**]
   b. [**Benjamin Moore & Co.**]
   c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   d. [**Sherwin-Williams Company (The)**]

2. VOC Content: [**600 g/L or less**][**350 g/L or less**][**200 g/L or less**][**Less than 51 g/L**].
3. MPI Green Performance Standard: [**GPS-1**][**GPS-2**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry in accordance with water-repellent manufacturer's requirements. Check moisture content in [**three**] representative locations by method recommended by manufacturer.
2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level in accordance with water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, in accordance with repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product in accordance with water-repellent manufacturer's written instructions.

1. Concrete-Based Substrates: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents on [**cast-in-place concrete**][**precast concrete**][**cast stone**][**and**][**concrete masonry unit**] substrate [**in accordance with ASTM E1857**].
2. Clay Brick Masonry Substrate: [**ASTM D5703.**][**Section 040110 "Masonry Cleaning."**]
3. Natural Stone Substrate: [**ASTM C1515.**][**ASTM D5107.**][**Section 040110 "Masonry Cleaning."**]
4. Portland Cement Plaster (Stucco) Substrate: [**ASTM E1857**].

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION OF WATER REPELLENTS

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using [**15 psi (103 kPa) pressure spray with a fan-type spray nozzle**][**roller**][**or**][**brush**] to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

1. At Contractor's option, first application of water repellent may be completed before installing [**precast concrete**][**and**][**cast stone**] units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto adjacent joint surfaces. Remove masking after repellent has cured.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Testing of Water-Repellent Material: the Owner reserves the right to invoke the following procedure at any time and as often as the Owner deems necessary during the period when water repellent is being applied:

1. the Owner may engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
3. the Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor to remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect, as directed by the Owner.

B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application, as directed by the Owner.

1. Notify Architect [**seven**] days in advance of the dates and times when surfaces will be tested, as directed by the Owner.
2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application, in accordance with manufacturer's written cleaning instructions, as work progresses. Correct damage to work of other trades caused by water-repellent application, as directed by the Owner.

END OF SECTION 07 19 00 00

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Task	Specification	Specification Description
07 19 13 00	07 19 00 00	Water Repellents
07 19 16 00	07 19 00 00	Water Repellents

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SECTION 07 21 00 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Molded (expanded) polystyrene foam-plastic board insulation.
3. Graphite-polystyrene foam-plastic board insulation.
4. Polyisocyanurate foam-plastic board insulation.
5. Glass-fiber blanket insulation.
6. Glass-fiber board insulation.
7. Mineral-wool blanket insulation.
8. Mineral-wool board insulation.
9. Loose-fill insulation.
10. Spray-applied cellulosic insulation.
11. Cellular-glass insulation.
12. Reflective insulation and radiant barriers.
13. Rigid vacuum insulation.
14. Glass-wool vacuum insulation.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
2. Section 061600 "Sheathing" for foam-plastic board sheathing installed directly over wood or steel framing.
3. [**Section 071326 "Self-Adhering Sheet Waterproofing"**][**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**][**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**][**Section 071416 "Cold Fluid-Applied Waterproofing"**] for insulated drainage panels installed with plaza deck insulation.
4. Section 072119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.
5. [**Section 070150.19 "Preparation for Reroofing"**][**Section 075113 "Built-up Asphalt Roofing"**][**Section 075116 "Built-up Coal Tar Roofing"**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing"**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing"**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing"**][**Section 075416 "Ketone Ethylene Ester (KEE) Roofing"**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing"**][**Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing"**][**Section 075552.13 "Atactic-Polypropylene (APP) Modified Bituminous Protected Membrane Roofing"**][**Section 075552.16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing"**][**Section 075556 "Fluid-Applied Protected Membrane Roofing"**][**and**][**Section 075700 "Coated Foamed Roofing"**] for insulation specified as part of roofing construction.
6. [**Section 092300 "Gypsum Plastering"**][**Section 092400 "Portland Cement Plastering"**][**Section 092613 "Gypsum Veneer Plastering"**][**Section 092900 "Gypsum Board"**] for sound attenuation blanket used as acoustic insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
10. Product Data: For adhesives, indicating VOC content.
11. Laboratory Test Reports: For insulation, indicating compliance with the VOC emissions evaluation.
12. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
2. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than [**Class A, 25 and 450**][**Class B, 75 and 450**][**Class C, 200 and 450**] when tested in accordance with ASTM E84.

B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

D. Labeling: Provide identification of mark indicating R-value of each piece of insulation **12 inches (305 mm)** and wider in width.

E. Thermal-Resistance Value (R-Value): [**R-value as indicated on Drawings**] in accordance with ASTM C518.

F. Verify insulation complies with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Verify insulation complies with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (XPS)

A. Extruded Polystyrene Board Insulation, Type X : ASTM C578, Type X, **15 psi (104 kPa)** minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DiversiFoam Products**]
b. [**DuPont de Nemours, Inc.**]
c. [**MBCI; Cornerstone Building Brands**]
d. [**Owens Corning**]
e. [**The Dow Chemical Company**]

B. Extruded Polystyrene Board Insulation, Type IV : ASTM C578, Type IV, **25 psi (173 kPa)** minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**DiversiFoam Products**]
b. [**DuPont de Nemours, Inc.**]
c. [**Kingspan Insulation LLC**]
d. [**Owens Corning**]
e. [**The Dow Chemical Company**]

C. Extruded Polystyrene Board Insulation, Type IV, Drainage Panels : ASTM C578, Type IV, **25 psi (173 kPa)** minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DiversiFoam Products**]
b. [**DuPont de Nemours, Inc.**]
c. [**Owens Corning**]
d. [**The Dow Chemical Company**]

D. Extruded Polystyrene Board Insulation, Type VI : ASTM C578, Type VI, **40 psi (276 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DiversiFoam Products**]
b. [**DuPont de Nemours, Inc.**]
c. [**Kingspan Insulation LLC**]
d. [**Owens Corning**]
e. [**The Dow Chemical Company**]

E. Extruded Polystyrene Board Insulation, Type VI, Drainage Panels : ASTM C578, Type VI, **40 psi (276 kPa)** minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DiversiFoam Products**]
b. [**DuPont de Nemours, Inc.**]
c. [**Owens Corning**]
d. [**The Dow Chemical Company**]

F. Extruded Polystyrene Board Insulation, Type VII : ASTM C578, Type VII, **60 psi (414 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**DuPont de Nemours, Inc.**]
   c. [**Kingspan Insulation LLC**]
   d. [**Owens Corning**]
   e. [**The Dow Chemical Company**]

G. Extruded Polystyrene Board Insulation, Type VII, Drainage Panels : ASTM C578, Type VII, **60 psi (414 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**DuPont de Nemours, Inc.**]
   c. [**Owens Corning**]
   d. [**The Dow Chemical Company**]

H. Extruded Polystyrene Board Insulation, Type V : ASTM C578, Type V, **100 psi (690 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DuPont de Nemours, Inc.**]
   b. [**Owens Corning**]
   c. [**The Dow Chemical Company**]

2.3 MOLDED (EXPANDED) POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (EPS)

A. Molded (Expanded) Polystyrene Board Insulation, Type I : ASTM C578, Type I, **10 psi (69 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alleguard (formerly Amvic Building System)**]
   b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   c. [**DiversiFoam Products**]
   d. [**Insulfoam; a Carlisle Company**]
   e. [**Plymouth Foam, an Altor Solutions Company**]

B. Molded (Expanded) Polystyrene Board Insulation, Type IV, Faced : ASTM C578, Type IV, **25 psi (173 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Insulfoam; a Carlisle Company**]

C. Molded (Expanded) Polystyrene Board Insulation, Type VI, Faced : ASTM C578, Type VI, **40 psi (276 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Insulfoam; a Carlisle Company**]

D. Molded (Expanded) Polystyrene Board Insulation, Type VII, Faced : ASTM C578, Type VII, **60 psi (414 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Insulfoam; a Carlisle Company**]

E. Molded (Expanded) Polystyrene Board Insulation, Type VIII : ASTM C578, Type VIII, **13 psi (90 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**DiversiFoam Products**]
   c. [**Insulfoam; a Carlisle Company**]
   d. [**Plymouth Foam, an Altor Solutions Company**]

F. Molded (Expanded) Polystyrene Board Insulation, Type II : ASTM C578, Type II, **15 psi (104 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**DiversiFoam Products**]
d. [**Insulfoam; a Carlisle Company**]
e. [**Plymouth Foam, an Altor Solutions Company**]

G. Molded (Expanded) Polystyrene Board Insulation, Type IX : ASTM C578, Type IX, **25 psi (173 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**DiversiFoam Products**]
d. [**Insulfoam; a Carlisle Company**]
e. [**Plymouth Foam, an Altor Solutions Company**]

H. Molded (Expanded) Polystyrene Board Insulation, Type X, Faced : ASTM C578, Type X, **15 psi (104 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Insulfoam; a Carlisle Company**]

I. Molded (Expanded) Polystyrene Board Insulation, Type XIV : ASTM C578, Type XIV, **40 psi (276 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**Insulfoam; a Carlisle Company**]
d. [**Plymouth Foam, an Altor Solutions Company**]

J. Molded (Expanded) Polystyrene Board Insulation, Type XV : ASTM C578, Type XV, **60 psi (414 kPa)** minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]

b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**Insulfoam; a Carlisle Company**]
d. [**Plymouth Foam, an Altor Solutions Company**]

2.4 GRAPHITE-POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (GPS)

A. Graphite-Polystyrene Foam-Plastic Board Insulation, Type I : ASTM C578, Type I, **10 psi (69 kPa)** minimum compressive strength; **4-perm (230-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alleguard (formerly Amvic Building System)**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**BASF**]
d. [**LOGIX Brands Ltd.**]
e. [**Opco, Inc.**]
f. [**Perma R Products, Inc.**]
g. [**Polar Industries, Inc.**]
h. [**Progressive Foam Technologies, Inc.**]
i. [**StarRFoam**]

B. Graphite-Polystyrene Foam-Plastic Board Insulation, Type I, Faced : ASTM C578, Type I, **10 psi (69 kPa)** minimum compressive strength; **4-perm (230-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Insulfoam; a Carlisle Company**]
c. [**LOGIX Brands Ltd.**]
d. [**Progressive Foam Technologies, Inc.**]

C. Graphite-Polystyrene Foam-Plastic Board Insulation, Type VIII : ASTM C578, Type VIII, **13 psi (90 kPa)** minimum compressive strength; **3.1-perm (178-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BASF**]
b. [**Opco, Inc.**]
c. [**Perma R Products, Inc.**]

d. [**Polar Industries, Inc.**]
e. [**StarRFoam**]

D. Graphite-Polystyrene Foam-Plastic Board Insulation, Type VIII, Faced : ASTM C578, Type VIII, **13 psi (90 kPa)** minimum compressive strength; **3.1-perm (178-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Perma R Products, Inc.**]

E. Graphite-Polystyrene Foam-Plastic Board Insulation, Type II : ASTM C578, Type II, **15 psi (104 kPa)** minimum compressive strength; **3.1-perm (178-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**BASF**]
c. [**Opco, Inc.**]
d. [**Polar Industries, Inc.**]
e. [**StarRFoam**]

F. Graphite-Polystyrene Foam-Plastic Board Insulation, Type IX : ASTM C578, Type IX, **25 psi (173 kPa)** minimum compressive strength; **2.5-perm (144-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**BASF**]
c. [**Perma R Products, Inc.**]
d. [**Polar Industries, Inc.**]
e. [**StarRFoam**]

G. Graphite-Polystyrene Foam-Plastic Board Insulation, Type IX, Faced : ASTM C578, Type IX, **25 psi (173 kPa)** minimum compressive strength; **2.5-perm (144-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**LOGIX Brands Ltd.**]
c. [**Perma R Products, Inc.**]

H. Graphite-Polystyrene Foam-Plastic Board Insulation, Type XI : **5 psi (35 kPa)** minimum compressive strength; maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M; R4.5 minimum stable R-value at **1-inch (25.4-mm)** thickness per ASTM C518.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

I. Graphite-Polystyrene Foam-Plastic Board Insulation, Type XIV : ASTM C578, Type XIV, **40 psi (276 kPa)** minimum compressive strength; **2.5-perm (144-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BASF**]

J. Graphite-Polystyrene Foam-Plastic Board Insulation, Type XV : ASTM C578, Type XV, **60 psi (414 kPa)** minimum compressive strength; **2.5-perm (144-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BASF**]

K. Graphite-Polystyrene Foam-Plastic Board Insulation, Type X, Faced : ASTM C578, Type X, **15 psi (104 kPa)** minimum compressive strength; **1.1-perm (63-ng/Pa x s x sq. m)** maximum vapor permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

L. Graphite-Polystyrene Foam-Plastic Board Insulation, Type IV, Faced : ASTM C578, Type IV, **25 psi (173 kPa)** minimum compressive strength; **1.1-perm (63-ng/Pa x s x sq. m)** maximum vapor

permeance at **1-inch (25.4-mm)** thickness per ASTM E96/E96M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Insulfoam; a Carlisle Company**]

2.5 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced : ASTM C1289, foil faced, Type I, Class 1 or 2.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Atlas Polyiso Roof and Wall Insulation**]
   c. [**Carlisle Coatings & Waterproofing Inc**]
   d. [**DuPont de Nemours, Inc.**]
   e. [**Elevate; Holcim Building Envelope**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**Johns Manville; a Berkshire Hathaway company**]
   h. [**Rmax, A Business Unit of Sika Corporation**]
   i. [**The Dow Chemical Company**]

B. Polyisocyanurate Board Insulation, Glass-Fiber-Mat Faced : ASTM C1289, glass-fiber-mat faced, Type II, Class 2.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Coatings & Waterproofing Inc**]
   c. [**Elevate; Holcim Building Envelope**]
   d. [**Hunter Panels; a Carlisle company**]
   e. [**Johns Manville; a Berkshire Hathaway company**]
   f. [**Rmax, A Business Unit of Sika Corporation**]

2.6 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced : ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]

B. Glass-Fiber Blanket Insulation, Polypropylene-Scrim-Kraft Faced : ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]

C. Glass-Fiber Blanket Insulation, Kraft Faced : ASTM C665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]

D. Glass-Fiber Blanket Insulation, Reinforced-Foil Faced : ASTM C665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]

E. Glass-Fiber Blanket Insulation, Foil Faced : ASTM C665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Owens Corning**]

2.7 GLASS-FIBER BOARD INSULATION

A. Glass-Fiber Board Insulation, Unfaced : ASTM C612, Type IA; unfaced [**passing ASTM E136 for combustion characteristics**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Owens Corning**]

2. Nominal Density: [**2.25 lb/cu. ft. (36 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**4.25 lb/cu. ft. (68 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**].

B. Glass-Fiber Board Insulation, Faced : ASTM C612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Owens Corning**]

2. Nominal Density: [**2.25 lb/cu. ft. (36 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**4.25 lb/cu. ft. (68 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**].

2.8 MINERAL-WOOL BLANKET INSULATION

A. Mineral-Wool Blanket Insulation, Unfaced : ASTM C665, Type I (blankets without membrane facing); consisting of fibers; complying with ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]

B. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced : ASTM C665, Type III (reflective faced); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]

2.9 MINERAL-WOOL BOARD INSULATION

A. Mineral-Wool Board Insulation, Types IA and IB, Unfaced : ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]

2. Nominal Density: [**1.6 lb/cu. ft. (26 kg/cu. m)**][**2.25 lb/cu. ft. (36 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**4 lb/cu. ft. (64 kg/cu. m)**][**4.3 lb/cu. ft. (69 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**].

B. Mineral-Wool Board Insulation, Types IA and IB, Faced : ASTM C612, Types IA and IB; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]

2. Nominal Density: [**1.6 lb/cu. ft. (26 kg/cu. m)**][**2.25 lb/cu. ft. (36 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**4 lb/cu. ft. (64 kg/cu. m)**][**4.3 lb/cu. ft. (69 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**].

C. Mineral-Wool Board Insulation, Type II, Unfaced : ASTM C612, Type II; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]

2. Nominal Density: [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**].

D. Mineral-Wool Board Insulation, Type II, Faced : ASTM C612, Type II; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**Specialty Products & Insulation (SPI)**]

2. Nominal Density: [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**].

E. Mineral-Wool Board Insulation, Type III, Unfaced : ASTM C612, Type III; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]

2. Nominal Density: [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**][**10 lb/cu. ft. (160 kg/cu. m)**].

F. Mineral-Wool Board Insulation, Type III, Faced : ASTM C612, Type III; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. [**Specialty Products & Insulation (SPI)**]

2. Nominal Density: [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**][**10 lb/cu. ft. (160 kg/cu. m)**].

G. Mineral-Wool Board Insulation, Type IVA : ASTM C612, Type IVA; [**unfaced**][**with black mat facer**].

1. Nominal Density: [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**][**10 lb/cu. ft. (160 kg/cu. m)**][**11 lb/cu. ft. (176 kg/cu. m)**][**12 lb/cu. ft. (192 kg/cu. m)**].

H. Mineral-Wool Board Insulation, Type IVB : ASTM C612, Type IVB; [**unfaced**][**with black mat facer**].

1. Nominal Density: [**4.3 lb/cu. ft. (69 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**][**10 lb/cu. ft. (160 kg/cu. m)**][**11 lb/cu. ft. (176 kg/cu. m)**][**12 lb/cu. ft. (192 kg/cu. m)**][**6.2 lb/cu. ft. (99 kg/cu. m) outer layer and 3.8 lb/cu. ft. (61 kg/cu. m) inner layer**].

2.10 LOOSE-FILL INSULATION

A. Cellulosic-Fiber Loose-Fill Insulation : ASTM C739, chemically treated for flame-resistance, processing, and handling characteristics. [**Type I for pneumatic application**][**or**][**Type II for poured application**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Greenfiber, LLC**]
b. [**Hamilton Manufacturing, Inc. (HMI)**]
c. [**Nu-Wool Co., Inc.**]

B. Glass-Fiber Loose-Fill Insulation : ASTM C764, [**Type I for pneumatic application**][**or**][**Type II for poured application**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]

C. Mineral-Fiber Loose-Fill Insulation : ASTM C764, [**Type I for pneumatic application**][**or**][**Type II for poured application**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Knauf Insulation**]
b. [**Owens Corning**]

2.11 SPRAY-APPLIED CELLULOSIC INSULATION

A. Self-Supported, Spray-Applied Cellulosic Insulation : ASTM C1149, [**Type I (materials applied with liquid adhesive; suitable for either exposed or enclosed applications),**][**Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications),**][**Type III (materials containing an adhesive mixed with water during application; intended for application on attic floors),**] chemically treated for flame-resistance, processing, and handling characteristics.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Greenfiber, LLC**]
b. [**Hamilton Manufacturing, Inc. (HMI)**]
c. [**International Cellulose Corp.**]

2.12 CELLULAR-GLASS INSULATION

A. Cellular-Glass Insulation : Type V, ASTM C1902, structural insulating block with compressive strength of minimum **304 psi (2096 kPa)**, per ASTM D1621.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Owens Corning**]

2.13 REFLECTIVE INSULATION AND RADIANT BARRIERS

A. Reflective Insulation : ASTM C1224, with one or more low-emittance surfaces with emittance value of 0.1 or less as measured per ASTM C1371.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Covertech Flexible Packaging; division of Balcan Plastics**]
b. [**Fi-Foil Company, Inc.**]
c. [**Innovative Energy, Inc**]

d. [**Innovative Insulation, Inc.**]
e. [**ISI Building Products**]
f. [**Reflectix Inc.**]

2. Construction: [**Surfaces separated with internal expanders**][**Surfaces separated by single-layer polyethylene bubble film**][**Surfaces separated by double-layer polyethylene bubble film**].
3. Water-Vapor Transmission: [**1 perm, maximum**][**5 perms or greater**].

B. Sheet Radiant Barriers : ASTM C1313/C1313M with at least one surface with emittance value of 0.1 or less as measured per ASTM C1371.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Covertech Flexible Packaging; division of Balcan Plastics**]
b. [**Fi-Foil Company, Inc.**]
c. [**Innovative Energy, Inc**]
d. [**Innovative Insulation, Inc.**]
e. [**ISI Building Products**]
f. [**Reflectix Inc.**]

2. Construction: [**Foil on one side of substrate**][**Foil on both sides of substrate**][**Vacuum metallizing on substrate**].

C. Interior Radiation Control Coating System : Silver-colored, low-emissivity, [**solvent**][**water**]-based coating; with a surface emittance value of 0.25 or less as measured per ASTM C1371.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SOLEC Solar Energy Corporation**]
b. [**STS Coatings, Inc.**]

2.14 RIGID VACUUM INSULATION (VIP)

A. Rigid Vacuum Insulation Panel, Foil Faced : A microporous, insulated core heat-sealed under vacuum and encased in metal film.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kingspan Insulation LLC**]
b. [**Panasonic Industrial**]

2.15 GLASS-WOOL VACUUM INSULATION (VIP)

A. Glass-Wool Vacuum Insulation Panel, Foil Faced : ASTM C1484, foil faced; Class A fire-rated in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Panasonic Industrial Devices Sales Company of America; division of Panasonic Corporation of America**]

2.16 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGM Industries, Inc**]
b. [**Gemco**]

2. Plate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.762 mm)** thick by **2 inches (50 mm)** square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; **0.105 inch (2.67 mm)** in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gemco**]

2. Angle: Formed from **0.030-inch- (0.762-mm-)** thick, perforated, galvanized carbon-steel sheet with each leg **2 inches (50 mm)** square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; **0.105 inch (2.67 mm)** in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than **1-1/2 inches (38 mm)** square or in diameter.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**AGM Industries, Inc**]
b. [**Gemco**]

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

a. Crawl spaces.
b. Ceiling plenums.
c. Attic spaces.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain airspace of [**1 inch (25 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**] between face of insulation and substrate to which anchor is attached.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gemco**]

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGM Industries, Inc**]
b. [**Gemco**]

F. Insulation Fastener Accessories: Provide double-pointed weld pins, lagging pins, quilting pins, duct liner pins, insulation hangers, specialty washers, special caps, j-hooks, capacitor discharge annular weld pins, capacitor discharge acoustical lagging pins, and other accessory materials that are recommended in writing by insulation fastener manufacturer to produce complete insulation supports.

2.17 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
3. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-

in-place applications.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Huntsman Building Solutions**]

B. Miscellaneous Application Accessories:

1. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
2. Crack Sealer: Closed-cell insulating foam in aerosol dispenser recommended in writing by insulation manufacturer for filling gaps in board insulation.
3. Curtain-Wall Insulation Clips: Z-shaped galvanized steel as recommended in writing by insulation manufacturer.
4. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.
5. Detailing Foam Insulation for Voids: Urethane foam complying with AAMA 812, low expansion pressure suitable for filling insulation gaps and voids adjacent to openings to protect against water, air, and sound intrusion.
6. Tapes for Reflective Insulation and Barriers:

   a. Aluminum-foil tape for repairs or splicing material.
   b. Double-sided tape for adhering to metal framing or overlapping material.
   c. Reinforced-foil tape for sealing tears or cuts in sheet vapor barrier.

7. Clip-and-Pin Components:

   a. Beam/Bar Joist Clips: For beams, bar joists, and Z-type purlins.
   b. C-Purlin Clips: For C-type purlins.
   c. Angle Clips: For sidewalks and floors.
   d. Tube Clips: For wood beams and metal tubular framing.
   e. Locking Washers: Aluminum; white to match reflective bubble insulation facing colors.

8. Wire Mesh Lath Support for Insulation: ASTM C1032.

   a. Material: Woven wire lath **1-1/2-inch (38-mm)** hexagonal-shaped mesh with minimum **0.0510-inch- (1.3-mm-)** diameter, galvanized-steel wire.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or those that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products, applications and applicable codes.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive in accordance with manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of [**24 inches (610 mm)**][**36 inches (915 mm)**] below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of [**24 inches (610 mm)**][**36 inches (915 mm)**] in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive in accordance with anchor manufacturer's written instructions.
2. Space anchors in accordance with insulation manufacturer's written instructions for insulation type, thickness, and application.
3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately **24 inches (610 mm)** o.c. both ways on inside face and as recommended in writing by manufacturer.

1. Fit courses of insulation between[**wall ties and other**] obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.
3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

B. Cellular-Glass Structural Insulating Blocks:

1. Verify manufacturer-recommended cure time for air and water barrier system and waterproofing before installing structural insulating block.
2. Install a single layer of cellular-glass structural insulating block with facers on top and bottom surfaces fully embedded into mortar set on brick ledge in accordance with manufacturer's written instructions.
3. Install cellular-glass structural insulating block maximum sizes to minimize joints.
4. Locate joints square to framing members. Do not cantilever cellular-glass structural insulating block.
5. Butt joints of cellular-glass structural insulating block with no gaps or mortar between joints.
6. Insulation board edges are to be butted together tightly and fit around openings and penetrations. Install square edges to fit square and tight.
7. Extend insulation in single course to cover entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Do not drill.

C. Mineral-Wool Board Insulation: Install insulation fasteners **4 inches (100 mm)** from each corner of board insulation, at center of board, and as recommended by manufacturer.

1. Fit courses of insulation between[**masonry wall ties and other**] obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members in accordance with the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain **3-inch (76-mm)** clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed **96 inches (2438 mm)**, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
6. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install unfaced blanket insulation over ceiling area in thickness indicated. Where partitions occur, extend insulation up either side of partition.
7. For wood-framed construction, install blankets in accordance with ASTM C1320 and as follows:

a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

8. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.

a. Exterior Walls: Set units with facing placed toward [**exterior of construction**][**interior of construction**][**as indicated on Drawings**].
b. Interior Walls: Set units with facing placed [**as indicated on Drawings**][**toward areas of high humidity**].

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately **2.5 lb/cu. ft. (40 kg/cu. m)**.
2. Detailing Foam Insulation for Voids: Apply in accordance with manufacturer's written instructions.

C. Loose-Fill Insulation: Apply in accordance with ASTM C1015 and manufacturer's written instructions.

1. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
2. For cellulosic-fiber loose-fill insulation, comply with CIMA's Technical Bulletin #2, "Standard Practice for Installing Cellulose Building Insulation."

D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation in accordance with manufacturer's written instructions.

1. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
2. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.7 INSTALLATION OF BOARD INSULATION

A. Install board insulation in accordance with manufacturer's written instructions per project applications and conditions.

3.8 INSTALLATION OF REFLECTIVE AND RADIANT BARRIERS INSULATION

A. Install sheet reflective insulation in accordance with ASTM C727.

B. Install sheet radiant barriers in accordance with ASTM C1744.

C. Install interior radiation control coating system in accordance with ASTM C1321.

3.9 INSTALLATION OF VACUUM INSULATION

A. Install vacuum insulation panels in accordance with manufacturer's written instructions.

3.10 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00 00

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Task	Specification	Specification Description
07 21 13 13	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 13	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 21 13 13	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 21 13 13	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 21 13 13	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 21 13 16	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 16	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 21 13 16	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 21 13 16	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 21 13 16	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 21 13 19	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 19	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 21 13 19	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 21 13 19	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 21 13 19	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 21 16 00	07 21 00 00	Thermal Insulation

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SECTION 07 21 19 00 - FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Closed-cell spray polyurethane foam insulation.
2. Open-cell spray polyurethane foam insulation.

B. Related Requirements:

1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.
2. Section 075700 "Coated Foamed Roofing" for spray polyurethane foam insulation used for roofing applications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.
2. Manufacturer Inventory: Provide manufacturer's ingredient inventory.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

4. Product Data: For insulation, indicating that R-values comply with tables in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning.
5. Laboratory Test Reports: For insulation, indicating compliance with the VOC emissions evaluation.
6. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

B. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Spray Polyurethane Foam: ASTM C1029.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMBIT Polyurethane**]
   b. [**Carlisle Spray Foam Insulation**]
   c. [**ENVERGE**]
   d. [**Gaco; Holcim Building Envelope**]
   e. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   f. [**Huntsman Building Solutions**]
   g. [**Johns Manville; a Berkshire Hathaway company**]
   h. [**NCFI Polyurethanes; a division of Barnhardt Manufacturing Company**]
   i. [**Quadrant Performance Materials**]
   j. [**SWD Urethane Company**]
   k. [**Thermoseal USA**]
   l. [**Volatile Free, Inc.**]

2. Type and Minimum Compressive Strength:

   a. Type II, minimum density of [**1.5 lb/cu. ft. (24 kg/cu. m)**] and minimum aged R-value at **1-inch (25.4-mm)** thickness of **6.2 deg F x h x sq. ft./Btu at 75 deg F (43 K x sq. m/W at 24 deg C)**.

3. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**][**75**] or less.
   b. Smoke-Developed Index: [**450**] or less.
   c. Fire-Propagation Characteristics: Passes [**NFPA 285**][**NFPA 276**] testing as part of an approved assembly.

4. Fire-Safety Barriers: Approved assembly as [**thermal barrier**][**ignition barrier**] with accessory components.

2.2 OPEN-CELL SPRAY POLYURETHANE FOAM INSULATION

A. Open-Cell Spray Polyurethane Foam: Spray-applied polyurethane foam using water as a blowing agent.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AMBIT Polyurethane**]
    b. [**Carlisle Spray Foam Insulation**]
    c. [**ENVERGE**]
    d. [**Gaco; Holcim Building Envelope**]
    e. [**General Coatings Manufacturing Corp.**]
    f. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
    g. [**Huntsman Building Solutions**]
    h. [**Johns Manville; a Berkshire Hathaway company**]
    i. [**NCFI Polyurethanes; a division of Barnhardt Manufacturing Company**]
    j. [**Quadrant Performance Materials**]
    k. [**SWD Urethane Company**]
    l. [**Thermoseal USA**]
    m. [**UPC; a General Coatings Manufacturing Corp. brand**]

2. Type and Minimum Compressive Strength:

    a. Minimum density of [**0.4 lb/cu. ft. (6.4 kg/cu. m)**] and minimum aged R-value at **1-inch (25.4-mm)** thickness of **3.4 deg F x h x sq. ft./Btu at 75 deg F (24 K x sq. m/W at 24 deg C)**.

3. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: [**25**][**75**] or less.
    b. Smoke-Developed Index: [**450**] or less.

4. Fire-Propagation Characteristics: Passes [**NFPA 285**][**NFPA 276**] testing as part of an approved assembly.
5. Fire-Safety Barriers: Approved assembly as [**thermal barrier**][**ignition barrier**] with accessory components.

2.3 ACCESSORIES

A. Prescriptive Thermal Barriers: Building-code-approved materials.

1. Gypsum Board: **1/2-inch (12.7-mm)** minimum thickness.
2. Wood Structural Panels: **23/32-inch (18.2-mm)** thickness.
3. Plywood: Nominal **1/2-inch (12.7-mm)** minimum thickness.
4. Heavy timber in accordance with the IBC.

B. Alternate Thermal Barriers: Assembly consisting of foam insulation with applied fire-protective intumescent coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flame Control Coatings, a brand of Seal for Life Industries**]
b. [**Flame Control Coatings, LLC**]
c. [**International Fireproof Technology Inc**]
d. [**No-Burn, Inc.**]
e. [**TPR2 Corporation**]

2. Fire-Performance Requirements: Materials as an equivalent assembly must pass the following fire test:

   a. NFPA 286 Fire Integrity Test: Ensures material remains in place for 15 minutes during specified large-scale fire tests. This could include UL 1715, UL 1040 or FM 4880.

3. Components:

   a. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.
   b. Fire-Protective Intumescent Coatings: Coating formulated for application over polyurethane foam plastics in thicknesses listed in compliance with the ICC-ES report.

C. Equivalent Thermal Barriers: Assembly consisting of foam insulation with applied fire-protective intumescent coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Firestable Insulation Company**]
   b. [**International Cellulose Corp.**]

2. Fire-Performance Requirements: Material or equivalent assembly is in compliance with the following two fire tests:

   a. ASTM E119 Temperature Transmission Fire Test: Average temperature rise of the unexposed surface less than **250 deg F (120 deg C)** after 15 minutes of fire exposure in accordance with ASTM E119 or UL 263.
   b. NFPA 286 Fire Integrity Test: Ensures material remain in place for 15 minutes during specified large-scale fire tests such as NFPA 286.
   c. NFPA 275: Combination of both ASTM E119 and NFPA 275 fire tests.

3. Components:

   a. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.
   b. Fire-Protective Intumescent Coatings: Coating formulated for application over polyurethane foam plastics in thicknesses listed in compliance with the ICC-ES report.

D. Prescriptive Ignition Barriers: Building-code-approved materials.

1. Mineral-Fiber Insulation: **1-1/2-inch (38-mm)** minimum thickness.
2. Wood Structural Panel or Hardboard: **1/4-inch (6-mm)** minimum thickness.

3. Particleboard: **0.325-inch (9.5-mm)** minimum thickness.
4. Gypsum Wallboard: **0.325-inch (9.5-mm)** minimum thickness.
5. Corrosion-Resistant Steel: **0.016-inch (0.4-mm)** base metal thickness.
6. Cellulose Insulation: **1-1/2-inch (38-mm)** minimum thickness, self-supported spray-applied; for attic spaces only.

E. Alternative Ignition Barriers: Assembly consisting of foam insulation with applied fire-protective intumescent coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ENVERGE**]
   b. [**Flame Seal Products, Inc.**]
   c. [**No-Burn, Inc.**]
   d. [**TPR2 Corporation**]

2. Fire-Performance Requirements:

   a. Fire-protective coating formulated for application over polyurethane foam plastics, compatible with insulation, and in compliance with ICC-ES AC377, Appendix X.
   b. ASTM E970 radiant heat flux test.

3. Components:

   a. Fire-Protective Intumescent Coatings: Coating formulated for application over polyurethane foam plastics in thicknesses listed in compliance with the ICC-ES report.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.

B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 INSTALLATION OF FOAMED-IN-PLACE INSULATION

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Spray insulation to envelop entire area to be insulated and fill voids.

C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on

Drawings.

E. Cavity Walls: Install into cavities to [**thickness indicated on Drawings**][**fully fill void**].

F. Miscellaneous Voids: Apply according to manufacturer's written instructions.

G. Install [**thermal**][**ignition**] barrier material.

1. Do not cover insulation prior to any required spray foam insulation inspections.

H. Apply barrier coatings in accordance with manufacturer's written instructions and to comply with requirements for listing and labeling for fire-propagation characteristics and surface-burning characteristics specified.

1. Use equipment and techniques best suited for substrate and type of material applied as recommended by coating manufacturer.
2. Apply coatings to prepared surfaces as soon as practical after preparation and before subsequent surface soiling or deterioration.
3. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Produce sharp lines and color breaks.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect spray foam insulation installation, including accessories. Report results in writing.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 07 21 19 00

Task	Specification	Specification Description
07 21 23 00	07 21 00 00	Thermal Insulation
07 21 26 00	07 21 00 00	Thermal Insulation
07 21 29 00	07 21 00 00	Thermal Insulation
07 22 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 22 16 00	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 22 16 00	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 22 16 00	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 22 16 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 24 13 00 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Polymer-based exterior insulation and finish system (EIFS).

1. EIFS-clad barrier-wall assemblies that are field applied over substrate.
2. Prefabricated panels consisting of EIFS-clad barrier-wall assemblies that are shop applied over sheathing on metal framing.

B. Related Requirements:

1. Section 072419 "Water-Drainage Exterior Insulation and Finish System (EIFS)" for EIFS-clad drainage-wall assemblies.
2. Section 072600 "Vapor Retarders" for wall sheet vapor retarders.
3. Section 072713 "Modified Bituminous Sheet Air Barriers" for self-adhering sheet air barriers composed of bituminous materials applied over sheathing behind mechanically fastened EIFS.
4. Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers" for self-adhering sheet air barriers composed of nonbituminous polymers applied over sheathing behind mechanically fastened EIFS.
5. Section 072726 "Fluid-Applied Membrane Air Barriers" for fluid-applied, synthetic polymer air barriers applied over sheathing behind EIFS-clad wall assemblies.

C. Products furnished, but not installed, under this Section include connections and other attachment devices for prefabricated panels to be [**cast in concrete**][**embedded in masonry assemblies**].

1.2 DEFINITIONS

A. Definitions in ASTM E2110 apply to Work of this Section.

B. EIFS: Exterior insulation and finish system(s).

C. IBC: International Building Code.

D. Polymer-Based Exterior Insulation and Finish System: Class PB EIFS, as defined in ASTM E2568.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each EIFS component, trim, and accessory.

B. Sustainable Design Submittals:

1. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.
2. Manufacturer Inventory: Provide manufacturer's ingredient inventory.
3. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

4. Product Data: For insulation, indicating that R-values comply with tables in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
5. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

C. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

D. Shop Drawings: For prefabricated EIFS panels.

1. Include plans, elevations, sections, details of components including build-outs, details of penetrations and terminations, flashing details, joint locations and configurations, lifting points, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.

E. Panel Schedule: For prefabricated panel fabrication.

F. Samples: For each exposed product and for each color and texture specified, [**8 inches (200 mm) square**] in size.

G. Samples for Initial Selection: For each type of finish-coat color and texture indicated.

1. Include similar Samples of exposed accessories involving color selection.

H. Samples for Verification: **24-inch- (600-mm-)** square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work, including [**custom trim, each profile,**][**an aesthetic reveal**].

1. Include [**exposed trim and accessory**] Samples to verify color selected.
2. Include a typical control joint filled with sealant of color selected, as specified in Section 079200 "Joint Sealants."

I. Delegated Design Submittal: For prefabricated EIFS panels.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**fabricator/erector**].

B. Manufacturer Certificates: Signed by EIFS manufacturer, certifying the following:

1. EIFS substrate is acceptable to EIFS manufacturer.
2. Accessory products installed with EIFS, including [**joint sealants,**][**flashing,**][**water-resistant barriers,**][**trim,**] whether or not furnished by EIFS manufacturer and whether or not specified in this Section, are acceptable to EIFS manufacturer.

C. Product Certificates: For [**cementitious materials and aggregates and for**] insulation, from manufacturer.

D. Product Test Reports: For each EIFS assembly and component, for tests performed by a qualified testing agency.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For EIFS to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: [**An installer who is certified in writing by AWCI International as qualified to install Class PB EIFS using trained workers**].

B. Fabricator/Erector Qualifications: Certified in writing by EIFS manufacturer as qualified to fabricate and erect manufacturer's prefabricated panel system using skilled and trained workers.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.

1. Stack insulation board flat and off the ground.
2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to

Project site before installation time.

3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1. Proceed with installation of adhesives or coatings only when ambient temperatures have remained, or are forecast to remain, above **40 deg F (4.4 deg C)** for a minimum of 24 hours before, during, and after application. Do not apply EIFS adhesives or coatings during rainfall.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of EIFS that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Bond integrity and weathertightness.
b. Deterioration of EIFS finishes and other EIFS materials beyond normal weathering.

2. Warranty coverage includes the following EIFS components:

a. EIFS finish, including base coats, finish coats, and reinforcing mesh.
b. Insulation installed as part of EIFS[**including buildouts**].
c. Insulation adhesive[**and mechanical fasteners**].
d. EIFS accessories, including trim components and flashing.

3. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corev America, Inc**]
2. [**Dryvit Systems, Inc.**]
3. [**Dryvit, part of Tremco CPG**]
4. [**Finestone, a Sika brand**]
5. [**Master Wall Inc.**]
6. [**Omega Products International, Inc.**]
7. [**Parex, a Sika brand**]
8. [**Senergy; a SIKA brand**]

9. [**Sto Corp.**]
10. [**Stuc-O-Flex International, Inc.**]
11. [**Total Wall, Inc.**]

B. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as tested and compatible with EIFS components.

2.2 PERFORMANCE REQUIREMENTS

A. EIFS Performance: Comply with ASTM E2568 and with the following:

1. Weathertightness: Resistant to water penetration from exterior.
2. System Fire Performance: [**Fire-resistance rating of wall assembly**][**Full-scale multistory fire test**].
3. Structural Performance of Assembly and Components:

   a. Wind Loads:

      1) Uniform pressure as indicated on Drawings.

4. Impact Performance: ASTM E2568, [**Standard**][**Medium**][**High**][**Ultra High**] impact resistance[**unless otherwise indicated**].
5. Abrasion Resistance of Finish Coat: Sample consisting of **1-inch- (25.4-mm-)** thick EIFS mounted on **1/2-inch- (12.7-mm-)** thick gypsum board; cured for a minimum of 28 days and shows no cracking, checking, or loss of film integrity after exposure to **528 quarts (500 L)** of sand when tested in accordance with ASTM D968, Method A.
6. Mildew Resistance of Finish Coat: Sample applied to **2-by-2-inch (50.8-by-50.8-mm)** clean glass substrate; cured for 28 days and shows no growth when tested in accordance with ASTM D3273 and evaluated in accordance with ASTM D3274.

B. Performance of Prefabricated Panels: EIFS to be designed as follows and withstand the structural performance indicated for Class PB EIFS and thermal movement limits indicated below without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design prefabricated panels, including comprehensive engineering analysis, using performance requirements and design criteria indicated.
2. Structural Performance: EIFS must withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

   a. Wind Loads:

      1) Uniform pressure as indicated on Drawings.

3. Deflection Limits: Design prefabricated panels to withstand design loads without deflections greater than [**1/240**].
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

   a. Temperature Change: [**100 deg F (55 deg C)**].

2.3 EIFS MATERIALS

A. Prefabricated Panels: Comply with requirements in Section 054000 "Cold-Formed Metal Framing" for metal framing supporting sheathing beneath EIFS and Section 061600 "Sheathing" for sheathing and sheathing joint treatment.

B. Flexible-Membrane Flashing: Cold-applied, self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.

C. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate and complying with [**one of**] the following:

1. Job-mixed formulation of portland cement, complying with ASTM C150/C150M, Type I, and polymer-based adhesive specified for base coat.
2. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
3. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
4. Adhesives shall have a VOC content of [**50**] g/L or less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
8. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Molded, (Expanded) Rigid Cellular Polystyrene Board Insulation: Comply with ASTM E2430/E2430M, unless otherwise noted, and the following:

1. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, in accordance with ASTM E84.
2. Dimensions: Provide insulation boards of not more than **24 by 48 inches (610 by 1219 mm)**, with thickness indicated on Drawings.
3. Foam Buildouts: Provide with profiles and dimensions indicated on Drawings.

E. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than **120 lbf/in. (21 dN/cm)** in accordance with ASTM E2098/E2098M and the following:

1. Reinforcing Mesh for EIFS, General: Not less than weight required to comply with impact-performance level specified in "Performance Requirements" Article.

2. Strip-Reinforcing Mesh: Not less than [**3.75 oz./sq. yd. (127 g/sq. m)**][**As recommended by EIFS manufacturer**].
3. Detail-Reinforcing Mesh: Not less than [**4.0 oz./sq. yd. (136 g/sq. m)**][**As recommended by EIFS manufacturer**].
4. Corner-Reinforcing Mesh: Not less than [**7.2 oz./sq. yd. (244 g/sq. m)**][**As recommended by EIFS manufacturer**].

F. Base Coat: EIFS manufacturer's standard mixture complying with [**one of**] the following:

1. Job-mixed formulation of portland cement complying with ASTM C150/C150M, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
3. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
4. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
5. Adhesives shall have a VOC content of [**50**] g/L or less.
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
10. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Water-Resistant Base Coat: EIFS manufacturer's standard waterproof formulation complying with[**one of**] the following:

1. Job-mixed formulation of portland cement complying with ASTM C150/C150M, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
3. Adhesives shall have a VOC content of [**50**] g/L or less.
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

H. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners, consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; designed to resist Project's design loads; capable of pulling fastener head below surface of insulation board; and complying with the following:

1. For attachment to steel studs from **0.033 to 0.112 inch (0.84 to 2.84 mm)** in thickness, provide steel drill screws complying with ASTM C954.
2. For attachment to light-gage steel framing members not less than **0.0179 inch (0.45 mm)** in thickness, provide steel drill screws complying with ASTM C1002.
3. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C1002, Type W.
4. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.

I. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

1. VOC Content: [**250**] g/L or less.
2. Low-Emitting Materials: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: [**100**] g/L or less.
4. Low-Emitting Materials: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. VOC Content: [**100**] g/L or less.
6. Low-Emitting Materials: VOC emissions of coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. VOC Content: [**100**] g/L or less.
8. Low-Emitting Materials: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. VOC Emissions: Coatings shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

J. Finish Coat: EIFS manufacturer's [**standard acrylic-based coating**][**standard acrylic-based coating**

with enhanced mildew resistance][**siliconized acrylic-based coating**][**elastomeric coating**] complying with the following:

1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
2. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.

    a. Aggregate: Marble chips of size and color [**as indicated by manufacturer's designations**][**to match Architect's sample**][**as selected by Architect from manufacturer's full range of industry colors and color densities**], as directed by the Owner.

3. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Textures: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.

L. Water: Potable.

M. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D1784 and ASTM C1063.

1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
2. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation, with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
3. Expansion Joint: Closed-cell polyethylene backer rod and elastomeric sealant, **3/4-inch (19-mm)** minimum.
4. Windowsill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
5. Parapet Cap Flashing: Type for both flashing and covering parapet top, with design complying with ASTM C1397[**and ANSI/SPRI/FM 4435/ES-1**].

2.4 MIXING

A. Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials, except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

2.5 PANEL FABRICATION

A. Panel Framing: Fabricate panel framing to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Connect panel framing by welding unless otherwise indicated.
2. Connections: Provide connections capable of adjustment, complying with erection tolerance

requirements, to anchor panels to structure.

B. Sheathing: Install on metal framing to comply with requirements in Section 061600 "Sheathing."

C. EIFS Application: Apply EIFS to sheathed metal-framed panels to comply with requirements in "Substrate Protection Application," "Trim Installation," "Insulation Installation," "Base-Coat Application," and "Finish-Coat Application" articles and as follows:

1. Wrap base coat and reinforcing mesh at edges of panels, and extend coverage not less than [**4 inches (100 mm) over backs of panels**][**full thickness to cover edges of metal framing**] unless otherwise indicated.
2. Continue finish coat around corners at edges of panels unless otherwise indicated, and extend to location indicated for sealant application. Do not extend finish coat over surfaces where sealant is applied.
3. Continue finish coat around corners at edges of panels, and extend over edges to cover base coat unless otherwise indicated.

D. Panel Fabrication Tolerances: Comply with the following:

1. Overall Height and Width: Plus or minus [**1/8 inch (3 mm)**].
2. Cumulative Height and Width over Length of Building: Not more than [**3/8 inch (10 mm)**].
3. Openings within One Unit: Plus or minus [**1/8 inch (3 mm)**] for window and door frames.
4. Out of Square: Plus or minus [**1/8 inch (3 mm)**].
5. Locations of Reveals and Architectural Features: Plus or minus [**1/8 inch (3 mm)**].
6. Thickness: Plus or minus [**1/16 inch (1.5 mm)**].
7. Flatness: Not more than [**1/8 inch in 8 feet (3 mm in 2.5 m)**] across face of panel.

2.6 SOURCE QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform shop tests and inspections indicated below and to prepare test reports:

1. Shop welds are subject to testing and inspection.
2. Testing and inspecting agency will interpret tests and report whether tested Work complies with or deviates from requirements.
3. Correct deficiencies in or replace EIFS prefabricated panels that test reports and inspections indicate do not comply with requirements.
4. Additional testing and inspection, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind EIFS and deterioration of substrates.

C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

1. Concrete Substrates: Provide clean, dry, neutral-pH substrate for insulation installation. Verify suitability of substrate by performing bond and moisture tests recommended by EIFS manufacturer.

3.3 INSTALLATION OF EIFS, GENERAL

A. Comply with ASTM C1397, ASTM E2511, and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate.

3.4 APPLICATION OF SUBSTRATE PROTECTION

A. Flexible-Membrane Flashing: Apply and lap to shed water; seal at openings, penetrations, and terminations. Prime substrates with flashing primer if required and install flashing.

3.5 INSTALLATION OF TRIM

A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, [**at windowsills,**] and elsewhere as indicated. Coordinate with installation of insulation.

1. Drip Screed/Track: Use at bottom edges of EIFS unless otherwise indicated.
2. Windowsill Flashing: Use at windows unless otherwise indicated.
3. Expansion Joint: Use where indicated on Drawings.
4. Casing Bead: Use at other locations.
5. Parapet Cap Flashing: Use where indicated on Drawings.

3.6 INSTALLATION OF INSULATION

A. Board Insulation: [**Adhesively**][**Mechanically**][**Adhesively and mechanically**] attach insulation to substrate in compliance with ASTM C1397 and the following:

1. Sheathing: Apply adhesive to insulation by notched-trowel method in a manner that results in

coating the entire surface of sheathing with adhesive once insulation is adhered to substrate. Apply adhesive to a thickness of not less than **1/4 inch (6.4 mm)** for factory mixed and not less than **3/8 inch (10 mm)** for field mixed, measured from surface of insulation before placement.

2. Concrete or Masonry: Apply adhesive by ribbon-and-dab method.
3. Press and slide insulation into place. Apply pressure over entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
4. Allow adhered insulation to remain undisturbed for not less than 24 hours, before[**installing mechanical fasteners,**] beginning rasping and sanding insulation or before applying base coat and reinforcing mesh.
5. Mechanically attach insulation to substrate. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:

    a. Steel Framing: **5/16 inch (8 mm)**.
    b. Wood Framing: **1 inch (25 mm)**.
    c. Concrete and Masonry: **1 inch (25 mm)**.

6. Apply insulation over dry substrates in courses, with long edges of boards oriented horizontally.
7. Begin first course of insulation from a level base line and work upward.
8. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
9. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints, so no piece of insulation is less than **12 inches (300 mm)** wide or **6 inches (150 mm)** high. Offset joints not less than **6 inches (150 mm)** from corners of window and door openings[**and not less than 4 inches (100 mm) from aesthetic reveals**].

    a. Adhesive Attachment: Offset joints of insulation not less than **6 inches (150 mm)** from horizontal and **4 inches (100 mm)** from vertical joints in sheathing.
    b. Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.

10. Interlock ends at internal and external corners.
11. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than **1/16 inch (1.6 mm)** occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
12. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
13. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than [**1/32 inch (0.8 mm)**][**1/16 inch (1.6 mm)**] from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than **1/16 inch (1.6 mm)**. Prevent airborne dispersal and immediately collect insulation raspings or sandings.
14. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than **3/4 inch (19 mm)**.
15. Install foam buildouts and attach to structural substrate by [**adhesive**][**mechanical fastening**][**adhesive and mechanical fastening**].
16. Interrupt insulation for expansion joints where indicated.
17. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
18. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between casing beads and between perimeter casing beads and adjoining surfaces of width indicated.
19. Before installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than **2-1/2 inches (64**

mm) over front and back face unless otherwise indicated on Drawings.

20. Treat exposed edges of insulation as follows:

    a. Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
    b. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
    c. At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.

21. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and EIFS lamina.

B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:

1. At expansion joints in substrates behind EIFS.
2. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
3. At floor lines in multilevel wood-framed construction.
4. Where wall height or building shape changes.
5. Where EIFS manufacturer requires joints in long continuous elevations.
6. Where panels abut one another.

3.7 APPLICATION OF BASE COAT

A. Water-Resistant Base Coat: Apply full-thickness coverage [**to exposed insulation and**] to exposed surfaces of [**sloped shapes**][**window sills**][**parapets**][**foam buildouts**] and to other surfaces indicated on Drawings.

B. Base Coat: Apply full coverage to exposed insulation [**and foam buildouts**] with not less than [**1/16-inch (1.6-mm)**] dry-coat thickness.

C. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners, overlapped not less than **2-1/2 inches (64 mm)** or otherwise treated at joints to comply with ASTM C1397. Do not lap reinforcing mesh within **8 inches (200 mm)** of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are invisible.

D. Double-Layer Reinforcing-Mesh Application: Where indicated or required, apply second base coat and second layer of reinforcing mesh, overlapped not less than **2-1/2 inches (64 mm)** or otherwise treated at joints to comply with ASTM C1397 in same manner as first application. Do not apply until first base coat has cured.

E. Additional Reinforcing Mesh: Apply strip-reinforcing mesh around openings, extending **4 inches (100 mm)** beyond perimeter. Apply additional **9-by-12-inch (230-by-300-mm)** strip-reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply **8-inch- (200-mm-)** wide, strip-reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than **4 inches (100 mm)** on each side of corners.

1. At aesthetic reveals, apply strip-reinforcing mesh not less than **8 inches (200 mm)** wide.
2. Embed strip-reinforcing mesh in base coat before applying first layer of reinforcing mesh.

F. Foam Buildouts: Fully embed reinforcing mesh in base coat.

G. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application, except without reinforcing mesh. Do not apply until first base coat has cured.

3.8 APPLICATION OF FINISH COAT

A. Primer: Apply over dry base coat.

B. Finish Coat: Apply full-thickness coverage over dry [**primed**]base coat, maintaining a wet edge at all times for uniform appearance, to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.

1. Embed aggregate in finish coat to produce a uniform applied-aggregate finish of color and texture matching approved sample.

C. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

3.9 INSTALLATION OF PREFABRICATED PANELS

A. General: Install panels according to Shop Drawings. Install [**by welding metal framing to structural-steel frame**][**by welding to steel-weld plates anchored in concrete**] to comply with requirements in Section 054000 "Cold-Formed Metal Framing" unless otherwise indicated.

1. Lift panels only as indicated on Shop Drawings.
2. Do not warp or stress panels by forcing alignment.
3. Adjust connections to align panels and maintain correct and uniform joint widths.
4. Install bracing as panels are erected. Weld securely to panel framing and to structure.

B. Erection Tolerances: Install panels level, plumb, and true to line with no variation in plane or alignment exceeding **1/16 inch (1.6 mm)** and no variation in position exceeding **1/8 inch (3 mm)**.

1. Maintain clearance between panels required for installing joint sealants.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform the following special inspections:

1. As stipulated in Ch. 17 of the IBC.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. EIFS Tests and Inspections: In accordance with ASTM E2568.

D. Prefabricated Panels: Test and inspect field welds.

E. EIFS will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

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SECTION 07 25 00 00 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Weather barrier types.
2. Accessory materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show details of [**building paper**][**building wrap**][**drainage wrap**] at terminations, openings, and penetrations. Show details of flexible flashing applications.

C. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.
10. Health Product Declaration (HPD): For each product.
11. Health Product Declaration (HPD): Provide HPD.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For weather barrier, by a qualified testing agency.

B. Product Test Reports: For weather barrier, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

C. Evaluation Reports: Report Type: [**Water-resistive barrier**][**and**][**flexible flashing**], from ICC-ES.

D. Source Quality Control Reports: For weather barriers.

E. Field Quality Control Reports: For weather barriers.

F. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**], as directed by the Owner.

1.5 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**to set quality standards for fabrication and installation**][**and**][**for preconstruction testing**], as directed by the Owner.

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver weather barrier materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit weather barrier materials to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.8 WARRANTY

A. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WEATHER BARRIER TYPES

A. Building Paper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]

2. Building Paper Materials: [**Type I, ASTM D226/D226M, (No. 15 asphalt-saturated organic felt),**

unperforated][**Type II, ASTM D226/D226M, (No. 30 asphalt-saturated organic felt), unperforated**][**Grade D, water-vapor-permeable, asphalt-saturated kraft building paper that complies with ICC-ES AC38**][**; except with water-resistance rating of not less than 1 hour**].

B. Building Wrap: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha ProTech**]
   b. [**Barricade Building Products**]
   c. [**Benjamin Obdyke Incorporated**]
   d. [**Dorken Systems Inc.**]
   e. [**DuPont de Nemours, Inc.**]
   f. [**Kingspan Insulation LLC**]
   g. [**PrimeSource Building Products, Inc.**]
   h. [**Typar; a Magnera Corporation brand**]

2. Building Wrap Materials: [**Type I, ASTM E2556/E2556M**][**Type I, ASTM E1677**][**Type II, ASTM E2556/E2556M**][**ICC-ES AC38**].
3. Composition Type: [**Perforated woven polyolefin**][**Polypropylene woven fabric with coating**][**Nonperforated, nonwoven polyolefin**].
4. Water-Vapor Permeance: Minimum [**75 perms (4300 ng/Pa x s x sq. m)**][**20 perms (1150 ng/Pa x s x sq. m)**][**11 perms (629 ng/Pa x s x sq. m)**][**8 perms (460 ng/Pa x s x sq. m)**] in accordance with ASTM E96/E96M, Desiccant Method (Procedure A).
5. Air Permeance: Not more than [**0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.005 L/s x sq. m at 75 Pa)**][**0.004 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.02 L/s x sq. m at 75 Pa)**] when tested in accordance with ASTM E2178.
6. Allowable UV Exposure Time: Not more than [**120**][**180**][**270**] days.
7. Flame Propagation Test: Materials and construction to be as tested in accordance with NFPA 285.

C. Drainage Wrap: Dimensional water-resistive barrier that also creates a drainage plane; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; and acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha ProTech**]
   b. [**Barricade Building Products**]
   c. [**Benjamin Obdyke Incorporated**]
   d. [**DuPont de Nemours, Inc.**]
   e. [**Kingspan Insulation LLC**]

2. Drainage Wrap Materials: [**Type I, ASTM E2556/E2556M**][**Type I, ASTM E1677**][**Type II, ASTM E2556/E2556M**][**ICC-ES AC38**].
3. Composition Type: [**Nonperforated**][**Nonwoven polyolefin with nondirectional drainage**

pattern].

4. Water-Vapor Permeance: Minimum [**55 perms (3147 ng/Pa x s x sq. m)**][**35 perms (2002 ng/Pa x s x sq. m)**][**15 perms (858 ng/Pa x s x sq. m)**][**5 perms (286 ng/Pa x s x sq. m)**] in accordance with ASTM E96/E96M, Desiccant Method (Procedure A).
5. Air Permeance: Maximum [**0.004 cfm/sq. ft. at 0.3 inch wg (0.02 L/s x sq. m at 75 Pa)**] when tested in accordance with ASTM E2178.
6. Drainage: Not less than [**90**][**95**][**98**] percent when tested in accordance with ASTM E2273.
7. Allowable UV Exposure Time: Not more than [**120**][**180**] days.

2.2 ACCESSORY MATERIALS

A. Requirement: Provide primers, fasteners, seam tapes, flashing, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by weather barrier manufacturer to produce a complete weather barrier assembly and that are compatible with primary weather barrier material and adjacent construction to which they may seal.

B. Drainage Mat: Free-draining, polymer-strand mesh sheets or strips materials to provide a continuous open space behind exterior cladding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Building Products Inc.**]
   b. [**CavClear; a division of Archovations, Inc.**]
   c. [**Dorken Systems Inc.**]
   d. [**DuPont de Nemours, Inc.**]
   e. [**Keene Building Products**]
   f. [**Mortar Net Solutions**]
   g. [**Stuc-O-Flex International, Inc.**]
   h. [**Wire-Bond**]

2. Drainage Mat Size: Thickness not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**] and installed to full height of cavity, [**with additional strips 4 inches (102 mm) high above flashing locations and thick enough to fill entire depth of cavity**] to maintain a continuous open space behind exterior cladding.
3. Location: [**Underneath siding**][**Behind portland cement plaster**][**Behind adhered masonry veneer**][**As indicated on Drawings**].

C. Drainage Accessories:

1. Component: [**Furring strips**] installed between water-resistive barrier and exterior cladding to create a continuous open space behind exterior cladding.

PART 3 - EXECUTION

3.1 INSTALLATION OF WEATHER BARRIERS

A. Weather Barriers:

1. Building Paper: Comply with manufacturer's written instructions and warranty requirements.
2. Building Wrap or Drainage Wrap: Comply with manufacturer's written instructions and warranty requirements.
3. Drainage Material: Comply with manufacturer's written instructions.

B. Install weather barrier accessories for a complete installation with weather barriers in accordance with manufacturer's written instructions.

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SECTION 07 26 00 00 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.
3. Fire-retardant, reinforced-polyethylene vapor retarders.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.
2. Section 072100 "Thermal Insulation" for vapor retarders integral with insulation products.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.
3. Fire-retardant, reinforced-polyethylene vapor retarders.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D4397, [**6-mil- (0.15-mm-)**][**10-mil- (0.25-mm-)**] thick sheet, with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

2.2 REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than [**20 lb/1000 sq. ft. (9 kg/100 sq. m)**], with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ISI Building Products**]
b. [**Reef Industries, Inc.**]
c. [**Viaflex**]
d. [**W. R. Meadows, Inc**]

2.3 FIRE-RETARDANT, REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than [**20 lb/1000 sq. ft. (9 kg/100 sq. m)**], with maximum permeance rating of **0.1 perm (5.7 ng/Pa x s x sq. m)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]
b. [**Viaflex**]

2. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of [**75 and 200**], respectively, per ASTM E84.

2.4 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Place vapor retarders on side of construction indicated on Drawings.

B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated

substrates, including those filled with loose-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 INSTALLATION OF VAPOR RETARDERS IN CRAWL SPACES

A. Install vapor retarders over prepared grade. Lap joints a minimum of **12 inches (305 mm)** and seal with manufacturer's recommended tape. Install second layer over pathways to equipment.

B. Extend vapor retarder over footings and seal to foundation wall or grade beam with manufacturer's recommended tape.

1. Extend vapor retarder vertically minimum [**16 inches (406 mm)**][**24 inches (610 mm)**] above top of footing.

C. Seal around penetrations such as utilities and columns in order to create a monolithic, airtight membrane at grade surface, perimeter, and all vertical penetrations.

3.4 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

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Task	Specification	Specification Description
07 26 00 00	07 25 00 00	Weather Barriers
07 26 13 00	06 10 00 00	Rough Carpentry
07 26 13 00	07 25 00 00	Weather Barriers
07 26 13 00	07 26 00 00	Vapor Retarders
07 27 00 00	07 25 00 00	Weather Barriers
07 27 23 00	07 25 00 00	Weather Barriers

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SECTION 07 31 13 00 - ASPHALT SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber-reinforced asphalt shingles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof ventilators.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Asphalt shingles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.
5. Asphalt roofing cement.
6. Elastomeric flashing sealant.

B. Shop Drawings: For sheet metal flashing and trim.

C. Samples: For each exposed product and for each color and blend specified, in sizes indicated.

1. Asphalt Shingles: Full size.
2. Ridge and Hip Cap Shingles: Full size.
3. Ridge Vent: **12-inch- (305-mm-)** long Sample.

4. Exposed Valley Lining: **12 inches (305 mm)** square.

D. Samples for Initial Selection:

1. For each type of asphalt shingle indicated.
2. For each type of accessory involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Asphalt Shingles: Full size.
2. Ridge and Hip Cap Shingles: Full size.
3. Ridge Vent: **12-inch- (305-mm-)** long Sample.
4. Exposed Valley Lining: **12 inches (305 mm)** square.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For roofing system Installer.

B. Product Test Reports: For each type of asphalt shingle and underlayment product indicated, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For asphalt shingles to include in maintenance manuals.

B. Materials warranties.

C. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Asphalt Shingles: [**100 sq. ft. (9.3 sq. m)**] of each type and in each color and blend, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified asphalt shingle system**

installers][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified asphalt shingle system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of asphalt shingles, including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 96 inches (2438 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

B. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double-stack rolls.

C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.

D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace asphalt shingles that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Manufacturing defects.

2. Materials Warranty Period: [**25**][**30**][**35**][**40**][**50**] years from date of Substantial Completion,

prorated, with first [**three**][**five**][**seven**][**10**][**15**][**20**] years nonprorated.

3. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds of up to [**60 mph (27 m/s)**][**70 mph (31 m/s)**][**80 mph (36 m/s)**][**100 mph (45 m/s)**][**110 mph (49 m/s)**][**130 mph (58 m/s)**][**135 mph (60 m/s)**] for [**five**][**15**] years from date of Substantial Completion.
4. Algae-Resistance Warranty Period: Asphalt shingles will not discolor for [**five**][**10**][**15**][**20**][**25**] years from date of Substantial Completion.
5. Workmanship Warranty Period: [**Two**][**20**][**25**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of asphalt shingle roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Wind Resistance: Provide asphalt shingles that comply with requirements of ASTM D3161/D3161M, Class F, and with ASTM D7158/D7158M, Class H.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

A. Laminated-Strip Asphalt Shingles: ASTM D3462/D3462M, laminated, multi-ply overlay construction; glass-fiber reinforced, mineral-granule surfaced, and self-sealing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Malarkey Roofing Products**]
g. [**Owens Corning**]
h. [**PABCO Roofing Products**]
i. [**Tamko Building Products LLC**]

2. Butt Edge: [**Straight**][**Notched**][**Crenelated**] cut.
3. Strip Size: [**Manufacturer's standard**].
4. Algae Resistance: Granules resist algae discoloration.
5. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Impact-Resistant, Laminated-Strip Asphalt Shingles: ASTM D3462/D3462M, laminated, multi-ply overlay construction; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with impact resistance complying with UL 2218, Class 4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**Malarkey Roofing Products**]

2. Butt Edge: [**Straight**][**Notched**][**Crenelated**] cut.
3. Strip Size: [**Manufacturer's standard**].
4. Algae Resistance: Granules resist algae discoloration.
5. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Three-Tab-Strip Asphalt Shingles: ASTM D3462/D3462M; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with tabs regularly spaced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Building Products of Canada Corp.**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Malarkey Roofing Products**]
g. [**Owens Corning**]
h. [**PABCO Roofing Products**]
i. [**Tamko Building Products LLC**]

2. Strip Size: [**Manufacturer's standard**].
3. Algae Resistance: Granules resist algae discoloration.
4. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Impact-Resistant, Three-Tab-Strip Asphalt Shingles: ASTM D3462/D3462M; glass-fiber reinforced, mineral-granule surfaced, and self-sealing; with tabs regularly spaced and with impact resistance complying with UL 2218, Class 4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]

2. Strip Size: [**Manufacturer's standard**].
3. Algae Resistance: Granules resist algae discoloration.
4. Color and Blends: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner..

E. Hip and Ridge Shingles: [**Manufacturer's standard units to match asphalt shingles**][**Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm)**].

2.4 UNDERLAYMENT MATERIALS

A. Organic Felt: Asphalt-saturated organic felts, nonperforated and complying with the following:

1. ASTM D226/D226M: [**Type I**][**Type II**].
2. ASTM D4869/D4869M: [**Type I**][**Type II**][**Type III**][**Type IV**].

B. Glass-Reinforced Felt: ASTM D6757/D6757M, asphalt-saturated, glass-reinforced organic felt or inorganic fiber-based felt.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**GAF**]
d. [**Owens Corning**]

C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALCO Products LLC**]
   b. [**Atlas Polyiso Roof and Wall Insulation**]
   c. [**Building Products of Canada Corp.**]
   d. [**CertainTeed; SAINT-GOBAIN**]
   e. [**Drexel Metals Corp.**]
   f. [**G.A.P. Roofing, Inc.**]
   g. [**GAF**]
   h. [**GCP Applied Technologies Inc.**]
   i. [**IKO Industries Inc.**]
   j. [**Malarkey Roofing Products**]
   k. [**Owens Corning**]
   l. [**PrimeSource Building Products, Inc.**]
   m. [**SDP Advanced Polymer Products Inc.**]
   n. [**SystemComponents Corporation**]
   o. [**Tamko Building Products LLC**]

D. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALCO Products LLC**]
   b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
   d. [**CertainTeed; SAINT-GOBAIN**]
   e. [**Drexel Metals Corp.**]
   f. [**GAF**]
   g. [**GCP Applied Technologies Inc.**]
   h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   i. [**IKO Industries Inc.**]
   j. [**Malarkey Roofing Products**]
   k. [**Owens Corning**]
   l. [**SDP Advanced Polymer Products Inc.**]
   m. [**Tamko Building Products LLC**]

2. Sheet Thickness: Minimum [**55 mils (1.4 mm)**][**50 mils (1.3 mm)**][**40 mils (1.0 mm)**].
3. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

E. Granular-Surfaced Valley Lining: [**ASTM D6380/D6380M, Class M, organic**][**ASTM D3909/D3909M, mineral-granular-surfaced, glass**]-felt-based, asphalt roll roofing; **36 inches (914 mm)** wide.

2.5 RIDGE VENTS

A. Rigid Ridge Vent: Manufacturer's standard, rigid-section, high-density, UV-stabilized plastic ridge vent for use under ridge shingles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Cor-A-Vent, Inc**]
e. [**GAF**]
f. [**Lomanco, Inc**]
g. [**Owens Corning**]
h. [**Tamko Building Products LLC**]
i. [**Tapco International Corporation; Mid-America Components**]

2. Features:

a. Nonwoven geotextile filter strips.
b. External deflector baffles.

B. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter[**bonded to a nonwoven, nonwicking, geotextile fabric cover**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**GAF**]
d. [**Owens Corning**]
e. [**Tamko Building Products LLC**]

2.6 SHEET METAL FLASHING AND TRIM

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange a minimum of [**4 inches (102 mm)**][**5 inches (127**

mm)] over and [4 inches (102 mm)] beyond each side of downslope asphalt shingles and [6 inches (152 mm)] up the vertical surface.

2. Step Flashings: Fabricate with a headlap of 2 inches (51 mm) and a minimum extension of [4 inches (102 mm)][5 inches (127 mm)] over the underlying asphalt shingle and up the vertical surface.
3. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [18 inches (457 mm)][24 inches (610 mm)] beneath upslope asphalt shingles and [6 inches (152 mm)] beyond each side of [**chimney**][**skylight**] and [6 inches (152 mm)] above the roof plane.
4. Counterflashings: Fabricate to cover [4 inches (102 mm)] of base flashing measured vertically; and in lengths required so that no step exceeds [8 inches (203 mm)] and overall length is no more than [10 feet (3 m)].

    a. Provide metal [**reglets**][**receivers**] for installation.

5. Open-Valley Flashings: Fabricate from metal sheet not less than [24 inches (610 mm)] wide in lengths not exceeding [10 feet (3 m)], with [1-inch- (25-mm-)] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [11 inches (279 mm)].

    a. Hem flange edges for fastening with metal cleats.
    b. Add stiffening ribs in flashings to promote drainage.

6. Drip Edges: Fabricate in lengths not exceeding [10 feet (3 m)] with minimum 2-inch (51-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
7. Vent-Pipe Flashings: ASTM B749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof, and extending at least 4 inches (102 mm) from pipe onto roof.

2.7 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Elastomeric Flashing Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant; of class and use classifications required to seal joints and remain watertight; recommended in writing by manufacturer for installation of flashing systems.

C. Roofing Nails: ASTM F1667, aluminum, stainless steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, sharp-pointed, with a 3/8- to 7/16-inch- (10- to 11-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through sheathing less than 3/4 inch (19 mm) thick.

    1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

D. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, 1-inch- (25-mm-) minimum diameter.

    1. Provide with minimum 0.0134-inch- (0.34-mm-) thick metal cap, 0.010-inch- (0.25-mm-) thick power-driven metal cap, or 0.035-inch- (0.89-mm-) thick plastic cap; and with minimum 0.083-inch- (2.11-mm-) thick ring shank or 0.091-inch- (2.31-mm-) thick smooth shank of length to penetrate at least 3/4 inch (19 mm) into roof sheathing or to penetrate through roof sheathing less than 3/4 inch (19 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through asphalt shingles.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with asphalt shingle and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

B. Organic Felt: Install on roof deck parallel with and starting at eaves and fasten with [**underlayment**][**roofing**] nails.

1. Single-Layer Installation:

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **4 inches (102 mm)**. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
d. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

3. Install felt underlayment [**on roof deck not covered**][**over areas protected**] by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

a. Lap sides of felt over self-adhering sheet not less than **4 inches (102 mm)** in direction that sheds water.

b. Lap ends of felt not less than **6 inches (152 mm)** over self-adhering sheet.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Synthetic Underlayment:

1. Install on roof deck parallel with and starting at the eaves.

   a. Lap sides and ends as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
   b. Stagger end laps between succeeding courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
   c. Fasten with underlayment nails in accordance with manufacturer's written instructions.
   d. Cover underlayment within period recommended in writing by manufacturer.

2. Install in single layer on roofs sloped at 4:12 and greater.
3. Install in double layer on roofs sloped at less than 4:12.
4. Install synthetic underlayment [**on roof deck not covered**][**over areas protected**] by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

   a. Lap sides of underlayment over self-adhering sheet not less than **4 inches (102 mm)** in direction to shed water.
   b. Lap ends of underlayment not less than **6 inches (152 mm)** over self-adhering sheet.

5. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
6. Terminate synthetic underlayment [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

D. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free, on roof deck.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.

   a. Lap sides not less than **4 inches (102 mm)**.
   b. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
   c. Roll laps with roller.

3. Prime concrete, masonry, and metal surfaces to receive self-adhering sheet.
4. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
5. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
6. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
7. Hips: Extend [**18 inches (457 mm)**] on each side.
8. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
9. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
10. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements not less

than [**4 inches (102 mm)**].
11. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.
12. Cover underlayment within seven days.

E. Granular-Surfaced, Concealed Valley Lining: For [**woven**][**closed-cut**] valleys. Comply with recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."

1. Lap roof-deck underlayment over valley lining at least **6 inches (152 mm)**.
2. Install a **36-inch- (914-mm-)** wide strip of granular-surfaced valley lining, with granular-surface face up, centered in valley and fastened to roof deck.
3. Lap ends of strips at least **12 inches (305 mm)** in direction to shed water, and seal with asphalt roofing cement.
4. Fasten to roof deck.

F. Metal-Flashed, Open-Valley Underlayment: Install two layers of minimum **36-inch- (914-mm-)** wide underlayment centered in valley.

1. Use same underlayment as installed on field of roof.
2. Stagger end laps between layers at least **72 inches (1829 mm)**.
3. Lap ends of each layer at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
4. Fasten each layer to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
5. Lap roof-deck underlayment over first layer of valley underlayment at least **6 inches (152 mm)**.

G. Granular-Surfaced, Open-Valley Lining: Before installing valley lining, install **36-inch- (914-mm-)** wide felt underlayment centered in valley. Fasten to roof deck with [**underlayment**][**roofing**] nails.

1. Lap roof-deck felt underlayment over valley felt underlayment at least **6 inches (152 mm)**.
2. Install an **18-inch- (457-mm-)** wide strip of valley lining centered in valley, with granular-surface face down.
3. Install a second **36-inch- (914-mm-)** wide strip of valley lining centered in valley, with granular-surface face up.
4. Lap ends of each strip at least **12 inches (305 mm)** in direction to shed water, and seal with asphalt roofing cement.
5. Stagger end laps between succeeding strips at least **72 inches (1829 mm)**.
6. Fasten each strip to roof deck.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install metal flashings and trim to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with recommendations in[**ARMA's "Asphalt Roofing Residential Manual - Design and Application Methods" and**] NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
2. Bed flanges of metal flashings using asphalt roofing cement or elastomeric flashing sealant.

B. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.

C. Step Flashings: Install with a headlap of **2 inches (51 mm)** and extend over underlying shingle and up the vertical face.

1. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying shingle.
2. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements extending concealed flange beneath upslope asphalt shingles and beyond each side.

E. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

F. Open-Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced [**8 inches (203 mm)**][**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
2. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to underlying self-adhering sheet, polymer-modified bitumen sheet.

a. Place strips parallel to and over flanges so that they will be just concealed by installed shingles.

3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

G. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

H. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

I. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

3.4 INSTALLATION OF GLASS-FIBER-REINFORCED ASPHALT SHINGLES

A. Install asphalt shingles in accordance with manufacturer's written instructions and recommendations in[**ARMA's "Asphalt Roofing Residential Manual - Design and Application Methods" and**] NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."

B. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip [**with tabs removed**][**at least 7 inches (178 mm) wide**] with self-sealing strip face up at roof edge.

1. Extend asphalt shingles [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] over fasciae at eaves and rakes.
2. Install starter strip along rake edge.

C. Install first and remaining courses of laminated asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.

D. Install first and remaining courses of three-tab-strip asphalt shingles stair-stepping diagonally across roof deck with [**4-inch (102-mm)**][**5-inch (127-mm)**][**6-inch (152-mm)**][**half-tab**][**one-third-tab**][**manufacturer's recommended**] offset pattern at succeeding courses, maintaining uniform exposure.

E. Fasten asphalt shingle strips with a minimum of [**four**][**five**][**six**] roofing nails, but not less than the

number indicated in manufacturer's written instructions for roof slope and design wind speed indicated on Drawings and for warranty requirements specified in this Section.

1. Locate fasteners in accordance with manufacturer's written instructions.
2. Where roof slope exceeds 18:12, hand seal self-sealing asphalt shingles to improve the shingles' positive bond by applying asphalt roofing cement spots between course overlaps after nailing the upper course.
3. Where roof slope is less than 4:12, hand seal self-sealing asphalt shingles to improve the shingles' positive bond by applying asphalt roofing cement spots between course overlaps after nailing the upper course.
4. When ambient temperature during installation is below [**50 deg F (10 deg C)**], hand seal self-sealing asphalt shingles by applying asphalt roofing cement spots between course overlaps after nailing the upper course.

F. Woven Valleys: Extend succeeding asphalt shingle courses from both sides of valley [**12 inches (305 mm)**] beyond center of valley, weaving intersecting shingle-strip courses over each other. Use one-piece shingle strips without joints in valley.

1. Do not nail asphalt shingles within **6 inches (152 mm)** of valley center.

G. Closed-Cut Valleys: Extend asphalt shingle strips from one side of valley [**12 inches (305 mm)**] beyond center of valley.

1. Use one-piece shingle strips without joints in valley.
2. Fasten with extra nail in upper end of shingle. Install asphalt shingle courses from other side of valley and cut back to a straight line **2 inches (51 mm)** short of valley centerline.
3. Trim upper concealed corners of cut-back shingle strips.
4. Do not nail asphalt shingles within **6 inches (152 mm)** of valley center.
5. Set trimmed, concealed-corner asphalt shingles in a **3-inch- (76-mm-)** wide bed of asphalt roofing cement.

H. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips.

1. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.
2. Extend shingle a minimum of **4 inches (102 mm)** over valley metal.
3. Set valley edge of asphalt shingles in a **3-inch- (76-mm-)** wide bed of asphalt roofing cement.
4. Do not nail asphalt shingles to metal open-valley flashings.

I. Ridge Vents: Install continuous ridge vents over asphalt shingles in accordance with manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.

J. Hip and Ridge Shingles: Maintain same exposure of cap shingles as roofing-shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds.

1. Fasten with roofing nails of sufficient length to penetrate sheathing.
2. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

3.5 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System, Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of the alterations, but only to the extent the alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting the alterations, has notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent the change affects the Work covered by this Warranty.
6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect the Work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 31 13 00

Task	Specification	Specification Description
07 31 13 13	07 31 13 00	Asphalt Shingles

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SECTION 07 31 16 00 - METAL SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal shingles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 074113.13 "Formed Metal Roof Panels" for sheet metal roofing panels that are installed as single panels extending from eave to ridge.
2. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each of the following:

a. Metal shingles.
b. Underlayment materials.
c. Ridge vents.
d. Bituminous coating.
e. Asphalt roofing cement.
f. Sealant.

B. Shop Drawings: For metal shingles. Include roof plans; sections at hips, gables, ridges, valleys, and

eaves; details of metal shingles and joint patterns, flashing, trim, accessories, and attachments to other Work.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.

D. Samples for Initial Selection:

1. For each type of metal shingle.
2. For each type of accessory involving color selection.

E. Samples for Verification: Full-size Samples of each type and finish of metal shingle indicated.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For metal shingles, for tests performed by a qualified testing agency.

B. Research Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**], indicating that product is suitable for intended use under applicable building codes for the following:

1. Polymer-modified bitumen sheet underlayment.
2. Synthetic underlayment.

C. Qualification Statements: For roofing system Installer.

D. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal shingles to include in maintenance manuals.

B. Materials warranties.

C. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Metal Shingles: [**100 sq. ft. (9.3 sq. m)**] of exposed area, in each type and color, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified metal shingle system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified metal shingle system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of metal shingles, including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 96 inches (2438 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store metal shingle materials in a dry, well-ventilated location protected from weather and moisture in accordance with manufacturer's written instructions. Do not allow metal shingles to contact with other materials that might cause staining, denting, or other surface damage. Store metal shingle materials away from uncured and wet concrete and masonry.

1. Retain strippable protective covering on metal shingles during installation.

B. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

1. Store on end, on pallets or other raised surfaces.
2. Do not double-stack rolls.

C. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.

D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace metal shingles and accessories that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including wind uplift.
b. Water penetration[**and hail perforation**].
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. High-Performance Organic Coating: Deterioration of fluoropolymer finish including, but not limited to, the following:

1) Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
2) Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Metal Shingle Warranty Period: [**15**][**25**][**50**] years from date of Substantial Completion.
3. High-Performance Organic Coating Warranty Period: [**10**][**20**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of metal shingle roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide metal shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by ULSE or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Wind-Uplift Resistance: Provide metal shingle assemblies that comply with the following wind-uplift requirements:

1. Class: [**15**][**30**][**60**][**90**] when tested in accordance with UL 580.
2. Uplift Resistance: [**75 lbf/sq. ft. (3.6 kPa)**][**120 lbf/sq. ft. (5.75 kPa)**][**165 lbf/sq. ft. (7.9 kPa)**] when tested in accordance with UL 1897.

C. Impact Resistance: [**Class 3**][**Class 4**] when tested in accordance with UL 2218.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 METAL SHINGLES

A. Aluminum Shingle Panels: Factory-formed, interlocking stamped units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Classic Metal Roofing Systems; Isaiah Industries, Inc.**]
   c. [**Custom-Bilt Metals Inc.**]

2. Material: Formed aluminum, [**0.019 inch (0.48 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**] thick.
3. Shape: [**Shakes**][**Shingles**][**Spanish tiles**][**Flat tiles**][**Scalloped tiles**].
4. Panel Size: [**24 by 12 inches (610 by 305 mm)**][**39-3/4 by 18-1/2 inches (1010 by 470 mm)**][**48 by 12 inches (1219 by 305 mm)**].
5. Finish: [**High-performance organic coating**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Aluminum, Individual Shingles: Factory-formed, interlocking units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Reinke Shakes; Division of Jame Kari LLC**]
   c. [**Zappone Manufacturing, LLC**]

2. Material: Formed aluminum, [**0.020 inch (0.51 mm)**][**0.032 inch (0.81 mm)**] thick.
3. Shape: [**Rectangular**][**Diamond**].
4. Exposure: [**12 by 8 inches (305 by 203 mm)**][**13-1/2 by 13-1/2 inches (343 by 343 mm)**][**14-1/2 by 8-1/8 inches (368 by 206 mm)**].
5. Features: [**Polystyrene backing**].
6. Finish: [**High-performance organic coating**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Steel Shingle Panels: Factory-formed, interlocking stamped units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allmet Roofing Products; a division of Metals USA Building Products Canada Inc.; Boral**]
   b. [**ATAS International, Inc.**]
   c. [**Decra Roofing Systems, Inc.**]
   d. [**Gerard Roofing Technologies; Boral Steel Stone Coated Roofing**]
   e. [**Metro Roof Products; Boral Steel Stone Coated Roofing**]
   f. [**Tamko Building Products LLC**]

2. Material: [**Aluminum-zinc alloy coated**][**Zinc-coated (galvanized)**] steel sheet, minimum nominal [**0.0162 inch (0.41 mm)**][**0.017 inch (0.43 mm)**] thickness.
3. Shape: [**Shakes**][**Shingles**][**Spanish tiles**][**Flat tiles**][**Scalloped tiles**].
4. Exposure: [**36 by 12 inches (914 by 305 mm)**][**39-3/8 by 11-7/8 inches (1000 by 302 mm)**].
5. Finish: [**Mill, acrylic-coated**][**Granular coating**][**High-performance organic coating**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Steel Individual Shingles: Factory-formed, interlocking rectangular units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Berridge Manufacturing Company**]

2. Material: Aluminum-zinc alloy coated steel sheet, nominal [**0.028 inch (0.71 mm) thick**].
3. Shape: [**Fish scale**][**Victorian**][**Classic stamped**].
4. Exposure: [**8-1/2 by 11-1/2 inches (216 by 392 mm)**][**9 by 12 inches (229 by 305 mm)**].
5. Finish: [**Mill, acrylic coated**][**High-performance organic coating**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Copper, Individual Shingles: Factory-formed, interlocking units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Reinke Shakes; Division of Jame Kari LLC**]
   c. [**Zappone Manufacturing, LLC**]

2. Material: Copper sheet, minimum [**12 oz./sq. ft. (0.41 mm thick)**][**16 oz./sq. ft. (0.55 mm thick)**].
3. Shape: [**Rectangular**][**Diamond**].
4. Exposure: [**12 by 8 inches (305 by 203 mm)**][**13-1/2 by 13-1/2 inches (343 by 343 mm)**][**14-1/2 by 8-1/8 inches (368 by 206 mm)**].
5. Features: [**Polystyrene backing**].
6. Finish: [**Mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

F. Zinc, Individual Shingles: Factory-formed, interlocking units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Rheinzink America**]
   c. [**VM Building Solutions USA**]

2. Material: Zinc-alloy sheet, minimum [**0.026 inch (0.65 mm)**][**0.028 inch (0.70 mm)**][**0.031 inch (0.80 mm)**] thick.
3. Shape: [**Rectangular**][**Diamond**].
4. Exposure: [**13-1/2 by 13-1/2 inches (343 by 343 mm)**][**16-1/16 by 22-1/16 inches (408 by 560 mm)**].
5. Features: [**Polystyrene backing**].
6. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

G. Finish Protection: Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.4 SHEET METAL MATERIALS

A. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: Uncoated aluminum sheet.
2. High-Performance Organic Coating (Coil-Coated Finishes): Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Two-Coat Fluoropolymer: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
   b. Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

3. Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat and with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

B. Aluminum-Zinc Alloy Coated Steel Sheet: ASTM A792/A792M, **Class AZ50 coating designation, Grade 37 (Class AZM150 coating designation, Grade 255)**; structural quality.

1. Mill Finish: Satin-finish, aluminum-zinc alloy coated steel sheet without additional coating.
2. Granular-Coating Finish: Entire upper surface of shingle, including flange edges, coated with

ceramic-colored quartz granules or crushed stone chips bonded to shingle with a resin adhesive and sealed with a clear overglaze.

C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating designation; structural quality.

1. Mill Finish: Zinc-coated (galvanized) steel sheet [**without additional coating**][**with manufacturer's standard mill-phosphatized finish**].
2. High-Performance Organic Coating (Coil-Coated Finishes): Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
   b. Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

D. Copper Sheet: ASTM B370; Temper H00, cold rolled unless Temper 060 is required for forming.

1. Mill Finish: Nonpatinated and exposed.
2. Pre-Patinated Finish: Pre-patinated in accordance with ASTM B882.

E. Zinc-Alloy Sheet: [**Alloy of 99.995 percent pure electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)**][**Zinc alloy consisting of 99 percent pure zinc with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum**].

1. Back Coating: Manufacturer's standard factory-applied, flexible, protective back coating.
2. Bright-Rolled Finish: Uncoated, bright-rolled zinc-alloy sheet.
3. Preweathered Finish: Factory-applied preweathering to uniform color.

2.5 UNDERLAYMENT MATERIALS

A. Organic Felt: Asphalt-saturated organic felts, nonperforated and complying with the following.

1. ASTM D226/D226M: [**Type I**][**Type II**].
2. ASTM D4869/D4869M: [**Type I**][**Type II**][**Type III**][**Type IV**].

B. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended in writing by manufacturer for use under metal shingles; and evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Drexel Metals Corp.**]
   c. [**G.A.P. Roofing, Inc.**]
   d. [**GAF**]

e. [**Malarkey Roofing Products**]
f. [**Owens Corning**]
g. [**SDP Advanced Polymer Products Inc.**]
h. [**SystemComponents Corporation**]
i. [**Tamko Building Products LLC**]

C. Polymer-Modified Bitumen Sheet, Mechanically Fastened: Styrene-butadiene-styrene- (SBS) modified asphalt, glass-fiber-mat-reinforced sheet; in minimum thickness as recommended in writing by manufacturer; and acceptable to authorities having jurisdiction for use as underlayment in metal steep-slope roofing systems; designed for mechanical fastening; and with manufacturer's standard non-abrasive, slip-resistant surface that will not scratch the underside of metal shingles. Granular or sand surfacings are unacceptable.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Boral Roofing LLC; Boral USA**]
c. [**G.A.P. Roofing, Inc.**]
d. [**GMC Roofing & Building Paper Products, Inc.**]
e. [**Tarco**]

D. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant, polymer-film or polyester-fabric top surface and release backing; cold applied; in minimum thickness as recommended in writing by manufacturer for use under metal roof shingles.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ALCO Products LLC**]
b. [**Atlas Polyiso Roof and Wall Insulation**]
c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Drexel Metals Corp.**]
f. [**GAF**]
g. [**GCP Applied Technologies Inc.**]
h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
i. [**IKO Industries Inc.**]
j. [**Malarkey Roofing Products**]
k. [**SDP Advanced Polymer Products Inc.**]
l. [**Tamko Building Products LLC**]

E. Self-Adhering, Polymer-Modified Bitumen Sheet, High Temperature: ASTM D1970/D1970M, glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant polymer-film or polyester-fabric top surface and release backing; cold applied; in minimum thickness as recommended in writing by manufacturer for use under metal roof shingles.[**Provide primer for adjoining concrete, masonry, and metal**

surfaces to receive underlayment.]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALCO Products LLC**]
   b. [**Atlas Polyiso Roof and Wall Insulation**]
   c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
   d. [**CertainTeed; SAINT-GOBAIN**]
   e. [**Drexel Metals Corp.**]
   f. [**GCP Applied Technologies Inc.**]
   g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   h. [**Malarkey Roofing Products**]
   i. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)** in accordance with ASTM D1970/D1970M.

2.6 RIDGE VENTS

A. Ridge Vents: Metal shingle manufacturer's continuous vented ridge caps matching material and finish of metal shingles[**with insect screen or insect-resisting geotextile filter strips**][**with external deflector baffles**]; for use with specified metal shingles.

1. Accessories: Splices, end caps, and other accessories matching metal and finish.

2.7 SHEET METAL FLASHING AND TRIM

A. Sheet Metal Flashing and Trim: Metal shingle manufacturer's flashing and trim components matching shingle material, color, and finish unless otherwise specified in this Section, indicated on Drawings, or recommended in writing by metal shingle manufacturer. Fabricate to sizes and configurations required for a weathertight installation. Unless otherwise specified in this Section or indicated on Drawings, fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."

1. Valley Flashing: Fabricate to extend not less than [**8 inches (203 mm)**] from the centerline of the valley with a splash-diverter rib not less than [**3/4 inch (19 mm)**] high at the flowline formed as part of the flashing.

2.8 ACCESSORIES

A. Wood Battens: Nominal [**2-by-2-inch (51-by-51-mm)**] untreated wood complying with requirements in Section 061000 "Rough Carpentry."

B. Metal Battens: Hat channels formed from zinc-coated (galvanized) steel sheet; ASTM A653/A653M, **G90 (Z275)** coating designation, not less than [**0.025-inch (0.64-mm)**] nominal thickness.

1. Size: [**Minimum 2-inch- (51-mm-) wide surface for fastening metal shingles and 1-1/2 inches (38 mm) deep**].

C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

D. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

E. Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag elastomeric polymer joint sealant as recommended in writing by metal shingle manufacturer for installation indicated; of class and use classifications required to seal joints and remain watertight. Where sealant is exposed, provide in color matching shingle.

F. Sheet Metal Fasteners: Noncorrosive screws, nails, and anchors designed to withstand design loads and recommended in writing by metal shingle manufacturer.

1. Exposed Fasteners: Heads matching color of metal shingles using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC washers under heads of exposed fasteners bearing on weather side of shingles.
2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
3. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
4. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
5. Fasteners for Aluminum-Zinc Alloy Coated Steel Sheet: Hot-dip galvanized steel in accordance with ASTM A153/A153M, ASTM F2329, or Series 300 stainless steel.
6. Fasteners for Zinc-Coated Steel Sheet: Hot-dip galvanized steel in accordance with ASTM A153/A153M, ASTM F2329, or Series 300 stainless steel.
7. Fasteners for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel.
8. Fasteners for Zinc Sheet: Hot-dip galvanized steel in accordance with ASTM A153/A153M, ASTM F2329, or Series 300 stainless steel.

G. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, **1-inch- (25-mm-)** minimum diameter.

1. Provide with minimum **0.0134-inch- (0.34-mm-)** thick metal cap, **0.010-inch- (0.25-mm-)** thick power-driven metal cap, or **0.035-inch- (0.89-mm-)** thick plastic cap; and with minimum **0.083-inch- (2.11-mm-)** thick ring shank or **0.091-inch- (2.31-mm-)** thick smooth shank of length to penetrate at least **3/4 inch (19 mm)** into roof sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.
2. Where nails are in contact with metal shingles or flashing, use nails made from same metal as metal shingles.

H. Wood Batten Nails: ASTM F1667; common or box, steel wire, flat head, and smooth shank; hot-dip galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances.

2. Verify that substrate is sound, dry to the maximum moisture content recommended in writing by metal shingle manufacturer, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through metal shingles.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with metal shingle and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

B. Organic Felt: Install on roof deck parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation:

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **4 inches (102 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

3. Install felt underlayment on roof deck not covered by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

a. Lap sides of felt over self-adhering sheet not less than **4 inches (102 mm)** in direction that sheds water.
b. Lap ends of felt not less than **6 inches (152 mm)** over self-adhering sheet underlayment.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Synthetic Underlayment:

1. Install on roof deck parallel with and starting at the eaves.

a. Lap sides and ends and treat laps as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
b. Stagger end laps between succeeding courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
c. Fasten with underlayment nails in accordance with manufacturer's written instructions.
d. Cover underlayment within period recommended in writing by manufacturer.

2. Install in double layer on roofs sloped at less than 4:12.
3. Install synthetic underlayment on roof deck not covered by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

a. Lap sides of underlayment over self-adhering sheet not less than **4 inches (102 mm)** in direction to shed water.
b. Lap ends of underlayment not less than **6 inches (152 mm)** over self-adhering sheet.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate synthetic underlayment [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

D. Polymer-Modified Bitumen Sheet, Mechanically Fastened: Install on roof deck parallel with and starting at eaves. Fasten with underlayment nails.

1. Single-Layer Installation:

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **6 inches (152 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

a. Install in overlapping layers with a half-width plus **1-inch- (25-mm-)** wide starter course at eaves completely covered by full-width second course. Install succeeding courses lapping previous courses by a half-width plus **1 inch (25 mm)** in shingle fashion.
b. Lap ends a minimum of **6 inches (152 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

3. Install mechanically fastened sheet on roof deck not covered by self-adhering, polymer-modified bitumen sheet unless otherwise specified in this Section or indicated on Drawings.

a. Lap sides of mechanically fastened sheets over self-adhering sheet not less than **4 inches (102 mm)** in direction to shed water.
b. Lap ends of mechanically fastened sheets not less than **6 inches (152 mm)** over self-adhering sheets.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate sheets [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

E. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free, on roof deck.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.

a. Lap sides not less than **4 inches (102 mm)**.
b. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
c. Roll laps with roller.

3. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
4. Single-Layer Installation: Install over entire roof deck.
5. Water and Ice-Dam Protection Installation: Install where indicated [**below**][**on Drawings**].

a. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
b. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
c. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
d. Hips: Extend [**18 inches (457 mm)**] on each side.
e. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
f. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls, and return vertically against sidewalls not less than [**4 inches (102 mm)**].
g. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements, and return vertically against penetrating elements not less than [**4 inches (102 mm)**].
h. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.

6. Cover underlayment within seven days.

F. Valley Underlayment: Install one layer of **36-inch- (914-mm-)** wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Use same underlayment as installed on field of roof.
2. Lap ends at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
4. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install metal flashings and trim in accordance with manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Install with minimum **4-inch (102-mm)** end laps.

3.4 INSTALLATION OF RIDGE VENTS

A. Install ridge vents with end closures at locations indicated on Drawings in accordance with manufacturer's written instructions unless more stringent requirements are specified in this Section or indicated on Drawings.

3.5 INSTALLATION OF ACCESSORIES

A. Install accessories in accordance with manufacturer's written instructions unless more stringent requirements are specified in this Section or indicated on Drawings.

B. Battens: Install battens in accordance with metal shingle manufacturer's written instructions.

1. Wood Battens: Install wood battens horizontally over installed underlayment with ends separated by **1/2 inch (13 mm)**, at spacing required by metal shingle manufacturer, and securely fasten to roof deck with wood batten nails.
2. Metal Battens: Install metal battens horizontally over installed underlayment with ends separated by **1/2 inch (13 mm)**, at spacing required by metal shingle manufacturer, and securely fasten to roof deck with sheet metal fasteners.

C. Metal Protection: Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering, polymer-modified bitumen sheet to each contact surface, or by other means of permanent separation recommended in writing by manufacturer of metal shingles or of the metals in contact.

3.6 INSTALLATION OF METAL SHINGLES

A. Install metal shingles in accordance with manufacturer's written instructions true in line.

B. Maintain uniform exposure and coursing of metal shingles throughout roof.

C. Apply sealant between shingles, flashing, trim, and exposed fasteners to achieve a weathertight system.

D. Interlock and overlap shingles, and [**stagger end joints from**][**align joints of tile-form**] shingle courses above and below.

E. Metal Protection: Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering, polymer-modified bitumen sheet to each contact surface, or by other means of permanent separation recommended in writing by manufacturer of metal shingles or of the metals in contact.

1. Do not use graphite pencils to mark metal surfaces.

3.7 ADJUSTING

A. Remove and replace damaged or deformed metal shingles. Replace shingles with damaged or deteriorated finishes and other components of the Work that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as metal shingles are installed unless otherwise indicated in manufacturer's written installation instructions.

C. On completion of installation, touch up minor nicks and abrasions in finish, in accordance with manufacturer's written instructions.

D. Remove excess sealants.

3.8 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the Work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of said alterations, but only to the extent said alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting said Work, has notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not

originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent said change affects the Work covered by this Warranty.

6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect the Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 31 16 00

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Task	Specification	Specification Description
07 31 16 00	07 31 13 00	Asphalt Shingles

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SECTION 07 31 26 00 - SLATE SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Slate shingles.
2. Underlayment materials.
3. Ridge accessories.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 077253 "Snow Guards" for snow guards.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

C. Samples: For each exposed product and for each color and texture specified, in sizes indicated.

1. Slate Shingles: Full size, of each color, size, texture, and shape.
2. Metal Ridge Cap: **12-inch- (305-mm-)** long Sample.
3. Rigid-Plastic Ridge Vent: **12-inch- (305-mm-)** long Sample.
4. Metal Valley Flashing: **12 inches (305 mm)** square.

D. Samples for Initial Selection:

1. For each type of slate shingle.
2. For each type of accessory involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Slate Shingle: Full size, of each color, size, texture, and shape.
2. Metal Ridge Cap: **12-inch- (305-mm-)** long Sample.
3. Rigid-Plastic Ridge Vent: **12-inch- (305-mm-)** long Sample.
4. Metal Valley Flashing: **12 inches (305 mm)** square.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each slate variety, by a qualified testing agency.

B. Research Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**], indicating that product is suitable for intended use under applicable building codes for the following:

1. Polymer-modified bitumen sheet underlayment.
2. Synthetic underlayment.

C. Qualification Statements: For roofing system Installer.

D. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Slate Shingles: [**100 sq. ft. (9.3 sq. m)**] of each size, type, and color, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified slate system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified slate system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for slate shingles including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 48 inches (1219 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet**

Metal Flashing and Trim."][**Section 077100 "Roof Specialties."**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

1. Store on end, on pallets or other raised surfaces.
2. Do not double-stack rolls.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

C. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Roofing System Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of slate-shingle roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide slate shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.3 SLATE SHINGLES

A. Slate Shingles: ASTM C406/C406M, [**Grade S1**][**Grade S2**]; hard, dense, and sound; with chamfered edges and nail holes machine punched or drilled and countersunk; with no broken or cracked slates, no broken exposed corners, and no broken corners on covered ends that could sacrifice nailing strength or laying of a watertight roof.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Slate Company**]
   b. [**Black Diamond Slate, LLC**]
   c. [**BUCKINGHAM SLATE, A PRODUCT OF BOXLEY MATERIALS COMPANY**]
   d. [**Evergreen Slate Company, Inc**]
   e. [**Greenstone Slate Company, Inc**]
   f. [**New England Slate**]
   g. [**North Country Slate**]
   h. [**Sheldon Slate Products Company, Inc.**]
   i. [**Slate International, Inc**]
   j. [**Structural Slate Company (The)**]
   k. [**Vermont Structural Slate Company, Inc**]
   l. [**Virginia Slate Company**]
   m. [**Williams & Sons Slate & Tile, Inc**]

2. Thickness and Surface Texture: Nominal [**1/4 inch (6 mm), smooth**][**1/4 to 3/8 inch (6 to 10 mm), rough**][**3/8 to 1/2 inch (10 to 13 mm), rough**].
3. Length: [**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**].
4. Width: [**14 inches (356 mm)**][**12 inches (305 mm)**][**11 inches (279 mm)**][**10 inches (254 mm)**][**9 inches (229 mm)**][**8 inches (203 mm)**][**random widths, but not less than one-half-length**].
5. Nail Holes: [**Two**][**Four**] per shingle.
6. Butt Shape: [**Standard square cut**][**Pointed**][**Deep bevel**][**Shallow bevel**][**Deep scallop**][**Shallow scallop**][**Round**].
7. Color: [**Black**][**Gray**][**Purple**][**Green**][**Blue-black**][**Blue-gray**][**Mottled purple and green**][**Red**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
8. Weather-Exposure Color Change: [**Unfading**][**Weathering**].

B. Starter Slate: Slate shingles with chamfered nail holes front-side punched.

1. Length: Exposure of slate shingle plus headlap.

C. Ridge Slate: Slate shingles fabricated with [**vertical**][**horizontal**] grain orientation.

2.4 UNDERLAYMENT MATERIALS

A. Asphalt-Saturated Organic Felt: [**ASTM D226/D226M Type I**][**ASTM D226/D226M Type II**][**ASTM D4869/D4869M Type III**][**ASTM D4869/D4869M Type IV**], unperforated.

B. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended, in writing, by manufacturer for use under slate shingles; and evaluated and documented to be suitable for

use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Products of Canada Corp.**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Drexel Metals Corp.**]
   d. [**G.A.P. Roofing, Inc.**]
   e. [**GAF**]
   f. [**Malarkey Roofing Products**]
   g. [**Owens Corning**]
   h. [**SDP Advanced Polymer Products Inc.**]
   i. [**SystemComponents Corporation**]
   j. [**Tamko Building Products LLC**]

C. Polymer-Modified Bitumen Sheet: Styrene-butadiene-styrene- (SBS) modified asphalt, glass-fiber-mat-reinforced sheet; minimum [**55-mil (1.4-mm)**][**40-mil (1.0-mm)**] nominal thickness; recommended in writing by manufacturer and acceptable to authorities having jurisdiction for use as underlayment in slate steep-slope roofing systems; and designed for mechanical fastening or adhesive attachment using roofing asphalt or cold-applied adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Boral Roofing LLC; Boral USA**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**G.A.P. Roofing, Inc.**]
   e. [**GMC Roofing & Building Paper Products, Inc.**]
   f. [**Malarkey Roofing Products**]
   g. [**Tarco**]

D. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALCO Products LLC**]
   b. [**Atlas Polyiso Roof and Wall Insulation**]
   c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
   d. [**CertainTeed; SAINT-GOBAIN**]
   e. [**Drexel Metals Corp.**]
   f. [**GAF**]

g. [**GCP Applied Technologies Inc.**]
h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
i. [**IKO Industries Inc.**]
j. [**Malarkey Roofing Products**]
k. [**Owens Corning**]
l. [**SDP Advanced Polymer Products Inc.**]
m. [**Tamko Building Products LLC**]

2. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

E. Self-Adhering, Polymer-Modified Bitumen Sheet, High Temperature: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ALCO Products LLC**]
b. [**Atlas Polyiso Roof and Wall Insulation**]
c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Drexel Metals Corp.**]
f. [**GCP Applied Technologies Inc.**]
g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
h. [**Malarkey Roofing Products**]
i. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)** in accordance with ASTM D1970/D1970M.
3. Top Surface: [**Granule**][**Textured polymer film**][**Polyester**].

2.5 RIDGE ACCESSORIES

A. Metal Ridge Cap: Metal covers with noncorrosive components complete with internal anchoring lag screws, compression plates, and snap-on caps, fabricated for slate roof system indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Castle Metal Products**]

2. Type: [**Exposed-metal**][**Slate-covered**] legs.
3. Venting:

a. Continuous, low-profile, compression-resistant ventilating base that provides a net free area of [**18 sq. in./ft. (380 sq. cm/m)**] of ridge.
b. [**With**][**Without**] external baffles.

4. Metal Components: [**Copper, 20-oz./sq. ft.- (0.7-mm-) thick sheet**][**Aluminum, 0.050-inch- (1.3-mm-) thick sheet, with manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight on exposed surfaces**].
5. Accessories:

a. Splices, end caps, and other accessories of matching metal and finish.

B. Rigid-Plastic Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under slate ridge shingles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cor-A-Vent, Inc**]
b. [**GAF**]
c. [**Tapco International Corporation; Mid-America Components**]

2.6 SHEET METAL FLASHING AND TRIM

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange extending a minimum of [**4 inches (102 mm)**][**6 inches (152 mm)**] over and [**4 inches (102 mm)**] beyond each side of downslope slate shingles and [**6 inches (152 mm)**] up the vertical surface.
2. Step Flashings: Fabricate with a headlap of **3 inches (76 mm)** and a minimum extension of [**4 inches (102 mm)**][**5 inches (127 mm)**] both horizontally and vertically.
3. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [**24 inches (610 mm)**] beneath upslope slate shingles, [**6 inches (152 mm)**] beyond each side of [**chimney**][**skylight**], and [**6 inches (152 mm)**] above the roof plane.
4. Counterflashings: Fabricate to cover [**4 inches (102 mm)**] of base flashing measured vertically; and in lengths required so that no step exceeds [**8 inches (203 mm)**] and overall length is no more than [**10 ft. (3 m)**].

a. Provide metal [**reglets**][**receivers**] for installation.

5. Hip Flashings: Fabricate to length of slate shingle and to extend [**3 inches (76 mm)**] beyond joint of hip shingle with adjoining roof shingle.
6. Open-Valley Flashings: Fabricate from metal sheet not less than [**18 inches (457 mm)**] wide in lengths not exceeding [**10 ft. (3 m)**], with [**1-inch- (25-mm-)**] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [**8 inches (203 mm)**].

a. Hem flange edges for fastening with metal cleats.

7. Closed-Valley Flashings: Fabricate in lengths not exceeding [**10 ft. (3 m)**] and equal flange widths of [**9 inches (229 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**].

a. Hem flange edges for fastening with metal cleats.

8. Interwoven Closed-Valley Flashings: Fabricate in lengths [**equal to shingle exposure plus headlap plus 2 inches (51 mm)**] and equal flange widths of [**9 inches (229 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**].
9. Drip Edges: Fabricate in lengths not exceeding [**10 ft. (3 m)**] with roof-deck flange and **1-1/2-inch (38-mm)** fascia flange with **3/8-inch (10-mm)** drip at lower edge.

a. Roof-Deck Flange at Eaves: [**Form to cover cant strip and fasten to roof deck**].
b. Roof-Deck Flange at Rakes: Form to extend minimum of [**2 inches (51 mm)**] onto roof deck.

C. Vent-Pipe Flashings: ASTM B749, Type L51121, at least **1/16 inch (1.6 mm)** thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least **4 inches (102 mm)** from pipe onto roof.

2.7 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.

C. Elastomeric Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant; of class and use classifications required to seal joints in slate-shingle roofing and remain watertight; recommended in writing by manufacturer for applications indicated.

D. Roofing Asphalt: ASTM D312/D312M Type IV.

E. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.

F. Slating Nails: ASTM F1667, [**copper**][**stainless steel**][**silicon-bronze**][**cut-brass**], smooth-shanked, wire nails; **0.135-inch- (3.4-mm-)** minimum thickness; sharp pointed; with **3/8-inch- (10-mm-)** minimum diameter flat head; of sufficient length to penetrate a minimum of **3/4 inch (19 mm)** into sheathing or extend at least **1/8 inch (3 mm)** through sheathing less than **3/4 inch (19 mm)** thick.

1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

G. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, **1-inch- (25-mm-)** minimum diameter.

1. Provide with minimum **0.0134-inch- (0.34-mm-)** thick metal cap, **0.010-inch- (0.25-mm-)** thick power-driven metal cap, or **0.035-inch- (0.89-mm-)** thick plastic cap; and with minimum **0.083-inch- (2.11-mm-)** thick ring shank or **0.091-inch- (2.31-mm-)** thick smooth shank of length to penetrate at least **3/4 inch (19 mm)** into roof sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.

H. Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

I. Nails for Wood Strips: ASTM F1667; common or box, steel wire, flat head, and smooth shank; hot-dip galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through roofing.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with slate-shingle and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

B. Asphalt-Saturated Organic Felt: Install on roof deck parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation:

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **4 inches (102 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

3. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)**

spacing at side and end laps.
4. Install felt over areas protected by self-adhering, polymer-modified bitumen sheet.
5. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Synthetic-Underlayment Top Layer: Install in accordance with manufacturer's written installation instructions and as second layer over anchor-layer underlayment.

1. Completely cover anchor-layer underlayment and install parallel with and starting at the eaves, with side laps offset halfway between side laps of underlying anchor layer.
2. Lap sides and ends as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
3. Stagger end laps from anchor-layer end laps and between succeeding top courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
4. Fasten with underlayment nails.
5. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.

D. Polymer-Modified Bitumen Sheet: Install parallel with and starting at eaves.

1. Single- or Anchor-Layer Installation:

   a. Install on roof deck.
   b. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
   c. Lap ends a minimum of **6 inches (152 mm)**.
   d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
   e. Fasten with underlayment nails.

2. Top-Layer Installation:

   a. Install as a second layer over anchor-layer underlayment.
   b. Completely cover anchor layer, with side laps offset halfway between side laps of underlying anchor layer.
   c. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**].
   d. Lap ends a minimum of **6 inches (152 mm)**.
   e. Stagger end laps from anchor-layer end laps and between succeeding top-layer courses at least **72 inches (1829 mm)**.
   f. [**Fasten with underlayment nails**][**Adhere to anchor layer in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature**][**Adhere to anchor layer in uniform coating of cold-applied adhesive**].

3. Double-Layer Installation:

   a. Install on roof deck in overlapping layers with a half-width plus **1-inch- (25-mm-)** wide starter course at eaves completely covered by full-width second course.
   b. Install succeeding courses lapping previous courses by a half-width plus **1 inch (25 mm)** in shingle fashion.
   c. Lap ends a minimum of **6 inches (152 mm)**.
   d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
   e. Fasten with underlayment nails.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install sheets over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate sheets [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls,

curbs, chimneys, and other roof projections.

E. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water. Lap sides not less than **4 inches (102 mm)**.
3. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
4. Roll laps with roller.
5. Prime concrete, masonry, and metal surfaces to receive self-adhering, polymer-modified bitumen sheet.
6. Single- or Anchor-Layer Installation: Install over entire roof deck.
7. Top-Layer Installation: Install as second layer over anchor-layer underlayment.

   a. Completely cover anchor-layer underlayment.
   b. Offset side laps halfway between side laps of underlying anchor layer and offset end laps from those of underlying anchor layer at least **72 inches (1829 mm)**.

8. Water and Ice-Dam Protection Installation: Install on roof deck where indicated [**below**][**on Drawings**].

   a. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
   b. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
   c. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
   d. Hips: Extend [**18 inches (457 mm)**] on each side.
   e. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
   f. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
   g. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements not less than [**4 inches (102 mm)**].
   h. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.

9. Cover underlayment within seven days.

F. Valley Underlayment: Install one layer of **36-inch- (914-mm-)** wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Use [**same underlayment as installed on field of roof**].
2. Lap ends at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.

3.3 INSTALLATION OF RIDGE ACCESSORIES

A. Metal Ridge Caps: Install units in accordance with manufacturer's written instructions.

1. Install slate shingles into retention channels, butting adjacent shingles.

B. Rigid-Plastic Ridge Vents: Install continuous ridge vents in accordance with manufacturer's written instructions. Fasten with slating nails of sufficient length to penetrate sheathing.

3.4 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install metal flashings and other sheet metal to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope slate shingles and up the vertical surface.

C. Step Flashings: Install with a headlap of **3 inches (76 mm)** and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying slate shingle. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope slate shingles and beyond each side.

E. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

F. Hip Flashings: Install centered over hip with lower edge of flashing concealed by butt of overlying slate shingle. Fasten to roof deck.

G. Open-Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water.

1. Fasten upper end of each length to roof deck beneath overlap.
2. Secure hemmed flange edges into metal cleats spaced [**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
3. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to [**underlying self-adhering, polymer-modified bitumen sheet**]. Place strips parallel to and over flanges so that they will be just concealed by installed shingles.
4. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

H. Closed-Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced [**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
2. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to [**underlying self-adhering, polymer-modified bitumen**] valley underlayment.

I. Interwoven Closed-Valley Flashings: Install centered in valleys at every shingle course overlapping the shingles in the preceding course similar to a step flashing treatment so that the butts just conceal the end of the flashing after installing the course. Fasten to roof approximately **8 inches (203 mm)** away from center of the valley.

J. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

K. Eave Drip Edges: [**Install over wood cant strip and under underlayment materials; fasten to roof deck**].

L. Pipe Flashings: Form flashing around pipe penetrations and slate shingles. Fasten and seal to slate shingles.

3.5 INSTALLATION OF SLATE SHINGLES

A. Beginning at eaves, install slate shingles in accordance with manufacturer's written instructions and with details and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

1. Install wood strip cant at eave edges [**under underlayment materials**].
2. Install shingle starter course chamfered face down.

B. Install first and succeeding shingle courses chamfered face up. Install full-width first course at rake edge.

1. Offset joints of uniform-width slate shingles by half the shingle width in succeeding courses.
2. Offset joints of random-width slate shingles a minimum of **3 inches (76 mm)** in succeeding courses.

C. Maintain a [**4-inch- (102-mm-)**][**3-inch- (76-mm-)**] minimum headlap between succeeding shingle courses.

D. Maintain uniform exposure of shingle courses [**between eaves and ridge**][**midway between eaves and ridge, and increase headlap of succeeding shingle courses to ensure uniform exposure on remaining shingle courses**].

E. At eaves, extend shingle starter course and first course **1 inch (25 mm)** over fasciae.

F. At rakes, extend shingle starter course and succeeding courses [**1 inch (25 mm)**][**2 inches (51 mm)**] over fasciae.

G. Cut and fit slate neatly around roof vents, pipes, ventilators, and other projections through roof.

H. Hang slate with [**two**][**four**] slating nails for each shingle, with nail heads lightly touching slate.

1. Do not drive nails home, which draws slates downward, and do not leave nail heads protruding enough to interfere with the overlapping shingle above.
2. At vented ridges, terminate slate shingles to produce a uniform airspace on each side of ridge apex.

I. Ridges: Install ridge slate in [**saddle**][**strip saddle**][**combed**] configuration.

1. Install and anchor wood nailer strips of thicknesses to match abutting courses of slate shingles, terminating nailer strip **3 to 4 inches (76 to 102 mm)** from the eave. Cover with [**self-adhering, polymer-modified bitumen sheet**], extending to underlying slate but concealed by ridge slate.
2. Lay ridge slate in bed of [**asphalt roofing cement**][**butyl sealant**].
3. Anchor ridge slate to supporting wood nailer strip with [**two**][**four**] nails for each slate shingle, without nails penetrating underlying slate.
4. Extend combed-ridge slate over leeward ridge slate by **1/8 to 1/4 inch (3 to 6 mm)**. Seal ridge joint with elastomeric sealant.

5. Cover heads of exposed nails at final ridge shingle with [**asphalt roofing cement**][**butyl sealant**].

J. Hips: Install and anchor slate hips in [**saddle**][**mitered**][**fantail**] configuration.

1. Install and anchor wood nailer strips of thickness to match abutting courses of slate shingles.

   a. Cover nailer strip with [**self-adhering, polymer-modified bitumen sheet**], extending on to underlying slate but concealed by hip slate.
   b. Anchor hip slate to nailer strip with [**two**] nails located in upper third of hip-slate length.

2. Notch starter shingle and first shingle course at hip to fit around nailer strips so no wood is exposed at ridge eave.
3. Lay hip slate in bed of [**asphalt roofing cement**][**butyl sealant**].
4. Seal hip centerline joint with elastomeric sealant.

K. Open Valleys: Cut slate shingles to form straight lines at open valleys, trimming upper concealed corners of shingles. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.

1. Do not nail shingles to valley metal flashings.

L. Closed Valleys: Cut slate shingles to form straight lines at closed valleys, trimming upper concealed corners of shingles.

1. Maintain uniform gap at centerline of valley of [**1/2 to 3/4 inch (13 to 19 mm)**][**3/4 to 1 inch (19 to 25 mm)**].
2. Do not nail shingles to valley metal flashings.
3. Wire-tie shingles to roof deck on either side of flashing as required to secure shingles.

M. Remove and replace damaged or broken slate shingles.

3.6 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the Work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of the alterations, but only to the extent the alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting the alterations, has notified the Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent the change affects the Work covered by this Warranty.
6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and affords reasonable opportunity for Roofing System Installer to inspect the Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 31 26 00

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SECTION 07 31 29 00 - WOOD SHINGLES AND SHAKES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood roof shingles.
2. Wood roof shakes.
3. Underlayment and shake interlayment materials.
4. Ridge vents.
5. Metal flashing and trim.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring.
2. Section 074624 "Wood Shingle and Shake Siding" for wood shingles and shakes applied to exterior walls.
3. Section 077200 "Roof Accessories" for accessories not specified in this Section.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]

1.5 ACTION SUBMITTALS

A. Product Data:

1. Wood roof shingles.
2. Wood roof shakes.
3. Underlayment and shake interlayment materials.
4. Ridge vents.
5. Metal flashing and trim.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: For metal flashing and trim.

D. Samples: For each exposed product, in sizes indicated.

1. Wood Roof Shingles: Full size.
2. Wood Roof Shakes: Full size.
3. Ridge Units: Full size.
4. Ridge Vent: **12 inches (305 mm)** long.

E. Samples for Initial Selection: For each type of wood product indicated.

1. Include Samples of accessories involving color selection.

F. Samples for Verification: For the following products, in sizes indicated:

1. Wood Roof Shingles: Full size.
2. Wood Roof Shakes: Full size.
3. Ridge Units: Full size.
4. Ridge Vent: **12 inches (305 mm)** long.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Research Reports: For wood products, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**], indicating that product is suitable for intended use under applicable building codes.

C. Sample Warranty: For manufacturer's materials warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wood products to include in maintenance manuals.

B. Materials warranties.

C. Roofing Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wood Roof Shingles: [**100 sq. ft. (9.3 sq. m)**] of each size and type, in unbroken bundles.
2. Wood Roof Shakes: [**100 sq. ft. (9.3 sq. m)**] of each size and type, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: CSSB member.

F. Grading Agency Qualifications: An independent testing and inspecting agency recognized by authorities having jurisdiction as qualified to label wood products for compliance with referenced grading rules.

G. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for wood products including accessories.

a. Size: [**48 inches (1219 mm) long by 48 inches (1219 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

B. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double-stack rolls.

C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.

D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.12 WARRANTY

A. Materials Warranty: Manufacturer's warranty administered by CSSB and on CSSB's standard form in which manufacturer agrees to repair or replace CSSB-labeled products that fail in materials within specified warranty period. Material failures include manufacturing defects that result in leaks.

1. Materials Warranty Period: Limited lifetime from date of Substantial Completion.

B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace installed products that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide roofing materials identical to those of assemblies tested for fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Wood Products: [**Class B**][**Class C**].

a. Fire-Retardant Treatment: Exterior-type pressure treatment complying with AWPA U1 and AWPA T1.
b. Accelerated Weathering: Subject test specimens to ASTM D2898 Method A before testing.
c. Identification: Attach a label to each bundle of wood products; include identification mark of testing agency acceptable to authorities having jurisdiction and identify manufacturer, chemical treatment, method of application, purpose of treatment, and warranties available.

B. Decay Resistance: Provide wood products treated in accordance with AWPA U1 and AWPA T1, chromated copper arsenate (CCA) pressure treatment; with a minimum of **0.40-lb/cu. ft. (6.4-kg/cu. m)** retention.

1. Identification: Attach a label to each bundle of wood products; identify manufacturer, chemical treatment, method of application, purpose of treatment, and warranties available.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be

certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

G. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. Grading Rules: Provide wood products that comply with [**CSSB**] grading rules for products indicated.

1. Identification: Attach a label to each bundle of wood products that identifies manufacturer, type of product, grade, dimensions, and identification mark of grading agency acceptable to authorities having jurisdiction.

2.3 WOOD ROOF SHINGLES

A. Cedar Shingles: Smooth-sawn western red cedar shingles.

1. Grade: No. 1, with starter courses of [**No. 1**][**No. 2**][**No. 3**].
2. Size: [**16 inches (406 mm) long; 0.40 inch (10 mm) thick**][**18 inches (457 mm) long; 0.45 inch (11 mm) thick**][**24 inches (610 mm) long; 0.50 inch (13 mm) thick**] at butt.

B. Cedar Shingle Ridge Units: [**Manufactured**][**Site-fabricated**], smooth-sawn western red cedar caps for ridges and hips of same thickness as shingles, **7 inches (178 mm)** wide; beveled, alternately overlapped, and nailed.

1. Grade: No. 1.
2. Length: [**16 inches (406 mm)**][**18 inches (457 mm)**].

C. Fancy-Butt Cedar Shingles: Clear heartwood red cedar, No. 1 grade, with butt shape indicated.

1. Butt Shape: [**Diagonal**][**Fish scale**][**Diamond**][**Square**][**Half cove**][**Hexagonal**][**Octagonal**][**Round**][**Arrow**].
2. Size: [**16 inches (406 mm)**][**18 inches (457 mm)**] long by **5 inches (127 mm)** wide, in manufacturer's standard thickness.

2.4 WOOD ROOF SHAKES

A. Split Cedar Shakes: Hand-split and resawn western red cedar shakes; rough split face and sawn back.

1. Grade:

a. Roof: [**Premium**][**No. 1**].
b. Starter Courses: [**Premium**][**No. 1**].

2. Length: [**18 inches (457 mm)**][**24 inches (610 mm)**], with **15-inch- (381-mm-)** long starter course.
3. Thickness: [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] at butt.

B. Taper-Sawn Cedar Shakes: Western red cedar shakes; sawn both sides.

1. Grade:

a. Roof: [**Premium**][**No. 1**].
b. Starter Courses: [**Premium**][**No. 1**].

2. Length: [**18 inches (457 mm)**][**24 inches (610 mm)**], with **15-inch- (381-mm-)** long starter course.
3. Thickness: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] at butt.

C. Cedar Shake Ridge Units: [**Manufactured**][**Site-fabricated**], western red cedar caps for ridges and hips of same type and grade as exposed roof shakes, **9 inches (229 mm)** wide; beveled, alternately overlapped, and nailed.

1. Length: [**18 inches (457 mm)**][**24 inches (610 mm)**].
2. Thickness: [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] at butt.

2.5 UNDERLAYMENT AND SHAKE INTERLAYMENT MATERIALS

A. Felt: Asphalt-saturated organic felts, nonperforated and complying with the following:

1. ASTM D226/D226M: [**Type I**][**Type II**].
2. ASTM D4869/D4869M: [**Type I**][**Type II**][**Type III**][**Type IV**].
3. Use as [**underlayment**][**shake interlayment**].

B. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ALCO Products LLC**]
b. [**Atlas Polyiso Roof and Wall Insulation**]
c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Drexel Metals Corp.**]
f. [**GAF**]
g. [**GCP Applied Technologies Inc.**]
h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
i. [**IKO Industries Inc.**]
j. [**Malarkey Roofing Products**]
k. [**Owens Corning**]
l. [**SDP Advanced Polymer Products Inc.**]
m. [**Tamko Building Products LLC**]

2. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

2.6 RIDGE VENTS

A. Rigid Ridge Vent: Manufacturer's standard, rigid high-density, UV-stabilized plastic ridge vent for use under ridge shingles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Cor-A-Vent, Inc**]
e. [**GAF**]
f. [**Lomanco, Inc**]
g. [**Owens Corning**]
h. [**Tamko Building Products LLC**]
i. [**Tapco International Corporation; Mid-America Components**]

2. Features:

a. Nonwoven geotextile filter strips.
b. External deflector baffles.

B. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter[**bonded to a nonwoven, nonwicking, geotextile fabric cover**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Benjamin Obdyke Incorporated**]
c. [**GAF**]
d. [**Owens Corning**]
e. [**Tamko Building Products LLC**]

2.7 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M, Type II, asbestos free.

B. Elastomeric Flashing Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant; of class and use classifications required to seal joints and remain watertight; recommended in writing by manufacturer for installation of flashing systems.

C. Drainage Mat: Manufacturer's standard, compression-resisting, three-dimensional, nonwoven,

entangled filament, nylon mat designed to permit air movement and to drain incidental moisture by gravity.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Building Products Inc.**]
   b. [**Benjamin Obdyke Incorporated**]

D. Roofing Nails: ASTM F1667, [**stainless steel, Type 304,**][**stainless steel, Type 316,**][**hot-dip galvanized-steel**] box-type wire nails, sharp pointed, and of sufficient length to penetrate a minimum of **3/4 inch (19 mm)** into sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.

1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

E. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, **1-inch- (25-mm-)** minimum diameter.

1. Provide with minimum **0.0134-inch- (0.34-mm-)** thick metal cap, **0.010-inch- (0.25-mm-)** thick power-driven metal cap, or **0.035-inch- (0.89-mm-)** thick plastic cap; and with minimum **0.083-inch- (2.11-mm-)** thick ring shank or **0.091-inch- (2.31-mm-)** thick smooth shank of length to penetrate at least **3/4 inch (19 mm)** into roof sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.

2.8 METAL FLASHING AND TRIM

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange extending a minimum of [**4 inches (102 mm)**][**6 inches (152 mm)**] over and [**4 inches (102 mm)**] beyond each side of downslope wood roofing and [**6 inches (152 mm)**] up the vertical surface.
2. Step Flashings: Fabricate with a headlap of **3 inches (76 mm)** and a minimum extension of [**4 inches (102 mm)**][**5 inches (127 mm)**] both horizontally and vertically.
3. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**] beneath upslope wood roofing and [**6 inches (152 mm)**] beyond each side of [**chimney**][**skylight**] and [**6 inches (152 mm)**]above the roof plane.
4. Counterflashings: Fabricate to cover [**4 inches (102 mm)**] of base flashing measured vertically; and in lengths required so that no step exceeds [**8 inches (203 mm)**] and overall length is no more than [**10 feet (3 m)**].

   a. Provide metal [**reglets**][**receivers**] for installation.

5. Open-Valley Flashings: Fabricate from metal sheet not less than [**24 inches (610 mm)**] wide in lengths not exceeding [**10 feet (3 m)**], with [**1-inch- (25-mm-)**] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [**11 inches (279 mm)**].
6. Drip Edges: Fabricate in lengths not exceeding [**10 feet (3 m)**] with minimum **2-inch (51-mm)** roof-deck flange and **1-1/2-inch (38-mm)** fascia flange with **3/8-inch (10-mm)** drip at lower edge.

C. Vent-Pipe Flashings: ASTM B749, Type L51121, at least **1/16 inch (1.6 mm)** thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least **6 inches (152 mm)** from pipe onto roof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through wood roofing.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WOOD ROOF SHINGLES

A. Install wood roof shingles in accordance with manufacturer's written instructions and recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roofing Systems."

B. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.

C. Install wood-shingle starter course along lowest roof edge.

1. Install in [**single layer**][**double layer with joints offset a minimum of 1-1/2 inches (38 mm)**].
2. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over fascia.
3. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over rake edge.

D. Install first course of wood roof shingles directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood roof shingles in continuous straight-line courses across roof deck.

1. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over rake edge.
2. Offset joints between shingles in succeeding courses a minimum of **1-1/2 inches (38 mm)**. Do not align vertical joints in alternate courses.
3. Space shingles a minimum of **1/4 inch (6 mm)** and a maximum of **3/8 inch (10 mm)** apart.
4. Fasten each shingle with two nails spaced **3/4 to 1 inch (19 to 25 mm)** from edge of shingle and **1-1/2 to 2 inches (38 to 51 mm)** above butt line of succeeding course. Drive fasteners flush with

top surface of shingles without crushing wood.
5. Maintain weather exposure of [**5 inches (127 mm) for 16-inch- (406-mm-)**][**5-1/2 inches (140 mm) for 18-inch- (457-mm-)**][**7-1/2 inches (191 mm) for 24-inch- (610-mm-)**] long shingles.

E. Open Valleys: Cut and fit wood roof shingles at open valleys, trimming upper concealed corners of shingles. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.

F. Fancy-Butt Shingles: Center each shingle in succeeding courses between the two shingles below it with **1/8-inch (3-mm)** space between shingles.

1. Install [**one**][**two**][**three**] course(s) of fancy-butt shingles in continuous straight-line courses across roof deck in locations indicated on Drawings.
2. Maintain weather exposure of **5 inches (127 mm)**.

G. Ridge Vents: Install continuous ridge vents over wood roof shingles in accordance with manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate roof sheathing.

H. Ridge Units: Install units over wood roof shingles trimmed at apex of ridges and hips.

1. Maintain same exposure dimension of units as roof-shingle exposure.
2. Lap units at ridges to shed water away from direction of prevailing winds.
3. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.
4. At unventilated ridges and hips, install concealed strip of [**felt**][**self-adhering, polymer-modified bitumen sheet**] underlayment over apex shingles and below ridge units.
5. Fasten ridge units to cover ridge vent without obstructing airflow.

3.3 INSTALLATION OF WOOD ROOF SHAKES

A. Install wood roof shakes in accordance with manufacturer's written instructions and recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roofing Systems."

B. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.

C. Install wood-shake starter course along lowest roof edge.

1. Install in [**single layer**][**double layer with joints offset a minimum of 1-1/2 inches (38 mm)**].
2. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over fascia.
3. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over rake edge.

D. Install first course of wood roof shakes directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood roof shakes in continuous straight-line courses across roof deck.

1. Extend [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] over rake edge.
2. Interlay **18-inch- (457-mm-)** wide strip of felt over top portion of first and each succeeding course. Set bottom edge of felt interlayment at a distance of twice the weather-exposure dimension above the shake butt. Stagger fasten to roof deck with felt-underlayment nails.
3. Offset joints between shakes in succeeding courses a minimum of **1-1/2 inches (38 mm)**.
4. Space shakes a minimum of **3/8 inch (10 mm)** and a maximum of **5/8 inch (16 mm)** apart.
5. Fasten each shake with two nails spaced **3/4 to 1 inch (19 to 25 mm)** from edge of shake and **1-**

1/2 to 2 inches (38 to 51 mm) above butt line of succeeding course. Drive fasteners flush with top surface of shakes without crushing wood.

6. Maintain weather exposure of [**5-1/2 inches (140 mm) for 18-inch- (457-mm-)**][**7-1/2 inches (191 mm) for 18-inch- (457-mm-)**][**7-1/2 inches (191 mm) for 24-inch- (610-mm-)**][**10 inches (254 mm) for 24-inch- (610-mm-)**] long shakes.

E. Open Valleys: Cut and fit wood roof shakes at open valleys, trimming upper concealed corners of shakes. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.

F. Ridge Vents: Install continuous ridge vents over wood roof shakes in accordance with manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.

G. Ridge Units: Install units over wood roof shakes trimmed at apex of ridges and hips.

1. Maintain same exposure dimension of units as roof-shake exposure.
2. Lap units at ridges to shed water away from direction of prevailing winds.
3. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.
4. At unventilated ridges and hips, install concealed strip of [**felt**][**self-adhering, polymer-modified bitumen sheet**] underlayment over apex shingles and below ridge units.
5. Fasten ridge units to cover ridge vent without obstructing airflow.

3.4 INSTALLATION OF UNDERLAYMENT AND SHAKE INTERLAYMENT MATERIALS

A. Comply with underlayment manufacturer's written installation instructions and with recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in the Section or indicated on Drawings.

B. Felt: Install on roof deck parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation:

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Double-Layer Installation:

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **4 inches (102 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt-underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply to a point not less than **24 inches (610 mm)** inside the exterior wall line of the building[**and at locations indicated on Drawings**].

3. Install felt underlayment [**on roof deck not covered**][**over areas protected**][**over eaves protected**] by self-adhering, polymer-modified bitumen sheet.

a. Lap sides of felt over self-adhering sheet not less than **4 inches (102 mm)** in direction that

sheds water.

b. Lap ends of felt not less than **6 inches (152 mm)** over self-adhering sheet.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free, on roof deck.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.
3. Lap sides not less than **4 inches (102 mm)**. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
4. Roll laps with roller.
5. Prime concrete, masonry, and metal surfaces to receive self-adhering sheet.
6. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
7. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
8. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
9. Hips: Extend [**18 inches (457 mm)**] on each side.
10. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
11. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
12. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements not less than [**4 inches (102 mm)**].
13. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.
14. Cover underlayment within seven days.

D. Metal-Flashed, Open-Valley Underlayment: Install one layer of **36-inch- (914-mm-)** wide felt underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Lap ends at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
2. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
3. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.5 INSTALLATION OF RIDGE VENTS

A. Rigid-Plastic Ridge Vents: Install continuous ridge vents over wood roof tiles in accordance with manufacturer's written instructions. Fasten with nails of sufficient length to penetrate substrate.

B. Flexible Ridge Vent: Install continuous-roll ridge vents over wood roof tiles in accordance with manufacturer's written instructions.

3.6 INSTALLATION OF METAL FLASHING AND TRIM

A. Install metal flashings and other sheet metal to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with recommendations for wood roofing in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope wood roofing and up the vertical surface.

C. Step Flashings: Install with a headlap of **3 inches (76 mm)** and extend over underlying wood roofing and up the vertical face. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying wood roofing. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements extending concealed flange beneath upslope wood roofing and beyond each side.

E. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

F. Open-Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Adhere minimum [**9-inch- (229-mm-)**] wide strip of self-adhering, polymer-modified bitumen sheet to metal flanges and to underlying self-adhering, polymer-modified bitumen sheet. Place strips parallel to and over flanges so that they will be just concealed by installed roofing.
2. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

G. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

H. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

I. Pipe Flashings: Form flashing around pipe penetrations and wood roofing. Fasten and seal to wood roofing.

3.7 ROOFING INSTALLER'S WARRANTY

A. WHEREAS [**Roofing Installer**] has performed roofing and associated work ("the work") on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Acceptance Date:
7. Warranty Period:
8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with the Owner or indirectly as a

subcontractor) to warrant the work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of the work as are necessary to correct faulty and defective work and as are necessary to maintain the work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the work and other parts of the building, and to building contents, caused by:

    a. Lightning;
    b. Peak gust wind speed, as directed by the Owner
    c. Fire;
    d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. Faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. Vapor condensation on bottom of roofing; and
    g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to the work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the work.
4. During Warranty Period, if the Owner allows alteration of the work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of the alterations, but only to the extent the alterations affect the work covered by this Warranty. If the Owner engages Roofing Installer to perform the alterations, Warranty shall not become null and void unless Roofing Installer, before starting the alterations, notified the Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty shall become null and void on date of the change, but only to the extent the change affects the work covered by this Warranty.
6. the Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect the work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on the work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of the work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner’s General Contractor.

END OF SECTION 07 31 29 00

Task	Specification	Specification Description
07 31 29 13	07 31 29 00	Wood Shingles And Shakes
07 31 29 16	07 31 29 00	Wood Shingles And Shakes
07 31 29 19	01 22 00 00	No Specification Required
07 31 29 19	07 31 29 00	Wood Shingles And Shakes
07 31 33 00	01 22 00 00	No Specification Required

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SECTION 07 32 13 00 - CLAY ROOF TILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clay roof tiles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 077253 "Snow Guards" for snow guards.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 and glossary in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

C. Samples: For each exposed product and for each color and texture specified, in sizes indicated.

1. Clay Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Sheet Metal Flashing: **12 inches (305 mm)** square.
4. Ridge Vents: **12-inch- (305-mm-)** long Sample.
5. Eave Closures: In manufacturer's standard size.

D. Samples for Initial Selection: For each type of clay roof tile and accessory tile.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Clay Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Sheet Metal Flashing: **12 inches (305 mm)** square.
4. Ridge Vents: **12-inch- (305-mm-)** long Sample.
5. Eave Closures: In manufacturer's standard size.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For roofing system Installer.

B. Product Test Reports: For each type of clay roof tile, based on evaluation of comprehensive tests performed by a qualified testing agency.

C. Research Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**], indicating that product is suitable for intended use under applicable building codes for the following:

1. [**Mortar**][**Adhesive**] tile-attachment systems.
2. Wire-tie tile-attachment systems.
3. Polymer-modified bitumen sheet underlayment.
4. Synthetic underlayment.

D. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing to include in maintenance manuals.

B. Materials warranties.

C. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Clay Roof Tiles: [**100 sq. ft. (9.3 sq. m)**] of each type, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified clay tile system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified clay tile system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for clay roof tiles including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 48 inches (1219 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

1. Store on end, on pallets or other raised surfaces. Do not double-stack rolls.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing Work is not in progress.

C. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related Work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.

1. Warranty Period: [**50**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of clay-tile roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide clay roof tiles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by UL Standards & Engagement Inc. or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 CLAY ROOF TILES

A. Clay Roof Tiles: ASTM C1167, molded- or extruded-clay roof tile units of shape and configuration indicated, kiln fired, and free of surface imperfections. Provide with fastening holes prepunched at factory before firing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Boral Roofing LLC; Boral USA**]
b. [**Claymex Brick and Tile, Inc.**]
c. [**D'Hanis Brick & Tile Company**]
d. [**Gladding, McBean; PABCO Clay Products, LLC; PABCO Building Products, LLC**]
e. [**Ludowici**]
f. [**MCA Clay Roof Tile**]
g. [**Zion Tile Corp.**]

2. Durability: [**Grade 1**][**Grade 2**][**Grade 3**].

3. High-Profile Shape: Type I, [**Spanish or "S"**][**two-piece tapered mission**][**two-piece straight mission**][**two-piece straight barrel mission**][**two-piece Greek**][**two-piece Roman**].

   a. Accessory Tiles: [**Ridge**][**ridge vent**][**ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**roll rake edge**][**starter**][**end band**][**terminal**][**eave closure**][**and**][**top fixture**] units.

4. Low-Profile Shape: Type II, [**French interlocking**].

   a. Accessory Tiles: [**Ridge**][**ridge vent**][**ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**roll rake edge**][**starter**][**end band**][**terminal**][**eave closure**][**and**][**top fixture**] units.

5. Flat Shape: Type III, [**flat shingle**][**flat interlocking**].

   a. Accessory Tiles: [**Ridge and closed ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**starter**][**end band**][**and**][**terminal**] units.

6. Size:

   a. Provide clay roof tiles of diminishing widths for circular bays or round towers.

7. Finish and Texture: [**Matte, smooth**][**Matte, striated**][**Glazed, smooth**].
8. Color: [**Terra cotta**][**Brown**][**Red**][**Blended red**][**Buff**].
9. Product Data: Verify materials were fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
10. Product Data: Verify materials were fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.4 UNDERLAYMENT MATERIALS

A. Felt: [**ASTM D226/D226M Type II, asphalt saturated**][**ASTM D4869/D4869M Type IV, asphalt saturated**][**ASTM D2626/D2626M, asphalt saturated and coated, mineral-granule surfaced on weather (top) side**], unperforated.

B. Asphalt Roll-Roofing: ASTM D6380/D6380M, Class M, Type II, asphalt-saturated and -coated organic felt; mineral-granule surfaced on weather (top) side.

C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended, in writing, by manufacturer for use under roof tile; and evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Drexel Metals Corp.**]
      b. [**G.A.P. Roofing, Inc.**]
      c. [**GAF**]

d. [**Owens Corning**]
e. [**SDP Advanced Polymer Products Inc.**]
f. [**SystemComponents Corporation**]
g. [**Tamko Building Products LLC**]

D. Polymer-Modified Bitumen Sheet: Styrene-butadiene-styrene- (SBS) modified asphalt, glass-fiber-mat-reinforced sheet; minimum [**55-mil (1.4-mm)**][**40-mil (1.0-mm)**] nominal thickness; recommended in writing by manufacturer and acceptable to authorities having jurisdiction for use as underlayment in tile steep-slope roofing systems; and designed for mechanical fastening or adhesive attachment using roofing asphalt or cold-applied adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Boral Roofing LLC; Boral USA**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**G.A.P. Roofing, Inc.**]
e. [**GMC Roofing & Building Paper Products, Inc.**]
f. [**Malarkey Roofing Products**]
g. [**Tarco**]

E. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ALCO Products LLC**]
b. [**Atlas Polyiso Roof and Wall Insulation**]
c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Drexel Metals Corp.**]
f. [**GAF**]
g. [**GCP Applied Technologies Inc.**]
h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
i. [**IKO Industries Inc.**]
j. [**Malarkey Roofing Products**]
k. [**SDP Advanced Polymer Products Inc.**]
l. [**Tamko Building Products LLC**]

2. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

F. Self-Adhering, Polymer-Modified Bitumen Sheet, High Temperature: ASTM D1970/D1970M, minimum

[**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALCO Products LLC**]
    b. [**Atlas Polyiso Roof and Wall Insulation**]
    c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Drexel Metals Corp.**]
    f. [**GCP Applied Technologies Inc.**]
    g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
    h. [**Malarkey Roofing Products**]
    i. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)** in accordance with ASTM D1970/D1970M.
3. Top Surface: [**Granule**][**Textured polymer film**][**Polyester**].

2.5 RIDGE VENTS

A. Rigid-Plastic Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under ridge tiles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cor-A-Vent, Inc**]

B. Flexible Ridge Vent: Manufacturer's standard roll-form ridge vent that protects against driven rain and snow and is recommended in writing by manufacturer for installation with roof tile indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Boral Roofing LLC; Boral USA**]

2. Features: [**Butyl adhesive strips at sides**][**Corrugated aluminum strips at sides**].

2.6 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.

C. Elastomeric Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant of class and use classifications required to seal joints in clay-tile roofing and remain watertight; recommended in writing by manufacturer for applications indicated.

D. Roofing Asphalt: ASTM D312/D312M Type IV.

E. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.

F. Mortar: ASTM C270, Type M, [**natural color**][**with ASTM C979/C979M, pigmented mortar matching the color of clay roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar**].

G. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended in writing for application by clay-roof-tile manufacturer.

H. Eave Closure: Manufacturer's standard [**EPDM**][**copper**][**stainless steel**][**galvanized-steel**][**aluminum, mill finish**] eave closure formed to shape of clay roof tiles.

I. Wood Nailers: Comply with requirements for pressure-preservative-treated wood in Section 061000 "Rough Carpentry."

J. Mesh Fabric: **18-by-14 (1.1-by-1.4-mm)** mesh of PVC-coated, glass-fiber thread.

2.7 FASTENERS

A. Roofing Nails: ASTM F1667, [**hot-dip galvanized-steel, 0.120-inch- (3.05-mm-)**][**stainless steel, 0.120-inch- (3.05-mm-)**][**copper, 0.135-inch- (3.43-mm-)**][**silicon-bronze, 0.120-inch- (3.05-mm-)**] diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum **3/8-inch- (10-mm-)** diameter head; of sufficient length to penetrate **3/4 inch (19 mm)** into substrate or extend at least **1/8 inch (3 mm)** through thickness of the sheathing, whichever is less.

1. Where nails are in contact with sheet metal flashing, use nails made from same metal as flashing.

B. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, **1-inch- (25-mm-)** minimum diameter.

1. Provide with minimum **0.0134-inch- (0.34-mm-)** thick metal cap, **0.010-inch- (0.25-mm-)** thick power-driven metal cap, or **0.035-inch- (0.89-mm-)** thick plastic cap; and with minimum **0.083-inch- (2.11-mm-)** thick ring shank or **0.091-inch- (2.31-mm-)** thick smooth shank of length to penetrate at least **3/4 inch (19 mm)** into roof sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.

C. Nails for Wood Nailers: ASTM F1667; common or box, steel wire, flat head, and smooth shank.

D. Wire Ties: [**Copper**][**Brass**][**Stainless steel**], **0.083-inch- (2.11-mm-)** minimum diameter.

E. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed **6 inches (152 mm)** apart, minimum [**0.101-inch- (2.57-mm-) diameter copper wire and 0.064-inch- (1.63-mm-) diameter copper tie wires**][**0.090-inch- (2.29-mm-) diameter stainless steel wire and 0.063-inch- (1.60-mm-) diameter stainless steel tie wires**][**0.105-inch- (2.67-mm-) diameter galvanized-steel wire and 0.063-inch- (1.60-mm-) diameter galvanized-steel tie wires**], with matching-metal folding clip anchors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
   b. [**Wire Works, Inc.**]

F. Single-Line, Wire-Tie System: Interconnecting eave-to-ridge system, minimum [**0.101-inch- (2.57-mm-) diameter copper**][**0.090-inch- (2.29-mm-) diameter stainless steel**][**0.105-inch- (2.67-mm-) diameter galvanized-steel**] wire, preformed to accommodate clay roof tile type and application indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
   b. [**Wire Works, Inc.**]

G. Hook Nails: One-piece wind lock and clay-roof-tile fastener system, minimum [**0.135-inch- (3.43-mm-) diameter brass**][**0.135-inch- (3.43-mm-) diameter copper**][**0.120-inch- (3.05-mm-) diameter stainless steel**][**0.120-inch- (3.05-mm-) diameter galvanized-steel**] wire, for direct deck nailing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
   b. [**Wire Works, Inc.**]

H. Tile Locks: [**Brass**][**Copper**][**Stainless steel**][**Hot-dip galvanized-steel**], nominal **0.1-inch- (2.5-mm-)** diameter wire device designed to secure butt edges of overlaid clay roof tiles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
   b. [**Wire Works, Inc.**]

I. Storm Clips: [**Brass, minimum 0.048-by-1/2-inch (1.22-by-13-mm)**][**Stainless steel, minimum 0.048-by-1/2-inch (1.22-by-13-mm)**][**Hot-dip galvanized-steel, minimum 0.048-by-1/2-inch (1.22-by-13-**

mm)] strap-type, L-shaped retainer clips designed to secure side edges of clay roof tiles. Provide with two fastener holes in base flange.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
   b. [**Wire Works, Inc.**]

2.8 SHEET METAL FLASHING AND TRIM

A. General: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange extending a minimum of [**4 inches (102 mm)**][**6 inches (152 mm)**] over and [**4 inches (102 mm)**] beyond each side of downslope tile roofing and [**6 inches (152 mm)**] up the vertical surface.
2. Step Flashings: Fabricate with a headlap of **4 inches (102 mm)** and a minimum extension of [**4 inches (102 mm)**][**5 inches (127 mm)**] both horizontally and vertically.
3. Channel Flashings: Fabricate with vertical surface extending a minimum of [**4 inches (102 mm)**][**5 inches (127 mm)**] above the clay roof tile and [**4 inches (102 mm)**][**6 inches (152 mm)**] beneath the tile roofing, with a [**1-inch- (25-mm-)**] high vertical return to form a runoff channel.
4. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and [**6 inches (152 mm)**] beneath the tile roofing, with a [**1-inch- (25-mm-)**] high vertical return to form a runoff channel.
5. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [**24 inches (610 mm)**] beneath upslope tile roofing, [**6 inches (152 mm)**] beyond each side of [**chimney**][**skylight**], and [**6 inches (152 mm)**] above the roof plane.
6. Counterflashings: Fabricate to cover [**4 inches (102 mm)**] of base flashing measured vertically; and in lengths required so that no step exceeds [**8 inches (203 mm)**] and overall length is no more than [**10 ft. (3 m)**].

   a. Provide metal [**reglets**][**receivers**] for installation.

7. Valley Flashings: Fabricate from metal sheet not less than [**24 inches (610 mm)**] wide in lengths not exceeding [**10 ft. (3 m)**], with [**1-inch- (25-mm-)**] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [**11 inches (279 mm)**].

   a. Hem flange edges for fastening with metal cleats.

8. Drip Edges: Fabricate in lengths not exceeding [**10 ft. (3 m)**], with minimum **2-inch (51-mm)** roof-deck flange and **1-1/2-inch (38-mm)** fascia flange with **3/8-inch (10-mm)** drip at lower edge.

C. Sheet Metal Ridge Vent: Fabricate from **16-oz./sq. ft.- (0.55-mm-)** thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net free ventilation area of **2.65 sq. in./ft.**

(56 sq. cm/m).

D. Vent-Pipe Flashings: ASTM B749, Type L51121, at least **1/16 inch (1.6 mm)** thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least **4 inches (102 mm)** from pipe onto roof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through roofing.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with clay-roof-tile and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Cover [**ridge**][**hip**] wood nailers with underlayment strips.

B. Felt: Install parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

3. Double-Layer Installation: Install on roof deck.

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **6 inches (152 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install felt over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Asphalt Roll-Roofing: Install parallel with and starting at eaves.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
d. Fasten with underlayment nails.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
d. [**Fasten with underlayment nails**][**Adhere to anchor layer in solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature**][**Adhere to anchor layer in uniform coating of cold-applied adhesive**][**Adhere to anchor layer in uniform coating of asphalt roofing cement**].

3. Double-Layer Installation: Install on roof deck.

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **6 inches (152 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Fasten with underlayment nails.
f. Apply a continuous layer of asphalt roofing cement over starter course and on roll-roofing surface to be concealed by succeeding courses as each roll-roofing course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install roll roofing over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate roll roofing [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

D. Synthetic-Underlayment Top Layer: Install in accordance with manufacturer's written installation instructions and as second layer over anchor-layer underlayment.

1. Completely cover anchor-layer underlayment and install parallel with and starting at the eaves, with side laps offset halfway between side laps of underlying anchor layer.
2. Lap sides and ends as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
3. Stagger end laps from anchor-layer end laps and between succeeding top courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
4. Fasten with underlayment nails.
5. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.

E. Polymer-Modified Bitumen Sheet: Install parallel with and starting at eaves.

1. Single- or Anchor-Layer Installation: Install on roof deck.

   a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
   b. Lap ends a minimum of **6 inches (152 mm)**.
   c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
   d. Fasten with underlayment nails.

2. Top-Layer Installation: Install as a second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

   a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**].
   b. Lap ends a minimum of **6 inches (152 mm)**.
   c. Stagger end laps from anchor-layer end laps and between succeeding top-layer courses at least **72 inches (1829 mm)**.
   d. [**Fasten with underlayment nails**][**Adhere to anchor layer in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature**][**Adhere to anchor layer in uniform coating of cold-applied adhesive**].

3. Double-Layer Installation: Install on roof deck in overlapping layers with a half-width plus **1-inch-(25-mm-)** wide starter course at eaves completely covered by full-width second course.

   a. Install succeeding courses lapping previous courses by a half-width plus **1 inch (25 mm)** in shingle fashion.
   b. Lap ends a minimum of **6 inches (152 mm)**.
   c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
   d. Fasten with underlayment nails.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install sheets over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate sheets [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

F. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.
3. Lap sides not less than **4 inches (102 mm)**.
4. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
5. Roll laps with roller.

6. Prime concrete, masonry, and metal surfaces to receive self-adhering, polymer-modified bitumen sheet.
7. Single-Layer Installation: Install over entire roof deck.
8. Top-Layer Installation: Install as second layer over anchor-layer underlayment.

    a. Completely cover anchor-layer underlayment.
    b. Offset side laps halfway between side laps of underlying anchor layer and offset end laps from those of underlying anchor layer at least **72 inches (1829 mm)**.

9. Water and Ice-Dam Protection Installation: Install on roof deck where indicated [**below**][**on Drawings**].

    a. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
    b. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
    c. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
    d. Hips: Extend [**18 inches (457 mm)**] on each side.
    e. Ridges: Extend [**36 inches (914 mm)**] on each side[**without obstructing continuous ridge vent slot**].
    f. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
    g. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements not less than [**4 inches (102 mm)**].
    h. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.

10. Cover underlayment within seven days.

G. Valley Underlayment: Install one layer of **36-inch- (914-mm-)** wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Use [**same underlayment as installed on field of roof**].
2. Lap ends at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
4. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.3 INSTALLATION OF RIDGE VENTS

A. Rigid-Plastic Ridge Vents: Install continuous ridge vents over clay roof tiles in accordance with manufacturer's written instructions. Fasten with nails of sufficient length to penetrate substrate.

B. Flexible Ridge Vent: Install continuous-roll ridge vents over clay roof tiles in accordance with manufacturer's written instructions.

3.4 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install sheet metal flashings and trim to comply with requirements in Section 076200 "Sheet Metal

Flashing and Trim."

1. Install in accordance with clay-roof-tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.

C. Step Flashings: Install with a headlap of **4 inches (102 mm)** and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.

E. Channel Flashings: Install over underlayment materials and fasten to roof deck.

F. Rake Pan Flashings: Install over underlayment materials and fasten to roof deck.

G. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

H. Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced [**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
2. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to [**underlying self-adhering, polymer-modified bitumen sheet**]. Place strips parallel to and over flanges so that they will be just concealed by installed tile.
3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

I. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

J. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

K. Sheet Metal Ridge Vents: Install centered on and mechanically fasten to wood ridge. Adhere each side to clay roof tile with elastomeric sealant.

1. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

L. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.

3.5 INSTALLATION OF WOOD NAILERS

A. Install wood nailers securely fastened to roof deck at the following locations:

1. Hips.
2. Ridges.
3. Rakes.

B. Install beveled wood-cant nailers at eaves and securely fasten to roof deck.

C. Install nominal **1-by-2-inch (25-by-51-mm)** wood-batten nailers horizontally [**over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips**][**in 48-inch (1219-mm) lengths with ends separated by 1/2 inch (13 mm)**], at spacing required by clay-roof-tile manufacturer, and securely fasten to roof deck.

1. Install nominal **1-by-2-inch (25-by-51-mm)** wood counter battens vertically spaced [**24 inches (610 mm)**] apart and securely fasten to roof deck.

3.6 INSTALLATION OF CLAY ROOF TILES

A. Install clay roof tiles in accordance with manufacturer's written instructions and recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Install to resist wind forces resulting from design wind speeds indicated on Drawings.
2. Maintain uniform exposure and coursing of clay roof tiles throughout roof.
3. Extend tiles **2 inches (51 mm)** over eave fasciae.
4. Nail Fastening: Drive nails to clear the clay roof tile so the tile hangs from the nail and is not drawn up.

   a. Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.

5. Wire-Tie Fastening: Install wire-tie systems and fasten clay roof tiles in accordance with manufacturer's written instructions.
6. Mortar Setting: Install clay roof tiles in accordance with manufacturer's written instructions and acceptance criteria of authorities having jurisdiction.
7. Foam-Adhesive Setting: Install clay roof tiles in accordance with adhesive and tile manufacturers' written instructions and acceptance criteria of authorities having jurisdiction.
8. Storm Clips: Install to capture edges of longitudinal sides of clay roof tiles and securely fasten to roof deck.
9. Tile Locks: Install to support and lock overlying tile butts to underlying tiles.
10. Cut and fit clay roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
11. Install clay roof tiles with color blend approved by Architect, as directed by the Owner.

B. Flat-Shingle Clay-Roof-Tile Installation:

1. Maintain **2-inch (51-mm)** headlap between succeeding courses of clay roof tiles.
2. Offset joints by half the clay-roof-tile width in succeeding courses.
3. Extend clay roof tiles **1 inch (25 mm)** over fasciae at rakes.
4. Install ridge tiles in [**V-ridge**][**saddle**][**mitered**] configuration with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Close voids where ridge tiles meet clay roof tiles with [**ridge closure**][**mortar struck with face of ridge cover**] tiles.

5. Install hip tiles in [**V-ridge**][**saddle**][**mitered**] configuration. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of

hip cover tiles.

C. Flat Interlocking Clay-Roof-Tile Installation:

1. Provide minimum **3-inch (76-mm)** lap between succeeding courses of clay roof tiles.
2. Offset joints by half the clay-roof-tile width in succeeding courses.
3. Install L-shaped rake tiles.
4. Install ridge tiles in [**V-ridge**][**saddle**][**mitered**] configuration with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Close voids where ridge tiles meet clay roof tiles with [**ridge closure**][**mortar struck with face of ridge cover**] tiles.

5. Install hip tiles in [**V-ridge**][**saddle**][**mitered**] configuration. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.

D. Low-Profile, Interlocking Clay-Roof-Tile Installation:

1. Provide minimum **3-inch (76-mm)** lap between succeeding courses of clay roof tiles.
2. Install rake tiles indicated.
3. Install ridge tiles with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

E. High-Profile Clay-Roof-Tile Installation:

1. Install [**tile**][**sheet metal**][**EPDM**] eave closure.
2. Provide minimum **3-inch (76-mm)** lap between succeeding courses of clay roof tiles.
3. Install rake tiles indicated.
4. Install ridge tiles with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

F. Open Valleys: Cut clay roof tiles at open valleys to form straight lines. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

G. Closed Valleys: Cut clay roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap of [**1/2 to 3/4 inch (13 to 19 mm)**][**3/4 to 1 inch (19 to 25 mm)**] on either side of water diverter at valley centerline.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

H. Remove and replace damaged or broken clay roof tiles.

3.7 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of the alterations, but only to the extent the alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting the alterations, has notified the Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent the change affects the Work covered by this Warranty.
6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and affords reasonable opportunity for Roofing System Installer to

inspect the Work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 32 13 00

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SECTION 07 32 16 00 - CONCRETE ROOF TILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete roof tiles.
2. Underlayment materials.
3. Ridge vents.
4. Sheet metal flashing and trim.

B. Related Requirements:

1. Section 077253 "Snow Guards" for snow guards.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 and glossary in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" for definitions of terms related to roofing Work in this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

C. Samples: For each exposed product and for each color and texture specified, in sizes indicated.

1. Concrete Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Sheet Metal Flashing: **12 inches (305 mm)** square.
4. Ridge Vents: **12-inch- (305-mm-)** long Sample.
5. Eave Closures: In manufacturer's standard size.

D. Samples for Initial Selection: For each type of concrete roof tile and accessory tile.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Concrete Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Sheet Metal Flashing: **12 inches (305 mm)** square.
4. Ridge Vents: **12-inch- (305-mm-)** long Sample.
5. Eave Closures: In manufacturer's standard size.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of concrete roof tile, based on evaluation of comprehensive tests performed by a qualified testing agency.

B. Research Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] indicating that product is suitable for intended use under applicable building codes for the following:

1. [**Mortar**][**Adhesive**] tile-attachment systems.
2. Wire-tie tile-attachment systems.
3. Polymer-modified bitumen sheet underlayment.
4. Synthetic underlayment.

C. Qualification Statements: For roofing system Installer.

D. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Materials warranties.

C. Roofing system Installer's warranty.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Concrete Roof Tiles: [**100 sq. ft. (9.3 sq. m)**] of each type, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Roofing System Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified concrete tile system**

installers][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified concrete tile system installers**].

1.10 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for concrete roof tiles including related roofing materials.

a. Size: [**48 inches (1219 mm) long by 48 inches (1219 mm) wide**].
b. Include gutter and downspout complying with requirements in [**Section 076200 "Sheet Metal Flashing and Trim."**][**Section 077100 "Roof Specialties."**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

1. Store on end, on pallets or other raised surfaces. Do not double-stack rolls.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

C. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.13 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace concrete roof tiles that fail in materials within specified warranty period.

1. Warranty Period: [**50**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, in which Installer agrees to repair or replace components of concrete-tile roofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide concrete roof tiles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 CONCRETE ROOF TILES

A. Concrete Roof Tiles: ASTM C1492, molded- or extruded-concrete roof tile units of shape and configuration indicated, with integral color, and free of surface imperfections. Provide with fastening holes prepunched at factory.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bartile**]
   b. [**Boral Roofing LLC; Boral USA**]
   c. [**Crown Roof Tiles**]
   d. [**Eagle Roofing Products**]
   e. [**Vande Hey Raleigh Mfg., Inc**]

2. Weight: [**Normal**][**Medium**][**Light**].
3. High-Profile Shape: Type I, [**Spanish or "S"**][**Spanish or "S," interlocking**].

   a. Accessory Tiles: Type IV, [**ridge**][**ridge vent**][**ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**roll rake edge**][**starter**][**end band**][**terminal**] units.

4. Medium-Profile Shape: Type II, [**French interlocking**].

a. Accessory Tiles: Type IV, [**ridge**][**ridge vent**][**ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**roll rake edge**][**starter**][**end band**][**terminal**] units.

5. Low-Profile Shape: Type III, [**flat shingle**][**flat interlocking**].

a. Accessory Tiles: Type IV, [**Ridge and closed ridge end**][**hip and hip starter**][**header course**][**L-shaped rake edge**][**starter**][**end band**][**terminal**] units.

6. Finish and Texture: [**Matte, smooth**][**Matte, striated**][**Glazed, smooth**].
7. Colors, Blends, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
8. Product Data: Verify materials were fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
9. Product Data: Verify materials were fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.4 UNDERLAYMENT MATERIALS

A. Felt: [**ASTM D226/D226M Type II, asphalt saturated**][**ASTM D4869/D4869M Type IV, asphalt saturated**][**ASTM D2626/D2626M, asphalt saturated and coated, mineral-granule surfaced on weather (top) side**], unperforated.

B. Asphalt Roll-Roofing: ASTM D6380/D6380M, Class M, Type II, asphalt-saturated and -coated organic felt; mineral-granule surfaced on weather (top) side.

C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended, in writing, by manufacturer for use under roof tile; and evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Drexel Metals Corp.**]
b. [**G.A.P. Roofing, Inc.**]
c. [**GAF**]
d. [**Owens Corning**]
e. [**SDP Advanced Polymer Products Inc.**]
f. [**SystemComponents Corporation**]
g. [**Tamko Building Products LLC**]

D. Polymer-Modified Bitumen Sheet: Styrene-butadiene-styrene- (SBS) modified asphalt, glass-fiber-mat-reinforced sheet; minimum [**55-mil (1.4-mm)**][**40-mil (1.0-mm)**] nominal thickness; recommended in writing by manufacturer and acceptable to authorities having jurisdiction for use as underlayment in tile steep-slope roofing systems; and designed for mechanical fastening or adhesive attachment using roofing asphalt or cold-applied adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Boral Roofing LLC; Boral USA**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**G.A.P. Roofing, Inc.**]
    e. [**GMC Roofing & Building Paper Products, Inc.**]
    f. [**Malarkey Roofing Products**]
    g. [**Tarco**]

E. Self-Adhering, Polymer-Modified Bitumen Sheet: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALCO Products LLC**]
    b. [**Atlas Polyiso Roof and Wall Insulation**]
    c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Drexel Metals Corp.**]
    f. [**GAF**]
    g. [**GCP Applied Technologies Inc.**]
    h. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
    i. [**IKO Industries Inc.**]
    j. [**Malarkey Roofing Products**]
    k. [**SDP Advanced Polymer Products Inc.**]
    l. [**Tamko Building Products LLC**]

2. Top Surface: [**Sand**][**Granule**][**Textured polymer film**][**Polyester**].

F. Self-Adhering, Polymer-Modified Bitumen Sheet, High Temperature: ASTM D1970/D1970M, minimum [**55-mil- (1.4-mm-)**][**50-mil- (1.3-mm-)**][**40-mil- (1.0-mm-)**] thick sheet; glass-fiber-mat-reinforced, polymer-modified asphalt; with slip-resistant top surface and release backing; cold applied; and recommended in writing by manufacturer for use in tile roofing system required.[**Provide primer for adjoining concrete, masonry, and metal surfaces to receive underlayment.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALCO Products LLC**]
    b. [**Atlas Polyiso Roof and Wall Insulation**]
    c. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]

d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Drexel Metals Corp.**]
f. [**GCP Applied Technologies Inc.**]
g. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
h. [**Malarkey Roofing Products**]
i. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)** in accordance with ASTM D1970/D1970M.
3. Top Surface: [**Granule**][**Textured polymer film**][**Polyester**].

2.5 RIDGE VENTS

A. Rigid-Plastic Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under ridge tiles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cor-A-Vent, Inc**]

B. Flexible Ridge Vent: Manufacturer's standard roll-form ridge vent that protects against driven rain and snow and is recommended in writing by manufacturer for installation with roof tile indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Boral Roofing LLC; Boral USA**]

2. Features: [**Butyl adhesive strips at sides**][**Corrugated aluminum strips at sides**].

2.6 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.

C. Elastomeric Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant of class and use classifications required to seal joints in concrete-tile roofing and remain watertight; recommended in writing by manufacturer for applications indicated.

D. Roofing Asphalt: ASTM D312/D312M Type IV.

E. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-

applied adhesive specially formulated for compatibility and use with underlayments.

F. Mortar: ASTM C270, Type M, [**natural color**][**with ASTM C979/C979M, pigmented mortar matching the color of concrete roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar**].

G. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended in writing for application by concrete-roof-tile manufacturer.

H. Eave Closure: Manufacturer's standard [**EPDM**][**copper**][**stainless steel**][**galvanized-steel**][**aluminum, mill finish**] eave closure formed to shape of concrete roof tiles.

I. Ridge Closure: Manufacturer's standard EPDM ridge closure, formed to shape of concrete roof tiles.

J. Wood Nailers: Comply with requirements for pressure-preservative-treated wood in Section 061000 "Rough Carpentry."

K. Mesh Fabric: **18-by-14 (1.1-by-1.4-mm)** mesh of PVC-coated, glass-fiber thread.

2.7 FASTENERS

A. Roofing Nails: ASTM F1667, [**hot-dip galvanized-steel, 0.120-inch- (3.05-mm-)**][**stainless steel, 0.120-inch- (3.05-mm-)**][**copper, 0.135-inch- (3.43-mm-)**][**silicon-bronze, 0.120-inch- (3.05-mm-)**] diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum **3/8-inch- (10-mm-)** diameter head; of sufficient length to penetrate **3/4 inch (19 mm)** into substrate or extend at least **1/8 inch (3 mm)** through thickness of the sheathing, whichever is less.

1. Where nails are in contact with sheet metal flashing, use nails made from same metal as flashing.

B. Underlayment Nails: Aluminum, stainless steel, or hot-dip galvanized-steel wire nails with low-profile metal or plastic caps, **1-inch- (25-mm-)** minimum diameter.

1. Provide with minimum **0.0134-inch- (0.34-mm-)** thick metal cap, **0.010-inch- (0.25-mm-)** thick power-driven metal cap, or **0.035-inch- (0.89-mm-)** thick plastic cap; and with minimum **0.083-inch- (2.11-mm-)** thick ring shank or **0.091-inch- (2.31-mm-)** thick smooth shank of length to penetrate at least **3/4 inch (19 mm)** into roof sheathing or to penetrate through roof sheathing less than **3/4 inch (19 mm)** thick.

C. Nails for Wood Nailers: ASTM F1667; common or box, steel wire, flat head, and smooth shank.

D. Wire Ties: [**Copper**][**Brass**][**Stainless steel**], **0.083-inch- (2.11-mm-)** minimum diameter.

E. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed **6 inches (152 mm)** apart, minimum [**0.101-inch- (2.57-mm-) diameter copper wire and 0.064-inch- (1.63-mm-) diameter copper tie wires**][**0.090-inch- (2.29-mm-) diameter stainless steel wire and 0.063-inch- (1.60-mm-) diameter stainless steel tie wires**][**0.105-inch- (2.67-mm-) diameter galvanized-steel wire and 0.063-inch- (1.60-mm-) diameter galvanized-steel tie wires**], with matching-metal folding clip anchors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
b. [**Wire Works, Inc.**]

F. Hook Nails: One-piece wind lock and concrete-roof-tile fastener system, minimum [**0.135-inch- (3.43-mm-) diameter brass**][**0.135-inch- (3.43-mm-) diameter copper**][**0.120-inch- (3.05-mm-) diameter stainless steel**][**0.120-inch- (3.05-mm-) diameter galvanized-steel**] wire, for direct deck nailing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
b. [**Wire Works, Inc.**]

G. Tile Locks: [**Brass**][**Copper**][**Stainless steel**][**Hot-dip galvanized-steel**], nominal **0.1-inch- (2.5-mm-)** diameter wire device designed to secure butt edges of overlaid concrete roof tiles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
b. [**Wire Works, Inc.**]

H. Storm Clips: [**Brass, minimum 0.048-by-1/2-inch (1.22-by-13-mm)**][**Stainless steel, minimum 0.048-by-1/2-inch (1.22-by-13-mm)**][**Hot-dip galvanized-steel, minimum 0.048-by-1/2-inch (1.22-by-13-mm)**] strap-type, L-shaped retainer clips designed to secure side edges of concrete roof tiles. Provide with two fastener holes in base flange.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frances Fasteners Inc., dba STORM-LOCK Tile Fasteners**]
b. [**Wire Works, Inc.**]

2.8 SHEET METAL FLASHING AND TRIM

A. General: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: [**Copper**][**Stainless steel**][**Zinc-tin alloy coated copper**][**Anodized aluminum**][**Aluminum, mill finished**].

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange extending a minimum of [**4 inches (102 mm)**][**6**

inches (152 mm)] over and [4 inches (102 mm)] beyond each side of downslope tile roofing and [6 inches (152 mm)] up the vertical surface.

2. Step Flashings: Fabricate with a headlap of 4 inches (102 mm) and a minimum extension of [4 inches (102 mm)][5 inches (127 mm)] both horizontally and vertically.
3. Channel Flashings: Fabricate with vertical surface extending a minimum of [4 inches (102 mm)][5 inches (127 mm)] above the concrete roof tile and [4 inches (102 mm)][6 inches (152 mm)] beneath the tile roofing, with a [1-inch- (25-mm-)] high vertical return to form a runoff channel.
4. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and [6 inches (152 mm)] beneath the tile roofing, with a [1-inch- (25-mm-)] high vertical return to form a runoff channel.
5. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of [24 inches (610 mm)] beneath upslope tile roofing, [6 inches (152 mm)] beyond each side of [**chimney**][**skylight**], and [6 inches (152 mm)] above the roof plane.
6. Counterflashings: Fabricate to cover [4 inches (102 mm)] of base flashing measured vertically; and in lengths required so that no step exceeds [8 inches (203 mm)] and overall length is no more than [10 ft. (3 m)].

    a. Provide metal [**reglets**][**receivers**] for installation.

7. Valley Flashings: Fabricate from metal sheet not less than [24 inches (610 mm)] wide in lengths not exceeding [10 ft. (3 m)] with [1-inch- (25-mm-)] high, inverted-V profile water diverter at center of valley and equal flange widths of not less than [11 inches (279 mm)].

    a. Hem flange edges for fastening with metal cleats.

8. Drip Edges: Fabricate in lengths not exceeding [10 ft. (3 m)] with minimum 2-inch (51-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.

C. Sheet Metal Ridge Vent: Fabricate from 16-oz./sq. ft.- (0.55-mm-) thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net free ventilation area of 2.65 sq. in./ft. (56 sq. cm/m).

D. Vent-Pipe Flashings: ASTM B749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (102 mm) from pipe onto roof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through roofing.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by roofing system Installer, listing conditions detrimental to

performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with concrete-roof-tile and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Cover [**ridge**][**hip**] wood nailers with underlayment strips.

B. Felt: Install parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.

3. Double-Layer Installation: Install on roof deck.

a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
c. Lap ends a minimum of **6 inches (152 mm)**.
d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install felt over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate felt [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

C. Asphalt Roll-Roofing: Install parallel with and starting at eaves.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
b. Lap ends a minimum of **4 inches (102 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
d. Fasten with underlayment nails.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

    a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
    b. Lap ends a minimum of **4 inches (102 mm)**.
    c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
    d. [**Fasten with underlayment nails**][**Adhere to anchor layer in solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature**][**Adhere to anchor layer in uniform coating of cold-applied adhesive**][**Adhere to anchor layer in uniform coating of asphalt roofing cement**].

3. Double-Layer Installation: Install on roof deck.

    a. Install a **19-inch- (483-mm-)** wide starter course at eaves and completely cover with a **36-inch- (914-mm-)** wide second course.
    b. Install succeeding **36-inch- (914-mm-)** wide courses lapping previous courses **19 inches (483 mm)** in shingle fashion.
    c. Lap ends a minimum of **6 inches (152 mm)**.
    d. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
    e. Fasten with underlayment nails.
    f. Apply a continuous layer of asphalt roofing cement over starter course and on roll-surface to be concealed by succeeding courses as each roll-roofing course is installed. Apply [**over entire roof**][**at locations indicated on Drawings**].

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install roll roofing over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate roll roofing [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

D. Synthetic-Underlayment Top Layer: Install in accordance with manufacturer's written installation instructions and as second layer over anchor-layer underlayment.

1. Completely cover anchor-layer underlayment and install parallel with and starting at the eaves, with side laps offset halfway between side laps of underlying anchor layer.
2. Lap sides and ends as recommended in writing by manufacturer, but not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] for side laps and **6 inches (152 mm)** for end laps.
3. Stagger end laps from anchor-layer end laps and between succeeding top courses at interval recommended in writing by manufacturer, but not less than **72 inches (1829 mm)**.
4. Fasten with underlayment nails.
5. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.

E. Polymer-Modified Bitumen Sheet: Install parallel with and starting at eaves.

1. Single- or Anchor-Layer Installation: Install on roof deck.

    a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**] over underlying course.
    b. Lap ends a minimum of **6 inches (152 mm)**.
    c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
    d. Fasten with underlayment nails.

2. Top-Layer Installation: Install as a second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of [**2 inches (51 mm)**][**4 inches (102 mm)**].
b. Lap ends a minimum of **6 inches (152 mm)**.
c. Stagger end laps from anchor-layer end laps and between succeeding top-layer courses at least **72 inches (1829 mm)**.
d. [**Fasten with underlayment nails**][**Adhere to anchor layer in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature**][**Adhere to anchor layer in uniform coating of cold-applied adhesive**].

3. Double-Layer Installation: Install on roof deck in overlapping layers with a half-width plus **1-inch-(25-mm-)** wide starter course at eaves completely covered by full-width second course.

a. Install succeeding courses lapping previous courses by a half-width plus **1 inch (25 mm)** in shingle fashion.
b. Lap ends a minimum of **6 inches (152 mm)**.
c. Stagger end laps between succeeding courses at least **72 inches (1829 mm)**.
d. Fasten with underlayment nails.

4. Install fasteners in a grid pattern of **12 inches (305 mm)** between side laps with **6-inch (152-mm)** spacing at side and end laps.
5. Install sheets over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate sheets [**flush**][**extended up not less than 4 inches (102 mm)**] against sidewalls, curbs, chimneys, and other roof projections.

F. Self-Adhering, Polymer-Modified Bitumen Sheet: Install, wrinkle free.

1. Comply with low-temperature installation restrictions of underlayment manufacturer.
2. Install lapped in direction that sheds water.
3. Lap sides not less than **4 inches (102 mm)**.
4. Lap ends not less than **6 inches (152 mm)**, staggered **24 inches (610 mm)** between succeeding courses.
5. Roll laps with roller.
6. Prime concrete, masonry, and metal surfaces to receive self-adhering, polymer-modified bitumen sheet.
7. Single-Layer Installation: Install over entire roof deck.
8. Top-Layer Installation: Install as second layer over anchor-layer underlayment.

a. Completely cover anchor-layer underlayment.
b. Offset side laps halfway between side laps of underlying anchor layer and offset end laps from those of underlying anchor layer at least **72 inches (1829 mm)**.

9. Water and Ice-Dam Protection Installation: Install on roof deck where indicated [**below**][**on Drawings**].

a. Eaves: Extend from edges of eaves [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
b. Rakes: Extend from edges of rakes [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior face of exterior wall.
c. Valleys: Extend from lowest to highest point [**18 inches (457 mm)**] on each side of centerline.
d. Hips: Extend [**18 inches (457 mm)**] on each side.
e. Ridges: Extend [**36 inches (914 mm)**] on each side [**without obstructing continuous ridge vent slot**].
f. Sidewalls: Extend [**18 inches (457 mm)**] beyond sidewalls and return vertically against sidewalls not less than [**4 inches (102 mm)**].
g. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend [**18 inches (457 mm)**] beyond penetrating elements and return vertically against penetrating elements

not less than [**4 inches (102 mm)**].

h. Roof-Slope Transitions: Extend [**18 inches (457 mm)**] on each roof slope.

10. Cover underlayment within seven days.

G. Valley Underlayment: Install one layer of **36-inch- (914-mm-)** wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Use [**same underlayment as installed on field of roof**].
2. Lap ends at least **12 inches (305 mm)** in direction that sheds water, and seal with asphalt roofing cement.
3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
4. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.3 INSTALLATION OF RIDGE VENTS

A. Rigid-Plastic Ridge Vents: Install continuous ridge vents over concrete roof tiles in accordance with manufacturer's written instructions. Fasten with nails of sufficient length to penetrate substrate.

B. Flexible Ridge Vent: Install continuous-roll ridge vents over concrete roof tiles in accordance with manufacturer's written instructions.

3.4 INSTALLATION OF SHEET METAL FLASHING AND TRIM

A. Install sheet metal flashings and trim to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with concrete-roof-tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.

C. Step Flashings: Install with a headlap of **4 inches (102 mm)** and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.

E. Channel Flashings: Install over underlayment materials and fasten to roof deck.

F. Rake Pan Flashings: Install over underlayment materials and fasten to roof deck.

G. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of **4 inches (102 mm)** secured in a waterproof manner.

1. Install in reglets or receivers.

H. Valley Flashings: Install centered in valleys, lapping ends at least [**8 inches (203 mm)**] in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced [**12 inches (305 mm)**][**24 inches (610 mm)**] apart and fastened to roof deck.
2. Adhere minimum [**9-inch- (229-mm-)**] wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to [**underlying self-adhering, polymer-modified bitumen sheet**]. Place strips parallel to and over flanges so that they will be just concealed by installed tile.
3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

I. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

J. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

K. Sheet Metal Ridge Vents: Install centered on and mechanically fasten to wood ridge. Adhere each side to concrete roof tile with elastomeric sealant.

1. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

L. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.

3.5 INSTALLATION OF WOOD NAILERS

A. Install wood nailers securely fastened to roof deck at the following locations:

1. Hips.
2. Ridges.
3. Rakes.

B. Install beveled wood-cant nailers at eaves and securely fasten to roof deck.

C. Install nominal **1-by-2-inch (25-by-51-mm)** wood-batten nailers horizontally [**over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips**][**in 48-inch (1219-mm) lengths with ends separated by 1/2 inch (13 mm)**], at spacing required by concrete-roof-tile manufacturer, and securely fasten to roof deck.

1. Install nominal **1-by-2-inch (25-by-51-mm)** wood counter battens vertically spaced [**24 inches (610 mm)**] apart and securely fasten to roof deck.

3.6 INSTALLATION OF CONCRETE ROOF TILES

A. Install concrete roof tiles in accordance with manufacturer's written instructions and recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Install tiles to resist wind forces resulting from design wind speeds indicated on Drawings.
2. Maintain uniform exposure and coursing of concrete roof tiles throughout roof.
3. Extend tiles **2 inches (51 mm)** over eave fasciae.
4. Nail Fastening: Drive nails to clear the concrete roof tile so the tile hangs from the nail and is not drawn up.

a. Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.

5. Wire-Tie Fastening: Install wire-tie systems and fasten concrete roof tiles in accordance with manufacturer's written instructions.
6. Mortar Setting: Install concrete roof tiles in accordance with manufacturer's written instructions and acceptance criteria of authorities having jurisdiction.
7. Foam-Adhesive Setting: Install concrete roof tiles in accordance with adhesive and tile manufacturers' written instructions and acceptance criteria of authorities having jurisdiction.
8. Storm Clips: Install to capture edges of longitudinal sides of concrete roof tiles and securely fasten to roof deck.
9. Tile Locks: Install to support and lock overlying tile butts to underlying tiles.
10. Cut and fit concrete roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
11. Install concrete roof tiles with color blend approved by Architect, as directed by the Owner.

B. Low-Profile, Flat-Shingle Concrete-Roof-Tile Installation:

1. Maintain **2-inch (51-mm)** headlap between succeeding courses of concrete roof tiles.
2. Offset joints by half the concrete-roof-tile width in succeeding courses.
3. Extend concrete roof tiles **1 inch (25 mm)** over fasciae at rakes.
4. Install ridge tiles in [**V-ridge**][**saddle**][**mitered**] configuration with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Close voids where ridge tiles meet concrete roof tiles with [**ridge closure**][**mortar struck with face of ridge cover**] tiles.

5. Install hip tiles in [**V-ridge**][**saddle**][**mitered**] configuration. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Fill voids with mortar where hip tiles meet concrete roof tiles, and strike mortar flush with face of hip cover tiles.

C. Low-Profile, Flat Interlocking Concrete-Roof-Tile Installation:

1. Provide minimum **3-inch (76-mm)** lap between succeeding courses of concrete roof tiles.
2. Offset joints by half the concrete-roof-tile width in succeeding courses.
3. Install L-shaped rake tiles.
4. Install ridge tiles in [**V-ridge**][**saddle**][**mitered**] configuration with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Close voids where ridge tiles meet concrete roof tiles with [**ridge closure**][**mortar struck with face of ridge cover**] tiles.

5. Install hip tiles in [**V-ridge**][**saddle**][**mitered**] configuration. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

   a. Fill voids with mortar where hip tiles meet concrete roof tiles, and strike mortar flush with face of hip cover tiles.

D. Medium-Profile, Interlocking Concrete-Roof-Tile Installation:

1. Provide minimum **3-inch (76-mm)** lap between succeeding courses of concrete roof tiles.
2. Install rake tiles indicated.
3. Install ridge tiles with laps facing away from prevailing wind. Seal laps with [**asphalt roofing**

cement][**butyl sealant**][**elastomeric sealant**].

E. High-Profile Concrete-Roof-Tile Installation:

1. Install [**tile**][**sheet metal**][**EPDM**] eave closure.
2. Provide minimum **3-inch (76-mm)** lap between succeeding courses of concrete roof tiles.
3. Install rake tiles indicated.
4. Install ridge tiles with laps facing away from prevailing wind. Seal laps with [**asphalt roofing cement**][**butyl sealant**][**elastomeric sealant**].

F. Open Valleys: Cut concrete roof tiles at open valleys to form straight lines. [**Maintain uniform width of exposed open valley**][**Widen exposed portion of open valley 1/8 inch in 12 inches (1:96)**] from highest to lowest point.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

G. Closed Valleys: Cut concrete roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap of [**1/2 to 3/4 inch (13 to 19 mm)**][**3/4 to 1 inch (19 to 25 mm)**] on either side of water diverter at valley centerline.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

H. Remove and replace damaged or broken concrete roof tiles.

3.7 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of the Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the work and other parts of the building, and to building contents, caused by:

a. lightning;

b. peak gust wind speed;
c. fire;
d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
e. faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
f. vapor condensation on bottom of roofing; and
g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When the Work has been damaged by any of foregoing causes, Warranty becomes null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to the Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the Work.
4. During Warranty Period, if the Owner allows alteration of the Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty becomes null and void on date of the alterations, but only to the extent the alterations affect the Work covered by this Warranty. If the Owner engages Roofing System Installer to perform the alterations, Warranty does not become null and void unless Roofing System Installer, before starting the alterations, has notified the Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty becomes null and void on date of the change, but only to the extent the change affects the Work covered by this Warranty.
6. the Owner to promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and affords reasonable opportunity for Roofing System Installer to inspect the Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and does not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty does not operate to relieve Roofing System Installer of responsibility for performance of the Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 32 16 00

Task	Specification	Specification Description
07 34 00 00	07 31 13 00	Asphalt Shingles
07 34 00 00	07 31 16 00	Metal Shingles
07 34 00 00	07 31 26 00	Slate Shingles
07 34 00 00	07 31 29 00	Wood Shingles And Shakes
07 34 00 00	07 32 13 00	Clay Roof Tiles

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SECTION 07 41 13 00 - FORMED METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corrugated-profile, exposed-fastener metal roof panels.
2. Tapered-rib-profile, exposed-fastener metal roof panels.
3. Vee-rib-profile, exposed-fastener metal roof panels.
4. Box-rib-profile, exposed-fastener metal roof panels.
5. Deep-box-rib-profile, exposed-fastener metal roof panels.
6. Horizontal-seam (Bermuda-type) metal roof panels.
7. Substrate board.
8. Vapor retarder.
9. Roof insulation.
10. Cover board.
11. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
2. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with the Owner‘s insurer if applicable, metal roof panel Installer, metal roof panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal roof panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of supporting structure during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other

construction that affect metal roof panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal roof panel systems during and after installation.
9. Review procedures for repair of metal roof panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish for metal roof panels, clips, fasteners, closures, and other metal panel accessories.

1. Size: [**Manufacturers' standard size**].

E. Sustainable Design Submittals:

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates for portable roll-forming equipment.

B. Product Test Reports: For formed metal roof panels, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Qualification Statements: For roof installers.

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal roof panels.

1.7 QUALITY ASSURANCE

A. Roof Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Metal Panel Roof Systems Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Metal Panel Roof Systems Installers**].

B. Portable Roll-Forming Equipment Certification: UL-certified, portable roll-forming equipment capable of producing metal roof panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of Work.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area and eave[**including fascia,**][**and soffit**] as shown on Drawings; approximately [**48 inches (1200 mm)**][**12 ft. (3.5 m)**] square by full thickness, including attachments, underlayment, and accessories.
2. Build mockups for typical roof area only, including accessories.

   a. Size: [**12 ft. (3.5 m) long by 6 ft. (1.75 m)**].
   b. [**Each type of exposed seam and seam termination**].

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness, with positive slope for drainage of water. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal roof panels during installation.

E. Copper Roof Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal roof panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal roof panel systems capable of withstanding the effects of the following loads when tested in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

B. Air Infiltration: Air leakage of not more than [**0.04 cfm/sq. ft. (0.2 L/s per sq. m)**][**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with [**ASTM E1680**] [**ASTM E283/E283M**] at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

C. Water Penetration under Static Pressure: No water penetration when tested in accordance with [**ASTM E1646**] [**ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

D. Watertightness: No water penetration when tested in accordance with ASTM E2140 for hydrostatic-head resistance.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: [**UL 30**][**UL 60**][**UL 90**].

F. FM Approvals Listing: Provide metal roof panels and component materials that comply with requirements in FM Approvals 4471 as part of a metal panel roofing system and that are listed in FM's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.

1. Fire/Windstorm Classification: Class 1A-[**60**][**75**][**90**][**105**][**120**].
2. Hail Resistance: [**MH**][**SH**].

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

H. Energy Performance:

1. Provide metal roof panels meeting one of the following requirements when tested in accordance with CRRC-1:

a. Three-year, aged solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
b. Three-year, aged Solar Reflectance Index (SRI) of not less than [**64**] when calculated in accordance with ASTM E1980.

2.2 EXPOSED-FASTENER METAL ROOF PANELS, GENERAL

A. Provide factory-formed metal roof panels designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners. Include all accessories required for weathertight installation.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 CORRUGATED-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
2. [**Berridge Manufacturing Company**]
3. [**CENTRIA, a Nucor Brand**]
4. [**Fabral; a brand of Flack Global Metals**]
5. [**Flexospan Steel Buildings, Inc**]
6. [**MBCI; Cornerstone Building Brands**]
7. [**McElroy Metal, Inc**]
8. [**Metal Sales Manufacturing Corporation**]
9. [**Morin - A Kingspan Group Company**]
10. [**Union Corrugating Company; Cornerstone Building Brands**]

B. Metal Roof Panels: Formed with alternating curved ribs.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Rib Spacing: [**2.67 inches (68 mm)**] o.c. across width of panel.
4. Panel Coverage: [**21.3 inches (541 mm)**][**29.3 inches (744 mm)**][**34.67 inches (881 mm)**][**37.3 inches (947 mm)**][**42.67 inches (1084 mm)**][**45.3 inches (1151 mm)**].
5. Panel Height: [**0.5 inch (13 mm)**][**0.875 inch (22 mm)**].
6. Fasteners: Manufacturer's standard screw fasteners.

2.4 TAPERED-RIB-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
2. [**Architectural Metal Systems**]
3. [**Berridge Manufacturing Company**]
4. [**Butler Manufacturing Company; a division of BlueScope Buildings North America, Inc.**]
5. [**CENTRIA, a Nucor Brand**]
6. [**Everlast Metals**]
7. [**Fabral; a brand of Flack Global Metals**]
8. [**Flexospan Steel Buildings, Inc**]
9. [**MBCI; Cornerstone Building Brands**]
10. [**McElroy Metal, Inc**]
11. [**Metal Sales Manufacturing Corporation**]
12. [**Morin - A Kingspan Group Company**]
13. [**PAC-CLAD; Petersen; a Carlisle company**]

14. [**Union Corrugating Company; Cornerstone Building Brands**]

B. Metal Roof Panels: Formed with raised, trapezoidal ribs spaced at regular intervals.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Panel Profile: [**Intermediate stiffening ribs, symmetrically spaced**][**Flat pan**] between major ribs.
4. Rib Spacing: [**6 inches (152 mm)**][**8 inches (203 mm)**][**9 inches (229 mm)**][**12 inches (305 mm)**] o.c.
5. Panel Coverage: [**24 inches (610 mm)**][**36 inches (914 mm)**].
6. Panel Height: [**0.625 inch (16 mm)**][**0.75 inch (19 mm)**][**1 inch (25 mm)**][**1.25 inches (32 mm)**][**1.5 inches (38 mm)**].
7. Fasteners: Manufacturer's standard screw fasteners.

2.5 VEE-RIB-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
2. [**Berridge Manufacturing Company**]
3. [**CENTRIA, a Nucor Brand**]
4. [**Fabral; a brand of Flack Global Metals**]
5. [**Flexospan Steel Buildings, Inc**]
6. [**MBCI; Cornerstone Building Brands**]
7. [**Metal Sales Manufacturing Corporation**]
8. [**Morin - A Kingspan Group Company**]
9. [**PAC-CLAD; Petersen; a Carlisle company**]
10. [**Sentrigard; NB Handy Company**]

B. Metal Roof Panels: Formed with raised, V-shaped ribs and recesses that are approximately same size, evenly spaced across panel width, and with rib/recess sides angled at approximately 45 degrees.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Rib Spacing: [**5.3 inches (135 mm)**][**7.2 inches (183 mm)**][**12 inches (305 mm)**].
4. Panel Coverage: [**30 inches (762 mm)**][**32 inches (813 mm)**][**36 inches (914 mm)**][**40 inches (1016 mm)**].
5. Panel Height: [**1.375 inches (35 mm)**][**1.5 inches (38 mm)**][**1.75 inches (44 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**].

2.6 BOX-RIB-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Berridge Manufacturing Company**]
2. [**Fabral; a brand of Flack Global Metals**]
3. [**MBCI; Cornerstone Building Brands**]

4. [**Metal Sales & Service, Inc.**]
5. [**Metal Sales Manufacturing Corporation**]

B. Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled 60 degrees or more.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Rib Spacing: [**2.67 inches (68 mm)**][**4 inches (102 mm)**][**5.3 inches (135 mm)**][**6 inches (152 mm)**] o.c.
4. Panel Coverage: [**24 inches (610 mm)**][**28 inches (711 mm)**][**30 inches (762 mm)**][**32 inches (813 mm)**][**36 inches (914 mm)**].
5. Panel Height: [**0.625 inch (16 mm)**][**1 inch (25 mm)**][**1.5 inches (38 mm)**][**2 inches (50 mm)**].

2.7 DEEP-BOX-RIB-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CENTRIA, a Nucor Brand**]
2. [**Fabral; a brand of Flack Global Metals**]
3. [**MBCI; Cornerstone Building Brands**]
4. [**Metal Sales & Service, Inc.**]
5. [**Metal Sales Manufacturing Corporation**]
6. [**Morin - A Kingspan Group Company**]

B. Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Rib Spacing: [**12 inches (305 mm)**] o.c.
4. Panel Coverage: [**24 inches (610 mm)**].
5. Panel Height: [**3 inches (75 mm)**][**4 inches (102 mm)**].

2.8 HORIZONTAL-SEAM (BERMUDA-TYPE) METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Berridge Manufacturing Company**]
2. [**Drexel Metals Corp.**]

B. Metal Roof Panels: Formed with horizontal seam at panel edges and smooth, flat pan; designed to be installed in sequential installation by engaging lower edge of each panel to upper edge of panel below and mechanically attaching panels to supports using concealed clips located under upper edge of panels.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Exposure: [**9.5 inches (241 mm)**][**11 inches (279 mm)**] nominal.
4. Seam Height: [**1 inch (25 mm)**][**1.5 inches (38 mm)**].
5. Seal: Factory-applied sealant or vinyl weatherseal in seam.
6. Clips: One piece.

    a. **0.028-inch- (0.71-mm-)** nominal thickness, [**zinc-coated (galvanized)**][**aluminum-zinc alloy-coated**] steel sheet.
    b. **0.025-inch- (0.64-mm-)** thick, stainless steel sheet.

2.9 METAL ROOF PANEL MATERIAL

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Sheet prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**].
2. Surface: [**Smooth, flat**][**Embossed**] texture.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**].
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**].
2. Surface: [**Smooth, flat**][**Embossed**] texture.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**][**Clear anodized**][**Color anodized**].
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], fully annealed.

1. Nominal Thickness: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**].
2. Exterior Finish: [**Polished**][**Bright, cold-rolled, unpolished**].

D. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

1. Thickness: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**].
2. Exposed Finish: [**Mill**][**Prepatinated**].
3. Prepatinated Color: [**Dark brown**][**Verdigris**].

2.10 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions for fastening substrate board to roof deck.

2.11 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.12 ROOF INSULATION

A. Insulation Over Solid Deck:

1. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Atlas Polyiso Roof and Wall Insulation**]
2) [**Carlisle Syntec Systems**]
3) [**CertainTeed; SAINT-GOBAIN**]
4) [**Elevate; Holcim Building Envelope**]
5) [**GAF**]
6) [**Hunter Panels; a Carlisle company**]
7) [**IKO Industries Inc.**]
8) [**Insulfoam; a Carlisle Company**]
9) [**Johns Manville; a Berkshire Hathaway company**]
10) [**Kingspan Insulation LLC**]
11) [**Polyglass U.S.A., Inc.**]
12) [**Rmax, A Business Unit of Sika Corporation**]

b. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
c. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
d. Thickness:

1) Base Layer: [**1-1/2 inches (38 mm)**]

2. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber-mat facer on the other surface.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Atlas Polyiso Roof and Wall Insulation**]
2) [**CertainTeed; SAINT-GOBAIN**]
3) [**Elevate; Holcim Building Envelope**]
4) [**GAF**]
5) [**Hunter Panels; a Carlisle company**]
6) [**Insulfoam; a Carlisle Company**]
7) [**Johns Manville; a Berkshire Hathaway company**]

b. Facer: [**Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
c. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

B. Insulation Over Open Framing:

1. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

    a. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
    b. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
    c. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

2.13 COVER BOARD

A. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

B. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

C. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

D. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

2.14 UNDERLAYMENT

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ATAS International, Inc.**]
    b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    c. [**GCP Applied Technologies Inc.**]
    d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
    e. [**Owens Corning**]
    f. [**Polyglass U.S.A., Inc.**]
    g. [**Protecto Wrap Company**]
    h. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **220 deg F (111 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.

B. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.15 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal roof panel system.

B. Roof Panel Accessories: Provide components required for a complete, weathertight roof panel system, including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal roof panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

D. Gutters: Formed from same material as metal roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum **96-inch- (2400-mm-)** long sections, of size and metal thickness in accordance with manufacturer's recommendations. Furnish gutter supports spaced a maximum of **36 inches (914 mm)** o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match [**metal roof panels**][**roof fascia and rake trim**].

E. Downspouts: Formed from same material as metal roof panels. Fabricate in **10-foot- (3-m-)** long sections, complete with formed elbows and offsets, of size and metal thickness in accordance with manufacturer's recommendations. Finish downspouts to match gutters.

F. Roof Curbs: Fabricated from same material as metal roof panels, [**0.048-inch- (1.2-mm)-)**] nominal thickness; with bottom of skirt profiled to match metal roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of **0.060-inch- (1.52-mm-)** nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.

1. Insulate roof curb with **1-inch- (25-mm-)** thick, rigid insulation.

G. Roof Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied

coating. Provide EPDM or PVC sealing washers for exposed fasteners.

H. Roof Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.16 FABRICATION

A. Fabricate and finish metal roof panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal roof panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Provide roof panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal roof panel manufacturer.

    a. Size: As recommended by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.17 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective

covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Roof Panels and Accessories:

1. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
3. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
4. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
5. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.
7. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

D. Aluminum Roof Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry

film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

7. Exposed Anodized Finish:

    a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
    b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

E. Stainless Steel Roof Panels and Accessories:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    c. Directional Satin Finish: ASTM A480/A480M No. 4.

3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

F. Copper Roof Panels and Accessories:

1. Prepatination: Factory prepatinate in accordance with ASTM B882 to convert the copper surface to an inorganic crystalline structure with the appearance and durability of naturally formed patina.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal roof panel manufacturer's written

recommendations.

3.3 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (610 mm)** in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

   a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tightly around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
4. Fasten substrate board in accordance with roofing system manufacturers' written installation instructions.

3.4 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 152 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with [**tape**][**adhesive**].

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.5 INSTALLATION OF ROOF INSULATION

A. General: Install insulation concurrently with metal roof panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written installation instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.

3.6 INSTALLATION OF COVER BOARD

A. Install cover boards over insulation in accordance with manufacturer's written installation instructions.

Install with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (152 mm)** in each direction.

3.7 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated [**below**][**on Drawings**], wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches (152 mm)** staggered **24 inches (610 mm)** between courses. Overlap side edges not less than **3-1/2 inches (90 mm)**.[**Extend underlayment into gutter trough.**] Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.
2. Apply over the roof area indicated below:

   a. Roof perimeter for a distance up from eaves of [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior wall line.
   b. Valleys, from lowest point to highest point, for a distance on each side of [**18 inches (460 mm)**]. Overlap ends of sheets not less than **6 inches (152 mm)**.
   c. Rake edges for a distance of [**18 inches (460 mm)**].
   d. Hips and ridges for a distance on each side of [**12 inches (305 mm)**].
   e. Roof-to-wall intersections for a distance from wall of [**18 inches (460 mm)**].
   f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of [**18 inches (460 mm)**].

B. Felt Underlayment: Apply at locations indicated [**below**][**on Drawings**], in shingle fashion to shed water, and with lapped joints of not less than **2 inches (50 mm)**.

1. Apply over the entire roof surface.
2. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than **3 inches (75 mm)**, in shingle fashion to shed water.

C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

D. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.8 INSTALLATION OF FORMED METAL ROOF PANELS

A. Install metal roof panels in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal roof panels.
2. Flash and seal metal roof panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that are concealed by metal roof panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal roof panel Work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal roof panels and fasten with blind rivets, bolts, or self-tapping screws.

Fasten flashings and trim around openings and similar elements with self-tapping screws.

8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Roof Panels: Use stainless steel fasteners for surfaces exposed to exterior; use galvanized-steel fasteners for surfaces exposed to interior.
2. Aluminum Roof Panels: Use aluminum or stainless steel fasteners for surfaces exposed to exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to interior.
3. Stainless Steel Roof Panels: Use stainless steel fasteners.
4. Copper Roof Panels: Use copper, stainless steel, or hardware-bronze fasteners.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal roof panel manufacturer.

D. Exposed-Fastener, Metal Roof Panels: Fasten metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal roof panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
5. Flash and seal panels with weather closures at perimeter of all openings.
6. Watertight Installation:

   a. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal roof panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
   b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
   c. At panel splices, nest panels with minimum **6-inch (152-mm)** end lap, sealed with sealant and fastened together by interlocking clamping plates.

E. Horizontal-Seam (Bermuda-Type) Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each horizontal-seam joint at location and spacing, and with fasteners recommended by manufacturer. Start at eave and work upward toward ridge.

1. Install clips to supports with self-drilling fasteners.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel system, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturer; or, if not indicated, provide types recommended in writing by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that are without buckling and tool marks, and that are true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing

and trim to fit substrates and achieve waterproof performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft. (3 m)**, with no joints allowed within **24 inches (610 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than **36 inches (914 mm)** o.c., using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely **1 inch (25 mm)** away from walls; locate fasteners at top and bottom and at approximately **60 inches (1524 mm)** o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

J. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

K. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.9 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by

finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13 00

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SECTION 07 41 13 00A - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum plate wall panels.

B. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 061600 "Sheathing" for structural wall sheathing.
3. Section 072100 "Thermal Insulation" for insulation.
4. Section 072500 "Weather Barriers" for weather-resistive barriers and sealing penetrations in barriers resulting from installation of support system.
5. Section 072726 "Fluid-Applied Membrane Air Barriers" for air barriers and sealing penetrations in barriers resulting from installation of wall panel support system.

1.2 DEFINITIONS

A. Wall Panel Assembly: Assembly consisting of wall panels, support systems, cavities, [**continuous insulation, girts,**] weather barriers, air barriers, and sheathing substrate that has been shown to comply with assembly testing and performance requirements.

1.3 COORDINATION

A. Coordinate installation of wall panels and support system with insulation, weather barriers, air barriers, flashings, and other adjoining construction to ensure proper sequencing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Meet with the Owner’s insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.

8. Review procedures for repair of field-cut metal panels or metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: [**Manufacturer's standard size**] .

E. Delegated Design Submittals: For wall panel assembly, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Wall Panel Assembly Test Reports: Certified test reports showing system compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For [**Installer**][**testing agency**][**and delegated design engineer**] .

D. Sample Warranties: For specified special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal plate wall panels.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: An agency acceptable to authorities having jurisdiction.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical metal wall panel assembly [**as indicated on Drawings**] including [**corner,**][**soffits,**] supports, attachments, flashing and trim, and accessories.
2. Water-Spray Test: Conduct water-spray test on mockup of metal wall panel assembly, testing for water penetration in accordance with AAMA 501.2.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.

B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal wall panels during installation.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal wall panel systems

that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures, including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal plate wall assembly, including support systems.

B. Structural Performance: Provide metal wall panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330/E330M:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**] .
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

C. Air Infiltration: Not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

D. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**] .

F. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL on its "Product iQ" website or from the listings of another qualified testing agency.

2.2 METAL PLATE WALL PANELS

A. Aluminum Plate Wall Panels : Factory-formed, wall panel fabricated into profile for installation method indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alfrex, LLC**]
b. [**Alply Insulated Panels LLC**]
c. [**American Metalcraft Inc.**]
d. [**Architectural Specialty Products, Inc**]
e. [**Carter Architectural Panels, Inc.**]
f. [**Castle Metal Products**]
g. [**DAMS Incorporated; D. Architectural Metal Solutions Incorporated**]
h. [**Fabral; a brand of Flack Global Metals**]
i. [**Fairview Architectural**]
j. [**Firestone Metal Products**]
k. [**Metal Sales & Service, Inc.**]
l. [**Protean Construction Products, Inc**]
m. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

2. Type of Panel: [**Flat**][**Profiled**] tension-leveled, smooth aluminum sheet, ASTM B209/B209M.
3. Nominal Thickness: [**0.120 inch (3.05 mm)**][**0.125 inch (3.18 mm)**][**0.1875 inch (4.76 mm)**][**0.190 inch (4.82 mm)**] thick.
4. Panel Depth: [**2 inches (51 mm)**][**As indicated on Drawings**] .
5. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Clear anodized**][**Color anodized**] .
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Attachment Assembly: [**Manufacturer's standard**][**Flange attachment**][**Clip**][**Subgirt and spline**][**Track support**][**Rail support**][**Rainscreen-principle system**] .

2.3 ACCESSORIES

A. Structural Performance: Provide support system for metal wall panels capable of withstanding and transferring design loads to building structure within limits and under conditions indicated.

B. Metal Subframing and Furring: ASTM C955, cold-formed, metallic-coated steel members, ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

C. Wall Panel Assembly Accessories, General: Provide components required for a complete, weathertight wall panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless

otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended in writing by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Provide flashing and trim formed from same material as metal wall panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

F. Panel Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer. Provide sealant types that are compatible with panel materials, are nonstaining, and do not damage panel finish.

2.4 FABRICATION

A. Fabricate and finish metal wall panels and accessories at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with panel manufacturer's written instructions that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's written instructions.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended in writing by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
6. Exposed Anodized Finish:

   a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
   b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

   a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install steel subframing, furring, and other miscellaneous support system members and anchorages in accordance with metal wall panel manufacturer's written instructions.

3.3 INSTALLATION OF METAL PLATE WALL PANELS, GENERAL

A. Install in accordance with metal wall panel manufacturer's written instructions in orientation, sizes, and locations indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide watertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

3.4 INSTALLATION OF ALUMINUM PLATE WALL PANELS

A. Install assembly required to support metal plate wall panels and to provide a complete watertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Attach metal plate wall panels to supports at locations, spacings, and with fasteners recommended in writing by manufacturer to achieve performance requirements specified.

a. Wet-Seal Systems: Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant in accordance with requirements specified in Section 079200 "Joint Sealants."

B. Rainscreen Principle Installation: Install using manufacturer's standard assembly with vertical channel

that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended in writing by manufacturer. Attach metal plate wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Do not apply sealants to joints unless otherwise indicated.

C. Install accessories with positive anchorage to building and watertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including copings, corners, seam covers, sealants, gaskets, fillers, closure strips, and similar items.

D. Flashing and Trim: Comply with performance requirements and panel manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft. (3 m)** with no joints allowed within **24 inches (605 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.5 INSTALLATION TOLERANCES

A. Shim and align metal plate wall panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated, and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of wall panel assembly [**as indicated on Drawings**][**as directed by Architect**] for water penetration in accordance with AAMA 501.2, as directed by the Owner.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

   a. Cost of retesting is Contractor's responsibility.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

a. Cost of retesting is Contractor's responsibility.

D. Remove and replace metal wall panel assembly where tests and inspections indicate that it does not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, will be required to determine if replaced or additional work complies with specified requirements.

F. Prepare test and inspection reports.

3.7 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of panel installation, clean finished surfaces as recommended in writing by metal wall panel manufacturer.

B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.8 PROTECTION

A. Maintain metal wall panels in a clean condition during the remainder of construction.

B. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13 00A

SECTION 07 41 13 00B - BATTEN-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Narrow-profile, snap-on-batten-seam metal roof panels.
2. Wide-profile, snap-on-batten-seam metal roof panels.
3. Tee-top, seamed-batten metal roof panels.
4. Substrate board.
5. Vapor retarder.
6. Roof insulation.
7. Cover board.
8. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
2. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with the Owner’s insurer if applicable, metal roof panel Installer, metal roof panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal roof panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written installation instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of supporting structure during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal roof panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.

8. Review temporary protection requirements for metal roof panel systems during and after installation.
9. Review procedures for repair of metal roof panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish for metal roof panels, clips, fasteners, closures, and other metal panel accessories.

1. Size: [**Manufacturers' standard size**].

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates for portable roll-forming equipment.

B. Product Test Reports: For batten-seam metal roof panels, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Qualification Statements: For roof installers.

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal roof panels.

1.7 QUALITY ASSURANCE

A. Roof Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Metal Panel Roof Systems Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Metal Panel Roof Systems Installers**].

B. Portable Roll-Forming Equipment Certification: UL-certified, portable roll-forming equipment capable of producing metal roof panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of Work.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof area and eave[**, including fascia,**][**and soffit**] as shown on Drawings; approximately [**48 inches (1200 mm)**][**12 ft. (3.5 m)**] square by full thickness, including attachments, underlayment, and accessories.
2. Build mockups for typical roof area only, including accessories.

   a. Size: [**12 ft. (3.5 m) long by 6 ft. (1.75 m)**].
   b. [**Each type of exposed seam and seam termination**].

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness, with positive slope for drainage of water. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal roof panels during installation.

E. Copper Roof Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal roof panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer agrees to repair or replace batten-seam metal roof panel systems that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: [**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal roof panel systems capable of withstanding the effects of the following loads when tested in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

B. Air Infiltration: Air leakage of not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested in accordance with [**ASTM E1680**][**ASTM E283/E283M**] at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

C. Water Penetration under Static Pressure: No water penetration when tested in accordance with [**ASTM E1646**][**ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

D. Watertightness: No water penetration when tested in accordance with ASTM E2140 for hydrostatic-head resistance.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: [**UL 30**][**UL 60**][**UL 90**].

F. FM Approvals Listing: Provide metal roof panels and component materials that comply with requirements in FM Approvals 4471 as part of a metal panel roofing system and that are listed in FM Approvals' "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.

1. Fire/Windstorm Classification: Class 1A-[**60**][**75**][**90**][**105**][**120**].
2. Hail Resistance: [**MH**][**SH**].

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

H. Energy Performance:

1. Provide metal roof panels meeting one of the following requirements when tested in accordance with CRRC-1:

a. Three-year, aged solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
b. Three-year, aged Solar Reflectance Index (SRI) of not less than [**64**] when calculated in accordance with ASTM E1980.

2.2 BATTEN-SEAM METAL ROOF PANELS, GENERAL

A. Provide factory-formed metal roof panels designed to be installed by mechanically attaching panels to supports using concealed clips and covering vertical side edges of adjacent panels with batten caps. Include all accessories required for weathertight installation.

B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

C. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

D. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 NARROW-PROFILE, SNAP-ON-BATTEN-SEAM METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
2. [**Architectural Building Components**]
3. [**ATAS International, Inc.**]
4. [**Berridge Manufacturing Company**]
5. [**CENTRIA, a Nucor Brand**]
6. [**Drexel Metals Corp.**]
7. [**Fabral; a brand of Flack Global Metals**]
8. [**Fashion, Inc**]
9. [**Garland Company, Inc. (The)**]
10. [**Innovative Metals Company, Inc**]
11. [**MBCI; Cornerstone Building Brands**]
12. [**McElroy Metal, Inc**]
13. [**Merchant & Evans Inc.**]
14. [**Metal Sales & Service, Inc.**]
15. [**Metal Sales Manufacturing Corporation**]
16. [**PAC-CLAD; Petersen; a Carlisle company**]
17. [**Ultra Seam Incorporated**]

B. Metal Roof Panels: Formed with vertical ribs at panel edges; designed for independent installation by mechanically attaching panels to supports using concealed clips located between panels and installing narrow profile caps over panel joints.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Panel Profile: [**Intermediate stiffening ribs symmetrically spaced between ribs**][**Flat pan**][**Striated pan**][**Curved**][**Tapered**].
4. Panel Coverage: [**12 inches (305 mm)**][**14 inches (356 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**][**24 inches (610 mm)**].
5. Panel Height: [**1.0 inch (25 mm)**][**1.5 inches (38 mm)**][**1.75 inches (44 mm)**].
6. Batten Cap: Manufacturer's standard. Same material, finish, and color as roof panels.

   a. Height: [**1.5 inches (38 mm)**][**1.75 inches (44 mm)**].
   b. Width: [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**].

7. Clips: [**One-piece fixed**][**Two-piece floating**] to accommodate thermal movement.

   a. Steel Clips: [**0.028-inch- (0.71-mm-)**][**0.064-inch- (1.63-mm-)**] nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   b. Stainless Steel Clips: [**0.0250-inch- (0.635-mm-)**][**0.0625-inch- (1.587-mm-)**] thick, stainless steel sheet.
   c. Clip Spacing: [**24 inches (610 mm)**][**36 inches (914 mm)**][**As indicated on approved Shop Drawings**].

2.4 WIDE-PROFILE, SNAP-ON-BATTEN-SEAM METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Advanced Architectural Frames**]
2. [**Advanced Architectural Products**]
3. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
4. [**ATAS International, Inc.**]
5. [**Berridge Manufacturing Company**]
6. [**CENTRIA, a Nucor Brand**]
7. [**Dimensional Metals, Inc.**]
8. [**Drexel Metals Corp.**]
9. [**Fabral; a brand of Flack Global Metals**]
10. [**Fashion, Inc**]
11. [**Garland Company, Inc. (The)**]
12. [**Innovative Metals Company, Inc**]
13. [**McElroy Metal, Inc**]
14. [**Merchant & Evans Inc.**]
15. [**Metal Sales Manufacturing Corporation**]
16. [**PAC-CLAD; Petersen; a Carlisle company**]
17. [**Ultra Seam Incorporated**]

B. Metal Roof Panels: Formed with vertical ribs at panel edges; designed for independent installation by mechanically attaching panels to supports using concealed clips located between panels, and installing wide profile caps over panel joints.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Panel Profile: [**Intermediate stiffening ribs symmetrically spaced between ribs**][**Flat pan**][**Striated pan**][**Curved**][**Tapered**].
4. Panel Coverage: [**12 inches (305 mm)**][**14 inches (356 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**][**24 inches (610 mm)**].
5. Panel Height: [**1.0 inch (25 mm)**][**1.5 inches (38 mm)**].
6. Batten Cap: Manufacturer's standard. Same material, finish, and color as roof panels.

   a. Height: [**1.5 inches (38 mm)**][**2 inches (38 mm)**].
   b. Width: [**1.5 inches (38 mm)**][**2 inches (38 mm)**].

7. Clips: [**One-piece fixed**][**Two-piece floating**] to accommodate thermal movement.

   a. Steel Clips: [**0.028-inch- (0.71-mm-)**][**0.064-inch- (1.63-mm-)**] nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   b. Stainless Steel Clips: [**0.0250-inch- (0.635-mm-)**][**0.0625-inch- (1.587-mm-)**] thick, stainless steel sheet.
   c. Clip Spacing: [**24 inches (610 mm)**][**36 inches (914 mm)**][**As indicated on approved Shop Drawings**].

2.5 TEE-TOP, SEAMED-BATTEN METAL ROOF PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Berridge Manufacturing Company**]
2. [**CENTRIA, a Nucor Brand**]
3. [**Englert, Inc.**]

4. [**Fabral; a brand of Flack Global Metals**]
5. [**Garland Company, Inc. (The)**]
6. [**Innovative Metals Company, Inc**]
7. [**PAC-CLAD; Petersen; a Carlisle company**]

B. Metal Roof Panels: Formed with vertical ribs at panel edges; designed for independent installation by mechanically attaching panels to supports using concealed clips located between panels, and mechanically seaming panel rib tops together to form tee-shaped joint.

1. Structural Support: Over [**solid deck**][**open framing**].
2. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**].
3. Panel Profile: [**Intermediate stiffening ribs symmetrically spaced between ribs**][**Flat pan**][**Striated pan**][**Curved**][**Tapered**].
4. Panel Coverage: [**12 inches (305 mm)**][**14 inches (356 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**][**24 inches (610 mm)**].
5. Panel Height: [**1.0 inch (25 mm)**][**1.5 inches (38 mm)**][**1.75 inches (44 mm)**].
6. Batten Cap: Manufacturer's standard. Same material, finish, and color as roof panels.

   a. Height: [**2.0 inches (51 mm)**][**3.0 inches (76 mm)**].
   b. Width: [**1.5 inches (38 mm)**][**1.75 inches (44 mm)**].

7. Clips: Two-piece floating to accommodate thermal movement.

   a. Steel Clips: [**0.028-inch- (0.71-mm-)**][**0.064-inch- (1.63-mm-)**] nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   b. Stainless Steel Clips: [**0.0250-inch- (0.635-mm-)**][**0.0625-inch- (1.587-mm-)**] thick, stainless steel sheet.
   c. Clip Spacing: [**24 inches (610 mm)**][**36 inches (914 mm)**][**As indicated on approved Shop Drawings**].

2.6 METAL ROOF PANEL MATERIAL

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Sheet prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**].
2. Surface: [**Smooth, flat**][**Embossed**] texture.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**].
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**].
2. Surface: [**Smooth, flat**][**Embossed**] texture.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**][**Clear anodized**][**Color anodized**].

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], fully annealed.

1. Nominal Thickness: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**].
2. Exterior Finish: [**Polished**][**Bright, cold-rolled, unpolished**].

D. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

1. Thickness: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**] thick.
2. Exposed Finish: [**Mill**][**Prepatinated**].
3. Prepatinated Color: [**Dark brown**][**Verdigris**].

2.7 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions for fastening substrate board to roof deck.

2.8 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber

adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.9 ROOF INSULATION

A. Insulation over Solid Deck:

1. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Atlas Polyiso Roof and Wall Insulation**]
      2) [**Carlisle Syntec Systems**]
      3) [**CertainTeed; SAINT-GOBAIN**]
      4) [**Elevate; Holcim Building Envelope**]
      5) [**GAF**]
      6) [**Hunter Panels; a Carlisle company**]
      7) [**IKO Industries Inc.**]
      8) [**Insulfoam; a Carlisle Company**]
      9) [**Johns Manville; a Berkshire Hathaway company**]
      10) [**Kingspan Insulation LLC**]
      11) [**Polyglass U.S.A., Inc.**]
      12) [**Rmax, A Business Unit of Sika Corporation**]

   b. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
   c. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
   d. Thickness:

      1) Base Layer: [**1-1/2 inches (38 mm)**].

2. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Atlas Polyiso Roof and Wall Insulation**]
      2) [**Carlisle Syntec Systems**]
      3) [**CertainTeed; SAINT-GOBAIN**]
      4) [**Elevate; Holcim Building Envelope**]
      5) [**GAF**]
      6) [**Hunter Panels; a Carlisle company**]
      7) [**Insulfoam; a Carlisle Company**]
      8) [**Johns Manville; a Berkshire Hathaway company**]

   b. Facer: [**Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
   c. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

B. Insulation over Open Framing:

   1. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

      a. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
      b. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
      c. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

2.10 COVER BOARD

A. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

   1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
   2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

B. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

C. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

   1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

D. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

2.11 UNDERLAYMENT

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
   c. [**GCP Applied Technologies Inc.**]
   d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   e. [**Owens Corning**]
   f. [**Polyglass U.S.A., Inc.**]
   g. [**Protecto Wrap Company**]
   h. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **220 deg F (111 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.

B. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.12 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Roof Panel Accessories: Provide components required for a complete, weathertight metal roof panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
2. Backing Plates: Provide metal backing plates at roof panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal roof panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and

trim with same finish system as adjacent metal roof panels.

D. Gutters: Formed from same material as metal roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum **96-inch- (2400-mm-)** long sections, of size and metal thickness in accordance with manufacturer's recommendations. Furnish gutter supports spaced a maximum of **36 inches (914 mm)** o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match [**metal roof panels**][**roof fascia and rake trim**].

E. Downspouts: Formed from same material as metal roof panels. Fabricate in **10-ft.- (3-m-)** long sections, complete with formed elbows and offsets, of size and metal thickness in accordance with manufacturer's recommendations. Finish downspouts to match gutters.

F. Roof Curbs: Fabricated from same material as roof panels, [**0.048-inch (1.2-mm)**] nominal thickness; with bottom of skirt profiled to match metal roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of **0.060-inch- (1.52-mm-)** nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.

1. Insulate roof curb with **1-inch- (25-mm-)** thick, rigid insulation.

G. Roof Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

H. Roof Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with metal roof panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.13 FABRICATION

A. Fabricate and finish metal roof panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal roof panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Provide roof panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal roof panel manufacturer.

    a. Size: As recommended by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.14 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Roof Panels and Accessories:

1. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
3. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
4. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
5. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.
7. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

D. Aluminum Roof Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.
7. Exposed Anodized Finish:

   a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
   b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

E. Stainless Steel Roof Panels and Accessories:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: ASTM A480/A480M No. 4.

3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

F. Copper Roof Panels and Accessories:

1. Prepatination: Factory prepatinate in accordance with ASTM B882 to convert the copper surface to an inorganic crystalline structure with the appearance and durability of naturally formed patina.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal roof panel manufacturer's written recommendations.

3.3 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (610 mm)** in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

    a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board in accordance with metal roof panel system manufacturers' written installation instructions.

3.4 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with [**tape**][**adhesive**].

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.5 INSTALLATION OF ROOF INSULATION

A. General: Install insulation concurrently with metal roof panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written installation instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.

3.6 INSTALLATION OF COVER BOARD

A. Install cover board over insulation in accordance with manufacturer's written installation instructions. Install with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (152 mm)** in each direction.

3.7 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated [**below**][**on Drawings**], wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches (152 mm)** staggered **24 inches (610 mm)** between courses. Overlap side edges not less than **3-1/2 inches (90 mm)**.[**Extend underlayment into gutter trough.**] Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.
2. Apply over the roof area indicated below:

a. Roof perimeter for a distance up from eaves of [**24 inches (610 mm)**][**36 inches (914 mm)**] beyond interior wall line.
b. Valleys, from lowest point to highest point, for a distance on each side of [**18 inches (460 mm)**]. Overlap ends of sheets not less than **6 inches (152 mm)**.
c. Rake edges for a distance of [**18 inches (460 mm)**].
d. Hips and ridges for a distance on each side of [**12 inches (305 mm)**].
e. Roof-to-wall intersections for a distance from wall of [**18 inches (460 mm)**].
f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of [**18 inches (460 mm)**].

B. Felt Underlayment: Apply at locations indicated [**below**][**on Drawings**], in shingle fashion to shed water, and with lapped joints of not less than **2 inches (50 mm)**.

1. Apply over the entire roof surface.
2. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than **3 inches (75 mm)**, in shingle fashion to shed water.

C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

D. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.8 INSTALLATION OF BATTEN-SEAM METAL ROOF PANELS

A. Install metal roof panels in accordance with manufacturer's written instructions and approved Shop Drawings in orientation, sizes, and locations indicated on Drawings. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal roof panels.
2. Flash and seal metal roof panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal roof panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal roof panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal roof panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Roof Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Roof Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
3. Stainless Steel Roof Panels: Use stainless steel fasteners.
4. Copper Roof Panels: Use copper, stainless steel, or hardware-bronze fasteners.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal roof panel manufacturer.

D. Batten-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling fasteners.
2. Apply caps to metal roof panel seams, fully engaged to provide weathertight joints.
3. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal roof panels, using sealant or tape as recommend by manufacturer as needed to make panels watertight.
b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum **6-inch (152-mm)** end lap, sealed with sealant and fastened together by interlocking clamping plates.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturer; or, if not indicated, provide types recommended by metal roof panel manufacturer.

F. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft. (3 m)** with no joints allowed within **24 inches (610 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

G. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than **36 inches (914 mm)** o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

H. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely **1 inch (25 mm)** away from walls; locate fasteners at top and bottom and at approximately **60 inches (1524 mm)** o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

I. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

J. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.9 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines as indicated and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed,

unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13 00B

Task	Specification	Specification Description
07 41 13 00	07 61 00 00	Sheet Metal Roofing

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SECTION 07 42 13 19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.
2. Laminated-insulation-core metal wall panels.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.

1.2 DEFINITIONS

A. Wall Panel Assembly: Assembly consisting of wall panels, support systems, cavities, weather barriers, air barriers, and sheathing substrate that has been shown to comply with assembly testing and performance requirements.

1.3 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Meet with the Owner, Architect, the Owner’s insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of field-cut metal panels or panels damaged after installation.
9. Review NFPA 285 requirements for wall assembly.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual Sample of finished products for each type of exposed finish.

1. Size: [**Manufacturer's standard size**].

E. Delegated Design Submittals: For wall panel assembly, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each specified product, for tests performed by a qualified testing agency.

B. Wall Panel Assembly Test Reports: Certified test reports showing system compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For Installer [**and**][**testing agency**] .

E. Delegated Design Engineer Qualifications: For insulated metal wall panels assembly.

F. Sample Warranties: For specified special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For insulated metal wall panels.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests [**and who is acceptable to authorities having jurisdiction**] .

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical metal wall panel assembly [**as indicated on Drawings**], including [**corner,**][**soffits,**] supports, attachments, flashing and trim, and accessories.
2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration in accordance with AAMA 501.2.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design insulated metal wall panel assembly.

B. Structural Performance: Provide metal panel systems, including associated support system, capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330/E330M:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

C. Air Infiltration: Not more than [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

D. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

E. Windborne-Debris-Impact Resistance: Pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For cementitious wall panels located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For cementitious wall panels located between **30 ft. (9.1 m)** and [**60 ft. (18.2 m)**] above grade.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

G. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E119.

   a. Indicate design designations from UL on its "Product iQ" website or from the listings of another qualified testing agency.

2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested in accordance with NFPA 268.
4. Potential Heat: Acceptable level when tested in accordance with NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

   a. Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.
   b. Density: **2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m)** when tested in accordance with ASTM D1622.
   c. Compressive Strength: Minimum **20 psi (140 kPa)** when tested in accordance with ASTM D1621.
   d. Shear Strength: **26 psi (180 kPa)** when tested in accordance with ASTM C273/C273M.

B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels : Formed with tongue-and-groove interlocking panel edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**All Weather Insulated Panels**]
b. [**CENTRIA, a Nucor Brand**]
c. [**Kingspan Insulated Panels, Inc.**]
d. [**MBCI; Cornerstone Building Brands**]
e. [**Metl-Span; a Nucor Brand**]

2. Panel Attachment Method: Designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
3. Material: Metallic-coated steel sheet.

a. Surface Texture: [**Smooth flat**][**Smooth striated**][**Embossed flat**].
b. Horizontal Joint Reveal Width: [**Flush**][**0.5 inch (13 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**].
c. Vertical Joint Reveal Width: [**Flush**][**0.5 inch (13 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**].

4. Backer Board: On back side of exterior facing.
5. Panel Coverage: [**36 inches (914 mm)**][**40 inches (1016 mm)**] nominal.
6. Panel Thickness: [**1.0 inch (25 mm)**][**1.5 inches (38 mm)**][**2.0 inches (51 mm)**][**2.5 inches (64 mm)**][**3.0 inches (76 mm)**][**4.0 inches (102 mm)**][**5.0 inches (127 mm)**].

7. Thermal-Resistance Value (R-Value): In accordance with ASTM C1363.

C. Exposed-Fastener, Foamed-Insulation-Core Metal Wall Panels : Formed with a raised, trapezoidal major rib at panel edge and two intermediate stiffening ribs symmetrically spaced between major rib and panel edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CENTRIA, a Nucor Brand**]
b. [**MBCI; Cornerstone Building Brands**]

2. Panel Attachment Method: Designed for sequential installation by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
3. Material: Metallic-coated steel sheet.

4. Backer Board: On back side of exterior facing.
5. Panel Coverage: [**36 inches (914 mm)**] nominal.
6. Panel Thickness: [**3.0 inches (76 mm)**][**4.0 inches (102 mm)**][**5.0 inches (127 mm)**].

7. Thermal-Resistance Value (R-Value): In accordance with ASTM C1363.

2.3 LAMINATED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives, and with joints between panels designed to form weathertight seals.

Include accessories required for weathertight installation.

B. Wrapped-Edge, Laminated-Insulation-Core Metal Wall Panels : Formed with flush exterior panel facing wrapped over panel edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CENTRIA, a Nucor Brand**]
   b. [**Kingspan Insulated Panels, Inc.**]
   c. [**Protean Construction Products, Inc**]

2. Panel Attachment Method: Designed for independent installation by mechanically attaching [**panels to supports using staggered, concealed side clips engaging panel edges**][**through extended panel edges to supports using concealed fasteners**] .
3. Panel Joints: [**Sealant**][**Gasketed**] .
4. Material: [**Metallic-coated steel**][**Aluminum**] sheet.
5. Core Material: [**Manufacturers' standard.**][**Board insulation of the following type:**]

   a. Polyisocyanurate Insulation: Closed-cell, modified polyisocyanurate foam using a non-CFC blowing agent, board type, with a maximum flame-spread index of 25 and a smoke-developed index of 450.

      1) Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.

   b. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, **1.60-lb/cu. ft. (26-kg/cu. m)** minimum density, unless otherwise indicated; with a maximum flame-spread index of 25 and a smoke-developed index of 450.
   c. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.9 lb/cu. ft. (14 kg/cu. m)**][**Type II, 1.35 lb/cu. ft. (22 kg/cu. m), Class 2 or 3, Grade 3**] ; with a maximum flame-spread index of 25 and a smoke-developed index of 450.
   d. Mineral-Wool Board Insulation: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.

      1) Density: Minimum [**8.0 lb/cu.ft. (128 kg./cu. m)**].

6. Backer Board: [**0.125-inch- (3-mm-)**][**0.250-inch- (6-mm-)**] thick hardboard behind exterior facing for increased impact resistance.

7. Clips: Manufacturer's standard one piece, formed from [**zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet**][**stainless steel**] .
8. Gaskets: Extruded, dry seal silicone.
9. Sealant: Manufacturer's standard silicone.
10. Panel Thickness: [**1.0 inch (25 mm)**][**2.0 inches (51 mm)**][**3.0 inches (76 mm)**][**4.0 inches (102 mm)**][**5.0 inches (127 mm)**][**6.0 inches (152 mm)**].

11. Thermal-Resistance Value (R-Value): In accordance with ASTM C1363.

C. Shiplap-Edge, Laminated-Insulation-Core Metal Wall Panels : Formed with flush exterior panel facing and with shiplap edges; designed for sequential installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**All Weather Insulated Panels**]
b. [**Alply Insulated Panels LLC**]
c. [**Kingspan Insulated Panels, Inc.**]
d. [**Protean Construction Products, Inc**]

2. Panel Attachment Method: Designed for sequential installation by mechanically attaching panels to supports using concealed clips and fasteners.
3. Panel Side Laps: Factory-applied [**sealant**][**gaskets**] .
4. Material: [**Metallic-coated steel**][**Aluminum**] sheet.
5. Core Material: [**Manufacturers' standard.**][**Board insulation of the following type:**]

   a. Polyisocyanurate Insulation: Closed-cell, modified polyisocyanurate foam using a non-CFC blowing agent, board type, with a maximum flame-spread index of 25 and a smoke-developed index of 450.

      1) Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.

   b. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, **1.60-lb/cu. ft. (26-kg/cu. m)** minimum density unless otherwise indicated; with a maximum flame-spread index of 25 and a smoke-developed index of 450.
   c. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.9 lb/cu. ft. (14 kg/cu. m)**][**Type II, 1.35 lb/cu. ft. (22 kg/cu. m), Class 2 or 3, Grade 3**] ; with a maximum flame-spread index of 25 and a smoke-developed index of 450.
   d. Mineral-Wool Board Insulation: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.

      1) Density: Minimum [**8.0 lb/cu.ft. (128 kg./cu. m)**].

6. Backer Board: [**0.125-inch- (3-mm-)**][**0.250-inch- (6-mm-)**] thick hardboard behind exterior facing for increased impact resistance.

7. Clips: Manufacturer's standard one piece, formed from [**zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet**][**stainless steel**] .
8. Gaskets: Extruded, dry seal silicone.
9. Sealant: Manufacturer's standard silicone.
10. Panel Thickness: [**1.0 inch (25 mm)**][**2.0 inches (51 mm)**][**3.0 inches (76 mm)**][**4.0 inches (102 mm)**][**5.0 inches (127 mm)**][**6.0 inches (152 mm)**].

11. Thermal-Resistance Value (R-Value): In accordance with ASTM C1363.

D. Framed-Edge, Laminated-Insulation-Core Metal Wall Panels : Formed with flush exterior panel facing and integral, extruded edge members.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alply Insulated Panels LLC**]
   b. [**Protean Construction Products, Inc**]

2. Panel Attachment Method: Designed for independent installation by mechanically attaching panels to supports through edge framing using concealed fasteners.
3. Panel Joints: Gasketed.
4. Material: [**Metallic-coated steel**][**Aluminum**] sheet.
5. Core Material: [**Manufacturers' standard.**][**Board insulation of the following type:**]

    a. Polyisocyanurate Insulation: Closed-cell, modified polyisocyanurate foam using a non-CFC blowing agent, board type, with a maximum flame-spread index of 25 and a smoke-developed index of 450.

        1) Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.

    b. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, **1.60-lb/cu. ft. (26-kg/cu. m)** minimum density unless otherwise indicated; with a maximum flame-spread index of 25 and a smoke-developed index of 450.
    c. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.9 lb/cu. ft. (14 kg/cu. m)**][**Type II, 1.35 lb/cu. ft. (22 kg/cu. m), Class 2 or 3, Grade 3**] ; with a maximum flame-spread index of 25 and smoke-developed index of 450.
    d. Mineral-Wool Board Insulation: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.

        1) Density: Minimum [**8.0 lb/cu.ft. (128 kg./cu. m)**].

6. Backer Board: [**0.125-inch- (3-mm-)**][**0.250-inch- (6-mm-)**] thick hardboard behind exterior facing for increased impact resistance.
7. Edge Members: Extruded aluminum, not less than **0.063-inch (1.60-mm)** wall thickness.
8. Gaskets: Extruded, dry seal silicone.
9. Panel Thickness: [**1.0 inch (25 mm)**][**2.0 inches (51 mm)**][**3.0 inches (76 mm)**][**4.0 inches (102 mm)**][**5.0 inches (127 mm)**][**6.0 inches (152 mm)**].

10. Thermal-Resistance Value (R-Value): In accordance with ASTM C1363.

2.4 METAL WALL PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Face Nominal Thickness: [**0.028 inch (0.71 mm)**][**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**] .

2. Liner Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**] .
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**]mock.

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

4. Interior Finish: [**Siliconized polyester**].

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with

temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] finish.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**][**Clear anodized**][**Color anodized**].

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

4. Interior Finish: [**Siliconized polyester**].

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.5 ACCESSORIES

A. Structural Performance: Provide support system for metal wall panels capable of withstanding and transferring design loads to building structure within limits and under conditions indicated.

B. Metal Subframing and Furring: ASTM C955, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

C. Wall Panel Assembly Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended in writing by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Backer Board: Hardboard complying with ANSI A135.4, Class 1 tempered, [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**] thick unless otherwise indicated.

E. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

G. Panel Sealants: Provide sealant type recommended in writing by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.6 FABRICATION OF INSULATED METAL WALL PANELS

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's written instructions .
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended in writing by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.7 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Metallic-Coated Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

7. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

D. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.
7. Exposed Anodized Finish:

    a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

    b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required in writing by metal wall panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF INSULATED METAL PANELS

A. Install in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Panel Fasteners:

1. Metallic-Coated Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended in writing by metal wall panel manufacturer.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

E. Weathertight Installation:

1. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
4. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.

3.4 INSTALLATION OF FOAM-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended in writing by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

B. Exposed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended in writing by manufacturer.

1. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
2. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.

3. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.

3.5 INSTALLATION OF LAMINATED-INSULATION-CORE METAL WALL PANELS

A. Wrapped-Edge, Laminated-Insulation-Core Metal Wall Panels:

1. Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with [**backer rod and sealant**][**manufacturer's standard gaskets**] .

2. Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with [**backer rod and sealant**][**manufacturer's standard gaskets**] .

B. Shiplap-Edge, Laminated-Insulation-Core Metal Wall Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.

1. Horizontal Joints: [**Maintain reveal joint of consistent width**][**Seal joints with backer rod and sealant**][**Seal joints with manufacturer's standard gaskets**] .
2. Vertical Joints: [**Maintain reveal joint of consistent width**][**Seal joints with backer rod and sealant**][**Seal joints with manufacturer's standard gaskets**] .

C. Framed-Edge, Laminated-Insulation-Core Metal Wall Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.

3.6 INSTALLATION OF ACCESSORIES

A. Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal panel manufacturer.

B. Flashing and Trim: Comply with performance requirements and with manufacturer's written installation instructions. Provide concealed fasteners, where possible, and set units true to line and level as indicated on Drawings. Install work with laps, joints, and seams that are permanently weathertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft. (3 m)** with no joints allowed within **24 inches (610 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.7 INSTALLATION TOLERANCES

A. Shim and align metal wall panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated on Drawings, and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of wall panel assembly [**indicated on Drawings**][**as directed by Architect**] for water penetration in accordance with AAMA 501.2 as directed by the Owner.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

    a. Cost of retesting is Contractor's responsibility.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

    a. Cost of retesting is Contractor's responsibility.

D. Tests and Inspections:

1. Remove and replace metal wall panel assembly where tests and inspections indicate that it does not comply with specified requirements.
2. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.9 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended in writing by metal panel manufacturer. Maintain in a clean condition during construction.

B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.10 PROTECTION

A. Maintain metal wall panels in a clean condition during the remainder of construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13 19

Task	Specification	Specification Description
07 42 13 19	08 80 00 00	Glazing

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SECTION 07 42 13 23 - COMPOSITE WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal composite material (MCM) wall panels.
2. Pressure-equalized rainscreen (PER) MCM system.
3. Drained and back-ventilated rainscreen (DBVR) MCM system.
4. Dry-seal barrier MCM system.
5. Wet-seal barrier MCM system.

B. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 061600 "Sheathing" for structural wall sheathing.
3. Section 072100 "Thermal Insulation" for insulation.
4. Section 072500 "Weather Barriers" for weather-resistive barriers and sealing penetrations in barriers resulting from installation of wall panel support system.
5. Section 072726 "Fluid-Applied Membrane Air Barriers" for air barriers and sealing penetrations in barriers resulting from installation of wall panel support system.

1.2 DEFINITIONS

A. DBVR: Drained and back-ventilated rainscreen. Wall assemblies with minimum **3/8-inch- (10-mm)** wide cavity designed to drain incidental water entering the cavity and promote drying by vents through the bottom and top of the assembly.

B. MCM: Metal composite material. Cladding material formed by joining two thin metal skins to PE or fire-retardant core and bonded under precise temperature, pressure, and tension.

C. PER: Pressure-equalized rainscreen. Wall assemblies in which the cavity is compartmentalized to control air pressure difference.

D. Wall Panel Assembly: Assembly consisting of wall panels, support systems, cavities, [**continuous insulation, girts,**] weather barriers, air barriers, and sheathing substrate that have been shown to comply with assembly testing and performance requirements.

1.3 COORDINATION

A. Coordinate installation of wall panels and support system with insulation, weather barriers, air barriers, flashings, and other adjoining construction to ensure proper sequencing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Meet with the Owner's insurer if applicable, MCM system Installer, MCM system manufacturer's representative, and installers whose work interfaces with or affects MCM panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to MCM system installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect MCM system.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for system assembly during and after installation.
8. Review procedures for repair of field-cut panels or panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
10. Review NFPA 285 requirements for wall assembly.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Include fabrication and installation layouts of MCM panels, details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details.
2. Accessories: Include details of flashing, trim, and anchorage, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: [**Manufacturer's standard size**] .

E. Delegated Design Submittals: For wall panel assembly, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.

9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each specified [**MCM panel**][**MCM system**] , for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] .

1. MCM Panel Manufacturer's Material Test Reports: Certified test reports showing compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.
2. Wall Panel Assembly Test Reports: Certified test reports showing system compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.

a. PER System: Tested to AAMA 508.
b. DBVR System: Tested to AAMA 509.
c. Dry- or Wet-Seal System: Tested to AAMA 501.1.

B. Preconstruction Test Reports: For specified MCM system.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For [**fabricator**][**Installer**][**testing agency**][**and delegated design engineer**] .

E. Sample Warranties: For specified special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For MCM wall panels.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: [**Approved by MCM panel manufacturer**][**Certified MCM fabricator by the MCA**] .

B. Installer: [**Fabricator of MCM system**][**Entity that employs installers and supervisors who are trained and approved by MCM system manufacturer**] .

C. Testing Agency Qualifications: An agency acceptable to authorities having jurisdiction.

D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical metal wall panel assembly [**as indicated on Drawings**], including [**corner,**][**soffits,**] supports, attachments, flashing and trim, and accessories.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on [**field mockups**][**laboratory mockups**] .

1. Provide test specimens and assemblies representative of proposed materials and construction.
2. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
3. Notify Architect [**seven**] days in advance of dates and times when laboratory mockups will be tested, as directed by the Owner.

B. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

1. Water-Spray Test: Conduct water-spray test [**of mockup**] of MCM system, testing for water penetration in accordance with AAMA 501.2.
2. Seismic Performance: Conduct seismic test [**of mockup**] of MCM system, testing for seismic performance in accordance with AAMA 501.4.
3. PER MCM System: Conduct all tests to determine wall performance and pressure equalization in accordance with AAMA 508.
4. DBVR MCM System: Conduct all tests to determine wall performance and provide a "V/W" classification in accordance with AAMA 509.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, MCM panels, and other manufactured items so as not to be damaged or deformed. Package MCM panels for protection during transportation and handling.

B. Unload, store, and erect MCM panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack MCM panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on MCM panels during installation.

E. Copper MCM Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.12 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of MCM panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.13 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of MCM panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace MCM panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Anodized Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, peeling, or chipping.

3. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

C. MCM System Warranty: [**System manufacturer**][**Fabricator**] agrees to repair or replace components of MCM system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**One**][**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design MCM wall panel assembly, including support systems.

B. Seismic Performance: No failure or deterioration of MCM system when laterally racked to **3/4 inch (19 mm)** in both directions and repeated for three cycles in accordance with AAMA 501.4. System must pass the static water test as described in ASTM E331 following the seismic racking.

C. Structural Performance: Provide MCM systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330/E330M:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**] .
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

D. Air Infiltration: Not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested in accordance with ASTM

E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

E. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

F. Water Penetration under Dynamic Pressure: No water penetration when tested in accordance with AAMA 501.1 at the following test pressure:

1. Test Pressure: [**6.24 psf (300 Pa)**][**12 psf (580 Pa)**][**15 psf (720 Pa)**] .

G. Pressure Cycling: Provide PER MCM system with a pass rating in accordance with AAMA 508.

1. Lag between the cavity and the cyclic wind pressure to not exceed 0.08 seconds.
2. Maximum differential between the cavity and the cyclic wind pressure to not exceed 50 percent of the maximum test pressure.

H. Provide DBVR MCM system [**with V-axis classification number greater than or equal to W-axis classification number**] in accordance with AAMA 509.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**] .

J. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL on its "Product iQ" website or from listings of another qualified testing agency.

K. Fire Propagation Characteristics: MCM system to pass NFPA 285 testing as part of an approved wall assembly.

2.2 METAL COMPOSITE MATERIAL (MCM) WALL PANELS

A. Metal Composite Material (MCM) Wall Panels : Provide MCM panels fabricated from two metal facings bonded to a solid, extruded thermoplastic core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alcotex Inc.**]
b. [**Alfrex, LLC**]
c. [**ALPOLIC**]
d. [**ALUCOBOND; 3A Composites USA, Inc**]
e. [**Alucoil North America**]
f. [**Arconic Architectural Products, LLC**]

g. [**Carter Architectural Panels, Inc.**]
h. [**Castle Metal Products**]
i. [**Fairview Architectural**]
j. [**StacBond**]
k. [**VM Building Solutions USA**]

2. Core: [**FR**][**PE**] .
3. Panel Thickness: [**0.118 inch (3 mm)**][**0.157 inch (4 mm)**][**0.236 inch (6 mm)**][**As indicated on Drawings**] .
4. Bond Strength: **22.5 in-lb/in. (100 N x mm/mm)** when tested for bond integrity in accordance with ASTM D1781.
5. Fire Performance: Flame-spread index less than [**25**][**75**] and smoke-developed index less than 450, in accordance with ASTM E84 or UL 723.
6. Perforated Panels: [**Geometric**][**Slotted**], maximum [**45**][**65**] percent open. [**Locations as indicated on Drawings.**]

B. MCM Panel Materials:

1. Aluminum-Faced Panels : ASTM B209/B209M [**alloy as standard with manufacturer, temper as required to suit finish and forming operations**][**Alloy 3003, Temper H14**][**Alloy 5005, Temper H14**] with [**0.020-inch- (0.50-mm-)**][**0.032-inch- (0.81-mm-)**] thick, aluminum sheet facings.

   a. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Clear anodized**][**Color anodized**].

      1) Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Copper-Faced Panels : ASTM B370 with [**12 oz./sq. ft. (0.41 mm thick)**][**14 oz./sq. ft. (0.48 mm thick)**] , copper sheet facings.

   a. Exterior Finish: [**Mill**][**Prepatinated**] .

3. Steel-Faced Panels:

   a. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

      1) Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**] .

         a) Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner .

   b. Stainless Steel: ASTM A240/A240M, [**Type 304**][**Type 316**] with **0.016-inch- (0.41-mm-)** thick, steel sheet facings.
   c. Weathering Steel: [**ASTM A242/242M**][**ASTM A588/588M**][**ASTM A606/606M**] with **0.016-inch- (0.41-mm-)** thick, steel sheet facings.

4. Titanium-Faced Panels : ASTM B265 with **0.016-inch- (0.41-mm-)** thick, titanium sheet facings.

   a. Exterior Finish: [**Mill**][**Reflective polished**] .

5. Zinc-Faced Panels : ASTM B69 with **0.020-inch- (0.50-mm-)** thick, zinc sheet facings.

   a. Exterior Finish: [**Mill**][**Prepatinated**] .

2.3 METAL COMPOSITE MATERIAL (MCM) WALL PANEL SYSTEMS

A. MCM Wall Panel Systems, General: Provide complete MCM assemblies including, but not limited to, panels, support structure, attachment hardware, flashings, and accessories [**by a single manufacturer**] in compliance with testing and performance requirements indicated.

B. System Panel Depth: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**As indicated by manufacturer's designations**][**As indicated on Drawings**] .

C. Support Structure and Attachment Assembly Components: [**Manufacturer's standard**][**Clips**][**Tracks**][**Channels**] formed from [**extruded aluminum**][**material compatible with panel facing**] .

D. Labeling: Comply with labeling requirement of applicable building code.

E. Pressure-Equalized Rainscreen (PER) MCM System : [**Factory-formed and -assembled,**] MCM panels formed into profile for PER system installation, drained at horizontal joints and at base of wall. Include panels, support system components, [**panel stiffeners,**] attachment hardware, flashings, and accessories required for compartmentalized, air-pressure-controlled rainscreen system.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      a. [**Carter Architectural Panels, Inc.**]
      b. [**Fairview Architectural**]
      c. [**NorthClad Rainscreen Solutions**]
      d. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
      e. [**Sobotec**]

F. Drained and Back-Ventilated Rainscreen (DBVR) MCM System : [**Factory-formed and -assembled,**] MCM panels for DBVR installation, drained at horizontal joints and at base of wall. Include attachment assembly components, [**panel stiffeners,**] attachment hardware, flashings, and accessories required for back-ventilated rainscreen system.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      a. [**Citadel Architectural Products, Inc.; a Carlisle Company**]
      b. [**Fairview Architectural**]
      c. [**NorthClad Rainscreen Solutions**]
      d. [**NOW Specialties, Inc.**]

e. [**Protean Construction Products, Inc**]
f. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

G. Dry-Seal Barrier MCM System : [**Factory-formed and -assembled,**] MCM panels formed into profile for dry-seal, gasketed barrier system installation. Include attachment assembly components, [**panel stiffeners,**] joint gaskets, attachment hardware, flashings, and accessories required for weathertight system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carter Architectural Panels, Inc.**]
b. [**Citadel Architectural Products, Inc.; a Carlisle Company**]
c. [**Coated Metals Group**]
d. [**East Coast Metal Systems**]
e. [**Fairfield Metal, LLC**]
f. [**MillerClapperton**]
g. [**NOW Specialties, Inc.**]
h. [**Sobotec**]

H. Wet-Seal Barrier MCM System : [**Factory-formed and -assembled,**] MCM panels formed into profile for wet-seal barrier system installation. Include attachment assembly components, [**panel stiffeners,**] joint sealants, attachment hardware, flashings, and accessories required for weathertight system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carter Architectural Panels, Inc.**]
b. [**Citadel Architectural Products, Inc.; a Carlisle Company**]
c. [**East Coast Metal Systems**]
d. [**Fairfield Metal, LLC**]
e. [**MillerClapperton**]
f. [**NOW Specialties, Inc.**]
g. [**Protean Construction Products, Inc**]
h. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
i. [**Sobotec**]

2.4 ACCESSORIES

A. Structural Performance: Provide support system for MCM panels capable of withstanding and transferring design loads to building structure within limits and under conditions indicated.

B. Metal Subframing and Furring: ASTM C955 cold-formed, metallic-coated steel members, ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of MCM system.

C. Low Thermally-Conductive Cladding Support System: Provide [**manufacturer's standard**] fiberglass or

fiberglass-reinforced-plastic support components designed to minimize thermal bridging.

D. Wall Panel Assembly Accessories, General: Provide components required for a complete MCM system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of MCM panels unless otherwise indicated.

E. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, [**parapet caps,**] soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent MCM panels.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads. Use gasketed or approved coated fasteners between dissimilar metals.

1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
2. Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.
3. Steel, Titanium, or Zinc Panels: Use stainless steel fasteners.
4. Provide exposed fasteners with heads matching color of MCM panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

G. Dry-Seal MCM System Gaskets: ASTM C509 or ASTM C864 as required to seal joints in MCM panels and remain weathertight, and as recommended in writing by MCM manufacturer.

H. Wet-Seal MCM System Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in MCM panels and remain weathertight; and as recommended in writing by MCM system manufacturer.

2.5 FABRICATION

A. Fabricate and finish MCM panels at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Shop-fabricate MCM systems and accessories by fabricator's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with requirements of MCM panel manufacturer, of indicated system profiles, and with dimensional and structural requirements.

1. Fabricate panels to dimensions indicated on Drawings based on an assumed design temperature of **70 deg F (21 deg C)**. Allow for ambient temperature range at time of fabrication.
2. Formed MCM panel lines, breaks, and angles to be sharp and straight, with surfaces free from warp or buckle.
3. Fabricate panels with sharply cut edges and no displacement of face sheet or protrusion of core.
4. Fabricated Panel Tolerances: Shop-fabricate panels to sizes and joint configurations indicated on Drawings.

   a. Width: Plus or minus **0.079 inch (2 mm)** at **70 deg F (21 deg C)**.
   b. Length: Plus or minus **0.079 inch (2 mm)** at **70 deg F (21 deg C)**.
   c. Squareness: Plus or minus **0.079 inch (2 mm)** at **70 deg F (21 deg C)**.

5. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
6. Attach routed-and-returned panel flanges to [**perimeter extrusions**][**panel clips**] with

manufacturer's standard [**fasteners**][**structural silicone adhesive**] .

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with MCM manufacturer's written instructions that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams.
4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's written instructions.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal manufacturer.

   a. Size: As recommended in writing by metal manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Coil-Coated Metal Finish:

1. PVDF Fluoropolymer: AAMA 2605, [**two-coat**][**three-coat**][**two-coat, with suspended mica flakes,**][**three-coat, with suspended metallic flakes,**] fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat [**and clear topcoat**] . Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. FEVE Fluoropolymer: AAMA 2605, [**one-coat**][**two-coat**][**three-coat**][**two-coat, with suspended mica flakes,**][**three-coat, with suspended metallic flakes,**] fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

D. Anodized Aluminum Finish: [**Clear**][**Color**] in accordance with AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

E. Copper Finish: [**Mill**][**Factory prepatinated in accordance with ASTM B882 with the appearance and durability of naturally formed patina**] .

F. Steel Finish, Stainless: Grind and polish surfaces to produce uniform finish in accordance with ASTM A480/480M, free of cross scratches. [**Run grain of directional finishes with long dimension of each piece.**]

1. Finish Pattern: [**No. 4 polished**][**No. 6 dull satin**][**No. 7 high luster**][**No. 8 mirror**] .

G. Steel Finish, Weathering: [**Natural**] .

H. Titanium Finish: [**Mill**][**Reflective polished**].

I. Zinc Finish, Prepatinated: [**Matte gray**][**Dark black**][**Colored mineral glaze**] .

J. Zinc Titanium Finish: ASTM B69 [**Type 1, blue-gray patina**][**Type 1, bright rolled zinc**][**Type 2, graphite-gray**] .

K. Custom finish of [**aluminum**][**copper**][**steel**][**titanium**][**zinc**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM system supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required in writing by MCM system manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required in writing by MCM system manufacturer.

   a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and assemblies penetrating MCM system to verify actual locations of penetrations relative to seam locations of MCM panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install steel subframing, furring, and other miscellaneous support system members and anchorages in accordance with MCM wall panel manufacturer's written instructions.

3.3 INSTALLATION OF METAL COMPOSITE MATERIAL (MCM) WALL PANELS

A. Install MCM system in accordance with panel manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor MCM system securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving MCM system.
2. Flash and seal MCM system at perimeter of all openings. Fasten with self-tapping screws.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as MCM system work proceeds.

6. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
7. Provide watertight escutcheons at items penetrating MCM system.
8. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action [**with gaskets**][**as recommended in writing by MCM system manufacturer**] .
9. Attach MCM panels to supports at locations, spacings, and with fasteners recommended in writing by manufacturer to meet listed performance requirements.

B. PER MCM System Installation: Install vertical [**tracks**][**drain channels**] and horizontal [**tracks**][**channels**] providing compartmentalization at locations, at spacings, and with fasteners recommended in writing by system manufacturer.

1. Attach MCM panels by interlocking panel [**clips**][**perimeter extrusion**] into [**tracks**][**channels**][**in a sequential series**] .
2. Insert matching MCM spline into [**tracks**][**channels**] at joint reveal locations.

C. DBVR MCM System Installation: Install vertical [**tracks**][**drain channels**] and horizontal [**tracks**][**channels**] at locations, at spacings, and with fasteners recommended in writing by system manufacturer.

1. Attach MCM panels by interlocking panel [**clips**][**perimeter extrusion**] into [**tracks**][**channels**][**in a sequential series**] .
2. Insert matching MCM spline into [**tracks**][**channels**] at joint reveal locations.

D. Dry-Seal MCM System Installation: Attach MCM panels by interlocking panel [**clips**][**perimeter extrusion**] into [**tracks**][**channels**][**in a sequential series**] .

1. Seal horizontal and vertical joints between adjacent MCM panels with manufacturer's standard gaskets.

E. Wet-Seal MCM System Installation: Attach MCM panels by interlocking panel [**clips**][**perimeter extrusion**] into [**tracks**][**channels**][**in a sequential series**] .

1. Seal horizontal and vertical joints between adjacent MCM panels with sealant backing and sealant in accordance with requirements specified in Section 079200 "Joint Sealants."

F. MCM Panel Installation: Install assembly required to support MCM panels and to provide a complete wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels. Install panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

G. Install accessories with positive anchorage to building and watertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete MCM system assembly including copings, corners, seam covers, [**sealants,**][**gaskets,**] fillers, closure strips, and similar items.

H. Flashing and Trim: Comply with performance requirements and panel manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install trim to fit substrates and achieve watertight performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft.** **(3 m)** with no joints allowed within **24 inches** **(605 mm)**

of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.4 INSTALLATION TOLERANCES

A. Shim and align MCM panels within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated, and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of wall panel assembly [**as indicated on Drawings**][**as directed by Architect**] for water penetration in accordance with AAMA 501.2, as directed by the Owner.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

a. Cost of retesting is Contractor's responsibility.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed MCM system installation, including accessories.

1. After testing, repair leaks, repeat tests, and make further repairs until wall panel assembly installation is watertight.

a. Cost of retesting is Contractor's responsibility.

D. Remove and replace MCM panel assembly where tests and inspections indicate that it does not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, will be required to determine if replaced or additional work complies with specified requirements.

F. Prepare test and inspection reports.

3.6 CLEANING

A. Remove temporary protective coverings and strippable films as MCM panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended in writing by MCM panel manufacturer. Maintain in a clean condition during construction.

B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.7 PROTECTION

A. Maintain MCM panels in a clean condition during the remainder of construction.

B. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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SECTION 07 42 93 00 - SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal soffit panels.

B. Related Requirements:

1. Section 074113.13 "Formed Metal Roof Panels" for metal roof panels.
2. Section 074213.13 "Formed Metal Wall Panels" for metal wall panels.

1.2 COORDINATION

A. Coordinate installation of soffit panels and support system with insulation, weather barriers, air barriers, flashings, and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual Sample of finished products for each type of exposed finish.

1. Size: [**Manufacturer's standard size**].

E. Delegated Design Submittals: For panels and support systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each specified product, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Delegated Design Engineer Qualifications: For panels and support systems.

D. Sample Warranties: For specified special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For soffit panels.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof eave [**including fascia,**] and soffit as indicated on Drawings; approximately [**four panels wide**] by full eave width, including attachments, flashing and trim, and accessories.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design panels and support systems.

B. Structural Performance: Provide metal panel systems, including associated support system, capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592 or ASTM E330/E330M:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**] .
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

C. Air Infiltration: Not more than [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

D. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] .

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

F. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL on its "Product iQ" website or from the listings of another qualified testing agency.

2.2 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Flush-Profile Metal Soffit Panels :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AEP Span a brand of ASC Profiles LLC, a part of BlueScope**]
b. [**ATAS International, Inc.**]
c. [**Berridge Manufacturing Company**]
d. [**CENTRIA, a Nucor Brand**]
e. [**Dimensional Metals, Inc.**]
f. [**Drexel Metals Corp.; a Carlisle Company**]
g. [**Elevate; Amrize Building Envelope LLC**]
h. [**Englert, Inc.**]
i. [**Fabral; a brand of Flack Global Metals**]
j. [**Innovative Metals Company, Inc**]
k. [**Knotwood US LLC**]
l. [**MBCI; Cornerstone Building Brands**]
m. [**McElroy Metal, Inc**]
n. [**Merchant & Evans Inc.**]
o. [**Metal Sales Manufacturing Corporation**]
p. [**Pac-Clad, Petersen; a Carlisle Company**]
q. [**Sentrigard; NB Handy Company**]
r. [**Ultra Seam Incorporated**]

2. Panel Surface: [**Solid**][**Perforated**] .
3. Panel Profile: Panel formed with vertical panel edges and [**intermediate stiffening ribs symmetrically spaced**][**a flat pan**] between panel edges; with flush joint between panels.
4. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**][**Zinc alloy**][**Same**

material, finish, and color as metal wall panels][**Same material, finish, and color as metal roof panels**] .

5. Panel Coverage: [**8 inches (203 mm)**][**12 inches (305 mm)**][**16 inches (406 mm)**][**20 inches (508 mm)**].
6. Panel Height: [**0.875 inch (22 mm)**][**1.0 inch (25 mm)**][**1.5 inches (38 mm)**][**3.0 inches (76 mm)**].

C. Reveal-Joint-Profile Metal Soffit Panels :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATAS International, Inc.**]
   b. [**Berridge Manufacturing Company**]
   c. [**Cheney Flashing Company**]
   d. [**Drexel Metals Corp.; a Carlisle Company**]
   e. [**Elevate; Amrize Building Envelope LLC**]
   f. [**Firestone Metal Products**]
   g. [**Merchant & Evans Inc.**]
   h. [**Pac-Clad, Petersen; a Carlisle Company**]
   i. [**Sentrigard; NB Handy Company**]

2. Panel Surface: [**Solid**][**Perforated**].
3. Panel Profile: Panel formed with vertical panel edges and [**intermediate stiffening ribs symmetrically spaced**][**a flat pan**] between panel edges, with recessed reveal joint between panels.
4. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**][**Zinc alloy**][**Same material, finish, and color as metal wall panels**][**Same material, finish, and color as metal roof panels**] .
5. Panel Coverage: [**8 inches (203 mm)**][**12 inches (305 mm)**][**16 inches (406 mm)**][**20 inches (508 mm)**] .
6. Panel Height: [**0.75 inch (19 mm)**][**1.0 inch (25 mm)**][**1.5 inches (38 mm)**].

D. V-Groove-Profile Metal Soffit Panels :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATAS International, Inc.**]
   b. [**Berridge Manufacturing Company**]
   c. [**Dimensional Metals, Inc.**]
   d. [**Englert, Inc.**]
   e. [**Fabral; a brand of Flack Global Metals**]
   f. [**Innovative Metals Company, Inc**]
   g. [**McElroy Metal, Inc**]
   h. [**Pac-Clad, Petersen; a Carlisle Company**]

2. Panel Surface: [**Solid**][**Perforated**].
3. Panel Profile: Panels formed with vertical panel edges and [**intermediate stiffening ribs**

symmetrically spaced][**a flat pan**] between panel edges; with a V-groove joint between panels.
4. Material: [**Metallic-coated steel**][**Aluminum**][**Stainless steel**][**Copper**][**Zinc alloy**][**Same material, finish, and color as metal wall panels**][**Same material, finish, and color as metal roof panels**] .
5. Panel Coverage: [**6 inches (152 mm)**][**12 inches (305 mm)**][**14 inches (356 mm)**].
6. Panel Height: [**0.375 inch (10 mm)**][**0.44 inch (11 mm)**][**0.50 inch (13 mm)**][**0.625 inch (16 mm)**].

2.3 METAL SOFFIT PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**] .
2. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**].
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**][**Perforated**] finish.
3. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Siliconized polyester**][**Clear anodized**][**Color anodized**].
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

C. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**] , fully annealed.

1. Nominal Thickness: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**] .
2. Exterior Finish: [**ASTM A480/A480M, No. 4**][**ASTM A480/A480M, No. 2B**].

D. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

1. Thickness: [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.68 mm thick)**] .
2. Exposed Finish: [**Mill**][**Prepatinated**] .

3. Prepatinated Color: [**Dark brown**][**Verdigris**].

E. Zinc-Alloy Sheet: ASTM B69. Alloy of electrolytic high-grade zinc with additives of copper, titanium, and aluminum.

1. Thickness: [**0.03 inch (0.8 mm)**][**0.04 inch (1.0 mm)**][**0.06 inch (1.5 mm)**] .
2. Exposed Finish: [**Bright-rolled**][**Preweathered**] .

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.4 ACCESSORIES

A. Structural Performance: Provide support system for metal panels capable of withstanding and transferring design loads to building structure within limits and under conditions indicated.

B. Metal Subframing and Furring: ASTM C955, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

C. Soffit Panel Assembly Accessories, General: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at panel edges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended in writing by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated on Drawings or necessary to ensure weathertight construction.

D. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

F. Panel Sealants: Provide sealant types recommended in writing by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION OF METAL SOFFIT PANELS

A. Fabricate and finish metal panels and accessories at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's written instructions.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended in writing by metal soffit panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Metallic-Coated Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

7. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film

thickness of **0.5 mil (0.013 mm)**.

D. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
6. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.
7. Exposed Anodized Finish:

    a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

    b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

E. Stainless Steel Panels and Accessories:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    c. Directional Satin Finish: ASTM A480/A480M, No. 4.

3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.

F. Copper Panels and Accessories:

1. Prepatination: Factory prepatinate in accordance with ASTM B882 to convert the copper surface to an inorganic crystalline structure with appearance and durability of naturally formed patina.

G. Zinc-Alloy Panels and Accessories:

1. Bright-Rolled Finish: Uncoated, bright-rolled zinc-alloy sheets.
2. Preweathered Finish: Factory-applied preweathering to uniform color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required in writing by metal panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install steel subframing, furring, and other miscellaneous support system members and anchorages in accordance with metal panel manufacturer's written instructions.

3.3 INSTALLATION OF METAL SOFFIT PANELS

A. Install in accordance with metal panel manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Panel Fasteners:

1. Metallic-Coated Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum fasteners for surfaces exposed to the interior.
3. Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.

4. Stainless Steel Panels: Use stainless steel fasteners.
5. Zinc-Alloy Panels: Use zinc fasteners recommended in writing by manufacturer.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Fasten metal soffit panels to supports with fasteners at each lapped joint at location and spacing recommended in writing by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Weathertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend in writing by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels weathertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum **6-inch (152-mm)** end lap, sealed with sealant and fastened together by interlocking clamping plates.

3.4 INSTALLATION OF ACCESSORIES

A. Install accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal panel manufacturer.

B. Flashing and Trim: Comply with performance requirements and with manufacturer's written installation instructions. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently weathertight.

1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 ft. (3 m)** with no joints allowed within **24 inches (610 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.5 INSTALLATION TOLERANCES

A. Shim and align metal soffit panel units within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated on Drawings, and within **1/8-inch (3-**

mm) offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended in writing by metal panel manufacturer.

B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.7 PROTECTION

A. Maintain metal panels in a clean condition during the remainder of construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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SECTION 07 46 16 00 - METAL PLATE WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes metal plate wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with the Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: **12 inches (305 mm)** long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly [**as shown on Drawings**], including [**corner,**][**soffits,**] supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of mockup of metal panel assembly, testing for water penetration according to AAMA 501.2.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or

deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E330:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: For wind loads, no greater than [**1/180**][**1/240**] of the span.

B. Air Infiltration: Air leakage of not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 METAL PLATE WALL PANELS

A. Metal Plate Wall Panels: Provide factory-formed, metal plate wall panels fabricated from single sheets of metal formed into profile for installation method indicated. Include attachment assembly components[**panel stiffeners**], and accessories required for weathertight system.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. [**Alfrex, LLC**]
b. [**Alply Insulated Panels LLC**]
c. [**American Metalcraft Inc.**]
d. [**Architectural Specialty Products, Inc**]
e. [**Castle Metal Products**]
f. [**DAMS Incorporated; D. Architectural Metal Solutions Incorporated**]
g. [**Fabral; a brand of Flack Global Metals**]

h. [**Fairview Architectural**]
i. [**Firestone Metal Products**]
j. [**Metal Sales & Service, Inc.**]
k. [**Protean Construction Products, Inc**]
l. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

B. Panel Depth: [**2 inches (51 mm)**][**As indicated on Drawings**].

C. Aluminum Sheet: Tension-leveled, smooth aluminum sheet, **ASTM B209 (ASTM B209M)**, [**0.120 inch (3.05 mm)**][**0.125 inch (3.18 mm)**][**0.1875 inch (4.76 mm)**][**0.190 inch (4.82 mm)**] thick.

1. Exterior Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Mica fluoropolymer**][**Metallic fluoropolymer**][**FEVE fluoropolymer**][**Clear anodized**][**Color anodized**].

a. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Attachment Assembly: [**Manufacturer's standard**][**Flange attachment**][**Clip**][**Subgirt and spline**][**Track support**][**Rail support**][**Rainscreen-principle system**].

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 (Z275 hot-dip galvanized)** coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer. Provide sealant types that are compatible with panel materials, are nonstaining, and do not damage panel finish.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a

weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Exposed Anodized Finish:

a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Attachment Assembly, General: Install attachment assembly required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

E. Installation: Attach metal plate wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.

1. Wet Seal Systems: Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200 "Joint Sealants."
2. Rainscreen Systems: Do not apply sealants to joints unless otherwise indicated.

F. Flange-Attachment Installation: Attach metal plate wall panels, formed with extended perimeter flanges, to supports at locations, spacings, and with fasteners recommended by manufacturer.

1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200 "Joint Sealants."
2. Seal horizontal and vertical joints between adjacent panels with manufacturer's standard gaskets.

G. Clip Installation: Attach panel clips to supports at locations, spacings, and with fasteners recommended by manufacturer. Attach flanges of metal plate wall panels to panel clips [**with fasteners**][**by welding**][**with fasteners or by welding**], as recommended by manufacturer.

1. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200 "Joint Sealants."
2. Seal horizontal and vertical joints between adjacent metal plate wall panels with manufacturer's standard gaskets.

H. Subgirt-and-Spline Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard subgirts and splines that provide support and complete secondary drainage assembly, draining to the exterior at horizontal joints. Attach metal plate wall panels by interlocking perimeter extrusions attached to panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal. Terminate edge of panels flush with perimeter extrusions.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Do not apply sealants to joints unless otherwise indicated.

I. Track-Support Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard horizontal tracks and vertical [**tracks**][**drain channels**] that provide support and secondary drainage assembly, draining to the

exterior at horizontal joints through drain tube. Attach metal plate wall panels to tracks by interlocking panel edges with manufacturer's standard "T" clips.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200 "Joint Sealants."

J. Rail-Support Installation: Install rails at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard interlocking rails that provide support and complete secondary drainage assembly, draining to the exterior at horizontal joints. Attach metal plate wall panels by overlapping and interlocking support rails with perimeter rails attached to panels. Apply sealant, foam sealant, and tape sealant at locations recommended by manufacturer. Leave horizontal and vertical joints with open reveal.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Install backer plates before installing support rails.
3. Do not apply sealants to joints unless otherwise indicated.

K. Rainscreen-Principle Installation: Install using manufacturer's standard assembly with vertical channel that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Do not apply sealants to joints unless otherwise indicated.

L. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal panel manufacturer.

M. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 feet (3 m)** with no joints allowed within **24 inches (605 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal plate wall panel units within installed tolerance of **1/4 inch in 20 feet (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated, and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified independent testing agency to perform field tests and inspections.

B. Water-Spray Test: After installation, test area of assembly [**shown on Drawings**][**as directed by Architect**] for water penetration according to AAMA 501.2, as directed by the Owner.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 46 16 00

SECTION 07 46 16 00A - ALUMINUM SIDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum siding.
2. Aluminum soffit.
3. Aluminum components.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
2. Section 062013 "Exterior Finish Carpentry" for exterior [**cellular PVC**][**foam-plastic**] trim.
3. Section 072500 "Weather Barriers" for weather-resistive barriers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include construction details, material descriptions, dimensions of individual components and profiles,[**assembly description and supports details,**] and finishes[**; signed and sealed by the qualified professional engineer responsible for their preparation**].

C. Samples for Initial Selection: For aluminum [**siding**][**soffit**][**components**] including related accessories.

D. Samples for Verification: Actual sample of finished products[**for each type, color, texture, and pattern required**].

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Environmental Product Declaration (EPD): For each product.
12. Third-Party Certifications: For each product.
13. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Research/Evaluation Reports: For each type of aluminum siding required, from ICC-ES.

B. Delegated Design Engineer Qualifications: For component assemblies.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories.

B. Warranty Documentation:

1. Manufacturers' special warranties.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of aluminum [**siding**][**soffit**][**components**] including related accessories.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as indicated on Drawings.
2. Build mockups for [**siding**][**soffit**][**components**] including accessories.

a. Size: [**48 inches (1200 mm) long by 60 inches (1800 mm) high**].
b. Include outside corner on one end of mockup [**and inside corner on other end**].

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store and protect materials on elevated platforms, under cover, and in a dry location.

1.10 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including cracking[**fading,**] and deforming.
b. Deterioration of metals, metal finishes, and other materials beyond weathering.

2. Fading is defined as loss of color, after cleaning with product recommended in writing by manufacturer, of more than [**4**][**5**][**7**] Hunter color-difference units as measured in accordance with ASTM D2244.
3. Warranty Period: [**10**][**15**][**20**][**25**][**50**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain products, including related accessories, from single source from single manufacturer.

2.2 ALUMINUM SIDING

A. Aluminum Siding: Formed and coated product complying with AAMA 1402.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Metal Solutions**]
b. [**Gentek Building Products, Inc**]
c. [**Kaycan Ltd**]
d. [**Knotwood US LLC**]

e. [**Longboard Products**]
f. [**Mastic; Ply Gem**]
g. [**Norandex**]
h. [**Rollex Corporation**]

2. Horizontal Pattern:

   a. **8-inch (203-mm)** exposure in [**plain, single-board**][**beaded-edge, single-board**][**plain, double, 4-inch (102-mm) board**] style.
   b. **10-inch (254-mm)** exposure in [**plain,**][**Dutch-lap,**] double, **5-inch (127-mm)** board style.

3. Vertical Pattern: [**12-inch (300-mm) exposure in board-and-batten, single-board style**][**16-inch (400-mm) exposure in V-grooved, triple, 5-1/3-inch (135-mm) board style**].
4. Texture: [**Smooth**][**Wood grain**].
5. Nominal Thickness: [**0.019 inch (0.5 mm)**][**0.024 inch (0.6 mm)**][**0.062 inch (1.6 mm)**].
6. Insulation: Manufacturer's standard integral insulation panels.
7. Related Materials: Provide siding starter strips, edge trim, outside and inside corner caps, and other items as recommended in writing by siding manufacturer for building configuration.

   a. Provide siding accessories [**made from same material as**][**matching color and texture of**] adjacent siding unless otherwise indicated.

8. Flashing: Provide aluminum flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

   a. Finish for Aluminum Flashing: [**Same as aluminum siding**][**Siliconized polyester coating, same color as siding**][**High-performance organic finish, same color as siding**][**Factory-prime coating**].

9. Fasteners:

   a. For fastening to wood, use [**siding nails**][**ribbed bugle-head screws**] of sufficient length to penetrate a minimum of **1 inch (25 mm)** into substrate.
   b. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch (6 mm)**, or three screw-threads, into substrate.
   c. For fastening aluminum, use aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

10. Accessories are to be made from same material as adjacent siding unless otherwise indicated.

    a. Corner posts[**with fluted faces**].
    b. Door and window casings[**with fluted faces**].
    c. Entrance and window head pediments.
    d. Pilasters[**with fluted faces**].
    e. Shutters with [**paneled**][**louvered**] faces.
    f. Louvers.
    g. Fasciae.
    h. Moldings
    i. Trim coils.

11. Finish: Manufacturer's standard [**three-coat PVDF**][**primer and baked-on acrylic**][**primer and baked-on polyester**].

    a. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As**

selected by Architect from manufacturer's full range of colors], as directed by the Owner.

2.3 ALUMINUM SOFFIT

A. Aluminum Soffit: Formed and coated product complying with AAMA 1402.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Metal Solutions**]
   b. [**Gentek Building Products, Inc**]
   c. [**Kaycan Ltd**]
   d. [**Mastic; Ply Gem**]
   e. [**Norandex**]
   f. [**Rollex Corporation**]

2. Pattern:

   a. **6-inch (152-mm)** exposure in V-grooved, single-board style.
   b. **10-inch (254-mm)** exposure in V-grooved, double, **5-inch (127-mm)** board style.
   c. **12-inch (300-mm)** exposure in V-grooved, double, **6-inch (152-mm)** board style.
   d. **16-inch (400-mm)** exposure in V-grooved, [**triple, 5-1/3-inch (135-mm)**][**quadruple, 4-inch (102-mm)**] board style.

3. Texture: [**Smooth**][**Wood grain**].
4. Ventilation: Provide [**perforated**][**unperforated**] soffit[**unless otherwise indicated**].
5. Nominal Thickness: [**0.019 inch (0.5 mm)**][**0.024 inch (0.6 mm)**][**0.062 inch (1.6 mm)**].
6. Insect Screening for Soffit Vents: [**Aluminum, 18-by-16-inch (1.4-by-1.6-mm) mesh**][**PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16-inch (1.4-by-1.8- or 1.4-by-1.6-mm) mesh**].
7. Continuous Soffit Vents: Aluminum, hat-channel shape, with [**stamped louvers**][**perforations**]; **2 inches (51 mm)** wide and not less than **96 inches (2438 mm)** long.

   a. Net-Free Area: [**4 sq. inch/linear ft. (280 sq. cm/m)**][**6 sq. inch/linear ft. (420 sq. cm/m)**][**8 sq. inch/linear ft. (560 sq. cm/m)**].
   b. Finish: [**Mill finish**][**White paint**][**Brown paint**][**Match soffit**].

8. Round Soffit Vents: Stamped aluminum louvered vents, [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**] in diameter, made to be inserted in round holes cut into soffit.

   a. Finish: [**Mill finish**][**White paint**][**Brown paint**][**Match soffit**].

9. Related Materials: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended in writing by siding manufacturer for building configuration.

   a. Provide accessories [**made from same material as**][**matching color and texture of**] adjacent siding unless otherwise indicated.

10. Flashing: Provide aluminum flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

a. Finish for Aluminum Flashing: [**Same as aluminum siding**][**Siliconized polyester coating, same color as siding**][**High-performance organic finish, same color as siding**][**Factory-prime coating**].

11. Fasteners:

a. For fastening to wood, use [**siding nails**][**ribbed bugle-head screws**] of sufficient length to penetrate a minimum of **1 inch (25 mm)** into substrate.
b. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch (6 mm)**, or three screw-threads, into substrate.
c. For fastening aluminum, use aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

12. Finish: Manufacturer's standard [**AAMA 2603**][**AAMA 2604**][**AAMA 2605**][**anti-graffiti**].

a. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**][**Match adjacent siding**], as directed by the Owner.

2.4 ALUMINUM COMPONENTS

A. Aluminum Components: Precoated, formed, extruded aluminum sheet; minimum 6063-T5 and structural performance to suit Project requirements.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Metal Solutions**]
b. [**B+N Industries, Inc.**]
c. [**Knotwood US LLC**]
d. [**Longboard Products**]

2. Component-Type Assembly: [**Cladding**][**Soffit**][**Fencing**][**Screen**][**Gate**][**Enclosure**][**Railing**][**Awning**][**Pergola**][**Trellis**][**Decking**][**Interior wall**][**Ceiling**][**Partition**].
3. Component-Type Materials: Extruded aluminum to match assembly type.
4. Nominal Thickness: [**0.019 inch (0.5 mm)**][**0.016 inch (0.41 mm)**][**0.024 inch (0.6 mm)**][**0.016 inch (0.41 mm)**][**0.055 inch (1.4 mm)**][**0.062 inch (1.6 mm)**][**0.071 inch (1.8 mm)**][**0.094 inch (2.40 mm)**].
5. Related Materials: Provide edge trim, mounting supports, clips, clip and grit system, infills, spacers, brackets, end mounts, corner trim, end caps, assembly hardware, [**siding board,**][**flat reveals,**][**U-reveals,**]and other items as recommended in writing by component manufacturer for building assembly configuration.

a. Provide accessories [**made from same material as**][**matching color and texture of**] adjacent siding unless otherwise indicated.

6. Acoustic: Manufacturer's noise reduction material or fabric.
7. Flashing: Provide aluminum flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

a. Finish for Aluminum Flashing: [**Same as aluminum siding**][**Siliconized polyester**

coating, same color as siding][**High-performance organic finish, same color as siding**].

8. Fasteners:

   a. For fastening to wood, use sufficient length to penetrate a minimum of **1 inch (25 mm)** into substrate. Provide fastener types as recommended in writing by manufacturer.
   b. For fastening to metal, provide fastener types as recommended in writing by manufacturer.
   c. For fastening aluminum, use aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

9. Finish:

   a. Type: Manufacturer's standard [**solid**][**wood grain**][**metallic**][**speckle**][**naturally aged metal**][**sublimated dye**].
   b. Texture: [**Smooth**][**Textured**].
   c. Sheen: Manufacturer's standard [**matte**][**satin**][**glossy**].
   d. Performance: [**AAMA 2603**][**AAMA 2604**][**AAMA 2605**][**anti-graffiti**].
   e. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of aluminum [**siding**][**soffit**][**components**] and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION OF ALUMINUM SIDING

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

   1. Provide thermal movement for materials as recommended in writing by manufacturer.

B. Install aluminum [**siding**][**soffit**][**components**] and related accessories in accordance with manufacturer's written instructions.

   1. Install fasteners as recommended in writing by manufacturer.

C. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

D. Where aluminum materials contact dissimilar metals, protect against galvanic action by painting contact

surfaces with primer or by applying sealant or tape, or installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces in accordance with manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 16 00A

SECTION 07 46 19 00 - STEEL SIDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel siding.
2. Steel soffit.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
2. Section 062013 "Exterior Finish Carpentry" for exterior [**cellular PVC**][**foam-plastic**] trim.
3. Section 072500 "Weather Barriers" for weather-resistive barriers.

1.2 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:[**Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.**]

1. Steel siding.
2. Steel soffit.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Samples for Initial Selection: For steel [**siding**][**soffit**] including related accessories.

D. Samples for Verification:[**For each type, color, texture, and pattern required.**]

1. **12-inch- (300-mm-)** long-by-actual-width Sample of siding.
2. **24-inch- (600-mm-)** wide-by-**36-inch- (900-mm-)** high Sample panel of siding assembled on plywood backing.
3. **12-inch- (300-mm-)** long-by-actual-width Sample of soffit.
4. **12-inch- (300-mm-)** long-by-actual-width Samples of trim and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of steel [**siding**][**soffit**].

B. Research/Evaluation Reports: For each type of steel siding required, from ICC-ES.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of steel [**siding**][**soffit**] including related accessories, in a quantity equal to 2 percent of amount installed.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for [**siding**][**soffit**] including accessories.

a. Size: [**48 inches (1200 mm) long by 60 inches (1800 mm) high**].
b. Include outside corner on one end of mockup[**and inside corner on other end**].

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracking and deforming.

b. Hail damage, including denting.
c. Deterioration of metals and other materials beyond normal weathering.
d. Deterioration of metal finishes, including chalking[**fading**].

2. Fading is defined as loss of color, after cleaning with product recommended by manufacturer, of more than [**4**][**5**][**7**] Hunter color-difference units as measured according to ASTM D2244.
3. Warranty Period: [**25**][**50**] years from date of Substantial Completion.
4. Warranty Period for Chalking[**Fading**]: [**10**][**15**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain products, including related accessories, from single source from single manufacturer.

2.2 STEEL SIDING

A. Steel Siding: Formed product[**in continuous lengths without end joints,**] made from galvanized steel complying with ASTM A653/A653M, **G90 (Z275)** coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EDCO Products Inc.**]
b. [**Gentek Building Products, Inc**]
c. [**Norandex**]
d. [**Quality Edge**]
e. [**Rollex Corporation**]
f. [**United States Seamless Inc.**]

B. Single-Board Horizontal Pattern: **8-inch (203-mm)** exposure in [**plain, single-board**][**plain, double, 4-inch (102-mm) board**] style.

C. Double-Board Horizontal Pattern: **10-inch (254-mm)** exposure in [**plain,**][**Dutch-lap,**] double, **5-inch (127-mm)** board style.

D. Vertical Pattern: **12-inch (300-mm)** exposure in [**board-and-batten, single**][**V-grooved, double**]-board style.

E. Texture: [**Smooth**][**Wood grain**].

F. Nominal Thickness: [**0.017 inch (0.43 mm)**][**0.019 inch (0.5 mm)**].

G. Finish: Manufacturer's standard [**primer and heat-fused PVC**].

1. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

2.3 STEEL SOFFIT

A. Steel Soffit: Formed product made from galvanized steel complying with ASTM A653/A653M, **G90 (Z275)** coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EDCO Products Inc.**]
b. [**Gentek Building Products, Inc**]
c. [**Norandex**]
d. [**Quality Edge**]
e. [**Rollex Corporation**]
f. [**United States Seamless Inc.**]

B. Pattern: **12-inch (300-mm)** exposure in [**board-and-batten, single**][**V-grooved, double**]-board style.

C. Texture: [**Smooth**][**Wood grain**].

D. Ventilation: Provide [**perforated**][**unperforated**] soffit[**unless otherwise indicated**].

E. Nominal Thickness: [**0.017 inch (0.43 mm)**][**0.019 inch (0.5 mm)**].

F. Finish: Manufacturer's standard [**primer and heat-fused PVC**].

1. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**][**Match adjacent siding**], as directed by the Owner.

2.4 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories [**made from same material as**][**matching color and texture of**] adjacent siding unless otherwise indicated.

B. Decorative Accessories: Provide the following steel decorative accessories as indicated:

1. Corner posts.
2. Door and window casings.
3. Shutters with [**paneled**][**louvered**] faces.
4. Fasciae.
5. Moldings and trim.

C. Colors for Decorative Accessories: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**][**Match adjacent siding**], as directed by the Owner.

D. Flashing: Provide flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

E. Fasteners:

1. For fastening to wood, use [**siding nails**][**ribbed bugle-head screws**] of sufficient length to penetrate a minimum of **1 inch (25 mm)** into substrate.
2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch (6 mm)**, or three screw-threads, into substrate.
3. For fastening galvanized steel, use hot-dip galvanized-steel fasteners. Where fasteners are exposed to view, use prefinished galvanized-steel fasteners in color to match item being fastened.

F. Insect Screening for Soffit Vents: [**PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 (1.4-by-1.8- or 1.4-by-1.6-mm) mesh**].

G. Continuous Soffit Vents: Galvanized-steel, hat-channel shape, with [**stamped louvers**][**perforations**]; **2 inches (51 mm)** wide and not less than **96 inches (2438 mm)** long.

1. Net-Free Area: [**4 sq. in./linear ft. (280 sq. cm/m)**][**6 sq. in./linear ft. (420 sq. cm/m)**][**8 sq. in./linear ft. (560 sq. cm/m)**].
2. Finish: [**White paint**][**Brown paint**].

H. Round Soffit Vents: Stamped galvanized-steel louvered vents, [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**] in diameter, made to be inserted in round holes cut into soffit.

1. Finish: [**White paint**][**Brown paint**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of steel [**siding**][**soffit**] and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION OF STEEL SIDING AND SOFFIT

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

C. Where steel siding contacts dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 19 00

Task	Specification	Specification Description
07 46 19 00	07 46 16 00	Metal Plate Wall Panels
07 46 19 00	07 46 16 00a	Aluminum Siding
07 46 23 00	06 10 00 00	Rough Carpentry
07 46 23 00	06 16 00 00	Sheathing
07 46 29 00	06 10 00 00	Rough Carpentry
07 46 29 00	06 16 00 00	Sheathing

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SECTION 07 46 33 00 - PLASTIC SIDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl siding.
2. Vinyl soffit.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
2. Section 062013 "Exterior Finish Carpentry" for exterior [**cellular PVC**][**foam-plastic**] trim.
3. Section 072500 "Weather Barriers" for weather-resistive barriers.

1.2 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Vinyl siding.
2. Vinyl soffit.

B. Product Data Submittals:

1. For each type of vinyl [**siding**][**soffit**].[**Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.**]
2. For vinyl siding, include VSI's official certification logo printed on Product Data.

C. Samples for Initial Selection: For vinyl [**siding**][**soffit**] including related accessories.

D. Samples for Verification:[**For each type, color, texture, and pattern required.**]

1. **12-inch- (300-mm-)** long-by-actual-width Sample of siding.
2. **24-inch- (600-mm-)** wide-by-**36-inch- (900-mm-)** high Sample panel of siding assembled on plywood backing.
3. **12-inch- (300-mm-)** long-by-actual-width Sample of soffit.
4. **12-inch- (300-mm-)** long-by-actual-width Samples of trim and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For vinyl siding Installer.

B. Product Certificates: For each type of vinyl [**siding**][**soffit**].

C. Research/Evaluation Reports: For each type of vinyl siding required, from ICC-ES.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of vinyl [**siding**][**soffit**] including related accessories, in a quantity equal to 2 percent of amount installed.

1.8 QUALITY ASSURANCE

A. Vinyl Siding Installer Qualifications: A qualified installer who employs a VSI-certified Installer on Project.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for vinyl [**siding**][**soffit**] including accessories.

a. Size: [**48 inches (1200 mm) long by 60 inches (1800 mm) high**].
b. Include outside corner on one end of mockup[**and inside corner on other end**].

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store materials under cover.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including cracking[**fading,**] and deforming.
   b. Deterioration of materials beyond normal weathering.

2. Fading is defined as loss of color, after cleaning with product recommended by manufacturer, of more than [**4**][**5**][**7**] Hunter color-difference units as measured in accordance with ASTM D2244.
3. Warranty Period: [**10**][**25**][**50**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain products, including related accessories, from single source from single manufacturer.

2.2 VINYL SIDING

A. Vinyl Siding: Integrally colored product complying with ASTM D3679.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alside Exterior Building Products**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Gentek Building Products, Inc**]
   d. [**Kaycan Ltd**]
   e. [**Mastic; Ply Gem**]
   f. [**Mitten Inc.**]
   g. [**Norandex**]
   h. [**ProVia**]
   i. [**RMC Siding**]
   j. [**Royal Building Products, a Westlake Company**]
   k. [**Veriform; Ply Gem**]

B. Vinyl Siding Certification Program: Provide products that are listed in VSI's list of certified products.

C. Horizontal Pattern:

1. **6-1/2- or 7-inch (165- or 178-mm)** exposure in beaded-edge, single-board style.
2. **8-inch (203-mm)** exposure in plain, [**single-board**][**double, 4-inch (102-mm) board**][**triple, 2-2/3-inch (68-mm) board**] style.
3. **8-inch (203-mm)** exposure in Dutch-lap, double, **4-inch (102-mm)** board style.
4. **9-inch (229-mm)** exposure in plain, [**double, 4-1/2-inch (114-mm)**][**triple, 3-inch (76-mm)**] board style.
5. **9-inch (229-mm)** exposure in Dutch-lap, double, **4-1/2-inch (114-mm)** board style.
6. **10-inch (254-mm)** exposure in [**plain,**][**Dutch-lap,**] double, **5-inch (127-mm)** board style.

D. Vertical Pattern:

1. **6-inch (152-mm)** exposure in V-grooved, single-board style.
2. **8-inch (203-mm)** exposure in beaded-edge, double, **4-inch (102-mm)** board style.
3. **10-inch (254-mm)** exposure in V-grooved, double, **5-inch (127-mm)** board style.
4. **12-inch (300-mm)** exposure in V-grooved, [**double, 6-inch (152-mm)**][**triple, 4-inch (102-mm)**] board style.

E. Shingle Pattern: **48-inch- (1200-mm-)** wide, [**straight-edge notched**][**staggered-edge notched**][**half-round edge**][**octagon edge**] sheets with wood-grain texture.

F. Texture: [**Smooth**][**Wood grain**].

G. Nominal Thickness: [**0.040 inch (1.0 mm)**][**0.044 inch (1.1 mm)**].

H. Minimum Profile Depth (Butt Thickness): [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].

I. Nailing Hem: Double thickness.

J. Finish: Wood-grain print with clear protective coating containing not less than 70 percent PVDF.

1. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

2.3 VINYL SOFFIT

A. Vinyl Soffit: Integrally colored product complying with ASTM D4477.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alside Exterior Building Products**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Gentek Building Products, Inc**]
d. [**Kaycan Ltd**]
e. [**Mastic; Ply Gem**]
f. [**Mitten Inc.**]
g. [**Norandex**]
h. [**ProVia**]
i. [**RMC Siding**]
j. [**Royal Building Products, a Westlake Company**]
k. [**Veriform; Ply Gem**]

B. Vinyl Siding Certification Program: Provide products that are listed in VSI's list of certified products.

C. Pattern:

1. **6-inch (152-mm)** exposure in [**V-grooved, single-board**][**beaded-edge, triple, 2-inch (51-mm) board**] style.
2. **8-inch (203-mm)** exposure in V-grooved, double, **4-inch (102-mm)** board style.
3. **10-inch (254-mm)** exposure in V-grooved, double, **5-inch (127-mm)** board style.
4. **12-inch (300-mm)** exposure in V-grooved, [**double, 6-inch (152-mm)**][**triple, 4-inch (102-mm)**] board style.

D. Texture: [**Smooth**][**Wood grain**].

E. Ventilation: Provide [**perforated**][**unperforated**] soffit [**unless otherwise indicated**].

F. Nominal Thickness: [**0.035 inch (0.9 mm)**][**0.040 inch (1.0 mm)**][**0.044 inch (1.1 mm)**].

G. Minimum Profile Depth: [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].

H. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**][**Match adjacent siding**], as directed by the Owner.

2.4 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories [**made from same material as**][**matching color and texture of**] adjacent siding unless otherwise indicated.

B. Vinyl Accessories: Integrally colored vinyl accessories complying with ASTM D3679 except for wind-load resistance.

1. Texture: [**Smooth**][**Wood grain**].

C. Decorative Accessories: Provide the following vinyl decorative accessories as indicated:

1. Corner posts[**with fluted faces**].
2. Door and window casings [**with fluted faces**][**and corner rosettes**].
3. Entrance and window head pediments.
4. Pilasters[**with fluted faces**].
5. Shutters with [**paneled**][**louvered**] faces.
6. Louvers.
7. Lattice.
8. Fasciae.
9. Moldings and trim.

D. Colors for Decorative Accessories: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**][**Match adjacent siding**], as directed by the Owner.

E. Flashing: Provide [**aluminum**][**stainless steel**] flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

1. Finish for Aluminum Flashing: [**Siliconized polyester coating, same color as siding**][**High-performance organic finish, same color as siding**][**Factory-prime coating**].

F. Fasteners:

1. For fastening to wood, use [**siding nails**][**ribbed bugle-head screws**] of sufficient length to penetrate a minimum of **1 inch (25 mm)** into substrate.
2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch (6 mm)**, or three screw-threads, into substrate.
3. For fastening vinyl, use [**aluminum**][**hot-dip galvanized**][**stainless steel**] fasteners. Where

fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

G. Insect Screening for Soffit Vents: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh**][**PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 (1.4-by-1.8- or 1.4-by-1.6-mm) mesh**].

H. Continuous Soffit Vents: Aluminum, hat-channel shape, with [**stamped louvers**][**perforations**]; **2 inches (51 mm)** wide and not less than **96 inches (2438 mm)** long.

1. Net-Free Area: [**4 sq. in./linear ft. (280 sq. cm/m)**][**6 sq. in./linear ft. (420 sq. cm/m)**][**8 sq. in./linear ft. (560 sq. cm/m)**].
2. Finish: [**Mill finish**][**White paint**][**Brown paint**].

I. Round Soffit Vents: Stamped aluminum louvered vents, [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**] in diameter, made to be inserted in round holes cut into soffit.

1. Finish: [**Mill finish**][**White paint**][**Brown paint**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of vinyl [**siding**][**soffit**] and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

B. Install vinyl [**siding**][**soffit**] and related accessories in accordance with ASTM D4756.

1. Install fasteners for horizontal vinyl siding no more than [**16 inches (400 mm)**] o.c.
2. Install fasteners for vertical vinyl siding no more than [**12 inches (300 mm)**] o.c.

C. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials

complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 33 00

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SECTION 07 46 46 00 - FIBER-CEMENT SIDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiber-cement siding.
2. Fiber-cement soffit.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
2. Section 062013 "Exterior Finish Carpentry" for exterior [**cellular PVC**][**foam-plastic**] trim.
3. Section 072500 "Weather Barriers" for weather-resistive barriers.

1.2 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Fiber-cement siding.
2. Fiber-cement soffit.

B. Product Data Submittals: For each type of fiber-cement [**siding**][**soffit**].[**Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.**]

C. Samples for Initial Selection: For fiber-cement [**siding**][**soffit**] including related accessories.

D. Samples for Verification:[**For each type, color, texture, and pattern required.**]

1. **12-inch- (300-mm-)** long-by-actual-width Sample of siding.
2. **24-inch- (600-mm-)** wide-by-**36-inch- (900-mm-)** high Sample panel of siding assembled on plywood backing.
3. **12-inch- (300-mm-)** long-by-actual-width Sample of soffit.
4. **12-inch- (300-mm-)** long-by-actual-width Samples of trim and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of fiber-cement [**siding**][**soffit**].

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.

C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of fiber-cement [**siding**][**soffit**], including related accessories, to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of fiber-cement [**siding**][**soffit**] including related accessories, in a quantity equal to 2 percent of amount installed.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for fiber-cement [**siding**][**soffit**] including accessories.

a. Size: [**48 inches (1200 mm) long by 60 inches (1800 mm) high**].
b. Include outside corner on one end of mockup[**and inside corner on other end**].

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including cracking and deforming.
   b. Deterioration of materials beyond normal weathering.

2. Warranty Period: [**10**][**25**][**50**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain products, including related accessories, from single source from single manufacturer.

2.2 FIBER-CEMENT SIDING

A. Fiber-Cement Siding: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested in accordance with ASTM E136; with a flame-spread index of 25 or less when tested in accordance with ASTM E84.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Allura**]
      b. [**American Fiber Cement Corporation**]
      c. [**CertainTeed; SAINT-GOBAIN**]
      d. [**GAF**]
      e. [**James Hardie Building Products, Inc.**]
      f. [**Nichiha USA, Inc.**]

B. Labeling: Provide fiber-cement siding that is tested and labeled in accordance with ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.

C. Nominal Thickness: Not less than **5/16 inch (8 mm)**.

D. Horizontal Pattern: Boards [**5-1/4 inches (133 mm)**][**6-1/4 to 6-1/2 inches (159 to 165 mm)**][**7-1/4 to 7-1/2 inches (184 to 190 mm)**][**8-1/4 to 8-1/2 inches (210 to 216 mm)**][**9-1/4 to 9-1/2 inches (235 to 241 mm)**] wide in [**plain**][**beaded-edge**] style.

   1. Texture: [**Smooth**][**Rough sawn**][**Wood grain**].

E. Vertical Pattern: **48-inch- (1200-mm-)** wide sheets with wood-grain texture and grooves [**8 inches (203 mm)**][**12 inches (300 mm)**] o.c.

F. Shingle Pattern: **48-inch- (1200-mm-)** wide, [**straight-edge notched**][**staggered-edge notched**] sheets with wood-grain texture.

G. Panel Texture: **48-inch- (1200-mm-)** wide sheets with [**smooth**][**stucco**][**wood-grain**] texture.

H. Factory Priming: Manufacturer's standard acrylic primer.

2.3 FIBER-CEMENT SOFFIT

A. Fiber-Cement Soffit: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested in accordance with ASTM E136; with a flame-spread index of 25 or less when tested in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allura**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**James Hardie Building Products, Inc.**]
d. [**Nichiha USA, Inc.**]

B. Nominal Thickness: Not less than **5/16 inch (8 mm)**.

C. Pattern: [**12-inch- (300-mm-)**][**16-inch- (400-mm-)**][**24-inch- (600-mm-)**] wide sheets with [**smooth**][**wood-grain**] texture.

D. Ventilation: Provide [**perforated**][**unperforated**] soffit[**unless otherwise indicated**].

E. Factory Priming: Manufacturer's standard acrylic primer.

2.4 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.

B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:

1. Corner posts.
2. Door and window casings.
3. Fasciae.
4. Moldings and trim.

C. Flashing: Provide [**aluminum**][**stainless steel**] flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

1. Finish for Aluminum Flashing: [**Siliconized polyester coating**][**High-performance organic finish**][**Factory-prime coating**].

D. Fasteners:

1. For fastening to wood, use [**siding nails**][**ribbed bugle-head screws**] of sufficient length to

penetrate a minimum of **1 inch (25 mm)** into substrate.
2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch (6 mm)**, or three screw-threads, into substrate.
3. For fastening fiber cement, use [**hot-dip galvanized**][**stainless steel**] fasteners.

E. Insect Screening for Soffit Vents: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh**][**PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 (1.4-by-1.8- or 1.4-by-1.6-mm) mesh**][**Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh**].

F. Continuous Soffit Vents: Aluminum, hat-channel shape, with [**stamped louvers**][**perforations**]; **2 inches (51 mm)** wide and not less than **96 inches (2438 mm)** long.

1. Net-Free Area: [**4 sq. in./linear ft. (280 sq. cm/m)**][**6 sq. in./linear ft. (420 sq. cm/m)**][**8 sq. in./linear ft. (560 sq. cm/m)**].
2. Finish: [**Mill finish**][**White paint**][**Brown paint**].

G. Round Soffit Vents: Stamped aluminum louvered vents, [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**] in diameter, made to be inserted in round holes cut into soffit.

1. Finish: [**Mill finish**][**White paint**][**Brown paint**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement [**siding**][**soffit**] and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Do not install damaged components.
2. Install fasteners no more than [**24 inches (600 mm)**] o.c.

B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 46 00

Task	Specification	Specification Description
07 46 46 00	01 22 00 00	No Specification Required
07 46 63 00	07 46 16 00a	Aluminum Siding

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SECTION 07 51 13 00 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Built-up asphalt roofing (BUR) system.
2. Roofing membrane sheet materials.
3. Base flashing sheet.
4. Asphalt materials.
5. Accessory roofing system materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation and accessories.
9. Cover board.
10. Electronic leak-detection (ELD) materials.
11. Roof coating system.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and roofing terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Crickets, saddles, and tapered edge strips, including slopes.
7. Insulation-fastening patterns for corner, perimeter, and field-of-roof locations.
8. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Roof Coating System: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
4. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746/C3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 BUILT-UP ASPHALT ROOFING (BUR) SYSTEM

A. BUR Roofing System Components: See the following articles for individual roof materials required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Building Products of Canada Corp.**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Malarkey Roofing Products**]
h. [**Tamko Building Products LLC**]
i. [**Tremco Incorporated**]

2.4 ROOFING MEMBRANE SHEET MATERIALS

A. SBS-Modified-Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], SBS-modified asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

B. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.

D. Asphalt-Coated, Organic-Felt Base Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

E. Ply Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

F. Cap Sheet: ASTM D3909/D3909M, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

2.5 BASE FLASHING SHEET

A. Asphalt-Impregnated, Glass-Fiber-Mat Backer Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

D. SBS-Modified-Bitumen Backer Sheet: [**ASTM D6164/D6164M, Type I or II, Grade S, reinforced with polyester fabric**][**ASTM D6163/D6163M, Type I or II, Grade S, reinforced with glass fibers**][**ASTM D6162/D6162M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

E. SBS-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6164/D6164M, Type I or II, Grade G, polyester reinforced**][**ASTM D6163/D6163M, Type I or II, Grade G, glass-fiber reinforced**][**ASTM D6162/D6162M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced; suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

F. SBS-Modified-Bitumen, Metal-Surfaced Flashing Sheet: ASTM D6298, glass-fiber-reinforced, SBS-modified, metal-foil-surfaced asphalt sheet, suitable for application method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

G. APP-Modified-Bitumen, Smooth-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade S, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**], smooth surfaced, suitable for application method specified.

H. APP-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade G, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced, suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

I. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.

J. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.6 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer for application**], suitable for installation method specified.

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.7 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

G. Cold-Applied Asphalt Adhesive: ASTM D4479/D4479M, Type I or Type II, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

H. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system, base flashings, and aggregate surfacing adhesive.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing manufacturer for application.

J. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.

L. Aggregate Surfacing: ASTM D1863/D1863M, No. 6 or No. 67, clean, dry, opaque, [**water-worn gravel or crushed stone, free of sharp edges**][**crushed slag, free of sharp edges**].

M. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.8 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Roof Substrate Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.9 VAPOR RETARDER

A. Rubberized Asphalt Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.10 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.0-lb/cu. ft. (48-kg/cu. m) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DuPont de Nemours, Inc.**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.

3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578 Type VIII, **1.15-lb/cu. ft. (18-kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Syntec Systems**]
   c. [**Cellofoam North America, Inc.**]
   d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35-lb/cu. ft. (22-kg/cu. m)**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m)**][**Type IX, 1.8-lb/cu. ft. (29-kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cellofoam North America, Inc.**]
   b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]

g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Hunter Panels; a Carlisle company**]
f. [**Insulfoam; a Carlisle Company**]
g. [**Johns Manville; a Berkshire Hathaway company**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type I, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (51 mm)**].

I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1200 mm)**.

J. Mineral Wool Board Insulation - Multidensity: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with an **11.2-lb/cu. ft. (180-kg/cu. m)** density and a lower layer with a **7.5-lb/cu. ft. (120-kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (51 mm)**].

4. Face Treatment: Bitumen coating.

K. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a **12.5-lb/cu. ft. (200-kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

M. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatible with other roofing system components.

N. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing membrane manufacturer.

O. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

P. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

Q. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

R. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1,**

cellulosic-fiber insulation board].

2.11 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 ROOF COATING SYSTEM

A. Primer: Roof coating manufacturer's standard primer to enhance the adhesion of roof coating to substrate.

B. Asphalt Emulsion Coating, Asbestos Free: ASTM D1227/D1227M, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**].

C. Asphalt Emulsion Coating, Nonfibered: ASTM D1227/D1227M, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**].

D. Aluminum-Pigmented Asphaltic Coating: ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**].

E. Acrylic Elastomer Emulsion Coating: ASTM D6083/D6083M, formulated for use on bituminous roof surfaces.

F. Silicone Coating: ASTM D6694/D6694M, formulated for use on bituminous roof surfaces.

G. Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches (762 mm by 762mm)**].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [**36 by 60 inches (914 mm by 1524 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

   a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood fiber panels are vertically aligned to within **1/8-inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF BUILT-UP ASPHALT ROOFING SYSTEM, GENERAL

A. Install roofing system in accordance with manufacturer's written instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Asphalt Heating:

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.
2. Circulate asphalt during heating.

a. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of application.

3. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
4. Do not heat asphalt within **25 deg F (14 deg C)** of flash point.
5. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.

a. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

F. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt in accordance with roofing manufacturer's written instructions.

G. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints,

entering building, or damaging roofing components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.

6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten **4-inch nominal- (89-mm actual-)** width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [**16 feet (4.88 m)**] apart for roof slopes greater than **1 inch per 12 inches (1:12)** but less than **3 inches per 12 inches (3:12)**.
2. [**48 inches (1200 mm)**] apart for roof slopes greater than **3 inches per 12 inches (3:12)**.

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF BUILT-UP ROOFING MEMBRANE

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations of NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:

1. Base Sheet: [**One**][**One, installed over sheathing paper**].
2. Number of Ply Sheets: [**Two**][**Three**][**Four**].
3. Surfacing: [**Aggregate**][**Asphalt surfacing or coating**][**Mineral-granule-surfaced cap sheet**].
4. Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing ply sheets parallel with slope.

1. Backnail roofing ply sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written instructions.

D. Coordinate installation of roofing, so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 inches (51 mm)** and **6 inches (150 mm)**, respectively.

F. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Mechanically fasten to substrate.
2. Spot or strip mop to substrate with hot roofing asphalt.
3. Adhere to substrate [**in a solid mopping of hot roofing asphalt**][**using cold-applied asphalt adhesive**][**using cold-applied polymer-modified asphalt adhesive**].

G. Install [**three**][**four**] ply sheets, starting at low point of roof.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

   a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.
4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
7. Install ply sheets without wrinkles, tears, and free from air pockets.

H. Cap Sheet: Install lapped granulated cap sheet, starting at low point of roofing.

1. Offset laps from laps of preceding ply sheets, and align cap sheet without stretching.
2. Lap in direction to shed water.
3. Extend cap sheet over and terminate above cants.
4. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing

system manufacturer.
6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing system manufacturer.
7. Install cap sheet without wrinkles, tears, and free from air pockets.

I. Aggregate Surfacing: After installing and testing roofing, base flashing, and stripping, promptly apply flood coat to roof surface with [**60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt**][**cold-applied polymer-modified asphalt adhesive at rate recommended by roof system manufacturer**]. [**While flood coat is hot and fluid, cast**][**Cast**] the following average weight of aggregate in a uniform course:

1. Aggregate Weight: [**400 lb/100 sq. ft. (20 kg/sq. m)**][**300 lb/100 sq. ft. (15 kg/sq. m)**].
2. If aggregate surfacing is delayed, promptly apply glaze coat of [**hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m)**][**cold-applied polymer-modified asphalt adhesive at a rate recommended by roof system manufacturer**].

J. Glaze-coat roofing surface with hot roofing asphalt applied at a rate of **10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m)**.

3.10 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate**] in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
3. Flashing Sheet Application, Hot: [**Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer**][**Torch-apply flashing sheet to substrate**].
4. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in [**cold-applied adhesive**][**cold-applied polymer-modified adhesive**][**asphalt roofing cement**] at rate required by roofing manufacturer.

B. Extend base flashing up walls or parapets a minimum of **8 inches (200 mm)** above built-up roofing and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing[**with a strip of glass-fiber fabric set in asphalt roofing cement**].

D. Install liquid flashing system in accordance with manufacturer's recommendations.

1. Extend liquid flashing not less than **3 inches (76 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Install stripping in accordance with roofing system manufacturer's written instructions, where metal flanges and edgings are set on roofing membrane.

1. Install flashing sheet stripping in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
2. Install flashing sheet stripping by heat welding and extend onto roofing membrane.
3. Install stripping of not fewer than two roofing ply sheets, setting each ply in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**], and extend onto roofing membrane **4 inches (100 mm)** and **6 inches (150 mm)**, respectively.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**] **4-pound (1.8-kg)** lead flashing in bed of asphaltic adhesive on completed roofing membrane.

1. Cover metal flashing with roofing cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing manufacturer's written instructions.

3.11 INSTALLATION OF ROOF COATING SYSTEM

A. Apply coating to [**roofing membrane**][**base flashings**] in accordance with manufacturer's written instructions, by spray, roller, or other suitable application method[**, to provide a dry film thickness of not less than 20 mils (0.5 mm)**].

3.12 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads, using units of size indicated or, if not indicated, of manufacturer's standard size, in accordance with walkway pad manufacturer's written instructions.

1. Install walkways at following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining pads.
3. Set walkway pads [**in additional pour coat of hot roofing asphalt**][**in cold-applied adhesive**][**in cold-applied polymer-modified adhesive**] after sweeping away loose aggregate surfacing.

B. Walkway Cap-Sheet Strips: Install walkway cap-sheet strips, approximately **36 inches (914 mm)** wide and in lengths not exceeding **10 feet (3 m)**, over roofing membrane, using same application method as used for roofing cap sheet.[**Install walkway cap-sheet strips before flood coat and aggregate surface is applied.**]

1. Install walkways strips at following locations:

   a. Perimeter of each rooftop unit.

b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

C. Roof-Paver Walkways: Install walkway roof pavers in accordance with roofing manufacturer's written instructions.

1. Install roof paver walkways at following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25**

mm)] and not exceeding a depth of [4 inches (100 mm)]. Maintain 2 inches (51 mm) of clearance from top of base flashing.

c. Flood each area for [**24**][**48**][**72**] hours.

d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

a. Perform tests before overlying construction is placed.

b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.

c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.

a. Perform tests before overlying construction is placed.

b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with SPRI/RCI NT-1.

a. Perform tests before overlying construction is placed.

b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system as follows:

1. Determine approximate quantities of components within roofing system in accordance with ASTM D3617/D3617M.
2. Examine test specimens for interply voids in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
3. Repair areas where test cuts were made in accordance with roofing manufacturer's written

instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify the Owner 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own

cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 51 13 00

Task	Specification	Specification Description
07 51 13 00	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 51 13 00	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 51 13 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 52 13 00 - ATACTIC-POLYPROPYLENE (APP) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Atactic-polypropylene (APP)-modified bituminous membrane roofing system.
2. Base sheet.
3. Cap sheet.
4. Base flashing sheet.
5. Accessory roofing system materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation and accessories.
9. Cover board.
10. Electronic leak-detection (ELD) materials.
11. Roof coating system.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and attachment details to other Work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastener spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Roof Coating System: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
4. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift Resistance Submittal: For roofing system indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of membrane roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified modified bitumen system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified modified bitumen system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**25**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test section in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34, [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

A. APP Roofing System Components: See the following articles for individual roof materials required for [**two**][**three**]-ply roofing system; [**cold-applied adhesive**][**heat-welded (torch)**] installation method [**with self-adhered base sheet layer**][**with mechanically fastened base sheet layer**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]
i. [**Tremco Incorporated**]

2.4 BASE SHEET

A. APP-Modified Bitumen, Polyester-Mat Base Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]

B. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade S, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

C. APP-Modified Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6509/D6509M, reinforced with glass fibers; smooth surfaced; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]

c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Mule-Hide Products Co., Inc**]
e. [**Performance Roof Systems**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Tremco Incorporated**]

D. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

E. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on bottom surface.

2.5 CAP SHEET

A. APP-Modified Bitumen, Polyester-Mat, Smooth-Surfaced Cap Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Mule-Hide Products Co., Inc**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Tremco Incorporated**]

B. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade S, reinforced with a combination of polyester fabric and glass fibers; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

C. APP-Modified Bitumen, Polyester-Mat, Granule-Surfaced Cap Sheet: ASTM D6222/D6222M, [**Type I**][**Type II**], Grade G, reinforced with polyester fabric; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Performance Roof Systems**]
h. [**Polyglass U.S.A., Inc.**]
i. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

D. APP-Modified Bitumen, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6223/D6223M, [**Type I**][**Type II**], Grade G, reinforced with a combination of polyester fabric and glass fibers; suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.6 BASE FLASHING SHEET

A. APP-Modified Bitumen, Base Flashing Sheet: Matching cap sheet, suitable for installation method specified.

B. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture-curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim; suitable for installation method specified.

2.7 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.

g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roofing membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive; specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other; tested by roofing system manufacturer to meet performance requirements.

G. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive; specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other; tested by roofing system manufacturer to meet performance requirements.

H. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

I. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

K. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained on **No. 40 (0.425-mm)** sieve; color matching cap sheet.

L. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

M. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.8 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Substrate Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Roof Substrate Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.9 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards, manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav-listed roof assemblies**][**SPRI's "Directory of Roof Assemblies" listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont de Nemours, Inc.**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Carlisle Syntec Systems**]
c. [**Cellofoam North America, Inc.**]
d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.

3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cellofoam North America, Inc.**]
   b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2 cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [Atlas Polyiso Roof and Wall Insulation]
b. [CertainTeed; SAINT-GOBAIN]
c. [Elevate; Holcim Building Envelope]
d. [GAF]
e. [Hunter Panels; a Carlisle company]
f. [Insulfoam; a Carlisle Company]
g. [Johns Manville; a Berkshire Hathaway company]

2. Facer: [Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick][Type V oriented strand board facer, 7/16 inch (11 mm) thick][Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick].
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].

G. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [Blue Ridge Fiberboard]
b. [GAF]
c. [Georgia-Pacific Gypsum LLC]
d. [Homasote Company]
e. [Huebert Fiberboard Inc]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1219 by 1219 mm)][48 by 96 inches (1219 by 2438 mm)].
4. Thickness:

a. Base Layer: [1 inch (25 mm)][2 inches (51 mm)].

H. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with 11.2 lb/cu. Ft. (180 kg/cu. M) density and a lower layer with 7.5 lb/cu. Ft. (120 kg/cu. M) density.

1. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
2. Size: 48 by 48 inches (1219 by 1219 mm).
3. Thickness:

a. Base Layer: [2 inches (51 mm)]

I. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material with 12.5 lb/cu. Ft. (200 kg/cu. M) density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1219 by 1219 mm)**.
3. Thickness: **1 inch (25 mm)**.

J. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

K. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use, compatibility with other roofing system components, and suitable for installation method specified.

L. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

M. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

N. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1,**

cellulosic-fiber insulation board].

O. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

P. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

2.11 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Panel Cover Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass**][**Paper**] facer.

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 1, **1/2 inch (13 mm)** thick.

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 ROOF COATING SYSTEM

A. Primer: Roof coating manufacturer's standard primer to enhance the adhesion of roof coating to substrate.

B. Asphalt Emulsion Coating, Asbestos Free: ASTM D1227/D1227M, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**].

C. Asphalt Emulsion Coating, Nonfibered: ASTM D1227/D1227M, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**].

D. Aluminum-Pigmented Asphaltic Coating: ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**].

E. Acrylic Elastomer Emulsion Coating: ASTM D6083/D6083M, formulated for use on bituminous roof surfaces.

F. Silicone Coating: ASTM D6694/D6694M, formulated for use on bituminous roof surfaces.

G. Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches (762 mm by 762mm)**].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [**36 by 60 inches (914 mm by 1524 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

   a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include roofing system manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie into existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting

sloping roof decks.

4. Fasten substrate board to top flanges of steel roof deck in accordance with roofing system manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten **4-inch nominal- (89-mm actual-)** width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [**16 ft. (4.88 m)**] apart for roof slopes greater than **1 inch per 12 inches (1:12)** but less than **3 inches per 12 inches (3:12)**.
2. [**48 inches (1219 mm)**] apart for roof slopes greater than **3 inches per 12 inches (3:12)**.

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Comply with roofing system and insulation manufacturer's written installation instructions.

B. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Secure cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
6. Secure cover board to resist specified uplift pressure at corners, perimeter, and field of roof.

C. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF APP ROOFING MEMBRANE, GENERAL

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing membrane sheets parallel with slope.

1. Backnail roofing sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written installation instructions.

D. Coordinate installation of roofing system so insulation and other components of roofing system not

permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.

1. Provide tie-offs at end of day's work to cover exposed roofing sheets and insulation with a course of roofing membrane set in adhesive, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.10 INSTALLATION OF BASE SHEET

A. Prime surface of substrate with primer in accordance with roofing membrane manufacturer's written installation instructions and allow primer to dry.

B. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for time recommended by roofing membrane manufacturer for the ambient temperature at which base sheet will be installed.

C. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

D. Installation of Base Sheet:

1. Install base sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
2. Extend base sheet over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere base sheet to substrate in a uniform coating of cold-applied adhesive.
5. Heat-weld (torch-apply) base sheet to substrate.

    a. Perform torch application in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

6. Self-adhere base sheet to substrate.
7. Mechanically fasten base sheet to substrate using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.

    a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

8. Install base sheet without wrinkles, rears, and free from air pockets.
9. Laps: Accurately align base sheet, without stretching, and maintain uniform side and end laps.

    a. Lap side laps as recommended by roofing membrane manufacturer, but not less than **3 inches (75 mm)**.
    b. Lap end laps as recommended by roofing membrane manufacturer, but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
    c. [**Heat-weld end**][**Completely bond and seal**] laps, leaving no voids.
    d. Roll laps with a **20 lb (9 kg)** roller.

10. Repair tears and voids in laps and lapped seams not completely sealed.
11. Apply pressure to body of base sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

E. Installation of Venting Base Sheet:

1. [**Mechanically fasten sheet to substrate, using fasteners specifically designed and sized for substrate**][**Spot or strip mop sheet to substrate with cold-applied adhesive**] with venting side down.

   a. Secure venting base sheet to substrate in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified wind-uplift load capacity**].
   b. Secure venting base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.11 INSTALLATION OF CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for time recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Adhere cap sheet to bottom layer in a uniform coating of cold-applied adhesive.
4. Heat-weld (torch-apply) cap sheet to bottom layer.

   a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

5. Install cap sheet without wrinkles or tears, and free from air pockets.
6. Install cap sheet so side and end laps shed water.

C. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roofing membrane manufacturer, but not less than **3 inches (75 mm)**.
2. Lap end laps as recommended by roofing membrane manufacturer, but not less than **12 inches (300 mm)**.
3. Stagger end laps not less than **18 inches (450 mm)**.
4. [**Heat-weld end**][**Completely bond and seal**] laps, leaving no voids.
5. Roll laps with a **20 lb (9 kg)** roller.
6. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to body of cap sheet in accordance with roofing membrane written manufacturer's instructions, to remove air pockets and to result in complete adhesion of cap sheet to substrate.

E. Apply roofing granules of same color as cap sheet to cover exuded bead at laps while bead is hot, to provide a continuous color appearance.

3.12 INSTALLATION OF BASE FLASHING AND STRIPPING

A. Install base flashing sheet over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's

written installation instructions and as follows:

1. Prime substrates with primer if required by roofing system manufacturer.
2. Base Flashing Sheet Application, Cold: Adhere base flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
3. Base Flashing Sheet Application, Hot: Head-weld (torch-apply) base flashing sheet to substrate.

    a. Perform torch application in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

B. Extend base flashing sheet up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing sheet securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing sheet.

D. Install liquid flashing system in accordance with roofing system manufacturer's written installation instructions.

1. Extend liquid flashing not less than **3 inches (75 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of cap sheet, into wet compound.

E. Install cap sheet stripping where metal flanges and edgings are set on roof in accordance with roofing system manufacturer's written installation instructions.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**], **4 lb (1.8 kg)** flashing in bed of adhesive on completed roofing membrane.

1. Cover flashing with cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing system manufacturer's written installation instructions.

3.13 INSTALLATION OF ROOF COATING SYSTEM

A. Apply coating to [**smooth-surfaced cap sheet**][**base flashing sheet**] in accordance with roofing membrane manufacturer's written application instructions, by spray, roller, or other suitable application method[**, to provide a dry film thickness of not less than 20 mils (0.5 mm)**].

3.14 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, secure to cap sheet in accordance with roofing system manufacturer's written installation instructions.

1. Install walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit

locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing system manufacturer's warranty requirements.

2. Provide **3-inch (75-mm)** clearance between adjoining pads.

B. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane, using same installation method as that used for cap sheet.

1. Install walkways strips at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections of substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957 after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)**

of clearance from top of base flashing.

b. Flood each area for [**24**][**48**][**72**] hours.

c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or by nuclear hydrogen detection testing.

b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
2. Examine test specimens for voids between plies in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the

Application of Polymer Modified Bitumen Roofing."

3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

G. Prepare test and inspection reports.

3.16 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.17 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner.:
2. the Owner.Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

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SECTION 07 52 16 00 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing system.
2. Base sheet.
3. Cap sheet.
4. Base flashing sheet.
5. Asphalt materials.
6. Accessory roofing system materials.
7. Substrate board.
8. Vapor retarder.
9. Roof insulation and accessories.
10. Cover board.
11. Electronic leak-detection (ELD) materials.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project**

site].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and attachment details to other Work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation layout, including slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastener spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.

8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: Actual sample of finished products for the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified modified bitumen system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified modified bitumen system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**25**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test section in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial Solar Reflectance Index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

A. Roofing System Components: See the following articles for individual roof materials required for [**two**][**three**] ply roofing system; [**hot-applied asphalt**][**cold-applied adhesive**][**heat-welded (torch)**][**self-adhered**][**mechanically fastened**] installation method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
g. [**Johns Manville; a Berkshire Hathaway company**]
h. [**Malarkey Roofing Products**]
i. [**MBTechnology**]
j. [**Mule-Hide Products Co., Inc**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Siplast**]
m. [**Soprema, Inc.**]
n. [**Tamko Building Products LLC**]
o. [**Tremco Incorporated**]

2.4 BASE SHEET

A. SBS-Modified Bitumen Polyester-Mat Base Sheet: ASTM D6164/D6164M, [**Type I**][**Type II**], Grade S, reinforced with polyester fabric, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Siplast**]
h. [**Soprema, Inc.**]
i. [**Tremco Incorporated**]

B. SBS-Modified Bitumen Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], Grade S, reinforced with glass fibers, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings &**

Waterproofing Inc. brands)]
g. [**Johns Manville; a Berkshire Hathaway company**]
h. [**Malarkey Roofing Products**]
i. [**Mule-Hide Products Co., Inc**]
j. [**Polyglass U.S.A., Inc.**]
k. [**Siplast**]
l. [**Soprema, Inc.**]
m. [**Tamko Building Products LLC**]
n. [**Tremco Incorporated**]

C. SBS-Modified Bitumen Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6162/D6162M, [**Type I**][**Type II**][**Type III**], Grade S, reinforced with a combination of polyester fabric and glass fibers, smooth surfaced, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**Garland Company, Inc. (The)**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**MBTechnology**]
e. [**Polyglass U.S.A., Inc.**]
f. [**Soprema, Inc.**]
g. [**Tremco Incorporated**]

2.5 CAP SHEET

A. SBS-Modified Bitumen, Granule-Surfaced, Polyester-Mat Cap Sheet: ASTM D6164/D6164M, [**Type I**][**Type II**], Grade G, reinforced with polyester fabric, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Siplast**]
i. [**Soprema, Inc.**]
j. [**Tamko Building Products LLC**]
k. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

B. SBS-Modified Bitumen, Granule-Surfaced, Glass-Fiber-Mat Cap Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], Grade G, SBS-modified asphalt sheet, reinforced with glass fibers, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Garland Company, Inc. (The)**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Malarkey Roofing Products**]
h. [**MBTechnology**]
i. [**Polyglass U.S.A., Inc.**]
j. [**Siplast**]
k. [**Soprema, Inc.**]
l. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

C. SBS-Modified Bitumen, Granule-Surfaced, Polyester and Glass-Fiber-Mat Cap Sheet: ASTM D6162/D6162M, [**Type I**][**Type III**], Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Garland Company, Inc. (The)**]
d. [**Johns Manville; a Berkshire Hathaway company**]
e. [**Soprema, Inc.**]
f. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.6 BASE FLASHING SHEET

A. SBS-Modified Bitumen, Smooth-Surfaced Backer Sheet: Matching base sheet, suitable for installation method specified.

B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and coated glass-fiber sheet, dusted with fine mineral surfacing on both sides, suitable for installation method specified.

C. SBS-Modified Bitumen, Granule-Surfaced Base Flashing Sheet: Matching cap sheet, suitable for installation method specified.

D. SBS-Modified Bitumen, Metal-Surfaced Base Flashing Sheet: ASTM D6298/D6298M, metal-foil-surfaced sheet, reinforced with glass fibers, suitable for installation method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

E. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim, suitable for installation method specified.

2.7 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer**], suitable for installation method specified.

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.8 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars,

approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roofing membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.

G. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane sheets**][**base flashing sheets**]; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.

H. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing membrane manufacturer.

I. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

J. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

L. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained on **No. 40 (0.425-mm)** sieve; color matching cap sheet.

M. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

N. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.9 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.10 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.11 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards, manufactured[**approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. Ft. (23 kg/cu. M) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. Ft. (48 kg/cu. M) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. Ft. (18 kg/cu. M)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Carlisle Syntec Systems**]
c. [**Cellofoam North America, Inc.**]
d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. Ft. (22 kg/cu. M)**][**Type VIII, 1.15 lb/cu. Ft. (18 kg/cu. M)**][**Type IX, 1.8 lb/cu. Ft. (29 kg/cu. M)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cellofoam North America, Inc.**]
b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-**

fiber facer][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]
    g. [**IKO Industries Inc.**]
    h. [**Insulfoam; a Carlisle Company**]
    i. [**Johns Manville; a Berkshire Hathaway company**]
    j. [**Kingspan Insulation LLC**]
    k. [**Polyglass U.S.A., Inc.**]
    l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

    a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber-mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]
    g. [**IKO Industries Inc.**]
    h. [**Insulfoam; a Carlisle Company**]
    i. [**Johns Manville; a Berkshire Hathaway company**]
    j. [**Kingspan Insulation LLC**]
    k. [**Polyglass U.S.A., Inc.**]
    l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GAF**]
   b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (50 mm)**].

I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1200 mm)**.

J. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with a **11.2 lb/cu. Ft. (180 kg/cu. M)** density and a lower layer with a **7.5 lb/cu. Ft. (120 kg/cu. M)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (50 mm)**].

4. Face Treatment: Bitumen coating.

K. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a **12.5 lb/cu. Ft. (200 kg/cu. M)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

M. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use, compatible with other roofing system components and suitable for installation method specified.

N. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing membrane manufacturer.

O. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.

i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

P. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

Q. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

R. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

2.12 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Panel Cover Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**]

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 1, **1/2 inch (13 mm)** thick.

2.13 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches**

(762 mm by 762mm)].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [**36 by 60 inches (914 mm by 1524 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

   a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete roof deck with asphalt primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include roofing system manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav listed roof**][**SPRI's "Directory of Roof Assemblies" listed roof**] assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before installation.
2. Circulate asphalt during heating.
3. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of installation.
4. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
5. Do not heat asphalt within **25 deg F (14 deg C)** of flash point.
6. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
7. Apply hot asphalt within **plus or minus 25 deg F (plus or minus 14 deg C)** of equiviscous

temperature.

F. SEBS-Modified Asphalt Heating: Heat and apply hot asphalt in accordance with roofing system manufacturer's written installation instructions.

G. Substrate-Joint Penetrations: Prevent hot-applied asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel roof deck in accordance with roofing system manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel roof deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less

than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl **plus 24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten **4-inch nominal- (89-mm actual-)** width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [**16 ft. (4.88 m)**] apart for roof slopes greater than **1 inch per 12 inches (1:12)** but less than **3 inches per 12 inches (3:12)**.
2. [**48 inches (1200 mm)**] apart for roof slopes greater than **3 inches per 12 inches (3:12)**.

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Comply with roofing system and insulation manufacturer's written installation instructions.

B. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board, so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Secure cover board to insulation in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
6. Secure cover board to resist specified uplift pressure at corners, perimeter, and field of roof.

C. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored

moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF SBS ROOFING MEMBRANE, GENERAL

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing membrane sheets parallel with slope.

1. Backnail roofing sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written installation instructions.

D. Coordinate installation of roofing system so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in adhesive, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.10 INSTALLATION OF BASE SHEET

A. Prime surface of substrate with primer in accordance with roofing membrane manufacturer's written installation instructions and allow primer to dry.

B. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which base sheet will be installed.

C. Loosely lay one course of sheathing paper, lapping edges, and ends a minimum of **2 inches (50 mm)** and **6 inches (150 mm)**, respectively.

D. Installation of Base Sheet:

1. Install base sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
2. Extend base sheet over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere base sheet to substrate in a uniform coating of [**hot-applied asphalt**][**cold-applied adhesive**].
5. Self-adhere base sheet to substrate.
6. Heat-weld (torch-apply) base sheet to substrate.

a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

7. Mechanically fasten base sheet to substrate using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.

    a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

8. Install base sheet without wrinkles or rears, and free from air pockets.
9. Laps: Accurately align base sheet, without stretching, and maintain uniform side and end laps.

    a. Lap side laps as recommended by roofing membrane manufacturer but not less than **3 inches (75 mm)**.
    b. Lap end laps as recommended by roofing membrane manufacturer but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
    c. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
    d. Roll laps with a **20 lb (9 kg)** roller.

10. Repair tears and voids in laps and lapped seams not completely sealed.
11. Apply pressure to body of base sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

E. Installation of Vented Base Sheet:

1. [**Mechanically fasten, using fasteners specifically designed and sized for applicable substrate**][**Spot or strip mop to substrate with hot-applied asphalt**] vented base sheet with vented side down.

    a. Fasten vented base sheet in accordance with [**FM Approval's RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
    b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.11 INSTALLATION OF CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Adhere cap sheet to bottom layer in a uniform coating of [**hot-applied asphalt**][**cold-applied adhesive**].
4. Self-adhere cap sheet to bottom layer.
5. Heat-weld (torch-apply) cap sheet to bottom layer.

    a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

6. Mechanically fasten cap sheet to bottom layer using fasteners specifically designed and sized for [**wood**][**wood panel**] decks.

a. Fasten cap sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

7. Install cap sheet without wrinkles or tears, and free from air pockets.
8. Install cap sheet so side and end laps shed water.

C. Laps: Accurately align roof sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roofing membrane manufacturer but not less than **3 inches (75 mm)**.
2. Lap end laps as recommended by roofing membrane manufacturer but not less than **12 inches (300 mm)**. Stagger end laps not less than **18 inches (450 mm)**.
3. [**Heat-weld laps**][**Completely bond and seal laps**], leaving no voids.
4. Roll laps with a **20 lb (9 kg)** roller.
5. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to body of cap sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and result in complete adhesion of cap sheet to substrate.

E. Apply roofing granules of same color as cap sheet to cover exuded bead at laps while bead is hot, to provide a continuous color appearance.

3.12 INSTALLATION OF BASE FLASHING AND STRIPPING

A. Install base flashing sheet over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates in accordance with roofing system manufacturer's written installation instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Installation: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate in a uniform layer of**][**hot-applied asphalt**][**cold-applied adhesive**].
3. Base Flashing Sheet Installation, Hot: [**Adhere base flashing sheet to substrate in a solid mopping of hot-applied asphalt applied at asphalt temperature recommended by base flashing sheet manufacturer. Apply hot-applied asphalt to back of base flashing sheet if recommended by roofing system manufacturer**][**Torch-apply base flashing sheet to substrate**].

   a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Base Flashing Sheet Installation, Cold: Adhere base flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.

B. Extend base flashing sheet up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing sheet securely at terminations and perimeter of roof.

1. Seal top termination of base flashing sheet.

D. Install liquid flashing system in accordance with roofing system manufacturer's written installation instructions.

1. Extend liquid flashing not less than **3 inches (75 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of cap sheet, into wet compound.

E. Install cap sheet stripping where metal flanges and edgings are set on roof in accordance with roofing system manufacturer's written installation instructions.

F. Roof Drains: Set [**30-by-30-inch- (762-by-762-mm-)**] **4 lb (1.8 kg)** flashing in bed of adhesive on completed roofing membrane.

1. Cover flashing with cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing system manufacturer's written installation instructions.

3.13 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size; secure to cap sheet in accordance with roofing system manufacturer's written installation instructions.

1. Install walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing system manufacturer's warranty requirements.

2. Provide **3-inch (75-mm)** clearance between adjoining pads.

B. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane, using same installation method as that used for cap sheet.

1. Install walkways strips at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections of substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing, or by nuclear hydrogen detection testing.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roofing system in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roofing system in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
2. Examine test specimens for voids between plys in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 of NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."
3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect and the Owner 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

G. Prepare test and inspection reports.

3.15 PROTECTION AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations,

attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 52 16 00

SECTION 07 53 16 00 - CHLOROSULFONATE-POLYETHYLENE (CSPE) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chlorosulfonate-polyethylene (CSPE) roofing.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.

B. Section includes the installation of sound absorbing insulation strips in ribs of roof deck. Sound absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking[**and for wood-based, structural-use roof deck panels**].
2. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
3. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge flashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
8. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written

instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Chlorosulfonate-polyethylene (CSPE) roofing.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.

B. Product Data Submittals:

1. For insulation and roof system component fasteners, include copy of [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listing.

C. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with air barrier.

E. Samples for Verification: For the following products:

1. Roof membrane and flashing, of color required.
2. Aggregate surfacing material in gradation[**and color**] required.
3. Roof paver[**full sized,**] in each color and texture required.
4. Walkway pads or rolls, of color required.

F. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

    a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Evaluation Reports: For components of roofing system, from ICC-ES.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's Directory of Roof Assemblies**] for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, [**roof insulation,**][**fasteners,**][**cover boards,**][**vapor retarder,**][**substrate board,**][**roof pavers,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, [**roof insulation,**][**fasteners,**][**cover boards,**][**substrate boards,**][**vapor retarders,**][**roof pavers,**] and [**walkway products,**]for the following warranty period:

1. Warranty Period: [**Two**] years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roofing system to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing system to resist impact damage when tested in accordance with ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

1. Wind Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

K. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for [**low**][**steep**]-slope roof products.

L. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with ANSI/CRRC S100.

M. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

N. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 CHLOROSULFONATE-POLYETHYLENE (CSPE) ROOFING

A. CSPE Sheet: ASTM D5019, Type 1, Grade 2, **45-mil- (1.1-mm-)** thick, reinforced, flexible uncured sheet formed from CSPE, and as follows:

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Conklin Company Inc**]
2. [**Tremco Incorporated**]

C. Exposed Face Color: [**White**][**Blue**][**Light gray**][**Tan**].

D. Source Limitations: Obtain components for roofing system from [**manufacturer of roof membrane**][**manufacturer approved by roof membrane manufacturer**].

2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.

e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Sheet Flashing: **45-mil- (1.1-mm-)** thick, reinforced or **55-mil- (1.4-mm-)** thick, nonreinforced CSPE, as recommended by roofing system manufacturer for intended use, of same color as CSPE roof membrane.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Roof Vents: As recommended by roof membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

E. Bonding Adhesive: Manufacturer's standard[**water based**].

F. Slip Sheet: [**ASTM D2178/D2178M, Type IV, glass fiber, asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

G. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt-impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

H. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

I. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

J. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

L. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: **5/8 inch (16 mm)**.

B. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

C. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

D. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER

A. Polyethylene Film: ASTM D4397, [**6 mils (0.15 mm)**][**10 mils (0.25 mm)**] thick, minimum, with maximum permeance rating of [**0.13 perm (0.084 metric perm)**][**0.076 perm (0.050 metric perm)**].

1. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.
2. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor retarder application.

B. Laminated Sheet Vapor Retarder: Two-layer, fire-retardant polyethylene laminate, reinforced with cord

grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

D. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

E. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.6 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured[**or approved**] by CSPE roof membrane manufacturer[**approved for use in FM Approvals' RoofNav listed roof assemblies**][**approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45-lb/cu. ft. (23-kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00-lb/cu. ft. (48-kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15-lb/cu. ft. (18-kg/cu. m)** minimum density, **13-psi (90-kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Syntec Systems**]
   c. [**DiversiFoam Products**]
   d. [**Dyplast Products**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35-lb/cu. ft. (22-kg/cu. m)**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m)**][**Type IX, 1.8-lb/cu. ft. (29-kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cellofoam North America, Inc.**]
   b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, [**Type II, Class 1, Grade 2**][**Type II, Class 2, Grade 2**], felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Dyplast Products**]
   e. [**Elevate; Holcim Building Envelope**]
   f. [**GAF**]
   g. [**Hunter Panels; a Carlisle company**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Polyglass U.S.A., Inc.**]

k. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**20 psi (138 kPa)**][**25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Elevate; Holcim Building Envelope**]
   d. [**GAF**]
   e. [**Homasote Company**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**Insulfoam; a Carlisle Company**]
   h. [**Johns Manville; a Berkshire Hathaway company**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

G. Perlite Board Insulation: ASTM C728, Type I, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GAF**]
   b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GAF**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Homasote Company**]
    d. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25.4 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by2438 mm)**].
4. Thickness:

    a. Base Layer: [**1 inch (25 mm)**][**2 inches (51 mm)**]

I. Cellular Glass Board Insulation: ASTM C552, Type IV, rigid, cellular glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25.4 mm)**.
3. Size: **24 by 48 inches (600 by 1219 mm)**.

J. Mineral Wool Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of **11.2-lb/cu. ft. (180-kg/cu. m)** density, and a lower layer of **7.5-lb/cu. ft. (120-kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25.4 mm)**.
2. Size: **48 by 48 inches (1219 mm by 1219 mm)**.
3. Thickness:

    a. Base Layer: [**2 inches (50 mm)**]

4. Face Treatment: Bitumen coating.

K. Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having **12.5-lb/cu. ft. (200-kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25.4 mm)**.
2. Size: **48 by 48 inches (1219 by 1219 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**]

2. Minimum Thickness: **1/4 inch (6.35 mm)**.
3. Slope:

    a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
    b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES AND COVER BOARD

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover boards**] to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
4. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
8. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber

insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

E. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

F. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

G. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

H. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

I. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

J. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa).)**

K. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.8 ASPHALT MATERIALS

A. Roofing Asphalt: [**ASTM D312/D312M, Type III or Type IV**][**ASTM D6152/D6152M, SEBS modified**].

B. Asphalt Primer: ASTM D41/D41M.

2.9 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer[**UL listed and FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Detec Systems**]

2. Grounding Screen: [**Welded, stainless steel mesh**][**Aluminum screen**], for use with vector mapping system[**FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

3. Electrically Conductive Fabric: Non-abrasive felt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

B. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.

1. Sensors measuring moisture content[**temperature, and vapor drive**], placed [**below roof insulation**][**over vapor barrier**] and connected to a monitoring program, with a notification indicating location of breach.
2. Sensors measuring moisture content[**temperature, and vapor drive**], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Detec Systems**]
b. [**ILD International Leak Detection**]

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Lightweight Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flex Membrane International Corp.**]
b. [**Hanover Architectural Products**]
c. [**Roofblok Limited**]
d. [**Sunny Brook Pressed Concrete, Co.**]
e. [**Tile Tech Pavers**]
f. [**Wausau Tile, Inc.**]
g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].

4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (914 by 1524 mm)**.
2. Color: Contrasting with roof membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Sunny Brook Pressed Concrete, Co.**]
d. [**Wausau Tile, Inc.**]
e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].
4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system

manufacturer, when tested in accordance with ASTM F2170.

a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with no fewer than three tests probes.
b. Submit test reports within 24 hours after performing tests.

6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
8. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
9. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
10. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3.2 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.

1. Submit test result within 24 hours after performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

D. Install sound absorbing insulation strips in accordance with acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system in accordance with roofing system manufacturer's written instructions, [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air

barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (610 mm)** in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

   a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with [**tape**][**adhesive**].

B. Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

C. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of **3-1/2 and 6 inches (90 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Seal laps by rolling.

D. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt **19 inches (483 mm)** over preceding felt.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Embed each felt in a solid mopping of hot roofing asphalt.
3. Glaze coat completed surface with hot roofing asphalt.
4. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

E. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:

1. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**][**and with long joints continuous at right angle to flutes of decking**].

   a. Locate end joints over crests of decking.
   b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   h. Loosely lay base layer of insulation units over substrate.
   i. Mechanically attach base layer of insulation[**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

      1) Fasten insulation in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**].
      2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

   a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
   b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.

c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
f. Trim insulation so that water flow is unrestricted.
g. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
h. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
i. Loosely lay each layer of insulation units over substrate.
j. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Wood and Wood Panel Decking:

1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to [**wood**][**wood panel**] decks.

a. Fasten slip sheet in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
g. Loosely lay base layer of insulation units over substrate.
h. Mechanically attach base layer of insulation[**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to [**wood**][**wood panel**] decks.

1) Fasten insulation in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

   a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
   b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
   c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   h. Loosely lay each layer of insulation units over substrate.
   i. Adhere each layer of insulation to substrate using adhesive in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

      1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
      2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

E. Installation Over Concrete Decks:

1. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   g. Loosely lay base layer of insulation units over substrate.
   h. Adhere base layer of insulation to [**concrete roof deck**][**vapor retarder**] in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

      1) Prime surface of concrete deck with asphalt primer at rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

2) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
3) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
4) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
h. Loosely lay each layer of insulation units over substrate.
i. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

F. Installation Over Cementitious Wood-Fiber Decks:

1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to cementitious wood-fiber decks.

a. Fasten slip sheet in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal

to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
g. Loosely lay base layer of insulation units over substrate.
h. Adhere base layer of insulation to slip sheet in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

1) Trim insulation so that water flow is unrestricted.

f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
h. Loosely lay each layer of insulation units over substrate.
i. Adhere each layer of insulation to substrate using adhesive in accordance with SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

G. Installation Over Lightweight Insulating Concrete Decks:

1. Mechanically fasten vented base sheet to lightweight insulating concrete, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.

a. Fasten vented base sheet in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**][**SPRI's Directory of Roof**

Assemblies for specified Wind Uplift Load Capacity].

b. Fasten vented base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with [**joints staggered not less than 24 inches (610 mm) in adjacent rows**][**end joints staggered not less than 12 inches (305 mm) in adjacent rows**].

   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   g. Loosely lay base layer of insulation units over substrate.
   h. Adhere base layer of insulation to vented base sheet in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

      1) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
      2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.

   a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
   b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
   c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
   e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.

      1) Trim insulation so that water flow is unrestricted.

   f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
   g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
   h. Loosely lay each layer of insulation units over substrate.
   i. Adhere each layer of insulation to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

   a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity**] and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

   a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.
   b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
   c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install slip sheet over cover board and beneath roof membrane.

3.8 INSTALLATION OF ELD COMPONENTS

A. Install conductive medium over [**cover board**][**insulation**][**and on vertical locations to receive roof membrane**] in accordance with manufacturer's written instructions.

B. Install sensors, [**wire loop**][**conductive fabric**], connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.9 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing, and install in accordance with roofing system manufacturer's written instructions. Unroll roof membrane and allow to relax before installing.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions

required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roof membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:

1. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with membrane roofing system manufacturer**].
2. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashing.
3. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
4. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.10 INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

A. Mechanically fasten roof membrane over area to receive roofing in accordance with roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. In-Seam Attachment: Secure one edge of CSPE sheet using fastening plates or metal battens centered within seam, and mechanically fasten CSPE sheet to roof deck.

I. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.

2. Weld seams as follows:

   a. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with roofing system manufacturer**].

3. Test lap edges with probe to verify seam weld continuity.
4. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
5. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
6. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.11 INSTALLATION OF LOOSELY LAID AND BALLASTED ROOF MEMBRANE

A. Loosely lay roof membrane over area to receive roofing, and install in accordance with roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

E. Accurately align roof membrane, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere perimeter of roof membrane in accordance with requirements in ANSI/SPRI RP-4.

G. [**Mechanically fasten**][**adhere**] roof membrane at corners, perimeters, and transitions in accordance with requirements in ANSI/SPRI RP-4.

   1. At corners and perimeters, omit aggregate ballast leaving roof membrane exposed.
   2. At corners and perimeters, adhere a second layer of roof membrane.

H. Apply roof membrane with side laps shingled with slope of deck where possible.

I. Seams: Clean seam areas, overlap roof membrane, and weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

   1. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.
   2. Weld seams as follows:

      a. Weld Method: [**Hot air**][**Solvent**][**Hot air or solvent, as standard with roofing system manufacturer**].

   3. Test lap edges with probe to verify seam weld continuity.
   4. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
   5. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
   6. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

K. Install protection mat over roof membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.

L. Aggregate Ballast: Apply uniformly over roof membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at the end of the workday.

1. Ballast Weight:

a. Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
b. Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
c. Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

M. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.

N. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

1. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
2. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

3.12 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates in accordance with roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.13 INSTALLATION OF WALKWAYS

A. Flexible Walkways:

1. Install flexible walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **6-inch (150-mm)** clearance between adjoining pads.
3. Heat-weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written instructions.

1. Install roof-paver walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests:

1. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

   a. Perform tests before overlying construction is placed.
   b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
   c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage [**horizontal membrane scanning platform**][**membrane electric field vector mapping**][**vertical membrane scanning**] in accordance with ASTM D8231.

   a. Perform tests before overlying construction is placed.
   b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

6. High-Voltage Membrane Testing: Testing agency surveys entire [**roof area,**][**flashings,**][**parapet walls**] to locate discontinuity in the roof membrane using an electrically charged metal "broom head."

a. Perform tests before overlying construction is placed.
b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."

1. Repair areas where test cuts were made in accordance with roofing manufacturer's written instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.15 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:

8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. the Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 53 16 00

Task	Specification	Specification Description
07 53 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 16 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 53 23 00 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Accessory roofing system materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation and accessories.
6. Cover board.
7. Electronic leak-detection (ELD) materials.
8. Ballast.
9. Walkways.

B. Section contains the installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry for wood nailers, curbs, and blocking[**and for wood-based, structural-use roof deck panels**].
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner’s insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work

interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products:

1. Roofing membrane and flashings of color required.
2. Aggregate surfacing material in gradation[**and color**] required.

3. Roof paver[**full sized,**] in each color and texture required.
4. Walkways, of color required.

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency, indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not

been affected by the Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified EPDM system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified EPDM system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897.

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical for that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING SYSTEM

A. EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, [**Type I, nonreinforced,**][**Type II, scrim or fabric internally reinforced,**][**self-adhering**] EPDM sheet[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GenFlex Roofing Systems**]
d. [**Johns Manville; a Berkshire Hathaway company**]
e. [**Lexcan, division of Lexsuco Corporation**]
f. [**Mule-Hide Products Co., Inc**]
g. [**Roofing Products International, Inc**]
h. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Thickness: [**45 mils (1.1 mm)**][**60 mils (1.5 mm)**][**75 mils (1.9 mm)**][**90 mils (2.2 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

B. Fabric-Backed EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, Type III, nonreinforced, EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Syntec Systems**]
    b. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Composite Thickness: [**90 mils (2.3 mm)**][**100 mils (2.5 mm)**][**105 mils (2.7 mm)**][**115 mils (2.9 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

2.4 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

B. Base and Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Protection Sheet: As recommended in writing by roofing membrane manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

D. Slip Sheet: [**ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

E. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt impregnated, fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

F. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

G. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

H. Bonding Adhesive: Roofing membrane manufacturer's standard[**water based**].

I. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-

backed membrane roofing.

J. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

K. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

L. Seaming Material: [**Single-component, butyl splicing adhesive and splice cleaner**][**Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film**][**Factory-applied seam tape, width as recommended by manufacturer**].

M. Lap Sealant: Manufacturer's standard, single-component sealant[**colored to match membrane roofing**].

N. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

O. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

P. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

Q. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

R. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

S. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

T. Liquid Roof Coating: Product specifically formulated for coating roofing membrane, as follows:

1. Type: [**Acrylic emulsion complying with ASTM D6083/D6083M**][**Chlorosulfonated polyethylene complying with ASTM D3468/D3468M**].
2. Color: [**White**][**Gray**][**Tan**][**As selected by Architect from manufacturer's full range**].

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

E. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.6 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers; fire-retardant polyethylene laminate; reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.7 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum**

density, 25 psi (173 kPa) minimum compressive strength][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**] square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DuPont**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Syntec Systems**]
   c. [**Cellofoam North America, Inc.**]
   d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Syntec Systems**]
   b. [**Cellofoam North America, Inc.**]
   c. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated,**

1/2 inch (13 mm) **thick**][**DOC PS 2, Exposure 1, OSB,** 7/16 inch (11 mm) **thick**].

3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2,** 20 psi (138 kPa)][**Grade 3,** 25 psi (172 kPa)].
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

   a. Base Layer: [1-1/2 inches (38 mm)].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2,** 1/2 inch (13 mm) **thick**][**Type V, OSB facer,** 7/16 inch (11 mm) **thick**][**Type VII, glass-mat-faced gypsum board facer,** 1/4 inch (6 mm) **thick**].

3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GAF**]
   b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood-fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (50 mm)**].

I. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of **11.2 lb/cu. ft. (180 kg/cu. m)** density, and a lower layer of **7.5 lb/cu. ft. (120 kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (50 mm)**].

J. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having **12.5 lb/cu. ft. (200 kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.

K. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

L. General: Roof insulation accessories as recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's standard adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

a. Modified asphaltic, asbestos-free, cold-applied adhesive.
b. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
c. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover board**] to substrate, and acceptable to roofing system manufacturer.

2.8 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1 inch (25 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

I. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended in writing by roofing system manufacturer for application.

2.9 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging in size from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Interlocking Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Rubber Roof Pavers: Interlocking, lightweight rubber units, **24 by 24 by 2-1/4 inches (600 by 600 by 57 mm)**, **6 lb/sq. ft. (30 kg/sq. m)**; with grooved back for four-way drainage, beveled and doweled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]

2. Perimeter Securement Strip: Manufacturer's standard [**coated steel sheet channel**][**aluminum sheet channel**][**mill-finish aluminum sheet hold-down**][**coated aluminum sheet hold-down, color as selected by Architect,**] and fasteners.
3. Color: [**Black**][**Gray**][**Terra cotta**].

D. Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Coatings & Waterproofing Inc**]
    b. [**Hanover Architectural Products**]
    c. [**Roofblok Limited**]
    d. [**Sunny Brook Pressed Concrete, Co.**]
    e. [**Tile Tech Pavers**]
    f. [**Wausau Tile, Inc.**]
    g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (900 by 1500 mm)**.
2. Color: Contrasting with roof membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hanover Architectural Products**]
    b. [**Roofblok Limited**]
    c. [**Sunny Brook Pressed Concrete, Co.**]
    d. [**Wausau Tile, Inc.**]
    e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's**

samples][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer when tested in accordance with ASTM F2170.

   a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roof system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

   a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

   1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
   2. Tightly butt substrate boards together.
   3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   4. Fasten substrate board to top flanges of steel deck in accordance with manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
   5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written installation instructions.
   6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
9. Loosely lay each layer of insulation over substrate.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

   a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift**

load capacity] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF EPDM ROOFING MEMBRANE

A. Install roofing membrane over roof area for [**adhered**][**self-adhered**][**mechanically attached**][**loose-laid, ballasted**] application method in accordance with roofing system manufacturer's written installation instructions.

B. Unroll roofing membrane and allow it to relax before installing.

C. Start installation in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

E. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roof area.

F. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Loose-Laid, Ballasted Application: Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

1. [**Mechanically fasten**][**Adhere**] roofing membrane at perimeter, corners, and transitions in accordance with requirements in ANSI/SPRI RP-4.
2. At corners and perimeters, omit aggregate ballast leaving roofing membrane exposed.
3. At corners and perimeters, adhere a second layer of roofing membrane.
4. Install protection mat over roofing membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.
5. Aggregate Ballast: Apply uniformly over roofing membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of

damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

a. Ballast Weight:

1) Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
2) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
3) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

6. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.
7. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

a. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
b. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

H. Adhesive Seam Installation: Clean both faces of splice areas and apply splicing cement.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.
3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

I. Tape Seam Installation: Clean and prime both faces of splice areas and apply splice tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

J. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

K. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

L. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roofing membrane in place with clamping ring.

M. Adhere protection sheet over roofing membrane at locations indicated.

3.10 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashings and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashings.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping flashings to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of terminations.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF LIQUID ROOF COATING

A. Apply coating to [**roof membrane**][**flashings**] in accordance with manufacturer's written recommendations, by spray, roller, or other suitable application method.

3.12 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written installation instructions.

1. Install flexible walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **6-inch (75-mm)** clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written installation instructions.

1. Install roof-paver walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

   a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

   a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**] of clearance from top of base flashing.
   b. Flood each area for [**24**][**48**][**72**] hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency to prepare survey report indicating locations initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

   a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

   a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection, as directed by the Owner.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:

6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract

directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 53 23 00

Task	Specification	Specification Description
07 53 23 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 29 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 29 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing

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SECTION 07 54 19 00 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing system materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation and accessories.
6. Cover board.
7. Electronic leak-detection (ELD) materials.
8. Ballast.
9. Walkways.

B. Section contains the installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work

interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and patterns for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products:

1. Roofing membrane and flashings, of color required.

2. Aggregate surfacing ballast material in gradation[**and color**] required.
3. Roof paver[**full sized,**] in each color and texture required.
4. Walkways, of color required.

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by the Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**ULSE listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used

for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified thermoplastic system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified thermoplastic system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet,[**ballast,**][**walkways,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end

of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet,[**ballast,**][**walkways,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897.

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical for that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a

qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 POLYVINYL CHLORIDE (PVC) ROOFING SYSTEM

A. PVC Roofing Membrane Sheet: ASTM D4434/D4434M, fabric reinforced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]
b. [**Cooley Group**]
c. [**Duro-Last; Holcim Solutions and Products US, LLC**]
d. [**Elevate; Holcim Building Envelope**]
e. [**Flex Membrane International Corp.**]
f. [**GAF**]
g. [**IB Roof Systems, Inc.**]
h. [**Johns Manville; a Berkshire Hathaway company**]
i. [**Mule-Hide Products Co., Inc**]
j. [**Sika Sarnafil**]
k. [**Siplast**]
l. [**Soprema, Inc.**]
m. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Classification: [**Type II**][**Type III**][**Type IV**][**with fabric backing**].
3. Nominal Thickness: [**50 mils (1.3 mm)**][**60 mils (1.5 mm)**][**80 mils (2.0 mm)**].
4. Exposed Face Color: [**White**][**Gray**][**Tan**].

B. PVC-Ketone Ethylene Ester (KEE)-Alloy Roofing Membrane Sheet: ASTM D4434/D4434M, fabric reinforced.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Syntec Systems**]
    b. [**Cooley Group**]
    c. [**Duro-Last; Holcim Solutions and Products US, LLC**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**Flex Membrane International Corp.**]
    f. [**GAF**]
    g. [**IB Roof Systems, Inc.**]
    h. [**Johns Manville; a Berkshire Hathaway company**]
    i. [**Mule-Hide Products Co., Inc**]
    j. [**Siplast**]
    k. [**Soprema, Inc.**]
    l. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Classification: Type III[**with fabric backing**].
3. Nominal Thickness: [**50 mils (1.3 mm)**][**60 mils (1.5 mm)**][**80 mils (2.0 mm)**].
4. Exposed Face Color: [**White**][**Gray**][**Tan**].

2.4 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

B. Base and Sheet Flashings: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

D. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

E. Bonding Adhesive: Roofing membrane manufacturer's standard[**water based**].

F. Water-Based, Fabric-Backed Membrane Adhesive: Roofing membrane manufacturer's standard water-

based, cold-applied adhesive formulated for compatibility and use with fabric-backed roofing membrane.

G. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roofing membrane manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed roofing membrane.

H. Slip Sheet: [**ASTM D2178/D2178M, Type IV, glass fiber, asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

I. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

J. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

K. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

L. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate, tested for required pullout strength, and acceptable to roofing membrane manufacturer.

M. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

N. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

E. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.6 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers; fire-retardant polyethylene laminate; reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.7 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DuPont**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle Syntec Systems**]
   c. [**Cellofoam North America, Inc.**]
   d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Syntec Systems**]
   b. [**Cellofoam North America, Inc.**]
   c. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, [**Grade 2,**][**Grade 3,**] felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]

b. [**Carlisle Syntec Systems**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Holcim Building Envelope**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle company**]
g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Carlisle Syntec Systems**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Holcim Building Envelope**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle company**]
g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, OSB facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]

b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood-fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GAF**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Homasote Company**]
   d. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (50 mm)**]

I. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of **11.2 lb/cu. ft. (180 kg/cu. m)** density, and a lower layer of **7.5 lb/cu. ft. (120 kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (50 mm)**]

J. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having **12.5 lb/cu. ft. (200 kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.

K. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

L. General: Roof insulation accessories as recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's standard adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

a. Modified asphaltic, asbestos-free, cold-applied adhesive.
b. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
c. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover board**] to substrate, and acceptable to roofing system manufacturer.
4. Induction-Welding Plates: Minimum **3-inch (75-mm)** diameter with recessed center, **0.034-inch (0.86-mm)** thick, aluminum-zinc-alloy-coated steel plates, factory coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners[**and thermal isolation spacers below plates**].

2.8 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]

b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended in writing by roofing system manufacturer for application.

2.9 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging in size from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Interlocking Roof Pavers: Interlocking, lightweight concrete units, grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Coatings & Waterproofing Inc**]
   b. [**Hanover Architectural Products**]
   c. [**Roofblok Limited**]
   d. [**Sunny Brook Pressed Concrete, Co.**]
   e. [**Tile Tech Pavers**]
   f. [**Wausau Tile, Inc.**]
   g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (900 by 1500 mm)**.
2. Color: Contrasting with roofing membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Sunny Brook Pressed Concrete, Co.**]
d. [**Wausau Tile, Inc.**]
e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system

manufacturer, when tested in accordance with ASTM F2170.

a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with no fewer than three test probes.
b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written instructions.

3.3 INSTALLATION OF POLYVINYL-CHLORIDE (PVC) ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
9. Place[**thermal spacers and**] plates on insulation in required fastening patterns[**to achieve FM rating**] and secure in accordance with manufacturer's instructions.

    a. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending **1 inch (25 mm)** minimum into roof deck; do not overdrive fasteners.

10. Loosely lay each layer of insulation over substrate.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and immediately beneath roofing membrane.

C. Place plates on cover board in required fastening patterns[**to achieve FM rating**] and secure in accordance with roofing system manufacturer's written installation instructions.

1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending **1 inch (25 mm)** minimum into roof deck; do not overdrive fasteners.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF PVC ROOFING MEMBRANE

A. Install roofing membrane over roof area for [**adhered**][**mechanically attached**][**loose-laid, ballasted**] application method in accordance with roofing system manufacturer's written installation instructions.

B. Unroll roofing membrane and allow it to relax before installing.

C. Start installation in presence of roofing system manufacturer's technical personnel[**the Owner's testing and inspection agency**].

D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

E. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

F. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
2. Induction-Weld Attachment: Secure roofing membrane to plates creating 100 percent bond between underside of membrane and top of plates; a partial bond is unacceptable. Test welds to verify adhesion of roofing membrane to top of plates in accordance with manufacturer's instructions.

G. Loose-Laid, Ballasted Application: Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

1. [**Mechanically fasten**][**Adhere**] roofing membrane at perimeter, corners, and transitions in accordance with requirements in ANSI/SPRI RP-4.
2. At corners and perimeters, omit aggregate ballast leaving roofing membrane exposed.
3. At corners and perimeters, adhere a second layer of roofing membrane.
4. Install protection mat over roofing membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.
5. Aggregate Ballast: Apply uniformly over roofing membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

   a. Ballast Weight:

      1) Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
      2) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
      3) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

6. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with

manufacturer's written instructions.

7. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

   a. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
   b. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

H. Seams and End Laps: Clean seam areas, overlap membrane, and hot-air-weld side seams and end laps of roofing membrane and sheet flashing to ensure a watertight installation.

   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane and sheet flashings.
   2. Verify field strength of seams a minimum of [**twice**] daily, and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.10 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashings and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean seam areas, overlap, and firmly roll flashings into the adhesive. Hot-air-weld side seams and end laps to ensure a watertight installation.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written instructions.

   1. Install flexible walkways at the following locations:

      a. Perimeter of each rooftop unit.
      b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
      c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
      d. Top and bottom of each roof access ladder.
      e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
      f. Locations indicated on Drawings.
      g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **6-inch (75-mm)** clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written instructions.

1. Install roof-paver walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspect substrate conditions, surface preparation, and application of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.13 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.14 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

a. lightning;
b. peak gust wind speed;
c. fire;
d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
f. vapor condensation on bottom of roofing; and
g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 54 19 00

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SECTION 07 54 23 00 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing system materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation and accessories.
6. Cover board.
7. Electronic leak-detection (ELD) materials.
8. Ballast.
9. Walkways.

B. Section contains the installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels [**and sound-absorbing insulation strips**] .
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**and**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**] .
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's " Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**]<**Insert location**> .

1. Meet with Owner, Architect, [**Construction Manager,**] Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or

affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**]<**Insert location**> .

1. Meet with Owner, Architect, [**Construction Manager,**] Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products:

1. Roofing membrane and flashings, of color required.
2. Aggregate surfacing ballast material in gradation [**and color**] required.
3. Roof paver [**, full sized,**] in each color and texture required.

4. Walkways, of color required.

D. Wind-Uplift-Resistance Submittal: For roofing system indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**]<**Insert evaluation agency**> showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**and**][**testing agency**] .

G. Sample Warranties: For specified special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Existing Warranty Documentation: Certified statement from existing roofing system manufacturer stating

that existing roof warranty has not been affected by the Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**ULSE listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified thermoplastic system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified thermoplastic system installers**] .

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives, [**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**]<**Insert number**> years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives, [**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**or**][**manufacturer approved by roofing membrane manufacturer**] .

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

1. Zone 1' (Roof Area Interior): <**Insert lbf/sq. ft. (kPa)**> .
2. Zone 1 (Roof Area Field): <**Insert lbf/sq. ft. (kPa)**> .
3. Zone 2 (Roof Area Perimeter): <**Insert lbf/sq. ft. (kPa)**> .

   a. Location: From roof edge to <**Insert dimension**> inside roof edge.

4. Zone 3 (Roof Area Corners): <**Insert lbf/sq. ft. (kPa)**> .

   a. Location: <**Insert dimension**> in each direction from each building corner.

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are

listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**]<**Insert class**> .
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**] .

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical for that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**]<**Insert capacity**> .

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**]<**Insert value**> and an emissivity of not less than [**0.75**]<**Insert value**> when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**] ; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

A. TPO Roofing Membrane Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**Cooley Group**]
c. [**Custom Seal Inc.**]

d. [**Elevate; Amrize Building Envelope LLC**]
e. [**Flex Membrane International Corp.**]
f. [**GAF**]
g. [**GenFlex Roofing Systems**]
h. [**IKO Innovi; IKO Industries Inc.**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Mule-Hide Products Co., Inc**]
k. [**Siplast**]
l. [**Versico Roofing Systems; a Carlisle Company**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**Cooley Group**]
c. [**Custom Seal Inc.**]
d. [**Elevate; Amrize Building Envelope LLC**]
e. [**Flex Membrane International Corp.**]
f. [**GAF**]
g. [**GenFlex Roofing Systems**]
h. [**IKO Innovi; IKO Industries Inc.**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Mule-Hide Products Co., Inc**]
k. [**Siplast**]
l. [**Versico Roofing Systems; a Carlisle Company**]
m. <**Insert manufacturer's name**>

3. Membrane Option: [**Manufacturer's standard**][**Fabric backed**][**Self-adhering**] .
4. Thickness: [**45 mils (1.1 mm)**][**60 mils (1.5 mm)**][**80 mils (2.0 mm)**]<**Insert value**> , nominal.
5. Exposed Face Color: [**Black**][**Gray**][**Tan**][**White**]<**Insert color**> .
6. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.

2.4 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Base and Sheet Flashings: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

D. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

E. Bonding Adhesive: Roofing membrane manufacturer's standard [**, water based**] .

F. Slip Sheet: [**ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**] .

G. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt impregnated, fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

H. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

I. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

K. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

L. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]

c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

3. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**] .
4. Surface Finish: [**Factory primed**][**Unprimed**] .

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**] .

C. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**] .

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

E. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.6 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers; fire-retardant polyethylene laminate; reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Reef Industries, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Reef Industries, Inc.**]
b. <**Insert manufacturer's name**>

3. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
4. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.

5. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
6. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.7 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured [**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.00 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**] , square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**DuPont**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**DuPont**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]
   e. <**Insert manufacturer's name**>

3. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]<**Insert thickness**> .
   b. Upper Layer: <**Insert thickness**> .

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle SynTec Systems; a Carlisle Company**]
   c. [**Cellofoam North America, Inc.**]
   d. [**Kingspan Insulation LLC**]

e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Carlisle SynTec Systems; a Carlisle Company**]
   c. [**Cellofoam North America, Inc.**]
   d. [**Kingspan Insulation LLC**]
   e. **<Insert manufacturer's name>**

3. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]**<Insert thickness>** .
   b. Upper Layer: **<Insert thickness>** .

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35 lb/cu. ft. (22 kg/cu. m)**][**Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)**][**Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Carlisle SynTec Systems; a Carlisle Company**]
   b. [**Cellofoam North America, Inc.**]
   c. [**Insulfoam; a Carlisle Company**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Carlisle SynTec Systems; a Carlisle Company**]
   b. [**Cellofoam North America, Inc.**]
   c. [**Insulfoam; a Carlisle Company**]
   d. **<Insert manufacturer's name>**

3. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick**]**<Insert material>** .
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness: **<Insert thickness>** .

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Carlisle SynTec Systems; a Carlisle Company**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Amrize Building Envelope LLC**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle Company**]
g. [**IKO Innovi; IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Carlisle SynTec Systems; a Carlisle Company**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Amrize Building Envelope LLC**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle Company**]
g. [**IKO Innovi; IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]
m. <**Insert manufacturer's name**>

3. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**] .
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**]<**Insert thickness**> .
b. Upper Layer: <**Insert thickness**> .

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Carlisle SynTec Systems; a Carlisle Company**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Amrize Building Envelope LLC**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle Company**]
g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]

i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**Carlisle SynTec Systems; a Carlisle Company**]
c. [**CertainTeed; SAINT-GOBAIN**]
d. [**Elevate; Amrize Building Envelope LLC**]
e. [**GAF**]
f. [**Hunter Panels; a Carlisle Company**]
g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]
m. <**Insert manufacturer's name**>

3. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, OSB facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**]<**Insert material**> .
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness: <**Insert thickness**> .

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. <**Insert manufacturer's name**>

3. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**]<**Insert thickness**> .

b. Upper Layer: <**Insert thickness**> .

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood-fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]
   f. <**Insert manufacturer's name**>

3. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
4. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**] .
5. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert thickness**> .
   b. Upper Layer: <**Insert thickness**> .

I. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of **11.2 lb/cu. ft. (180 kg/cu. m)** density, and a lower layer of **7.5 lb/cu. ft. (120 kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (50 mm)**]<**Insert thickness**> .
   b. Upper Layer: <**Insert thickness**> .

J. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having **12.5 lb/cu. ft. (200 kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.

K. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**]<**Insert material**> .
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**]<**Insert slope**> unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**]<**Insert slope**> unless otherwise indicated on Drawings.

L. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**][**and**] to another insulation layer as follows:

   a. Modified asphaltic, asbestos-free, cold-applied adhesive.
   b. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
   c. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

3. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
4. Induction-Welding Plates: Minimum **3-inch (75-mm)** diameter with recessed center, **0.034-inch (0.86-mm)** thick, aluminum-zinc-alloy-coated steel plates, factory coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners [**and thermal isolation spacers below plates**] .

2.8 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert thickness**> .
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**]<**Insert finish**> .

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**USG Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**USG Corporation**]
   e. <**Insert manufacturer's name**>

3. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**] .
4. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**] .

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**] .

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**] .

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Continuus Materials, LLC**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Continuus Materials, LLC**]
   b. <**Insert manufacturer's name**>

3. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**] .
4. Surface Finish: [**Fiberglass facer**][**Paper facer**] .
5. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content

not less than <**Insert number**> percent.

H. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1 inch (25 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

I. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended in writing by roofing system manufacturer for application.

2.9 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging in size from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**]<**Insert size**> .

B. Interlocking Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

d. **<Insert manufacturer's name>**

3. Size: **<Insert actual size of pavers>** .
4. Weight: **<Insert weight or weight range>** .
5. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**]**<Insert value>** , minimum.
6. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

C. Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**] , factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Carlisle Coatings & Waterproofing Inc**]
   b. [**Hanover Architectural Products**]
   c. [**Roofblok Limited**]
   d. [**Sunny Brook Pressed Concrete, Co.**]
   e. [**Tile Tech Pavers**]
   f. [**Wausau Tile, Inc.**]
   g. [**Westile Roofing Products; an Oldcastle company**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Carlisle Coatings & Waterproofing Inc**]
   b. [**Hanover Architectural Products**]
   c. [**Roofblok Limited**]
   d. [**Sunny Brook Pressed Concrete, Co.**]
   e. [**Tile Tech Pavers**]
   f. [**Wausau Tile, Inc.**]
   g. [**Westile Roofing Products; an Oldcastle company**]
   h. **<Insert manufacturer's name>**

3. Size: [**24 by 24 inches (600 by 600 mm)**]**<Insert dimensions>** . Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
4. Weight: **<Insert value>** .
5. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**]**<Insert value>** , minimum.
6. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

D. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**or**][**rolls**] , approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (900 by 1500 mm)**.
2. Color: Contrasting with roofing membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**] , factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Sunny Brook Pressed Concrete, Co.**]
   d. [**Wausau Tile, Inc.**]
   e. [**Westile Roofing Products; an Oldcastle company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Sunny Brook Pressed Concrete, Co.**]
   d. [**Wausau Tile, Inc.**]
   e. [**Westile Roofing Products; an Oldcastle company**]
   f. <**Insert manufacturer's name**>

3. Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**> . Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
4. Weight: <**Insert value**> .
5. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**]<**Insert value**> , minimum.
6. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**]<**Insert number**> percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**]<**Insert area**> , or portion thereof, of roof deck, with not less than three tests probes.
    b. Submit test reports within 24 hours after performing tests.

7. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours after performing tests.

    a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written instructions.

3.3 INSTALLATION OF THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING SYSTEM

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition [**and to not void warranty for existing roofing system**] .

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install

minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**] .
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
9. Place [**thermal spacers and**] plates on insulation in required fastening patterns [**to achieve FM rating**] and secure in accordance with manufacturer's instructions.

    a. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending **1 inch (25 mm)** minimum into roof deck; do not overdrive fasteners.

10. Loosely lay each layer of insulation over substrate.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and beneath roofing membrane.

C. Place plates on cover board in required fastening patterns [**to achieve FM rating**] and secure in accordance with roofing system manufacturer's written installation instructions.

1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending **1 inch (25 mm)** minimum into roof deck; do not overdrive fasteners.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF TPO ROOFING MEMBRANE SHEET

A. Install roofing membrane over roof area for [**adhered**][**self-adhered**][**mechanically attached**][**loose-laid, ballasted**] application method in accordance with roofing system manufacturer's written installation instructions.

B. Unroll roofing membrane and allow it to relax before installing.

C. Start installation in presence of roofing system manufacturer's technical personnel [**and Owner's testing and inspection agency**] .

D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

E. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roof area.

F. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
2. Induction-Weld Attachment: Secure roofing membrane to plates creating 100 percent bond between underside of membrane and top of plates; a partial bond is unacceptable. Test welds to verify adhesion of roofing membrane to top of plates in accordance with manufacturer's instructions.

G. Loose-Laid, Ballasted Application: Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**] .

1. [**Mechanically fasten**][**Adhere**] roofing membrane at perimeter, corners, and transitions in accordance with requirements in ANSI/SPRI RP-4.
2. At corners and perimeters, omit aggregate ballast leaving roofing membrane exposed.
3. At corners and perimeters, adhere a second layer of roofing membrane.
4. Install protection mat over roofing membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.
5. Aggregate Ballast: Apply uniformly over roofing membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

a. Ballast Weight:

1) Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
2) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
3) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.
4) Size 3 aggregate, <**Insert weight**> , at corners, <**Insert weight**> at perimeter, and <**Insert weight**> , elsewhere.

6. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.
7. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

a. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
b. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

H. Seams and End Laps: Clean seam areas, overlap membrane, and hot-air-weld side seams and end laps of roofing membrane and sheet flashings to ensure a watertight installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane and sheet flashings.
2. Verify field strength of seams a minimum of [**twice**]<**Insert number of daily seam tests**> daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing membrane in place with clamping ring.

3.10 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashing and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean seam areas, overlap, and firmly roll flashings into the adhesive. Hot-air-weld side seams and end laps to ensure a watertight installation.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written installation instructions.

1. Install flexible walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **6-inch (75-mm)** clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written installation instructions.

1. Install roof-paver walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspect substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

    a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

        1) Cost of retesting is Contractor's responsibility.

    b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install

temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Flood to an average depth of [**2-1/2 inches (63 mm)**]<**Insert depth**> with a minimum depth of [**1 inch (25 mm)**]<**Insert depth**> and not exceeding a depth of [**4 inches (100 mm)**]<**Insert depth**> . Maintain **2 inches (50 mm)** of clearance from top of base flashing.
b. Flood each area for [**24**][**48**][**72**] hours.
c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

1. Notify Architect [**and Owner**] 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.13 CLEANING

A. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.14 PROTECTION

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. Owner: <**Insert name of Owner**> .
2. Owner Address: <**Insert address**> .
3. Building Name/Type: <**Insert information**> .
4. Building Address: <**Insert address**> .
5. Area of Work: <**Insert information**> .
6. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding <**Insert mph (m/s)**> ;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 54 23 00

SECTION 07 55 52 13 - ATACTIC-POLYPROPYLENE (APP) MODIFIED BITUMINOUS PROTECTED MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Atactic-polypropylene (APP)-modified bituminous protected membrane roofing.
2. Base sheet materials.
3. Interply sheets.
4. Atactic-polypropylene (APP)-modified bituminous cap sheet.
5. Base flashing sheet materials.
6. Asphalt materials.
7. Accessory roofing materials.
8. Roof insulation.
9. Insulation accessories.
10. Electronic leak detection (ELD) materials.
11. Coating materials.
12. Ballast.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
5. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written

instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Atactic-polypropylene (APP)-modified bituminous protected membrane roofing.
2. Base sheet materials.
3. Interply sheets.
4. Atactic-polypropylene (APP)-modified bituminous cap sheet.
5. Base flashing sheet materials.
6. Asphalt materials.
7. Accessory roofing materials.
8. Roof insulation.
9. Insulation accessories.
10. Electronic leak detection (ELD) materials.
11. Coating materials.
12. Ballast.
13. For insulation, include copy of [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listing.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

C. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tie-in with adjoining air barrier.

D. Samples for Verification: For the following products:

1. Ballast in gradation[**and color**] indicated.
2. Roof paver[**, full sized,**] in each color and texture required.

E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**testing agency**].

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:

1. Concrete internal relative humidity test reports.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's Directory of Roof Assemblies**] for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Installer to employ on Project installers and supervisors certified through the NRCA/MRCA Certified Roofing Torch Applicator (CERTA) program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, [**roof insulation,**][**vapor retarder,**][**roof pavers,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system, such as roof membrane, base flashing, [**roof insulation,**][**vapor retarders,**][**roof pavers,**] for the following warranty period:

1. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746/D3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

1. Wind Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on

testing identical products by a qualified testing agency.

I. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

K. Energy Star Listing: Roofing pavers to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for roof paver products.

L. Energy Performance: Roof pavers to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with ANSI/CRRC S100.

M. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; testing by a qualified testing agency.

1. Identify products with appropriate markings of applicable testing agency.

N. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.2 ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS PROTECTED MEMBRANE ROOFING

A. Atactic-Polypropylene (APP)-Modified Bituminous Protected Membrane Roof System: See the following articles for individual roof materials required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

2.3 SOURCE LIMITATIONS

A. Obtain components, including roof insulation for roofing system from [**same manufacturer as membrane roofing**][**manufacturer approved by membrane roofing manufacturer**].

2.4 BASE SHEET MATERIALS

A. APP-Modified Bitumen, Polyester-Mat Base Sheet: ASTM D6222/D6222M, Type I or II, Grade S, APP-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]

B. APP-Modified Bitumen, Polyester-Mat Base Sheet, Torch: ASTM D6222/D6222M, Type I or II, Grade S, APP-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

C. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6223/D6223M, Type I, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for cold adhesive application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

D. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat Base Sheet, Torch: ASTM D6223/D6223M, Type I, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for torch application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Performance Roof Systems**]

E. APP-Modified Bitumen Type II. Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6223/D6223M, Type II, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

F. APP-Modified Bitumen Type II, Polyester- and Glass-Fiber-Mat Base Sheet, Torch: ASTM D6223/D6223M, Type II, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

G. APP-Modified Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6509/D6509M, APP-modified asphalt sheet, reinforced with glass fibers; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Performance Roof Systems**]

H. APP-Modified Bitumen, Glass-Fiber-Mat Base Sheet, Torch: ASTM D6509/D6509M, APP-modified asphalt sheet, reinforced with glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**Performance Roof Systems**]

e. [**Tremco Incorporated**]

I. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.

2.5 INTERPLY SHEETS

A. Glass-Fiber Interply Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

2.6 ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS CAP SHEET

A. APP-Modified Bitumen, Polyester-Mat, Smooth-Surfaced Cap Sheet: ASTM D6222/D6222M, Type I or II, Grade S, APP-modified asphalt sheet, reinforced with polyester fabric; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Tremco Incorporated**]

B. APP-Modified Bitumen, Polyester-Mat, Smooth-Surfaced Cap Sheet, Torch: ASTM D6222/D6222M, Type I or II, Grade S, APP-modified asphalt sheet, reinforced with polyester fabric; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

C. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet: ASTM D6223/D6223M, Type I, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

D. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet, Torch: ASTM D6223/D6223M, Type I. Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Performance Roof Systems**]

E. APP-Modified Bitumen Type II, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet: ASTM D6223/D6223M, Type II, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Performance Roof Systems**]

F. APP-Modified Bitumen Type II, Polyester- and Glass-Fiber-Mat, Smooth-Surfaced Cap Sheet, Torch: ASTM D6223/D6223M, Type II, Grade S, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Performance Roof Systems**]

G. APP-Modified Bitumen, Polyester-Mat, Granule-Surfaced Cap Sheet: ASTM D6222/D6222M, Type I or II, Grade G, APP-modified asphalt sheet, reinforced with polyester fabric; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Tremco Incorporated**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

H. APP-Modified Bitumen, Polyester-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6222/D6222M, Type I or II, Grade G, APP-modified asphalt sheet, reinforced with polyester fabric; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

I. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6223/D6223M, Type I, Grade G, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Performance Roof Systems**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

J. APP-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6223/D6223M, Type I, Grade G, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Performance Roof Systems**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

K. APP-Modified Bitumen Type II, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6223/D6223M, Type II, Grade G, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Performance Roof Systems**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

L. APP-Modified Bitumen Type II, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6223/D6223M, Type II, Grade G, APP-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Performance Roof Systems**]

2. Granule Material: Mineral [**ceramic coated**][**slate**].
3. Granule Color: [**White**][**Gray**][**Tan**].

2.7 BASE FLASHING SHEET MATERIALS

A. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

B. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. APP-Modified Bitumen Backer Sheet: [**ASTM D6222/D6222M, Type I or II, Grade S, reinforced with polyester fabric**][**ASTM D6223/D6223M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

D. APP-Modified Bitumen, Smooth-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade**

S, reinforced with polyester fabric][**ASTM D6223/D6223M, Type I, Grade S, reinforced with a combination of polyester fabric and glass fibers**][**ASTM D6223/D6223M, Type II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

E. APP-Modified Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade G, reinforced with polyester fabric**][**ASTM D6223/D6223M, Type I, Grade G, reinforced with a combination of polyester fabric and glass fibers**][**ASTM D6223/D6223M, Type II, Grade G, reinforced with a combination of polyester fabric and glass fibers**]; granule surfaced; suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

F. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.

G. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.8 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer for application**].

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M.

2.9 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing manufacturer for intended use and compatible with other roofing components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

C. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

D. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane**][**base flashings**].

E. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent-and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing components.

F. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing system manufacturer for application.

G. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

H. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

I. Metal Flashing Sheet: As specified in Section 076200 "Sheet Metal Flashing and Trim."

J. Separator Sheet: Polyethylene sheet, **4 mils (0.1 mm)** thick, minimum.

K. Miscellaneous Accessories: Provide accessories recommended by roofing system manufacturer.

2.10 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured[**or approved**] by roof membrane manufacturer,[**approved for use in FM Approvals' RoofNav listed roof assemblies**][**, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation, Type VI: ASTM C578, **1.8 lb/cu. ft. (29 kg/cu. m)** minimum density, **40 psi (276 kPa)** minimum compressive strength, with drainage channels on bottom side, and with two or four edges rabbeted.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DiversiFoam Products**]
    b. [**Kingspan Insulation LLC**]
    c. [**Owens Corning**]
    d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**24 by 96 inches (600 by 2438 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

    a. Base Layer: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**].

C. Extruded-Polystyrene Board Insulation, Type VII: ASTM C578, **2.2 lb/cu. ft. (35 kg/cu. m)** minimum density, **60 psi (414 kPa)** minimum compressive strength, with drainage channels on bottom side, and with two or four edges rabbeted.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**DiversiFoam Products**]
    b. [**Kingspan Insulation LLC**]
    c. [**Owens Corning**]
    d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: **24 by 96 inches (600 by 2438 mm)**.
4. Thickness:

    a. Base Layer: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**].

D. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, **1.8-lb/cu. ft. (29-kg/cu. m)** minimum density, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [**3/8 inch (10 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**][**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**T. Clear Corporation, a subsidiary of Fin Pan Inc**]

2. Insulation Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1219 mm)**.
4. Insulation Thickness: [**2 inches (51 mm)**][**3 inches (76 mm)**].

2.11 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with other roofing system components.

B. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

C. Metal Securement System: Perimeter securement flashing and strapping fabricated from **3-inch- (76-mm-)** wide stainless steel, a minimum of **0.031 inch (0.8 mm)** thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

2.12 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer[**, UL listed and FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Detec Systems**]

2. Grounding Screen: [**Welded, stainless steel mesh**][**Aluminum screen**], for use with vector mapping system[**, FM Global approved**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

3. Electrically Conductive Fabric: Non-abrasive felt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

B. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.

1. Sensors measuring moisture content[**, temperature, and vapor drive**], placed [**below roof insulation**][**over vapor barrier**] and connected to a monitoring program, with a notification indicating location of breach.
2. Sensors measuring moisture content[**, temperature, and vapor drive**], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Detec Systems**]
    b. [**ILD International Leak Detection**]

2.13 COATING MATERIALS

A. Roof Coating:

1. ASTM D1227, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**] asphalt emulsion, asbestos free.
2. ASTM D1227, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**] asphalt emulsion, nonfibered.
3. ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**], aluminum-pigmented asphaltic coating.
4. ASTM D6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.

    a. Color: [**White**][**Gray**][**Tan**].

2.14 BALLAST

A. Aggregate Ballast: [**Smooth, washed riverbed gravel or other acceptable smooth-faced stone**][**Crushed, washed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation; of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 65 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**][**Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm)**].

B. Lightweight Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hanover Architectural Products**]
    b. [**Roofblok Limited**]
    c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**3000 psi (21 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Integral Paver Supports: Integral corner pedestals, creating a minimum **3/16-inch- (5-mm-)** high ventilation air space.
5. Paver Support Assembly: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

C. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent according to ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Sunny Brook Pressed Concrete, Co.**]
   d. [**Wausau Tile, Inc.**]
   e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]; manufactured to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].
4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
6. Integral Paver Supports: Integral corner pedestals, creating a minimum **3/16-inch- (5-mm-)** high ventilation air space.
7. Paver Support Assembly: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.

3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.

    a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation, according to roofing system manufacturer's written instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)** and allow primer to dry.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing," [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and accessory materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier, with air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Start installation of roofing in presence of manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

F. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing sheets parallel with slope.

G. Coordinate installation of roofing system, so components of the roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets with a course of coated felt set in roofing cement[**or hot roofing asphalt**], with joints and edges sealed.
2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

H. Asphalt Heating: Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.

1. Circulate asphalt during heating.
2. Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application.
3. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating.
4. Do not heat roofing asphalt within **25 deg F (14 deg C)** of flash point.
5. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
6. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

I. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt according to roofing system manufacturer's written instructions.

J. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF ELD COMPONENTS

A. Install conductive medium over [**cover board**][**insulation**][**and on vertical locations to receive roof membrane**] in accordance with manufacturer's written instructions.

B. Install sensors, [**wire loop**][**conductive fabric**], connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF BASE SHEET

A. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature.

B. Install lapped base-sheet course, extending sheet over and terminating above cants.

1. Install base sheet in a shingle fashion.
2. Adhere to substrate in a uniform coating of cold-applied adhesive.
3. Torch-apply to substrate.

a. Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Install base sheet without wrinkles, tears, or air pockets.
5. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

a. Lap side laps as recommended by roof membrane manufacturer but not less than **3 inches (76 mm)**.
b. Lap end laps as recommended by roof membrane manufacturer but not less than **12 inches (300 mm)**.
c. Stagger end laps not less than **18 inches (457 mm)**.
d. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
e. Roll laps with a **20-pound (9-kg)** roller.

6. Repair tears and voids in laps and lapped seams not completely sealed.
7. Apply pressure to the body of the base sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

C. Installation of Vented Base Sheet:

1. Spot or strip mop to substrate with hot roofing asphalt vented base sheet, with vented side down.

a. Fasten vented base sheet according to requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**].
b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.6 INSTALLATION OF INTERPLY SHEETS

A. Install [**two**][**three**] ply sheets, starting at low point of roofing.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.
4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.

3.7 INSTALLATION OF ATACTIC-POLYPROPYLENE (APP)-MODIFIED BITUMINOUS CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install modified bituminous roofing cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Install cap sheet as follows:

a. Adhere to substrate in a uniform coating of cold-applied adhesive.
b. Torch-apply to substrate.

1) Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Install cap sheet without wrinkles tears, or air pockets.
5. Install cap sheet, so side and end laps shed water.

C. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roof membrane manufacturer but not less than **3 inches (76 mm)**.
2. Lap end laps as recommended by roof membrane manufacturer but not less than **12 inches (300 mm)**.
3. Stagger end laps not less than **18 inches (457 mm)**.
4. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
5. Roll laps with a **20-pound (9-kg)** roller.
6. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to the body of the cap sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

3.8 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate**] in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].

a. Seal all laps.

3. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in [**cold-applied adhesive**][**asphalt roofing cement**].
4. Flashing Sheet Application, Hot: Torch-apply flashing sheet to substrate.

a. Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

B. Extend base flashing up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing[**with a strip of glass-fiber fabric set in asphalt roofing cement**].

D. Install liquid flashing system according to manufacturer's recommendations.

1. Extend liquid flashing not less than **3 inches (76 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Install roofing cap sheet stripping where metal flanges and edgings are set on roofing according to roofing system manufacturer's written instructions.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**] **4-pound (1.8-kg)** lead flashing in bed of asphaltic adhesive on roofing.

1. Cover lead flashing with roofing cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing.
2. Clamp roofing, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping according to roofing system manufacturer's written instructions.

3.9 INSTALLATION OF COATINGS

A. Apply coating to base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.

3.10 INSTALLATION OF INSULATION

A. Loosely lay separator sheet over cooled roofing membrane, with minimum **2-inch (51-mm)** side laps and **4-inch (100-mm)** end laps.

B. Loosely lay insulation over roof membrane, with long joints of insulation in continuous straight lines and with end joints staggered not less than **12 inches (300 mm)** between rows.

1. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
2. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
3. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.

C. Install upper layer of insulation with joints of each layer offset not less than **12 inches (300 mm)** from previous layer of insulation.

1. Install with long joints continuous and with end joints staggered not less than **12 inches (300 mm)** in adjacent rows.
2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
3. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
4. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
5. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.

D. Install protection layer over insulation, overlapping edges and ends at least **12 inches (300 mm)**.

1. Do not lap ends of fabric sheets within **72 inches (1800 mm)** of roof perimeter.
2. Extend fabric **2 to 3 inches (51 to 76 mm)** above ballast at perimeter and penetrations.
3. Apply additional layer of fabric around penetrations to prevent aggregate from getting between penetration and insulation.
4. Do not cover drains or restrict water flow to drains.

3.11 INSTALLATION OF BALLAST

A. Install aggregate ballast[**and roof paver ballast**] uniformly over protection layer.

B. Spread aggregate to not damage roof membrane or base flashings.

C. Apply ballast as insulation is installed, leaving roof insulated and ballasted at end of workday.

D. Install aggregate ballast at rate required by insulation manufacturer, but not less than the following:

1. Zone 1 (Roof Area Field): [**10 lb/sq. ft. (50 kg/sq. m) of Size 5 aggregate**][**12 lb/sq. ft. (60 kg/sq. m) of Size 5 aggregate**][**13 lb/sq. ft. (65 kg/sq. m) of Size 2 aggregate**].
2. Zone 2 (Roof Area Perimeter): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**.

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
   b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

3. Zone 3 (Roof Area Corners): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**].

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
   b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

4. Within **48 Inches (1219 mm)** of Roof Penetrations: [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**Two rows of roof pavers around perimeter of penetration**]. A "penetration" is defined as any object projecting above the roof insulation that measures **48 inches (1219 mm)** or more on any side.

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].

E. Roof Paver Walkways: Install walkway roof pavers using [**one row**][**two rows**] of roof pavers, loosely laid and butted.

1. Install roof paver walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.

3.12 INSTALLATION OF ROOF PAVERS

A. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area according to manufacturer's written instructions.

B. Install roof pavers over roofed area according to insulation manufacturer's written instructions.

1. Mechanically fasten securement strapping to center of first two perimeter rows and first two perimeter corner rows of roof pavers in each direction from corner, closest to edge of roof, using straps running parallel to parapet wall or roof edge.

C. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.

3.13 INSTALLATION OF MORTAR-FACED BOARD INSULATION

A. Install mortar-faced board insulation loosely laid, according to manufacturer's written instructions, with tongue-and-groove joints nested.

1. Stagger end joints of adjoining rows and abut insulation.
2. Mechanically fasten metal securement strapping at penetrations and at perimeter edges of mortar-faced board insulation.
3. Over mortar-faced board insulation, install roof pavers on roof perimeter and corners according to manufacturer's written instructions.

B. Install [**one row**][**two rows**] of **24-inch- (600-mm-)** wide roof pavers to roof perimeter, corners, and penetrations according to mortar-faced board insulation manufacturer's written instructions.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests:

1. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**]> with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (51 mm)** of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of the Contractor.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

    a. Perform tests before overlying construction is placed.
    b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
    c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ASTM D7954/D7954M.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ANSI/SPRI/RCI NT-1.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Low-Voltage Electrical Conductance Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage [**horizontal membrane scanning platform**][**membrane electric field vector mapping**][**vertical membrane scanning**] in accordance with ASTM D8231.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

6. High-Voltage Membrane Testing: Testing agency surveys entire [**roof area,**][**flashings,**][**parapet walls**] to locate discontinuity in the roof membrane using an electrically charged metal "broom head."

a. Perform tests before overlying construction is placed.
b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

C. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane according to ASTM D3617/D3617M.
2. Examine test specimens for interply voids according to ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
3. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect and the Owner 48 hours in advance of date and time of inspection, as directed by the Owner.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.15 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called

the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:
8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Installer will, at Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on

date of said change, but only to the extent said change affects work covered by this Warranty.

6. the Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 55 52 13

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SECTION 07 55 52 16 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS PROTECTED MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Styrene-butadiene-styrene (SBS)-modified bituminous protected membrane roofing.
2. Base sheet materials.
3. Interply sheets.
4. Styrene-butadiene-styrene (SBS)-modified bituminous cap sheet.
5. Base flashing sheet materials.
6. Asphalt materials.
7. Accessory roofing materials.
8. Roof insulation.
9. Insulation accessories.
10. Electronic leak detection (ELD) materials.
11. Coating materials.
12. Ballast.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
5. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written

instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Styrene-butadiene-styrene (SBS)-modified bituminous protected membrane roofing.
2. Base sheet materials.
3. Interply sheets.
4. Styrene-butadiene-styrene (SBS)-modified bituminous cap sheet.
5. Base flashing sheet materials.
6. Asphalt materials.
7. Accessory roofing materials.
8. Roof insulation.
9. Insulation accessories.
10. Electronic leak detection (ELD) materials.
11. Coating materials.
12. Ballast.
13. For insulation, include copy of [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listing.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. Environmental Product Declaration: For each product.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tie-in with adjoining air barrier.

D. Samples for Verification: For the following products:

1. Ballast in gradation[**and color**] indicated.
2. Roof paver[**, full sized,**] in each color and texture required.

E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**testing agency**].

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:

1. Concrete internal relative humidity test reports.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's Directory of Roof Assemblies**] for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Installer to employ on Project installers and supervisors certified through the NRCA/MRCA Certified Roofing Torch Applicator (CERTA) program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, [**roof insulation,**][**vapor retarder,**][**roof pavers,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system, such as roof membrane, base flashing, [**roof insulation,**][**vapor retarders,**][**roof pavers,**] for the following warranty period:

1. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746/D3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897.

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

1. Wind Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

K. Energy Star Listing: Roof pavers to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for roof paver products.

L. Energy Performance: Roof pavers to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with ANSI/CRRC S100.

M. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; testing by a qualified testing agency.

1. Identify products with appropriate markings of applicable testing agency.

N. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.2 STYRENE-BUTADIENE-STYRENE (SBS)-MODIFIED BITUMINOUS PROTECTED MEMBRANE ROOFING

A. Styrene-Butadiene-Styrene (SBS)-Modified Bituminous Protected Membrane Roof System: See the following articles for individual roof materials required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

2.3 SOURCE LIMITATIONS

A. Obtain components, including roof insulation for roofing system from [**same manufacturer as membrane roofing**][**manufacturer approved by membrane roofing manufacturer**].

2.4 BASE SHEET MATERIALS

A. SBS-Modified Bitumen Type I, Polyester-Mat Base Sheet: ASTM D6164/D6164M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]
h. [**Tremco Incorporated**]

B. SBS-Modified Bitumen Type I, Polyester-Mat Base Sheet, Torch: ASTM D6164/D6164M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**GAF**]
c. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
d. [**IKO Industries Inc.**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]

C. SBS-Modified Bitumen Type II, Polyester-Mat Base Sheet: ASTM D6164/D6164M, Type II, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**GAF**]
c. [**Polyglass U.S.A., Inc.**]

D. SBS-Modified Bitumen Type II, Polyester-Mat Base Sheet, Torch: ASTM D6164/D6164M, Type II, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Polyglass U.S.A., Inc.**]

E. SBS-Modified Bitumen Type I, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with glass fibers fabric; smooth surfaced; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
f. [**IKO Industries Inc.**]
g. [**Johns Manville; a Berkshire Hathaway company**]
h. [**Polyglass U.S.A., Inc.**]
i. [**Siplast**]

F. SBS-Modified Bitumen Type I, Glass-Fiber-Mat Base Sheet, Torch: ASTM D6163/D6163M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with glass fibers; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**IKO Industries Inc.**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]

g. [**Siplast**]

G. SBS-Modified Bitumen Type II, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, Type II, Grade S, SBS-modified asphalt sheet, reinforced with glass fibers; smooth surfaced; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elevate; Holcim Building Envelope**]
b. [**Siplast**]

H. SBS-Modified Bitumen Type II, Glass-Fiber-Mat Base Sheet, Torch: ASTM D6163/D6163M, Type II, Grade S, SBS-modified asphalt sheet, reinforced with glass fibers, smooth surfaced, suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Siplast**]

I. SBS-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6162/D6162M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Johns Manville; a Berkshire Hathaway company**]

J. SBS-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat Base Sheet, Torch: ASTM D6162/D6162M, Type I, Grade S, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers, smooth surfaced, suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IKO Industries Inc.**]

K. SBS-Modified Bitumen Type III, Polyester- and Glass-Fiber-Mat Base Sheet: ASTM D6162/D6162M, Type III, Grade S, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers, smooth surfaced, suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Soprema, Inc.**]

L. SBS-Modified Bitumen Type III, Polyester- and Glass-Fiber-Mat Base Sheet, Torch: ASTM D6162/D6162M, Type III, Grade S, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; smooth surfaced; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Tremco Incorporated**]

M. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.

2.5 INTERPLY SHEETS

A. Glass-Fiber Interply Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

2.6 STYRENE-BUTADIENE-STYRENE (SBS)-MODIFIED BITUMINOUS CAP SHEET

A. SBS-Modified Bitumen Type I, Polyester-Mat, Granule-Surfaced Cap Sheet: ASTM D6164/D6164M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bitec, Inc**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Elevate; Holcim Building Envelope**]
   d. [**GAF**]
   e. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
   f. [**IKO Industries Inc.**]
   g. [**Johns Manville; a Berkshire Hathaway company**]
   h. [**Polyglass U.S.A., Inc.**]
   i. [**Tamko Building Products LLC**]
   j. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Gray**][**Tan**].

B. SBS-Modified Bitumen Type I, Polyester-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6164/D6164M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Polyglass U.S.A., Inc.**]

2. Granule Color: [**White**][**Gray**][**Tan**].

C. SBS-Modified Bitumen Type II, Polyester-Mat, Granule-Surfaced Cap Sheet: ASTM D6164/D6164M, Type II, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**GAF**]
d. [**IKO Industries Inc.**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Gray**][**Tan**].

D. SBS-Modified Bitumen Type II, Polyester-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6164/D6164M, Type II, Grade G, SBS-modified asphalt sheet, reinforced with polyester fabric; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]

b. [**Elevate; Holcim Building Envelope**]
c. [**IKO Industries Inc.**]
d. [**Johns Manville; a Berkshire Hathaway company**]
e. [**Polyglass U.S.A., Inc.**]

2. Granule Color: [**White**][**Gray**][**Tan**].

E. SBS-Modified Bitumen Type I, Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6163/D6163M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with glass fibers; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bitec, Inc**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Johns Manville; a Berkshire Hathaway company**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Siplast**]
h. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Gray**][**Tan**].

F. SBS-Modified Bitumen Type I, Glass-Fiber-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6163/D6163M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Elevate; Holcim Building Envelope**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Polyglass U.S.A., Inc.**]
e. [**Siplast**]

2. Granule Color: [**White**][**Gray**][**Tan**]

G. SBS-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6162/D6162M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**MBTechnology**]

H. SBS-Modified Bitumen Type I, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6162/D6162M, Type I, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IKO Industries Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**MBTechnology**]

2. Granule Color: [**White**][**Gray**][**Tan**]

I. SBS-Modified Bitumen Type III, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet: ASTM D6162/D6162M, Type III, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Polyglass U.S.A., Inc.**]
b. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Gray**][**Tan**]

J. SBS-Modified Bitumen Type III, Polyester- and Glass-Fiber-Mat, Granule-Surfaced Cap Sheet, Torch: ASTM D6162/D6162M, Type III, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers; suitable for torch application method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Polyglass U.S.A., Inc.**]
b. [**Tremco Incorporated**]

2. Granule Color: [**White**][**Gray**][**Tan**]

2.7 BASE FLASHING SHEET MATERIALS

A. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

B. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. SBS-Modified Bitumen Backer Sheet: [**ASTM D6164/D6164M, Type I or II, Grade S, reinforced with polyester fabric**][**ASTM D6163/D6163M, Type I or II, Grade S, reinforced with glass fibers**][**ASTM D6162/D6162M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

D. SBS-Modified Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6164/D6164M, Type I or II, Grade G, reinforced with polyester fabric**][**ASTM D6163/D6163M, Type I or II, Grade G, reinforced with glass fibers**][**ASTM D6162/D6162M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**]; granule surfaced; suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**]

E. SBS-Modified Bitumen, Metal-Surfaced Flashing Sheet: ASTM D6298, metal-foil-surfaced SBS-modified asphalt sheet, reinforced with glass fibers, suitable for application method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

F. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.

G. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.8 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer for application**].

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M.

2.9 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing manufacturer for intended use and compatible with other roofing components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.

b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

C. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

D. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with [**roofing membrane**][**base flashings**].

E. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent-and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing components.

F. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing system manufacturer for application.

G. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

H. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

I. Metal Flashing Sheet: As specified in Section 076200 "Sheet Metal Flashing and Trim."

J. Separator Sheet: Polyethylene sheet, **4 mils (0.1 mm)** thick, minimum.

K. Miscellaneous Accessories: Provide accessories recommended by roofing system manufacturer.

2.10 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured[**or approved**] by roof membrane manufacturer, [**approved for use in FM Approvals' RoofNav listed roofing assemblies**][**, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies**].

B. Extruded-Polystyrene Board Insulation, Type VI: ASTM C578, **1.8 lb/cu. ft. (29 kg/cu. m)** minimum density, **40 psi (276 kPa)** minimum compressive strength, with drainage channels on bottom side, and with two or four edges rabbeted.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**24 by 96 inches (600 by 2438 mm)**][**48 by 96 inches (1219 by 2438 mm)**]
4. Thickness:

   a. Base Layer: [**1-1/2 inch (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**].

C. Extruded-Polystyrene Board Insulation, Type VII: ASTM C578, **2.2 lb/cu. ft. (35 kg/cu. m)** minimum density, **60 psi (414 kPa)** minimum compressive strength, with drainage channels on bottom side, and with two or four edges rabbeted.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DiversiFoam Products**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**The Dow Chemical Company**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25.4 mm)**.
3. Size: **24 by 96 inches (600 by 2438 mm)**.
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**].

D. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, **1.8-lb/cu. ft. (29-kg/cu. m)** minimum density, with tongue-and-groove edges on long dimension, and latex-modified

cement mortar topping, [**3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**][**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**T. Clear Corporation, a subsidiary of Fin Pan Inc**]

2. Insulation Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1219 mm)**.
4. Insulation Thickness: [**2 inches (51 mm)**][**3 inches (76 mm)**].

2.11 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with other roofing system components.

B. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

C. Metal Securement System: Perimeter securement flashing and strapping fabricated from **3-inch- (76-mm-)** wide stainless steel, a minimum of **0.031 inch (0.8 mm)** thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

2.12 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer[**, UL listed and FM Global approved**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Detec Systems**]

2. Grounding Screen: [**Welded, stainless steel mesh**][**Aluminum screen**], for use with vector mapping system[**, FM Global approved**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

3. Electrically Conductive Fabric: Non-abrasive felt.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ILD International Leak Detection**]

B. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.

1. Sensors measuring moisture content[**, temperature, and vapor drive**], placed [**below roof insulation**][**over vapor barrier**] and connected to a monitoring program, with a notification indicating location of breach.
2. Sensors measuring moisture content[**, temperature, and vapor drive**], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Detec Systems**]
b. [**ILD International Leak Detection**]

2.13 COATING MATERIALS

A. Roof Coating:

1. ASTM D1227, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**] asphalt emulsion, asbestos free.
2. ASTM D1227, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**] asphalt emulsion, nonfibered.
3. ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**], aluminum-pigmented asphaltic coating.
4. ASTM D6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.

a. Color: [**White**][**Gray**][**Tan**]

2.14 BALLAST

A. Aggregate Ballast: [**Smooth, washed riverbed gravel or other acceptable smooth-faced stone**][**Crushed, washed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation; of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 65 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**][**Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm)**].

B. Lightweight Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**3000 psi (21 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Integral Paver Supports: Integral corner pedestals, creating a minimum **3/16-inch- (5-mm-)** high ventilation air space.
5. Paver Support Assembly: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

C. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent according to ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hanover Architectural Products**]
   b. [**Roofblok Limited**]
   c. [**Sunny Brook Pressed Concrete, Co.**]
   d. [**Wausau Tile, Inc.**]
   e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]; manufactured to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Weight: [**18 lb/sq. ft. (90 kg/sq. m)**][**22 lb/sq. ft. (110 kg/sq. m)**].
4. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
5. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
6. Integral Paver Supports: Integral corner pedestals, creating a minimum **3/16-inch- (5-mm-)** high ventilation air space.
7. Paver Support Assembly: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to**

3/16 inch (3 to 5 mm)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.
3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.

   a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.

5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation, according to roofing system manufacturer's written instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)** and allow primer to dry.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing," [**FM Approvals' RoofNav**][**SPRI's Directory of Roof Assemblies**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and accessory materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier, with air barrier specified in [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Start installation of roofing in presence of manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

F. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing sheets parallel with slope.

G. Coordinate installation of roofing system, so components of the roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets with a course of coated felt set in roofing cement[**or hot roofing asphalt**], with joints and edges sealed.
2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

H. Asphalt Heating:

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.

   a. For cap sheets, heat asphalt according to cap sheet manufacturer's recommendations.

2. Circulate asphalt during heating.
3. Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application.

   a. For cap sheets, comply with cap sheet manufacturer's recommendations.

4. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating.
5. Do not heat roofing asphalt within **25 deg F (14 deg C)** of flash point.
6. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
7. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

   a. For cap sheets, comply with cap sheet manufacturer's recommendations.

I. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt according to roofing system manufacturer's written instructions.

J. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF ELD COMPONENTS

A. Install conductive medium over roof deck[**and on vertical locations to receive roof membrane**] in accordance with manufacturer's written instructions.

B. Install sensors, [**wire loop**][**conductive fabric**], connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF BASE-SHEET

A. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature.

B. Installation of SBS-Modified Bitumen Polyester-Mat, SBS-Modified Fiberglass-Mat, SBS-Modified Bitumen Polyester and Fiberglass-Mat Base Sheet:

1. Install base sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.
2. Extend roofing sheets over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere to substrate in a uniform coating of cold-applied adhesive.
5. Torch-apply to substrate.

    a. Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

6. Install base sheet without wrinkles, tears, or air pockets.
7. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

    a. Lap side laps as recommended by roof membrane manufacturer but not less than **3 inches (76 mm)**.
    b. Lap end laps as recommended by roof membrane manufacturer but not less than **12 inches (300 mm)**.
    c. Stagger end laps not less than **18 inches (457 mm)**.
    d. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
    e. Roll laps with a **20-pound (9-kg)** roller.

8. Repair tears and voids in laps and lapped seams not completely sealed.
9. Apply pressure to the body of the base sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

C. Installation of Asphalt-Coated Glass-Fiber-Mat Base Sheet:

1. Install base sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.
2. Extend roofing sheets over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere to substrate in a [**solid mopping of hot roofing asphalt**][**uniform coating of cold-**

applied adhesive]

5. Install base sheet without wrinkles, tears, or air pockets.
6. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

    a. Lap side laps as recommended by roof membrane manufacturer but not less than **3 inches (76 mm)**.
    b. Lap end laps as recommended by roof membrane manufacturer but not less than **12 inches (300 mm)**.
    c. Stagger end laps not less than **18 inches (457 mm)**.
    d. Completely bond and seal laps, leaving no voids.

7. Repair tears and voids in laps and lapped seams not completely sealed.

D. Installation of Vented Base Sheet:

1. Spot or strip mop to substrate with hot roofing asphalt vented base sheet with vented side down.

    a. Fasten vented base sheet according to requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**].
    b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

3.6 INSTALLATION OF INTERPLY SHEETS

A. Install [**two**][**three**] ply sheets, starting at low point of roofing.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

    a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.
4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.

3.7 INSTALLATION OF STYRENE-BUTADIENE-STYRENE (SBS)-MODIFIED BITUMINOUS CAP SHEET

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install modified bituminous roofing cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Install cap sheet as follows:

    a. Adhere to substrate in a solid mopping of hot roofing asphalt applied at asphalt temperature recommended by cap sheet manufacturer.
    b. Adhere to substrate in a uniform coating of cold-applied adhesive.
    c. Torch-apply to substrate.

1) Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Install cap sheet without wrinkles, tears, or air pockets.
5. Install cap sheet, so side and end laps shed water.

C. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roof membrane manufacturer but not less than **3 inches (76 mm)**.
2. Lap end laps as recommended by roof membrane manufacturer but not less than **12 inches (300 mm)**.
3. Stagger end laps not less than **18 inches (457 mm)**.
4. [**Heat-weld end laps,**][**Completely bond and seal laps,**] leaving no voids.
5. Roll laps with a **20-pound (9-kg)** roller.
6. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to the body of the cap sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

3.8 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate**] in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].

   a. Seal all laps.

3. Flashing Sheet Application, Hot: [**Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at asphalt temperature recommended by flashing sheet manufacturer. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer**][**Torch-apply flashing sheet to substrate**].

   a. Perform torch application according to NFPA 241, including two-hour fire watch after torches have been extinguished.

4. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in [**cold-applied adhesive**][**asphalt roofing cement**] at rate required by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of **8 inches (200 mm)** above roofing membrane and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing[**with a strip of glass-fiber fabric set in asphalt roofing cement**].

D. Install liquid flashing system according to manufacturer's recommendations.

1. Extend liquid flashing not less than **3 inches (76 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Install roofing cap sheet stripping where metal flanges and edgings are set on roofing according to roofing system manufacturer's written instructions.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**] **4-pound (1.8-kg)** lead flashing in bed of asphaltic adhesive on roofing.

1. Cover lead flashing with roofing cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing.
2. Clamp roofing, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping according to roofing system manufacturer's written instructions.

3.9 INSTALLATION OF COATINGS

A. Apply coating to base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.

3.10 INSTALLATION OF INSULATION

A. Loosely lay separator sheet over cooled roofing membrane, with minimum **2-inch (51-mm)** side laps and **4-inch (100-mm)** end laps.

B. Loosely lay insulation over roof membrane, with long joints of insulation in continuous straight lines and with end joints staggered not less than **12 inches (300 mm)** between rows.

1. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
2. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
3. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.

C. Install upper layer of insulation with joints of each layer offset not less than **12 inches (300 mm)** from previous layer of insulation.

1. Install with long joints continuous and with end joints staggered not less than **12 inches (300 mm)** in adjacent rows.
2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
3. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
4. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
5. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.

D. Install protection layer over insulation, overlapping edges and ends at least **12 inches (300 mm)**.

1. Do not lap ends of fabric sheets within **72 inches (1800 mm)** of roof perimeter.
2. Extend fabric **2 to 3 inches (51 to 76 mm)** above ballast at perimeter and penetrations.
3. Apply additional layer of fabric around penetrations to prevent aggregate from getting between penetration and insulation.
4. Do not cover drains or restrict water flow to drains.

3.11 INSTALLATION OF BALLAST

A. Install aggregate ballast[**and roof paver ballast**] uniformly over protection layer.

B. Spread aggregate to not damage roof membrane or base flashings.

C. Apply ballast as insulation is installed, leaving roof insulated and ballasted at end of workday.

D. Install aggregate ballast at rate required by insulation manufacturer, but not less than the following:

1. Zone 1 (Roof Area Field): [**10 lb/sq. ft. (50 kg/sq. m) of Size 5 aggregate**][**12 lb/sq. ft. (60 kg/sq. m) of Size 5 aggregate**][**13 lb/sq. ft. (65 kg/sq. m) of Size 2 aggregate**].
2. Zone 2 (Roof Area Perimeter): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**].

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
   b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

3. Zone 3 (Roof Area Corners): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**].

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
   b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

4. Within **48 Inches (1219 mm)** of Roof Penetrations: [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**Two rows of roof pavers around perimeter of penetration**]. A "penetration" is defined as any object projecting above the roof insulation that measures **48 inches (1219 mm)** or more on any side.

   a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].

E. Roof Paver Walkways: Install walkway roof pavers using [**one row**][**two rows**] of roof pavers, loosely laid and butted.

1. Install roof paver walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.

3.12 INSTALLATION OF ROOF PAVERS

A. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area according to manufacturer's written instructions.

B. Install roof pavers over roofed area according to insulation manufacturer's written instructions.

1. Mechanically fasten securement strapping to center of first two perimeter rows and first two perimeter corner rows of roof pavers in each direction from corner, closest to edge of roof, using straps running parallel to parapet wall or roof edge.

C. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.

3.13 INSTALLATION OF MORTAR-FACED BOARD INSULATION

A. Install mortar-faced board insulation loosely laid, according to manufacturer's written instructions, with tongue-and-groove joints nested.

1. Stagger end joints of adjoining rows and abut insulation.
2. Mechanically fasten metal securement strapping at penetrations and at perimeter edges of mortar-faced board insulation.
3. Over mortar-faced board insulation, install roof pavers on roof perimeter and corners according to manufacturer's written instructions.

B. Install [**one row**][**two rows**] of **24-inch- (600-mm-)** wide roof pavers to roof perimeter, corners, and penetrations according to mortar-faced board insulation manufacturer's written instructions.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests:

1. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (51 mm)** of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is the responsibility of the Contractor.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

    a. Perform tests before overlying construction is placed.
    b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
    c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ASTM D7954/D7954M.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ANSI/SPRI/RCI NT-1.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage [**horizontal membrane scanning platform**][**membrane electric field vector mapping**][**vertical membrane scanning**] in accordance with ASTM D8231.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

6. High-Voltage Membrane Testing: Testing agency surveys entire [**roof area,**][**flashings,**][**parapet walls**] to locate discontinuity in the roof membrane using an electrically charged metal "broom head."

a. Perform tests before overlying construction is placed.
b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

C. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane according to ASTM D3617/D3617M.
2. Examine test specimens for interply voids according to ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
3. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect and the Owner 48 hours in advance of date and time of inspection, as directed by the Owner.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Roofing system will be considered defective if it does not pass tests and inspections.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.15 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called

the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:
8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Installer will, at Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on

date of said change, but only to the extent said change affects work covered by this Warranty.

6. the Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

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SECTION 07 56 00 00 - FLUID-APPLIED PROTECTED MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot fluid-applied rubberized-asphalt roofing system.
2. Base flashing sheet.
3. Accessory roofing system materials.
4. Roof insulation and accessories.
5. Electronic leak-detection (ELD) materials.
6. Ballast.
7. Roof pavers.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for compressive strength, curing methods, and finishes for roof decks.
2. Section 034100 "Precast Structural Concrete" for grouting between units, erection tolerances, and finishes for roof decks.
3. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 077273 "Vegetated Roof Systems" for vegetated roof assemblies and components.
9. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
10. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 COORDINATION

A. Coordinate Work under this Section with adjacent work, including wood blocking, flashing, joints and overburden materials.

B. Coordinate requirements for concrete finishing to provide suitable substrate for roofing membrane and to minimize penetrations through membrane.

1.4 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, and other installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing system installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.
10. Review delivery, storage, handling, and protection procedures.
11. Review manufacturer's warranty requirements and installation instructions.
12. Review coordination requirements for other portions of the Work including, but not limited to, the following:

    a. Structural Decks: Review curing methods, attachment, surface finishing, slope requirements, moisture and vapor control, and other requirements.
    b. Other Building Envelope Systems: Review transitions, interfaces, material compatibility, and other requirements.

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, including the following:

a. Construction details, material descriptions, and tested physical and performance properties of roofing system components.
b. Manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Include plans, sections, and attachment details to other Work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, and fastener spacings and pattern for corner, perimeter, and field-of-roof locations.
6. Crickets, saddles, and tapered edge strips, including slopes.
7. Tie-in with adjoining wall system air barrier.
8. Locations, extent, and details of roof pavers.

C. Samples for Verification: For the following products:

1. Base flashing sheet.
2. Aggregate ballast in gradation[**and color**] indicated.
3. Roof paver[**, full sized,**] in each color and texture required.

D. Wind-Uplift Resistance Submittal: For roofing system indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.
2. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.
3. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.

E. Field quality-control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Installer Qualifications: Entity that employs installers and supervisors who are trained and [**certified**][**approved**] by roofing system manufacturer to install manufacturer's product and product is eligible to receive manufacturer's special warranty.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockup of typical roofing system installation to demonstrate surface preparation, joint and crack treatment, and thickness of roofing system.

a. Size: [**100 sq. ft. (9.3 sq. m) in area**][**As indicated on Drawings**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.12 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace components of roofing system that fail in materials or workmanship to remain watertight within specified warranty period.

1. Warranty includes leak remediation, including repair, removal, and replacement of base flashings[**, insulation**] and other components of roofing system.
2. Pavers Warranty: Pavers must not dish or warp, nor crack, split, or disintegrate in freeze-thaw conditions.
3. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering Work of this Section, including all components of roofing system, such as roof insulation, fasteners, adhesives, roofing membranes, base flashing sheet, [**walkway products,**]and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

B. Roof Pavers: Obtain pavers[**and paver pedestal assembly**] from single source from single manufacturer for consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and flashings to remain watertight.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Roof Edge: Design and install roof edge in accordance with ANSI/SPRI/FM 4435/ES-1 tested to specified design pressure.

D. Wind-Uplift Resistance: Tested by a qualified testing agency to resist the following uplift pressures. Values below to comply with ANSI/SPRI RP-4, ACSE/SEI 7 or determined by Structural Engineer.

E. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4470 as part of a roofing system, and are to be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34, [**MH**][**SH**][**VSH**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

2.3 HOT FLUID-APPLIED RUBBERIZED-ASPHALT ROOFING SYSTEM

A. Single-Component Roofing Membrane: [**Reinforced**][**Unreinforced**]; 100 percent solids; rubberized-asphalt membrane.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Hydrotech, Inc.**]
b. [**Barrett Company**]
c. [**Carlisle Coatings & Waterproofing Inc**]
d. [**CETCO is a subsidiary of Minerals Technologies Inc.**]
e. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
f. [**Siplast**]
g. [**Soprema, Inc.**]
h. [**Tremco Incorporated**]

2. Flow: **1/8 inch (3 mm)** maximum at **140 deg F (60 deg C)** in accordance with ASTM D5329.
3. Flash Point: Not less than **500 deg F (260 deg C)** and not less than **77 deg F (25 deg C)** above manufacturer's maximum recommended application temperature in accordance with ASTM D92.
4. Water-Vapor Permeance: 0.027 perm in accordance with ASTM E96/E96M, Procedure E.
5. Crack Bridging Capability: No cracking, splitting, or loss of adhesion in accordance with ASTM C1305.

2.4 BASE FLASHING SHEET

A. Elastomeric Flashing Sheet: Manufacturer's standard uncured sheet neoprene flashing sheet.

1. Adhesive: Manufacturer's standard contact adhesive.

B. SBS-Modified Bituminous, Granule-Surfaced Base Flashing Sheet: [**ASTM D6164/D6164M, Type I or Type II, Grade G, polyester-reinforced**][**ASTM D6163/D6163M, Type I or Type II, Grade G, glass-fiber reinforced**][**ASTM D6162/D6162M, Type I or Type II, Grade G, reinforced with a combination of polyester fabric and glass fibers**]; suitable for application method specified.

1. Granule Color: [**White**][**Gray**][**Tan**].
2. Backer Sheet: Matching base flashing sheet, except smooth surfaced; suitable for application method specified.

C. APP-Modified Bituminous Base Flashing Sheet: [**ASTM D6222/D6222M, Type I or Type II, Grade S, polyester-reinforced**][**ASTM D6223/D6223M, Type I or Type II, Grade S, reinforced with a combination of polyester fabric and glass fibers**], smooth surfaced; suitable for application method specified.

D. Liquid Base Flashing System: Roofing membrane manufacturer's standard moisture-curing resin with low solvent content, consisting of a primer, flashing cement, and reinforcing scrim; suitable for installation method specified.

2.5 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing system manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

B. Asphalt Primer: ASTM D41/D41M.

C. Reinforcing Fabric: Manufacturer's standard fiberglass-mesh or spun-bonded polyester fabric.

D. Metal Termination Bars: Manufacturer's standard, predrilled, stainless steel or aluminum bars; approximately **1 by 1/8 inch (25 by 3 mm)** thick; with stainless steel anchors.

E. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

F. Aggregate Surfacing: ASTM D1863/D1863M, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges crushed slag, free of sharp edges.

G. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.6 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer,[**approved for use in FM Approvals' RoofNav-listed roof assemblies**] selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type VII, 2.2 lb/cu. ft. (35 kg/cu. m), minimum density, 60 psi (414 kPa) minimum compressive strength**][**Type V, 3.0 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength**], fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DuPont de Nemours, Inc.**]
   b. [**Kingspan Insulation LLC**]
   c. [**Owens Corning**]
   d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1219 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**]

C. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C578, Type VI, **1.8-lb/cu. ft. (29-kg/cu. m)** minimum density, **40 psi (276 kPa)** minimum compressive strength, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, [**3/8 inch (9 mm) thick, 4.5 lb/sq. ft. (19.5 kg/sq. m)**][**15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**T. Clear Corporation, a subsidiary of Fin Pan Inc**]

D. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatible with other roofing system and with roofing membrane.

E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, of type and weight as recommended in writing by roofing system manufacturer for application.

F. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of **0.031 inch (0.8 mm)** thick. Provide fasteners as recommended in writing by mortar-faced insulation manufacturer.

2.7 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

C. Fiber-Reinforced Gypsum Cover Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

D. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

E. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

2.8 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.9 BALLAST

A. Aggregate Ballast: Washed, crushed stone or smooth stone that withstands weather exposure without significant deterioration and does not contribute to membrane degradation; of the following size:

1. Size: ASTM D448, [**Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**][**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**].

2.10 ROOF PAVERS

A. Interlocking Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**].
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Coatings & Waterproofing Inc**]
b. [**Hanover Architectural Products**]
c. [**Roofblok Limited**]
d. [**Sunny Brook Pressed Concrete, Co.**]
e. [**Tile Tech Pavers**]
f. [**Wausau Tile, Inc.**]
g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (610 by 610 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum; ASTM C140/C140M.

4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Paver Supports:

    a. Integral Paver Supports: Integral corner pedestals creating a minimum **3/16-inch- (5-mm-)** high, ventilation airspace.
    b. Paver Support Assembly: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

C. Roof-Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of **3 inches (75 mm)** wide by **0.031 inch (0.8 mm)** thick with stainless steel anchors.

D. Paver Pedestals: Paver-support assembly, [**standard with paver manufacturer**][**as named below**], including [**fixed-height**][**adjustable or stackable**] pedestals, shims, and spacer tabs for joint spacing of [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**][**1/8 to 3/16 inch (3 to 5 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Buzon USA**]
    b. [**Envirospec, Inc.**]
    c. [**Hanover Architectural Products**]
    d. [**Roofblok Limited**]
    e. [**Soprema, Inc.**]
    f. [**Sunny Brook Pressed Concrete, Co.**]
    g. [**Tile Tech Pavers**]
    h. [**Wausau Tile, Inc.**]
    i. [**Westile Roofing Products; an Oldcastle company**]

2. Fill: As recommended in writing by pedestal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Roofing System Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.
3. Verify that minimum concrete drying period recommended in writing by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.

B. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.

C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, and other voids.

F. Coordinate with the Owner for impact to air-intake equipment in the vicinity of the Work. Cover or filter air-intake louvers before proceeding with work that could affect indoor air quality or that could activate smoke detectors in the ductwork.

3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive roofing, including joints and cracks, roof drains, and penetrations, in accordance with roofing system manufacturer's written instructions.

1. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt in accordance with ASTM D4258.
2. Adhere strip of elastomeric sheet to substrate in a layer of hot fluid-applied, rubberized asphalt. Extend elastomeric sheet a minimum of **6 inches (150 mm)** on each side of moving joints and cracks or joints and cracks exceeding **1/8 inch (3 mm)** thick, and beyond roof drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
3. Embed strip of reinforcing fabric into a layer of hot fluid-applied, rubberized asphalt. Extend reinforcing fabric a minimum of **6 inches (150 mm)** on each side of nonmoving joints and cracks not exceeding **1/8 inch (3 mm)** thick, and beyond roof drains and penetrations.

   a. Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.

B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of **6 inches (150 mm)** on each side of joints, and adhere to substrates in a layer of hot fluid-applied, rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.4 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.5 INSTALLATION OF BASE FLASHING SHEET

A. Install sheet flashing at terminations of roofing membrane in accordance with manufacturer's written instructions.

B. Prime substrate with asphalt primer if required by manufacturer.

C. Bond elastomeric flashing sheet in contact adhesive against wall substrate to within **3 inches (75 mm)** of deck. Adhere remaining vertical leg and horizontal leg of flashing sheet in a layer of hot fluid-applied, rubberized asphalt.

D. Bond modified bituminous flashing sheet to substrate as follows:

1. Adhere SBS-modified bituminous[**backer sheet and**] flashing sheet to substrate in a layer of hot fluid-applied, rubberized asphalt.
2. Torch apply APP-modified bituminous flashing sheet to substrate.
3. Adhere SBS-modified bituminous[**backer sheet and**] flashing sheet to substrate in a layer of hot fluid-applied, rubberized asphalt, or torch apply APP-modified bituminous flashing sheet to substrate as standard with manufacturer.

E. Extend flashing sheet up walls or parapets a minimum of **8 inches (200 mm)** above insulation and **6 inches (150 mm)** onto roof deck.

F. Install termination bars and mechanically fasten to top of flashing sheet at terminations and perimeter of roofing membrane.

G. Install metal counter flashing over flashing sheet where providing a substrate for sealant joints at curtain wall, wall cladding materials, and other locations where meeting adjacent portions of the Work. Provide metal flashing receivers where sequencing requires installation of metal counter flashing prior to roof base flashing installation.

3.6 INSTALLATION OF FLUID-APPLIED ROOFING MEMBRANE

A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.

B. Heat and apply rubberized asphalt in accordance with manufacturer's written instructions.

1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.

C. Start installation in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

D. Unreinforced Membrane: Apply hot fluid-applied, rubberized asphalt to area to receive roofing. Spread hot fluid-applied, rubberized asphalt to form a uniform, unreinforced, seamless membrane, [**180-mil**

(4.5-mm) minimum thickness][**180-mil (4.5-mm) average thickness, but not less than 125 mils (3.2 mm) thick**].

E. Reinforced Membrane: Apply hot fluid-applied, rubberized asphalt to area to receive roofing. Spread a **90-mil- (2.3-mm-)** thick layer of hot fluid-applied, rubberized asphalt; embed reinforcing fabric, overlapping sheets **2 inches (50 mm)**; spread another **125-mil- (3.2-mm-)** thick layer of hot fluid-applied, rubberized asphalt to form a uniform, reinforced, seamless membrane, **215 mils (5.5 mm)** thick.

F. Apply hot fluid-applied, rubberized asphalt over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

G. Cover membrane with protection course with overlapped joints before membrane is subject to construction traffic.

3.7 INSTALLATION OF ROOF INSULATION

A. Install one or more layers of insulation to achieve required thickness over roofing membrane. Cut and fit to within **3/4 inch (19 mm)** of projections and penetrations.

1. Where overall insulation thickness is **2 inches (50 mm)** or more, install required thickness in two or more layers with joints of each succeeding layer staggered over joints of previous layer a minimum of **6 inches (150 mm)** in each direction.

B. Installation of Mortar-Faced Board Insulation:

1. Install mortar-faced board insulation loosely laid, in accordance with manufacturer's written instructions, with tongue-and-groove joints nested. Stagger end joints of adjoining rows and abut insulation.

a. Mechanically fasten metal securement strapping at penetrations and at perimeter edges of mortar-faced board insulation.
b. Over mortar-faced board insulation, install roof pavers on roof perimeter and corners in accordance with manufacturer's written instructions.

2. Install [**one row**][**two rows**] of roof pavers to roof perimeter, corners, and penetrations in accordance with mortar-faced board insulation manufacturer's written instructions.

C. Installation of Roof Cover Board: Install over insulation in accordance with roofing system manufacturer's written instructions.

3.8 INSTALLATION OF BALLAST

A. Install aggregate ballast[**and roof paver ballast**] uniformly over protection layer.

B. Spread aggregate to not damage roofing membrane or base flashings.

C. Apply ballast as insulation is installed, leaving roof insulated and ballasted at end of workday.

D. Install aggregate ballast at rate required in writing by roofing system manufacturer, but not less than the following:

1. Zone 1 (Roof Area Field): [**10 lb/sq. ft. (50 kg/sq. m) of Size 5 aggregate**][**12 lb/sq. ft. (60 kg/sq. m) of Size 5 aggregate**][**13 lb/sq. ft. (65 kg/sq. m) of Size 2 aggregate**].
2. Zone 2 (Roof Area Perimeter): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**].

    a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
    b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

3. Zone 3 (Roof Area Corners): [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**One row of roof pavers**][**Two rows of roof pavers**][**Three rows of roof pavers**][**Four rows of roof pavers**].

    a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].
    b. Mechanically fasten securement strapping to center of first perimeter row of roof pavers closest to edge of roof, using straps running parallel to parapet wall or roof edge.

4. Within 48 Inches (1219 mm) of Roof Penetrations: [**15 lb/sq. ft. (75 kg/sq. m)**][**20 lb/sq. ft. (100 kg/sq. m)**][**Two rows of roof pavers around perimeter of penetration**]. A "penetration" is defined as any object projecting above the roof insulation that measures **48 inches (1219 mm)** or more on any side.

    a. Aggregate: [**Size 5**][**Size 4**][**Size 2**].

5. Walkway Pavers: Install walkways formed from [**one row**][**two rows**] of roof pavers, loosely laid and butted.
6. Install roof paver walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.

3.9 INSTALLATION OF ROOF PAVERS

A. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area in accordance with manufacturer's written instructions.

B. Install roof pavers over roofed area in accordance with roofing system manufacturer's written instructions.

C. Mechanically securement strapping to center of first perimeter and first perimeter corner row of roof pavers.

D. Install roof pavers over roofed area in accordance with insulation manufacturer's written instructions.

E. Mechanically fasten securement strapping to center of first two perimeter rows and first two perimeter corner rows of roof pavers in each direction from corner, closest to edge of, using straps running parallel to parapet wall or roof edge.

F. Install roof pavers on pedestals set in accordance with pedestal manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Engage a full-time site representative qualified by roofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of membrane, base flashings, protection, insulation, and ballast; furnish daily reports.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, and application of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

C. Perform the following tests:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

   a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

   a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**]. Maintain **2 inches (50 mm)** of clearance from top of base flashing.
   b. Flood each area for [**24**][**48**][**72**] hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installation are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency will prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

   a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or by nuclear hydrogen detection testing.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

    a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

    a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

D. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Determine approximate quantities of components within roofing membrane in accordance with ASTM D3617/D3617M.
2. Examine test specimens for voids between plies in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
3. Repair areas where test cuts were made in accordance with roofing system manufacturer's written installation instructions.

E. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection, as directed by the Owner.

F. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

3.11 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
8. Date of Substantial Completion:

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.

3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 56 00 00

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Task	Specification	Specification Description
07 56 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 56 00 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 56 00 00	07 57 00 00	Coated Foamed Roofing

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SECTION 07 57 00 00 - COATED FOAMED ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Spray-applied, coated, polyurethane foam roofing.

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking, curbs, cants, and nailers.
2. Section 072119 "Foamed-In-Place Insulation" for spray-applied polyurethane foam specified as general building insulation within walls and rafter spaces.
3. Section 076200 "Sheet Metal Flashing and Trim" for foam stops, roof penetration flashings, and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, fillers, and preparation.

1.2 DEFINITIONS

A. Applicator: A qualified person employed to apply spray-applied, coated, polyurethane foam roofing.

B. Installer: A qualified firm contracted to install spray-applied, coated, polyurethane foam roofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to coated foamed roofing, including, but not limited to, the following:

a. Load limitations on in-place roofing.
b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Surface preparation specified in other Sections.
d. Minimum curing period.
e. Forecasted weather conditions.
f. Special details and sheet flashings.
g. Repairs.

1.4 ACTION SUBMITTALS

A. Product Data:[**Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties.**]

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

C. Samples for Initial Selection: For each type of exposed product, finish, and color.

1. Include Samples of accessory materials and accessories involving color and finish selection.

D. Samples for Verification: For coated foamed roofing, prepared on Samples of size indicated below:

1. Samples, **24 by 24 inches (600 by 600 mm)**, on rigid backing, showing polyurethane foam of thickness required and stepped coatings in colors required to illustrate buildup of coated foamed roofing.
2. Include Samples of accessories to verify color and finish selected.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For SPFA-qualified [**Installer**][**applicators**].

B. Product Certificates: For each type of coated foam roofing.

C. Evaluation Reports: For coated foamed roofing, from ICC-ES.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coated foamed roofing to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified coated-foamed-roofing installer who is approved, authorized, or licensed by coating manufacturer for installation of coating manufacturer's product over polyurethane foam.

1. Engage an installer who participates in and who has fulfilled requirements of the SPFA program

for company accreditation as "SPFA PCP Accredited Company Roofing," with individual applicator certification for personnel assigned to work on Project.

B. Comply with recommendations in SPFA AY-104.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area as shown on Drawings.

a. Size: [**10 feet (3 m) by 10 feet (3 m)**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer.

C. Remove and replace material that cannot be applied within its stated shelf life.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Apply materials within the range of ambient and substrate temperatures recommended in writing by material manufacturers, but not below **50 deg F (10 deg C)**.
2. Apply materials within range of relative humidity recommended in writing by manufacturer of each component, but not when relative humidity exceeds 85 percent, or when temperatures are less than **5 deg F (3 deg C)** above dew point.
3. Do not apply materials to damp or wet surfaces.
4. Do not apply primers, polyurethane foam, or coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period.
5. Do not apply polyurethane foam when wind conditions result in surface finish textures not complying with requirements.
6. Do not apply coatings when wind conditions prevent uniform coating application.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within specified warranty period.

1. Warranty Period: [**Five**][**10**][**15**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**coating and polyurethane foam from single source from single manufacturer**][**coating from single source from single manufacturer and polyurethane foam from single manufacturer acceptable in writing to coating manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Coated foamed roofing to withstand exposure to weather without failure due to defective manufacture, installation, or other defects in construction. Membrane roofing to remain watertight.

1. Material Compatibility: Provide polyurethane foam, coatings, substrate board, and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Fire-Test-Response Characteristics: Provide coated foamed roofing with the fire-test-response characteristics indicated, as determined by testing identical systems in accordance with test methods below for deck type and slopes indicated by a qualified testing and inspecting agency that is acceptable to authorities having jurisdiction.

1. [**Class A**][**Class B**][**Class C**] roof covering in accordance with ASTM E108.
2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**75**] or less.

3. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM 4474, UL 580, or UL 1897.

D. FM Approvals Listing: Provide roofing system and component materials that comply with requirements in [**FM Approvals Standard 4450 for steel roof decks and**]FM Approvals Standard 4470 for roof covers as part of a foamed roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-[**60**][**75**][**90**][**105**][**120**].
2. Hail-Resistance Classification: [**MH**][**SH**].

E. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Energy Star Listing: Provide coated foam roofing that is listed on the EPA/DOE's "Energy Star Roof Product List" for [**low**][**steep**]-slope roof products.

K. Energy Performance: Provide coated foamed roofing certified and labeled in accordance with one of the following when tested in accordance with ANSI/CRRC S100:

1. Three-year, aged solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged Solar Reflectance Index of not less than [**64**] when calculated in accordance with ASTM E1980.

2.3 POLYURETHANE FOAM

A. Polyurethane Foam: Rigid, cellular polyurethane; complying with ASTM C1029, [**Type III**][**Type IV**]; spray applied, with fire retardants as required, and acceptable to coating manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Conklin Company Inc**]
   b. [**Gaco; Holcim Building Envelope**]
   c. [**General Coatings Manufacturing Corp.**]
   d. [**Huntsman Building Solutions**]
   e. [**Master Builders Solutions**]
   f. [**NCFI; Barnhart Manufacturing Co.**]
   g. [**Neogard; Hempel Group**]
   h. [**SWD Urethane Company**]
   i. [**Volatile Free, Inc.**]

2. In-Place Density: **2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m)**; ASTM D1622/D1622M.

2.4 URETHANE COATINGS

A. Urethane Coating: Liquid urethane elastomeric coating system specifically formulated for coating spray-applied polyurethane foam roofing.[**One-component urethanes must comply with ASTM D6947/D6947M.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aldo Products Inc.**]
   b. [**ER Systems; a Holcim brand**]
   c. [**Gaco; Holcim Building Envelope**]
   d. [**GAF**]

e. [**Master Builders Solutions**]
f. [**NCFI; Barnhart Manufacturing Co.**]
g. [**Neogard; Hempel Group**]
h. [**Volatile Free, Inc.**]

2. Base Coat: [**One**][**Two**][**One- or two**]-component urethane[**color contrasting with topcoat**].
3. Topcoat: [**One**][**Two**][**One- or two**]-component urethane.

   a. Color: [**White**][**Gray**][**Tan**].
   b. Color at Walkways: [**White**][**Gray**][**Tan**].

4. Tensile Strength: **600 psi (4.1 MPa)** minimum in accordance with ASTM D2370.
5. Elongation: 350 percent minimum in accordance with ASTM D412 after 1000 hours accelerated weathering in accordance with ASTM D4798/D4798M.
6. Water Absorption: 3 percent maximum by weight in accordance with ASTM D471.
7. Fungal Resistance: Zero rating in accordance with ASTM G21.
8. Tear Resistance: **100 lbf/inch (17.5 kN/m)** minimum in accordance with ASTM D624.
9. Low-Temperature Flexibility: Pass **0.5-inch (12.5-mm)** mandrel at **minus 15 deg F (minus 26 deg C)** in accordance with ASTM D522/D522M.
10. Vapor Permeance: Minimum [**0.7 perm (40.2 ng/Pa x s x sq. m)**][**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.5 SILICONE COATINGS

A. Silicone Coating: Liquid silicone elastomeric coating system[**complying with ASTM D6694/D6694M and**] specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aldo Products Inc.**]
   b. [**ER Systems; a Holcim brand**]
   c. [**Gaco; Holcim Building Envelope**]
   d. [**GAF**]
   e. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
   f. [**General Coatings Manufacturing Corp.**]
   g. [**Huntsman Building Solutions**]
   h. [**Master Builders Solutions**]
   i. [**NCFI; Barnhart Manufacturing Co.**]
   j. [**Neogard; Hempel Group**]
   k. [**Volatile Free, Inc.**]

2. Composition: [**One**][**Two**][**One- or two**]-component silicone.
3. Base-Coat Color: Contrasting with topcoat.
4. Topcoat Color: [**White**][**Gray**][**Tan**].
5. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
6. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.6 ACRYLIC COATINGS

A. Acrylic Coating: Liquid acrylic elastomeric emulsion coating system specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**Conklin Company Inc**]
c. [**ER Systems; a Holcim brand**]
d. [**Gaco; Holcim Building Envelope**]
e. [**GAF**]
f. [**General Coatings Manufacturing Corp.**]
g. [**Huntsman Building Solutions**]
h. [**NCFI; Barnhart Manufacturing Co.**]
i. [**Neogard; Hempel Group**]
j. [**SWD Urethane Company**]

2. Base-Coat Color: Contrasting with topcoat.
3. Topcoat Color: [**White**][**Gray**][**Tan**].
4. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
5. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.7 SUBSTRATE BOARD

A. Gypsum Board Thermal Barrier: ASTM C1396/C1396M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**] thick.

B. Thermal Barrier Board: Board product tested in accordance with and meeting the requirements of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

C. Glass Mat Gypsum Thermal Barrier: Water-resistant gypsum board with fiberglass mat laminated to both sides, ASTM C1177/C1177M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

D. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals Standard 4470, and designed and sized for fastening thermal barrier to substrate.

2.8 ACCESSORY MATERIALS

A. General: Accessory materials recommended in writing by roofing manufacturer for intended use.

1. Liquid-type accessory materials must comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Primer: Polyurethane-foam manufacturer's standard factory-formulated primer.

C. Vapor Retarder: [**Fluid applied**][**Bituminous membrane**][**As recommended in writing by coated foamed roofing manufacturer**].

D. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained by **No. 40 (0.42-mm)** sieve.

1. Color: [**Buff white**][**Gray**][**Green**][**Red**]

E. Aggregate: Coarse mineral aggregate, **3/4 inch (19 mm)** maximum, ASTM D1863/D1863M, No. 7 or No. 67 gradation.

F. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended in writing by coating manufacturer for embedment in liquid coating.

G. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of **5/16-inch (8-mm)**

nominal thickness, and approved by coating manufacturer. Provide pad sizes indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sika Greenstreak**]

2. Color: [**Yellow**][**Gray**][**Blue**][**Orange**][**Green**].

H. Sealant: ASTM C920, Class 25, Use NT, Grade NS, [**Type M, multicomponent urethane**][**Type S, one-component, neutral- or acid-curing silicone**], and as recommended in writing by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.

I. Sheet Flashing and Accessories: Types recommended in writing by coated foamed roofing manufacturer, provided at locations indicated and as recommended.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that related work is complete. Do not install coated foamed roofing until roof openings, curbs, and parapets, if any, are complete and roof drains, vents, and other roof penetrations are in place.

B. Examine substrates, areas, and conditions under which coated foamed roofing will be applied, with Installer present, for compliance with requirements.

C. Proceed with installation only after unsatisfactory conditions have been corrected and substrates are dry.

D. Proceed with installation only after minimum concrete curing and drying period recommended in writing by coated foamed roofing manufacturer.

E. Verify that concrete substrate is visibly dry and free of moisture. Test concrete substrate for capillary moisture by plastic sheet method in accordance with ASTM D4263[**at start of each day's work and**] at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet.

3.2 INSTALLATION OF SUBSTRATE BOARD

A. General: Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

B. Thermal Barrier: [**Fasten to top flanges of steel deck in accordance with recommendations in FM Global's "Approval Guide" and its FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification**][**Fasten to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with coated foamed roofing manufacturer's written instructions**].

C. Recover Board: Install in accordance with coated foamed roofing manufacturer's written instructions and

the requirements in Section 070150.19 "Preparation for Re-Roofing." Fasten through existing roofing to roof structure as indicated. Space fasteners [**for wind-uplift conditions at Project site**][**as indicated**].

3.3 SURFACE PREPARATION

A. General: Clean and prepare substrate in accordance with coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.

B. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.

C. Prepare substrate for re-covering in accordance with Section 070150.19 "Preparation for Re-Roofing" and to coated foamed roofing manufacturer's written instructions.

D. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Temporarily close off roof drains, removing roof-drain plugs when not doing coated foamed roofing work or when rain is forecast.

1. Remove masking after polyurethane foam application; cover and re-mask adjoining surfaces before coating polyurethane foam.

E. Prime substrate as recommended in writing by coated foamed roofing manufacturer.

F. Fill, cover, or tape joints and cracks in substrate that exceed a width of **1/4 inch (6 mm)**. Remove dust and dirt from narrower joints and cracks before applying polyurethane foam.

G. Install vapor retarder in accordance with coated foamed roofing manufacturer's written instructions.

3.4 APPLICATION OF POLYURETHANE FOAM

A. General: Mix and apply polyurethane foam in accordance with ASTM D5469/D5469M and coated foamed roofing manufacturer's written instructions.

1. Fill irregularities and depressions to prevent ponding water.
2. Apply the required full thickness of polyurethane foam in any specific area on same day.
3. Apply only the area of polyurethane foam that can be covered with required base coating on same day or within 24 hours.
4. Apply polyurethane foam to avoid overspray beyond immediate area of work.

B. Apply polyurethane foam in lift thicknesses of not less than **1/2 inch (13 mm)** and not more than **1-1/2 inches (38 mm)**.

C. Uniformly apply total thickness of polyurethane foam indicated, but not less than **1 inch (25 mm)**, to a surface tolerance of plus **1/4 inch (6 mm)** and no minus.

1. Slope to Drain: Vary thickness uniformly and fill low spots to achieve minimum **1/4-inch-per-foot (1:48)** slope to drain unless otherwise indicated.

D. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least **4 inches (100 mm)** above elevation of adjacent roof field.

E. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface

textures as defined by ASTM D5469/D5469M:

1. Texture: Smooth to [**orange peel**][**coarse orange peel**][**verge of popcorn**].

F. Remove and replace polyurethane foam not complying with surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

3.5 APPLICATION OF COATING

A. Allow polyurethane foam substrate to cure for a minimum of two hours before coating, and apply coating system to polyurethane foam no later than 24 hours after applying the foam. Remove dust, dirt, water, and other contaminants before applying coating system.

B. Apply coating system to polyurethane foam by spray, roller, or other suitable application method in accordance with coating manufacturer's written instructions.

C. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting color tints for successive coats.

1. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
2. Urethane Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 30 mils (0.76 mm)**][**of 35 mils (0.89 mm)**].
3. Silicone Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 20 mils (0.50 mm)**][**of 22 mils (0.56 mm)**][**of 26 mils (0.66 mm)**][**of 30 mils (0.76 mm)**].
4. Acrylic Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 28 mils (0.71 mm)**][**of 32 mils (0.81 mm)**].

D. Height at Terminations: Apply coating system at wall terminations and other vertical surfaces to extend vertically beyond polyurethane foam by a minimum of **4 inches (100 mm)**.

E. Mineral Granules: Apply mineral granules over wet topcoat, using pressure equipment at the rate of [**0.5 lb/sq. ft. (2.45 kg/sq. m)**]. Remove excess granules after topcoat has cured.

F. Sealant: Apply sealant to perimeter and other terminations where indicated on Drawings or required by coated foamed roofing manufacturer.

G. Walkways: Install roof walkways in pattern and locations indicated and as follows:

1. Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one or two additional topcoats to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
2. Fabric-Reinforced, Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one additional topcoat to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
3. Preformed Walkway-Pad Walkways: Adhere walkway pads to substrate with compatible adhesive in accordance with coated foamed roofing manufacturer's written instructions.

H. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than **6 lb/sq. ft. (29 kg/sq. m)** and a minimum thickness of **3/4 inch (19 mm)**. Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing agency will identify, seal, and certify samples of materials taken from Project site, with Contractor present.
2. Testing agency will perform tests for product characteristics specified or cited in manufacturer's product data.

   a. Two core samples will be required for roof areas of up to **10,000 sq. ft. (900 sq. m)**, and one core sample will be required for each additional **10,000 sq. ft. (900 sq. m)** or part thereof.
   b. Six slit-test samples will be required for each **10,000 sq. ft. (900 sq. m)** of roof area to determine, as a minimum, the number of coats applied and dry film thickness of coating.

3. Testing agency will verify that surfaces slope to drain.

B. Coated foamed roofing will be considered defective if it does not pass tests and inspections.

C. Refill cores, repair slits, and re-coat test areas.

D. Prepare test and inspection reports.

3.7 REPAIR AND RE-COATING

A. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.

B. Repair and re-coat coated foamed roofing in accordance with ASTM D6705/D6705M and manufacturer's written instructions.

3.8 CURING, PROTECTING, AND CLEANING

A. Cure coatings in accordance with manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.

B. Protect coated foamed roofing from damage and wear during remainder of construction period.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 57 00 00

Task	Specification	Specification Description
07 57 13 00	07 57 00 00	Coated Foamed Roofing
07 58 00 00	07 51 13 00	Built-Up Asphalt Roofing

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SECTION 07 61 00 00 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal roofing material.
2. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for manufactured metal panels used in horizontal soffit applications.
2. Section 077100 "Roof Specialties" for manufactured [**fasciae**][**copings**] that are not part of sheet metal roofing.
3. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 COORDINATION

A. Coordinate sheet metal roofing layout and seams with sizes and locations of roof curbs, equipment supports, equipment provided, and roof penetrations.

B. Coordinate sheet metal roofing installation with rain drainage work, flashing, trim, and construction of roofing substrate, parapets, walls, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review structural loading limitations of substrates during and after roofing installation.
3. Review insulation, air barrier, vapor retarder, and underlayment requirements.
4. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affect sheet metal roofing.
5. Review requirements for insurance and certificates if applicable.
6. Review roof observation and repair procedures after sheet metal roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For sheet metal roofing panels. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and panel installation layouts, expansion joint locations, points of fixity, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include details for forming, including seams and dimensions.
4. Include details for joining and securing, including layout and spacing of fasteners, cleats, and other attachments. Include pattern of seams.
5. Include details of expansion joints, including showing direction of expansion and contraction from points of fixity.
6. Include details of roof penetrations.
7. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, corners, flashings, and counterflashings.
8. Include details of special conditions.
9. Include details of connections to adjoining work.
10. Detail the following accessory items, at scale of not less than [**1-1/2 inches per 12 inches (1:10)**][**3 inches per 12 inches (1:5)**]:

    a. Flashing and trim.
    b. Roof curbs.

C. Samples: For each exposed product and for each color and texture specified, **12 inches (300 mm)** long by actual width.

D. Samples for Initial Selection: For each type of sheet metal with factory-applied finishes.

1. Include Samples of trim and accessories involving finish or color selection.

E. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Roofing: **12 inches (300 mm)** long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, [**battens,**]and other attachments.
2. Trim and Metal Closures: **12 inches (300 mm)** long and in required profile. Include fasteners and other exposed accessories.
3. Other Accessories: **12-inch- (300-mm-)** long Samples for each type of other accessory.

F. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Sheet metal roofing, seam locations, and attachments.
2. Roof hatches.
3. Equipment supports, pipe supports, and penetrations.
4. Lighting fixtures and cable runs.
5. Snow guards.
6. Items mounted on roof curbs.
7. Details for penetrations.

B. Qualification Statements: For [**Installer**][**fabricator**].

1. Include listing of completed projects of comparable scale of this Project, including name, address, telephone, and contact person for Architect, and name, address, telephone number, and contact person for building the Owner, as directed by the Owner.

C. Product Test Reports: For self-adhering, high-temperature underlayment, from ICC-ES.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal roofing and accessories.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.7 QUALITY ASSURANCE

A. Roof Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Metal Panel Roof Systems Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Metal Panel Roof Systems Installers**].

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area and eave as indicated on Drawings, including[**underlayment,**] attachments, and accessories.

a. Size: Approximately [**12 feet (3.5 m) long by 6 feet (1.75 m)**][**48 inches (1200 mm) square**][**12 feet (3.5 m) square**].
b. Include [**each type of exposed seam and seam termination**][**fascia**][**soffit**][**gable end and rake**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal roofing materials away from uncured concrete and masonry.
2. Protect stored sheet metal roofing materials from contact with water.

B. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal roofing installation.

C. Copper Roof Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 WARRANTY

A. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as fasteners, adhesives, sheet metal roofing, and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Sheet metal roofing system, including, but not limited to, metal roof panels, cleats, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim[**battens**], underlayment, and accessories, is to comply with requirements without failure due to defective manufacture, fabrication, or installation, or due to other defects in construction. Sheet metal roofing is to remain watertight.

B. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or indicated on Drawings.

C. Copper Roofing Standard: Comply with CDA Publication A4050. Conform to dimensions and profiles shown unless more stringent requirements are specified or indicated on Drawings.

D. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Energy Performance: Provide sheet metal roofing meeting one of the following when tested in accordance with CRRC-1:

1. Three-year, aged, solar reflectance of not less than [**0.63**][**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged, Solar Reflectance Index (SRI) of not less than [**75**][**64**] when calculated in accordance with ASTM E1980.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 SHEET METAL ROOFING MATERIAL

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide [**zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation**][**aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275)**]; with [**smooth, flat**][**embossed**] surface; prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Thickness: Nominal [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**] unless otherwise indicated.

a. Batten Caps: Nominal **0.028 inch (0.71 mm)** thick.

2. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
c. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
d. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
e. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As**

selected by Architect from manufacturer's full range], as directed by the Owner.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Sheet: **ASTM B209 (ASTM B209M)** alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**] unless otherwise indicated.

   a. Batten Caps: **0.050 inch (1.27 mm)** thick.

2. As-Milled Finish: [**Mill**][**One-side bright mill**][**Standard one-side bright**][**Standard two-side bright**].
3. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
4. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of **0.2 mil (0.005 mm)**.
5. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEFE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
   f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
7. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

D. Copper Sheet: ASTM B370 cold-rolled copper sheet, H00 temper.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hussey Copper Ltd.**]
   b. [**Revere Copper Products, Inc**]

2. Weight (Thickness): [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.70 mm thick)**] unless otherwise indicated.

   a. Batten Caps: **20 oz./sq. ft. (0.70 mm)** thick.

3. Nonpatinated Exposed Finish: Mill.
4. Nonpatinated Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products."

   a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac" [**waterborne**][**solvent-borne**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
   b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac" [**waterborne**][**solvent-borne**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

5. Prepatinated Copper-Sheet Finish: [**Dark brown**][**Verdigris**], prepatinated in accordance with ASTM B882.

E. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370 cold-rolled copper sheet, H00 temper, coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Revere Copper Products, Inc**]

2. Weight (Thickness): [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.70 mm)**] uncoated, with **0.787-mil (0.020-mm)** coating thickness applied to each side.

   a. Batten Caps: **20 oz./sq. ft. (0.70 mm)** uncoated, with **0.787-mil (0.020-mm)** coating thickness applied to each side unless otherwise indicated.

F. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], dead soft, fully annealed; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.0156 inch (0.396 mm)**][**0.0188 inch (0.477 mm)**] unless otherwise indicated.

   a. Batten Caps: **0.0188 inch (0.477 mm)** thick.

2. Finish: [**ASTM A480/A480M, No. 2D (dull, cold rolled)**][**ASTM A480/A480M, No. 2B (bright,**

cold rolled)][**ASTM A480/A480M, No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M, No. 4 (polished directional satin)**].

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches. Run grain of directional finishes with long dimension of each piece.
c. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

G. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed temper O61.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heyco Metals**]
b. [**SEMCO Southeastern Metals, A Gibraltar Industries Company**]

2. Thickness: [**0.016 inch (0.40 mm)**] unless otherwise indicated.

a. Batten Caps: [**0.018 inch (0.46 mm)**] thick.

H. Zinc Sheet: [**99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)**][**Zinc, 99 percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum**]; with manufacturer's standard factory-applied, flexible, protective back coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Artazn LLC**]
b. [**Rheinzink America**]

2. Thickness: [**0.027 inch (0.70 mm)**][**0.032 inch (0.81 mm)**] unless otherwise indicated.

a. Batten Caps: **0.032 inch (0.80 mm)** thick.

3. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

I. Titanium Sheet: ASTM B265, Grade 1; with [**smooth, flat**][**embossed**] surface.

1. Thickness: [**0.015 inch (0.38 mm)**][**0.020 inch (0.51 mm)**] unless otherwise indicated.

a. Batten Caps: **0.020 inch (0.51 mm)** thick.

2. Finish: [**Low**][**Medium**] matte.
3. Color Anodic Finish (Light-Interference Phenomenon): [**Silver**][**Gold**][**Purple**][**Blue**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range of colors and color densities**].

2.3 UNDERLAYMENT

A. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; acceptable to authorities having jurisdiction for use as underlayment in roofing system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
b. [**Intertape Polymer Group**]
c. [**Kirsch Building Products**]
d. [**SDP Advanced Polymer Products Inc.**]

B. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Owens Corning**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]
h. [**SDP Advanced Polymer Products Inc.**]

2. Thermal Stability: Stable after testing at **220 deg F (111 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at minus **20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

D. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

E. Ventilation Mat: **0.40-inch (10.16-mm-)** thick, three-dimensional nylon mat.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Low & Bonar PLC**]
b. [**Rheinzink America**]

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners[**solder**], protective coatings, sealants, and other miscellaneous items as required for complete roofing system and as recommended by primary sheet metal manufacturer unless otherwise indicated.

B. Wood Battens: Lumber in accordance with requirements for nailers for roofing in Section 061000 "Rough Carpentry."

C. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. General:

a. Exposed Fasteners: Heads matching color of sheet metal roofing, using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of roofing.
b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed; with hex-washer head.
c. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
5. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
6. Fasteners for Zinc Sheet: Series 300 stainless steel[**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**].
7. Fasteners for Titanium Sheet: Titanium or Series 300 stainless steel.

D. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead**][**with maximum lead content of 0.2 percent**].
2. For Copper or Copper-Clad Stainless Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead**][**with maximum lead content of 0.2 percent**].
3. For Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**], with acid flux of type recommended by stainless steel sheet manufacturer.
4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
5. For Zinc: ASTM B32, [**40 percent tin and 60 percent lead with low antimony,**][**with maximum lead content of 0.2 percent,**] as recommended by zinc manufacturer.

E. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.

F. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**polysulfide**][**silicone**] polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.

G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187.

I. Underlayment Adhesive:

1. Cold-Applied Asphalt Adhesive: ASTM D3019, Type III, asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
2. Cold-Applied Polymer-Modified Asphalt Adhesive: Underlayment manufacturer's standard solvent-and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.5 ACCESSORIES

A. Sheet Metal Accessories: Provide components required for complete sheet metal roofing assembly, including trim, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.

1. Cleats: Intermittent and continuous attachment devices for mechanically seaming into joints and formed from the following materials and thicknesses unless otherwise indicated:

   a. Metallic-Coated Steel or Aluminum Roofing: [**0.0250-inch- (0.635-mm-)**] thick stainless steel.
   b. Copper or Zinc-Tin Alloy-Coated Copper Roofing: [**16-inch- (0.55-mm-)**][**20-inch- (0.70-mm-)**] thick copper sheet.
   c. Stainless Steel or Titanium Roofing: [**0.0250-inch- (0.635-mm-)**] thick stainless steel.
   d. Copper-Clad Stainless Steel Roofing: [**0.024-inch- (0.61-mm-)**] thick, copper-clad stainless steel.
   e. Zinc Roofing: Manufacturer's preformed stainless steel cleats.

2. Expansion-Type Cleats: Cleats of a design that allows longitudinal movement of roof panels without stressing panel seams; of same material as other cleats.
3. Backing Plates: Plates at roofing splices, fabricated from material recommended by SMACNA's "Architectural Sheet Metal Manual."
4. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where necessary to ensure weathertight construction.
5. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum [**0.018 inch (0.46 mm)**] thick.

B. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

C. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness [**matching the sheet metal roofing**] with bottom of skirt profiled to match roof panel and seam profiles; with weatherproof top box and integral full-length cricket.

1. Fabricate curb subframing of nominal [**0.062-inch- (1.59-mm-)**] thick, angle-, C- or Z-shaped, galvanized-steel or stainless steel sheet.
2. Fabricate curb and subframing to withstand indicated loads of size and height indicated.
3. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
4. Insulate curbs with [**1-inch- (25-mm-)**] thick, rigid insulation.
5. Provide treated wood nailers at tops of curbs.

2.6 FABRICATION

A. Custom-Fabricated Sheet Metal Roofing: Comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation. Fabricate sheet metal roofing and accessories in shop to greatest extent possible.

B. Flat-Seam Sheet Metal Roofing: Form flat-seam panels from metal sheets [**20 by 28 inches (508 by 710 mm)**] with **1/2-inch (13-mm)** notched and folded edges.

C. Standing-Seam Sheet Metal Roofing: Form standing-seam panels with finished seam height [**of 1 inch (25 mm)**][**of 1-1/2 inches (38 mm)**][**as indicated**].

D. Batten-Seam Sheet Metal Roofing: Form batten-seam panels with edges turned up [**2-1/8 inches (54 mm)**][**as indicated**] and with **1/2-inch (13-mm)** flange turned toward center of pan.

E. Horizontal-Seam (Bermuda-Type) Sheet Metal Roofing: Form horizontal-seam (Bermuda-type) panels with upper edges of lower panels turned up and extending **1/2 inch (13 mm)** above continuous horizontal steps in substrate.

F. Fabrication Tolerances: [**Fabricate sheet metal roofing that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.**][**Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Metal Roof Installation Manual."**]

G. Form exposed sheet metal work to fit substrates with little oil canning; free of buckling and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

1. Lay out sheet metal roofing, so transverse seams, if required, are made in direction of flow, with higher panels overlapping lower panels.
2. Fold and cleat eaves and transverse seams in shop.
3. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements indicated on Drawings and as required for leakproof construction.

H. Built-in Gutters (Integral Gutters): Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

1. Fabricate in minimum **96-inch- (2400-mm-)** long sections.

2. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Fabricate gutters with built-in expansion joints.

I. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work.

1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

J. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant in accordance with SMACNA's "Architectural Sheet Metal Manual."

K. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item required. Obtain field measurements for accurate fit before shop fabrication.

1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
2. Seams: Fabricate nonmoving seams with flat-lock seams. [**Tin edges to be seamed, form seams, and solder.**][**Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.**][**Rivet joints where necessary for strength.**]
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices of sizes recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

L. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances required for finished roofing installation.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for drainage, flashings, and penetrations through sheet metal roofing.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Lay out panel arrangement, and [**nail battens to wood sheathing**][**screw battens to wood sheathing**][**screw battens to metal deck**] before installation of sheet metal roofing.

1. Space fasteners not more than [**18 inches (460 mm)**] o.c.

3.3 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Apply from eave to ridge.
2. Apply on roof not covered by self-adhering sheet underlayment.
3. Lap horizontal joints not less than **4 inches (100 mm)**.
4. Lap end joints not less than **12 inches (300 mm)**.

B. Self-Adhering High-Temperature Sheet Underlayment:

1. Install self-adhering high-temperature sheet underlayment, wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days of installation.
8. Install self-adhering high-temperature underlayment at the following locations:

a. Over entire roof.
b. Roof perimeter for a distance up from eaves of [**24 inches (600 mm)**][**36 inches (910 mm)**] beyond interior wall line.
c. Valleys, from lowest to highest point, for a distance on each side of [**18 inches (460 mm)**].
d. Rake edges for a distance of [**18 inches (460 mm)**].
e. Hips and ridges for a distance on each side of [**12 inches (300 mm)**].
f. Roof-to-wall intersections for a distance from wall of [**18 inches (460 mm)**].
g. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of [**18 inches (460 mm)**].
h. Below entire area of integral gutters, up from eaves a minimum of [**36 inches (910 mm)**] beyond interior wall line, but not less than [**12 inches (300 mm)**] up from ridge side of gutter.
i. Directional transitions for a distance of [**12 inches (300 mm)**] in each direction.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal roofing.

1. Install in shingle fashion to shed water, with lapped joints of not less than **4 inches (100 mm)**.
2. Apply from eave to ridge.
3. Apply on roof not covered by self-adhering sheet underlayment.

D. Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal roofing and related flashing.

1. Install in shingle fashion to shed water, with lapped joints of not less than **4 inches (100 mm)**.

E. Install ventilation mat over underlayment before installing sheet metal roofing and related flashing.

F. Install flashings to cover [**underlayment**][**slip sheet**][**ventilation mat**] in accordance with requirements in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION, GENERAL

A. Install sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners[**solder**], protective coatings, separators, sealants, and other miscellaneous items as required for complete roofing system.
2. Install sheet metal roofing true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**][**welds**][**sealant**].
3. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Do not field cut sheet metal roofing by torch.
5. Provide metal closures at [**peaks**][**rake edges**][**rake walls**][**eaves**] each side of ridge[**and hip**] caps.
6. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
7. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
8. Install ridge[**and hip**] caps as sheet metal roofing work proceeds.
9. Lap metal flashing over sheet metal roofing to direct moisture to run over and off roofing.
10. Do not use graphite pencils to mark metal surfaces.

B. Thermal Movement: Rigidly fasten metal roof panels to structure at only one location for each panel.

1. Allow remainder of panel to move freely for thermal expansion and contraction.
2. Point of Fixity: Fasten each panel along a single common line of fixing located at [**eave**][**ridge**][**center of panel length**][**locations indicated on Drawings**].
3. Avoid attaching accessories through roof panels in manner that inhibits thermal movement.

C. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**].

D. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended in SMACNA's "Architectural Sheet Metal Manual."

1. Coat concealed side of [**uncoated-aluminum**][**stainless steel**] sheet metal roofing with bituminous coating where roofing contacts wood, ferrous metal, or cementitious construction.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Fasciae:

1. Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws.
2. Flash and seal sheet metal roofing with closure strips where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.5 INSTALLATION OF SHEET METAL ROOFING

A. Install sheet metal roofing system with lines and corners of exposed units true and accurate.

1. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering metal temper and reflectivity.
2. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
3. Fold back sheet metal to form hem on concealed side of exposed edges unless otherwise indicated.

B. Install cleats to hold sheet metal roofing panels in position.

1. Attach each cleat with at least two fasteners to prevent rotation.
2. Space cleats not more than [**12 inches (300 mm)**] o.c.
3. Bend tabs over fastener head.
4. Provide expansion-type cleats for roof panels that exceed **30 feet (9.1 m)** in length.

C. Seal joints as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.
e. Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pre-tin edges of sheets with solder to a width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
2. Do not solder [**metallic-coated steel**][**aluminum**][**titanium**] sheet.
3. Do not pre-tin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

6. Stainless Steel Soldering:

a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.

b. Promptly remove acid flux residue from metal after tinning and soldering.
c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

E. Rivets: Rivet joints in [**uncoated aluminum**][**zinc**] where necessary for strength.

F. Flat-Seam Roofing:

1. Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. After panels are in place, mallet seams tight and solder.
3. Attach roofing panels with cleats spaced not more than [**24 inches (600 mm)**] o.c. Lock and solder panels to base flashing.
4. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [**12-inch (300-mm)**] o.c. spacing. Lock panels to edge flashing and [**solder**][**apply sealant**].

G. Standing-Seam Roofing:

1. Attach standing-seam metal panels to substrate with double-fastened cleats spaced at [**12 inches (300 mm)**] o.c.
2. Install panels reaching from eave to ridge before moving to adjacent panels.

   a. Where transverse joints are required, stagger joints in adjacent panels not less than **48 inches (1200 mm)**.

3. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel.
4. Lock standing seams by folding over twice, so cleat and panel edges are completely engaged.
5. Lock each panel to panel below with [**soldered**][**sealed**] transverse seam.
6. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
7. Loose-lock panels at eave edges to continuous edge flashing exposed **24 inches (600 mm)** from roof edge.

   a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [**12-inch (305-mm)**] o.c. spacing.
   b. Lock panels to edge flashing.

8. [**Leave seams upright**][**Fold over seams**] after locking at ridges and hips.

H. Batten-Seam Roofing:

1. Attach batten-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. Hold cleats in place with battens, and fold edges of cleats over to hold panels.
3. After panels are in place and before batten cap is installed, apply continuous bead of sealant to top of upturned flanges of each panel.
4. Install batten cap covering batten and panel edges, and fold batten cap and panel together, so batten cap and panel edges are completely engaged in seams.
5. Hook each panel to panel below with [**soldered**][**sealed**] transverse seam.
6. Splay upturned edges of panels at a slightly obtuse angle, so pan-bottom width is slightly narrower than space between battens, to provide expansion capability.
7. Close batten ends with metal closures. Fold together with panel edges and end of batten cap.
8. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
9. Loose-lock panels at eave edges to continuous-edge flashing exposed **24 inches (600 mm)** from

roof edge.

a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at [**12-inch (305-mm)**] o.c. spacing.
b. Lock panels to edge flashing.

I. Horizontal-Seam (Bermuda-Type) Roofing:

1. Attach horizontal-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
2. Attach cleats along continuous horizontal steps in substrate, with cleats at [**8-inch (203-mm)**] o.c. spacing.
3. Lock lower edge of each panel to turned-up upper edge of panel below, folding seam over to engage cleat and panel edges.
4. After first fold, mallet seams against substrate, leaving joint slightly angled over lower panel to form drip.
5. Hook end of each panel to adjacent panel with [**soldered**][**sealed**] cross seam.
6. Hook panel at eave edge to continuous cleat.
7. Join ridges and hips with a standing seam, and [**leave seams upright**][**fold over seams**] after locking.

J. Built-in Gutters:

1. Anchor back edge of gutter with continuous cleat.
2. Provide expansion joints at locations indicated on Drawings, but not less than **50 feet (14 m)** on center.
3. Join gutter sections with soldered joints.

   a. Join sections with lapped joints sealed with sealant where required for expansion.

4. Provide for thermal expansion.
5. Slope gutters to drainage points.
6. Provide end closures and seal watertight with sealant.
7. Install self-adhering, high-temperature sheet underlayment inside built-in gutter as indicated on Drawings.

   a. Extend self-adhering, high-temperature sheet underlayment to eave drip edges and beneath roof underlayment.
   b. Lap edges **2 inches (50 mm)**.
   c. Lap ends **4 inches (100 mm)**.

3.6 INSTALLATION OF ACCESSORIES

A. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion.

1. Coordinate installation with flashings and other components.
2. Install components required for complete sheet metal roofing assembly, including trim, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
3. Install accessories integral to sheet metal roofing that are specified in Section 076200 "Sheet Metal Flashing and Trim" to comply with that Section's requirements.

B. Flashing and Trim: Comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual."

1. Provide concealed fasteners where possible, and install units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
3. Install flashing and trim as required to seal against weather and to provide finished appearance, including, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
4. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual" and on Drawings.
5. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
6. Install sheet metal flashing and trim to fit substrates, and to result in waterproof and weather-resistant performance.
7. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

    a. Space expansion joints at maximum of **10 feet (3 m)** with no joints within **24 inches (600 mm)** of corner or intersection.
    b. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, and filled with butyl sealant concealed within joints.
    c. Use lapped expansion joints only where indicated on Drawings.

C. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended in SMACNA's "Architectural Sheet Metal Manual."

D. Roof Curbs: Install flashing around bases where curbs meet sheet metal roofing.

3.7 INSTALLATION TOLERANCES

A. Installation Tolerances: [**Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.**][**Shim and align sheet metal roofing within installed tolerances specified in MCA's "Metal Roof Installation Manual."**]

3.8 CLEANING

A. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions.

B. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

C. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer.

D. Clean and neutralize flux materials. Clean off excess solder.

E. Clean off excess sealants.

3.9 PROTECTION

A. Prohibit traffic of any kind on installed sheet metal roofing.

B. Maintain sheet metal roofing in clean condition during construction.

C. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as directed by the Owner.

3.10 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
8. Date of Substantial Completion:

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

   a. lightning;
   b. peak gust wind speed;
   c. fire;
   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. vapor condensation on bottom of roofing; and
   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have

notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 61 00 00

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Task	Specification	Specification Description
07 61 13 00	07 61 00 00	Sheet Metal Roofing
07 61 16 00	07 61 00 00	Sheet Metal Roofing
07 61 19 00	07 61 00 00	Sheet Metal Roofing

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SECTION 07 62 00 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.
4. Roof-drainage sheet metal fabrications.
5. Sloped roof sheet metal fabrications.
6. Wall sheet metal fabrications.
7. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
3. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
4. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
5. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
6. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies subject to vehicular traffic.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.

3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples: For each exposed product and for each color and texture specified, **12 inches (300 mm)** long by actual width.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

E. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.

1. Sheet Metal Flashing and Trim: [**Manufacturers' standard size**] . Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is [**ANSI/SPRI/FM 4435/ES-1 tested**][**FM Approvals approved**] .

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For copings and roof edge flashing, from [**an agency acceptable to authority having jurisdiction**][**ICC-ES**] showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For fabricator.

E. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**] .

C. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested [**and FM Approvals approved**] , shop is to be listed as able to fabricate required details as tested and approved.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof [**edge**][**eave**] , including [**built-in gutter**][**fascia**][**fascia trim**][**apron flashing**], approximately [**10 ft. (3.0 m)**] long, including supporting construction cleats, seams, attachments, [**underlayment,**] and accessories.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with [**NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"**][**SMACNA's "Architectural Sheet Metal Manual"**] requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Design Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

   1. Design Pressure: [**As indicated on Drawings**] .

E. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**]. Identify materials with name of fabricator and design approved by FM Approvals.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 SHEET METAL MATERIALS

A. Sheet Metal Materials, General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.

   1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch**

(0.86 mm)][0.040 inch (1.02 mm)][0.052 inch (1.32 mm)] .

2. Surface: [**Smooth, flat**][**Embossed**][**and mill phosphatized for field painting**][**and with manufacturer's standard clear acrylic coating on both sides**] .
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    d. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    e. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Sheet: ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin

manufacturers' written instructions [**for seacoast and severe environments**] .

d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.
6. Clear Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
7. Color Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

   a. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

   b. Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

8. As-Milled Finish: [**Mill**][**One-side bright mill**][**Standard one-side bright**][**Standard two-side bright**] .
9. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
10. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of **0.2 mil (0.005 mm)**.

D. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**] ; dead soft, fully annealed.

1. Nominal Thickness: [**0.0156 inch (0.396 mm)**][**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exterior Finish: [**ASTM A480/A480M, No. 2B (bright, cold rolled)**][**ASTM A480/A480M, No. 2D (dull, cold rolled)**][**ASTM A480/A480M, No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4**].

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

   b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hussey Copper Ltd.**]
   b. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**].
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

   a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
   b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

5. Prepatinated Copper-Sheet Finish: [**Dark brown**][**Verdigris**], prepatinated in accordance with ASTM B882.

F. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper; coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.68 mm thick)**][**24 oz./sq. ft. (0.82 mm thick)**][**25 oz./sq. ft. (0.87 mm thick)**] .

G. Zinc Sheet: With manufacturer's standard factory-applied, flexible, protective back coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Artazn LLC**]
   b. [**Rheinzink America**]

2. Grade: [**99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)**][**Zinc, 99**

percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum] .

3. Thickness: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] .
4. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

H. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed Temper O61.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Heyco Metals**]
   b. [**SEMCO Southeastern Metals, A Gibraltar Industries Company**]

2. Thickness: [**0.016 inch (0.40 mm)**][**0.018 inch (0.46 mm)**][**0.027 inch (0.69 mm)**] .
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

   a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
   b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

I. Lead Sheet: ASTM B749 lead sheet.

1. Thickness: **4 lb (1.8 kg)**.

2.3 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
   b. [**Intertape Polymer Group**]
   c. [**Kirsch Building Products**]
   d. [**SDP Advanced Polymer Products Inc.**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet

underlayment, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ATAS International, Inc.**]
    b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    c. [**GCP Applied Technologies Inc.**]
    d. [**Henry; a Carlisle Company**]
    e. [**Owens Corning**]
    f. [**Polyglass U.S.A., Inc.**]
    g. [**Protecto Wrap Company**]
    h. [**SDP Advanced Polymer Products Inc.**]

2. Thickness: **30 mils (0.76 mm)** minimum.
3. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
4. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners [**solder**] , protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal [**manufactured item**] unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal [**manufactured item**] .

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
5. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet:

Copper, hardware bronze or passivated Series 300 stainless steel.

6. Fasteners for Zinc Sheet: Series 300 stainless steel [**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**] .

C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead**][**with maximum lead content of 0.2 percent**] .
2. For Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
3. For Copper or Copper-Clad Stainless Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead**][**with maximum lead content of 0.2 percent**] .
4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
5. For Zinc: ASTM B32, [**40 percent tin and 60 percent lead with low antimony,**][**with maximum lead content of 0.2 percent,**] as recommended by zinc manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.

E. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

1. Material: [**Polyurethane**][**Polysulfide**][**Silicone**] .

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

J. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated [**with factory-mitered and - welded corners and junctions**][**with interlocking counterflashing on exterior face, of same metal as reglet**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cheney Flashing Company**]
b. [**Fry Reglet Corporation**]
c. [**Heckmann Building Products, Inc.**]
d. [**Hohmann & Barnard, Inc**]
e. [**Keystone Flashing Company, Inc**]
f. [**Metal-Era, Inc.; a Carlisle Company**]
g. [**OMG Roofing Products; a Division of OMG, Inc.**]

2. Material: [**Galvanized steel, 0.022 inch (0.56 mm) thick**][**Aluminum, 0.024 inch (0.61 mm) thick**][**Stainless steel, 0.0188 inch (0.477 mm) thick**][**Copper, 16 oz./sq. ft. (0.55 mm thick)**] .
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:

    a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

8. Finish: [**Mill**][**With manufacturer's standard color coating**].

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard [**and by FM Global Property Loss Prevention Data Sheet 1-49**] for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. [**Rivet joints where necessary for strength.**]
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. [**Rivet joints where necessary for strength.**]

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Brackets, Spacers, and Straps: Furnish flat-stock gutter brackets and [**flat-stock**][**twisted**] gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than [**twice the gutter thickness**][**dimension indicated on Drawings**].
3. Gutter Components: Fabricate expansion joints, expansion-joint covers, [**gutter bead reinforcing bars,**] and gutter accessories from same metal as gutters. [**Shop fabricate interior and exterior corners.**]
4. Gutter Profile: [**Style A**][**Style B**][**Style C**][**Style D**][**Style E**][**Style F**][**Style G**][**Style H**][**Style I**][**Style J**][**Style K**][**Style L**] in accordance with cited sheet metal standard.
5. Expansion Joints: [**Lap type**][**Butt type**][**Butt type with cover plate**][**Built in**] .
6. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Wire-ball downspout strainer**][**Valley baffles**] .
7. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:

   a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
   b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
   c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
   d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
   e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
   f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
   g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
   h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

8. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:

   a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
   b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
   c. Aluminum: [**0.040 inch (1.02 mm)**] thick.
   d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
   e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
   f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
   g. Zinc: [**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**] thick.

h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

9. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
c. Aluminum: [**0.050 inch (1.27 mm)**] thick.
d. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
e. Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
g. Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

10. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
c. Aluminum: [**0.063 inch (1.60 mm)**] thick.
d. Stainless Steel: [**0.0313 inch (0.795 mm)**] thick.
e. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].

11. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.052 inch (1.32 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.052 inch (1.32 mm)**] thick.
c. Stainless Steel: [**0.0375 inch (0.952 mm)**] thick.
d. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**25 oz./sq. ft. (0.87 mm thick)**].

B. Built-In Gutters: Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Components: Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Expansion Joints: Fabricate gutters with built-in expansion joints [**and gutter-end expansion joints at walls**] .
4. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Bronze wire-ball downspout strainer**][**Wire-ball downspout strainer**] .
5. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Downspouts: Fabricate downspouts to dimensions indicated on Drawings.

1. Type: [**Round**][**Rectangular**][**Open face**] .
2. Downspout Elbows: Mitered [**and shop fabricated**] .
3. Metal Hangers: Provide [**same material as downspouts and anchors**].
4. Fabricated Hanger Style: [**Fig. 1-35A**][**Fig. 1-35B**][**Fig. 1-35C**][**Fig. 1-35D**][**Fig. 1-35E**][**Fig. 1-35F**][**Fig. 1-35G**][**Fig. 1-35H**][**Fig. 1-35I**][**Fig. 1-35J**] in accordance with SMACNA's "Architectural Sheet Metal Manual."

5. Manufactured Hanger Style: [**Fig. 1-34A**][**Fig. 1-34B**][**Fig. 1-34C**][**Fig. 1-34D**][**Fig. 1-34E**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
6. Fabricate from the following materials:

    a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
    c. Aluminum: [**0.024 inch (0.61 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

D. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. [**Fasten gravel guard angles to base of scupper.**]

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes [**exterior flange trim,**][**built-in overflows**] .

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

F. Splash Pans: Fabricate to dimensions and shape required.

1. Fabricate from the following materials:

    a. Aluminum: [**0.040 inch (1.02 mm)**] thick.
    b. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    c. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    d. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    e. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    f. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.7 SLOPED ROOF SHEET METAL FABRICATIONS

A. Low-Sloped Roof Sheet Metal Fabrications:

1. Roof Edge Flashing (Gravel Stop) and Fascia Cap:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long sections. Furnish with **6-inch- (150-mm-)** wide, joint cover plates. [**Shop fabricate interior and exterior corners.**]
b. Joint Style: [**Overlapped, 4 inches (100 mm) wide**][**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**].
c. Scuppers: Fabricate with scuppers spaced [**10 ft. (3 m)**] apart, to dimensions required with **4-inch- (100-mm-)** wide flanges and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**] .
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2. Copings:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and [**drill elongated holes for fasteners on**] interior leg. Miter corners, [**fasten and seal**][**solder or weld**] watertight. [**Shop fabricate interior and exterior corners.**]
b. Coping Profile: [**Fig. 3-4A**][**Fig. 3-4B**][**Fig. 3-4C**][**Fig. 3-4D**][**Fig. 3-4E**][**Fig. 3-4F**][**Fig. 3-4G**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
c. Joint Style: [**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**] .
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
6) Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

3. Expansion-Joint Covers:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate [**roof**][**roof-to-wall transition**][**roof-to-roof edge-flashing (gravel-stop) transition**][**roof-to-roof edge-flashing (gravel-stop) and fascia-cap transition**] expansion-joint cover from the following materials:

1) Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

4. Base Flashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.040 inch (1.02 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].

f. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
g. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.
h. Lead: [**4 lb (1.8 kg)**].

8. Roof-Drain Flashing: Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**12 oz./sq. ft. (0.41 mm thick)**].
c. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

B. Steep-Slope Roof Sheet Metal Fabrications:

1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

2. Valley Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
g. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

3. Drip Edges: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
g. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.
h. Lead: [**4 lb (1.8 kg)**].

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing:

1. General: Fabricate continuous flashings in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend **6 inches (150 mm)** beyond each side of wall openings; and form with **2-inch- (50-mm-)** high, end dams. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

B. Opening Flashings in Frame Construction:

1. General: Fabricate head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings. Form head and sill flashing with **2-inch- (50-mm-)** high, end dams.

Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Aluminum: [**0.040 inch (1.02 mm)**] thick.
4. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
4. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
5. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
6. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
4. Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
5. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
6. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.
2. Lap end joints not less than **12 inches (300 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners [**solder**] , protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**][**welds**][**sealant**] .
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than **12 inches (300 mm)** o.c.
6. Space individual cleats not more than **12 inches (300 mm)** apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.

8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of [**uncoated-aluminum**][**stainless steel**] sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of [**10 ft. (3 m)**] with no joints within **24 inches (600 mm)** of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**].

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of **1-1/2 inches (38 mm)**; however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder [**metallic-coated steel**][**aluminum**] sheet.
3. Do not pretin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

6. Stainless Steel Soldering:

   a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
   b. Promptly remove acid-flux residue from metal after tinning and soldering.
   c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

H. Rivets: Rivet joints in [**uncoated aluminum**][**zinc**] where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**] .
8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**24 inches (600 mm)**] apart.
9. Anchor gutter with [**gutter brackets**][**straps**][**twisted straps**] spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**][**36 inches (910 mm)**] apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
10. Anchor gutter with spikes and ferrules spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**] apart.
11. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.
12. Install continuous gutter screens on gutters with noncorrosive fasteners, [**removable**][**hinged to swing open**] for cleaning gutters.

C. Built-In Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Slope to downspouts.
4. Provide end closures and seal watertight with sealant.
5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.

   a. Lap sides minimum of **2 inches (50 mm)** over underlying course.
   b. Lap ends minimum of **4 inches (100 mm)**.
   c. Stagger end laps between succeeding courses at least **72 inches (1830 mm)**.
   d. Fasten with roofing nails.
   e. Install slip sheet over underlayment.

6. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**].
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**18 inches (460 mm)**] apart.
8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.

D. Downspouts:

1. Join sections with **1-1/2-inch (38-mm)** telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately **60 inches (1500 mm)** o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

E. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and [**solder**][**seal with elastomeric sealant**] to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. [**Solder**][**seal with elastomeric sealant**] exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of **1 inch (25 mm)** below [**scupper**][**gutter**] discharge.

G. Splash Pans:

1. Install where downspouts discharge on [**low-slope roofs**].
2. Set in [**asphalt roofing cement**][**elastomeric sealant**] compatible with the substrate.

H. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of **4 inches (100 mm)** in direction of water flow.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements [**sheet metal manufacturer's written installation instructions,**] and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at [**staggered 3-inch (75-mm)**] centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

    a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at [**24-inch (600-mm)**][**16-inch (400-mm)**] centers.
    b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at [**24-inch (600-mm)**] centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches (100 mm)** over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing **4 inches (100 mm)** over base flashing.
3. Lap counterflashing joints minimum of **4 inches (100 mm)**.
4. Secure in waterproof manner by means of [**snap-in installation and sealant or lead wedges and sealant**][**interlocking folded seam or blind rivets and sealant**][**anchor and washer spaced at 12 inches (300 mm) o.c. along perimeter and 6 inches (150 mm) o.c. at corners areas**] unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with [**elastomeric**][**butyl**] sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings.

C. Reglets: Installation of reglets is specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 042000 "Unit Masonry."**]

3.7 INSTALLATION OF MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as directed by the Owner.

END OF SECTION 07 62 00 00

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Task	Specification	Specification Description
07 62 13 00	07 62 00 00	Sheet Metal Flashing And Trim
07 62 19 00	07 62 00 00	Sheet Metal Flashing And Trim
07 63 00 00	07 62 00 00	Sheet Metal Flashing And Trim
07 63 00 00	21 05 00 00	Common Work Results for Fire Suppression
07 63 00 00	22 05 00 00	Common Work Results for Plumbing
07 63 00 00	23 05 00 00	Common Work Results for HVAC
07 65 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 65 16 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 65 16 00	07 57 00 00	Coated Foamed Roofing

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SECTION 07 71 00 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.
4. Reglets and counterflashings.
5. Underlayment.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing embedded reglets.
2. Section 042000 "Unit Masonry" for installing embedded reglets and for masonry through-wall flashing with receiver for counterflashing.
3. Section 055000 "Metal Fabrications" for downspout guards and downspout boots.
4. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
5. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim.
6. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
9. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
10. Section 099113 "Exterior Painting" for field painting of roof specialties.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect, the Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of roof specialty.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Plans, expansion-joint locations, keyed details, and attachments to other work. Distinguish between factory pre manufactured- and field-assembled installation.
2. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Details of termination points and assemblies, including fixed points.
5. Details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

E. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include [**copings**][**roof-edge specialties**][**roof-edge drainage systems**][**reglets and counterflashings**] made from **12-inch** **(300-mm)** lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of roof specialty [**copings**][**roof-edge flashings**] that is [**ANSI/SPRI/FM 4435/ES-1 tested**][**FM Approvals approved**].

B. Product Test Reports: For [**copings**][**roof-edge flashings**], for tests performed by a qualified testing agency.

C. Research Reports: For [**copings**][**roof-edge flashings**], from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For manufacturer.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roof specialties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products that are [**FM Approvals listed for specified class**][**ANSI/SPRI/FM 4435/ES-1 tested to specified design pressure**].

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof edge as indicated on Drawings.
2. Build mockup of typical roof edge as part of "Integrated Exterior Mockup" specified in [**Section 014000 "Quality Requirements."**]
3. Build mockup of typical roof edge, including [**fascia**][**gutter**][**downspout**], approximately [**10 ft. (3.0 m)**] long, including supporting construction, seams, attachments,[**underlayment,**] and accessories.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 COORDINATION

A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.

1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.

B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.

C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.11 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finishes or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. FM Approvals' Listing: Manufacture and install [**copings**][**roof-edge specialties**] that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, [**Class 1-60**][**Class 1-75**][**Class 1-90**][**Class 1-105**][**Class 1-120**]. Identify materials with FM Approvals' markings.

D. SPRI Wind Design Standard: Manufacture and install [**copings**][**roof-edge specialties**] tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressures:

1. Design Pressure: [**As indicated on Drawings**].

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 COPINGS

A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding [**12 ft. (3.6 m)**], concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Architectural Products Company**]
b. [**ATAS International, Inc.**]
c. [**Berridge Manufacturing Company**]
d. [**Castle Metal Products**]
e. [**Cheney Flashing Company**]
f. [**Drexel Metals Corp.**]
g. [**Englert, Inc.**]
h. [**EXCEPTIONAL Metals**]
i. [**FlashCo Manufacturing Inc.**]
j. [**Hickman; an MTL Company**]
k. [**Merchant & Evans Inc.**]
l. [**Metal-Era, Inc.**]
m. [**OMG Roofing Products; a Division of OMG, Inc.**]
n. [**PAC-CLAD; Petersen; a Carlisle company**]
o. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
p. [**Sentrigard; NB Handy Company**]

2. Metallic-Coated Steel Coping Caps: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Coping Caps: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Coping Caps: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

   a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Formed Stainless Steel Coping Caps: Stainless steel sheet, nominal [**0.0313-inch (0.795-mm) thickness**][**thickness as required to meet performance requirements**].

   a. Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].

6. Formed Copper Coping Caps: Copper sheet, [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].

    a. Copper Finish: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose-face leg**][**Two-way sloped coping cap**].
9. Coping-Cap Attachment Method: [**Snap-on**][**face leg hooked to continuous cleat with back leg fastener exposed**], fabricated from coping-cap material.

    a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, **12 inches (300 mm)** wide, with integral cleats.
    b. Face-Leg Cleats: Concealed, continuous [**galvanized-steel sheet**][**stainless steel**].

2.3 ROOF-EDGE SPECIALTIES

A. Canted Roof-Edge Fascia and Gravel Stop : Manufactured, two-piece, roof-edge fascia consisting of [**snap-on**][**compression-clamped**] metal fascia cover in section lengths not exceeding [**12 ft. (3.6 m)**] and a continuous formed galvanized-steel sheet cant, **0.028 inch (0.71 mm)** thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Products Company**]
    b. [**ATAS International, Inc.**]
    c. [**Berridge Manufacturing Company**]
    d. [**Castle Metal Products**]
    e. [**Cheney Flashing Company**]
    f. [**Drexel Metals Corp.**]
    g. [**Englert, Inc.**]
    h. [**FlashCo Manufacturing Inc.**]
    i. [**Merchant & Evans Inc.**]
    j. [**Metal-Era, Inc.**]
    k. [**OMG Roofing Products; a Division of OMG, Inc.**]
    l. [**PAC-CLAD; Petersen; a Carlisle company**]
    m. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

2. Metallic-Coated Steel Fascia Covers: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

    a. Surface: [**Smooth, flat**][**Embossed**] finish.
    b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
    c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Fascia Covers: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Fascia Covers: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

   a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
6. Splice Plates: [**Concealed**][**Exposed**], of same material, finish, and shape as fascia cover.
7. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose fascia cover**][**Cornice fascia cover**][**Cove fascia cover**].
8. Fascia Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**][**Overflow scuppers**][**Overflow scuppers with perforated screens**][**Spillout scuppers**][**Downspout scuppers with integral conductor head and downspout adapters**][**Downspout scuppers with integral conductor head and downspout adapters and perforated screens**].

B. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding [**12 ft. (3.6 m)**] and a continuous metal receiver with integral drip-edge cleat to engage fascia cover[**and secure single-ply roof membrane**]. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATAS International, Inc.**]
   b. [**Berridge Manufacturing Company**]
   c. [**Drexel Metals Corp.**]
   d. [**Englert, Inc.**]
   e. [**EXCEPTIONAL Metals**]
   f. [**Fabral; a brand of Flack Global Metals**]
   g. [**FlashCo Manufacturing Inc.**]
   h. [**Hickman; an MTL Company**]
   i. [**Metal-Era, Inc.**]
   j. [**OMG Roofing Products; a Division of OMG, Inc.**]

2. Metallic-Coated Steel Fascia Covers: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Fascia Covers: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

   a. Surface: [**Smooth, flat**][**Embossed**] finish.
   b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
   c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
5. Splice Plates: [**Concealed**][**Exposed**], of same material, finish, and shape as fascia cover.
6. Receiver: [**Galvanized-steel sheet, nominal 0.040-inch (1.02-mm) thickness**][**Aluminum sheet, 0.050 inch (1.27 mm) thick**][**Extruded aluminum, 0.080 inch (2.03 mm) thick**][**Manufacturer's standard material and thickness**].
7. Special Fabrications: [**Radiused sections**][**Arched sections**][**Bullnose fascia cover**][**Cornice fascia cover**][**Cove fascia cover**].
8. Fascia Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**][**Overflow scuppers**][**Overflow scuppers with perforated screens**][**Spillout scuppers**][**Downspout scuppers with integral conductor head and downspout adapters**][**Downspout scuppers with integral conductor head and downspout adapters and perforated screens**].

C. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding [**12 ft. (3.6 m)**], with a horizontal flange and vertical leg[**drain-through**] fascia[**terminating in a drip edge**], and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Products Company**]
   b. [**Berridge Manufacturing Company**]
   c. [**Castle Metal Products**]
   d. [**Cheney Flashing Company**]
   e. [**Drexel Metals Corp.**]
   f. [**OMG Roofing Products; a Division of OMG, Inc.**]
   g. [**PAC-CLAD; Petersen; a Carlisle company**]
   h. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

2. Metallic-Coated Steel Gravel Stops: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal [**0.028-inch (0.71-mm) thickness**][**0.034-inch (0.86-mm) thickness**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].
c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Formed Aluminum Gravel Stops: Aluminum sheet, [**0.040 inch (1.02 mm) thick**][**0.050 inch (1.27 mm) thick**][**0.063 inch (1.60 mm) thick**][**thickness as required to meet performance requirements**].

a. Surface: [**Smooth, flat**][**Embossed**] finish.
b. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded-Aluminum Gravel Stops: Extruded aluminum, [**0.080 inch (2.03 mm) thick**][**0.125 inch (3.18 mm) thick**][**thickness as required to meet performance requirements**].

a. Finish: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].
b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Formed Stainless Steel Gravel Stops: Stainless steel sheet, nominal [**0.0313-inch (0.795-mm) thickness**][**thickness as required to meet performance requirements**].

a. Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].

6. Formed Copper Gravel Stops: Copper sheet, [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].

a. Copper Finish: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Accessories: [**Fascia extenders with continuous hold-down cleats**][**Wall cap**][**Soffit trim**].

2.4 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Architectural Products Company**]
2. [**ATAS International, Inc.**]
3. [**Berger; division of OmniMax International, Inc.**]
4. [**Castle Metal Products**]
5. [**Cheney Flashing Company**]

6. [**CopperCraft by Fabral**]
7. [**Drexel Metals Corp.**]
8. [**EXCEPTIONAL Metals**]
9. [**Hickman; an MTL Company**]
10. [**Merchant & Evans Inc.**]
11. [**Metal-Era, Inc.**]
12. [**OMG Roofing Products; a Division of OMG, Inc.**]
13. [**RDCA; Roof Drainage Components & Accessories**]
14. [**SAF (Southern Aluminum Finishing Company, Inc.)**]

B. Gutters: Manufactured in uniform section lengths not exceeding [**12 ft. (3.6 m)**], with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least **1 inch (25 mm)** above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**][**0.034-inch (0.86-mm)**].
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.
3. Formed Copper Sheet: [**16-oz./sq. ft. (0.55-mm)**][**20-oz./sq. ft. (0.68-mm)**][**24-oz./sq. ft. (0.82-mm)**] thickness.
4. Gutter Profile: [**Style A**][**Style B**][**Style F**][**Style G**][**Style H**][**Style I**][**Style K**][**Style K highback**][**Half-round single bead**][**Half-round highback**][**Quarter round**][**Ogee**][**As indicated**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
5. Embossed Surface: Embossed with design [**as indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**].
6. Applied Fascia Cover (Concealed Gutter): Exposed, formed [**copper, 16 oz./sq. ft. (0.55 mm thick)**][**aluminum, 0.040 inch (1.02 mm) thick**], with factory-mitered corners, ends, and concealed splice joints.
7. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
8. Gutter Supports: [**Gutter brackets**][**Straps**][**Spikes and ferrules**][**Manufacturer's standard supports as selected by Architect**] with finish matching the gutters.
9. Special Fabrications: [**Radiused sections**].
10. Gutter Accessories: [**Continuous screened leaf guard with sheet metal frame**][**Continuous hinged leaf guard of solid metal designed to shed leaves**][**Continuous snap-in plastic leaf guard**][**Bronze wire ball downspout strainer**][**Wire ball downspout strainer**][**Flat ends**][**Bullnose ends for half-round gutter**].

C. Downspouts: [**Plain round**][**Corrugated round**][**Plain rectangular**][**Corrugated rectangular**][**Open-face rectangular**] complete with [**machine-crimped**][**mitered**][**smooth-curve**] elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**][**0.034-inch (0.86-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.
3. Extruded Aluminum: [**0.125 inch (3.18 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

D. Parapet Scuppers: Manufactured with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof.[**Fasten gravel guard angles to base of scuppers.**]

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout[**exterior flange trim,**][**built-in overflow**].

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0156 inch (0.396 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

F. Splash Pans: Fabricate from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.040 inch (1.02 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Size: [**As indicated on Drawings**].

G. Finishes:

1. Metallic-Coated Steel: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Aluminum: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].

   a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel: [**ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].
4. Copper: [**Non-patinated, mill**][**Pre-patinated dark brown**][**Pre-patinated verdigris**].

2.5 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ATAS International, Inc.**]
2. [**Berridge Manufacturing Company**]

3. [**Castle Metal Products**]
4. [**Cheney Flashing Company**]
5. [**Drexel Metals Corp.**]
6. [**EXCEPTIONAL Metals**]
7. [**Fry Reglet Corporation**]
8. [**Heckmann Building Products, Inc.**]
9. [**Hickman; an MTL Company**]
10. [**Keystone Flashing Company, Inc**]
11. [**Metal-Era, Inc.**]
12. [**OMG Roofing Products; a Division of OMG, Inc.**]

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.022-inch (0.56-mm)**][**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.024 inch (0.61 mm)**][**0.050 inch (1.27 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].
5. Corners: Factory mitered and [**soldered**][**continuously welded**][**mechanically clinched and sealed watertight**].
6. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
7. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
8. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
9. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
10. Multiuse Type, Embedded: For multiuse embedment in [**cast-in-place concrete**][**masonry mortar joints**].

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by **4 inches (100 mm)** and in lengths not exceeding [**12 ft. (3.6 m)**] designed to snap into [**reglets**][**through-wall-flashing receiver**] and compress against base flashings with joints lapped, from the following exposed metal:

1. Metallic-Coated Steel Sheet: Nominal [**0.022-inch (0.56-mm)**][**0.028-inch (0.71-mm)**] thickness.
2. Formed Aluminum Sheet: [**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] thick.
3. Formed Stainless Steel Sheet: [**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**] thick.
4. Formed Copper Sheet: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**][**Thickness as required to meet performance requirements**].

D. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Finishes:

1. Metallic-Coated Steel: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**].

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Aluminum: [**Two-coat fluoropolymer**][**Three-coat fluoropolymer**][**Two-coat mica fluoropolymer**][**Three-coat metallic fluoropolymer**][**Clear anodic**][**Color anodic**].

    a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel: [**ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)**][**ASTM A480/A480M No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4 (bright, polished directional satin)**].
4. Copper: [**Non-patinated, mill**][**Pre-patinated verdigris**].

2.6 SHEET METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.[**Mill phosphatized for field painting where indicated**].

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

B. Aluminum Sheet: ASTM B209/B209M, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
3. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
4. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.
5. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.

6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Extrusions and Tubes: **ASTM B221 (ASTM B221M)**, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise, mill finished.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.7 UNDERLAYMENT

A. Synthetic Underlayment: Provide laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures greater than **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**GCP Applied Technologies Inc.**]
d. [**Kirsch Building Products**]
e. [**Owens Corning**]
f. [**Palisade; Brand of Intertape Polymer Group (IPG)**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)**]
e. [**Palisade; Brand of Intertape Polymer Group (IPG)**]

f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]

C. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3-lb/100 sq. ft. (0.16-kg/sq. m)** minimum.

2.8 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Roof specialty manufacturer's recommended fasteners, designed to meet performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
4. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
5. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

D. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**silicone**] polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

H. Solder for Copper: ASTM B32, [**lead-free solder**][**Grade Sn50, 50 percent tin and 50 percent lead**].

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION, GENERAL

A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete

roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer's written installation instructions.

1. Coat concealed side of [**uncoated aluminum**][**stainless steel**] roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of [**12 ft. (3.6 m)**] with no joints within [**18 inches (450 mm)**] of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended in writing by fastener manufacturer to achieve maximum pull-out resistance**].

E. Seal concealed joints with butyl sealant as required by roof specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below **40 deg F (4 deg C)**.

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 INSTALLATION OF COPINGS

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at [**30-inch (762-mm) centers**][**40-inch (1016-mm) centers**][**manufacturer's required spacing that meets performance requirements**].
2. Interlock face-leg drip edge into continuous cleat anchored to substrate at [**24-inch (610-mm)**

centers][**16-inch (406-mm) centers**][**manufacturer's required spacing that meets performance requirements**]. Anchor back leg of coping with screw fasteners and elastomeric washers at [**24-inch (610-mm) centers**][**16-inch (406-mm) centers**][**manufacturer's required spacing that meets performance requirements**].

3.5 INSTALLATION OF ROOF-EDGE SPECIALTIES

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

A. Install components to produce a complete roof-edge drainage system in accordance with manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**] apart. Attach ends with rivets and [**seal with sealant**][**solder**] to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.
2. Install continuous leaf guards on gutters with noncorrosive fasteners, [**removable**][**hinged to swing open**] for cleaning gutters.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and **1 inch (25 mm)** away from walls; locate fasteners at top and bottom and at approximately [**60 inches (1500 mm)**] o.c.

1. Provide elbows at base of downspouts at grade to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

D. Splash Pans: Install where downspouts discharge on [**low-slope roofs**]. Set in [**asphalt roofing cement**][**elastomeric sealant**].

E. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall with elevation of conductor top edge **1 inch (25 mm)** below [**scupper**][**gutter**] discharge.

3.7 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

A. Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See [**Section 033000 "Cast-in-Place Concrete"**][**Section 042000 "Unit Masonry"**] for installation of reglets.

C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap **4 inches (100 mm)** over top edge of base flashings.

D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap **4 inches (100 mm)** over top edge of base flashings. Lap counterflashing joints a minimum of **4 inches (100 mm)** and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.8 CLEANING AND PROTECTION

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Section 099113 "Exterior Painting."

C. Clean and neutralize flux materials. Clean off excess solder and sealants.

D. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

E. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as directed by the Owner.

END OF SECTION 07 71 00 00

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Task	Specification	Specification Description
07 71 13 00	07 71 00 00	Roof Specialties
07 71 19 00	07 71 00 00	Roof Specialties
07 71 23 00	01 22 00 00	No Specification Required
07 71 23 00	07 62 00 00	Sheet Metal Flashing And Trim
07 71 23 00	07 71 00 00	Roof Specialties
07 71 26 00	07 62 00 00	Sheet Metal Flashing And Trim
07 71 26 00	07 71 00 00	Roof Specialties

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SECTION 07 72 00 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Heat and smoke vents.
5. Gravity ventilators.
6. Pipe and duct supports.
7. Pipe portals.
8. Preformed flashing sleeves.
9. Roof walkways.
10. Underlayment.
11. Miscellaneous materials.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 061000 "Rough Carpentry" for roof cants, nailers, blocking, and other pressure-preservative-treated wood.
3. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashing.
4. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof accessories and adjacent materials.
6. Section 099113 "Exterior Painting" for field painting of roof accessories.
7. Section 099114 "Exterior Painting (MPI Standards)" for field painting of roof accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples for Initial Selection: For each type of roof accessory indicated with factory-applied color finishes.

D. Samples for Verification: Include Samples of each type of roof accessory to verify finish and color

selection, in manufacturer's standard sizes.

E. Delegated Design Submittals: For roof curbs [**roof walkways,**][**and equipment supports**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items, including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Qualification Statements: For [**manufacturer**][**fabricator**][**Installer**][**specialist**][**testing agency**][**manufacturer's technical representative**][**factory-authorized service representative**].

C. Delegated Design Engineer Qualifications: For roof curbs [**roof walkways**][**and**][**equipment supports**] .

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**roof hatches**][**heat and smoke vents**][**and gravity ventilators**] .

1.5 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof accessories in contact with other materials that might cause staining, denting, or other surface damage. Store roof accessories in accordance with manufacturer's instructions.

B. Store materials off ground in dry location and in accordance with manufacturer's instructions in well-ventilated area.

C. Store and protect roof accessories from nicks, scratches, and blemishes.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-accessory substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate layout and installation of roof accessories with [**roofing membrane and base flashing and**] interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs [**roof walkways,**][**and equipment supports**] to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: [**As indicated on Drawings**].

2.2 ROOF CURBS

A. Roof Curb : Internally reinforced roof-curb unit capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AES Industries, Inc**]
b. [**AES Sunoptics; Acuity Brands International, Inc.**]
c. [**Air Balance; MESTEK, Inc.**]
d. [**ATAS International, Inc.**]
e. [**Conn-Fab Sales, Inc**]
f. [**Curbs Plus, Inc**]
g. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
h. [**Greenheck Fan Corporation**]
i. [**KCC Manufacturing**]
j. [**Lloyd Industries, Inc.**]
k. [**LMCurbs**]

l. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
m. [**Metallic Products Corporation**]
n. [**Pate Company (The)**]
o. [**Plenums of Florida Incorporated**]
p. [**RCS Fabrications Inc.**]
q. [**Roof Products and Systems (RPS); Duravent Group**]
r. [**Roof Products, Inc.**]
s. [**Thybar Corporation**]
t. [**Vent Products Co., Inc**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed deck-mounting flange at perimeter bottom.
4. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

5. Supported Load Capacity: [**Coordinate load capacity with information on Shop Drawings of equipment to be supported**].

6. Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet, [**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**][**0.079 inch (2.01 mm)**] thick.

   a. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

7. Aluminum: [**0.090 inch (2.28 mm)**][**0.125 inch (3.17 mm)**] thick sheet.

   a. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

8. Stainless Steel: [**0.0781 inch (1.983 mm)**] thick sheet.

   a. Finish: [**Manufacturer's standard**].

9. Fabrication:

   a. Curb Profile: [**Manufacturer's standard**][**Profile as indicated on Drawings**] compatible with roofing system.
   b. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

   c. Minimum Height: Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
   d. Top Surface: Level top of curb, with roof slope accommodated [**by sloping deck-mounting flange**][**by use of leveler frame**] .
   e. Sloping Roofs: Where roof slope exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

f. Insulation: Factory insulated with [**1-1/2-inch- (38-mm-)**] thick glass-fiber board insulation.

g. Liner: Same material as curb, of manufacturer's standard thickness and finish.

h. Nailer: Factory-installed wood nailer [**along top flange of curb**][**under top flange on side of curb**] , continuous around curb perimeter.

i. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to comply with wind-uplift requirements.

j. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from **3/4-inch- (19-mm-)** thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.

k. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

l. Security Grille: [**Provide for all units**][**Provide where indicated**] .

m. Damper Tray: Provide damper tray or shelf with opening [**3 inches (76 mm)**][**less than interior curb dimensions indicated**][**of size indicated**] .

2.3 EQUIPMENT SUPPORTS

A. Equipment Support : Metal equipment support capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AES Industries, Inc**]
b. [**Air Balance; MESTEK, Inc.**]
c. [**Conn-Fab Sales, Inc**]
d. [**Curbs Plus, Inc**]
e. [**Greenheck Fan Corporation**]
f. [**JL Industries; Activar Construction Products Group, Inc.**]
g. [**KCC Manufacturing**]
h. [**Lloyd Industries, Inc.**]
i. [**LMCurbs**]
j. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
k. [**Pate Company (The)**]
l. [**Plenums of Florida Incorporated**]
m. [**Portals Plus; Duravent Group**]
n. [**RCS Fabrications Inc.**]
o. [**Roof Products and Systems (RPS); Duravent Group**]
p. [**Roof Products, Inc.**]
q. [**Thybar Corporation**]
r. [**Vent Products Co., Inc**]

2. Type: [**Internally reinforced perimeter**][**Rail type**] .

3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Curb Sides: [**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.
5. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

6. Supported Load Capacity: [**Coordinate load capacity with information on Shop Drawings of equipment to be supported**].

7. Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet, [**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**][**0.079 inch (2.01 mm)**] thick.

    a. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

    b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

8. Aluminum: [**0.090 inch (2.28 mm)**][**0.125 inch (3.17 mm)**] thick sheet.

    a. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

    b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

9. Stainless Steel: [**0.0781 inch (1.983 mm)**] thick sheet.

    a. Finish: [**Manufacturer's standard**].

10. Construction:

    a. Curb Profile: [**Manufacturer's standard**][**Profile as indicated on Drawings**] compatible with roofing system.

    b. Insulation: Factory insulated with [**1-1/2-inch- (38-mm-)**] thick glass-fiber board insulation.

    c. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.

    d. Nailer: Factory-installed continuous wood nailers [**3-1/2 inches (90 mm)**][**5-1/2 inches (140 mm)**] wide [**on top flange of equipment supports**][**under top flange on side of curb**], continuous around support perimeter.

    e. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to comply with wind-uplift requirements.

    f. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from **3/4-inch- (19-mm-)** thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
    g. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
    h. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

i. Fabricate equipment supports to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
j. Sloping Roofs: Where roof slope exceeds **1/4 inch per 12 inches (1:48)**, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

k. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

2.4 ROOF HATCHES

A. Roof Hatch : Metal roof-hatch unit with lid and insulated curbs, continuous lid-to-curb counterflashing, and weathertight perimeter gasketing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACUDOR Products, Inc**]
b. [**AES Industries, Inc**]
c. [**Architectural Specialties, Inc.**]
d. [**Babcock-Davis**]
e. [**Best Access Doors**]
f. [**BILCO Company (The)**]
g. [**Dur-Red Products**]
h. [**JL Industries; Activar Construction Products Group, Inc.**]
i. [**Karp Associates, Inc**]
j. [**KCC Manufacturing**]
k. [**Kingspan Light + Air LLC**]
l. [**Lexcor; a division of Luxsuco corp.**]
m. [**Metallic Products Corporation**]
n. [**Milcor by Duravent; Duravent Group.**]
o. [**Nystrom, Inc.**]
p. [**O'Keeffe's Inc.**]
q. [**Pate Company (The)**]
r. [**Precision Ladders, LLC**]
s. [**Williams Brothers Corporation of America**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.
5. Type and Size:

a. Single-Leaf Lid: [**Size as indicated on Drawings**][**30 by 36 inches (750 by 900 mm)**][**36 by 36 inches (900 by 900 mm)**][**30 by 54 inches (750 by 1370 mm)**][**30 by 96 inches (750 by 2438 mm)**].
b. Double-Leaf Lid: [**Size as indicated on Drawings**][**72 by 96 inches (1830 by 2438 mm)**].

6. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

a. Dome Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft.**

(0.95 kPa)] internal uplift load.

7. Hatch Material, Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-coated**] steel sheet.

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].

   b. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

8. Hatch Material, Aluminum:

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].
   b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

9. Hatch Material, Stainless Steel:

   a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.0781 inch (1.983 mm)**].
   b. Finish: [**Manufacturer's standard**].

10. Construction:

   a. Insulation: [**1-inch- (25-mm-) thick, cellulosic-fiber board**][**1-inch- (25-mm-) thick, glass-fiber board**][**2-inch- (50-mm-) thick, polyisocyanurate board**] .

      1) R-Value: [**2.78**][**4.3**][**12.0**] in accordance with ASTM C1363.

   b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

   c. Hatch Lid: [**Opaque**][**Glazed**] , insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.

   d. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   e. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.

   f. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
   g. Sloping Roofs: Where slope or roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip hatch with water diverter or cricket on side that obstructs water flow.

11. Hatch-Lid Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads.

   a. Single-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted,**

transparent][**Bronze tinted, transparent**].

b. Outer Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].
c. Inner Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

12. Hardware: Spring operators, hold-open arm, [**galvanized**][**stainless**] steel spring latch with turn handles, [**galvanized**][**stainless**] steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

a. Provide two-point latch on lids larger than **84 inches (2130 mm)**.
b. Provide remote-control operation.

13. Safety Railing System: Roof-hatch manufacturer's standard system, including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

a. Height: [**42 inches (1060 mm)**] above finished roof deck.

b. Posts and Rails: Galvanized-steel pipe, **1-1/4 inches (31 mm)** in diameter or galvanized-steel tube, **1-5/8 inches (41 mm)** in diameter.
c. Flat Bar: Galvanized steel, **2 inches (50 mm)** high by **3/8 inch (9 mm)** thick.

d. Maximum Opening Size: System constructed to prevent passage of a sphere **21 inches (533 mm)** in diameter.

e. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
f. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
g. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
h. Provide weep holes or another means to drain-entrapped water in hollow sections of handrail and railing members.
i. Fabricate joints exposed to weather to be watertight.
j. Fasteners: Manufacturer's standard, finished to match railing system.
k. Finish: [**Manufacturer's standard**].

1) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

14. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

a. Operation: Post locks in place on full extension; release mechanism returns post to closed position.

b. Height: [**42 inches (1060 mm)**] above finished roof deck.
c. Material: [**Steel tube**][**Stainless steel**][**Aluminum**] .

d. Post: [**1-5/8-inch- (41-mm-)**] diameter pipe.
e. Finish: [**Manufacturer's standard**].

1) Color: [**As indicated by manufacturer's designations**][**Match Architect's**

sample][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.5 HEAT AND SMOKE VENTS

A. Hatch-Type Heat and Smoke Vent : Manufacturer's standard, with insulated curbs, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**AES Sunoptics; Acuity Brands International, Inc.**]
   c. [**Babcock-Davis**]
   d. [**BILCO Company (The)**]
   e. [**Dur-Red Products**]
   f. [**JL Industries; Activar Construction Products Group, Inc.**]
   g. [**KCC Manufacturing**]
   h. [**Kingspan Light + Air LLC**]
   i. [**Lexcor; a division of Luxsuco corp.**]
   j. [**Milcor by Duravent; Duravent Group.**]
   k. [**Nystrom, Inc.**]
   l. [**O'Keeffe's Inc.**]
   m. [**Pate Company (The)**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Operation: Automatic self-lifting mechanisms activated by [**UL-listed fusible link rated at 165 deg F (74 deg C)**][**fire-suppression system**][**smoke-detection system**] locking the fully opened position.
5. Type and Size:

   a. Single-Leaf Lid: [**Size as indicated on Drawings**][**30 by 36 inches (750 by 900 mm)**][**30 by 54 inches (750 by 1370 mm)**][**30 by 96 inches (750 by 2438 mm)**].
   b. Double-Leaf Lid: [**Size as indicated on Drawings**][**72 by 96 inches (1830 by 2438 mm)**].

6. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**30 lbf/sq. ft. (1.4 kPa)**] internal uplift load.

   a. When release is actuated, lid to open against [**10 lbf/sq. ft. (0.5 kPa)**] snow or wind load and lock in position.

   b. Hatch-Lid Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

7. Heat and Smoke Vent Standard: Provide units that have been tested and [**listed to comply with ANSI/CAN/UL 793**][**and**][**are FM Approved**] .

8. Curb, Framing, and Lid Material, Steel: [**Zinc-coated (galvanized)**][**Aluminum-zinc alloy-**

coated] steel sheet.

a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**] .

b. Finish: [**Mill phosphatized**][**Factory prime coating**][**Powder coat**].

c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

9. Curb, Framing, and Lid Material, Aluminum:

a. Thickness: [**Manufacturer's standard thickness for hatch size indicated**][**0.079 inch (2.01 mm)**].

b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

10. Construction:

a. Insulation: [**1-inch- (25-mm-) thick, cellulosic-fiber board**][**1-inch- (25-mm-) thick, glass-fiber board**][**2-inch- (50-mm-) thick, polyisocyanurate board**] .

1) R-Value: [**2.78**][**4.3**][**12.0**] in accordance with ASTM C1363.

b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

c. Hatch Lid: [**Opaque**][**Glazed**] , insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.

d. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

e. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.

f. Sloping Roofs: Where slope or roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip hatch with water diverter or cricket on side that obstructs water flow.

g. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

11. Hatch-Lid Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads; [**colorless, transparent**][**white, translucent**].

12. Hardware: Manufacturer's standard [**corrosion resistant**][**stainless steel**] ; with hinges, hold-open devices, and independent manual-release devices for [**inside**][**and**][**outside**] operation of lids.

B. Dropout-Type Heat and Smoke Vent: Manufacturer's standard, gravity operated and automatic; with insulated curbs and frame, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening in accordance with heat and smoke vent standard indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Construction Specialties, Inc.**]
b. [**Kingspan Light + Air LLC**]
c. [**Pate Company (The)**]
d. [**Plasteco, Inc**]

2. Insulated Curb Type: [**Single**][**Double**] walled.
3. Corner Joints: Welded [**or mechanically fastened and sealed**] .
4. Size: [**As indicated on Drawings**][**48 by 48 inches (1219 by 1219 mm)**][**48 by 60 inches (1219 by 1524 mm)**][**48 by 72 inches (1219 by 1829 mm)**][**48 by 90 inches (1219 by 2286 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

5. Loads: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**30 lbf/sq. ft. (1.4 kPa)**] internal uplift load.

   a. Dome Glazing: Minimum [**40 lbf/sq. ft. (1.9 kPa)**] external live load and [**20 lbf/sq. ft. (0.95 kPa)**] internal uplift load.

6. Heat and Smoke Vent Standard: Provide units that have been tested and [**listed to comply with ANSI/CAN/UL 793**][**and**][**are FM Approved**] .
7. Curb and Framing Material: Aluminum sheet.

   a. Thickness: [**Manufacturer's standard thickness for vent size indicated**][**0.079 inch (2.01 mm)**].
   b. Finish: [**Mill**][**Factory prime coating**][**Clear anodic**][**Color anodic**][**Powder coat**].

   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Light bronze**][**Medium bronze**][**Dark bronze**] as directed by the Owner.

8. Construction:

   a. Insulation: Manufacturer's standard.

   b. Nailer: Factory-installed wood nailer continuous around hatch perimeter.

   c. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

   d. Fabricate curbs to minimum height of [**12 inches (305 mm)**] above roofing surface unless otherwise indicated.
   e. Sloping Roofs: Where slope of roof deck exceeds **1/4 inch per 12 inches (1:48)**, fabricate curb with perimeter curb height that is [**constant**][**tapered to accommodate roof slope so that top surfaces of perimeter curb are level**] . Equip unit with water diverter or cricket on side that obstructs water flow.

9. Dome Glazing: [**Single**][**Double**][**acrylic**][**polycarbonate**] glazing of thickness capable of resisting indicated loads.

   a. Single-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

b. Outer Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].
c. Inner Double-Dome Color: [**Colorless, transparent**][**White, translucent**][**Gray tinted, transparent**][**Bronze tinted, transparent**].

10. Fall Protection Safety Structure: Manufacturer's standard meeting impact load requirements of 29 CFR 1910.23 and authorities having jurisdiction, [**equipped with hail protection galvanized steel wire mesh screen,**] and manually openable from exterior without special tools.
11. Hardware: Manufacturer's standard, corrosion resistant; with hinges, hold-open devices, and independent manual-release devices for [**inside**][**and**][**outside**] operation of lids.

2.6 GRAVITY VENTILATORS

A. Low-Profile, Cylindrical-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Active Ventilation Products, Inc.**]
b. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
c. [**Dur-Red Products**]
d. [**Greenheck Fan Corporation**]
e. [**Loren Cook Company**]
f. [**Metallic Products Corporation**]
g. [**Moffitt Corporation**]
h. [**PennBarry; division of Air System Components**]
i. [**Romlair Ventilator Co.**]
j. [**Thaler Metal Industries Ltd.**]
k. [**Vent Products Co., Inc**]

2. Construction: Integral base flange, vent cylinder, cylinder bird screen, and [**rain cap**][**hood**] .
3. Dimensions: [**As indicated on Drawings**] .

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .
8. Vent Cylinder, Base Flange, Rain-Cap, and Hood Material: [**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**][**Stainless steel**] sheet, of manufacturer's standard thickness.
9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Louvered Penthouse-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Dur-Red Products**]
b. [**FlashCo Manufacturing Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Loren Cook Company**]
e. [**PennBarry; division of Air System Components**]
f. [**Romlair Ventilator Co.**]
g. [**Vent Products Co., Inc**]

2. Construction: Integral frame with base flange, weathertight cap [**with clear acrylic dome**][**with white translucent acrylic dome**] , and weatherproof sidewall louvers.
3. Dimensions: [**As indicated on Drawings**].

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .
8. Frame, Base Flange, Cap, and Louver Material: [**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**][**Stainless steel**] sheet, of manufacturer's standard thickness.
9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

C. Turbine-Style Gravity Ventilator : Manufacturer's standard, fabricated as indicated, with manufacturer's standard welded or sealed mechanical joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Air Vent, Inc.; Gibraltar Industries, Inc.**]
b. [**Metallic Products Corporation**]
c. [**Moffitt Corporation**]
d. [**PennBarry; division of Air System Components**]
e. [**Romlair Ventilator Co.**]

2. Provide integral weathertight base cap, outlet duct, and rotating louvered turbine.
3. Throat Size and Height: [**As indicated on Drawings**].

4. Configuration: [**As indicated on Drawings**].

5. Bird Screens: Manufacturer's standard mesh with rewireable frame.
6. Insect Screens: Manufacturer's standard mesh with rewireable frame.

7. Security Grille: [**Provide for all units**][**Provide where indicated on Drawings**] .

8. Weathertight Base Cap, Outlet Duct, and Turbine Material: [**Manufacturer's standard**][**Zinc-coated (galvanized) steel**][**Aluminum-zinc alloy-coated**][**Aluminum**] sheet, of manufacturer's standard thickness.

9. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.7 PIPE AND DUCT SUPPORTS

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Maximum Diameter Pipe or Conduit: [**1-1/2 inches (38 mm)**].

B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with roller carrying assembly accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Roller Carrying Assembly Material: [**Polycarbonate**][**Stainless steel**] .
2. Maximum Diameter Pipe or Conduit: [**7 inches (178 mm)**].

C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

1. Maximum Diameter Pipe or Conduit: [**18 inches (457 mm)**].

D. Adjustable-Height Structure-Mounted Pipe Supports: Extruded-aluminum tube, filled with urethane insulation; accommodating pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded-aluminum carrier assemblies; as required for quantity of pipe runs and sizes.

1. Aluminum Tube Diameter: [**2 inches (50 mm)**].
2. Maximum Diameter Pipe or Conduit: [**7 inches (178 mm)**].

E. Curb-Mounted Pipe Supports: Galvanized-steel support with adjustable-height roller-bearing pipe support accommodating pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**Pate Company (The)**]
   c. [**PHP Systems/Design**]
   d. [**Portals Plus; Duravent Group**]
   e. [**Roof Products and Systems (RPS); Duravent Group**]
   f. [**Thaler Metal Industries Ltd.**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness**

of roof insulation] and integrally formed structure-mounting flange at bottom.
4. Maximum Diameter Pipe or Conduit: [**20 inches (508 mm)**].

F. Duct Supports: Extruded-aluminum, urethane-insulated supports, with manufacturer's recommended hardware for mounting to structure or structural roof deck.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Roof Products and Systems (RPS); Duravent Group**]
b. [**Thaler Metal Industries Ltd.**]

2. Aluminum Tube Diameter: [**2 inches (50 mm)**].
3. Finish: [**Manufacturer's standard**].

2.8 PIPE PORTALS

A. Curb-Mounted Pipe Portal: Insulated roof-curb units with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Portals Plus; Duravent Group**]
b. [**Roof Products and Systems (RPS); Duravent Group**]

2. Corner Joints: Welded [**or mechanically fastened and sealed**] .
3. Curb Sides: [**Straight**][**Integral metal cant**][**Stepped integral metal cant to raise the thickness of roof insulation**] and integrally formed structure-mounting flange at bottom.

B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Portals Plus; Duravent Group**]

2.9 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, with removable metal hood and metal collar.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
    b. [**Menzies Metal Products**]
    c. [**Thaler Metal Industries Ltd.**]

2. Height: [**12 inches (300 mm)**].
3. Metal Collar: [**Slotted**][**Perforated**] .

4. Metal: Aluminum sheet, [**0.063 inch (1.60 mm)**] thick.
5. Diameter: [**As indicated on Drawings**][**3 inches (76 mm)**][**4 inches (100 mm)**][**5 inches (125 mm)**][**6 inches (150 mm)**][**7 inches (178 mm)**][**8 inches (200 mm)**][**9 inches (225 mm)**][**10 inches (250 mm)**].
6. Finish: [**Manufacturer's standard**] .

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Custom Solution Roof and Metal Products, a division of Colony Heating**]
    b. [**Menzies Metal Products**]
    c. [**Milcor by Duravent; Duravent Group.**]
    d. [**Thaler Metal Industries Ltd.**]

2. Metal: [**Aluminum sheet, 0.063 inch (1.60 mm) thick**].
3. Height: [**7 inches (178 mm)**][**13 inches (330 mm)**][**19 inches (480 mm)**].
4. Diameter: [**As indicated on Drawings**][**2 inches (50 mm)**][**3 inches (76 mm)**][**4 inches (100 mm)**][**5 inches (125 mm)**][**6 inches (150 mm)**].
5. Finish: [**Manufacturer's standard**].

2.10 ROOF WALKWAYS

A. Roof Walkway: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atkore Unistrut**]
    b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    c. [**Kee Safety, Inc.**]
    d. [**MIRO Industries Inc.**]
    e. [**PHP Systems/Design**]

2. Compliance Requirements:

   a. Include step units or stairs of similar construction for changes in elevation. Comply with ASCE/SEI 7, 29 CFR 1910.23, and requirements of authorities having jurisdiction.
   b. Equip walkways with safety railings where required to comply with local building codes and requirements of authorities having jurisdiction.

3. Plank Width: [**4-3/4 inches (121 mm)**][**7 inches (178 mm)**][**9-1/2 inches (241 mm)**][**11-3/4 inches (298 mm)**][**18-3/4 inches (476 mm)**][**24 inches (610 mm)**][**As indicated**] .
4. Walkway Width: [**As indicated**].
5. Channel Depth: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**As indicated**] .
6. Metal Material: [**0.079-inch- (2.01-mm-) thick zinc-coated (galvanized) steel sheet**][**0.108-inch- (2.74-mm-) thick zinc-coated (galvanized) steel sheet**][**0.0625-inch- (1.587-mm-) thick stainless steel sheet**][**0.0781-inch- (1.983-mm-) thick stainless steel sheet**][**0.080-inch- (2.03-mm-) thick aluminum sheet**][**0.100-inch- (2.54-mm-) thick aluminum sheet**], perforated, with serrated slip-resistant walking surface.

7. Support Stands: Manufacturer's standard, with protective pads compatible with roofing material.

8. Support Pads: Continuous wood isolation pads, pressure-preservative treated as specified in Section 061000 "Rough Carpentry"; attach roof-walkway supports to pads so that supports are separated from roof membrane surface and walkway support loads are distributed evenly.

9. Wind Restraint: Provide wind-restraint attachment to roof structure of size and spacing required to comply with wind-uplift requirements.
10. Finish: [**Manufacturer's standard**].

2.11 METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheer complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.

   1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.
   3. Powder Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

B. Aluminum Sheet: ASTM B209/B209M, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

   1. Mill Finish: As manufactured.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil (0.005 mm)**.

3. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
4. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

5. Powder Coat Finish: AAMA 2603. After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Extrusions and Tubes: **ASTM B221 (ASTM B221M)**, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M unless otherwise indicated.

F. Steel Tube: ASTM A500/A500M, round tube.

G. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized in accordance with ASTM A123/A123M.

H. Steel Pipe: ASTM A53/A53M, galvanized.

2.12 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ATAS International, Inc.**]
b. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
c. [**GCP Applied Technologies Inc.**]
d. [**Kirsch Building Products**]
e. [**Owens Corning**]
f. [**Palisade; Brand of Intertape Polymer Group (IPG)**]
g. [**PrimeSource Building Products, Inc.**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ATAS International, Inc.**]
b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
c. [**GCP Applied Technologies Inc.**]
d. [**Henry; a Carlisle Company**]
e. [**Palisade; Brand of Intertape Polymer Group (IPG)**]
f. [**Polyglass U.S.A., Inc.**]
g. [**Protecto Wrap Company**]

2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum.

2.13 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

C. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated in accordance with UL 972 with an average impact strength of [**12 to 16 ft. lbf/in. (640 to 854 J/m)**] of width when tested in accordance with ASTM D256, Method A (Izod).

D. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

E. Glass-Fiber Board Insulation: ASTM C726, nominal density of **3 lb/cu. ft. (48 kg/cu. m)**, thermal resistivity of **4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C)**, thickness as indicated.

F. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

G. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, [**containing no arsenic or chromium,**] and complying with AWPA C2; not less than **1-1/2 inches (38 mm)** thick.

H. Security Grilles: [**3/4-inch (19-mm)**] diameter, ASTM A1011/A1011M steel bars spaced [**6 inches (150 mm)**] o.c. in one direction and [**12 inches (300 mm)**] o.c. in the other; factory finished as follows:

1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free,

universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.

I. Fasteners: Roof accessory manufacturer's recommended fasteners, designed to comply with performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

J. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

K. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**][**silicone**] polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

L. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

M. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

N. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.14 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION, GENERAL

A. Install roof accessories in accordance with manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended in writing by manufacturer's written installation instructions.

1. Coat concealed side of [**uncoated aluminum**][**and**][**stainless steel**] roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Seal joints with [**elastomeric**][**butyl**] sealant as required by roof accessory manufacturer.

3.4 INSTALLATION OF ROOF ACCESSORIES

A. Roof Curbs: Install each roof curb so top surface is level.

B. Equipment Supports: Install equipment supports so top surfaces are level with each other.

C. Roof Hatches:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post in accordance with manufacturer's written instructions.

D. Heat and Smoke Vents:

1. Install heat and smoke vents so top perimeter surfaces are level.
2. Install and test heat and smoke vents and their components for proper operation in accordance with NFPA 204.

E. Gravity Ventilators: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.

F. Pipe and Duct Supports: Comply with MSS SP-58. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.

1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

G. Flashing Pipe Portal: Secure pipe portal to roof membrane in accordance with pipe portal manufacturer's written instructions; flash pipe portal flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

H. Preformed Flashing Sleeves: Secure flashing sleeve to roof membrane in accordance with flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

I. Security Grilles: Weld bar intersections and [**using tamper-resistant bolts, attach the**] ends of bars to structural frame or primary curb walls.

3.5 INSTALLATION OF ROOF WALKWAYS

A. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.

B. Remove ballast from top surface of low-slope roofing at locations of contact with roof-walkway supports.

C. Install roof-walkway support pads prior to placement of roof-walkway support stands onto low-slope roofing.

D. Redistribute removed ballast after installation of support pads.

3.6 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards."**]

C. On completion of installation, clean exposed surfaces in accordance with manufacturer's written instructions. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as roof accessories are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof accessories in a clean condition during construction.

B. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by the Owner.

END OF SECTION 07 72 00 00

Task	Specification	Specification Description
07 72 13 00	07 72 00 00	Roof Accessories
07 72 13 00	23 37 23 00	HVAC Gravity Ventilators
07 72 23 00	07 72 00 00	Roof Accessories
07 72 26 00	07 31 13 00	Asphalt Shingles
07 72 26 00	07 72 00 00	Roof Accessories
07 72 29 00	07 72 00 00	Roof Accessories
07 72 33 00	07 72 00 00	Roof Accessories
07 72 36 00	07 72 00 00	Roof Accessories
07 72 38 00	07 72 00 00	Roof Accessories
07 72 38 13	07 72 00 00	Roof Accessories
07 72 46 00	07 72 00 00	Roof Accessories

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SECTION 07 72 53 00 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-type, flat-mounted metal snow guards.
2. Pad-type, flat-mounted plastic snow guards.
3. Pad-type, seam-mounted cast-metal snow guards.
4. Pad-type, seam-mounted plastic snow guards.
5. Rail-type, flat-mounted snow guards.
6. Rail-type, seam-mounted snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Pad-type, flat-mounted metal snow guards.
2. Pad-type, flat-mounted plastic snow guards.
3. Pad-type, seam-mounted cast-metal snow guards.
4. Pad-type, seam-mounted plastic snow guards.
5. Rail-type, flat-mounted snow guards.
6. Rail-type, seam-mounted snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Pad-Type Snow Guards: Full-size unit with installation hardware.

a. For units with factory-applied finishes, submit [**manufacturer's standard color selections**][**specified color**].

2. Rail-Type Snow Guards: Bracket, **12-inch- (300-mm-)** long rail, and installation hardware.

a. For units with factory-applied finishes, submit [**manufacturer's standard color selections**][**specified color**].

D. Delegated Design Submittals: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the [**jurisdiction**][**state**] in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: [**2**][**3**].

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

C. Structural Performance: Snow guards to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: [**As indicated on Drawings**].

2.2 PAD-TYPE SNOW GUARDS

A. Pad-Type, Flat-Mounted Metal Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpine SnowGuards**]
   b. [**Berger; division of OmniMax International, Inc.**]
   c. [**IceBlox Inc.**]
   d. [**Rocky Mountain Snow Guards, Inc.**]
   e. [**Sieger Snow Guards Inc.**]
   f. [**TRA Snow and Sun, Inc.**]
   g. [**Zaleski Snow-Guards for Roofs, Inc.**]

2. Material:

   a. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, not less than [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick.

      1) Finish: [**Mill**][**Black epoxy coating**][**Powder coat finish complying with AAMA 2603, with a minimum dry film thickness of 1.5 mils (0.04 mm)**][**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

         a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

   b. Cast Aluminum: ASTM B26/B26M.
   c. Cast Bronze: ASTM B584.
   d. Copper Sheet: ASTM B370, not less than **16 oz./sq. ft. (0.55 mm thick)**.
   e. Metallic-Coated Steel Sheet: ASTM A653/A653M, with **G90 (Z275)** coating, not less than [**0.022 inch (0.56 mm)**] thick.

      1) Finish: [**Powder coat finish complying with AAMA 2603, with a minimum dry film thickness of 1.5 mils (0.04 mm)**][**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

         a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

   f. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, **Class AZ50 (Class AZM150)**, **Grade 40 (Grade 275)**, not less than [**0.022 inch (0.56 mm)**] thick.

      1) Finish: [**High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat**].

         a) Color: [**As selected by Architect from manufacturer's full range**][**Match sheet metal roofing**], as directed by the Owner.

   g. Steel Sheet: ASTM A606/A606M, not less than [**0.022 inch (0.56 mm)**] thick.
   h. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**], not less than [**0.0156 inch (0.396 mm)**] thick.

1) Finish: ASTM A480/A480M, [**No. 2D**][**No. 2B**][**No. 3**][**No. 4**].

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

B. Pad-Type, Flat-Mounted Plastic Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpine SnowGuards**]
b. [**Berger; division of OmniMax International, Inc.**]
c. [**IceBlox Inc.**]
d. [**Levi's Building Components**]
e. [**Polar Blox, Inc.**]
f. [**Zaleski Snow-Guards for Roofs, Inc.**]

2. Polycarbonate: ASTM D6098.

a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

C. Pad-Type, Seam-Mounted Cast-Metal Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpine SnowGuards**]
b. [**Berger; division of OmniMax International, Inc.**]
c. [**Levi's Building Components**]
d. [**Sieger Snow Guards Inc.**]
e. [**TRA Snow and Sun, Inc.**]

2. Material:

a. Cast Aluminum: ASTM B26/B26M; [**mill**][**factory black epoxy**] finish.
b. Cast Bronze: ASTM B584; polished finish.
c. Cast Brass: ASTM B584; polished finish.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

D. Pad-Type, Seam-Mounted Plastic Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Polar Blox, Inc.**]

2. Material: Clear UV-stabilized polycarbonate.
3. Attachment: Manufacturer's tested system, capable of resisting design loads.

2.3 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Flat-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpine SnowGuards**]
   b. [**Berger; division of OmniMax International, Inc.**]
   c. [**IceBlox Inc.**]
   d. [**Rocky Mountain Snow Guards, Inc.**]
   e. [**S-5! Metal Roof Innovations, Ltd.**]
   f. [**Sieger Snow Guards Inc.**]
   g. [**TRA Snow and Sun, Inc.**]

2. Description: Units fabricated from metal baseplate anchored to [**adjustable**][**fixed**] bracket and equipped with [**one**][**two**][**three**][**four**] bar(s), rail(s), or pipe(s).
3. Brackets and Baseplate: [**ASTM B209 (ASTM B209M) aluminum; mill finished**][**ASTM B209 (ASTM B209M) aluminum; clear anodized**][**ASTM B584 bronze or brass**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**][**Galvanized steel, G90 coating**][**Galvanized steel, G60 (Z180) coating**].
4. Bars: [**ASTM B221 (ASTM B221M) aluminum; mill finish**][**ASTM B221 (ASTM B221M) aluminum; clear anodized**][**ASTM B584 bronze or brass**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**].

   a. Profile: [**Round**][**Square**][**with integral track to accept color-matching inserts of material and finish used for metal roof**].

5. Seam Clamps: **ASTM B221 (ASTM B221M)** aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

B. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpine SnowGuards**]
   b. [**Berger; division of OmniMax International, Inc.**]
   c. [**IceBlox Inc.**]
   d. [**LMCurbs**]
   e. [**PMC Industries, Inc**]
   f. [**Rocky Mountain Snow Guards, Inc.**]
   g. [**S-5! Metal Roof Innovations, Ltd.**]

h. [**TRA Snow and Sun, Inc.**]

2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with [**one rail**][**two rails**][**three rails**][**one rail with integral track to accept color-matching inserts of material and finish used for metal roof**][**two rails with integral track to accept color-matching inserts of material and finish used for metal roof**][**three rails with integral track to accept color-matching inserts of material and finish used for metal roof**].
3. Brackets and Baseplate: [**ASTM B209 (ASTM B209M) aluminum; mill finished**][**ASTM B209 (ASTM B209M) aluminum; clear anodized**][**ASTM A240/A240M, Type 304 stainless steel; mill**][**ASTM A240/A240M, Type 304 stainless steel; 180-grit polished finish, uniform, directionally textured finish**][**ASTM A240/A240M, Type 304 stainless steel; 320-grit polished finish, oil-ground, uniform, fine, directionally textured finish**][**ASTM B584 brass; polished**].
4. Bars: [**ASTM B221 (ASTM B221M) aluminum; mill finish**][**ASTM B221 (ASTM B221M) aluminum, clear anodized**][**ASTM A240/A240M, Type 304 stainless steel; mill finish**][**ASTM A240/A240M, Type 304 stainless steel; 180-grit polished finish, uniform, directionally textured finish**][**ASTM A240/A240M, Type 304 stainless steel; 320-grit polished finish, oil-ground, uniform, fine, directionally textured finish**][**ASTM B584 brass; polished**][**Galvanized steel, G90 (Z275) coating**][**Galvanized steel, G60 (Z180) coating**].

   a. Profile: [**Round**][**Square**][**with integral track to accept color-matching inserts of material and finish used for metal roof**].

5. Seam Clamps: **ASTM B221 (ASTM B221M)** aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on [**Drawings**][**Shop Drawings**].
2. Space rows as recommended by manufacturer.

B. Attachment for Asphalt Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit mechanical anchor and counterflashing sleeve system**].
2. Rail-Type, Flat-Mounted, Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

C. Attachment for Wood Shingle and Shake Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit mechanical anchor and counterflashing sleeve system**][**Hook and mechanically anchored through each factory-prepared hole, concealed by shingles and shakes**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

D. Attachment for Slate Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Retrofit strap-and-hook system**][**Retrofit mechanical anchor and counterflashing sleeve system**][**Hook and mechanically anchored through each factory-prepared hole, concealed by shingles**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

E. Attachment for Metal Shingle Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Mechanically anchored through each factory-prepared hole with fasteners concealed by the shingles**][**Mechanical anchor and counterflashing sleeve system**].
2. Rail Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

F. Attachment for Tile Roofing:

1. Pad-Type, Flat-Mounted Snow Guards: [**Hooked to tile and roof batten with head of snow guard positioned over headlap of tile**][**Hook and mechanically anchored through each factory-prepared hole, concealed by roof tiles**].
2. Rail-Type, Flat-Mounted Snow Guards: [**Mounting plates bolted or screwed to the roof framing or roof deck**].

G. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

   a. [**Mechanically attach**][**Adhere**] to metal roofing in accordance with manufacturer's written instructions.
   b. Solder to copper roofing in accordance with manufacturer's written instructions.

3. Pad-Type, Seam-Mounted Snow Guards:

a. Install snow guards in straight rows.
b. Secure in place using stainless steel set screws, incorporating round nonpenetrating point.
c. Torque set screw in accordance with manufacturer's written instructions.

4. Rail-Type, Seam-Mounted Snow Guards:

a. Install brackets to vertical ribs in straight rows.
b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
c. Torque set screw in accordance with manufacturer's written instructions.
d. Install cross members to brackets.

H. Attachment for Exposed Fastened Metal Roofing:

1. Do not use fasteners that will void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

a. Adhere to metal roofing in accordance with manufacturer's written instructions.
b. Mechanically fasten to metal roofing, using fasteners identical to those used to secure metal roofing to substrate.
c. Solder to copper roofing in accordance with manufacturer's written instructions.

3. Rail-Type, Flat-Mounted Snow Guards:

a. Install brackets in straight rows.
b. Mechanically fasten to metal roofing, using sealant and mechanical fasteners identical to those used to secure metal roofing to substrate.
c. Install cross members to brackets.

END OF SECTION 07 72 53 00

Task	Specification	Specification Description
07 72 53 00	07 31 13 00	Asphalt Shingles
07 72 53 00	07 72 00 00	Roof Accessories
07 72 56 00	07 72 00 00	Roof Accessories
07 72 56 00	21 05 33 00	Heat Tracing for Fire-Suppression Piping
07 72 56 00	22 05 33 00	Heat Tracing for Plumbing Piping
07 72 56 00	23 05 33 00	Heat Tracing for HVAC Piping
07 72 56 00	23 83 13 00	Radiant-Heating Electric Cables
07 72 63 00	01 22 00 00	No Specification Required
07 72 63 00	07 72 00 00	Roof Accessories
07 73 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 73 00 00	07 52 13 00	Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing
07 73 00 00	07 52 16 00	Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
07 73 00 00	07 53 16 00	Chlorosulfonate-Polyethylene (CSPE) Roofing
07 73 00 00	07 53 23 00	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 76 16 00	01 22 00 00	No Specification Required

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SECTION 07 81 00 00 - APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Sprayed fire-resistive materials.

B. Related Requirements:

1. Section 078123 "Intumescent Fire Protection" for mastic and intumescent fire-resistive coatings.
2. Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding but not fire resistive.

1.2 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of applied fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum applied fire protection material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of sprayed fire-resistive material after application.

C. Samples: For each exposed product and for each color and texture specified, [**in manufacturer's standard dimensions**][**4 inches (102 mm) square**] in size.

D. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Health Product Declaration (HPD): Provide documentation confirming product compliance with

one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of applied fire protection material for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Research Reports: For each type of applied fire protection material, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**].

C. Preconstruction Test Reports: For each type of applied fire protection material.

D. Field Quality-Control Reports: For each type of applied fire protection material.

E. Qualification Statements: For [**Installer**] [**testing agency**].

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by applied fire protection material manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

1.7 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals and to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**for preconstruction testing**].

1. Build mockup of [**each type of applied fire protection and different substrate**][**each required finish**] as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on[**field mockups of**] applied fire protection.

1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength in accordance with ASTM E736/E736M. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum

specified in Part 2.
2. Density: Test for density in accordance with ASTM E605/E605M. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with applied fire protection material.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain applied fire protection material manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not apply applied fire protection when ambient or substrate temperature is [**44 deg F (7 deg C)**] or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain applied fire protection[**for each fire-resistance design**] from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide applied fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

B. Fire-Resistance Design: Indicated on Drawings, tested in accordance with [**ASTM E119 or UL 263**]; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

C. VOC Content: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

D. Low-Emitting Materials: For field applications, coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoaters: 100 g/L.

F. Asbestos: Provide products containing no detectable asbestos.

2.3 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and [**mixed with water at Project site to form a slurry or mortar before conveyance and application**][**conveyed in a dry state and mixed with atomized water at place of application**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carboline Company; a subsidiary of RPM International**]
    b. [**GCP Applied Technologies Inc.**]
    c. [**Isolatek International**]
    d. [**Southwest Fireproofing Products Co.**]

2. Application: Designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
3. Bond Strength: Minimum [**150-lbf/sq. ft. (7.18-kPa)**][**430-lbf/sq. ft. (20.59-kPa)**][**1000-lbf/sq. ft. (47.88-kPa)**] cohesive and adhesive strength based on field testing in accordance with ASTM E736/E736M.
4. Density: Not less than density specified in the approved fire-resistance design, in accordance with ASTM E605/E605M.
5. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design or ASTM E605/E605M, whichever is thicker, but not less than **0.375 inch (9 mm)**.
6. Combustion Characteristics: ASTM E136.
7. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: [**10**] or less.
    b. Smoke-Developed Index: [**10**] or less.

8. Compressive Strength: Minimum [**10 lbf/sq. in. (68.9 kPa)**][**100 lbf/sq. in. (689 kPa)**][**300 lbf/sq. in. (2068 kPa)**] in accordance with ASTM E761/E761M.
9. Corrosion Resistance: No evidence of corrosion in accordance with ASTM E937/E937M.
10. Deflection: No cracking, spalling, or delamination in accordance with ASTM E759/E759.
11. Effect of Impact on Bonding: No cracking, spalling, or delamination in accordance with ASTM E760/E760M.
12. Air Erosion: Maximum weight loss of [**0.025 g/sq. ft. (0.270 g/sq. m)**] in 24 hours in accordance

with ASTM E859/E859M.

13. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in [**no growth on specimens per ASTM G21**][**rating of 10 in accordance with ASTM D3274 when tested in accordance with ASTM D3273**].
14. Sound Absorption: [**NRC**][**SAA**] of [**0.50 to 0.75**][**0.60 to 0.70**][**0.65 to 0.75**][**not less than 0.60**] in accordance with ASTM C423 for Type A mounting in accordance with ASTM E795.
15. Finish: [**As selected by Architect from manufacturer's standard finishes**][**Spray-textured finish**][**Rolled, spray-textured finish**][**Skip-troweled finish**][**Skip-troweled finish with corner beads**].[**Apply separate, colored topcoat after finishing.**]

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved in writing by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests in accordance with ASTM E736/E736M.

C. Bonding Agent: Product approved in writing by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, in accordance with fire-resistance designs indicated and sprayed fire-resistive material manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.

G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Isolatek International**]

H. Topcoat: Suitable for application over sprayed fire-resistive material; of type recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.

1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Carboline Company; a subsidiary of RPM International**]
2) [**Isolatek International**]

2. Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM. Provide application at a rate of [**30 sq. ft./gal. (0.75 sq. m/L)**][**60 sq. ft./gal. (1.5 sq. m/L)**][**120 sq. ft./gal. (3 sq. m/L)**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Isolatek International**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of applied fire protection with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating applied fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving applied fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Verify that concrete work on steel deck is complete before beginning Work.

C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.

D. Conduct tests in accordance with sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of applied fire protection materials during application.

B. Clean substrates of substances that could impair bond of applied fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive applied fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of applied fire protection. Remove minor projections and fill voids that would telegraph through applied fire protection after application.

3.3 APPLICATION

A. Construct applied fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting applied fire protection Work.

B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove applied fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Metal Decks:

1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.

E. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.

F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.

G. Extend applied fire protection in full thickness over entire area of each substrate to be protected.

H. Install body of applied fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.

I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.

J. Where sealers are used, apply products that are tinted to differentiate them from applied fire protection over which they are applied.

K. Provide a uniform finish complying with description indicated for each type of applied fire protection material and matching finish approved for required mockups.

L. Cure applied fire protection in accordance with sprayed fire-resistive material manufacturer's written instructions.

M. Do not install enclosing or concealing construction until after applied fire protection has been inspected, tested, and corrections have been made to deficient applications.

N. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC[**Subsection 1705.15, "Sprayed Fire-Resistant Materials."**][**as indicated on Schedule of Special Inspections.**]

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Applied fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace applied fire protection that does not pass tests and inspections, and retest.
2. Apply additional applied fire protection, in accordance with manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect applied fire protection from damage resulting from construction operations or other causes in accordance with manufacturer's and Installer's written instructions, so applied fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other adjacent construction proceeds, inspect applied fire protection and repair damaged areas due to work of other trades before concealing it with other construction.

B. Repair applied fire protection using same method and materials as original installation or using manufacturer's recommended trowel-applied repair product.

END OF SECTION 07 81 00 00

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Task	Specification	Specification Description
07 81 16 00	07 81 00 00	Applied Fire Protection

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SECTION 07 81 23 00 - INTUMESCENT FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mastic and intumescent fire-resistive coatings.

B. Related Requirements:

1. Section 078100 "Applied Fire Protection" for sprayed fire-resistive materials (SFRM).
2. Section 099646 "Intumescent Painting" for intumescent paints that are fire retarding, but not fire resistive.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Mastic and intumescent fire-resistive coatings.
2. Substrate primers.
3. Reinforcing fabric.
4. Reinforcing mesh.
5. Topcoat.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

   a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
   b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
   c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

C. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency

acceptable to authorities having jurisdiction.
3. Minimum mastic and intumescent fire-resistive coating thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of mastic and intumescent fire-resistive coating after application.

D. Samples: For each exposed product and for each color and texture specified, [**in manufacturer's standard dimensions**][**4 inches (102 mm) square**] in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**testing agency**].

B. Product Certificates: For each type of mastic and intumescent fire-resistive coating.

C. Evaluation Reports: For mastic and intumescent fire-resistive coating, from ICC-ES.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by mastic and intumescent fire-resistive coating manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

B. Mockups: Build mockups [**to verify selections made under Sample submittals and to demonstrate aesthetic effects**][**to set quality standards for materials and execution**].

1. Build mockup of [**each type of fire protection and different substrate**][**each required finish**] as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is [**50 deg F (10 deg C)**] or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection[**for each fire-resistance design**] from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested in accordance with [**ASTM E119 or UL 263**]; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content, LEED 2009: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.

E. Low-Emitting Materials, LEED 2009: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. VOC Content, LEED v4: For field applications, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

G. Low-Emitting Materials, LEED v4: For field applications, coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Material Emissions and Pollutant Control: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Primers, Sealers, and Undercoaters: 100 g/L.

I. Emissions Requirements: Field-applied coatings shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Primers, Sealers, and Undercoats: 100 g/L.

J. Asbestos: Provide products containing no detectable asbestos.

2.2 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

A. Mastic and Intumescent Fire-Resistive Coating: Manufacturer's standard, [**factory-mixed formulation**][**factory-mixed, multicomponent system consisting of intumescent base coat and topcoat**], and complying with indicated fire-resistance design.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Albi Protective Coatings**]
   b. [**Carboline Company; a subsidiary of RPM International**]
   c. [**Contego International, Inc.**]
   d. [**FlameOff Coatings, Inc.**]
   e. [**Hilti, Inc.**]
   f. [**International Protective Coatings; AkzoNobel**]
   g. [**Isolatek International**]
   h. [**PPG Paints; PPG Industries, Inc.**]
   i. [**Sherwin-Williams Company (The)**]

2. Application: Designated for [**"exterior"**][**"interior general purpose"**][**"conditioned interior space purpose"**] use by a qualified testing agency acceptable to authorities having jurisdiction.
3. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design.
4. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**50**][**450**] or less.

5. Hardness: Not less than [**45**][**65**][**80**], Type D durometer, in accordance with ASTM D2240.
6. Finish: [**As selected by Architect from manufacturer's standard finishes**][**Spray-textured finish**][**Rolled, spray-textured finish**].

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with mastic and intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by mastic and intumescent fire-resistive coating manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer.

D. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by mastic and intumescent fire-resistive coating manufacturer. Include pins and attachment.

E. Topcoat: Suitable for application over mastic and intumescent fire-resistive coating; of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Conduct tests in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Clean substrates of substances that could impair bond of fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by mastic and intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other

materials and procedures affecting fire protection Work.

B. Comply with mastic and intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and mastic and intumescent fire-resistive coating manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

E. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

F. Extend fire protection in full thickness over entire area of each substrate to be protected.

G. Install body of fire protection in a single course unless otherwise recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

H. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

I. Cure fire protection in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions.

J. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

K. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC[**, Subsection 1705.14, "Mastic and Intumescent Fire-Resistant Coatings."**][**as indicated on Schedule of Special Inspections.**]

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect fire protection, in accordance with advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

B. Repair fire protection damaged by other work before concealing it with other construction.

C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

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Task	Specification	Specification Description
07 81 23 00	07 81 00 00	Applied Fire Protection
07 81 33 00	07 81 00 00	Applied Fire Protection

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SECTION 07 84 13 00 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Penetration firestopping systems.

1. Penetration firestopping systems in fire-resistance-rated walls.
2. Penetration firestopping systems in horizontal assemblies.
3. Penetration firestopping systems in smoke barriers.
4. Exposed penetration firestopping systems.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
2. Section 079200 "Joint Sealants" for non-fire-resistance-rated joint sealants.
3. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

C. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestopping manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestopping systems in EJs.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) recommended guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

D. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Entity that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL Solutions and found to comply with "UL Solutions Qualified Firestop Contractor Program."

B. Manufacturer Qualifications: Entity that has received UL Solutions' "Firestop Movement Certification," which demonstrates that manufacturer's firestopping products designated with M-Ratings are based on exposure to cyclic movement and UL 1479 fire test evaluation when tested in accordance with ASTM E3037.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of each penetration firestopping system type required for Project, including supporting construction substrates, attachments, and accessories.
2. Where one penetration firestopping system type may be used for different penetrating items or in different wall or floor constructions, install one assembly for each different combination.
3. Obtain approval of mockups from authorities having jurisdiction before proceeding.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping systems when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping system materials in accordance with manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be accessed and installed in accordance with specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain penetration firestopping systems for each type of opening indicated from single manufacturer.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M Building and Construction**]
2. [**Balco; a CSW Industrials Company**]
3. [**Everkem Diversified Products, Inc.**]
4. [**FireShield; Fire Rated Solutions LLC**]
5. [**Grabber Construction Products, Inc.**]
6. [**Hilti, Inc.**]
7. [**Holdrite; a division of Reliance Worldwide Corporation**]
8. [**International Fireproof Technology Inc**]
9. [**NUCO Inc**]
10. [**Passive Fire Protection Partners**]
11. [**Roxtec Inc.**]
12. [**Specified Technologies Inc.**]
13. [**STC Sound Control**]
14. [**Tremco Incorporated**]
15. [**Unique Fire Stop Products**]

B. Penetration firestopping systems must be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Penetration firestopping systems must be installed with products bearing the classification marking of a qualified testing agency.

   a. UL Solutions in its online directory "Product iQ."
   b. Intertek Group in its "Directory of Building Products."
   c. FM Approvals in its "Approval Guide."

2. Provide components for each penetration firestopping system that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during and after construction.
3. Provide components for each penetration firestopping system that do not contain ethylene glycol.
4. Provide components for each penetration firestopping system that are sufficiently flexible to accommodate movement, such as pipe vibration, water hammer, thermal expansion, and other normal building movement without damage.
5. Provide components for each penetration firestopping system that are appropriately tested for the thickness and type of insulation utilized.

C. Provide penetration firestopping systems that resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

D. Penetration Firestopping Systems in Fire-Resistance-Rated Walls: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall assembly penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
3. M-Rating: Provide penetration firestopping systems meeting specified F-Rating after being tested in accordance with ASTM E3037.

E. Penetration Firestopping Systems in Horizontal Assemblies: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly. The following horizontal penetrations do not require a T-rating:

   a. Those within the cavity of a wall.
   b. Floor, tub, or shower drains within a concealed space.
   c. **4-inch (200-mm)** or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
4. M-Rating: Provide penetration firestopping systems meeting specified [**F-Rating,**][**T-Rating,**][**W-Rating**] after being tested in accordance with ASTM E3037.

F. Penetration Firestopping Systems in Smoke Barriers: Systems with ratings determined in accordance with UL 1479.

1. L-Rating: Not exceeding **5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m)** of penetration opening and no more than **50-cfm (0.024-cu. m/s)** cumulative total for any **100 sq. ft. (9.3 sq. m)** at both ambient and elevated temperatures.
2. M-Rating: Provide penetration firestopping systems meeting specified L-Rating after being tested in accordance with ASTM E3037.

G. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84 or UL 723.

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.
2. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 ACCESSORIES

A. Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated, including but not limited to:

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Cast-in-Place Firestopping Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestopping Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, and when required by a listed system, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed or dislodged.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

K. Thermal and Endothermic Wraps: Flexible, insulating, and fire-resistant protective wraps tested and listed for up to 2-hour fire ratings in accordance with ASTM E814 or UL 1479; for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines, and for thermal barrier and circuit integrity protection in accordance with ASTM E1725 or UL 1724.

L. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls which accept standard accessories.

M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

1. Fire-rated cable pathway devices are the preferred product for data, video, and communications cable penetrations. Install these devices in locations where frequent cable moves, add-ons, and changes will occur. Such devices must be:

a. Capable of retrofit around existing cables.
b. Designed so that two or more devices can be ganged together.
c. Maintenance-free so no action is required to activate the smoke- and fire-sealing mechanism.

2. Where fire-rated cable pathway devices are not practical, openings within walls and floors designed to accommodate data, video, and communications cabling must be provided with re-enterable products specifically designed for retrofit, such as retrofit devices for cable bundles, firestopping putty, plugs, or pillows.

N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.

O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestopping gasket for use around rectangular steel HVAC ducts without fire dampers.

Q. Firestopping Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to **1/2 inch (13 mm)** in diameter.

S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings in accordance with manufacturer's written instructions and with the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with penetration firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than **3 inches (76 mm)** high and with minimum **0.375-inch (9.5-mm)** strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at **15 ft. (4.57 m)** from end of wall and at intervals not exceeding **30 ft. (9.14 m)**.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of

permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. the Owner will engage a qualified inspection agency to conduct and report on inspections in accordance with ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 84 13 00

Task	Specification	Specification Description
07 84 13 16	07 84 13 00	Penetration Firestopping
07 84 13 16	07 84 43 00	Joint Firestopping
07 84 13 19	07 84 13 00	Penetration Firestopping
07 84 13 19	07 84 43 00	Joint Firestopping
07 84 16 00	03 30 00 00	Cast-In-Place Concrete

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SECTION 07 84 43 00 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Intumescent gypsum wall framing gaskets.
2. Perimeter fire-barrier system.
3. Joints in or between fire-resistance-rated construction.
4. Joints at exterior curtain-wall/floor intersections.
5. Joints in smoke barriers.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers[**and for wall identification**].
2. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
3. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
4. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies subject to vehicular traffic.
5. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestop manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestop systems in EJs.

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an EJ or equivalent fire-resistance-rated assembly developed in accordance with current IFC guidelines.

D. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems in accordance with manufacturer's written installation instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed in accordance with specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
2. Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.3 JOINT FIRESTOPPING SYSTEM TYPES

A. General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets: Applied to steel tracks, runners, and studs prior to framing installation. Provide products with fire, smoke, and acoustical ratings that allow movement of up to 100 percent compression and/or extension when tested in accordance with UL 2079 or ASTM E1966; have an L Rating of less than **1 cfm/ft. (0.00115 cu. m/s x m)** when tested in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 when tested in accordance with ASTM E90 or ASTM C919.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**International Fireproof Technology Inc**]
d. [**Specified Technologies Inc.**]

C. Perimeter Fire-Barrier System: Provide perimeter fire-barrier system that does not require direct screw

attachment to mullions and transoms to support and fasten curtain-wall insulation for aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least **2-1/2 by 5 inches (64 by 127 mm)**. System will be tested in accordance with ASTM E2307 for up to two-hour fire resistance and with ASTM E1233/E1233M for wind cycling equivalent to **108 mph (174 km/h)** wind for 500 cycles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CEMCO; California Expanded Metal Products Co.**]
   b. [**Grabber Construction Products, Inc.**]
   c. [**Specified Technologies Inc.**]

D. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**3M Building and Construction**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**CEMCO; California Expanded Metal Products Co.**]
   d. [**ClarkDietrich**]
   e. [**Everkem Diversified Products, Inc.**]
   f. [**Grabber Construction Products, Inc.**]
   g. [**Hilti, Inc.**]
   h. [**International Fireproof Technology Inc**]
   i. [**Marino\WARE**]
   j. [**Nelson; Emerson Electric Co., Automation Solutions**]
   k. [**NUCO Inc**]
   l. [**Owens Corning**]
   m. [**Passive Fire Protection Partners**]
   n. [**RectorSeal Firestop; a CSW Industrials Company**]
   o. [**ROCKWOOL**]
   p. [**Specified Technologies Inc.**]
   q. [**Tremco Incorporated**]
   r. [**Willseal LLC, part of Tremco CPG**]

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

E. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined in accordance with ASTM E2307.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M Building and Construction**]
b. [**Balco; a CSW Industrials Company**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Grabber Construction Products, Inc.**]
e. [**Hilti, Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Nelson; Emerson Electric Co., Automation Solutions**]
h. [**NUCO Inc**]
i. [**Owens Corning**]
j. [**RectorSeal Firestop; a CSW Industrials Company**]
k. [**ROCKWOOL**]
l. [**Specified Technologies Inc.**]
m. [**Tremco Incorporated**]

2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

F. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined in accordance with UL 2079 based on testing at a positive pressure differential of **0.30 inch wg (74.7 Pa)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M Building and Construction**]
b. [**Balco; a CSW Industrials Company**]
c. [**CEMCO; California Expanded Metal Products Co.**]
d. [**Everkem Diversified Products, Inc.**]
e. [**Grabber Construction Products, Inc.**]
f. [**Hilti, Inc.**]
g. [**International Fireproof Technology Inc**]
h. [**Marino\WARE**]
i. [**Nelson; Emerson Electric Co., Automation Solutions**]
j. [**NUCO Inc**]
k. [**Owens Corning**]
l. [**Passive Fire Protection Partners**]
m. [**Polyset**]
n. [**RectorSeal Firestop; a CSW Industrials Company**]
o. [**Specified Technologies Inc.**]
p. [**Tremco Incorporated**]
q. [**Willseal LLC, part of Tremco CPG**]

2. L-Rating: Not exceeding **5.0 cfm/ft. (0.00775 cu. m/s x m)** of joint at both ambient and elevated temperatures.

G. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined in accordance with ASTM E84.

1. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints in accordance with fire-resistive joint system manufacturer's written installation instructions and the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.

3.3 INSTALLATION

A. General: Install joint firestopping systems in accordance with manufacturer's written installation

instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Apply elastomeric fill in voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than **3 inches (76 mm)** high and with minimum **0.375-inch (9.5-mm)** strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at **15 ft. (4.57 m)** from end of wall and at intervals not exceeding **30 ft. (9.14 m)**.

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of joint edge, so labels are visible to anyone seeking to remove joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. the Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product [**Category XHBN**][**Category XHDG**].

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category [**Expansion/Seismic Joints**][**Firestop Systems**].

C. Floor-to-Floor, Joint Firestopping Systems: .

1. UL-Classified Systems: FF-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].
4. W-Rating: No leakage of water at completion of water-leakage testing.

D. Wall-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: WW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

E. Floor-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: FW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

F. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:

1. UL-Classified Systems: HW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

G. Bottom-of-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: BW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

H. Wall-to-Wall, Joint Firestopping Systems Intended for Use as Corner Guards:

1. UL-Classified Systems: CG-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**][**3000-3999**][**4000-4999**].
2. Assembly Rating: [**One hour**][**Two hours**].
3. Nominal Joint Width: [**As indicated**].

I. Perimeter Joint Firestopping Systems:

1. UL-Classified Perimeter Fire-Containment Systems: CW-[**D**][**S**][**0000-0999**][**1000-1999**][**2000-2999**].
2. Integrity Rating: [**One hour**][**Two hours**].
3. Insulation Rating: [**Zero hour**][**1/4 hour**][**3/4 hour**][**1 hour**].
4. Linear Opening Width: [**2-1/2 inches (64 mm)**][**8 inches (203 mm)**][**As indicated**], maximum.
5. F-Rating: [**One hour**][**Two hours**].

END OF SECTION 07 84 43 00

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Task	Specification	Specification Description
07 84 43 00	07 84 13 00	Penetration Firestopping
07 86 00 00	07 84 13 00	Penetration Firestopping
07 86 00 00	07 84 43 00	Joint Firestopping

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SECTION 07 91 00 00 - PREFORMED JOINT SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for liquid sealants applied over preformed seals in dual-seal systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Samples for Initial Selection: Manufacturer's color sheets, showing full range of available colors for each type of exposed preformed joint seal.

C. Samples for Verification: Actual samples of each type and color of exposed preformed joint seal.

1. Size: **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint seals.

D. Preformed Joint Seal Schedule: Include the following information:

1. Joint seal location and designation.
2. Joint width and movement capability.
3. Joint seal manufacturer and product name.
4. Joint seal color.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each preformed joint seal, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.5 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**and**][**to set quality standards for materials and execution**].

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace preformed joint seals that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish preformed joint seals to repair or replace those that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For preformed joint seals, obtain each color, type, and variety of joint seal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PREFORMED, FOAM JOINT SEALS

A. Preformed, Foam Joint Seals : Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce them in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EMSEAL; a Sika Company**]
b. [**LymTal International, Inc.**]
c. [**MM Systems Corporation**]
d. [**Nystrom, Inc.**]
e. [**Pecora Corporation**]
f. [**Schul International Company, LLC**]

g. [**Watson Bowman Acme Corp.**]
h. [**Willseal LLC, part of Tremco CPG**]

2. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.3 EXTRUDED-SILICONE JOINT SEALS

A. Extruded-Silicone Joint Seals : Manufacturer's standard seal consisting of precured low-modulus silicone extrusion, with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Nystrom, Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation**]
e. [**The Dow Chemical Company**]
f. [**Tremco Incorporated**]

2. Joint Seal Width: [**4 inches (102 mm)**][**Joint size indicated on Drawings plus 3/4 inch (19 mm)**][**Joint size indicated on Drawings plus 1 inch (25 mm)**]
3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by preformed joint seal manufacturer for joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to preformed joint seal manufacturer, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces, and formulated to promote best adhesion to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with preformed joint seals and surfaces adjacent to joints.

D. Sealant for Adhering Extruded-Silicone Joint Seals: Silicone adhesive sealant recommended by extruded-silicone joint seal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive preformed joint seals, with Installer present, for compliance with

requirements for joint configuration, installation tolerances, and other conditions affecting preformed joint seal performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing preformed joint seals to comply with preformed joint seal manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of preformed joint seal, including dust, paints (except for permanent protective coatings tested and approved for seal adhesion and compatibility by seal manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimal bond with preformed joint seals. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint seals. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by preformed joint seal manufacturer or as indicated by tests or prior experience. Apply primer to comply with joint seal manufacturer's written instructions. Confine primers to areas of joint seal bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of adhesive or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF PREFORMED, FOAM JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.

3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

3.4 INSTALLATION OF EXTRUDED-SILICONE JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Apply masking tape to each side of joint, outside of area to be covered by seal system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone seal system manufacturer's written instructions and covering a bonding area of not less than **3/8 inch (10 mm)**. Hold edge of sealant bead **1/4 inch (6 mm)** inside masking tape.
3. Press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact with substrate.
4. Complete installation of seal system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.5 PROTECTION

A. Protect preformed joint seals from damage resulting from construction operations or other causes so seals are without deterioration or damage at time of Substantial Completion.

B. Cut out, remove, and repair damaged or deteriorated seals so repaired areas are indistinguishable from original work.

END OF SECTION 07 91 00 00

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Task	Specification	Specification Description
07 91 23 00	07 91 00 00	Preformed Joint Seals
07 91 23 00	07 92 00 00	Joint Sealants
07 91 26 00	07 91 00 00	Preformed Joint Seals
07 91 26 00	07 92 00 00	Joint Sealants
07 91 33 00	07 91 00 00	Preformed Joint Seals

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SECTION 07 92 00 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
3. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint

sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with [**stone**][**masonry**] substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect, as directed by the Owner.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected, as directed by the Owner.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Sika Corporation - Building Components**]

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability. nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Premier Building Solutions**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Pecora Corporation**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. [**Sika Corporation - Building Components**]
g. [**The Dow Chemical Company**]

E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Pecora Corporation**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**PPG Paints; PPG Industries, Inc.**]
g. [**Premier Building Solutions**]
h. [**Sika Corporation - Building Components**]
i. [**The Dow Chemical Company**]

F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]
b. [**The Dow Chemical Company**]

G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Soudal Accumetric**]
b. [**The Dow Chemical Company**]

H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]
b. [**Sika Corporation - Building Components**]

I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]

J. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

2.4 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Pecora Corporation**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**Soudal Accumetric**]
f. [**The Dow Chemical Company**]
g. [**Tremco Incorporated**]

D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

2.5 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Master Builders Solutions**]
e. [**Pecora Corporation**]
f. [**Permathane; a Holcim brand**]
g. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
h. [**PPG Paints; PPG Industries, Inc.**]

i. [**Sherwin-Williams Company (The)**]
j. [**Sika Corporation - Building Components**]
k. [**Tower Sealants, Inc.**]
l. [**Tremco Incorporated**]

B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]

E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
d. [**Sherwin-Williams Company (The)**]

F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]

G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Sherwin-Williams Company (The)**]

H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]

J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]

K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Sherwin-Williams Company (The)**]
f. [**Tremco Incorporated**]

2.6 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants: Suitable for immersion in liquids; ASTM C1247, [**Class 1**][**Class 2**]; tested in deionized water unless otherwise indicated.

B. Urethane, Immersible, S, NS, 100/50, NT, I: Immersible, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

C. Urethane, Immersible, S, NS, 35, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

D. Urethane, Immersible, S, NS, 50, T, NT, I: Immersible, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

E. Urethane, Immersible, S, NS, 35, T, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

F. Urethane, Immersible, S, NS, 25, T, NT, I: Immersible, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]

G. Urethane, Immersible, S, P, 50, T, NT, I: Immersible, single-component, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

H. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]
b. [**W. R. Meadows, Inc**]

I. Polysulfide, Immersible, M, NS, 25, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and

minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]

J. Urethane, Immersible, M, NS, 50, T, NT, I: Immersible, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**LymTal International, Inc.**]
   b. [**Tremco Incorporated**]

K. Urethane, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Master Builders Solutions**]

L. Polysulfide, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Pecora Corporation**]

M. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

2.7 SILANE-MODIFIED POLYMER JOINT SEALANTS

A. Silane-Modified Polymer, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Premier Building Solutions**]
f. [**Sherwin-Williams Company (The)**]
g. [**Sika Corporation - Building Components**]
h. [**Soudal Accumetric**]

B. Silane-Modified Polymer, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Premier Building Solutions**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silane-Modified Polymer, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Everkem Diversified Products, Inc.**]
b. [**Franklin International**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sika Corporation - Building Components**]

D. Silane-Modified Polymer, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 100, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Soudal Accumetric**]
   b. [**Sto Corp.**]

E. Silane-Modified Polymer, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Franklin International**]
   b. [**Soudal Accumetric**]

F. Silane-Modified Polymer, S, NS, 35, T, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Soudal Accumetric**]

G. Silane-Modified Polymer, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Soudal Accumetric**]

H. Silane-Modified Polymer, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Franklin International**]
    b. [**Premier Building Solutions**]
    c. [**Soudal Accumetric**]

2.8 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Adfast**]
    b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
    c. [**Pecora Corporation**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Sika Corporation - Building Components**]
    f. [**Soudal Accumetric**]
    g. [**The Dow Chemical Company**]
    h. [**Tremco Incorporated**]

C. Silane-Modified Polymer, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Master Builders Solutions**]

2.9 POLYSULFIDE JOINT SEALANTS

A. Polysulfide, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**W. R. Meadows, Inc**]

B. Polysulfide, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**W. R. Meadows, Inc**]

C. Polysulfide, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**W. R. Meadows, Inc**]

2.10 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bostik; Arkema**]
   b. [**Everkem Diversified Products, Inc.**]
   c. [**GSSI Sealants**]
   d. [**Pecora Corporation**]
   e. [**Sika Corporation - Building Components**]

2.11 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Pecora Corporation**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**Tremco Incorporated**]

2.12 JOINT-SEALANT BACKING

A. Sealant Backing Material: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Alcot Plastics Ltd.**]
c. [**Construction Foam Products; a division of Nomaco, Inc.**]
d. [**Master Builders Solutions**]

B. Cylindrical Sealant Backings: ASTM C1330, [**Type C (closed-cell material with a surface skin)**][**Type O (open-cell material)**][**Type B (bicellular material with a surface skin)**][**or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated**], and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.13 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at [**locations indicated on Drawings**] in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at [**locations indicated on Drawings**] in accordance with Figure 8C in ASTM C1193.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform [**10**] tests for the first [**1000 ft. (300 m)**] of joint length for each kind of sealant and joint substrate.
2) Perform one test for each [**1000 ft. (300 m)**] of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

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Task	Specification	Specification Description
07 92 13 00	07 92 00 00	Joint Sealants

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SECTION 07 92 19 00 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Acoustical joint sealants.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.

C. Samples for Verification: For each type and color of acoustical joint sealant required.

1. Size: **1/2-inch- (13-mm-)** wide sealant joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained between **40 and 95 deg F (4 and 35 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between [**35 and 100 deg F (2 and 38 deg C)**][**60 and 90 deg F (16 and 32 deg C)**].[**Warm surfaces to be coated to 70 deg F (21 deg C) to enhance drying.**]

1.7 WARRANTY

A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DAP Products Inc.**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Grabber Construction Products, Inc.**]
e. [**Hilti, Inc.**]
f. [**OSI Sealants; Henkel Corporation**]
g. [**Pecora Corporation**]
h. [**Specified Technologies Inc.**]

2. Colors of Exposed Acoustical Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**OSI Sealants; Henkel Corporation**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]
d. [**USG Corporation**]

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage

or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

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Task	Specification	Specification Description
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SECTION 07 95 13 00 - PARKING DECK EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Parking deck expansion joint covers.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Parking deck expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement: As indicated on Drawings.

2.3 PARKING DECK EXPANSION JOINT COVERS

A. Metal-Plate Parking Deck Joint Cover : Assembly consisting of metal cover plate in continuous contact with metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**LymTal International, Inc.**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]
i. [**Willseal LLC, part of Tremco CPG**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Manufacturer's standard**].
   b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

B. T-Joint Parking Deck Joint Cover : Assembly consisting of factory-formed polyurethane block with tapered edges over steel plate. Provide manufacturer's standard, liquid-applied nosing sealant for preformed voids at tapered edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**Erie Metal Specialties, Inc.**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Manufacturer's standard**].
b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

6. Polyurethane Block:

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Compression-Seal Parking Deck Joint Cover : Complying with ASTM E1612/E1612M. Elastomeric seal designed to always stay in compression. Install using manufacturer's recommended lubricant adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**Erie Metal Specialties, Inc.**]
f. [**inpro Corporation**]
g. [**LymTal International, Inc.**]
h. [**MM Systems Corporation**]
i. [**Nystrom, Inc.**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Precompressed Foam Parking Deck Expansion Joint Seals : Manufacturer's precompressed, self-expanding foam joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam, impregnated with a nondrying, water-repellent agent, and coated with traffic-grade silicone wearing surface. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Balco; a CSW Industrials Company**]
b. [**EMSEAL; a Sika Company**]

c. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Application: Slab to slab.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Joint Seal Color: [**Gray**][**As indicated by manufacturer's designations**].

E. Epoxy-Bonded-Seal Parking Deck Joint Covers : Elastomeric seal, epoxy-bonded to sides of joint gap. Install using manufacturer's recommended epoxy adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**D.S. Brown; a Gibraltar Industries company**]
   e. [**Erie Metal Specialties, Inc.**]
   f. [**LymTal International, Inc.**]
   g. [**MM Systems Corporation**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Strip-Seal Parking Deck Joint Covers : Complying with ASTM E1783/E1783M. Assembly consisting of elastomeric seal mechanically locked into a metal frame or edge rails cast into slab edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**D.S. Brown; a Gibraltar Industries company**]
   b. [**Erie Metal Specialties, Inc.**]

c. [**inpro Corporation**]
d. [**LymTal International, Inc.**]
e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Winged-Seal Parking Deck Joint Covers : Winged elastomeric seal grouted into block outs without mechanical attachment. Fully grout block out with manufacturer's elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**EMSEAL; a Sika Company**]
f. [**Erie Metal Specialties, Inc.**]
g. [**inpro Corporation**]
h. [**LymTal International, Inc.**]
i. [**MM Systems Corporation**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Bolt-In Parking Deck Joint Cover : Assembly consisting of winged elastomeric seal locked into slab-edge block outs by metal frames bolted to slab. Fully grout block outs with elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**LymTal International, Inc.**]
    d. [**MM Systems Corporation**]
    e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Split-Slab Membrane Parking Deck Joint Cover : Designed for use with slabs to receive toppings. Assembly consisting of elastomeric winged seals locked into metal edge rails, with flashing for hot-splicing into deck waterproofing. Provide stainless steel retaining caps for edge rails.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Balco; a CSW Industrials Company**]
    b. [**Construction Specialties, Inc.**]
    c. [**EMSEAL; a Sika Company**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**LymTal International, Inc.**]
    f. [**MM Systems Corporation**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Height: [**To match adjacent topping materials**].
5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

a. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

D. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.

E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

F. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.6 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's stainless steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support, using nonmetallic, shrinkage-resistant grout.
2. Install frames in continuous contact with adjacent surfaces.

   a. Shimming is not permitted.

3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written

instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer before installing compression seals.

E. Precompressed Foam Parking Deck Expansion Joint Seals:

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.

G. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

H. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

I. Elastomeric Concrete: Install according to manufacturer's written application instructions.

J. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work, so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

K. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals, and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 00

SECTION 07 95 13 13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**or**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies to be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 FLOOR EXPANSION JOINT COVERS

A. Metal-Plate Floor Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Surface mounted.
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Floor Joint Cover : Assembly consisting of center plate that slides over metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**MM Systems Corporation**]

f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Floor Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

6. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

D. Hidden-Sightline Floor Joint Cover : Sliding leaf-spring and metal frame assembly designed to accept field-applied finish materials on visible surfaces for minimum frame exposure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**Construction Specialties, Inc.**]
   c. [**inpro Corporation**]
   d. [**MM Systems Corporation**]
   e. [**Nystrom, Inc.**]
   f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

E. Seismic-Pan Floor Joint Cover : Seismic pan assembly with sloped sides allowing extension of unit above floor plane during joint contraction, and equipped with springs to return unit back into alignment during joint expansion. Provide manufacturer's recommended sealant at pan edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**Nystrom, Inc.**]
   f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Pan Recess Depth: [**As required to accommodate adjacent flooring**][**1 inch (25 mm)**][**1-1/2 inch (38 mm)**].

F. Elastomeric-Seal Floor Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**EMSEAL; a Sika Company**]
    e. [**Erie Metal Specialties, Inc.**]
    f. [**inpro Corporation**]
    g. [**MM Systems Corporation**]
    h. [**Nystrom, Inc.**]
    i. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**].
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].

d. Brass: [**Mill**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric membrane or extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Dual-Elastomeric-Seal Floor Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
b. Concentrated Load: [**300 lb (136 kg)**].
c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Center-Plate Design: [**Plain**][**Serrated**][**Recessed to accept field-applied finish materials**].

a. Center-Plate Recess Depth: [**As required to accommodate adjacent flooring**][**1/8 inch (3 mm)**][**3/8 inch (10 mm)**].

7. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

8. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 WALL EXPANSION JOINT COVERS

A. Metal-Plate Wall Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Wall Joint Cover : Assembly consisting of center plate that slides over gaskets in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**MM Systems Corporation**]
   f. [**Nystrom, Inc.**]
   g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

4. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Wall Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Wall Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]

b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Wall Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class**

I][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 CEILING EXPANSION JOINT COVERS

A. Metal-Plate Ceiling Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides over gasket in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**Nystrom, Inc.**]
f. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Ceiling Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

4. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Ceiling Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Elastomeric-Seal Acoustical Ceiling Joint Cover : Elastomeric-seal assembly designed for use in acoustical ceilings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**Nystrom, Inc.**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

H. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.9 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.10 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

2. Install frames in continuous contact with adjacent surfaces.

   a. Shimming is not permitted.

3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 13

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Task	Specification	Specification Description
07 95 13 13	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 07 95 13 16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior expansion joint covers.

B. Related Requirements:

1. Section 077129 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion joint cover assemblies.
2. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.
3. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for expansion joint cover assemblies subject to vehicular traffic.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Exterior expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.

6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Metal-Plate Joint Cover : Assembly consisting of sliding metal cover plate in continuous contact with gaskets mounted on metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**MM Systems Corporation**]
   f. [**Nystrom, Inc.**]
   g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: Surface mounted.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

B. Exterior Elastomeric-Seal Joint Cover : Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**MM Systems Corporation**]
   f. [**Nystrom, Inc.**]
   g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: [**Surface-mounted**][**Recessed**].
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

5. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membrane or extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Preformed Foam Joint Seals: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**EMSEAL; a Sika Company**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Nystrom, Inc.**]
   f. [**Pecora Corporation**]
   g. [**Schul International Company, LLC**]
   h. [**Watson Bowman Acme Corp.**]
   i. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**,

Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.5 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.7 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.8 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Install frames in continuous contact with adjacent surfaces.

   a. Shimming is not permitted.

5. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Elastomeric Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Preformed Foam Joint Seals: Install in compliance with manufacturer's written instructions. Install with minimum number of end joints.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

E. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

F. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

G. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

H. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints."[**Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.**]

3.5 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13 16

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Task	Specification	Specification Description
07 95 13 16	07 95 13 13	Interior Expansion Joint Cover Assemblies
07 95 13 16	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 08 01 52 61 - WOOD WINDOW REPAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes wood window repairs as follows:

1. Repairing wood windows.
2. Repairing wood storm windows.
3. Repairing wood shutters.
4. Repairing wood insect screens.
5. Replacing wood windows with custom-fabricated replicas.
6. Replacing wood storm windows with custom-fabricated replicas.
7. Replacing wood shutters with custom-fabricated replicas.
8. Replacing wood insect screens with custom-fabricated replicas.
9. Replacing weather stripping.
10. Providing new storm windows where none existed previously.
11. Providing new shutters where they no longer exist.
12. Reglazing.
13. Repairing, refinishing, and replacing hardware.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for specific requirements relating to selectively demolishing construction, including window and trim removal.
2. Section 085200 "Wood Windows" for new replacement wood windows or sash not custom fabricated to replicate the originals.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances for wood window repairs.

1. Perform wood window repairs under quantity allowances and only as authorized. Authorized Work includes [**the Work required by Drawings and Specifications and**][**only**] the Work as directed in writing by Architect.
2. Notify Architect [**weekly**]<**Insert time interval**> of extent of the Work performed that is attributable to quantity allowances.
3. Perform the Work that exceeds quantity allowances only as authorized by Change Orders.

B. Provide preconstruction testing as part of testing and inspecting allowance.

C. Replace wood sash in Window No. 1 as part of <**Insert name of allowance**>.

D. Replace shutters at 10 windows as part of <**Insert name of allowance**>.

E. Repair <**Insert item description**> as part of <**Insert name of allowance**>.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting the Work of this Section.

1. Unit prices apply to authorized Work covered by [**quantity allowances**][**estimated quantities**].
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

1.4 DEFINITIONS

A. Design Reference Sample: A sample that represents the Architect's prebid selection of the Work to be matched; it may be existing Work or Work specially produced for the Project.

B. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.

C. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.

D. Window: Includes window frame, sash, trim, and hardware unless otherwise indicated by context.

E. Window Unit: Includes window and [**storm window,**][**exterior shutters,**][**interior shutters,**][**insect screens**] and associated hardware and accessories, unless otherwise indicated by context.

F. Window Component Terminology: Wood window components for repair work include the following classifications:

1. Frame Components: Head, jambs, and sill.
2. Sash Components: Stiles and rails, parting bead, stop, and muntins.
3. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
4. Interior Trim: Casing, stool, and apron.
5. <**Insert item**>.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**Project site**][**by web conference**]<**Insert location**>.

1.6 SEQUENCING AND SCHEDULING

A. Perform window repairs in the following sequence, which includes the Work specified in this and other Sections:

1. Label each window frame with permanent opening-identification number in inconspicuous location.
2. Tag existing window sash, trim, storm windows, shutters, and insect screens with opening-identification numbers and remove for on-site or off-site repair. Indicate on tags the locations on window of each component, such as "top sash," "bottom sash," "left shutter," and "right shutter."
3. Remove window, dismantle hardware, and tag hardware with opening-identification numbers.
4. Install temporary protection and security at window openings.
5. In the shop, label each sash, trim, storm window, shutter, and insect screen with permanent opening-identification number in inconspicuous location and remove site-applied tags.
6. Sort units by condition, separating those that need extensive repair.
7. Clean surfaces.

8. General Wood-Repair Sequence:

    a. Remove paint to bare wood.
    b. Rack frames slightly to inject adhesive into mortise and tenon joints; square frames to proper fit before adhesive sets.
    c. If thicker than original glass is required, rout existing muntins to required rebate size.
    d. Repair wood by consolidation, member replacement, partial member replacement, and patching.
    e. Sand, prime, fill, sand again, and prime surfaces again for refinishing.

9. Repair, refinish, and replace hardware if required. Reinstall operating hardware.
10. Install glazing.
11. Remove temporary protection and security at window openings.
12. Reinstall units.
13. Apply finish coats.
14. Install remaining hardware and weather stripping.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

    1. Include recommendations for product application and use.
    2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

    1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, joinery, reinforcing, method of splicing into or attaching to existing wood window unit, accessory items, and finishes.
    2. Include field-verified dimensions and provisions for [**sealant joints**][**flashing**][**and**]<**Insert item**> as required for location.
    3. <**Insert requirements**>.

C. Samples for Initial Selection: For each type of exposed wood and finish.

    1. Identify wood species, cut, and other features.
    2. Include Samples of hardware and accessories involving color selection.

D. Samples for Verification: Actual sample of finished product for the following products in manufacturer's standard sizes unless otherwise indicated:

    1. Replacement Wood Window Units: **12-inch- (300-mm-)** long, full-size sections with applied finish.
    2. Replacement Wood Window Unit Members: **12 inches (300 mm)** long for each wood replacement member.
    3. Repaired Wood Window Unit Members: Prepare Samples using existing wood window members removed from site, repaired, and prepared for refinishing.
    4. Refinished Wood Window Unit Members: Prepare Samples using existing wood window members removed from site, repaired, and refinished.
    5. Hardware: Full-size units with each factory-applied or restored finish.
    6. Weather Stripping: **12-inch- (300-mm-)** long sections.
    7. Glass: [**Full-size**]<**Insert dimensions**> units of each type and appearance.

1.8 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For wood window repairs.

B. Qualification Statements: For [**wood-window-repair specialist**][**and**][**wood-repair-material manufacturer**].

1.9 QUALITY ASSURANCE

A. Wood-Window-Repair Specialist Qualifications: A qualified wood window specialist, experienced in repairing, refinishing, and replacing wood window units in whole and in part. Experience only in fabricating and installing new wood windows is insufficient experience for repairing wood windows.

1. Title X Requirement: Each firm conducting activities that disturb painted surfaces is required to be a "Lead-Safe Certified Firm" in accordance with 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.

B. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing [**wood consolidant**][**and**][**wood-patching compound**] that have been used for similar wood-repair applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

1.10 MOCKUPS

A. Prepare mockups of window repair to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation. Prepare mockups so they are inconspicuous.

1. Locate mockups [**on existing windows where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**]<**Insert requirement**>.
2. Wood Window Repairs: Prepare one entire window to serve as mockup to demonstrate samples of each type of repair of wood window members including frame, sash, glazing, and hardware. Demonstrate operable windows will operate as intended after repair.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified wood-window-repair specialist to perform preconstruction testing on wood window units.

1. Provide test specimens representative of proposed materials and existing construction.
2. Test repair products and methods for effectiveness and compliance with specified requirements.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, broken, or otherwise damaged.

B. Store products inside a well-ventilated area and protect from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.13 FIELD CONDITIONS

A. Weather Limitations: Proceed with wood window repairs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 HISTORIC WOOD REPAIR QUALITY STANDARD

A. Quality Standard: Comply with applicable requirements in Section 06, "Millwork," in AWMAC/WI's NAAWS for construction, finishes, grades of wood windows, and other requirements, unless otherwise indicated and with the exception of practices cited that delegate Contractor's repair work to specific trades.

2.2 REPLACEMENT WOOD WINDOWS

A. Replacement Wood Windows: Custom-fabricated replicated wood window [**frames**][**and**][**sash**][**and**][**trim**], with operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Architectural Millwork Co.**]
b. [**Architectural Components, Inc.**]
c. [**Bear Wood Windows, Inc.**]
d. [**Cleary and Son, Inc.**]
e. [**H. Hirschmann LTD**]
f. [**Kingsland Architectural Millwork**]
g. [**Olek Lejbzon & Co.**]
h. [**Parrett Manufacturing, Inc.**]
i. [**Weston Millwork Company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adams Architectural Millwork Co.**]
b. [**Architectural Components, Inc.**]
c. [**Bear Wood Windows, Inc.**]
d. [**Cleary and Son, Inc.**]
e. [**H. Hirschmann LTD**]
f. [**Kingsland Architectural Millwork**]
g. [**Olek Lejbzon & Co.**]
h. [**Parrett Manufacturing, Inc.**]

i. [**Weston Millwork Company**]
j. <**Insert manufacturer's name**>

3. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
4. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than **1/32 inch (0.8 mm)** deep by **2 inches (51 mm)** wide.

   a. Species: [**Ponderosa pine**][**Match species of each existing type of wood component or assembly**]<**Insert species**> unless otherwise indicated.

5. Frame Heads and Jambs: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**Redwood**][**Douglas fir**][**African mahogany**][**Western red cedar**]<**Insert species**>.
6. Exterior Trim: [**Match existing species**][**Match frame heads and jambs**][**All-heart vertical grain redwood**][**African mahogany**]<**Insert species**>.
7. Sills: [**Match existing species**][**White oak**][**All-heart vertical grain redwood**][**African mahogany**][**Western red cedar**]<**Insert species**>.
8. Sash Components: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**African mahogany**][**Douglas fir**]<**Insert species**>.
9. Interior Trim: [**Match existing species**][**Ponderosa pine**][**Ponderosa pine, eastern white pine, or Idaho white pine**][**African mahogany**]<**Insert species**>.
10. Wood Cut: [**Match cut of existing components**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
11. Wood Window Members: Replicate existing window members.
12. Glazing Stops: Provide replacement glazing stops coordinated with glazing system indicated.
13. Integral Sash Inserts: Manufacturer's standard [**aluminum**][**wood**]-framed [**storm**][**and**][**screen**] sash inserts; Sash-insert frames recessed fully in rebates routed in window frame or sash as required; and secured with turn-button hardware.

    a. Provide insect screen [**for each operable exterior sash or ventilator**][**where indicated on Drawings**][**where indicated in Wood-Window-Repair Schedule**]<**Insert requirement**>.

14. Exposed Hardware: [**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
15. Weather Stripping: Full-perimeter[**and meeting rail**] weather stripping for each operable sash.

2.3 STORM WINDOWS

A. Wood Storm Windows: [**New, custom-fabricated storm window**][**Replacement, custom-fabricated replicated storm window**], tight fitting, with operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adams Architectural Millwork Co.**]
   b. [**Allied Window Inc.**]
   c. [**Cleary and Son, Inc.**]
   d. [**Kingsland Architectural Millwork**]

e. [**Weston Millwork Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Adams Architectural Millwork Co.**]
   b. [**Allied Window Inc.**]
   c. [**Cleary and Son, Inc.**]
   d. [**Kingsland Architectural Millwork**]
   e. [**Weston Millwork Company**]
   f. <**Insert manufacturer's name**>

3. Fabricate storm windows for installation [**on inside of primary window**][**on outside of primary window**][**matching design reference sample**][**matching existing location**][**where indicated on Drawings**][**where indicated in Wood-Window-Repair Schedule**]<**Insert requirement**>.
4. Fabricate storm window frame and sash so as not to be visible from the [**exterior**][**interior**].
5. Make storm windows removable for cleaning and storage.
6. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
7. Wood Species: [**Match wood species of existing storm windows**][**Match wood species of exterior trim and sash parts**][**Cedar**]<**Insert requirement**>.
8. Wood Cut: [**Match cut of existing storm windows**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Storm-Window Members: [**Match design reference sample**][**Replicate existing wood storm window member**][**As indicated on Drawings**]<**Insert requirement**>.
10. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
11. Glazing Material: [**Uncoated clear float glass**][**Plastic glazing**]<**Insert requirement**>.

B. Interior Aluminum Storm Windows: New storm windows fabricated from extruded aluminum to fit inside the wood window frame; finish as indicated; storm window frames concealed from exterior view.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allied Window Inc.**]
   b. [**edi Window Systems, Inc.**]
   c. [**Mon-Ray, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Allied Window Inc.**]
   b. [**edi Window Systems, Inc.**]
   c. [**Mon-Ray, Inc.**]
   d. <**Insert manufacturer's name**>

3. Aluminum Finish: Manufacturer's standard [**clear anodized**][**light bronze anodized**][**medium**

bronze anodized][**dark bronze anodized**][**anodized color matching design reference sample**][**anodized color matching Architect's sample**][**anodized color as selected by Architect from manufacturer's full range**]<**Insert color**>.

4. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]<**Insert color**>.
5. Hardware: Provide new hardware.
6. Glazing Material: [**Uncoated clear float glass**][**Plastic glazing**]<**Insert requirement**>.

2.4 SHUTTERS

A. Exterior Wood Shutters: [**New, custom fabricated stile and rail units**][**Replacement, custom fabricated replicated stile and rail units**], tight fitting, with concealed fasteners and operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adams Architectural Millwork Co.**]
   b. [**Beech River Mill**]
   c. [**Custom Shutter Company**]
   d. [**Kestrel Shutters & Doors, Inc.**]
   e. [**Kingsland Architectural Millwork**]
   f. [**Shuttercraft, Inc.**]
   g. [**Timberlane, Inc**]
   h. [**Weston Millwork Company**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Adams Architectural Millwork Co.**]
   b. [**Beech River Mill**]
   c. [**Custom Shutter Company**]
   d. [**Kestrel Shutters & Doors, Inc.**]
   e. [**Kingsland Architectural Millwork**]
   f. [**Shuttercraft, Inc.**]
   g. [**Timberlane, Inc**]
   h. [**Weston Millwork Company**]
   i. <**Insert manufacturer's name**>

3. Operation: [**Fixed to wall**][**Swinging on vertical stile**][**Bahama or Bermuda style, out-swinging from top rail**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
4. Panel Configuration: [**Louvered**][**Flat**][**Raised**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.
5. Joint Construction: [**Mortise and tenon joints**][**Doweled joints**][**Joints matching design reference sample**][**Joints matching existing**]<**Insert requirement**>.
6. Louver-Slat Construction: [**Routed slats**][**Dadoed slats**][**Pivot pin movable slats with interior control rod**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

7. Wood Species: [**Match wood species of existing shutters**][**Match wood species of exterior trim and sash parts**][**Cedar**]<**Insert requirement**>.
8. Wood Cut: [**Match cut of existing shutters**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Shutter Members: [**Match wood profiles of design reference sample**][**Replicate existing wood shutter members**][**As indicated on Drawings**]<**Insert requirement**>.
10. Wood Preservative: Apply borate preservative treatment to accessible surfaces of exterior wood shutters before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
11. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].
12. Drip Cap: [**Aluminum**][**Copper**]<**Insert requirement**> drip cap fitted to window head; finished [**to match window trim**][**white**]<**Insert requirement**>.

B. Interior Wood Shutters: [**New, custom fabricated stile and rail units**][**Replacement, custom fabricated replicated stile and rail units**], tight fitting and removable, and with concealed fasteners and operating and latching hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Beech River Mill**]
   b. [**Custom Shutter Company**]
   c. [**Kestrel Shutters & Doors, Inc.**]
   d. [**Shuttercraft, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Beech River Mill**]
   b. [**Custom Shutter Company**]
   c. [**Kestrel Shutters & Doors, Inc.**]
   d. [**Shuttercraft, Inc.**]
   e. <**Insert manufacturer's name**>

3. Operation: [**Swinging on vertical stile**][**Bifolding leaves, swinging on vertical stile**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
4. Panel Configuration: [**Louvered**][**Flat**][**Raised**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

   a. Height: [**Full-height, single units**][**Full-height, double-stacked units**][**Half-height units**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.

5. Joint Construction: [**Mortise and tenon joints**][**Doweled joints**][**Match design reference sample**][**Match existing**]<**Insert requirement**>.
6. Louver-Slat Construction: [**Routed slats**][**Dadoed slats**][**Pivot pin movable slats with interior control rod**][**Match design reference sample**][**Match existing**][**As indicated on Drawings**]<**Insert requirement**>.
7. Wood Species: [**Match wood species of existing interior shutters**][**Match wood species of interior trim and sash parts**][**White oak**]<**Insert requirement**>.

8. Wood Cut: [**Match cut of existing interior shutters**][**Match cut of existing exterior wood window trim and sash parts**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
9. Wood Shutter Members: [**Match wood profiles of design reference sample**][**Replicate existing wood shutter members**][**As indicated on Drawings**]<**Insert requirement**>.
10. Hardware: [**Provide new hardware**][**Reuse existing hardware unless otherwise indicated; repair and refinish as required**][**Provide replacement hardware**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**].

2.5 REPLACEMENT INSECT SCREENS

A. Replacement Wood Insect-Screen Frames: Custom-fabricated, replicated wood insect-screen frame; tight fitting and removable, with a minimum of exposed fasteners and latches.

1. Joint Construction: [**Joints matching existing**][**Mortise and tenon joints**][**Doweled joints**]<**Insert requirement**>.
2. Wood Species: [**Match wood species of existing insect screen**][**Match wood species of window**][**Cedar**]<**Insert requirement**>.
3. Wood Cut: [**Match cut of existing insect screen**][**Match cut of window wood**][**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**]<**Insert requirement**>.
4. Insect-Screen Members: [**Replicate existing insect screen members**][**As indicated on Drawings**]<**Insert requirement**>.

B. Replacement Aluminum Insect-Screen Frames: Extruded aluminum custom fabricated to fit inside interior wood window frame; tight fitting and removable, with a minimum of exposed fasteners and latches; finish as indicated; concealed from exterior view.

1. Mounting: Manufacturer's standard [**magnetic mounting consisting of extruded-aluminum guide at head with magnetic tape at jambs and weather seal at sill**][**mounting consisting of extruded-aluminum guide at sill with screw attachment at head and jambs**]<**Insert description**>.
2. Aluminum Finish: Manufacturer's standard [**clear anodized**][**light bronze anodized**][**medium bronze anodized**][**dark bronze anodized**][**anodized color matching design reference sample**][**anodized color matching Architect's sample**][**anodized color as selected by Architect from manufacturer's full range**]<**Insert color**>.
3. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]<**Insert color**>.

C. Wickets: Provide [**sliding**][**or**][**hinged**] wickets matching insect-screen frame material and finish; framed and trimmed for a tight fit and durability during use.

D. Copper Wire Fabric: **16-by-16 count per sq. in. (1.3-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter copper wire.

E. Bronze Wire Fabric: **18-by-14 count per sq. in. (1.1-by-1.5-mm)** mesh of [**0.009-inch- (0.23-mm-)**][**0.011-inch- (0.28-mm-)**] diameter bronze wire with a clear varnish finish.

F. Aluminum Wire Fabric: **18-by-16 count per sq. in. (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire; [**natural bright**][**charcoal gray**][**black**] finish.

2.6 WOOD-REPAIR MATERIALS

A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.

B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated due to weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ConServ Epoxy LLC**]
c. [**Gougeon Brothers, Inc.**]
d. [**Protective Coating Company**]
e. [**System Three Resins, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abatron, Inc**]
b. [**ConServ Epoxy LLC**]
c. [**Gougeon Brothers, Inc.**]
d. [**Protective Coating Company**]
e. [**System Three Resins, Inc.**]
f. <**Insert manufacturer's name**>

C. Wood-Patching Compound: Two-part epoxy-resin wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound capable of filling deep holes and spreading to feather edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**Advanced Repair Technology, Inc.**]
c. [**ConServ Epoxy LLC**]
d. [**Gougeon Brothers, Inc.**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Protective Coating Company**]
g. [**System Three Resins, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abatron, Inc**]
b. [**Advanced Repair Technology, Inc.**]
c. [**ConServ Epoxy LLC**]
d. [**Gougeon Brothers, Inc.**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Protective Coating Company**]
g. [**System Three Resins, Inc.**]
h. <**Insert manufacturer's name**>

2.7 GLAZING MATERIALS

A. Glass:

1. See Section 088000 "Glazing."
2. [**Uncoated clear float-glass**][**Clear insulating-glass**][**Low-E clear insulating-glass**][**Glass Type GL-xx**]<**Insert description**> units according to Section 088000 "Glazing."
3. <**Insert requirements**>.

B. Plastic Glazing: [**Uncoated monolithic acrylic**][**Coated monolithic acrylic**][**Uncoated monolithic polycarbonate**][**Abrasion- and UV-resistant monolithic polycarbonate**][**UV-resistant monolithic polycarbonate**]<**Insert description**> sheet according to Section 088400 "Plastic Glazing."

C. Glazing Systems:

1. Traditional Glazing Products: Glazing points and oil-based glazing putty or latex glazing compound. Tint to required color in accordance with manufacturer's written instructions.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) DAP Products Inc.
2) Sarco Putty Company, Inc.
3) <**Insert manufacturer's name**>.

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

2. Polyurethane Glazing Products: Glazing points and single-component polyurethane glazing compound; ASTM C920, Type S, Grade NS, Class 25, Use G; struck uniformly to match taper of existing glazing system (removed); colored as required to match painted sash.
3. Silicone Glazing Products: Glazing securement and silicone glazing sealant according to Section 088000 "Glazing"; struck uniformly to match taper of existing glazing system (removed); colored as required to match painted sash.
4. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.8 HARDWARE

A. General:

1. Window Hardware: Provide complete sets of window hardware consisting of sash balances,

hinges, pulls, latches, and accessories indicated for each window or required for proper operation. Sets to include replacement hardware to complement repaired and refinished, existing hardware, where required, unless otherwise indicated. Window hardware to smoothly operate, tightly close, and securely lock wood windows and be sized to accommodate sash or ventilator weight and dimensions.

2. Other Hardware: Provide complete sets of hardware for each type of [**storm window**][**shutter**][**and**][**insect screen**] consisting of hinges, pulls, latches, and accessories indicated or required for proper operation. Sets to include replacement hardware to complement repaired and refinished, existing hardware, where required, unless otherwise indicated. Hardware to smoothly operate, tightly close, and secure units appropriately for unit weight and dimensions.

B. New Hardware: Provide hardware for [**storm windows**][**and**][**shutters**] as follows:

1. Wood Storm Windows: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure storm window to window frames**]<**Insert requirement**>
2. Interior Aluminum Storm Windows: [**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure storm window to window frames**][**Magnetic mounting**][**Extruded-aluminum track slides at head and sill**]<**Insert requirement**>.
3. Exterior Wood Shutters: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure shutter to window frames and latch tightly**][**As required to secure shutter to window frames, with pintle hinges to allow removability, and to latch tightly**][**As required to secure shutter to wall**]<**Insert requirement**>.
4. Interior Wood Shutters: [**Match design reference sample**][**As indicated on Drawings**][**As indicated in Wood-Window-Repair Schedule**][**As required to secure shutter to window frames and latch tightly**]<**Insert requirement**>.

C. Replacement Hardware: Replace existing damaged or missing hardware with new [**custom hardware to replicate existing hardware**][**hardware matching type and appearance of existing hardware**] manufactured by one of the following:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Resource Center (The)**]
   b. [**Ball and Ball, LLC**]
   c. [**Blaine Window Hardware Inc.**]
   d. [**Bronze Craft Corporation (The)**]
   e. [**Phelps Company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Architectural Resource Center (The)**]
   b. [**Ball and Ball, LLC**]
   c. [**Blaine Window Hardware Inc.**]
   d. [**Bronze Craft Corporation (The)**]
   e. [**Phelps Company**]
   f. <**Insert manufacturer's name**>

3. Replacement Hardware Types: Duplicate existing exposed hardware of the following types:

    a. Projected window hinge.
    b. Window lock.
    c. Window latch.
    d. Handle.
    e. Pole ring.
    f. Shutter hinges.
    g. Shutter dogs (tiebacks).
    h. Shutter pull rings.
    i. Shutter slide bolts.
    j. Shutter catches.
    k. <**Insert hardware type**>.

4. Weight and Pulley Sash-Balance: Concealed weight and pulley balance system including steel or cast iron weights, cast-bronze pulleys, [**synthetic sash cord**][**bronze sash chain**][**or**][**stainless-steel sash chain**]<**Insert requirement**>; size and capacity to hold sash stationary at any open position.
5. Spring Sash-Balance: Concealed [**tape-spring**][**spiral-tube**][**spring-loaded, block-and-tackle**]<**Insert description**> type; size and capacity to hold sash stationary at any open position.

D. Hardware Materials: [**Solid bronze of alloy indicated**][**Cast or wrought aluminum**][**Nonmagnetic stainless steel**]<**Insert material**> unless otherwise indicated.

E. Hardware Finishes: Comply with ANSI/BHMA A156.18 for base material and finish requirements indicated by the following:

1. ANSI/BHMA 605: Bright brass, clear-coated; brass base metal.
2. ANSI/BHMA 606: Satin brass, clear-coated; brass base metal.
3. ANSI/BHMA 611: Bright bronze, clear-coated; bronze base metal.
4. ANSI/BHMA 612: Satin bronze, clear-coated; bronze base metal.
5. ANSI/BHMA 613: Dark-oxidized satin bronze, oil-rubbed; bronze base metal.
6. ANSI/BHMA 624: Dark-oxidized statuary bronze, clear-coated; bronze base metal.
7. ANSI/BHMA 628: Satin aluminum, clear-anodized; aluminum base metal.
8. ANSI/BHMA 630: Satin stainless steel; stainless-steel base metal.
9. ANSI/BHMA 689: Aluminum painted; over any base metal.
10. <**Insert finish or special custom finish**>.

2.9 REPLACEMENT WEATHER STRIPPING

A. Replacement Compression-Type Weather Stripping: Compressible weather stripping designed for permanently resilient sealing under bumper or wiper action; completely concealed when window is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**National Guard Products, Inc**]
    b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
    c. [**Reese Enterprises, Inc**]
    d. [**Zero International; Allegion plc**]

e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**National Guard Products, Inc**]
   b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
   c. [**Reese Enterprises, Inc**]
   d. [**Zero International; Allegion plc**]
   e. **<Insert manufacturer's name>**

3. Weather-Stripping Material: Match existing materials and profiles as much as possible unless otherwise indicated.

   a. Cellular Elastomeric Gaskets: Preformed; complying with ASTM C509.
   b. Dense Elastomeric Gaskets: Preformed; complying with ASTM C864.

B. Replacement Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**National Guard Products, Inc**]
   b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
   c. [**Reese Enterprises, Inc**]
   d. [**Zero International; Allegion plc**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**National Guard Products, Inc**]
   b. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
   c. [**Reese Enterprises, Inc**]
   d. [**Zero International; Allegion plc**]
   e. **<Insert manufacturer's name>**

3. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.

C. Replacement Metal Weather Stripping: [**Bronze**][**Zinc**]**<Insert metal>** weather stripping; designed either as one piece to seal by sliding into a groove in the sash or as two pieces that interlock; and completely concealed when window is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reese Enterprises, Inc**]
b. [**Zero International; Allegion plc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Reese Enterprises, Inc**]
b. [**Zero International; Allegion plc**]
c. <**Insert manufacturer's name**>

2.10 MISCELLANEOUS MATERIALS

A. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage by decay fungi and wood-boring insects; containing no boric acid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Nisus Corporation**]
b. [**System Three Resins, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Nisus Corporation**]
b. [**System Three Resins, Inc.**]
c. <**Insert manufacturer's name**>

B. Cleaning Materials:

1. Detergent Solution: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent that contains no ammonia, **5 quarts (5 L)** of 5 percent sodium hypochlorite bleach, and **15 quarts (15 L)** of warm water for each **5 gal. (20 L)** of solution required.
2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing **1/3 cup (80 mL)** of household detergent that contains no ammonia, **1 quart (1 L)** of 5 percent sodium hypochlorite bleach, and **3 quarts (3 L)** of warm water.

C. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at **70 deg F (21 deg C)**, in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure condition.

D. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.

1. Match existing fasteners in material and type of fastener unless otherwise indicated.
2. Use concealed fasteners for interconnecting wood components.
3. Use concealed fasteners for attaching items to other work unless exposed fasteners are

[**unavoidable**][**or**][**the existing fastening method**].

4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.

E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B633 for SC 3 (Severe) service condition.

2.11 WOOD WINDOW UNIT FINISHES

A. Unfinished Replacement Units: Provide exposed [**exterior**][**and**][**interior**] wood surfaces of replacement units unfinished; smooth, filled, and suitably prepared for on-site priming and finishing.

B. Factory-Primed Replacement Units: [**Manufacturer's standard**]<**Insert requirement**> factory-prime coat on exposed [**exterior**][**and**][**interior**] wood surfaces; compatible with indicated finish coating.

C. Factory-Finished Units: [**Alkyd**][**Latex**]<**Insert system type**> finish system consisting of [**primer and two finish coats**]<**Insert requirement**> on exposed [**exterior**][**and**][**interior**] wood surfaces.

1. Finish Coats: [**Manufacturer's standard.**][**Match intermediate coat and topcoat products used for adjacent, repaired wood windows.**]<**Insert requirement.**>
2. Color and Gloss: Match [**Munsell Color 10 G 8/2**][**Plochere Color System #8da399**][**colors indicated on Drawings**]<**Insert color(s) or requirement**>.

PART 3 - EXECUTION

3.1 WOOD-WINDOW-REPAIR SPECIALIST

A. Wood-Window-Repair Specialist Firms: Subject to compliance with requirements, [**provide wood window repairs by one of the following**][**firms that may provide wood window repairs include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, names of wood-window-repair specialist firms**>.

3.2 WOOD WINDOW UNIT REPAIRS, GENERAL

A. Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the window interior at [**5 ft. (1.5 m)**][**10 ft. (3 m)**]<**Insert distance**> away and from the window exterior at [**20 ft. (6 m)**][**50 ft. (15 m)**]<**Insert distance**> away.

B. General: In repairing wood window units, disturb them as minimally as possible and as follows:

1. Stabilize and repair wood window units to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
2. Repair items in place where possible.
3. Refinish wood window units in accordance with Section 090190.52 "Maintenance Repainting" unless otherwise indicated.
4. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use gentle mechanical

methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail.

C. Identify removed window units with numbering system corresponding to window locations to ensure reinstallation in same location. Key window units to Drawings indicating location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.3 EXAMINATION

A. Examine areas, and conditions, with wood-window-repair specialist present, for compliance with requirements for environmental conditions, and other conditions affecting performance of the Work.

1. If existing wood window units cannot be prepared to an acceptable condition for repair, notify Architect in writing.
2. Notify Architect of undocumented detrimental conditions, including rotted wood and other deteriorated items.

B. Begin wood window unit repair work only after unsatisfactory conditions have been corrected.

3.4 PREPARATION

A. Protect adjacent materials from damage by performing wood window unit repairs.

B. Install temporary protective measures to protect wood window unit work that is indicated to be completed later.

C. Clean wood window units of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.

D. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

E. Remove coatings and apply borate preservative treatment before repair. Remove coatings in accordance with Section 090190.52 "Maintenance Repainting" unless otherwise indicated.

F. Protection of Openings: Where sash or windows are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.

3.5 WOOD WINDOW UNIT REPAIR

A. Repair and Refinish Existing Hardware: Dismantle window hardware; strip paint, repair, and refinish it to match finish samples; and lubricate moving parts just enough to function smoothly.

B. Repair Wood Window Units: Replicate existing.

1. Repair wood window units by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
2. Sash Balance: Repair sash balances to function according to type as specified in "Hardware" Article" above. Provide missing sash balances.

3.6 WOOD WINDOW UNIT PATCH-TYPE REPAIR

A. General: Patch wood members that exhibit depressions, holes, or similar voids and that have limited amounts of rotted or decayed wood.

1. Remove [**sash**][**storm windows**][**and**][**screens**] from windows before performing patch-type repairs at meeting or sliding surfaces unless otherwise indicated. Reglaze units before reinstallation.
2. Verify that surfaces are sufficiently clean and free of paint residue before patching.
3. Remove rotted or decayed wood down to sound wood.

B. Apply borate preservative treatment to accessible surfaces after removing rotted or decayed wood and before applying wood consolidant or patching compound. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.

C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.

1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
2. Mix only as much patching compound as can be applied in accordance with manufacturer's written instructions.
3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
5. Clean spilled compound from adjacent materials immediately.

3.7 WOOD WINDOW UNIT, MEMBER-REPLACEMENT REPAIR

A. General: Replace parts of or entire wood window unit members at locations [**indicated on Drawings**][**indicated in the Wood-Window-Repair Schedule**][**and**][**where damage is too extensive to patch**]<**Insert requirement**>.

1. Remove [**sash**][**storm windows**][**and**][**shutters**] from windows before performing member-replacement repairs unless otherwise indicated.
2. Verify that surfaces are sufficiently clean and free of paint residue before repair.
3. Remove broken, rotted, and decayed wood down to sound wood.
4. Custom fabricate new wood part or member to replace missing wood part or member; either replace entire wood member or splice new wood part into existing member.
5. Secure new wood part or member using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.

B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.

C. Repair remaining depressions, holes, or similar voids with patch-type repairs.

D. Clean spilled materials from adjacent surfaces immediately.

E. Glazing: Reglaze units before reinstallation.

1. Mill new and rout existing glazed members to accommodate new glass thickness.
2. Provide replacement glazing stops coordinated with glazing system indicated.
3. Provide glazing stops to match contour of sash frames.

F. Reinstall units removed for repair into original openings.

G. Weather Stripping: Replace nonfunctioning and install missing weather stripping to ensure full-perimeter[**and meeting rail**] weather stripping for each operable sash.

3.8 WOOD WINDOW UNIT REPLACEMENT

A. General: Replace existing wood [**window frame**][**sash**][**exterior trim**][**interior trim**][**storm window**][**exterior shutter**][**interior shutter**][**and**][**insect screen**] units with custom-fabricated, replicated units at locations [**indicated on Drawings**][**indicated in the Wood-Window-Repair Schedule**][**and**][**where damage is too extensive to repair**]<**Insert requirement**>.

B. Use surviving prototypes to create patterns for duplicate replacements.

C. Apply borate preservative treatment to accessible surfaces before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.

D. Mill glazed members to accommodate glass thickness. Glaze units before installation.

3.9 REGLAZING

A. Comply with combined written instructions of manufacturers of glass, glazing systems, and glazing materials, unless more stringent requirements are indicated.

B. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.

C. Remove existing glass and glazing where indicated [**on Drawings**][**in the Wood-Window-Repair Schedule**], and prepare surfaces for reglazing.

D. Remove glass and glazing from openings and prepare surfaces for reglazing.

E. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.

F. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.

G. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass, in accordance with glazing-system manufacturer's instructions.

H. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.

I. Install glazing system.[**Install silicone glazing products as specified in Section 088000 "Glazing."**]

J. Disposal of Removed Glass: [**Remove from Owner's property and legally dispose of it**][**Protect unbroken lites and deliver as salvage to Owner for storage where directed**]<**Insert requirement**> unless otherwise indicated.

3.10 INSTALLATION OF REPLACEMENT WOOD WINDOWS

A. Install units, hardware, weather stripping, accessories, and other components[**as indicated on Drawings**].

B. Install units level, plumb, square, true to line, without distortion or impeding movement; anchored securely in place to structural support; and in proper relation to wall flashing, trim, and other adjacent construction.

C. Set sill members in bed of sealant for weathertight construction unless otherwise indicated.

D. Install window units with new anchors into existing openings.

E. Weather Stripping: Install full-perimeter[**and meeting rail**] weather stripping for each operable sash.

F. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

G. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.11 INSTALLATION OF STORM WINDOWS

A. Install wood storm windows at each window jamb[**indicated**].

B. Install interior aluminum storm windows at each window[**indicated**].

C. Install units by mounting to window frames[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

D. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.12 INSTALLATION OF SHUTTERS

A. Install wood shutters at each window jamb[**indicated**].

B. Install units by mounting[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

C. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.13 INSTALLATION OF REPLACEMENT INSECT SCREENS

A. Install [**wood**][**aluminum**] insect-screen frames [**for each operable exterior sash or ventilator**][**where indicated**]<**Insert requirement**>.

1. Locate insect-screen frames on [**inside**][**outside**] of window unless otherwise indicated.
2. Install insect-screen frames by mounting to window or sash frame[**as indicated on Drawings and**] in accordance with manufacturer's written instructions.

B. Install insect screening to be smooth, flat, and uniformly taut.

C. Disposal of Removed Units: [**Remove from Owner's property and legally dispose of them**][**Deliver as salvage to Owner for storage where directed**]<**Insert requirement**>.

3.14 INSTALLATION OF REPLACEMENT WEATHER STRIPPING

A. Install weather stripping for tight seal of joints as determined by preconstruction testing and demonstrated in mockup.

3.15 ADJUSTING

A. Adjust existing and replacement operating sash, screens, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.16 CLEANING AND PROTECTION

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. Monitor window surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact window surfaces, remove contaminants immediately.

B. Clean exposed surfaces immediately after repairing wood windows. Avoid damage to coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction.

3.17 WOOD-WINDOW-REPAIR SCHEDULE

A. Wood Window Repair: [**WW-#**]<**Insert drawing designation**>

1. Description: [**Single-hung**][**Double-hung**][**Triple-hung**][**Casement**][**Fixed**]<**Insert window description**> window.
2. General: Repair existing wood windows using indicated treatments. Repair sash, storm windows, and shutters [**on-site**][**or**][**off-site**]<**Insert requirement**>.
3. Removal of Existing Paint and Refinishing: See Section 090190.52 "Maintenance Repainting" for paint removal, surface preparation for refinishing, and refinishing wood windows.
4. Window Frame Repair: [**Wood consolidant**][**patch-type repairs**][**whole or partial member-replacement repairs**][**and**][**re-anchor frame as indicated on Drawings**]<**Insert repair description**>.
5. Window Frame Member Repair: Repair [**head**][**jambs**][**sill**] with [**wood consolidant**][**patch-type repairs**][**and**][**whole or partial member-replacement repairs**]. [**Re-anchor**][**and**][**realign**] the [**head**][**jambs**][**sill**]. <**Insert repair description**>.
6. Window Sash Repair: [**Wood consolidant**][**patch-type repairs with sash removed from opening**][**patch-type repairs in place**][**and**][**whole or partial member-replacement repairs**]<**Insert repair description**>.
7. Window Sash Member Repair: Repair [**stile**][**rails**][**parting bead**][**stop**][**and**][**muntins**]<**Insert component**> with [**wood consolidant**][**patch-type repairs**][**and**][**whole or partial member-**

replacement repairs]. Realign [**stiles**][**rails**][**parting bead**][**and**][**stops**]<**Insert component**>.

8. Window Sash Replacement: Remove existing units for replacement with custom-fabricated, replicated units.
9. Hardware: [**Sash balance**][**Projected window hinge**][**Window lock**][**Window latch**][**Handle**][**Pole ring**]<**Insert hardware type**>.
10. <**Insert requirements**>.

B. Wood Window Replacement: [**WW-#**]<**Insert drawing designation**>

1. Description: [**Single-hung**][**Double-hung**][**Triple-hung**][**Casement**][**Fixed**]<**Insert window description**> window.
2. General: Remove wood window completely, including window frame and sash, and replace with custom-fabricated, replicated wood windows.
3. Wood Exterior Shutters: Custom-fabricated, [**new**][**replicated**] units specified in this Section.
4. Wood Interior Shutters: Custom-fabricated, [**new**][**replicated**] units specified in this Section.
5. Hardware: [**Sash balance**][**Projected window hinge**][**Window lock**][**Window latch**][**Handle**][**Pole ring**]<**Insert hardware type**>.
6. <**Insert requirements**>.

END OF SECTION 08 01 52 61

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Task	Specification	Specification Description
08 01 52 61	08 52 00 00	Wood Windows
08 01 81 10	08 80 00 00	Glazing
08 05 13 00	01 22 00 00	No Specification Required
08 05 13 00	08 14 16 00	Flush Wood Doors

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SECTION 08 11 13 00 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.

B. Related Requirements:

1. Section 081119 "Stainless-Steel Doors and Frames" for hollow-metal doors and frames manufactured from stainless steel.
2. Section 083473.13 "Metal Sound Control Door Assemblies" for packaged, acoustically rated hollow-metal door and frame assemblies.
3. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for door hardware for hollow-metal doors.
4. Section 119812 "Detention Doors and Frames" for hollow-metal doors and frames for detention facilities.
5. Section 134900 "Radiation Protection" for lead-lined, hollow-metal doors and frames.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data:

1. Interior standard steel doors and frames.

2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, core descriptions, [**fire-resistance ratings,**][**temperature-rise ratings,**] and finishes.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

D. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

E. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.

F. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (75 by 127 mm)**.
2. Fabrication: Prepare Samples approximately [**12 by 12 inches (305 by 305 mm)**][**8 by 10 inches (203 by 254 mm)**] to demonstrate compliance with requirements for quality of materials and construction:

   a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
   b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

G. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of [**fire-rated hollow-metal door and frame assembly**][**fire-rated borrowed-lite assembly**][**windborne-debris impact resistance door**][**and**][**thermally rated door assemblies**] for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.8 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch- (102-mm-)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 HOLLOW METAL DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtec Corporation**]
2. [**Apex Industries, Inc**]
3. [**BARON Metal Industries, Inc.; ASSA ABLOY of Canada, Ltd.; ASSA ABLOY**]
4. [**Ceco Door; AADG, Inc.; ASSA ABLOY**]
5. [**Concept Frames, AADG, Inc.; ASSA ABLOY Group**]
6. [**Curries, AADG, Inc.; ASSA ABLOY Group**]
7. [**Custom Metal Products**]
8. [**Daybar Industries, Ltd**]
9. [**DCI Hollow Metal on Demand**]
10. [**DE LA FONTAINE**]
11. [**Deansteel Manufacturing Company, Inc.**]
12. [**Deronde Products**]
13. [**DKS Steel Door & Frame Systems, Inc.**]
14. [**Fleming Door Products Ltd.; ASSA ABLOY Group**]
15. [**Gensteel Doors**]
16. [**HMF Express**]
17. [**Hollow Metal Xpress**]
18. [**JR Metal Frames, Inc.**]
19. [**Karpen Steel Custom Doors & Frames**]
20. [**L.I.F. Industries, Inc**]
21. [**LaForce, LLC**]
22. [**MegaMet Industries**]
23. [**Mesker Door; Mesker Openings Group**]
24. [**Metropolitan Door Industries Corp.**]
25. [**Michbi Doors Inc**]
26. [**MPI Group, LLC (The)**]
27. [**National Custom Hollow Metal Doors & Frames**]
28. [**North American Door Corp**]
29. [**Philipp Manufacturing Co (The)**]
30. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
31. [**Premier Products, Inc**]
32. [**Republic Doors and Frames; a Allegion brand**]
33. [**Rocky Mountain Metals, Inc**]
34. [**Security Metal Products; a brand of ASSA ABLOY**]
35. [**Steelcraft; Allegion plc**]
36. [**Steward Steel, Door & Frame Division**]
37. [**Stiles Custom Metal, Inc**]
38. [**Titan Metal Products**]
39. [**Trillium Steel Doors Limited**]
40. [**West Central Manufacturing, Inc.**]

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings[**and**

temperature-rise limits] indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Temperature-Rise Limit: [**Where indicated on Drawings**][**At vertical exit enclosures and exit passageways**], provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

C. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazed openings located within [**30 feet (9.1 m)**] of grade.

D. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than [**0.50 deg Btu/F x h x sq. ft. (2.84 W/K x sq. m)**][**0.40 deg Btu/F x h x sq. ft. (2.27 W/K x sq. m)**][**0.38 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m)**] when tested in accordance with ASTM C1363 or ASTM E1423.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: ANSI/SDI A250.8, Level 1; ANSI/SDI A250.4, Level C. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule on Drawings.
   b. Thickness: [**1-3/4 inches (44.5 mm)**][**1-3/8 inches (34.9 mm)**].
   c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.032 inch (0.8 mm)**.
   d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**].
   e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
   f. Core: [**Manufacturer's standard**][**Kraft-paper honeycomb**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].
   g. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

   a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.042 inch (1.0 mm)**.
   b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door

frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

C. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.042 inch (1.0 mm)**.
d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
f. Core: [**Manufacturer's standard**][**Kraft-paper honeycomb**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].
g. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

D. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**][**Model 3, Stile and Rail**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
f. Core: [**Manufacturer's standard**][**Kraft-paper honeycomb**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].
g. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.

b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

E. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.067 inch (1.7 mm)**.
d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
f. Core: [**Manufacturer's standard**][**Kraft-paper honeycomb**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].
g. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.067 inch (1.7 mm)**.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: Metallic-coated steel sheet, minimum thickness of **0.042 inch (1.0 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.
d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors[**where required for attachment of weather**

stripping] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

h. Core: [**Manufacturer's standard**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].

i. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener with insulation**][**laminated mineral board**] core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.

b. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

C. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.

b. Thickness: **1-3/4 inches (44.5 mm)**.

c. Face: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.

d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**][**Model 3, Stile and Rail**].

e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].

f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.

g. Bottom Edges: Close bottom edges of doors[**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

h. Core: [**Manufacturer's standard**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].

i. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener with insulation**][**laminated mineral board**] core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.

b. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

D. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.

b. Thickness: **1-3/4 inches (44.5 mm)**.

c. Face: Metallic-coated steel sheet, minimum thickness of **0.067 inch (1.7 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.

d. Edge Construction: [**Model 1, Full Flush**][**Model 2, Seamless**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Provide manufacturer's standard beveled or square edges**].
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors[**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: [**Manufacturer's standard**][**Polystyrene**][**Polyurethane**][**Polyisocyanurate**][**Vertical steel stiffener**].
i. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener with insulation**][**laminated mineral board**] core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of **0.067 inch (1.7 mm)**, with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.
b. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Factory**].

2.5 INTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Hollow-Metal Doors and Frames: NAAMM-HMMA 860; ANSI/SDI A250.4, Physical Performance Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of [**0.032 inch (0.8 mm)**][**0.042 inch (1.0 mm)**][**0.053 inch (1.3 mm)**].
d. Edge Construction: [**Continuously welded with no**][**Projection or tack welded with no**][**Interlocking with**][**Projection or tack welded with**] visible seam.
e. Core: Steel stiffened.
f. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: Prime.

B. Commercial Doors and Frames: NAAMM-HMMA 861; ANSI/SDI A250.4, Physical Performance Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.

b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.042 inch (1.0 mm)**.
d. Edge Construction: Continuously welded with no visible seam.
e. Core: Steel stiffened.
f. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, except **0.067 inch (1.7 mm)** for openings exceeding **4 feet (1219 mm)** wide.
b. Sidelite and Transom Frames: Fabricated from same material as adjacent door frame.
c. Construction: [**Face**][**Full profile**] welded.

3. Exposed Finish: Prime.

C. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; ANSI/SDI A250.4, Physical Performance Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of [**0.032 inch (0.8 mm)**][**0.042 inch (1.0 mm)**][**0.053 inch (1.3 mm)**].
d. Edge Construction: [**Continuously welded with no visible seam**][**Interlocking with visible seam**][**Interlocking with no visible seam**][**Projection, spot, or tack welded with or without visible seams**].
e. Edge Bevel: [**Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm)**][**Bevel lock edge 1/8 inch in 2 inches (3.2 mm in 51 mm)**].
f. Core: [**Kraft-paper honeycomb**][**Polyisocyanurate**][**Polystyrene**][**Polyurethane**][**Vertical steel stiffener**].
g. Fire-Rated Core: Manufacturer's standard [**vertical steel stiffener**][**laminated mineral board**] core for fire-rated [**and temperature-rise-rated**]doors.

2. Frames:

a. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Unprimed**].

2.6 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Commercial Doors and Frames: NAAMM-HMMA 861; ANSI/SDI A250.4, Physical Performance Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.

b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.30 mm)**, with minimum **G60 or A60 (ZF180)** coating.
d. Edge Construction: Continuously welded with no visible seam.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors[**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: Steel stiffened.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, except **0.067 inch (1.7 mm)** for openings exceeding **4 feet (1219 mm)** wide; with minimum **G60 or A60 (ZF180)** coating.
b. Construction: [**Face**][**Full profile**] welded.

3. Exposed Finish: Prime.

B. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; ANSI/SDI A250.4, Physical Performance Level A. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: **1-3/4 inches (44.5 mm)**.
c. Face: Metallic-coated steel sheet, minimum thickness of [**0.053 inch (1.3 mm)**][**0.042 inch (1.0 mm)**], with minimum **G60 or A60 (ZF180)** coating.
d. Edge Construction: [**Continuously welded with no visible seam**][**Interlocking with visible seam**][**Interlocking with no visible seam**][**Projection, spot, or tack welded with or without visible seams**].
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors[**where required for attachment of weather stripping**] with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: [**Kraft-paper honeycomb**][**Polyisocyanurate**][**Polystyrene**][**Polyurethane**][**Vertical steel stiffener**].

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum **G60 or A60 (ZF180)** coating.
b. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

3. Exposed Finish: [**Prime**][**Unprimed**].

2.7 BORROWED LITES

A. Fabricate of [**uncoated**][**metallic-coated**] steel sheet, minimum thickness of [**0.053 inch (1.3 mm)**][**0.042 inch (1.0 mm)**].

B. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.8 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.9 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each **24 inches (610 mm)** of frame height above **7 feet (2.1 m)**.
3. Postinstalled Expansion Anchor: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than **2-inch (51-mm)** height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), **04Z (12G)** coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.10 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated,

fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.11 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch (19 mm)** beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding[**or by rigid mechanical anchors**].
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

4. Terminated Stops (Hospital Stops): Terminate stops [**6 inches (152 mm)**] above finish floor with a [**45**][**90**]-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with [**butted**][**mitered**] hairline joints.

1. Provide stops and moldings flush with face of door, and with [**beveled**][**square**] stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced

uniformly not more than **9 inches (230 mm)** o.c. and not more than **2 inches (51 mm)** o.c. from each corner.

2.12 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.13 LOUVERS

A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of **0.020-inch- (0.5-mm-)** thick, cold-rolled steel sheet set into **0.032-inch- (0.8-mm-)** thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.

B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with [**ANSI/SDI A250.11**][**NAAMM-HMMA 840**].

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

   a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
   b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.[**Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.**]
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

   a. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with [**ANSI/SDI A250.8**][**NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated**].
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections and to furnish reports to Architect, as directed by the Owner.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress

door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**].

3.4 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish in accordance with manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13 00

SECTION 08 11 73 00 - SLIDING METAL FIRE DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sliding metal fire doors.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for on-site finish painting of factory prime-coated sliding metal fire doors.
2. Section 099123 "Interior Painting" for on-site finish painting of factory prime-coated sliding metal fire doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic closing device and testing and resetting instructions.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
5. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing and inspecting agency**].

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Certificates: For each type of sliding metal fire door.

C. Oversized Special-Purpose Fire Door Assembly Certification: For door assemblies required to be fire rated and that exceed size limitations of labeled assemblies, signed by authorized representative of

testing agency.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sliding metal fire doors to include in emergency, operation, and maintenance manuals.

B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.6 FIELD CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Fire-Rated Swinging Pass Door Assemblies: Based on testing as a component of sliding metal fire door assembly.
3. Temperature-Rise Limit: Where indicated on Drawings, provide doors that have a maximum transmitted temperature end point of not more than indicated temperature above ambient after 30 minutes of standard fire-test exposure.

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: [**As indicated on Drawings**][**Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward**].
2. Testing: According to [**ASTM E330**].
3. Operability under Wind Load: Design overhead coiling doors to remain operable under [**design**][**uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa)**] wind load, acting inward and outward.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SLIDING METAL FIRE DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AST Doors, Inc.**]
2. [**Chase Doors; a Senneca Company**]
3. [**Door Engineering and Manufacturing, LLC**]
4. [**Shure Star**]

B. Source Limitations: Obtain sliding metal fire doors from single source from single manufacturer.

C. Fire-Protection Rating: [**4 hours**][**3 hours**][**1-1/2 hours**][**3/4 hour**][**As indicated**].

1. Temperature-Rise Limit: [**250 deg F (139 deg C)**][**450 deg F (250 deg C)**][**650 deg F (361 deg C)**].

D. Door Type: [**Overhead supported from wall-mounted track**][**Bottom supported on floor track with top guide**], with hidden reinforcements for mounting- and hardware-attachment locations, and with attached armor edges and astragals.

1. Configuration: [**Single-leaf**][**Biparting**][**Multiple-leaf (telescoping)**].
2. Door Construction: Manufacturer's standard for opening size and required performance.
3. Hollow-Metal Construction: Facing material bonded to both sides of core and with perimeter steel channels as reinforcing and to enclose the core material. Splice panel sections of wide leaves with a manufacturer's continuous, steel H column splice kit with surface-applied splice plate or otherwise reinforce panels at connecting joints to provide a solid one-piece door. Weld and fill joints and grind exposed welds smooth and flush.[**Splice plate shall have no visible fasteners.**]
4. Tubular-Frame Construction: Facing material welded to both sides of steel-tube perimeter frame and internal stiffeners, with mitered corner joints in frame and welded frame and stiffener joints; joints in face sheets located over stiffeners. Splice panel sections of wide leaves with a manufacturer's continuous, surface-applied, through-bolt splice plate or otherwise reinforce panels at connecting joints to provide a solid one-piece door. Weld and fill joints and grind exposed welds smooth and flush.

E. Operating System: [**Counterbalanced**][**Power operated**].

F. Facing Material:

1. Steel Sheet: [**0.033-inch (0.8-mm)**][**0.043-inch (1.1-mm)**][**0.053-inch (1.35-mm)**][**0.067-inch (1.7-mm)**] minimum thickness.

2. Metallic-Coated Steel Sheet: [**0.040-inch (1.0-mm)**][**0.052-inch (1.3-mm)**][**0.064-inch (1.6-mm)**][**0.079-inch (2.0-mm)**] nominal thickness.
3. Stainless Steel Sheet: [**0.038-inch (0.96-mm)**][**0.050-inch (1.3-mm)**][**0.062-inch (1.57-mm)**][**0.078-inch (1.98-mm)**] nominal thickness.

G. Core Material: Provide [**manufacturer's standard**][**resin-impregnated honeycomb**][**mineral-fiber board**][**mineral wool**][**urethane**][**fiberglass**][**calcium silicate**][**inorganic mineral**] core material according to fire-protection-rating[**and temperature-rise**] requirements.

H. Operating Hardware: Manufacturer's standard, labeled, automatic-closing-type, sliding fire door hardware complete with track, roller assemblies, adjustable roller guides, binders, floor stops, cables, counterbalance or motorized operator system as required, and fusible links. Furnish necessary hangers, fittings, and fasteners required for attaching hardware to door and for door sliding operation, including latch or handle for manual operation.

I. Counterweight System: Cable-and-pulley system powered by weights that move within a formed-metal safety enclosure.

1. Safety Enclosure: Continuous, **0.064-inch- (1.6-mm-)** thick, metallic-coated steel sheet; size as required for counterweights and clearance.

J. Crush Plates: Continuous **3/16-inch-thick by 6-inch-wide (4.8-mm-thick by 150-mm-wide)** steel-bearing plates on hollow concrete masonry walls to bridge wall cavities and prevent through-wall bolts from crushing the masonry units.

K. Track Hood: Formed, [**metallic-coated steel**][**stainless steel**] sheet; shape and size as required for door clearance and to protect tracks; finished to match door.

L. Weather Stripping: Manufacturer's standard [**neoprene**][**vinyl**][**nylon filament brush-style**] weather stripping around full door perimeter, with concealed attachments for mounting at head, jamb, and bottom edges of door, and acceptable to authorities having jurisdiction.

M. Motorized Operator: Adjustable speed operator listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction; with reversing motor of sufficient size to operate door at no more than 75 percent of rated motor capacity, high-starting-torque, and thermal-overload protection. Include fusible-link release to disengage operator and to allow door to close automatically.

1. Design operator for current characteristics of electrical service supplied.
2. Electrical Characteristics:

   a. Horsepower: [**1/4**][**1/2**] hp.
   b. Single-Phase Voltage: [**115-V ac**][**208-V ac**], 60 Hz.
   c. Three-Phase Voltage: [**208-V ac**][**230-V ac**][**460-V ac**], 60 Hz.

3. Equip door for completely automatic operation with clutch, speed reducer, brake, limit switches, sensing edge, brackets, bolts, and release for manual operation. Control equipment includes [**two pull cords**][**two three-button control stations with push buttons labeled "OPEN," "CLOSE," and "STOP"**][**two motion detectors**][**two loop detectors**][**two photoelectric obstruction detectors**][**time delay for closing**][**and**][**electric interlock for pass door**].

N. Interconnecting Device: Device that connects fusible links for doors on both sides of wall.

O. Door-Release Device: Electromagnetic release device compatible with [**smoke detectors**][**and**][**building's fire-alarm system**].

P. Smoke Detectors: Early warning, photoelectric smoke detectors or ionization detectors coupled to electromagnetic door-release device[**and building's fire-alarm system**].

Q. Door Sill: Noncombustible door sill according to [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] unless otherwise indicated.

R. Pass Door: Swing door and frame assembly, listed for use in sliding metal fire door.

1. Pass-Door Hardware: Factory installed in the sliding metal fire door and including one and one-half pairs of mortise [**spring hinges**][**butt hinges and closer**] and [**mortise latchset**][**mortise lock**][**fire-exit device**].

S. Vision Panels: Factory fabricated in door with removable glass stops. Provide glazing product listed and labeled as a component for fire-protection-rated sliding fire door assembly by a qualified testing agency acceptable to authorities having jurisdiction; do not exceed area allowed for door's fire-protection rating.

2.3 MATERIALS

A. Steel Plate, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheets: [**ASTM A1008/A1008M, cold rolled**][**ASTM A1011/A1011M, hot rolled**] Commercial Steel (CS) or Drawing Steel (DS).

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), with [**G60 (Z180)**][**G90 (Z275)**] zinc coating[**or A60 (ZF180) zinc-iron-alloy (galvannealed) coating**]; restricted flatness.

D. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**]; stretcher-leveled standard of flatness; ASTM A480/A480M, No. [**4**][**6**] finish.

E. Hardware and Fastener Finish: [**Manufacturer's standard**][**Hot-dip galvanize according to ASTM A153/A153M where units are used on galvanized-steel exterior doors**][**Stainless steel**].

2.4 FABRICATION

A. Fabricate sliding metal fire door assemblies to be rigid and free of defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Factory prepare sliding metal fire door assemblies and frames to receive hardware and accessories including cutouts, reinforcements, mortising, drilling, and tapping.

2.5 METALLIC-COATED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard

two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning"**].[**After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.**]

B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.7 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M No. 4.
4. Dull Satin Finish: ASTM A480/A480M No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine floor under door to confirm that floor is level for the full travel of door.
2. Examine wall where track assembly mounts and area behind door to confirm that wall is smooth and in same plane for the full travel of door.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sliding metal fire doors according to NFPA 80 and manufacturer's written instructions for type of door operation indicated and fire-protection rating required.

1. Connect fire-detection devices with building's fire-alarm system.

B. Concrete Masonry: Install continuous crush plates between concrete masonry walls and tracks and operating mechanisms mounted to the walls.

C. Drill necessary holes for anchors in concrete and masonry cleanly, with no broken areas or spalls. Remove and replace or repair damaged concrete and masonry as directed.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform acceptance testing according to NFPA 80.

a. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.

2. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door[**and pass door**]. Reset door-closing mechanism after successful test.
3. Operational Test: After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**].

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain sliding metal fire doors.

END OF SECTION 08 11 73 00

SECTION 08 12 13 00 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standard steel frames.
2. Exterior standard steel frames.
3. Interior custom hollow-metal frames.
4. Exterior custom hollow-metal frames.
5. Borrowed lites.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for hollow-metal doors and frames.
2. Section 081119 "Stainless Steel Doors and Frames" for hollow-metal doors and frames manufactured from stainless steel.
3. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data:

1. Interior standard steel frames.
2. Exterior standard steel frames.
3. Interior custom hollow-metal frames.
4. Exterior custom hollow-metal frames.

5. Borrowed lites.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, [**fire-resistance ratings,**] and finishes.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

D. Shop Drawings: Include the following:

1. Elevations of each frame type.
2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
3. Locations of reinforcement and preparations for hardware.
4. Details of each different wall opening condition.
5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.

E. Samples for Initial Selection: For hollow-metal frames with factory-applied color finishes.

F. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (75 by 127 mm)**.
2. Fabrication: Prepare Samples approximately [**12 by 12 inches (305 by 305 mm)**][**8 by 10 inches (203 by 254 mm)**] to demonstrate compliance with requirements for quality of materials and construction. Show profile, corner joint, floor and wall anchors, and silencers.

G. Product Schedule: For hollow-metal frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of [**fire-rated hollow-metal frame assembly**][**and**][**fire-rated borrowed-lite assembly**] for tests performed by a qualified testing agency indicating compliance with performance requirements.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum **4-inch-(102-mm-)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 HOLLOW METAL FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtec Corporation**]
2. [**Apex Industries, Inc**]
3. [**BARON Metal Industries, Inc.; ASSA ABLOY of Canada, Ltd.; ASSA ABLOY**]
4. [**Ceco Door; AADG, Inc.; ASSA ABLOY**]
5. [**Concept Frames, AADG, Inc.; ASSA ABLOY Group**]
6. [**Curries, AADG, Inc.; ASSA ABLOY Group**]
7. [**Custom Metal Products**]
8. [**Daybar Industries, Ltd**]
9. [**DCI Hollow Metal on Demand**]
10. [**DE LA FONTAINE**]
11. [**Deansteel Manufacturing Company, Inc.**]
12. [**Deronde Products**]
13. [**DKS Steel Door & Frame Systems, Inc.**]
14. [**Fleming Door Products Ltd.; ASSA ABLOY Group**]
15. [**Gensteel Doors**]
16. [**HMF Express**]
17. [**Hollow Metal Xpress**]
18. [**JR Metal Frames, Inc.**]
19. [**Karpen Steel Custom Doors & Frames**]
20. [**L.I.F. Industries, Inc**]
21. [**LaForce, LLC**]
22. [**MegaMet Industries**]
23. [**Mesker Door; Mesker Openings Group**]
24. [**Metropolitan Door Industries Corp.**]
25. [**Michbi Doors Inc**]
26. [**MPI Group, LLC (The)**]
27. [**National Custom Hollow Metal Doors & Frames**]
28. [**North American Door Corp**]
29. [**Philipp Manufacturing Co (The)**]
30. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
31. [**Premier Products, Inc**]
32. [**Republic Doors and Frames; a Allegion brand**]

33. [**Rocky Mountain Metals, Inc**]
34. [**Security Metal Products; a brand of ASSA ABLOY**]
35. [**Steelcraft; Allegion plc**]
36. [**Steward Steel, Door & Frame Division**]
37. [**Stiles Custom Metal, Inc**]
38. [**Titan Metal Products**]
39. [**Trillium Steel Doors Limited**]
40. [**West Central Manufacturing, Inc.**]

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Frames: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that frames comply with standard construction requirements for tested and labeled fire-rated assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 STANDARD STEEL FRAMES

A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Interior Standard Steel Frames: SDI A250.8. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of [**0.042 inch (1.0 mm)**][**0.053 inch (1.3 mm)**][**0.067 inch (1.7 mm)**].
2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
3. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].
4. Exposed Finish: [**Prime**][**Factory**].

C. Exterior Standard Steel Frames: SDI A250.8. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Materials: Metallic-coated steel sheet, minimum thickness of [**0.053 inch (1.3 mm)**][**0.067 inch (1.7 mm)**], with minimum [**A40 (ZF120)**][**A60 (ZF180)**] coating.
2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
3. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].
4. Exposed Finish: [**Prime**][**Factory**].

2.4 CUSTOM HOLLOW-METAL FRAMES

A. Interior Custom Hollow-Metal Frames: NAAMM-HMMA 861. [**At locations indicated in the Door and**

Frame Schedule on Drawings].

1. Materials: [**Uncoated**][**Metallic-coated**] steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
3. Construction: [**Knocked down**][**Slip-on drywall**][**Face welded**][**Full profile welded**].
4. Exposed Finish: Prime.

B. Exterior Custom Hollow-Metal Frames: NAAMM-HMMA 861. [**At locations indicated in the Door and Frame Schedule on Drawings**].

1. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
3. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].
4. Exposed Finish: Prime.

2.5 BORROWED LITES

A. Fabricate of [**uncoated**][**metallic-coated**] steel sheet, minimum thickness of [**0.053 inch (1.3 mm)**][**0.042 inch (1.0 mm)**].

B. Construction: [**Knocked down**][**Face welded**][**Full profile welded**].

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each **24 inches (610 mm)** of frame height above **7 feet (2.1 m)**.
3. Postinstalled Expansion Anchor: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than **2-inch (51-mm)** height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), **04Z (12G)** coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.8 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding[**or by rigid mechanical anchors**].
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

4. Terminated Stops: Terminate stops [**6 inches (152 mm)**] above finish floor with a [**45**][**90**]-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule on Drawings, and templates.

1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with [**butted**][**mitered**] hairline joints.

1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is

capable of being removed independently.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior frames. Provide loose stops and moldings on inside of hollow-metal frames.
3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than **9 inches (230 mm)** o.c. and not more than **2 inches (51 mm)** o.c. from each corner.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with [**SDI A250.11**][**NAAMM-HMMA 840**].

B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
2. Install frames with removable stops located on secure side of opening.

C. Fire-Rated Openings: Install frames according to NFPA 80.

D. Floor Anchors: Secure with postinstalled expansion anchors.

1. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

E. Solidly pack mineral-fiber insulation inside frames.

F. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.

G. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.[**Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.**]

H. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

1. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.

I. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 12 13 00

Task	Specification	Specification Description
08 12 13 13	08 12 13 00	Hollow Metal Frames
08 13 73 00	08 35 13 00	Folding Doors

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SECTION 08 14 16 00 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core five-ply flush wood veneer-faced doors and transom panels for transparent finish.
2. Solid-core five-ply flush wood doors and transom panels for opaque finish.
3. Solid-core seven-ply flush wood veneer-faced doors and transom panels for transparent finish.
4. Solid-core seven-ply flush wood doors and transom panels for opaque finish.
5. Solid-core flush wood doors and transom panels with plastic-laminate faces.
6. Hollow-core flush wood veneer-faced doors for transparent finish.
7. Hollow-core flush wood doors for opaque finish.
8. Hollow-core flush wood doors with plastic-laminate faces.
9. Fire-rated wood door frames.
10. Light frames and louvers.

B. Related Requirements:

1. Section 064023 "Interior Architectural Woodwork" for wood door frames [**including 20-minute fire-rated wood door frames**] .
2. Section 064216 "Flush Wood Paneling" for requirements for veneers from the same flitches for both flush wood doors and flush wood paneling.
3. Section 083473.16 "Wood Sound Control Door Assemblies" for acoustic flush wood doors.
4. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for door hardware for flush wood doors.
5. Section 088000 "Glazing" for glass view panels in flush wood doors.
6. [**Section 099113 "Exterior Painting"**][**Section 099114 "Exterior Painting (MPI Standards)"**][**Section 099123 "Interior Painting"**][**Section 099124 "Interior Painting (MPI Standards)"**][**and**][**Section 099300 "Staining and Transparent Finishing"**][**Section 099301 "Staining and Transparent Finishing (MPI Standards)"**] for field finishing doors.
7. Section 134900 "Radiation Protection" for lead-lined flush wood doors.

1.2 COORDINATION

A. Coordinate requirements for installing door hardware, including electrified door hardware, and access control and security systems.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product. Include information indicating compliance with performance requirements indicated.

1. Door core materials and construction.
2. Door edge construction.
3. Door face type and characteristics.
4. Door louvers.
5. Door trim for openings.
6. Door frame construction.
7. Factory-machining criteria.
8. Factory- [**priming**][**finishing**] specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in product data; and the following:

1. Door schedule indicating door [**and frame**] location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory [**primed**][**finished**] and application requirements.
10. Apply [**AWI Quality Certification**][**WI Certified Compliance**] Program label to Shop Drawings.

C. Samples for Initial Selection: For [**plastic-laminate faces**][**polymer edging**][**factory-finished doors**][**and**][**factory-finished door frames**] .

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately **8 by 10 inches (200 by 250 mm)**, for each material and finish. [**For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.**]
2. Plastic-laminate, **6 inches (150 mm)** square, for each color, texture, and pattern selected.
3. Polymer edging, in manufacturer's standard colors.
4. Corner sections of doors, approximately **8 by 10 inches (200 by 250 mm)**, with door faces and edges representing actual materials to be used.
5. Louver blade and frame sections, **6 inches (150 mm)** long, for each material and finish specified.
6. Frames for light openings, **6 inches (150 mm)** long, for each material, type, and finish required.

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.
10. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

11. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
12. Chain-of-Custody Qualification Data: For manufacturer and vendor.
13. Laboratory Test Reports: For adhesives, indicating compliance with VOC requirements in the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
14. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
15. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] for the following:

1. Fire-rated door assemblies.
2. Smoke- and draft-control door assemblies.

B. Oversize Construction Certification: For assemblies required to be fire-rated that exceed limitations of labeled assemblies.

C. Field quality control reports.

D. Qualification Statements: For field testing and inspecting agency [**and**][**Fire-Rated Door Inspector**][**Egress Door Inspector**] .

E. Sample Warranties: For specified special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI Quality Certification**][**WI Certified Compliance**] Program certificates.

B. Record Documents: For [**fire-rated**][**and**][**smoke- and draft-control**] door assemblies, list of door numbers and applicable room name and number to which door provides access.

1.7 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

C. Manufacturer's Certification: Licensed participant in [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] .

D. Fire-Rated Door Inspector Qualifications: Documented as complying with requirements in NFPA 80 [**and having Door and Hardware Institute's Certified Fire + Egress Door Assembly Inspector (CFDAI) credentials**] .

E. Egress Door Inspector Qualifications: Documented as complying with requirements in NFPA 101 [**and having Door and Hardware Institute's Certified Fire + Egress Door Assembly Inspector (CFDAI)**

credentials] .

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in [**plastic bags or cardboard cartons**][**cardboard cartons, and wrap bundles of doors in plastic sheeting**] .

C. Mark each door on [**top and**] bottom rail with opening number used on Shop Drawings.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
2. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 55**][**43 and 70**][**17 and 50**] percent during remainder of construction period.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors [**and frames**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination of veneer.
b. Warping (bow, cup, or twist) more than **1/4 inch (6.4 mm)** in a **42-by-84-inch (1067-by-2134-mm)** section.
c. Telegraphing of core construction in face veneers exceeding **0.01 inch in a 3-inch (0.25 mm in a 76.2-mm)** span.

2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors [**and frames**] .
3. Warranty Period for Solid-Core Exterior Doors: [**Two**][**Five**] years from date of Substantial Completion.
4. Warranty Period for Solid-Core Interior Doors: Life of installation.
5. Warranty Period for Hollow-Core Interior Doors: [**One**][**Two**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain flush wood doors [**indicated to be blueprint matched with paneling**][**and wood paneling**]

from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings [**and temperature-rise limits**] indicated [**on Drawings**][**in schedules**] , based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Temperature-Rise Limit: Where indicated [**on Drawings**][**in schedules**] , provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Smoke- and Draft-Control Door and Frame Assemblies: Listed and labeled for smoke and draft control based on testing in accordance with UL 1784 by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 FLUSH WOOD DOORS AND FRAMES, GENERAL

A. Quality Standard: In addition to requirements specified, comply with [**AWI/AWMAC/WI's "Architectural Woodwork Standards."**][**ANSI/WDMA I.S. 1A.**]

1. Provide [**labels**][**and**][**certificates**] from [**AWI**][**WI**] certification program indicating that doors [**and frames**] comply with requirements of grades specified.

   a. This project has been registered with AWI as AWI Quality Certification Program Number .
   b. Contractor registers the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.

2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

B. Regional Materials: Wood doors shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Indigenous Materials: Wood doors shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Certified Wood: Verify wood doors are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Verify wood doors are labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or be certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Verify wood doors are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001

and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

G. Adhesives: Use adhesives that comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

I. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

J. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

2.4 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS FOR TRANSPARENT FINISH

A. Exterior Doors, Solid-Core Five-Ply Veneer-Faced :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Lambton Doors**]
   b. [**Oregon Door**]
   c. [**Oshkosh Door Company**]
   d. [**VT Industries, Inc.**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**as indicated on Drawings**] .
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Faces: Single-ply wood veneer not less than **1/50 inch (0.508 mm)** thick.

   a. Species: [**Anigre**][**Select white ash**][**Figured select white ash**][**Select white birch**][**Select red birch**][**Cherry**][**Select red gum**][**Figured select red gum**][**Select white maple**][**Red oak**][**White oak**][**Persimmon**][**Sapele**][**Sycamore**][**Walnut**] .
   b. Cut: [**Rotary cut**][**Plain sliced (flat sliced)**][**Quarter sliced**][**Rift cut**] .
   c. Match between Veneer Leaves: [**Book**][**Slip**][**Random**] match.
   d. Assembly of Veneer Leaves on Door Faces: [**Center-balance**][**Balance**][**Running**] match.
   e. Pair and Set Match: Provide for doors hung in same opening [**or separated only by mullions**] .

6. Exposed Vertical and Top Edges: [**Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A**][**Same species as faces - Architectural Woodwork Standards edge Type A**][**Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B**][**Applied**

wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D] .

7. Core: Structural Composite Lumber.

   a. Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**] in accordance with WDMA T.M. 10.
   b. Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**] in accordance with WDMA T.M. 10.

8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
9. Adhesives: Type I in accordance with WDMA T.M. 6.

B. Interior Doors, Solid-Core Five-Ply Veneer-Faced :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Forte Openings**]
   b. [**Lambton Doors**]
   c. [**Lynden Door, Inc.**]
   d. [**Oregon Door**]
   e. [**Oshkosh Door Company**]
   f. [**VT Industries, Inc.**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**Standard Duty**][**as indicated on Drawings**] .
3. Performance Grade by Location:

   a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [**Classrooms**][**public toilets**][**janitor's closets**][**assembly spaces**][**exits**][**and**][**patient rooms**][**and where indicated on Drawings**] .
   b. ANSI/WDMA I.S. 1A Standard Duty: [**Closets (not including janitor's closets)**][**and**][**private toilets**][**and where indicated on Drawings**] .

4. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
5. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
6. Faces: Single-ply wood veneer not less than **1/50 inch (0.508 mm)** thick.

   a. Species: [**Anigre**][**Select white ash**][**Figured select white ash**][**Select white birch**][**Select red birch**][**Cherry**][**Select red gum**][**Figured select red gum**][**Select white maple**][**Red oak**][**White oak**][**Persimmon**][**Sapele**][**Sycamore**][**Walnut**] .
   b. Cut: [**Rotary cut**][**Plain sliced (flat sliced)**][**Quarter sliced**][**Rift cut**] .
   c. Match between Veneer Leaves: [**Book**][**Slip**][**Random**] match.
   d. Assembly of Veneer Leaves on Door Faces: [**Center-balance**][**Balance**][**Running**] match.
   e. Pair and Set Match: Provide for doors hung in same opening [**or separated only by mullions**] .
   f. Room Match:

      1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by [**10 ft. (3 m)**][**20 ft. (6 m)**] or more.
      2) Provide door faces of compatible color and grain within each separate room or area of building.

g. Transom Match: [**Continuous match**][**End match**][**As indicated**] .
h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064216 "Flush Wood Paneling."

7. Exposed Vertical and Top Edges: [**Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A**][**Same species as faces - Architectural Woodwork Standards edge Type A**][**Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B**][**Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D**] .

a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
b. Fire-Rated Pairs of Doors:

1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
2) Provide formed-steel edges and astragals with intumescent seals.

a) Finish steel edges and astragals with baked enamel [**same color as doors**] .
b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

1) Screw-Holding Capability: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Core for Non-Fire-Rated Doors:

a. Particleboard: ANSI A208.1, [**Grade LD-1**][**Grade LD-2**] .

1) Blocking: Provide wood blocking in particleboard-core doors as [**needed to eliminate through-bolting hardware.**][**follows:**]

a) **5-inch (125-mm)** top-rail blocking, in doors indicated to have closers.
b) **5-inch (125-mm)** bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
c) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

2) Provide doors with structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

b. Structural Composite Lumber:

1) Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
2) Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

9. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

   a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as [**needed to eliminate through-bolting hardware.**][**follows:**]

      1) **5-inch (125-mm)** top-rail blocking.
      2) **5-inch (125-mm)** bottom-rail blocking, in doors indicated to have protection plates.
      3) **5-inch (125-mm)** midrail blocking, in doors indicated to have armor plates.
      4) **4-1/2-by-10-inch (114-by-250-mm)** lock blocks, in doors without exit devices.
      5) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

10. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 SOLID-CORE FIVE-PLY FLUSH WOOD DOORS AND TRANSOM PANELS FOR OPAQUE FINISH

A. Exterior Doors, Solid-Core Five-Ply for Opaque Finish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Lambton Doors**]
   b. [**Oregon Door**]
   c. [**Oshkosh Door Company**]
   d. [**VT Industries, Inc.**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**as indicated on Drawings**] .
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Faces: [**MDO**][**Any closed-grain hardwood of mill option**] .

   a. Apply MDO to [**standard-thickness, closed-grain, hardwood face veneers**][**directly to high-density hardboard crossbands**] .

6. Exposed Vertical and Top Edges: Any closed-grain hardwood.
7. Core: Structural Composite Lumber.

   a. Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
   b. Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Construction: Five plies, hot-pressed, bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
9. Adhesives: Type I in accordance with WDMA T.M. 6.

B. Interior Doors, Solid-Core Five-Ply for Opaque Finish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Forte Openings**]
b. [**Lambton Doors**]
c. [**Lynden Door, Inc.**]
d. [**Oregon Door**]
e. [**Oshkosh Door Company**]
f. [**VT Industries, Inc.**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**Standard Duty**][**as indicated on Drawings**] .
3. Performance Grade by Location:

   a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [**Classrooms**][**public toilets**][**janitor's closets**][**assembly spaces**][**exits**][**and**][**patient rooms**][**and where indicated on Drawings**] .
   b. ANSI/WDMA I.S. 1A Standard Duty: [**Closets (not including janitor's closets)**][**and**][**private toilets**][**and where indicated on Drawings**] .

4. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
5. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
6. Faces: [**MDO**][**Any closed-grain hardwood of mill option**][**Hardboard or MDF**] .

   a. Apply MDO to [**standard-thickness, closed-grain, hardwood face veneers**][**directly to high-density hardboard crossbands**] .
   b. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
   c. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.

7. Exposed Vertical and Top Edges: Any closed-grain hardwood.

   a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
   b. Fire-Rated Pairs of Doors:

      1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
      2) Provide formed-steel edges and astragals with intumescent seals.

         a) Finish steel edges and astragals with baked enamel [**same color as doors**] .
         b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

   c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

      1) Screw-Holding Capability: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Core for Non-Fire-Rated Doors:

   a. Particleboard: ANSI A208.1, [**Grade LD-1**][**Grade LD-2**] .

      1) Blocking: Provide wood blocking in particleboard-core doors as [**needed to**

eliminate through-bolting hardware.][**follows:**]

a) **5-inch (125-mm)** top-rail blocking, in doors indicated to have closers.
b) **5-inch (125-mm)** bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
c) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

2) Provide doors with structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

b. Structural Composite Lumber:

1) Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
2) Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

9. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as [**needed to eliminate through-bolting hardware.**][**follows:**]

1) **5-inch (125-mm)** top-rail blocking.
2) **5-inch (125-mm)** bottom-rail blocking, in doors indicated to have protection plates.
3) **5-inch (125-mm)** midrail blocking, in doors indicated to have armor plates.
4) **4-1/2-by-10-inch (114-by-250-mm)** lock blocks.
5) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

10. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.6 SOLID-CORE SEVEN-PLY FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS FOR TRANSPARENT FINISH

A. Exterior Doors, Seven-Ply Veneer-Faced :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Haley Brothers, Inc**]
b. [**Lambton Doors**]
c. [**Vancouver Door Company**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**as indicated on Drawings**] .
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Faces: [**Single-ply wood veneer not less than 1/50 inch (0.508 mm) thick**][**two-ply wood panel with wood veneer not less than 1/50 inch (0.508 mm) thick**] .

a. Species: [**Anigre**][**Select white ash**][**Figured select white ash**][**Select white**

birch][Select red birch][Cherry][Select red gum][Figured select red gum][Select white maple][Red oak][White oak][Persimmon][Sapele][Sycamore][Walnut] .
b. Cut: [Rotary cut][Plain sliced (flat sliced)][Quarter sliced][Rift cut] .
c. Match between Veneer Leaves: [Book][Slip][Random] match.
d. Assembly of Veneer Leaves on Door Faces: [Center-balance][Balance][Running] match.
e. Pair and Set Match: Provide for doors hung in same opening [or separated only by mullions] .

6. Exposed Vertical and Top Edges: [Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A][Same species as faces - Architectural Woodwork Standards edge Type A][Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B][Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D] .
7. Core: Structural Composite Lumber.

a. Screw Withdrawal, Door Face: [550 lbf (2440 N)][475 lbf (2110 N)][400 lbf (1780 N)] in accordance with WDMA T.M. 10.
b. Screw Withdrawal, Vertical Door Edge: [550 lbf (2440 N)][475 lbf (2110 N)][400 lbf (1780 N)] in accordance with WDMA T.M. 10.

8. Construction: Seven plies, [hot-pressed][cold-pressed] bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
9. Adhesives: Type I in accordance with WDMA T.M. 6.

B. Interior Doors, Seven-Ply Veneer-Faced :

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [Haley Brothers, Inc]
b. [Lambton Doors]
c. [Vancouver Door Company]

2. Performance Grade: ANSI/WDMA I.S. 1A [Extra Heavy Duty][Heavy Duty][Standard Duty][as indicated on Drawings] .
3. Performance Grade by Location:

a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [Classrooms][public toilets][janitor's closets][assembly spaces][exits][and][patient rooms][and where indicated on Drawings] .
b. ANSI/WDMA I.S. 1A Standard Duty: [Closets (not including janitor's closets)][and][private toilets][and where indicated on Drawings] .

4. ANSI/WDMA I.S. 1A Quality Grade: [Premium][Custom] .
5. Architectural Woodwork Standards Quality Grade: [Premium][Custom] .
6. Faces: [Single-ply wood veneer not less than 1/50 inch (0.508 mm) thick][two-ply wood panel with wood veneer not less than 1/50 inch (0.508 mm) thick] .

a. Species: [Anigre][Select white ash][Figured select white ash][Select white birch][Select red birch][Cherry][Select red gum][Figured select red gum][Select white maple][Red oak][White oak][Persimmon][Sapele][Sycamore][Walnut] .
b. Cut: [Rotary cut][Plain sliced (flat sliced)][Quarter sliced][Rift cut] .

c. Match between Veneer Leaves: [**Book**][**Slip**][**Random**] match.
d. Assembly of Veneer Leaves on Door Faces: [**Center-balance**][**Balance**][**Running**] match.
e. Pair and Set Match: Provide for doors hung in same opening [**or separated only by mullions**] .
f. Room Match:

1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by [**10 ft. (3 m)**][**20 ft. (6 m)**] or more.
2) Provide door faces of compatible color and grain within each separate room or area of building.

g. Transom Match: [**Continuous match**][**End match**][**As indicated on Drawings**] .
h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064216 "Flush Wood Paneling."

7. Exposed Vertical and Top Edges: [**Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A**][**Same species as faces - Architectural Woodwork Standards edge Type A**][**Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B**][**Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D**] .

a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
b. Fire-Rated Pairs of Doors:

1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
2) Provide formed-steel edges and astragals with intumescent seals.

a) Finish steel edges and astragals with baked enamel [**same color as doors**] .
b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

1) Screw-Holding Capability: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Particleboard Core for Non-Fire-Rated Doors: ANSI A208.1, [**Grade LD-1**][**Grade LD-2**] .

a. Blocking: Provide wood blocking in particleboard-core doors as [**needed to eliminate through-bolting hardware.**][**follows:**]

1) **5-inch (125-mm)** top-rail blocking, in doors indicated to have closers.
2) **5-inch (125-mm)** bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
3) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

b. Provide doors with structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in [**Section 087100 "Door Hardware."**][**Section**

087111 "Door Hardware (Descriptive Specification)."]

9. Structural Composite Lumber Core for Non-Fire-Rated Doors:

   a. Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
   b. Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

10. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

    a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as [**needed to eliminate through-bolting hardware.**][**follows:**]

       1) **5-inch (125-mm)** top-rail blocking.
       2) **5-inch (125-mm)** bottom-rail blocking, in doors indicated to have protection plates.
       3) **5-inch (125-mm)** midrail blocking, in doors indicated to have armor plates.
       4) **4-1/2-by-10-inch (114-by-250-mm)** lock blocks.
       5) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

11. Construction: Seven plies, [**hot-pressed**][**cold-pressed**] , bonded or unbonded.

2.7 SOLID-CORE SEVEN-PLY FLUSH WOOD DOORS AND TRANSOM PANELS FOR OPAQUE FINISH

A. Exterior Doors, Seven-Ply for Opaque Finish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Haley Brothers, Inc**]
   b. [**Lambton Doors**]
   c. [**Vancouver Door Company**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**as indicated on Drawings**] .
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Faces: [**MDO**][**Any closed-grain hardwood of mill option**] .

   a. Apply MDO to [**standard-thickness, closed-grain, hardwood face veneers**][**directly to high-density hardboard crossbands**] .

6. Exposed Vertical and Top Edges: Any closed-grain hardwood.
7. Core: Structural Composite Lumber.

   a. Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
   b. Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Construction: Seven plies, [**hot-pressed**][**cold-pressed**] , bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.
9. Adhesives: Type I in accordance with WDMA T.M. 6.

B. Interior Doors, Seven-Ply for Opaque Finish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Haley Brothers, Inc**]
   b. [**Lambton Doors**]
   c. [**Vancouver Door Company**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**Standard Duty**][**as indicated on Drawings**] .
3. Performance Grade by Location:

   a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [**Classrooms**][**public toilets**][**janitor's closets**][**assembly spaces**][**exits**][**and**][**patient rooms**][**and where indicated on Drawings**] .
   b. ANSI/WDMA I.S. 1A Standard Duty: [**Closets (not including janitor's closets)**][**and**][**private toilets**][**and where indicated on Drawings**] .

4. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
5. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
6. Faces: [**MDO**][**Any closed-grain hardwood of mill option**][**Hardboard or MDF**] .

   a. Apply MDO to [**standard-thickness, closed-grain, hardwood face veneers**][**directly to high-density hardboard crossbands**] .
   b. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
   c. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.

7. Exposed Vertical and Top Edges: Any closed-grain hardwood.

   a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
   b. Fire-Rated Pairs of Doors:

      1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
      2) Provide formed-steel edges and astragals with intumescent seals.

         a) Finish steel edges and astragals with baked enamel [**same color as doors**] .
         b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

   c. Mineral Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

      1) Screw-Holding Capability: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

8. Particleboard Core for Non-Fire-Rated Doors: ANSI A208.1, [**Grade LD-1**][**Grade LD-2**] .

   a. Blocking: Provide wood blocking in particleboard-core doors as [**needed to eliminate through-bolting hardware.**][**follows:**]

      1) **5-inch (125-mm)** top-rail blocking, in doors indicated to have closers.
      2) **5-inch (125-mm)** bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
      3) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

   b. Provide doors with structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

9. Structural Composite Lumber Core for Non-Fire-Rated Doors:

   a. Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
   b. Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

10. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

    a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as [**needed to eliminate through-bolting hardware.**][**follows:**]

       1) **5-inch (125-mm)** top-rail blocking.
       2) **5-inch (125-mm)** bottom-rail blocking, in doors indicated to have protection plates.
       3) **5-inch (125-mm)** midrail blocking, in doors indicated to have armor plates.
       4) **4-1/2-by-10-inch (114-by-250-mm)** lock blocks.
       5) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

11. Construction: Seven plies, [**hot-pressed**][**cold-pressed**] .

2.8 SOLID-CORE FLUSH WOOD DOORS AND TRANSOM PANELS WITH PLASTIC-LAMINATE FACES

A. Interior Doors, Solid Core with Plastic-Laminate Faces :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Forte Openings**]
   b. [**Haley Brothers, Inc**]
   c. [**Lambton Doors**]
   d. [**Lynden Door, Inc.**]
   e. [**Oregon Door**]
   f. [**Oshkosh Door Company**]
   g. [**Vancouver Door Company**]
   h. [**VT Industries, Inc.**]

2. Performance Grade: ANSI/WDMA I.S. 1A [**Extra Heavy Duty**][**Heavy Duty**][**Standard Duty**][**as**

indicated on Drawings] .

3. Performance Grade by Location:

   a. ANSI/WDMA I.S. 1A Extra Heavy Duty: [**Classrooms**][**public toilets**][**janitor's closets**][**assembly spaces**][**exits**][**and**][**patient rooms**][**and where indicated on Drawings**] .
   b. ANSI/WDMA I.S. 1A Standard Duty: [**Closets (not including janitor's closets)**][**and**][**private toilets**][**and where indicated on Drawings**] .

4. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
5. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
6. Plastic-Laminate Faces: High-pressure decorative laminates complying with ISO 4586-3, [**Grade HGS**][**Grade HSH**] .
7. Colors, Patterns, and Finishes: [**As indicated**][**As selected by Architect from laminate manufacturer's full range of products**] , as directed by the Owner.
8. Exposed Vertical and Top Edges: [**Hardwood edges for staining to match faces**][**Hardwood edges for painting**][**Plastic-laminate that matches faces, applied before faces**][**impact-resistant polymer edging, applied after faces**] .

   a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
   b. Fire-Rated Pairs of Doors:

      1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
      2) Provide formed-steel edges and astragals with intumescent seals.

         a) Finish steel edges and astragals with baked enamel [**same color as doors**] .
         b) Finish steel edges and astragals to match door hardware (locksets or exit devices).

   c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

      1) Screw-Holding Capability: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

9. Core for Non-Fire-Rated Doors:

   a. Particleboard: ANSI A208.1, [**Grade LD-1**][**Grade LD-2**] .

      1) Blocking: Provide wood blocking in particleboard-core doors as [**needed to eliminate through-bolting hardware.**][**follows:**]

         a) **5-inch (125-mm)** top-rail blocking, in doors indicated to have closers.
         b) **5-inch (125-mm)** bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
         c) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

      2) Provide doors with structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

   b. Structural Composite Lumber:

1) Screw Withdrawal, Door Face: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.
2) Screw Withdrawal, Vertical Door Edge: [**550 lbf (2440 N)**][**475 lbf (2110 N)**][**400 lbf (1780 N)**] in accordance with WDMA T.M. 10.

10. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

    a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as [**needed to eliminate through-bolting hardware.**][**follows:**]

        1) **5-inch (125-mm)** top-rail blocking.
        2) **5-inch (125-mm)** bottom-rail blocking, in doors indicated to have protection plates.
        3) **5-inch (125-mm)** midrail blocking, in doors indicated to have armor plates.
        4) **4-1/2-by-10-inch (114-by-250-mm)** lock blocks.
        5) **5-inch (125-mm)** midrail blocking, in doors indicated to have exit devices.

11. Construction:

    a. Three plies, [**hot-pressed**][**cold-pressed**] bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before faces are applied.
    b. Five plies, [**hot-pressed**][**cold-pressed**] bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before faces and crossbands are applied.

2.9 HOLLOW-CORE FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors, Hollow-Core Veneer Faced :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Haley Brothers, Inc**]
    b. [**Lambton Doors**]
    c. [**Lynden Door, Inc.**]
    d. [**Oregon Door**]
    e. [**Vancouver Door Company**]

2. Performance Grade: ANSI/WDMA I.S. 1A Standard Duty.
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Species: [**Anigre**][**Select white ash**][**Figured select white ash**][**Select white birch**][**Select red birch**][**Cherry**][**Select red gum**][**Figured select red gum**][**Select white maple**][**Red oak**][**White oak**][**Persimmon**][**Sapele**][**Sycamore**][**Walnut**] .
6. Cut: [**Rotary cut**][**Plain sliced (flat sliced)**][**Quarter sliced**][**Rift cut**] .
7. Match between Veneer Leaves: [**Book**][**Slip**][**Random**] match.
8. Assembly of Veneer Leaves on Door Faces: [**Center-balance**][**Balance**][**Running**] match.
9. Pair and Set Match: Provide for doors hung in same opening [**or separated only by mullions**] .
10. Exposed Vertical and Top Edges: [**Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A**][**Same species as faces - Architectural Woodwork Standards edge Type A**][**Applied wood-veneer edges of same species as faces and covering edges of faces - Architectural Woodwork Standards edge Type B**][**Applied wood edges of same species as faces and covering edges of crossbands - Architectural**

Woodwork Standards edge Type D] .

11. Construction: [**Institutional**][**Standard**] hollow core.
12. Blocking: Provide wood blocking with minimum dimensions as follows:

    a. **5-by-18-inch (125-by-460-mm)** lock blocks [**at both stiles**] .
    b. **5-inch (125-mm)** top- [**and bottom-**] rail blocking.
    c. **10-inch (250-mm)**[**top- and**] bottom-rail blocking.
    d. **2-1/2-inch (64-mm)** midrail blocking.

2.10 HOLLOW-CORE FLUSH WOOD DOORS FOR OPAQUE FINISH

A. Interior Doors, Hollow Core for Opaque Finish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Haley Brothers, Inc**]
    b. [**Lambton Doors**]
    c. [**Lynden Door, Inc.**]
    d. [**Oregon Door**]
    e. [**Vancouver Door Company**]

2. Performance Grade: WDMA ANSI/I.S. 1A Standard Duty.
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Faces: [**Any closed-grain hardwood of mill option**][**Hardboard or MDF**] .

    a. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
    b. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.

6. Exposed Vertical and Top Edges: Any closed-grain hardwood.
7. Construction: [**Institutional**][**Standard**] hollow core.
8. Blocking: Provide wood blocking with minimum dimensions as follows:

    a. **5-by-18-inch (125-by-460-mm)** lock blocks [**at both stiles**] .
    b. **5-inch (125-mm)** top- [**and bottom-**] rail blocking.
    c. **10-inch (250-mm)**[**top- and**] bottom-rail blocking.
    d. **2-1/2-inch (64-mm)** midrail blocking.

2.11 HOLLOW-CORE FLUSH WOOD DOORS WITH PLASTIC-LAMINATE FACES

A. Interior Doors, Hollow Core with Plastic-Laminate Faces :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Haley Brothers, Inc**]
    b. [**Lambton Doors**]
    c. [**Vancouver Door Company**]

2. Performance Grade: ANSI/WDMA I.S. 1A Standard Duty.
3. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
4. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
5. Plastic-Laminate Faces: High-pressure decorative laminates complying with ISO 4586-3, [**Grade HGS**][**Grade HSH**] .

    a. Colors, Patterns, and Finishes: [**As indicated**][**As selected by Architect from laminate manufacturer's full range of products**] , as directed by the Owner.

6. Exposed Vertical and Top Edges: [**Hardwood edges for staining to match faces**][**Hardwood edges for painting**][**Plastic-laminate that matches faces, applied before faces**][**Impact-resistant polymer edging, applied after faces**] .

    a. Polymer Edging Color: [**Beige**][**Brown**][**Same color as faces**] .

7. Construction: [**Institutional**][**Standard**] hollow core.
8. Blocking: Provide wood blocking with minimum dimensions as follows:

    a. **5-by-18-inch (125-by-460-mm)** lock blocks [**at both stiles**] .
    b. **5-inch (125-mm)** top- [**and bottom-**] rail blocking.
    c. **10-inch (250-mm)**[**top- and**] bottom-rail blocking.
    d. **2-1/2-inch (64-mm)** midrail blocking.

2.12 FIRE-RATED WOOD DOOR FRAMES

A. Interior Fire-Rated Door Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Forte Openings**]
    b. [**Lambton Doors**]
    c. [**Oshkosh Door Company**]

2. ANSI/WDMA I.S. 1A Quality Grade: [**Premium**][**Custom**] .
3. Architectural Woodwork Standards Quality Grade: [**Premium**][**Custom**] .
4. Wood Species and Cut: Match species and cut indicated for wood doors unless otherwise indicated.
5. Species: [**Anigre**][**Select white ash**][**Figured select white ash**][**Select white birch**][**Select red birch**][**Cherry**][**Select red gum**][**Figured select red gum**][**Select white maple**][**Red oak**][**White oak**][**Persimmon**][**Sapele**][**Sycamore**][**Walnut**] .
6. Cut: [**Plain sliced/plain sawn**][**Quarter cut/quarter sawn**][**Rift cut/rift sawn**] .
7. Wood Moisture Content: [**5 to 10**][**8 to 13**][**4 to 9**] percent.
8. Profile: [**T-stop**][**Flat**][**Single rabbet**][**Double rabbet**][**As indicated on Drawings**] .
9. Construction: Solid lumber, fire-retardant particleboard, or fire-retardant medium density fiberboard (MDF) with veneered exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated on Drawings.

2.13 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: [**Same species as door faces**][**Species compatible with door faces**][**Any closed-grain hardwood**] .
2. Profile: [**Flush rectangular beads**][**Recessed tapered beads**][**Recessed tapered beads with exposed banding**][**Lipped tapered beads**][**Manufacturer's standard shape**] .
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of **0.048-inch- (1.2-mm-)** thick, cold-rolled steel sheet; [**factory primed for paint**][**with baked-enamel- or powder-coated**] finish; and approved for use in doors of fire-protection rating indicated on Drawings.

D. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.

1. Wood Species: [**Same species as door faces**][**Species compatible with door faces**][**Any closed-grain hardwood**] .
2. Profile: [**Flat**][**Chevron**] .

E. Metal Louvers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Allegion plc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**ASSA ABLOY**]
   d. [**JL Industries; Activar Construction Products Group, Inc.**]
   e. [**L & L Louvers, Inc.**]
   f. [**McGill Architectural Products**]

2. Blade Type: [**Vision-proof, inverted V**][**Vision-proof, inverted Y**][**Darkroom-type, double inverted V**] .
3. Metal and Finish:

   a. Hot-Dip Galvanized Steel: **0.040 inch (1.0 mm)** thick, [**factory primed for paint**][**with baked-enamel- or powder-coated**] finish.
   b. Extruded Aluminum: [**Class II, clear anodic finish, AA-M12C22A31**][**Class II, color anodic finish, AA-M12C22A32/A34**] .

      1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

F. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Allegion plc**]
    b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    c. [**ASSA ABLOY**]
    d. [**JL Industries; Activar Construction Products Group, Inc.**]
    e. [**L & L Louvers, Inc.**]
    f. [**McGill Architectural Products**]

2. Metal and Finish: Hot-dip galvanized steel, **0.040 inch (1.0 mm)** thick, [**factory primed for paint**][**with baked-enamel- or powder-coated**] finish.

    a. Color: [**As indicated**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

2.14 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

1. Locate hardware to comply with DHI-TDH-007.
2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels:

1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
3. Fabricate door and transom panels with full-width, solid-lumber [**rabbeted,**] meeting rails.
4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
3. Louvers: Factory install louvers in prepared openings.

E. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but

before factory [**priming**][**finishing**] .

1. Flash top of outswinging doors with manufacturer's standard metal flashing.

2.15 FACTORY PRIMING

A. Doors for Opaque Finish: Factory prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

2.16 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on [**top and**] bottom edges, edges of cutouts, and mortises.

B. Factory finish doors where indicated in schedules or on Drawings as factory finished.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: [**Premium**][**Custom**] .

   a. System-5, Varnish, Conversion.
   b. System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
   c. System-10, UV Curable, Water Based.
   d. System-11, Polyurethane, Catalyzed.

2. ANSI/WDMA I.S. 1A Grade: [**Premium**][**Custom**] .

   a. TR-4 Conversion Varnish.
   b. TR-6 Catalyzed Polyurethane.
   c. TR-8 UV Cured Acrylated Polyester/Urethane.

3. Staining: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**None required**] , as directed by the Owner.
4. Sheen: [**Satin**][**Semigloss**] .

D. Opaque Finish:

1. Architectural Woodwork Standards Grade: [**Premium**][**Custom**] .

   a. System-5, Varnish, Conversion.
   b. System-9, UV Curable, Acrylated Epoxy, Polyester, or Urethane.
   c. System-10, UV Curable, Water Based.
   d. System-11, Polyurethane, Catalyzed.

2. ANSI/WDMA I.S. 1A Grade: [**Premium**][**Custom**] .

   a. OP-4 Conversion Varnish.

b. OP-6 Catalyzed Polyurethane.

3. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
4. Sheen: [**Satin**][**Semigloss**][**Gloss**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FLUSH WOOD DOORS AND TRANSOM PANELS

A. Hardware: For installation, see [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

B. Install doors [**transom panels,**][**and frames**] to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.

1. Shim as required with concealed shims. Install level and plumb to a tolerance of **1/8 inch in 96 inches (3.2 mm in 2400 mm)**.
2. Anchor frames to anchors or blocking built in or directly attached to substrates.

a. Secure with countersunk, concealed fasteners and blind nailing.
b. Use fine finishing nails [**or finishing screws**] for exposed fastening, countersunk and filled flush with woodwork.

1) For factory-finished items, use filler matching finish of items being installed.

3. Fire-Rated Door and Frame Assemblies: Install in accordance with NFPA 80.
4. Smoke- and Draft-Control Door and Frame Assemblies: Install in accordance with NFPA 105.

D. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.

a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.

2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:

a. Provide **1/8 inch (3.2 mm)** at heads, jambs, and between pairs of doors.
b. Provide **1/8 inch (3.2 mm)** from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
c. Where threshold is shown or scheduled, provide **1/4 inch (6.4 mm)** from bottom of door to top of threshold unless otherwise indicated.
d. Comply with NFPA 80 for fire-rated doors.

5. Bevel non-fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** at lock and hinge edges.
6. Bevel fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections and to furnish reports to Architect, as directed by the Owner.

B. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] , certifying that wood doors and frames, including installation, comply with the specified grade.

C. Fire-Rated Door and Frame Acceptance Testing: Test and inspect smoke- and draft-control door and frame assemblies in accordance with NFPA 105.

D. Egress-Door Acceptance Testing: Test and inspect egress doors in accordance with NFPA 101.

E. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

F. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

G. Inspection Report: Prepared and submitted in writing to Architect and Contractor within 24 hours after testing, as directed by the Owner.

3.4 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Factory Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16 00

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Task	Specification	Specification Description
08 14 23 13	01 22 00 00	No Specification Required
08 14 23 16	08 14 16 00	Flush Wood Doors
08 14 23 19	08 14 16 00	Flush Wood Doors
08 14 66 00	01 22 00 00	No Specification Required
08 14 73 00	08 14 16 00	Flush Wood Doors
08 17 23 00	08 14 16 00	Flush Wood Doors

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SECTION 08 18 16 00 - SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior sliding aluminum-framed glass doors.

B. Related Requirements:

1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.
2. Section 085113 "Aluminum Windows" for [**transom and sidelite windows, mullions, and**]coordinating finishes among aluminum fenestration units.
3. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of sliding aluminum-framed glass doors with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Main Framing Member: **12-inch-long (300-mm-long)** section with weather stripping, glazing bead, and factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.

E. Product Schedule: For sliding aluminum-framed glass doors. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each configuration of sliding aluminum-framed glass door, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports. For sliding aluminum-framed glass doors,

C. Qualification Statements: For [**manufacturer**][**Installer**][**and**][**testing agency**].

D. Sample Warranties: For sliding aluminum-framed glass doors.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes, weather stripping, operable panels, and operating hardware to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating sliding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: Entity acceptable to sliding aluminum-framed glass door manufacturer for installation of units required for this Project.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sliding aluminum-framed glass doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures, including excessive deflection, water penetration, and air leakage.
   b. Faulty operation of operable panels and hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Failure of insulating glass[**and laminated glass**].

2. Warranty Period:

   a. Sliding Aluminum-Framed Glass Doors: [**Two**][**Three**][**Five**][**10**] years from date of Substantial Completion.
   b. Insulating-Glass Units: [**Five**][**10**][**20**] years from date of Substantial Completion.
   c. Laminated Glass: [**Five**][**10**] years from date of Substantial Completion.
   d. Aluminum Finish: [**Five**][**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

   1. Product Certification: AAMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

   1. Minimum Performance Class: [**Class R**][**Class LC**][**Class CW**][**Class AW**][**As indicated on Drawings**].
   2. Minimum Performance Grade: [**Grade 15**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 50**][**Grade 60**][**Grade 80**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum whole-unit U-factor of [**0.33 Btu/sq. ft. x h x deg F (1.87 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 whole-unit maximum SHGC of [**0.41**][**0.27**].

E. Condensation-Resistance Factor (CRF): AAMA 1503, minimum [**39**][**46**] CRF.

F. Thermal Movements: Provide sliding aluminum-framed glass doors, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

   1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C)**], material surfaces.

G. Sound Transmission Class (STC): Rated for not less than [**30**][**39**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

H. Outside-Inside Transmission Class (OITC): Rated for not less than [**25**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing [**located within 30 ft. (9.1 m) of grade**].
2. Small-Missile Test: For glazing located [**between 30 ft. (9.1 m) and 60 ft. (18.3 m)**][**greater than 30 ft. (9.1 m)**] above grade.

2.2 EXTERIOR SLIDING ALUMINUM-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Arcadia Inc.**]
2. [**Boyd Aluminum Mfg. Co.**]
3. [**EFCO Corporation**]
4. [**Fleetwood Windows & Doors**]
5. [**Graham Architectural Products Corporation**]
6. [**Kawneer Company, Inc.; Arconic Corporation**]
7. [**Milgard Manufacturing, LLC**]
8. [**Northern Architectural Systems**]
9. [**PGT Custom Windows + Doors; PGT Innovations (PGTI)**]
10. [**PRL Glass Systems Inc.**]
11. [**Solar Innovations, Inc.**]
12. [**Thermal Windows, Inc.**]
13. [**Wausau Window and Wall Systems; Apogee Wausau Group, Inc.**]
14. [**WinDoor; a PGTI brand**]
15. [**Wojan Window & Door Corporation**]
16. [**YKK AP America Inc.**]

B. Source Limitations: Obtain sliding aluminum-framed glass doors from single source from single manufacturer.

C. Door Assemblies: Fabricate frames and glazed panels from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Broken Construction: Fabricate frames and glazed panels with an integral, concealed, low-conductance thermal barrier (break) located between separate exterior and interior aluminum profiles in a manner that eliminates direct metal-to-metal contact.
2. Door Panels: Provide stationary panels and sliding panels [**in configurations indicated on Drawings**].
3. Transoms: Provide manufacturer's standard fixed transoms held within the same frame as door panels in configuration [**indicated on Drawings**].
4. Sidelites: Provide manufacturer's standard fixed sidelites held within the same frame as door panels in configuration [**indicated on Drawings**].
5. Mullions: Provide mullions and mullion casing and cover plates as indicated on Drawings, matching door units, complete with anchors for support to structure and installation of sliding aluminum-framed glass door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design loads of door units.
6. True Divided Lites: Fabricate glazed panels with true muntins resulting in individually glazed lites; provide muntin configuration and profile indicated on Drawings.

D. Threshold and Sill Cap/Track: Provide extruded-aluminum threshold and track of dimensions and profile

indicated on Drawings; designed to comply with performance requirements indicated and to drain to the exterior; with manufacturer's standard finish.

1. Low-Profile Threshold and Sill Cap/Track: Provide ADA-ABA compliant thresholds and tracks [**where indicated on Drawings**][**where indicated in schedules**].

2.3 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal.[**Comply with requirements for windborne-debris impact resistance.**][**Comply with requirements indicated in Section 088000 "Glazing."**]

1. Glass: ASTM C1036, Type 1, q3, Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with [manufacturer's][SGCC] certification label indicating manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
4. Insulating-Glass Units: ASTM E2190[certified through IGCC as complying with requirements of IGCC].

   a. Filling: Fill space between glass lites with [**air**][**argon**].
   b. Lites: [**Two**][**Three**].
   c. Low-E Coating: [**Manufacturer's standard**][**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].
   d. Spacer Color: [**Manufacturer's standard**]<**Inset color**>.

B. Simulated Divided Lites: Provide grilles in configuration indicated on Drawings; finished to match panels.

1. Location: [**Between lites of insulating-glass units**][**Permanently applied to outside face of glazing units**][**Permanently applied to outside and inside faces of glazing units**].
2. Profile: [**Flat**][**Manufacturer's standard contoured profile**][**As indicated on Drawings**].
3. Width: [**5/8-inch (16-mm)**][**3/4-inch (19-mm)**][**1-inch (25-mm)**][**1-1/16-inch (27-mm)**][**As indicated on Drawings**].

2.4 HARDWARE

A. General: Manufacturer's [**standard**] hardware complying with requirements in AAMA 907; fabricated from a corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock sliding aluminum-framed glass doors; and sized to accommodate panel weight and dimensions.

B. Door Pulls: [**Provide manufacturer's standard pull**].

1. Color and Finish: [**As indicated by manufacturer's designations**][**Match door frame**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Lock: Manufacturer's keyed cylinder lock and [**multipoint**] locking device to secure each operable panel, lockable from the inside [**only**][**and outside**]. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

1. Keying System: [**All cylinders keyed alike**][**Keyed to match other building entrances**].

D. Rollers: On each operable panel, dual [**corrosion-resistant**][**stainless steel**] ball-bearing rollers.

2.5 INSECT SCREENS

A. General: Design sliding aluminum-framed glass doors to accommodate screens in a tight-fitting, removable arrangement, fully integrated with door frame. Provide screen for each operable door panel.

B. Aluminum Frames: Manufacturer's standard extruded-aluminum profile finished to match door frame; fabricated from aluminum alloy complying with requirements in SMA 1201; with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC or PE spline/anchor concealing edge of frame.

1. Fiberglass Mesh Fabric: ASTM D3656/D3656M, [**manufacturer's standard**] mesh of PVC-coated fiberglass.

a. Mesh Color: [**Manufacturer's standard**][**Charcoal gray**][**Silver gray**].

2. Aluminum Wire Fabric: [**Manufacturer's standard**] mesh of coated aluminum wire.

a. Wire-Fabric Finish: [**Manufacturer's standard**][**Silver**][**Charcoal gray**].

C. Hardware: [**Manufacturer's standard noncorrosive pull and keyless locking device; lockable from inside only; designed to allow unobstructed movement of panels and screen**].

2.6 ACCESSORIES

A. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

B. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Impact Resistance: Provide anchors of same design used in windborne-debris impact-resistance testing.

C. Nail Fins: Manufacturer's standard.

2.7 FABRICATION

A. Fabricate sliding aluminum-framed glass doors in sizes and with stile and rail dimension indicated on Drawings. Include a complete system for assembling components and anchoring doors.

B. Fabricate sliding aluminum-framed glass doors that are reglazable without dismantling panel framing.

C. Weather Stripping: Provide full-perimeter weather stripping for each door panel.

D. Weep Holes: Provide weep holes and internal drainage passages to conduct infiltrating water to exterior.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

F. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory. Comply with requirements in [**Section 088000 "Glazing" and**] AAMA/WDMA/CSA 101/I.S.2/A440.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry-film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and curing finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin

manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of threshold/track substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight sliding aluminum-framed glass door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SLIDING ALUMINUM-FRAMED GLASS DOORS

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing doors, hardware, accessories, and other components.

B. Windborne-Debris Impact Resistance: Anchor sliding aluminum-framed glass doors that have been tested for windborne-debris impact resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris impact-resistance testing.

C. Install sliding aluminum-framed glass doors level, plumb, square, true in line, without distortion, without warp or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.

D. Set sill members in bed of sealant, as indicated on Drawings, to provide weathertight construction.

E. Install sliding aluminum-framed glass doors and components to drain condensation, water penetrating joints, and moisture migrating within doors to the exterior.

F. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Test and inspect installed sliding aluminum-framed glass doors as follows:

1. Testing Methodology: Test sliding aluminum-framed glass doors for air-leakage and water-penetration resistance in accordance with AAMA 502.
2. Air-Leakage Resistance Testing:

    a. Test Pressure: Pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
    b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Penetration Resistance Testing:

    a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
    b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] sliding aluminum-framed glass doors of each type as selected by Architect and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured, as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Sliding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Lubricate hardware and moving parts in accordance with manufacturer's written instructions.

B. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding, and a weathertight closure.

C. Adjust hardware for proper alignment, smooth operation, and proper latching without requiring unnecessary force or having excessive clearance.

D. Clean exposed surfaces immediately after installing sliding aluminum-framed glass doors. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

E. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

F. Protect sliding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact sliding aluminum-framed glass door surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

G. Refinish or replace sliding aluminum-framed glass doors with damaged finishes.

H. Replace damaged components.

END OF SECTION 08 18 16 00

SECTION 08 18 16 00A - MULTIPANEL SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multipanel sliding aluminum-framed glass doors.

B. Related Requirements:

1. Section 083513.13 "Multipanel Folding Aluminum-Framed Glass Doors" for multipanel aluminum-framed glass doors that operate by folding.
2. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units on the building exterior.
3. Section 085113 "Aluminum Windows" for coordinating finishes among aluminum fenestration units on the building exterior.
4. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Multipanel sliding aluminum-framed glass doors.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for multipanel sliding aluminum-framed glass doors.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

D. Shop Drawings:

1. Include plans, elevations, sections, and installation details.
2. Indicate dimensions, configuration of panels, and stacking layout.

E. Samples: For each multipanel sliding aluminum-framed glass door and for each color specified, **12-**

inch-long (300-mm-long) section with factory-applied color finish.

F. Samples for Initial Selection: For doors and hardware with factory-applied color finish.

G. Samples for Verification: For multipanel sliding aluminum-framed glass doors and components required, prepared on Samples of size indicated below:

1. Main Framing Member: 12-inch-long (300-mm-long) section with weather stripping, glazing bead, and factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.

H. Product Schedule: For multipanel sliding aluminum-framed glass doors.[**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Product Test Reports: For each multipanel sliding aluminum-framed glass door, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**]; and for each class and performance grade indicated, tested at AAMA gateway size.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For multipanel sliding aluminum-framed glass doors to include in maintenance manuals. Include finishes, weather stripping, operable panels, and operating hardware.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating multipanel sliding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

B. Installer Qualifications: An installer acceptable to multipanel sliding aluminum-framed glass door manufacturer for installation of units required for this Project.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup for multipanel sliding aluminum-framed glass doors, as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace multipanel sliding aluminum-

framed glass doors that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Failure to meet performance requirements.
   b. Structural failures, including excess deflection.
   c. Excessive water leakage or air infiltration.
   d. Faulty operation of movable panels and hardware.
   e. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   f. Failure of insulating glass[**and laminated glass**].

2. Warranty Period:

   a. Multipanel Sliding Aluminum-Framed Glass Doors: [**Five**][**Ten**][**20**] year(s) from date of Substantial Completion.
   b. Insulating-Glass Units: [**10**][**20**] years from date of Substantial Completion.
   c. Laminated Glass: [**Five**] years from date of Substantial Completion.
   d. Aluminum Finish: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Product Certification: AAMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**Class R**][**Class LC**][**Class CW**][**Class AW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**Grade 15**][**Grade 20**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 45**][**Grade 50**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum total fenestration product U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**][**0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.43 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum total fenestration product SHGC of [**0.40**][**0.30**][**0.27**].

E. Condensation-Resistance Factor (CRF): Provide multipanel sliding aluminum-framed glass doors tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

F. Thermal Movements: Provide multipanel sliding aluminum-framed glass doors, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C)**], material surfaces.

G. Sound Transmission Class (STC): Rated for not less than [**28**][**32**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

H. Outside-Inside Transmission Class (OITC): Rated for not less than [**23**][**27**][**29**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within **30 feet (9.1 m)** of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

2.2 MULTIPANEL SLIDING ALUMINUM-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Arcadia Inc.**]
3. [**Euro-Wall Systems, LLC**]
4. [**LaCantina Doors; a division of JELD-WEN**]
5. [**Milgard Manufacturing, LLC**]
6. [**Nana Wall Systems, Inc.**]
7. [**Panda Windows & Doors**]
8. [**Ply-Gem**]
9. [**Solar Innovations, Inc.**]

B. Multipanel Sliding Aluminum-Framed Glass Doors: Provide extruded-aluminum-framed, multipanel sliding glass doors, designed for exterior use, complete with glazing, threshold, flashings, support, and anchorage devices.

1. Stack Storage Configuration: [**Panels open from center to both sides and are stored within opening**][**Panels open from one side stack into storage area outside of opening**][**As shown on Drawings**].

C. Frames and Door Panels: Fabricate from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440 and indicated requirements. Provide factory-assembled door panels that are reglazable without dismantling panel framing and [factory-assembled][field-assembled] frames.

1. Thermally Improved Construction: Fabricate frames and door panels with an integral, concealed, low-conductance thermal barrier located between exterior and interior surfaces in a manner that eliminates direct metal-to-metal contact.
2. Door Panel Design: [As indicated][Narrow stile][Medium stile][Wide stile] design[with 10-inch (254-mm) nominal height bottom rail].
3. Grilles (False Muntins): Provide between-glass grilles in designs indicated to each panel lite, with material and finish to match adjacent door panel finish.

a. Bar Width: Not less than [**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1-1/8 inches (28 mm)**] wide.
b. Bar Profile: [**Beveled**][**Ovolo**][**Square**].

2.3 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal. [**Comply with requirements for windborne-debris resistance**][**Comply with requirements indicated in Section 088000 "Glazing"**].

1. Glass: ASTM C1036, Type 1, q3; Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][the manufacturer]. Label must indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
4. Insulating-Glass Units: ASTM E2190[certified through IGCC as complying with requirements of IGCC].

a. Filling: Fill space between glass lites with [**air**][**argon**].
b. Lites: [**Two**][**Three**].
c. Low-E Coating: [**Manufacturer's standard**][**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

2.4 HARDWARE

A. Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with door panels and other components, and complying with AAMA 907. Provide hardware designed to smoothly operate, tightly close, and securely lock multipanel sliding aluminum-framed glass doors. Size hardware to accommodate panel weights and dimensions. Provide full-perimeter weatherstripping for each door panel.

B. Bottom-Supported Panel System: Provide panel support system designed for size, weight, and

performance requirements of multipanel sliding aluminum-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Bottom Carriers: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track. Provide carriers with sealed ball bearings.
2. Lock: Provide manufacturer's standard multipoint locking device on primary door panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Provide manufacturer's standard lock mechanism on each secondary door panel operable from the inside. Adjust locking devices to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

    a. Trim Design: [**As selected from manufacturer's full range**].
    b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
    c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded-aluminum [thermally broken,] multitrack threshold with [raised, weather-resistant profile][low profile, compliant with United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

    a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

C. Lift-and-Slide Panel System: Provide panel support system designed for size, weight, and performance requirements of multipanel sliding aluminum-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Bottom Carriers: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track. Provide carriers with sealed ball bearings, incorporating lift-and-slide mechanism operated by locking handle.
2. Lock: Provide multipoint locking system on each door panel designed to unlock and raise panel from track, and engage bottom carrier. Provide exterior cylinder lock on primary panel. Provide [**interior**][**and**][**exterior**] finger pulls on each panel. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

    a. Trim Design: [**As selected from manufacturer's full range**].
    b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
    c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded-aluminum [thermally broken,] multitrack threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

    a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

D. Multitrack Top-Supported Panel System: Provide panel support system designed for size, weight, and performance requirements of multipanel sliding aluminum-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Overhead Carriers: Provide multiwheeled overhead carriers suspended from steel or aluminum

track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide carriers with sealed ball bearings.

2. Lock: Provide manufacturer's standard keyed cylinder lock and multipoint locking device on primary door panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Provide manufacturer's standard lock mechanism on each secondary door panel operable from the inside. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

    a. Trim Design: [**As selected from manufacturer's full range**].
    b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
    c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded-aluminum [thermally broken,] threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

    a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

E. Single-Track Top-Supported Panel System: Provide panel support system designed for size, weight, and performance requirements of multipanel sliding aluminum-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Overhead Carriers: Provide overhead carriers suspended from steel or aluminum track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide carriers with sealed ball bearings.
2. Stacking Track System: Provide intersections, switches, and accessories required for operation, storage, track configuration, and layout indicated for multipanel sliding wood-framed glass doors. Fabricate track intersections and switches from steel or aluminum.
3. Lock: Provide manufacturer's standard multipoint locking device on each movable panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

    a. Trim Design: [**As selected from manufacturer's full range**].
    b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
    c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

4. Threshold Configuration: Extruded-aluminum [thermally broken,] threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

    a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

2.5 ACCESSORIES

A. Trim: Provide interior and exterior casings, jamb extensions, and other components in material and

finish to match door frames.

B. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

C. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for multipanel sliding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Resistance: Provide anchors of same design used in windborne-debris resistance testing.

2.6 INSECT SCREENS

A. Screen Fabric: Provide screen mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; and complying with ASTM D3656/D3656M.

1. Fabric Color: [**Manufacturer's standard**][**Charcoal gray**][**Silver gray**].

B. Pleated Insect Screen: Screen suspended from the top, with bottom guide, and finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

C. Coiling Insect Screen: Coiling screen housed in jamb-mounted cartridge, guided by upper and lower tracks. Finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

2.7 FABRICATION

A. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

B. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory.

2.8 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight hinged-door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing multipanel sliding aluminum-framed glass doors, hardware, accessories, and other components.

B. Windborne-Debris Resistance: Anchor multipanel sliding aluminum-framed glass doors that have been tested for windborne-debris resistance to structure, using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris resistance testing.

C. Install multipanel sliding aluminum-framed glass doors level, plumb, square, true to line; without distortion, warp, or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.

D. Set threshold members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Test and inspect installed multipanel sliding aluminum-framed glass doors as follows:

1. Testing Methodology: Test multipanel sliding aluminum-framed glass doors for air infiltration and water resistance in accordance with AAMA 502.
2. Air-Infiltration Testing:

a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.

b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] multipanel sliding aluminum-framed glass doors of each type as selected by Architect and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured, as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Multipanel sliding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING

A. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.

B. Adjust hardware and operable panels to function smoothly, and lubricate as recommended by manufacturer.

3.5 CLEANING

A. Clean exposed surfaces immediately after installation. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.6 PROTECTION

A. Protect multipanel sliding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately in accordance with manufacturer's written instructions.

B. Refinish or replace sliding aluminum-framed glass doors with damaged finishes.

END OF SECTION 08 18 16 00A

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SECTION 08 18 16 00B - SLIDING WOOD-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-clad sliding wood-framed glass doors.
2. Vinyl-clad sliding wood-framed glass doors.
3. Unclad sliding wood-framed glass doors.

B. Related Requirements:

1. Section 085200 "Wood Windows" for [**transom and sidelite windows, mullions, and**] coordinating finishes among fenestration units.
2. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in this Section.
3. Section 099300 "Staining and Transparent Finishing" for on-site finishing of unfinished sliding wood-framed glass doors.
4. [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for on-site finishing of [**unfinished**][**and**][**factory-primed**] sliding wood-framed glass doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of sliding wood-framed glass doors with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Main Framing Member: **12-inch-long (300-mm-long)** section with weather stripping, glazing bead, and specified finishes.
2. Exposed Hardware: Full-size units with factory-applied finish.

E. Product Schedule: For sliding wood-framed glass doors. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each configuration of sliding wood-framed glass door, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports. For sliding wood-framed glass doors,

C. Qualification Statements: For [**manufacturer**][**vendor**][**Installer**][**and**][**testing agency**].

D. Sample Warranties: For sliding wood-framed glass doors.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**factory-applied finishes,**]weather stripping, operable panels, and operating hardware to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

C. Manufacturer Qualifications: A manufacturer capable of fabricating sliding wood-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

D. Installer Qualifications: Entity acceptable to sliding wood-framed glass door manufacturer for installation of units required for this Project.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of sliding wood-

framed glass doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures, including excessive deflection, water penetration, and air leakage.
   b. Faulty operation of operable panels and hardware.
   c. Deterioration of materials and factory-applied finishes beyond normal weathering.
   d. Failure of insulating glass[**and laminated glass**].

2. Warranty Period:

   a. Sliding Wood-Framed Glass Doors: [**Five**][**10**][**20**] years from date of Substantial Completion.
   b. Insulating Glass: [**10**][**20**] years from date of Substantial Completion.
   c. Laminated Glass: [**Five**] years from date of Substantial Completion.
   d. Exterior Factory-Applied Finishes: [**Five**][**10**][**20**] years from date of Substantial Completion.
   e. Interior Factory-Applied Finishes: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sliding wood-framed glass doors from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

   1. Product Certification: WDMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

   1. Minimum Performance Class: [**Class R**][**Class LC**][**Class CW**][**As indicated on Drawings**].
   2. Minimum Performance Grade: [**Grade 15**][**Grade 20**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 45**][**Grade 50**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum whole-unit U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.70 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 whole-unit maximum SHGC of [**0.40**][**0.25**].

E. Sound Transmission Class (STC): Rated for not less than [**29**][**30**][**31**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

F. Outside-Inside Transmission Class (OITC): Rated for not less than [**23**][**24**][**25**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

G. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing [**located within 30 ft. (9.1 m) of grade**].
2. Small-Missile Test: For glazing located [**between 30 ft. (9.1 m) and 60 ft. (18.3 m)**][**greater than 30 ft. (9.1 m)**] above grade.

2.3 ALUMINUM-CLAD SLIDING WOOD-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Crestline Windows and Doors**]
3. [**JELD-WEN, Inc.**]
4. [**Kolbe Windows & Doors**]
5. [**Marvin**]
6. [**Pella Corporation**]
7. [**Ply-Gem**]
8. [**Sierra Pacific Windows; Sierra Pacific Industries**]
9. [**Weather Shield Mfg., Inc**]

B. Exterior Surfaces: [**Manufacturer's standard aluminum cladding**].

1. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry-film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and curing finish.

   a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Fir**][**Alder**][**Oak**][**Cherry**][**Mahogany**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 VINYL-CLAD SLIDING WOOD-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]

B. Exterior Surfaces: Vinyl-clad frames; vinyl-clad or high-performance color-coated finish on glazed panels.

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Oak**][**Maple**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied color-coated white finish**].

2.5 UNCLAD SLIDING WOOD-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**JELD-WEN, Inc.**]
2. [**Marvin**]
3. [**Sierra Pacific Windows; Sierra Pacific Industries**]
4. [**Weather Shield Mfg., Inc**]

B. Exterior Surfaces: [**Manufacturer's standard paint-grade wood species**][**Pine**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Manufacturer's standard factory-applied primer**][**Manufacturer's standard factory-applied color-coated finish**][**Unfinished**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Mahogany**][**Fir**][**Alder**][**Oak**][**Cherry**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. True Divided Lites: Fabricate glazed panels with true muntins resulting in individually glazed lites; provide muntin configuration and profile indicated on Drawings.

2.6 DOOR-ASSEMBLY COMPONENTS

A. Wood Components: Laminated veneer lumber (LVL) or fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to maximum moisture content of 12 percent at time of

fabrication; water-repellent preservative treated.

B. Certified Wood: Wood doors shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood doors shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

D. Certified Wood: Wood doors shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

E. Trim and Glazing Stops: Material and finish to match adjacent door components.

F. Transoms: Provide manufacturer's fixed transoms from same product line as doors; fabricated and finished to match door frame and panels; in configuration [**indicated on Drawings**].

G. Sidelites: Provide manufacturer's fixed sidelites from same product line as doors; fabricated and finished to match door frame and panels; in configuration [**indicated on Drawings**].

H. Mullions: Provide mullions and mullion casing and cover plates as shown on Drawings, matching door units, complete with anchors for support to structure and installation of sliding wood-framed glass door units. Allow for erection tolerances and provide for movement of door units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design loads of door units.

I. Integral Nailing Fin: Manufacturer's standard nailing fin for securing frame to structure; with sufficient strength to withstand design pressure indicated.

J. Drip Caps: Manufacturer's standard; factory-fabricated and -finished to match exterior door frame; designed to direct water away from building when installed horizontally at head of sliding wood-framed glass doors.

K. Threshold and Sill Cap/Track: [**Manufacturer's standard**]; of dimensions and profile indicated on Drawings; designed to comply with performance requirements indicated and to drain to exterior.

1. Color: [**Bronze**][**Black**][**Beige**][**Manufacturer's standard**].
2. Low-Profile Threshold and Sill Cap/Track: Provide ADA-ABA compliant thresholds and tracks [**where indicated on Drawings**][**where indicated in schedules**].
3. Sill Ramps: Provide ADA-ABA compliant sill ramps [**where indicated on Drawings**][**where indicated in schedules**].

   a. Interior Section: [**Maple**][**Oak**][**Aluminum**].
   b. Exterior Section: [**Aluminum**][**Manufacturer's standard**].

2.7 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal.[**Comply with requirements for windborne-debris impact resistance.**]

1. Glass: ASTM C1036, Type 1, q3, Category II safety glass complying with testing requirements in 16 CFR 1201.

2. Safety Glazing Labeling: Permanently mark safety glazing with [manufacturer's][SGCC] certification label indicating manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
4. Insulating-Glass Units: ASTM E2190[certified through IGCC as complying with requirements of IGCC].

    a. Filling: Fill space between glass lites with [**air**][**argon**].
    b. Lites: [**Two**][**Three**].
    c. Low-E Coating: [**Manufacturer's standard**][**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].
    d. Spacer Color: [**Manufacturer's standard**][**Silver**][**Gray**][**Black**]<**Inset color**>.

5. Dual Glazing:

    a. Interior Glazing: [**Monolithic glass**].
    b. Exterior Glazing: [**Monolithic glass**][**Insulating-glass unit**].

B. Integral Louver Blinds: Manufacturer's standard horizontal louver blinds with aluminum slats and polyester-fiber cords, located in space between [**interior and exterior glazing of dual-glazed units**][**insulating-glass lites**], and operated by hardware located on inside face of door panel.

1. Operation: [**Tilt only**][**Tilt, raising, and lowering**].
2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Simulated Divided Lites: Provide grilles in configuration indicated on Drawings and as follows:

1. Grilles Between Lites: Provide grilles permanently installed between lites of insulating-glass units in color [**selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Exterior Grilles: Provide grilles permanently applied to outside face of glazing units and finished to match door exterior.
3. Interior Grilles: Provide grilles that are [**removable**][**permanently applied to inside face of glazing units**]; finished to match door interior.
4. Profile: [**Flat**][**Manufacturer's standard contoured profile**][**As indicated on Drawings**].
5. Width: [**5/8-inch (16-mm)**][**7/8-inch (22-mm)**][**1-1/8 inch (29-mm)**][**As indicated on Drawings**].

2.8 HARDWARE

A. General: Manufacturer's [**standard**] hardware complying with requirements in AAMA 907; fabricated from corrosion-resistant material compatible with materials with which it comes in contact; designed to smoothly operate, tightly close, and securely lock sliding wood-framed glass doors; and sized to accommodate panel weight and dimensions.

B. Door Pulls: [**Provide manufacturer's standard pull**].

1. Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Lock: Manufacturer's keyed cylinder lock and [**multipoint**] locking device to secure each operable panel, lockable from the inside [**only**][**and outside**]. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

1. Keying System: [**All cylinders keyed alike**][**Keyed to match other building entrances**].

D. Security Foot Bolt: Foot-operated dead bolt to lock operable panel when fully closed and when partially open to permit ventilation.

E. Rollers: On each operable panel, dual [**corrosion-resistant**][**stainless steel**] ball-bearing rollers.

F. Limit Stops: Resilient rubber.

2.9 INSECT SCREENS

A. General: Design sliding wood-framed glass doors to accommodate screens in a tight-fitting, removable arrangement fully integrated with door frame. Provide screen for each operable door panel.

B. Sliding Insect Screens: SMA 1201.

1. Aluminum Frames: Manufacturer's standard [extruded][roll-formed tubular] members finished to match door frame; fabricated with mitered or coped joints, concealed fasteners, adjustable rollers, and removable PVC or PE spline/anchor concealing edge of mesh.
2. Fiberglass Mesh Fabric: ASTM D3656/D3656M, [**manufacturer's standard**] mesh of PVC-coated fiberglass.

   a. Mesh Color: [**Manufacturer's standard**][**Charcoal gray**][**Silver gray**].

3. Aluminum Wire Fabric: [**Manufacturer's standard**] coated aluminum wire.

   a. Wire-Fabric Finish: [**Manufacturer's standard**][**Silver**][**Charcoal gray**].

4. Hardware: [**Manufacturer's standard noncorrosive pull and keyless locking device; lockable from inside only; designed to allow unobstructed movement of panels and screen**].

C. Retractable Insect Screen: [**Manufacturer's standard self-storing screen assembly mounted behind vertical cover at door interlocker**].

1. Cover Finish: [**Match panel finish**].
2. Hardware: [**Manufacturer's standard noncorrosive pull and keyless locking device; lockable from inside only**].
3. Fiberglass Mesh: ASTM D3656/D3656M, [**manufacturer's standard**] PVC-coated fiberglass mesh.

2.10 ACCESSORIES

A. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

B. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding wood-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Impact Resistance: Provide anchors of same design used in windborne-debris

impact-resistance testing.

2.11 FABRICATION

A. Fabricate sliding wood-framed glass doors in sizes and with stile and rail dimensions indicated on Drawings. Include a complete system for assembling components and anchoring doors.

B. Fabricate sliding wood-framed glass doors that are reglazable without dismantling panel framing.

C. Weather Stripping: Provide full-perimeter weather stripping for each door panel.

D. Factory-machine sliding wood-framed glass doors for openings and hardware that is not surface applied.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

F. Factory-Glazed Fabrication: Glaze sliding wood-framed glass doors in the factory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of threshold/track substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight sliding wood-framed glass door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SLIDING WOOD-FRAMED GLASS DOORS

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing sliding doors, hardware, accessories, and other components.

B. Windborne-Debris Impact Resistance: Anchor sliding wood-framed glass doors that have been tested for windborne-debris impact resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris impact-resistance testing.

C. Install sliding wood-framed glass doors level, plumb, square, true in line, without distortion, without warp or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction. Comply with requirements in ASTM E2112.

D. Set sill members in bed of sealant, as indicated on Drawings, to provide weathertight construction.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials in accordance with ASTM E2112.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Test and inspect installed sliding wood-framed glass doors as follows:

1. Testing Methodology: Test sliding wood-framed glass doors for air leakage and water penetration in accordance with AAMA 502.
2. Air-Leakage Resistance Testing:

   a. Test Pressure: Pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Penetration Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] sliding wood-framed glass doors of each type as selected by Architect and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured, as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Sliding wood-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Lubricate hardware and moving parts in accordance with manufacturer's written instructions.

B. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding, and weathertight closure.

C. Adjust hardware for proper alignment, smooth operation, and proper latching without requiring unnecessary force or having excessive clearance.

D. Clean exposed surfaces immediately after installing sliding wood-framed glass doors. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

E. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

F. Protect sliding wood-framed glass door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact sliding wood-framed glass door surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

G. Refinish or replace sliding wood-framed glass doors with damaged factory-applied finishes.

H. Replace damaged components.

END OF SECTION 08 18 16 00B

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SECTION 08 18 16 00C - MULTIPANEL SLIDING WOOD-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multipanel sliding wood-framed glass doors.

B. Related Requirements:

1. Section 081816.23 "Multipanel Folding Wood-Framed Glass Doors" for multipanel wood-framed glass doors that operate by folding.
2. Section 085200 "Wood Windows" for related wood-framed transom and sidelite windows and mullions, and for coordinating combinations and finish among wood fenestration units.
3. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in this Section.
4. Section 099300 "Staining and Transparent Finishing" for on-site finishing of unfinished multipanel sliding wood-framed glass doors.
5. [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for on-site finishing of [**unfinished**][**and**][**factory-primed**] multipanel sliding wood-framed glass doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for multipanel sliding wood-framed glass doors.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings:

1. Include plans, elevations, sections, and installation details.
2. Indicate dimensions, configuration of panels, and stacking layout.

D. Samples: For each multipanel sliding wood-framed glass door and for each color specified; **12-inch-long (300-mm-long)** section with factory-applied color finish.

E. Samples for Initial Selection: For doors and hardware with factory-applied color finish.

F. Samples for Verification: For multipanel sliding wood-framed glass doors and components required, prepared on Samples of size indicated below:

1. Main Framing Member: **12-inch-long (300-mm-long)** section with weather stripping, glazing bead and factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.

G. Product Schedule: For multipanel sliding wood-framed glass doors.[**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Product Test Reports: For each multipanel sliding wood-framed glass door, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**]; and for each class and performance grade indicated, tested at AAMA gateway size.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For multipanel sliding wood-framed glass doors to include in maintenance manuals. Include finishes, weather stripping, operable panels, and operating hardware.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: An installer acceptable to multipanel sliding wood-framed glass door manufacturer for installation of units required for this Project.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup for multipanel sliding wood-framed glass doors, as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace multipanel sliding wood-framed glass doors that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excess deflection.
c. Excessive water leakage or air infiltration.
d. Faulty operation of movable panels and hardware.
e. Deterioration of wood, metals, metal finishes, and other materials beyond normal weathering.
f. Failure of insulating glass[**and laminated glass**].

2. Warranty Period:

a. Multipanel Sliding Wood-Framed Glass Doors: [**Five**][**Ten**][**20**] year(s) from date of Substantial Completion.
b. Insulating-Glass Units: [**10**][**20**] years from date of Substantial Completion.
c. Laminated Glass: [**Five**] years from date of Substantial Completion.
d. Aluminum Finish: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Product Certification: AAMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**Class R**][**Class LC**][**Class CW**][**Class AW**][**As indicated on**

Drawings].
2. Minimum Performance Grade: [**Grade 15**][**Grade 20**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 45**][**Grade 50**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum total fenestration product U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**][**0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.43 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum total fenestration product SHGC of [**0.40**][**0.30**][**0.27**].

E. Condensation-Resistance Factor (CRF): Provide multipanel sliding wood-framed glass doors tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

F. Sound Transmission Class (STC): Rated for not less than [**28**][**32**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

G. Outside-Inside Transmission Class (OITC): Rated for not less than [**23**][**27**][**29**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within **30 feet (9.1 m)** of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

2.2 MULTIPANEL SLIDING WOOD-FRAMED GLASS DOORS

A. Multipanel Sliding Wood-Framed Glass Doors: Provide multipanel wood-framed sliding glass doors, designed for exterior use, complete with glazing, threshold, flashings, support, and anchorage devices.

1. Stack Storage Configuration: [**Panels open from center to both sides, and are stored within opening**][**Panels open from one side stack into storage area outside of opening**][**As shown on Drawings**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Centor North America, Inc.**]
3. [**Dynamic Architectural Windows & Doors, Inc.**]
4. [**JELD-WEN, Inc.**]
5. [**LaCantina Doors; a division of JELD-WEN**]
6. [**Lanai Doors**]
7. [**Milgard Manufacturing, LLC**]
8. [**Nana Wall Systems, Inc.**]
9. [**Panda Windows & Doors**]
10. [**Sierra Pacific Windows; Sierra Pacific Industries**]
11. [**Weather Shield Mfg., Inc**]

C. Frames and Door Panels: Fabricate from wood components complying with AAMA/WDMA/CSA 101/I.S.2/A440 and indicated requirements. Provide factory-assembled door panels that are reglazable

without dismantling panel framing and [factory-assembled][field-assembled] frames.

1. Door Panel Design: [Narrow-profile][Standard-profile][Wide-profile] design[with 10-inch (254-mm) nominal height bottom rail].
2. True Divided Lites: Provide glazing with true muntins, resulting in individually glazed lites, in pattern indicated.
3. Grilles (False Muntins): Provide grilles in designs indicated to each panel lite.

    a. Type: [**Interior, removable**][**Exterior and interior, removable**][**Exterior and interior, adhered to glass**][**with between-glass grille**].
    b. Design: [**Rectangular**][**Diamond**][**as indicated on Drawings**].
    c. Bar Width: Not less than [**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1-1/8 inches (28 mm)**] wide.
    d. Bar Profile: [**Beveled**][**Ovolo**][**Square**].
    e. Color: [**White**][**Bronze**][**To match adjacent door finish**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Aluminum-Clad Exterior Finish: Aluminum cladding with [**manufacturer's standard baked-on enamel finish**][**manufacturer's standard high-performance organic finish**][**manufacturer's standard fluoropolymer two-coat system with fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight and complying with AAMA 2605**].

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Wood Exterior Finish: [**Manufacturer's standard factory-applied primer**][**Manufacturer's standard factory-applied color finish**][**Unfinished**].

1. Wood Species: [**Manufacturer's standard paint-grade species**][**Pine**][**Mahogany**][**Douglas Fir**][**Western Hemlock**][**Spruce**].
2. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Interior Surfaces: [**Unfinished**][**Manufacturer's standard factory-applied primer**][**Manufacturer's standard factory-applied color finish**][**Manufacturer's standard stain-and varnish-finish**].

1. Wood Species: [**Manufacturer's standard species**][**Pine**][**Mahogany**][**Fir**][**Alder**][**Oak**][**Cherry**].
2. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Wood Components: Manufacturer's standard LVL or fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than **1/32 inch (0.8 mm)** deep by **2 inches (51 mm)** wide; water-repellent preservative treated.

H. Certified Wood: Wood doors shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

I. Certified Wood: Wood doors shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood doors shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

K. Certified Wood: Wood doors shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

L. Certified Wood: Wood doors shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.3 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal. [**Comply with requirements for windborne-debris resistance**][**Comply with requirements indicated in Section 088000 "Glazing"**].

1. Glass: ASTM C1036, Type 1, q3; Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][the manufacturer]. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
4. Insulating-Glass Units: ASTM E2190[certified through IGCC as complying with requirements of IGCC].

   a. Filling: Fill space between glass lites with [**air**][**argon**].
   b. Lites: [**Two**][**Three**].
   c. Low-E Coating: [**Manufacturer's standard**][**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

2.4 HARDWARE

A. Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with door panels and other components, and complying with AAMA 907. Provide hardware designed to smoothly operate, tightly close, and securely lock multipanel sliding wood-framed glass doors. Size hardware to accommodate panel weights and dimensions. Provide full-perimeter weatherstripping for each door panel.

B. Bottom-Supported Panel System: Provide panel support system designed for size, weight, and performance requirements of multipanel sliding wood-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Bottom Carriers: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track. Provide carriers with sealed ball bearings.
2. Lock: Provide manufacturer's standard multipoint locking device on primary door panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Provide manufacturer's standard lock mechanism on each secondary door panel operable from the inside. Adjust locking devices to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

   a. Trim Design: [**As selected from manufacturer's full range**].
   b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
   c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded-aluminum [thermally broken,] multitrack threshold with [raised, weather-resistant profile][low profile, compliant with United States Access Board's "Americans

with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

C. Lift-and-Slide Panel System: Provide panel support system designed for size, weight and performance requirements of multipanel sliding wood-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Bottom Carriers: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track. Provide carriers with sealed ball bearings incorporating lift-and-slide mechanism operated by locking handle.
2. Lock: Provide multipoint locking system on each door panel designed to unlock and raise panel from track, and engage bottom carrier. Provide exterior cylinder lock on primary panel. Provide [**interior**][**and**][**exterior**] finger pulls on each panel. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

   a. Trim Design: [**As selected from manufacturer's full range**].
   b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
   c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded aluminum [thermally broken,] multitrack threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush] profile[with concealed drainage system].

   a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

D. Multitrack Top-Supported Panel System: Provide panel support system designed for size, weight, and performance requirements of multipanel sliding wood-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Overhead Carriers: Provide multiwheeled overhead carriers suspended from steel or aluminum track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide carriers with sealed ball bearings.
2. Lock: Provide manufacturer's standard keyed cylinder lock and multipoint locking device on primary door panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Provide manufacturer's standard lock mechanism on each secondary door panel operable from the inside. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

   a. Trim Design: [**As selected from manufacturer's full range**].
   b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
   c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Threshold Configuration: Extruded-aluminum [thermally broken,] threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

E. Single-Track Top-Supported Panel System: Provide panel support system designed for size, weight and performance requirements of multipanel sliding wood-framed glass doors indicated, capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

1. Overhead Carriers: Provide overhead carriers suspended from steel or aluminum track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide carriers with sealed ball bearings.
2. Stacking Track System: Provide intersections, switches, and accessories required for operation, storage, track configuration, and layout indicated for multipanel sliding wood-framed glass doors. Fabricate track intersections and switches from steel or aluminum.
3. Lock: Provide manufacturer's standard multipoint locking device on each movable panel, lockable from the inside. Provide exterior cylinder lock on primary panel. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

   a. Trim Design: [**As selected from manufacturer's full range**].
   b. Trim Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].
   c. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

4. Threshold Configuration: Extruded-aluminum [thermally broken,] threshold with [raised, weather-resistant profile][low profile, compliant with the United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush][with concealed drainage system].

   a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

2.5 ACCESSORIES

A. Trim: Provide interior and exterior casings, jamb extensions, and other components in material and finish to match door frames.

B. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

C. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for multipanel sliding wood-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Resistance: Provide anchors of same design used in windborne-debris resistance testing.

2.6 INSECT SCREENS

A. Screen Fabric: Provide screen mesh of PVC-coated, glass-fiber threads; woven and fused to form a

fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; and complying with ASTM D3656/D3656M.

1. Fabric Color: [**Manufacturer's standard**][**Charcoal gray**][**Silver gray**].

B. Pleated Insect Screen: Screen suspended from the top, with bottom guide, and finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

C. Coiling Insect Screen: Coiling screen housed in jamb-mounted cartridge, guided by upper and lower tracks. Finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

2.7 FABRICATION

A. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

B. Factory-Glazed Fabrication: Glaze sliding wood-framed glass doors in the factory.

2.8 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA

2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.10 WOOD FINISHES

A. Factory-Applied Primer: Provide manufacturer's standard factory-applied prime coat complying with WDMA T.M. 11. on exposed [**exterior**][**and**][**interior**] wood surfaces.

B. Factory-Applied Color Finish: Provide manufacturer's standard factory-applied finish [**complying with WDMA T.M. 12**]. Apply finish to exposed [**exterior**][**and**][**interior**] wood surfaces.

1. Color: [**White**][**Brown**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight hinged door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing multipanel sliding wood-framed glass doors, hardware, accessories, and other components.

B. Windborne-Debris Resistance: Anchor multipanel sliding wood-framed glass doors that have been tested for windborne-debris resistance to structure, using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris resistance testing.

C. Install multipanel sliding wood-framed glass doors level, plumb, square, true to line; without distortion, warp, or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.

D. Set threshold members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Test and inspect installed multipanel sliding wood-framed glass doors as follows:

1. Testing Methodology: Test multipanel sliding wood-framed glass doors for air infiltration and water resistance in accordance with AAMA 502.
2. Air-Infiltration Testing:

   a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] multipanel sliding wood-framed glass doors of each type as selected by Architect and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured, as directed by the Owner.

5. Test Reports: Prepared in accordance with AAMA 502.

C. Multipanel sliding wood-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING

A. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.

B. Adjust hardware and operable panels to function smoothly, and lubricate as recommended by manufacturer.

3.5 CLEANING

A. Clean exposed surfaces immediately after installation. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.6 PROTECTION

A. Protect multipanel sliding wood-framed glass door surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately in accordance with manufacturer's written instructions.

B. Refinish or replace sliding wood-framed glass doors with damaged finishes.

END OF SECTION 08 18 16 00C

SECTION 08 31 13 00 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flush access doors with exposed flanges.
2. Flush access doors with concealed flanges.
3. Recessed access doors with exposed flanges.
4. Recessed access doors with concealed flanges.
5. Aluminum flush access doors.
6. Lightweight flush access doors.
7. Exterior flush access doors.
8. Interior flush GFRG access doors with concealed flanges.
9. Exterior flush GFRC access doors with concealed flanges.
10. Fire-rated access doors with exposed flanges.
11. Fire-rated access doors with concealed flanges.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof hatches.
2. Section 083113.53 "Security Access Doors and Frames" for access doors and frames for security applications.
3. Section 083123 "Floor Doors" for doors installed in floors.
4. Section 233300 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, [**fire ratings,**] material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum **6 by 6 inches (150 by 150 mm)** in size.

C. Product Schedule: For access doors and frames. [**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For fire-rated door inspections.

B. Qualification Statements: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.5 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection [**and temperature-rise limit**] ratings indicated, in accordance with NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACUDOR Products, Inc**]
b. [**Babcock-Davis**]
c. [**Best Access Doors**]
d. [**Cendrex Inc.**]
e. [**Elmdor; Morris Group International, Inc.**]
f. [**JL Industries; Activar Construction Products Group, Inc.**]
g. [**Karp Associates, Inc**]
h. [**Lane-Aire Manufacturing Corp.**]
i. [**Larsen's Manufacturing Company**]
j. [**Maxam Metal Products Limited**]
k. [**Metropolitan Door Industries Corp.**]
l. [**MIFAB, Inc**]
m. [**Milcor by Duravent; Duravent Group.**]
n. [**Nystrom, Inc.**]
o. [**Williams Brothers Corporation of America**]

2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable doors**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Uncoated Steel Sheet for Door: [**Nominal 0.060 inch (1.52 mm), 16 gage**] , factory

[**primed**][**finished**] .

6. Metallic-Coated Steel Sheet for Door: [**Nominal 0.064 inch (1.63 mm), 16 gage**] , factory [**primed**][**finished**] .
7. Stainless Steel Sheet for Door: [**Nominal 0.062 inch (1.59 mm), 16 gage**] , ASTM A480/A480M No. 4 finish.
8. Frame Material: [**Same material, thickness, and finish as door**] .
9. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

B. Flush Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**Babcock-Davis**]
   c. [**Bauco Access Panel Solutions Inc.**]
   d. [**Best Access Doors**]
   e. [**Cendrex Inc.**]
   f. [**Elmdor; Morris Group International, Inc.**]
   g. [**JL Industries; Activar Construction Products Group, Inc.**]
   h. [**Karp Associates, Inc**]
   i. [**Lane-Aire Manufacturing Corp.**]
   j. [**Larsen's Manufacturing Company**]
   k. [**Maxam Metal Products Limited**]
   l. [**Metropolitan Door Industries Corp.**]
   m. [**MIFAB, Inc**]
   n. [**Milcor by Duravent; Duravent Group.**]
   o. [**Nystrom, Inc.**]
   p. [**Williams Brothers Corporation of America**]

2. Description: Face of door flush with frame; with concealed flange for [**gypsum board**][**plaster**] installation and concealed hinge.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable doors**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Uncoated Steel Sheet for Door: [**Nominal 0.060 inch (1.52 mm), 16 gage**] , factory [**primed**][**finished**] .
6. Metallic-Coated Steel Sheet for Door: [**Nominal 0.064 inch (1.63 mm), 16 gage**] factory [**primed**][**finished**] .
7. Stainless Steel Sheet for Door: [**Nominal 0.062 inch (1.59 mm), 16 gage**] , ASTM A480/A480M No. 4 finish.
8. Frame Material: [**Same material and thickness as door**] .
9. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

C. Recessed Access Doors with Exposed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ACUDOR Products, Inc**]
    b. [**Babcock-Davis**]
    c. [**Cendrex Inc.**]
    d. [**Elmdor; Morris Group International, Inc.**]
    e. [**JL Industries; Activar Construction Products Group, Inc.**]
    f. [**Karp Associates, Inc**]
    g. [**Lane-Aire Manufacturing Corp.**]
    h. [**Larsen's Manufacturing Company**]
    i. [**Maxam Metal Products Limited**]
    j. [**Metropolitan Door Industries Corp.**]
    k. [**MIFAB, Inc**]
    l. [**Nystrom, Inc.**]
    m. [**Williams Brothers Corporation of America**]

2. Description: Door face recessed [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**1 inch (25 mm)**] for [**gypsum board**][**plaster**][**acoustical tile**] infill, with exposed flange and concealed hinge.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable doors**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Uncoated Steel Sheet for Door: [**Nominal 0.060 inch (1.52 mm), 16 gage**] , factory [**primed**][**finished**] .
6. Metallic-Coated Steel Sheet for Door: [**Nominal 0.064 inch (1.63 mm), 16 gage**] , factory [**primed**][**finished**] .
7. Stainless Steel Sheet for Door: [**Nominal 0.062 inch (1.59 mm), 16 gage**] , ASTM A480/A480M No. 4 finish.
8. Frame Material: [**Same material and thickness as door**] .
9. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

D. Recessed Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ACUDOR Products, Inc**]
    b. [**Babcock-Davis**]
    c. [**Bauco Access Panel Solutions Inc.**]
    d. [**Best Access Doors**]
    e. [**Cendrex Inc.**]
    f. [**Elmdor; Morris Group International, Inc.**]
    g. [**JL Industries; Activar Construction Products Group, Inc.**]
    h. [**Karp Associates, Inc**]
    i. [**Lane-Aire Manufacturing Corp.**]
    j. [**Larsen's Manufacturing Company**]
    k. [**Maxam Metal Products Limited**]

l. [**Metropolitan Door Industries Corp.**]
m. [**MIFAB, Inc**]
n. [**Milcor by Duravent; Duravent Group.**]
o. [**Nystrom, Inc.**]
p. [**Williams Brothers Corporation of America**]

2. Description: Door face recessed [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**1 inch (25 mm)**] for [**gypsum board**][**plaster**][**acoustical tile**] infill; with concealed flange for [**gypsum board**][**plaster**][**no bead for acoustical tile**] installation and concealed hinge.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable door**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Uncoated Steel Sheet for Door: [**Nominal 0.060 inch (1.52 mm), 16 gage**] , factory [**primed**][**finished**] .
6. Metallic-Coated Steel Sheet for Door: [**Nominal 0.064 inch (1.63 mm), 16 gage**] , factory [**primed**][**finished**] .
7. Stainless Steel Sheet for Door: [**Nominal 0.062 inch (1.59 mm), 16 gage**] , [**ASTM A480/A480M No. 4**][**ASTM A480/A480M No. 2b**] finish.
8. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

E. Aluminum Flush Access Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ACUDOR Products, Inc**]
b. [**Babcock-Davis**]
c. [**Best Access Doors**]
d. [**Cendrex Inc.**]
e. [**Lane-Aire Manufacturing Corp.**]
f. [**Metropolitan Door Industries Corp.**]
g. [**MIFAB, Inc**]
h. [**Milcor by Duravent; Duravent Group.**]
i. [**Williams Brothers Corporation of America**]

2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable doors**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Aluminum Sheet for Door: [**Nominal 0.045 inch (1.15 mm)**] , with [**mill**][**manufacturer's standard baked-enamel or powder-coat**] finish.
6. Frame Material: [**Same material, thickness, and finish as door**] .
7. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

F. Lightweight Flush Access Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ACUDOR Products, Inc**]
    b. [**Babcock-Davis**]
    c. [**Cendrex Inc.**]
    d. [**JL Industries; Activar Construction Products Group, Inc.**]
    e. [**Karp Associates, Inc**]
    f. [**Larsen's Manufacturing Company**]
    g. [**Maxam Metal Products Limited**]
    h. [**Metropolitan Door Industries Corp.**]
    i. [**MIFAB, Inc**]
    j. [**Nystrom, Inc.**]
    k. [**Williams Brothers Corporation of America**]

2. Description: Face of door flush with exposed flange, with exposed piano hinge; frameless for surface installation.
3. Optional Features: [**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Louvers**][**Masonry anchors**][**Removable door**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Uncoated Steel Sheet for Door: [**Nominal 0.018 inch (0.46 mm), 26 gage**] , factory [**primed**][**finished**] .
6. Metallic-Coated Steel Sheet for Door: [**Nominal 0.022 inch (0.56 mm), 26 gage**] , factory [**primed**][**finished**] .
7. Frame Material: [**Aluminum, nominal 0.045 inch (1.15 mm), mill finish**] .
8. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**Cam latch, spanner-head wrench operated**][**Latch bolt, knurled-knob operated**][**Latch bolt, key operated**][**Prepared for mortise cylinder**][**As indicated on Drawings**][**As indicated in schedule**][**with interior release**] .

G. Exterior Flush Access Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Babcock-Davis**]
    b. [**JL Industries; Activar Construction Products Group, Inc.**]
    c. [**Karp Associates, Inc**]
    d. [**Larsen's Manufacturing Company**]
    e. [**Maxam Metal Products Limited**]
    f. [**MIFAB, Inc**]
    g. [**Nystrom, Inc.**]
    h. [**Williams Brothers Corporation of America**]

2. Description: Weatherproof assembly, with face of door fit flush with frame and with exposed frame. Include extruded door gaskets and minimum **2-inch- (50-mm-)** thick fiberglass insulation.
3. Optional Features: [**Piano hinges**][**Removable doors**] .
4. Locations: [**Wall**] .
5. Metallic-Coated Steel Sheet for Door: [**Nominal 0.064 inch (1.63 mm), 16 gage**] , factory [**primed**][**finished**] .

6. Aluminum Sheet for Door: [**Nominal 0.045 inch (1.15 mm)**] , with [**mill**][**manufacturer's standard baked-enamel or powder-coat**] finish.
7. Stainless Steel Sheet for Door: [**Nominal 0.062 inch (1.59 mm), 16 gage**] , [**ASTM A480/A480M No. 4**][**ASTM A480/A480M No. 2b**] finish.
8. Frame Material: [**Same material, thickness, and finish as door**] .
9. Latch and Lock: Cam latch operated by handle, [**without lock**][**with keyed lock in handle**][**with separate mortise lock**][**with preparation for mortise lock**][**as indicated on Drawings**][**as indicated in schedule**][**with interior release**] .

H. Interior Flush GFRG Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**Babcock-Davis**]
   c. [**Best Access Doors**]
   d. [**Cendrex Inc.**]
   e. [**Elmdor; Morris Group International, Inc.**]
   f. [**JL Industries; Activar Construction Products Group, Inc.**]
   g. [**Karp Associates, Inc**]
   h. [**MIFAB, Inc**]
   i. [**Milcor by Duravent; Duravent Group.**]
   j. [**Williams Brothers Corporation of America**]

2. Description: Face of [**drop-in**][**concealed-hinge**] door flush with frame, with concealed flange for gypsum board installation.
3. Optional Features: [**Gasketing**][**Piano hinges**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
5. Door Type [**Drop in, radius corner**][**Drop in, square corner**][**Concealed-hinge, radius corner**][**Concealed-hinge, square corner**] .
6. Door and Frame Material: Unpainted glass-fiber-reinforced gypsum, with frames reinforced for hardware and fastenings.
7. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**As indicated on Drawings**][**As indicated in schedule**] .

I. Exterior Flush GFRC Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**JL Industries; Activar Construction Products Group, Inc.**]
   c. [**Karp Associates, Inc**]
   d. [**MIFAB, Inc**]
   e. [**Milcor by Duravent; Duravent Group.**]
   f. [**Williams Brothers Corporation of America**]

2. Description: Face of door flush with frame, neoprene gasketed, with concealed flange for gypsum board installation.
3. Optional Features: [**Piano hinges**] .
4. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .

5. Door Type: [**Drop in, radius corner**][**Drop in, square corner**][**Concealed-hinge, radius corner**][**Concealed-hinge, square corner**] .
6. Door and Frame Material: Unpainted glass-fiber-reinforced cement, with frames reinforced for hardware and fastenings.
7. Latch and Lock: [**Cam latch, screwdriver operated**][**Cam latch, key operated**][**Cam latch, hex-head wrench operated**][**Cam latch, pinned-hex-head wrench operated**][**As indicated on Drawings**][**As indicated in schedule**] .

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated Access Doors with Exposed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**Babcock-Davis**]
   c. [**Best Access Doors**]
   d. [**Cendrex Inc.**]
   e. [**Elmdor; Morris Group International, Inc.**]
   f. [**JL Industries; Activar Construction Products Group, Inc.**]
   g. [**Karp Associates, Inc**]
   h. [**Lane-Aire Manufacturing Corp.**]
   i. [**Larsen's Manufacturing Company**]
   j. [**Maxam Metal Products Limited**]
   k. [**Metropolitan Door Industries Corp.**]
   l. [**MIFAB, Inc**]
   m. [**Milcor by Duravent; Duravent Group.**]
   n. [**Nystrom, Inc.**]
   o. [**Williams Brothers Corporation of America**]

2. Description: Door flush with frame [[**with a core of mineral-fiber insulation enclosed in sheet metal**][[**uninsulated**] ; with exposed flange, self-closing door, and concealed hinge.
3. Door Type:

   a. Flush.
   b. Recessed [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**1 inch (25 mm)**] for [**gypsum board**][**plaster**][**acoustical tile**] .

4. Optional Features: [**Upward-opening doors for ceilings**][**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Masonry anchors**] .
5. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
6. Fire-Resistance Rating: Not less than [**that indicated**][**that of adjacent construction**][**45 minutes**][**1 hour**][**1-1/2 hours**][**2 hours**][**3 hours**] .
7. Temperature-Rise Rating: [**450 deg F (250 deg C)**][**250 deg F (139 deg C)**] at the end of 30 minutes.
8. Uncoated Steel Sheet for Door: [**Nominal 0.036 inch (0.91 mm), 20 gage**] , factory [**primed**][**finished**] .
9. Metallic-Coated Steel Sheet for Door: [**Nominal 0.040 inch (1.02 mm), 20 gage**] , factory [**primed**][**finished**] .
10. Stainless Steel Sheet for Door: [**Nominal 0.038 inch (0.95 mm), 20 gage**] , ASTM A480/A480M No. 4 finish.

11. Frame Material: [**Same material, thickness, and finish as door**] .
12. Latch and Lock: Self-latching door hardware, [**operated by knurled-knob**][**operated by key**][**prepared for mortise cylinder**][**as indicated on Drawings**][**as indicated in schedule**][**with interior release**] .

B. Fire-Rated Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ACUDOR Products, Inc**]
   b. [**Babcock-Davis**]
   c. [**Best Access Doors**]
   d. [**Cendrex Inc.**]
   e. [**JL Industries; Activar Construction Products Group, Inc.**]
   f. [**Karp Associates, Inc**]
   g. [**Maxam Metal Products Limited**]
   h. [**Metropolitan Door Industries Corp.**]
   i. [**MIFAB, Inc**]
   j. [**Milcor by Duravent; Duravent Group.**]
   k. [**Nystrom, Inc.**]
   l. [**Williams Brothers Corporation of America**]

2. Description: Door flush with frame, [**with a core of mineral-fiber insulation enclosed in sheet metal**][**uninsulated**] ; with concealed flange for [**gypsum board**][**plaster**] installation, self-closing door, and concealed hinge.
3. Door Type:

   a. Flush.
   b. Recessed [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**1 inch (25 mm)**] for [**gypsum board**][**plaster**][**acoustical tile**] .

4. Optional Features: [**Upward-opening doors for ceilings**][**Gasketing**][**Double-leaf doors**][**Piano hinges**][**Masonry anchors**] .
5. Locations: [**Wall**][**Ceiling**][**Wall and ceiling**] .
6. Fire-Resistance Rating: Not less than [**that indicated**][**that of adjacent construction**][**45 minutes**][**1 hour**][**1-1/2 hours**][**2 hours**][**3hours**] .
7. Temperature-Rise Rating: [**450 deg F (250 deg C)**][**250 deg F (139 deg C)**] at the end of 30 minutes.
8. Uncoated Steel Sheet for Door: [**Nominal 0.036 inch (0.91 mm), 20 gage**] , factory [**primed**][**finished**] .
9. Metallic-Coated Steel Sheet for Door: [**Nominal 0.040 inch (1.02 mm), 20 gage**] , factory [**primed**][**finished**] .
10. Stainless Steel Sheet for Door: [**Nominal 0.038 inch (0.95 mm), 20 gage**] , ASTM A480/A480M No. 4 finish.
11. Frame Material: [**Same material, thickness, and finish as door**] .
12. Latch and Lock: Self-closing, self-latching door hardware, [**operated by knurled-knob**][**operated by key**][**prepared for mortise cylinder**][**as indicated on Drawings**][**as indicated in schedule**][**with interior release**] .

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum **G60 (Z180)** or **A60 (ZF180)** metallic coating.

D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**] . Remove tool and die marks and stretch lines, or blend into finish.

E. Stainless Steel Flat Bars: ASTM A666, [**Type 304**][**Type 316**] . Remove tool and die marks and stretch lines, or blend into finish.

F. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063.

G. Aluminum Sheet: ASTM B209/B209M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

H. Frame Anchors: Same material as door face.

I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices, and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.

E. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.
3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive**

Specification)."]

F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of **1 mil (0.025 mm)** for topcoat.

a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**] , as directed by the Owner.

E. Stainless Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ACCESS DOORS AND FRAMES

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections and to furnish reports to Architect, as directed by the Owner.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**] .

3.4 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 31 13 00

SECTION 08 33 13 00 - COILING COUNTER DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Counter door assemblies.
2. Fire-rated counter door assemblies.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for door-opening framing and corner guards.
2. Section 099123 "Interior Painting" for finish painting of factory-primed doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of coiling counter door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Show locations of controls, locking devices[**detectors or replaceable fusible links**], and other accessories.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats[**including full vision window secured to slat**].
2. Bottom bar[**with sensor edge**].
3. Guides.
4. Brackets.
5. Hood.

6. Laminate-clad counter panel product for each type, color, pattern, and surface finish; laminated to core.
7. Locking device(s).
8. Include similar Samples of accessories involving color selection.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing and inspecting agency**].

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coiling counter doors to include in maintenance manuals.

B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain coiling counter doors from single source from single manufacturer.

1. Obtain operators and controls from coiling counter door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to [**NFPA 252**][**UL 10B**].

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Temperature-Rise Limit: [**Where indicated**][**At exit enclosures and exit passageways**], provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.
3. Smoke Control: [**Where indicated**][**In corridors and smoke barriers**], provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of **3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m)** of door opening at **0.10 inch wg (24.9 Pa)** for both ambient and elevated temperature tests.

B. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

2.3 COUNTER DOOR ASSEMBLY

A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACME Rolling Doors**]
   b. [**Alpine Overhead Doors, Inc**]
   c. [**Alumatec Pacific Products**]
   d. [**Amarr Company**]
   e. [**ASTA America; Janus International Group**]
   f. [**C.H.I. Overhead Doors, Inc.**]
   g. [**City Gates USA**]
   h. [**Clopay Building Products**]
   i. [**Cookson; a CornellCookson company**]
   j. [**Cornell; a CornellCookson company**]
   k. [**Lawrence Roll-Up Doors, Inc.**]
   l. [**McKeon Door Company**]
   m. [**Metro Door LLC**]
   n. [**Overhead Door Corporation**]
   o. [**Wayne Dalton; a division of Overhead Door Corporation**]
   p. [**Woodfold Manufacturing, Inc.**]

B. Operation Cycles: Door components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**]. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. STC Rating: [**26**].

D. Curtain R-Value: [**4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W)**][**5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W)**][**6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W)**].

E. Door Curtain Material: [**Galvanized steel**][**Stainless steel**][**Aluminum**].

F. Door Curtain Slats: [**Curved**][**Flat**] profile slats of [**1-1/4-inch (32-mm)**][**1-1/2-inch (38-mm)**] center-to-center height.

1. Perforated Slats: Approximately [**1/16-inch (1.6-mm) pinholes**][**3/32-inch (2.4-mm) pinholes**][**7/8-inch- (22-mm-) wide by 3/8-inch- (10-mm-) high slots**].
2. Fenestrated Slats: Approximately [**3- by 5/8-inch (76- by 16-mm)**][**4- by 5/8-inch (102- by 16-mm)**][**10- by 1-5/8-inch (254- by 41-mm)**] openings spaced approximately [**1-1/2 inches (38 mm)**] apart and beginning **12 inches (305 mm)** from jamb guides.
3. Vision Panels: Approximately **10- by 1-5/8-inch (254- by 41-mm)** openings spaced approximately **2 inches (51 mm)** apart and beginning **12 inches (305 mm)** from end guides; in [**two**][**three**] rows of slats at height indicated on Drawings; installed with[**insulated**] vision-panel glazing.
4. Insulated-Slat Interior Facing: [**Metal**][**Plastic**].
5. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

G. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, fabricated [**hot-dip galvanized steel**][**stainless steel**][**aluminum extrusion**] and finished [**to match door**].

H. Curtain Jamb Guides: [**Galvanized steel**][**Stainless steel**][**Aluminum**] with exposed finish matching curtain slats.[**Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.**][**Provide removable post(s) and jamb guides where indicated on Drawings.**]

I. Hood: [**Match curtain material and finish**][**Galvanized steel**][**Stainless steel**][**Aluminum**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

J. Integral Frame, Hood, and Fascia: [**Galvanized**][**Stainless**] steel.

1. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

K. Sill Configuration: [**No sill**][**Integral metal sill**].

L. Locking Devices: Equip door with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

M. Manual Door Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank operator**][**Awning-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

N. Electric Door Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].

4. Motor Electrical Characteristics:

   a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
   b. Voltage:

      1) [**115-V ac**][**208-V ac**][**230-V ac**], single phase, 60 Hz.
      2) [**208-V ac**][**230-V ac**][**460-V ac**], three phase, 60 Hz.

5. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
6. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

   a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

7. Control Station(s): [**Interior-side mounted**][**Exterior-side mounted**][**Where indicated on Drawings**].

O. Curtain Accessories: Equip door with [**smoke seals**][**weatherseals**][**astragal**][**push/pull handles**][**pull-down strap**][**pole hook**][**and**][**automatic closing device**].

P. Door Finish:

1. Aluminum Finish: [**Mill**][**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Black anodized**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Factory Prime Finish: Manufacturer's standard color.
4. Stainless Steel Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 4 (polished directional satin)**].
5. Interior Curtain-Slat Facing: [**Match finish of exterior curtain-slat face**][**PVC plastic**].

2.4 FIRE-RATED COUNTER DOOR ASSEMBLY

A. Fire-Rated Counter Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACME Rolling Doors**]
   b. [**Alpine Overhead Doors, Inc**]
   c. [**Amarr Company**]
   d. [**ASTA America; Janus International Group**]
   e. [**C.H.I. Overhead Doors, Inc.**]
   f. [**City Gates USA**]
   g. [**Clopay Building Products**]
   h. [**Cookson; a CornellCookson company**]
   i. [**Cornell; a CornellCookson company**]
   j. [**Lawrence Roll-Up Doors, Inc.**]

k. [**McKeon Door Company**]
l. [**Overhead Door Corporation**]
m. [**Wayne Dalton; a division of Overhead Door Corporation**]

B. Operation Cycles: Door components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**]. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Fire Rating: [**3/4 hour**][**1 hour**][**1-1/2 hours**][**3 hours**][**4 hours**][**with temperature-rise limit**][**and**][**with smoke control**].

D. STC Rating: [**27**].

E. Curtain R-Value: [**4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W)**][**5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W)**][**6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W)**].

F. Door Curtain Material: [**Galvanized**][**Stainless**] steel.

G. Door Curtain Slats: [**Curved**][**Flat**] profile slats of [**1-1/4-inch (32-mm)**][**1-1/2-inch (38-mm)**] center-to-center height.

1. Vision Panels: Approximately **10- by 1-5/8-inch (254- by 41-mm)** openings spaced approximately **2 inches (51 mm)** apart and beginning **12 inches (305 mm)** from end guides; in [**two**][**three**] rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
2. Insulated-Slat Interior Facing: Metal.

H. Curtain Jamb Guides: [**Galvanized**][**Stainless**] steel with exposed finish matching curtain slats.

I. Hood: [**Match curtain material and finish**][**Galvanized steel**][**Stainless steel**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

J. Integral Frame, Hood, and Fascia: [**Galvanized**][**Stainless**] steel.

1. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

K. Sill Configuration: [**No sill**][**Integral metal sill**][**Fire-rated, laminate counter**].

1. High-Pressure Decorative Laminate: Match color, pattern, and finish [**as indicated by manufacturer's designations**][**of Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.

L. Locking Devices: Equip door with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

M. Manual Door Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank**

operator][**Awning-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

N. Electric Door Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].
4. Motor Electrical Characteristics:

   a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
   b. Voltage:

      1) [**115-V ac**][**208-V ac**][**230-V ac**], single phase, 60 Hz.
      2) [**208-V ac**][**230-V ac**][**460-V ac**], three phase, 60 Hz.

5. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
6. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

   a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

7. Control Station(s): [**Interior-side mounted**][**Exterior-side mounted**][**Where indicated on Drawings**].

O. Curtain Accessories: Equip door with smoke seals, automatic closing device, [**astragal**][**push/pull handles**][**pull-down strap**][**pole hook**][**and**].

P. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Factory Prime Finish: Manufacturer's standard color.
3. Stainless Steel Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 4 (polished directional satin)**].
4. Interior Curtain-Slat Facing: [**Match finish of exterior curtain-slat face**].

2.5 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 DOOR CURTAIN MATERIALS AND FABRICATION

A. Door Curtains: Fabricate coiling counter door curtain of interlocking metal slats in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical

properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with **G90 (Z275)** zinc coating; nominal sheet thickness (coated) of **0.028 inch (0.71 mm)**; and as required.
2. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of **0.025 inch (0.64 mm)**; and as required.
3. Aluminum Door Curtain Slats: **ASTM B209 (ASTM B209M)** sheet or **ASTM B221 (ASTM B221M)** extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of **0.050 inch (1.27 mm)**; and as required.
4. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
5. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
6. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
7. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of [**25**][**75**][**200**] and smoke-developed index of 450, according to ASTM E84 or UL 723.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.7 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal **0.028-inch- (0.71-mm-)** thick, hot-dip galvanized-steel sheet with **G90 (Z275)** zinc coating, complying with ASTM A653/A653M.
2. Stainless Steel: **0.025-inch- (0.64-mm-)** thick, stainless steel sheet, Type 304, complying with ASTM A240/A240M or ASTM A666.
3. Aluminum: **0.040-inch- (1.02-mm-)** thick aluminum sheet complying with **ASTM B209 (ASTM B209M)**, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
4. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.

B. Integral Frame, Hood, and Fascia: Welded sheet metal assembly of the following sheet metal(s):

1. Galvanized Steel: Hot-dip galvanized-steel sheet with **G90 (Z275)** zinc coating, complying with ASTM A653/A653M.
2. Stainless Steel: Type 304, complying with ASTM A240/A240M or ASTM A666.

C. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.8 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: As [**specified in Section 087100 "Door Hardware"**][**specified in Section 087111 "Door Hardware (Descriptive Specification)"**][**standard with manufacturer**][**and keyed to building keying system**].
2. Keys: [**Two**][**Three**] for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 CURTAIN ACCESSORIES

A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.

B. Weatherseals: Equip door with weather-stripping gaskets fitted to entire perimeter of door for air-resistant installation unless otherwise indicated.

1. At door head, use **1/8-inch- (3-mm-)** thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, [**flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene**][**nylon brushes**].

C. Astragal: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

E. Pull-Down Strap: Provide pull-down straps for doors more than **84 inches (2130 mm)** high.

F. Pole Hooks: Provide pole hooks and poles for doors more than **84 inches (2130 mm)** high.

G. Automatic-Closing Device: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism.[**Testing for manually operated doors allows resetting by opening the door without retensioning the counterbalance mechanism.**][**Release mechanism for motor-operated doors allows testing without mechanical release of the door.**] Automatic-closing device is to be designed for activation by the following:

1. Replaceable fusible links with temperature rise and melting point of [**165 deg F (74 deg C)**] interconnected and mounted on both sides of door opening.
2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
4. Building fire-detection, smoke-detection, and -alarm systems.

2.10 COUNTER DOOR ACCESSORIES

A. Integral Metal Sill: Fabricate sills as integral part of frame assembly of Type 304 stainless steel in manufacturer's standard thickness with [**ASTM A480/A480M No. 4**] finish.

B. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure, decorative laminate-covered countertop; UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.

2.11 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, [**seamless**][**welded**] carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than **0.03 in./ft. (2.5 mm/m)** of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic closing device operates.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.12 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Door Operation: Design counterbalance mechanism so that required lift or pull for door operation does not exceed [**25 lbf (111 N)**].

C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum [**25-lbf (111-N)**][**30-lbf (133-N)**] force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than [**25-lbf (111-N)**][**30-lbf (133-N)**] force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.13 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.

1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.

D. Motors: Reversible-type motor[**with controller (disconnect switch)**] for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than **8 in./sec. (203 mm/s)** and not more than **12 in./sec. (305 mm/s)**, without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening.[**For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.**][**For fire-rated doors, activation delays closing.**]

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.

2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

   a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Type: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed [**25 lbf (111 N)**][**30 lbf (133 N)**].

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.14 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.15 ALUMINUM FINISHES

A. Mill Finish: Manufacturer's standard.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.16 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.17 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install coiling counter doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install coiling counter doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Fire-Rated Doors: Install according to NFPA 80.

D. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and

inspections and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**].

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service is to include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of coiling-door Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain coiling counter doors.

END OF SECTION 08 33 13 00

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Task	Specification	Specification Description
08 33 16 00	08 33 26 00	Overhead Coiling Grilles

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SECTION 08 33 23 00 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service doors.
2. Insulated service doors.
3. Fire-rated service doors.
4. Fire-rated, insulated service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.
2. [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for finish painting of factory-primed doors.
3. Section 111200 "Parking Control Equipment" for parking control equipment interlocked to overhead coiling doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
5. Show locations of controls, locking devices[**detectors or replaceable fusible links**], and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats[**including full vision window secured to slat**].
2. Bottom bar[**with sensor edge**].
3. Guides.
4. Brackets.
5. Hood.
6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing and inspecting agency**].

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to [**NFPA 252**][**UL 10B**].

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Temperature-Rise Limit: [**Where indicated**][**At exit enclosures and exit passageways**], provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.
3. Smoke Control: [**Where indicated**][**In corridors and smoke barriers**], provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of **3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m)** of door opening at **0.10 inch wg (24.9 Pa)** for both ambient and elevated temperature tests.

B. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

C. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

D. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:

1. Design Wind Load: [**As indicated on Drawings**][**Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward**].
2. Testing: According to ASTM E330/E330M[**or DASMA 108 for garage doors and complying with acceptance criteria of DASMA 108**].
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under [**design**][**uniform pressure (velocity pressure) of 20-lbf/sq. ft. (960-Pa)**] wind load, acting inward and outward.

E. Windborne-Debris Impact Resistance: Provide [**glazed**][**and**][**impact-protective**] overhead coiling doors that pass ASTM E1886 missile-impact and cyclic-pressure tests according to [**ASTM E1996 for Wind Zone 1**][**ASTM E1996 for Wind Zone 2**][**ASTM E1996 for Wind Zone 3**][**ASTM E1996 for Wind Zone 4**][**or DASMA 115**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For overhead coiling doors located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For overhead coiling doors located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

F. Seismic Performance: Overhead coiling doors are to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

2.3 DOOR ASSEMBLY

A. Overhead Coiling Door: [**Service**][**Insulated service**] overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACME Rolling Doors**]
b. [**Advanced Door Technologies**]
c. [**Alpine Overhead Doors, Inc**]
d. [**Alumatec Pacific Products**]
e. [**Amarr Company**]
f. [**ASTA America; Janus International Group**]
g. [**C.H.I. Overhead Doors, Inc.**]
h. [**City Gates USA**]
i. [**Clopay Building Products**]
j. [**Cookson; a CornellCookson company**]
k. [**Cornell; a CornellCookson company**]
l. [**Dynamic Closures Corporation**]
m. [**Hormann High Performance Doors**]
n. [**Lawrence Roll-Up Doors, Inc.**]
o. [**McKeon Door Company**]
p. [**Metro Door LLC**]
q. [**Overhead Door Corporation**]
r. [**Raynor Garage Doors**]
s. [**Southwestern Rolling Steel Door Co**]
t. [**Wayne Dalton; a division of Overhead Door Corporation**]
u. [**Windsor Door**]

B. Operation Cycles: Door components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**] cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Air Infiltration: Maximum rate of [**0.4 cfm/sq. ft. (2.03 L/s per sq. m)**][**1.0 cfm/sq. ft. (5.1 L/s per sq. m)**] at **15 and 25 mph (24.1 and 40.2 km/h)** when tested according to [**ASTM E283**][**DASMA 105**].

D. STC Rating: [**26**].

E. Insulated Door Curtain R-Value: [**4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W)**].

F. Insulated Door Assembly U-Factor: [**0.90 Btu/deg F x h x sq. ft. (5.1 W/K x sq. m)**].

G. Door Curtain Material: [**Galvanized steel**][**Stainless steel**][**Aluminum**].

H. Door Curtain Slats: [**Curved**][**Flat**] profile slats of [**1-7/8-inch (48-mm)**][**2-5/8-inch (67-mm)**][**3-1/4-inch (83-mm)**] center-to-center height.

1. Perforated Slats: Approximately [**1/16-inch (1.6-mm) pinholes**][**3/32-inch (2.4-mm) pinholes**][**7/8-inch- (22-mm-) wide by 3/8-inch- (10-mm-) high slots**].
2. Fenestrated Slats: Approximately [**3- by 5/8-inch (76- by 16-mm)**][**4- by 5/8-inch (102- by 16-mm)**][**10- by 1-5/8-inch (254- by 41-mm)**] openings spaced approximately [**1-1/2 inches (38 mm)**] apart and beginning **12 inches (305 mm)** from jamb guides.
3. Vision Panels: Approximately **10- by 1-5/8-inch (254- by 41-mm)** openings spaced approximately **2 inches (51 mm)** apart and beginning **12 inches (305 mm)** from end guides; in [**two**][**three**] rows of slats at height indicated on Drawings; installed with[**insulated**] vision-panel glazing.
4. Insulated-Slat Interior Facing: [**Metal**][**Plastic**].
5. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

I. Bottom Bar: Two angles, each not less than [**1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick**]; fabricated from [**hot-dip galvanized steel**][**stainless steel**][**aluminum extrusions**] and finished [**to match door**].

J. Curtain Jamb Guides: [**Galvanized steel**][**Stainless steel**][**Aluminum**] with exposed finish matching curtain slats.

K. Pass Door(s): [**Hinged**][**Rigid**] frame with [**lockset**][**exit hardware**].

L. Hood: [**Match curtain material and finish**][**Galvanized steel**][**Stainless steel**][**Aluminum**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

M. Locking Devices: Equip door with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

N. Manual Door Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank operator**][**Awning-crank operator**][**Wall-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

O. Electric Door Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use[**moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. (2.44 m) or lower**].

4. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].
5. Motor Electrical Characteristics:

    a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
    b. Voltage: [**115 V ac, single phase, 60 Hz**][**208 V ac, single phase, 60 Hz**][**230 V ac, single phase, 60 Hz**][**208 V ac, three phase, 60 Hz**][**230 V ac, three phase, 60 Hz**][**460 V ac, three phase, 60 Hz**].

6. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
7. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

    a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Control Station(s): [**Interior mounted**][**Exterior mounted**][**Where indicated on Drawings**].
9. Other Equipment: [**Audible and visual signals**][**Portable radio-control system**].

P. Curtain Accessories: Equip door with [**smoke seals**][**weatherseals**][**astragal**][**push/pull handles**][**pull-down strap**][**pole hook**][**and**][**automatic-closing device**].

Q. Door Finish:

1. Aluminum Finish: [**Mill**][**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Black anodized**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Factory Prime Finish: Manufacturer's standard color.
4. Stainless Steel Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 4 (polished directional satin)**].
5. Interior Curtain-Slat Facing: [**Match finish of exterior curtain-slat face**][**Finish as indicated by manufacturer's designations**][**Finish matching Architect's sample**][**Finish as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 FIRE-RATED DOOR ASSEMBLY

A. Fire-Rated Overhead Coiling Door: [**Service**][**Insulated service**] overhead fire-rated coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACME Rolling Doors**]
    b. [**Advanced Door Technologies**]
    c. [**Alpine Overhead Doors, Inc**]
    d. [**Amarr Company**]
    e. [**ASTA America; Janus International Group**]
    f. [**C.H.I. Overhead Doors, Inc.**]
    g. [**City Gates USA**]

h. [**Clopay Building Products**]
i. [**Cookson; a CornellCookson company**]
j. [**Cornell; a CornellCookson company**]
k. [**Lawrence Roll-Up Doors, Inc.**]
l. [**McKeon Door Company**]
m. [**Overhead Door Corporation**]
n. [**Raynor Garage Doors**]
o. [**Southwestern Rolling Steel Door Co**]
p. [**Wayne Dalton; a division of Overhead Door Corporation**]

B. Operation Cycles: Door components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**] cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Fire Rating: [**3/4 hour**][**1 hour**][**1-1/2 hours**][**3 hours**][**4 hours**][**with temperature-rise limit**][**and**][**with smoke control**].

D. Air Infiltration: Maximum rate of [**0.4 cfm/sq. ft. (2.03 L/s per sq. m)**][**1.0 cfm/sq. ft. (5.1 L/s per sq. m)**] at **15 and 25 mph (24.1 and 40.2 km/h)** when tested according to [**ASTM E283**][**DASMA 105**].

E. STC Rating: [**27**].

F. Insulated Door Curtain R-Value: [**4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W)**].

G. Insulated Door Assembly U-Factor: [**0.90 Btu/deg F x h x sq. ft. (5.1 W/K x sq. m)**].

H. Door Curtain Material: [**Galvanized**][**Stainless**] steel.

I. Door Curtain Slats: [**Curved**][**Flat**] profile slats of [**1-7/8-inch (48-mm)**][**2-5/8-inch (67-mm)**][**3-1/4-inch (83-mm)**] center-to-center height.

1. Vision Panels: Approximately **10- by 1-5/8-inch (254- by 41-mm)** openings spaced approximately **2 inches (51 mm)** apart and beginning **12 inches (305 mm)** from end guides; in [**two**][**three**] rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
2. Insulated-Slat Interior Facing: Metal.

J. Bottom Bar: Two angles, each not less than [**1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick**]; fabricated from [**hot-dip galvanized steel**][**stainless steel**][**aluminum extrusions**] and finished [**to match door**].

K. Curtain Jamb Guides: [**Galvanized**][**Stainless**] steel with exposed finish matching curtain slats.

L. Pass Door(s): [**Hinged**][**Rigid**] frame with [**lockset**][**exit hardware**].

M. Hood: [**Match curtain material and finish**][**Galvanized steel**][**Stainless steel**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**As indicated on Drawings**].

N. Locking Devices: Equip door with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

O. Manual Door Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank operator**][**Awning-crank operator**][**Wall-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

P. Electric Door Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use[**moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. (2.44 m) or lower**].
4. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].
5. Motor Electrical Characteristics:

   a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
   b. Voltage: [**115 V ac, single phase, 60 Hz**][**208 V ac, single phase, 60 Hz**][**230 V ac, single phase, 60 Hz**][**208 V ac, three phase, 60 Hz**][**230 V ac, three phase, 60 Hz**][**460 V ac, three phase, 60 Hz**].

6. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
7. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

   a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Control Station(s): [**Interior mounted**][**Exterior mounted**][**Where indicated on Drawings**].
9. Other Equipment: [**Audible and visual signals**][**Portable radio-control system**].

Q. Curtain Accessories: Equip door with smoke seals, automatic-closing device, [**astragal**][**push/pull handles**][**pull-down strap**][**pole hook**][**and**].

R. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Factory Prime Finish: Manufacturer's standard color.
3. Stainless Steel Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled)**][**ASTM A480/A480M No. 4 (polished directional satin)**].
4. Interior Curtain-Slat Facing: [**Match finish of exterior curtain-slat face**][**Finish as indicated by manufacturer's designations**][**Finish matching Architect's sample**][**Finish as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with **G90 (Z275)** zinc coating; nominal sheet thickness (coated) of **0.028 inch (0.71 mm)**; and as required.
2. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of **0.025 inch (0.64 mm)**; and as required.
3. Aluminum Door Curtain Slats: **ASTM B209 (ASTM B209M)** sheet or **ASTM B221 (ASTM B221M)** extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of **0.050 inch (1.27 mm)**; and as required.
4. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
5. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
6. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with [**minimum steel thickness of 0.010 inch (0.25 mm)**][**and**][**minimum aluminum thickness of 0.032 inch (0.80 mm)**].
7. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of [**25**][**75**][**200**] and smoke-developed index of 450, according to ASTM E84 or UL 723.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain[**and a continuous bar for holding windlocks**].

C. Pass Door(s): Swinging-door and frame assembly constructed integrally with the coiling-door assembly[**and bearing the same fire rating**]. Comply with the accessibility standard of authorities having jurisdiction.

1. Door Frame and Integral Jamb Guide: Fabricate of angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading.
2. Hinged Frame: Hinged pass door and frame that swings out of the way, as a unit, to allow use of the full coiling-door opening width. One jamb of the pass-door frame is hinged and the other jamb includes a guide for the lower, narrower part of the coiling-door curtain.
3. Rigid Frame: Rigid pass door and frame that are built into the rigid, lower part of the door curtain and that raise with the curtain.
4. Locking Hardware:

a. [**Lockset**][**Exit Hardware**]: [**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**][**As selected by Architect from manufacturer's full range.**], as directed by the Owner

b. Lock Cylinders: As [**specified in Section 087100 "Door Hardware"**][**specified in Section 087111 "Door Hardware (Descriptive Specification)"**][**standard with manufacturer**][**and keyed to building keying system**].
c. Keys: [**Two**][**Three**] for each cylinder.

5. Thresholds: Equip pass doors with integral thresholds that comply with the accessibility standard of authorities having jurisdiction.

2.7 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal **0.028-inch- (0.71-mm-)** thick, hot-dip galvanized-steel sheet with **G90 (Z275)** zinc coating, complying with ASTM A653/A653M.
2. Stainless Steel: **0.025-inch- (0.64-mm-)** thick, stainless steel sheet, Type 304, complying with ASTM A240/A240M or ASTM A666.
3. Aluminum: **0.040-inch- (1.02-mm-)** thick aluminum sheet complying with **ASTM B209 (ASTM B209M)**, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
4. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
5. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.8 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: As [**specified in Section 087100 "Door Hardware"**][**specified in Section 087111 "Door Hardware (Descriptive Specification)"**][**standard with manufacturer**][**and keyed to building keying system**].
2. Keys: [**Two**][**Three**] for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 CURTAIN ACCESSORIES

A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for

smoke and draft control as required for door listing and labeling by a qualified testing agency.

B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use **1/8-inch- (3-mm-)** thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, [**flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene**][**nylon brushes**].

C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

E. Pull-Down Strap: Provide pull-down straps for doors more than **84 inches (2130 mm)** high.

F. Pole Hooks: Provide pole hooks and poles for doors more than **84 inches (2130 mm)** high.

G. Automatic-Closing Device: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism.[**Testing for manually operated doors allows resetting by opening the door without retensioning the counterbalance mechanism**][**Release mechanism for motor-operated doors allows testing without mechanical release of the door.**] Automatic-closing device is to be designed for activation by the following:

1. Replaceable fusible links with temperature rise and melting point of [**165 deg F (74)**] interconnected and mounted on both sides of door opening.
2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
4. Building fire-detection, smoke-detection, and -alarm systems.

2.10 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, [**seamless**][**welded**] carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than **0.03 in./ft. (2.5 mm/m)** of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic-closing device operates.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.11 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed [**25 lbf (111 N)**].

C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum [**25-lbf (111-N)**][**30-lbf (133-N)**] force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than [**25-lbf (111-N)**][**30-lbf (133-N)**] force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.12 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.

1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.

D. Motors: Reversible-type motor[**with controller (disconnect switch)**] for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not

less than **8 in./sec. (203 mm/s)** and not more than **12 in./sec. (305 mm/s)**, without exceeding nameplate ratings or service factor.

2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening.[**For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.**][**For fire-rated doors, activation delays closing.**]

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

   a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.

2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

   a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed [**25 lbf (111 N)**][**30 lbf (133 N)**].

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

L. Portable Radio-Control System: Consisting of [**one**][**two**] of the following per door operator:

1. Three-channel universal coaxial receiver to open, close, and stop door.
2. Portable control device to open and stop door may be momentary-contact type; control to close door is to be sustained- or constant-pressure type.
3. Remote-antenna mounting kit.

2.13 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.14 ALUMINUM FINISHES

A. Mill Finish: Manufacturer's standard.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.15 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.16 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.

D. Fire-Rated Doors: Install according to NFPA 80.

E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

F. Power-Operated Doors: Install[**automatic garage doors openers**] according to UL 325.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**].

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of coiling-door Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08 33 23 00

Task	Specification	Specification Description
08 33 23 11	08 33 23 00	Overhead Coiling Doors
08 33 23 11	08 33 26 00	Overhead Coiling Grilles
08 33 23 13	01 22 00 00	No Specification Required
08 33 23 13	08 33 23 00	Overhead Coiling Doors

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SECTION 08 33 26 00 - OVERHEAD COILING GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open-curtain overhead coiling grilles.
2. Closed-curtain overhead coiling grilles.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, angle-framing of grille opening, corner guards, and bollards.
2. [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for finish painting of factory-primed grilles.
3. Section 111200 "Parking Control Equipment" for parking control equipment interlocked to overhead coiling grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling grille and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for curtain components, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction.
5. Show locations of controls, locking devices, and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Open-curtain grille with full-size components consisting of rods, spacers, and links as required to illustrate each assembly[**including glazed inserts**].

2. Closed-curtain grille with full-size components consisting of ribs and infill as required to illustrate each assembly.
3. Bottom bar[**with sensor edge**].
4. Guides.
5. Mounting frame.
6. Brackets.
7. Hood.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling grilles to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of grilles that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain overhead coiling grilles from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-grille manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Overhead coiling grilles withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

2.3 OPEN-CURTAIN GRILLE ASSEMBLY

A. Open-Curtain Grille: Overhead coiling[**countertop**] grille with a curtain having a network of horizontal rods that interconnect with vertical links.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACME Rolling Doors**]
b. [**Advanced Door Technologies**]
c. [**Alpine Overhead Doors, Inc**]
d. [**Alumatec Pacific Products**]
e. [**Amarr Company**]
f. [**C.H.I. Overhead Doors, Inc.**]
g. [**City Gates USA**]
h. [**Clopay Building Products**]
i. [**Cookson; a CornellCookson company**]
j. [**Cornell; a CornellCookson company**]
k. [**Dynaflair Corporation**]
l. [**Dynamic Closures Corporation**]
m. [**Lawrence Roll-Up Doors, Inc.**]
n. [**McKeon Door Company**]
o. [**Metro Door LLC**]
p. [**Overhead Door Corporation**]

B. Operation Cycles: Grille components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**]. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Grille Curtain Material: [**Aluminum**][**Stainless steel**][**Galvanized steel**].

1. Rod Spacing: Approximately [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**] o.c.
2. Link Spacing: Approximately [**3 inches (76 mm)**][**6 inches (152 mm)**][**9 inches (228 mm)**] apart in a [**straight in-line**][**brick (staggered)**] pattern.
3. Glazing Inserts: [**Manufacturer's standard**].
4. Spacers: [**Metal tubes matching curtain material**][**PVC**].

D. Bottom Bar: Continuous [**tubular shape**][**channel**][**doubled angles**], fabricated from [**aluminum extrusion**][**hot-dip galvanized steel**][**stainless steel**] and finished [**to match grille**].

E. Curtain Jamb Guides: [**Aluminum**][**Stainless steel**][**Galvanized steel**] with exposed finish [**matching curtain slats**]. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.[**Provide removable post(s) and jamb guides where indicated on Drawings.**]

F. Hood: [**Match curtain material and finish**][**Aluminum**][**Stainless steel**][**Galvanized steel**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**On mounting frame**][**As indicated on Drawings**].

G. Locking Devices: Equip grille with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

H. Manual Grille Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank operator**][**Awning-crank operator**][**Wall-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

I. Electric Grille Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use[**moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.4 m) or lower**].
4. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].
5. Motor Electrical Characteristics:

   a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
   b. Voltage, Single Phase, 60 Hz: [**115-V ac**][**208-V ac**][**230-V ac**].
   c. Voltage, Three Phase, 60 Hz: [**208-V ac**][**230-V ac**][**460-V ac**].

6. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
7. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

   a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Control Station: [**Interior mounted**][**Exterior mounted**][**Where indicated on Drawings**].
9. Other Equipment: [**Audible and visual signals**][**Emergency-egress release**][**Self-opening mechanism**].

J. Curtain Accessories: Equip grille with [**astragal**][**push/pull handles**][**and**][**pole hook**].

K. Grille Finish:

1. Aluminum Finish: [**Mill**][**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Black anodized**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Factory Prime Finish: Manufacturer's standard color.
4. Stainless Steel Finish: [**No. 2B (bright, cold rolled)**][**No. 4 (polished directional satin)**].
5. PVC Spacers: [**Color as indicated by manufacturer's designations**][**Color as selected by**

Architect from manufacturer's full range], as directed by the Owner.

2.4 CLOSED-CURTAIN GRILLE ASSEMBLY

A. Closed-Curtain Grille: Overhead coiling[**countertop**] grille with a curtain having a series of horizontal ribs alternating with continuous horizontal infill panels secured by the ribs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alumatec Pacific Products**]
b. [**Dynaflair Corporation**]
c. [**Dynamic Closures Corporation**]
d. [**Metro Door LLC**]
e. [**QMI Security Solutions**]

B. Operation Cycles: Grille components and operators capable of operating for not less than [**10,000**][**20,000**][**50,000**][**100,000**][**200,000**]. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Grille Curtain Material: Aluminum ribs with continuous inserts indicated.

1. Rib Spacing: Approximately [**3 inches (76 mm)**] o.c.
2. Inserts: [**Glass panels**][**Clear, transparent plastic panels**][**Translucent plastic panels**][**Solid aluminum panels**][**Perforated aluminum panels**].

D. Bottom Bar: Continuous [**tubular shape**][**channel**][**doubled angles**], fabricated from [**aluminum extrusion**][**hot-dip galvanized steel**][**stainless steel**] and finished [**to match grille**].

E. Curtain Jamb Guides: Aluminum with exposed finish [**matching curtain slats**]. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.[**Provide removable post(s) and jamb guides where indicated on Drawings.**]

F. Hood: [**Match curtain material and finish**][**Aluminum**][**Stainless steel**][**Galvanized steel**].

1. Shape: [**Round**][**Square**][**As indicated on Drawings**].
2. Mounting: [**Face of wall**][**Between jambs**][**On mounting frame**][**As indicated on Drawings**].

G. Locking Devices: Equip grille with [**slide bolt for padlock**][**locking device assembly**][**and**][**chain lock keeper**].

1. Locking Device Assembly: [**Single-jamb side**][**Cremone-type, both jamb sides**] locking bars, operable from [**inside with thumbturn**][**outside with cylinder**][**outside only, with cylinder**][**inside and outside with cylinders**].

H. Manual Grille Operator: [**Push-up operation**][**Chain-hoist operator**][**Manufacturer's standard crank operator**][**Awning-crank operator**][**Wall-crank operator**].

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

I. Electric Grille Operator:

1. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
2. Operator Location: [**Top of hood**][**Front of hood**][**Wall**][**Bench**][**Through wall**][**As indicated on Drawings**].
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use[**moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.4 m) or lower**].
4. Motor Exposure: [**Interior**][**Exterior, wet, and humid**].
5. Motor Electrical Characteristics:

   a. Horsepower: [**1/2**][**1**][**2**][**3**] hp.
   b. Voltage, Single Phase, 60 Hz: [**115-V ac**][**208-V ac**][**230-V ac**].
   c. Voltage, Three Phase, 60 Hz: [**208-V ac**][**230-V ac**][**460-V ac**].

6. Emergency Manual Operation: [**Push-up**][**Chain**][**Crank**] type.
7. Obstruction-Detection Device: Automatic [**photoelectric sensor**][**electric sensor edge on bottom bar**][**pneumatic sensor edge on bottom bar**][**self-monitoring type**].

   a. Sensor Edge Bulb Color: [**Black**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Control Station: [**Interior mounted**][**Exterior mounted**][**Where indicated on Drawings**].
9. Other Equipment: [**Audible and visual signals**][**Emergency-egress release**][**Self-opening mechanism**].

J. Grille Finish:

1. Aluminum Finish: [**Mill**][**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Black anodized**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's designations**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Factory Prime Finish: Manufacturer's standard color.
4. Stainless Steel Finish: [**No. 2B (bright, cold rolled)**][**No. 4 (polished directional satin)**].

2.5 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 GRILLE CURTAIN MATERIALS AND CONSTRUCTION

A. Open-Curtain Grilles: Fabricate metal grille curtain as an open network of horizontal rods, spaced at regular intervals, that are interconnected with vertical links, which are formed and spaced as indicated and are free to rotate on the rods.

1. Aluminum Grille Curtain: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2. Stainless Steel Grille Curtain: ASTM A666 or ASTM A240/A240M, Type 300 series.
3. Steel Grille Curtain: Hot-dip zinc coated (galvanized) complying with ASTM A123/A123M, or electrogalvanized complying with ASTM 653/A653M, and phosphatized before fabrication.
4. Glazing Insert: Manufacturer's standard glazing of clear polycarbonate sheet secured by the curtain links.

B. Closed-Curtain Grilles: Fabricate curtain as a series of horizontal double-C ribs, spaced at regular intervals, that alternate with continuous horizontal infill panels secured by the ribs.

1. Aluminum Horizontal Ribs: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. Glass Panels: Uncoated, clear, heat-treated, fully tempered float glass; complying with ASTM C1048, Condition A, Type I, Class I, Quality q3, Kind FT; manufacturer's standard panel dimensions and thickness.
3. Plastic Panels: Fire-retardant polycarbonate sheet manufactured by the extrusion process; UV resistant; manufacturer's standard panel dimensions and thickness.
4. Aluminum Panels: **ASTM B209 (ASTM B209M)**, alloy and temper standard with manufacturer for type of use and finish indicated; manufacturer's standard panel dimensions and thickness; finished to match ribs.

a. Perforations: [**Manufacturer's standard pinholes**].

C. Bottom Bar: Manufacturer's standard continuous shape unless otherwise indicated, finished to match grille.

1. Astragal: Equip grille bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
2. Provide motor-operated grilles with combination bottom astragal and sensor edge.

D. Grille Curtain Jamb Guides: Manufacturer's standard shape having curtain groove with return lips or bars to retain curtain. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise; with removable stops on guides to prevent overtravel of curtain.

1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.7 HOODS AND ACCESSORIES

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal **0.028-inch- (0.71-mm-)** thick, hot-dip galvanized-steel sheet with **G90 (Z275)** zinc coating, complying with ASTM A653/A653M.
2. Stainless Steel: **0.025-inch- (0.64-mm-)** thick, stainless steel sheet, Type 304, complying with ASTM A666 or ASTM A240/A240M.
3. Aluminum: **0.040-inch- (1.02-mm-)** thick aluminum sheet, complying with **ASTM B209 (ASTM B209M)**, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

C. Mounting Frame: Manufacturer's standard mounting frame designed to support grille; factory fabricated

from ASTM A36/A36M structural-steel [**tubes**][**shapes**], hot-dip galvanized per ASTM A123/A123M; fastened to floor and structure above grille; to be built into wall construction; and complete with anchors, connections, and fasteners.

D. Push/Pull Handles: Equip push-up-operated or emergency-operated grille with lifting handles on each side of grille, finished to match grille.

E. Pull-Down Strap: Provide pull-down straps for grilles more than **84 inches (2130 mm)** high.

F. Pole Hooks: Provide pole hooks and poles for grilles more than **84 inches (2130 mm)** high.

2.8 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: As [**specified in Section 087100 "Door Hardware"**][**specified in Section 087111 "Door Hardware (Descriptive Specification)"**][**standard with manufacturer**][**and keyed to building keying system**].
2. Keys: [**Two**][**Three**] for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated grilles with safety interlock switch to disengage power supply when grille is locked.

2.9 COUNTERBALANCE MECHANISM

A. General: Counterbalance grilles by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, [**seamless**][**welded**] carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of parts and to limit barrel deflection to not more than **0.03 in./ft. (2.5 mm/m)** of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 MANUAL GRILLE OPERATORS

A. General: Equip grille with manual grille operator by grille manufacturer.

B. Push-up Grille Operation: Lift handles and pull rope for raising and lowering grille, with counterbalance mechanism designed so that required lift or pull for grille operation does not exceed [**25 lbf (111 N)**].

C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum [**25-lbf (111-N)**][**30-lbf (133-N)**] force for grille operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than [**25-lbf (111-N)**][**30-lbf (133-N)**] force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.11 ELECTRIC GRILLE OPERATORS

A. General: Electric grille operator assembly of size and capacity recommended and provided by grille manufacturer for grille and operation cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking grille, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each grille.

C. Grille Operator Location(s): Operator location indicated for each grille.

1. Top-of-Hood Mounted: Operator is mounted to the right or left grille head plate, with the operator on top of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
2. Front-of-Hood Mounted: Operator is mounted to the right or left grille head plate, with the operator on coil side of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of grille and connected to grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
4. Bench Mounted: Operator is mounted to the right or left grille head plate and connected to the grille drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of grille.

D. Motors: Reversible-type motor[**with controller (disconnect switch)**] for motor exposure indicated for each grille assembly.

1. Electrical Characteristics: Minimum as indicated for each grille assembly. If not indicated, large enough to start, accelerate, and operate grille in either direction from any position, at a speed not less than **8 in./sec. (203 mm/s)** and not more than **12 in./sec. (305 mm/s)**, without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized grille with adjustable switches interlocked with motor controls and set to automatically stop grille at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses downward grille travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in grille opening without contact between grille and obstruction.

a. Self-Monitoring Type: Designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, grille closes only with sustained or constant pressure on close button.

2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

a. Self-Monitoring Type: Four-wire-configured device designed to interface with grille operator control circuit to detect damage to or disconnection of sensor edge.

3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type; NEMA ICS 6, Type 4 enclosure, key operated.

H. Emergency Manual Operation: Equip electrically powered grille with capability for emergency manual operation. Design manual mechanism so required force for grille operation does not exceed [**25 lbf (111 N)**][**30 lbf (133 N)**].

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

L. Emergency-Egress Release: Flush, wall-mounted handle mechanism, for accessibility-code-compliant egress feature, not dependent on electric power. The release allows an unlocked grille to partially open without affecting limit switches to permit passage, and it automatically resets motor drive on return of

handle to original position.

M. Self-Opening Mechanism: Automatic release mechanism triggered by [**smoke detector,**][**emergency push-button station,**] fire alarm or power failure. When activated, the grille self-opens by means of a fail-safe operator to the fully open position without the need for power operation or battery backup systems. When the[**emergency push-button is reset, and the**] alarm is cleared and power is restored, the grille will operate normally.

2.12 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.13 ALUMINUM FINISHES

A. Mill Finish: Manufacturer's standard.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.14 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.15 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling grilles and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports, according to manufacturer's written instructions and as specified.

B. Install overhead coiling grilles, hoods, controls, and operators at the mounting locations indicated for each grille.

C. Accessibility: Install overhead coiling grilles, switches, and controls along accessible routes in compliance with the accessibility standard.

D. Power-Operated Grilles: Install[**automatic garage grille openers**] according to UL 325.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Test grille opening when activated by detector, fire-alarm system, emergency-egress release, or self-opening mechanism as required. Reset grille-opening mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly, so that grilles operate easily, free of warp, twist, or distortion.

1. Adjust exterior components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

3.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service is to include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of coiling-grille Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components,

lubrication, cleaning, and adjusting as required for proper grille operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, 7-day-per-week, emergency callback service.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain overhead coiling grilles.

END OF SECTION 08 33 26 00

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SECTION 08 33 43 00 - OVERHEAD COILING SMOKE CURTAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Smoke-protective curtain assemblies for elevator entrances.
2. Smoke- and fire-protective curtain assemblies for elevator entrances.
3. Deployable draft curtains.
4. Fixed draft curtains.

B. Related Requirements:

1. Section 083344 "Overhead Coiling Fire Curtains" for overhead coiling fire-protective curtain assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 COORDINATION

A. Coordinate smoke curtain assemblies with power, signal, fire-alarm, and smoke-detection systems specified in Division 26 and Division 28.

B. Coordinate elevator smoke-protective curtain assemblies with elevator hoistway door frames specified in Division 14.

C. Coordinate smoke-protective curtain assemblies with ceilings for operational clearances and maintenance access requirements.

D. Coordinate smoke-protective curtain assemblies with walls for support requirements, rating continuity above ceilings, and recessed wall switches.

E. Coordinate requirements for metal supports required for smoke-protective curtain assemblies.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of smoke-protective curtain assembly and draft curtain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for smoke curtains.
2. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
3. Include ratings, operating components, electrical characteristics, control systems, and furnished specialties and accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and attachment details.
2. Include details of smoke curtain assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Detail fabrication and assembly of fire-protective curtain assemblies.
5. Show locations of controls, detectors, and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (152 mm)** in length.

D. Samples for Initial Selection: Manufacturer's finish charts showing full range of material and finish options available for units with factory-applied finishes.

1. Curtain guide.
2. Bottom bar.

E. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

1. Curtain guide
2. Bottom bar.

F. Product Schedule: For smoke curtain assemblies.[**Use same designations indicated on Drawings.**]

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, testing agency, and factory-authorized service representative.

B. Evaluation Reports: For curtain assemblies, from ICC-ES or another qualified testing agency.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For smoke curtain assemblies to include in emergency, operation, and maintenance manuals.

B. Field quality-control reports for required testing.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: An entity experienced in manufacturing smoke-and-draft-control curtain assemblies that have been successfully installed in compliance with requirements of authorities having jurisdiction.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

C. Smoke-Protective Curtain Assembly Inspector Qualifications: Inspector for field quality control inspections of smoke-protective curtain assemblies complying with NFPA 105.

1.8 FIELD CONDITIONS

A. Field Measurements: Field-verify and coordinate dimensions and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of curtain assemblies that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain smoke-protective curtains from single source from single manufacturer.

1. Obtain operators and controls from smoke-protective curtain manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Smoke Protective Curtain Assemblies: Provide smoke-protective curtains that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784; with maximum air-leakage rate of **3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m)** of opening at **0.10 inch wg (24.9 Pa)** for both ambient and elevated temperature tests.

B. Smoke- and Fire-Protective Curtain Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible in accordance with UL 10D.

1. Oversize Rated Curtain Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that curtain assemblies comply with standard construction requirements for tested and labeled fire-rated curtain assemblies, except for size.
2. Smoke Control: Provide smoke-protective curtains that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784; with maximum air-leakage rate of **3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m)** of opening at **0.10 inch wg (24.9 Pa)** for both ambient and elevated temperature tests.

C. Curtain Fabric Fire-Test-Response Characteristics: Provide products that pass NFPA 701, as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

E. Seismic Performance: Smoke-protective curtain assembly shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

2.3 SMOKE-PROTECTIVE CURTAIN ASSEMBLIES FOR ELEVATOR ENTRANCES

A. Alarm-activated transparent-film smoke curtain assembly complying with ICC-ES AC77.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cookson; a CornellCookson company**]
2. [**Cornell; a CornellCookson company**]
3. [**Door Systems**]
4. [**Smoke Guard, a CSW Industrials Company**]

C. Smoke Containment: Assemblies complying with UL 1784 for air leakage and requirements of ASME 17.1/CSA B44.

D. Transparent-Film Curtain: Manufacturer's standard transparent film with flame-spread and smoke-developed indexes of 25 and 450, respectively, when tested in accordance with ASTM E84.

E. Operation: Controlled descent automatically by fail-safe [**gravity**][**motor-driven**] deployment and motorized rewind.

F. Curtain Attachment: Curtain shall form a pressure-resisting seal by one of the following methods:

1. Magnetic Adhesion: With Type 430 ferritic stainless steel elevator door frames, use magnets for closure with door frame.
2. Auxiliary Rails: With magnetic closure of curtain with incompatible elevator door frame material, provide magnetic stainless steel cladding for door frame, formed from ASTM A240/A240M, Type 430 ferritic stainless steel.

   a. Finish: Match stainless steel elevator door frame.

3. Captured Side Guides: Formed from galvanized-steel sheet complying with ASTM A653/A653M with integral pressure-retaining tabs.

G. Control System: Provide factory-assembled control unit as required for assembly specified.

1. Fail-safe[**gravity-closing**] device[**with battery backup**] deploys on activation of local smoke detector[**and building fire alarm**] or testing key switch in compliance with UL 864.
2. Curtain Rewind Switch: Include switch to rewind screen into housing.
3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Housing Type: Sheet metal housings containing support rollers and associated electronics.

1. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.4 SMOKE- AND FIRE-PROTECTIVE CURTAIN ASSEMBLIES FOR ELEVATOR ENTRANCES

A. Alarm-activated flame-resistant fabric smoke curtain assembly complying with ICC-ES AC77.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Door Systems**]
2. [**McKeon Door Company**]
3. [**U.S. Smoke & Fire**]

C. Smoke Containment: Assemblies complying with UL 1784 for air leakage and requirements of ASME 17.1/CSA B44.

D. Fire-Resistance Rating of Fabric: Comply with UL 10D; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Rating: 1-hour [**As indicated in door schedule**].

E. Operation: Motorized automatic operation with controlled descent.

F. Automatic-Closing Device: Equip each deployable curtain assembly with fail-safe, gravity-closing device or holder-release mechanism and governor unit complying with UL 864 and NFPA 105, and an easily tested and reset release mechanism. Automatic-closing device shall be designed for activation by the following:

1. Manufacturer's standard UL-labeled smoke detector and holder-release devices.
2. Manufacturer's standard UL-labeled heat detector and holder-release devices.
3. Building fire-detection, smoke-detection, and fire-alarm systems.

G. Hood/Head Box: Manufactured from galvanized steel in accordance with ASTM A653/A653M; rated at the same temperature as the curtain fabric.

H. Curtain: Manufacturer's standard multilayer glass-fiber fabric woven-coated on one or both sides [**with egress**][**and**][**vision panel**].

1. Fire Rating: UL-listed fabric tested in accordance with UL 10D and ASTM E119 for [**1-hour**] fire resistance.

I. Roller: Manufacturer's standard curtain roller assembly to contain motor.

J. Weighted Bottom Bar: Provide weighted bottom bar to ensure smooth operation and hold curtain taut.

K. Curtain Guides: As selected by Architect from manufacturer's available standard materials and finishes, as directed by the Owner.

L. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended by curtain manufacturer for assembly specified, with electric motors and factory-prewired

motor controls, control devices, and accessories required for proper operation.

1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.

2.5 DEPLOYABLE DRAFT CURTAINS

A. Alarm-activated fabric smoke curtain assembly.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Door Systems**]
2. [**McKeon Door Company**]
3. [**Smoke Guard, a CSW Industrials Company**]
4. [**U.S. Smoke & Fire**]

C. Smoke Containment: Assemblies complying with UL 1784 for air leakage.

D. Operation: Motorized automatic operation with controlled descent.

E. Automatic-Closing Device: Equip each deployable curtain assembly with fail-safe, gravity-closing device or holder-release mechanism and governor unit complying with UL 864 and NFPA 105, and an easily tested and reset release mechanism. Automatic-closing device shall be designed for activation by the following:

1. Manufacturer's standard UL-labeled smoke detector and holder-release devices.
2. Manufacturer's standard UL-labeled heat detector and holder-release devices.
3. Building fire-detection, smoke-detection, and fire-alarm systems.

F. Hood/Head Box: Manufactured from galvanized steel in accordance with ASTM A653/A653M; rated at the same temperature as the curtain fabric.

G. Curtain: Manufacturer's standard multilayer glass-fiber fabric coated on one or both sides.

1. Fabric Egress Slot: Outlined by stenciling.

a. Curtain fabric to include an overlap with magnets at center.
b. Fabric Pull Strap: Mounted on pull side of egress slot at **42 inches (1067 mm)** AFF.

H. Roller: Manufacturer's standard curtain roller assembly to contain motor.

I. Weighted Bottom Bar: Provide weighted bottom bar to ensure smooth operation, hold curtain taut, and prevent deflection from air movement.

J. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.

1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.

2.6 FIXED DRAFT CURTAINS

A. Fixed fabric smoke curtain assembly.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Door Systems**]
2. [**McKeon Door Company**]
3. [**Smoke Guard, a CSW Industrials Company**]
4. [**U.S. Smoke & Fire**]

C. Operation: Fixed.

D. Curtain: Manufacturer's standard multilayer glass-fiber fabric coated on one or both sides.

E. Top and Bottom Bar: Provide top bar for suspending curtain and weighted bottom bar to hold curtain taut and prevent deflection from air movement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Smoke- and Fire-Protective Curtains: Install in accordance with manufacturer's written installation instructions, NFPA 80, and NFPA 105.

B. Smoke-Protective Curtains: Install smoke-protective curtain assemblies in accordance with manufacturer's written installation instructions and NFPA 105.

1. Install smoke-protective curtain assemblies for elevator entrances in accordance with ASME 17.1/CSA B44.

C. Power-Operated Curtains: Install in accordance with UL 864.

D. Install anchorage devices to securely fasten assembly to substrate and building framing without

distortion or stress.

E. Securely brace components suspended from structure.

F. Fit and align assembly, including vertical guides, level and plumb, to provide smooth operation.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified opening protective assembly inspector to perform tests and inspections and to furnish reports to Architect, as directed by the Owner.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test release mechanism, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed curtain. Reset closing mechanism after successful test.
2. Inspections: Inspect each smoke-protective curtain assembly in accordance with NFPA 105.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each smoke-protective curtain assembly indicating compliance with each item listed in NFPA 105.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain overhead coiling smoke curtains.

3.5 MAINTENANCE

A. Engage a manufacturer's authorized service representative to test, adjust, and maintain the smoke-protective assemblies once per year, as required by NFPA 105.

END OF SECTION 08 33 43 00

Task	Specification	Specification Description
08 34 00 00	02 41 16 00	Structure Demolition
08 34 13 00	01 22 00 00	No Specification Required
08 34 23 00	08 31 13 00	Access Doors And Frames
08 34 49 13	13 49 00 00	Radiation Protection
08 34 56 00	11 98 12 00	Detention Doors And Frames

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SECTION 08 34 73 13 - METAL SOUND CONTROL DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Side-hinged, steel sound control door assemblies.

B. Related Requirements:

1. Section 08473.16 "Wood Sound Control Door Assemblies" for sound control assemblies with wood doors in hollow metal frames.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include information indicating compliance with assembly performance requirements, construction details, material descriptions, and finishes.

B. Shop Drawings:

1. Elevations of each type and style of door; details of doors, frames, anchorages, wall-opening conditions, sound control seals, door bottoms, and thresholds; and locations of reinforcements and preparations for hardware.

C. Samples for Initial Selection: For units with factory-applied finishes, manufacturer's standard finish sheets, showing full range of available finishes.

D. Samples for Verification: For each type of exposed finish not less than **3 by 5 inches (76 by 127 mm)**.

1. Doors and Frames: Samples approximately **12 by 12 inches (305 by 305 mm)**.

a. Doors: Include section of vertical-edge, top, and bottom construction; automatic door bottom or gasket; core construction; [**glazing;**]and hinge and other applied hardware reinforcement.
b. Frames: Include profile, corner joint, anchors, and seals.

E. Product Schedule: For sound control door assemblies. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.

3. Environmental Product Declaration: For each product.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Third-Party Certifications: For each product.
7. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each sound control door assembly, for tests performed by [a qualified testing agency][manufacturer and witnessed by a qualified testing agency].

B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

C. Field Quality-Control Reports: For sound control door assemblies.

D. Qualification Statements: For [**manufacturer**][**Installer**][**and**][**field testing and inspecting agency**].

E. Sample Warranties: For sound control door assemblies.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound control door assemblies.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating sound control door assemblies that meet or exceed assembly performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory in accordance with NIST's National Voluntary Laboratory Accreditation Program.

D. Fire-Rated Door Inspector Qualifications: Documented as complying with requirements in NFPA 80 [**and having Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification**].

E. Egress Door Inspector Qualifications: Documented as complying with requirements in NFPA 101 [**and having Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage.

1. Welded Frames: Deliver with two temporary shipping spreader bars each, tack welded across

bottom of frames.

B. Upon delivery, remove cardboard and wrappings from doors and frames to promote air circulation.

C. Do not use nonvented plastic or canvas to cover doors and frames to prevent entrapping moisture.

D. Store doors and frames vertically under cover at Project site, spaced with blocking that provides a minimum **1/4-inch (6-mm)** space between each stacked unit to permit air circulation between components. Stand doors on top end on minimum **4-inch- (102-mm-)** high wood blocking, to avoid damage to bottom end, unless otherwise indicated in manufacturer's written instructions.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sound control door assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of product materials and workmanship.
b. Failures of assemblies to have NIC ratings within 5 dB of laboratory STC ratings specified when tested in accordance with ASTM E336, with results calculated in accordance with ASTM E413.
c. Faulty operation of sound seals.
d. Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sound control door assemblies from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Acoustic Performance: Provide sound control door assemblies with minimum STC [**ratings indicated on Drawings**][**ratings indicated in schedules**] for the entire assembly, calculated in accordance with ASTM E413 when tested in an operable condition in accordance with ASTM E90.

B. Fire-Rated Assemblies: Complying with requirements in NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated [**on Drawings**][**in schedules**], based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Temperature-Rise Limit: Where indicated [**on Drawings**][**in schedules**], provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.

C. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control based on testing in accordance with UL 1784 by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 SIDE-HINGED, STEEL SOUND CONTROL DOOR ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allmark Door**]
2. [**AMBICO Limited**]
3. [**Ceco Door; AADG, Inc.; ASSA ABLOY**]
4. [**Curries, AADG, Inc.; ASSA ABLOY Group**]
5. [**IAC Acoustics**]
6. [**Krieger Specialty Products Company**]
7. [**Noise Barriers, LLC.**]
8. [**Overly Door Company**]
9. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
10. [**Protective Door Industries**]

B. Assemblies: Comply with requirements in NAAMM-HMMA 865 unless otherwise specified or indicated on Drawings. Provide complete assemblies with steel doors, hollow-metal frames, sound seals, and specified hardware and accessories.

1. Manufacturer's Nameplate: Affix permanent nameplate to assembly indicating manufacturer's name and STC rating.

C. Steel Doors:

1. Face Design: [**As indicated in door schedule**].
2. Thickness: [**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**2-1/4 inches (57 mm)**][**As required to comply with assembly performance requirements**][**As indicated in door schedule**].
3. Exterior Doors Faces: Metallic-coated steel sheet in thickness required to comply with assembly performance requirements but not less than minimum [**0.064-inch (1.63-mm)**] nominal thickness.
4. Interior Doors Faces:

   a. Commercial-Quality Steel Sheet: [**Hot**][**Cold**] rolled, in thickness required to comply with assembly performance requirements but not less than [**0.048-inch (1.21-mm)**] nominal thickness.
   b. Metallic-Coated Steel Sheet: In thickness required to comply with assembly performance requirements but not less than [**0.052-inch (1.32-mm)**] nominal thickness.

5. Core: [**Manufacturer's standard sound control core as required to comply with assembly performance requirements**].
6. Loose Stops for Glazed Lites in Doors: Same material as face sheets, prepared for countersunk [**tamper-resistant**]flat- or oval-head machine screws.
7. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than **6 inches (152 mm)** o.c.
8. Hardware Reinforcement: Comply with requirements in BHMA A156.115 for preparing doors for hardware.

D. Hollow-Metal Frames: [**NAAMM-HMMA 820, continuously welded**][**Two-piece slip-on**][**Manufacturer's standard**] frames with corners mitered and reinforced.

1. Exterior Frames: Fabricated from metallic-coated steel sheet in thickness required to support door and comply with assembly performance requirements but not less than [**0.079-inch (2.01-mm)**] nominal thickness.
2. Interior Frames: Provide [**straight**][**back bend, gypsum board**] returns.

a. Commercial-Quality Steel Sheet: [**Hot**][**Cold**] rolled, in thickness required to support door and comply with assembly performance requirements but not less than [**0.075-inch (1.90-mm)**] nominal thickness.
b. Metallic-Coated Steel Sheet: In thickness required to support door and comply with assembly performance requirements but not less than [**0.079-inch (2.01-mm)**] nominal thickness.

3. Hardware Reinforcement: Comply with requirements in BHMA A156.115 for preparing frames for hardware.
4. Grouted-Frame Head Reinforcement for Welded Frames: Metallic-coated steel channel or angle stiffener, not less than **0.108-inch (2.74-mm)** nominal thickness.
5. Grout Guards for Welded Frames: Metallic-coated steel sheet, not less than **0.026 inch (0.66 mm)** thick.

E. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls in accordance with ASTM A153/A153M, Class B.

1. Jamb Anchors: Anchors of minimum size and type required by wall construction and assembly performance requirements.

a. Postinstalled Expansion Anchors: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

2. Floor Anchors for Welded Frames: Metallic-coated steel in thickness matching frame but not less than [**0.079-inch (2.01-mm)**] nominal thickness.

a. Monolithic Concrete Slabs: Provide clip-type anchors, with two holes to receive fasteners.
b. Separate Topping Concrete Slabs: Provide adjustable-type anchors with extension clips, allowing not less than **2-inch (51-mm)** height adjustment. Terminate bottom of frames at finish floor surface.

3. Ceiling Struts: Not less than **3/8-inch-thick by 2-inch- (9.5-mm-thick by 51-mm-)** wide uncoated steel unless otherwise indicated [**on Drawings**][**in schedules**].

F. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

G. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching frames of type indicated.

H. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

I. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B metallic coated by the hot-dip process.

a. Exterior-Door and Frame Coating: [**A40 (ZF120) zinc-iron alloy (galvannealed)**][**G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron alloy (galvannealed)**][**G60 (Z180) zinc (galvanized)**].
b. Interior-Door and Frame Coating: [**A25 (ZF75) zinc-iron alloy (galvannealed)**][**A40**

(ZF120) zinc-iron alloy (galvannealed)][G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron alloy (galvannealed)][G60 (Z180) zinc (galvanized)].

J. Finishes:

1. Prime Finish: Apply manufacturer's standard rust-inhibitive primer immediately after cleaning and pretreating metal.

   a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with requirements in SDI A250.10 for acceptance criteria; recommended in writing by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with requirements in SDI A250.3 for performance and acceptance criteria.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE

A. Sound Control Door Hardware: Manufacturer's standard sound control system required to comply with assembly performance requirements.

1. Head and Jamb Seals:[**Provide one of the following:**]

   a. Neoprene Compression Seals: One-piece units consisting of closed-cell sponge neoprene seal held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.
   b. Silicone Compression Seals: One-piece units consisting of silicone compression bulb and stabilizer flange; attached to door frame adhesively.
   c. Magnetic Seals: One-piece units consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.

2. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

   a. Mounting: [Mortised or semimortised into bottom of door][surface mounted on face of door] as required to comply with assembly performance requirements.

3. Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
4. Cam-Lift Hinges: [**Manufacturer's standard full-mortise type as required to support weight of door**].
5. Thresholds: Flat, smooth, unfluted type recommended in writing by manufacturer; fabricated from [**aluminum**][**stainless steel**].

   a. Finish: [**Clear**][**Color**] anodic finish.
   b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

B. Astragals for Double Doors: [**Manufacturer's standard metal acoustic astragals with integral acoustic seals**].

C. Other Hardware: Comply with requirements in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

2.5 SOUND CONTROL ACCESSORIES

A. Glass and Glazing: [**Manufacturer's glazing system complying with assembly performance requirements.**][**Comply with requirements in Section 088000 "Glazing."**][**Comply with requirements in Section 088813 "Fire-Rated Glazing."**]

1. Glass: [**ASTM C1036, Type 1, q3, safety glass complying with testing requirements in 16 CFR 1201 for category based on lite size**].

B. Grout: ASTM C476, with a slump of not more than **4 inches (102 mm)** as measured in accordance with ASTM C143/C143M.

C. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 FABRICATION

A. Fabrication Standard: Comply with requirements in NAAMM-HMMA 865 unless otherwise specified or indicated on Drawings.

B. Hardware Preparation: Factory prepare frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.

1. Reinforce doors and frames to receive nontemplated mortised and surface-mounted hardware.
2. Locate hardware as indicated [**on Drawings**][**in accordance with NAAMM-HMMA 831**].

C. Steel Doors: Fabricate to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; grind, fill, and dress welds to make them invisible and to provide a smooth, flush surface.
2. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
3. Glazed Lites: Factory install glazed lites in accordance with requirements of tested assembly and to comply with assembly performance requirements. Provide fixed stops and moldings welded on secure side of door.

D. Hollow-Metal Frames: Fabricate to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Where welded frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners or provide plug buttons to conceal fasteners.

4. Floor Anchors for Welded Frames: Weld anchors to bottom of jambs and fixed mullions with at least four spot welds per anchor.
5. Masonry Jamb Anchors for Welded Frames: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and provide minimum quantity as follows:

    a. Two anchors per jamb up to **60 inches (1524 mm)** in height.
    b. Three anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.
    c. Four anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** in height.
    d. Four anchors per jamb plus one additional anchor per jamb for each **24 inches (610 mm)**, or fraction thereof, more than **96 inches (2438 mm)** in height.

6. In-Place Masonry or Concrete Jamb Anchors for Welded Frames: Locate anchors installed using postinstalled expansion anchors not more than **6 inches (152 mm)** from top and bottom of frame. Space anchors not more than **26 inches (660 mm)** o.c. and provide minimum quantity as follows:

    a. Three anchors per jamb up to **60 inches (1524 mm)** in height.
    b. Four anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.
    c. Five anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** in height.
    d. Five anchors per jamb plus one additional anchor per jamb for each **24 inches (610 mm)**, or fraction thereof, more than **96 inches (2438 mm)** in height.

7. Stud-Wall Jamb Anchors for Welded Frames: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and provide minimum quantity as follows:

    a. Three anchors per jamb up to **60 inches (1524 mm)** in height.
    b. Four anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.
    c. Five anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** in height.
    d. Five anchors per jamb plus one additional anchor per jamb for each **24 inches (610 mm)**, or fraction thereof, more than **96 inches (2438 mm)** in height.
    e. Two anchors per head for frames more than **42 inches (1067 mm)** wide and mounted in metal-stud partitions.

8. Jamb Anchors for Two-Piece Slip-On Frames: Locate as required to transfer loads to adjoining construction, but not more than **8 inches (203 mm)** from top and bottom of frame and spaced not more than **12 inches (305 mm)** o.c.
9. Grouted-Frame Head Reinforcement for Welded Frames: For grouted frames more than **48 inches (1219 mm)** wide, weld continuous head reinforcement to back of frame at head full for the width of opening.
10. Grout Guards for Welded Frames: Weld guards to frame at back of hardware cutouts, sound control seal preparations, and as required to close off other interior of openings in frames to be grouted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Welded Frames: Remove temporary shipping spreader bars installed at factory. Restore exposed finishes by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION OF SIDE-HINGED, STEEL SOUND CONTROL DOOR ASSEMBLIES

A. General: Install sound control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.

1. Fire-Rated Assemblies: Install in accordance with NFPA 80.
2. Smoke- and Draft-Control Assemblies: Install in accordance with NFPA 105.

B. Welded Frames: Set accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

1. Frames Fabricated in Sections: Field splice by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.
2. Corrosion-Resistant Coating: Apply corrosion-resistant coating to backs of frames to be filled with grout containing antifreezing agents.
3. Floor Anchors: Secure with postinstalled expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Grouted Frames in Masonry or Concrete Construction: Hand trowel grout to solidly fill space between frames and substrate. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
5. Metal-Stud Partitions: Fully fill frames with mineral-fiber insulation.
6. In-Place Masonry or Concrete Construction: Secure jambs with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Gypsum Board Partitions: Secure jambs with countersunk anchors, and fill and make smooth, flush, and invisible on exposed faces.
8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above unless frame is anchored to structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

C. Two-Piece Slip-On Frames: Set accurately in position; plumbed, and aligned in accordance with manufacturers written instruction.

D. Steel Doors: Fit doors accurately in frames in accordance with manufacturer's written instructions and to comply with assembly performance requirements.

E. Sound Control Seals: Where seals have been factory prefit and preinstalled and subsequently removed for shipping, reinstall seals and adjust in accordance with manufacturer's written instructions.

F. Cam-Lift Hinges: Install in accordance with manufacturer's written instructions.

G. Thresholds: Set thresholds in full bed of sealant complying with requirements in Section 079200 "Joint

Sealants."

H. Astragals for Double Doors: Install in accordance with manufacturer's written instructions.

I. Glazing: Comply with installation requirements in [**Section 088000 "Glazing"**][**Section 088813 "Fire-Rated Glazing"**] and with manufacturer's written instructions.

1. Secure stops with [**tamper-resistant**]countersunk flat- or oval-head machine screws spaced uniformly not more than **9 inches (229 mm)** o.c. and not more than **2 inches (51 mm)** o.c. from each corner.

J. Installation Tolerances:

1. Opening Width: Plus **1/16 inch (1.6 mm)** or minus **1/32 inch (0.8 mm)**, measured from rabbet to rabbet at top, middle, and bottom of frame.
2. Opening Height: Plus **1/16 inch (1.6 mm)** or minus **1/32 inch (0.8 mm)**, measured from head rabbet to top of floor or bottom of frame minus jamb extensions at each jamb and across head.
3. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
4. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
5. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines and perpendicular to plane of wall.
6. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a perpendicular line from head to floor.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Acoustical Testing: To verify assemblies comply with acoustical performance requirements.

1. Testing Extent: [**One sound control door assembly chosen at random**][**Every sound control door assembly**].
2. Testing Method: ASTM E336, with NIC rating calculated in accordance with ASTM E413.
3. Acceptable Results: NIC rating within 5 dB of laboratory STC rating.

C. Fire-Rated Door Assembly Acceptance Testing: Test and inspect fire-rated sound control door assemblies in accordance with NFPA 80.

D. Smoke- and Draft-Control Door Assembly Acceptance Testing: Test and inspect smoke- and draft-control door assemblies in accordance with NFPA 105.

E. Egress Door Assembly Acceptance Testing: Test and inspect egress doors in accordance with NFPA 101.

F. Repair or remove and replace installations where testing and inspections indicate that they do not comply with specified requirements.

G. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

H. Inspection Report: Prepared and submitted in writing to Architect and Contractor within 24 hours after testing, as directed by the Owner.

3.5 ADJUSTING AND CLEANING

A. Grouted Welded Frames: Clean grout off frames immediately after installation.

B. Metallic-Coated Surface Touchup: Immediately after installation, clean abraded areas of doors and frames and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

C. Prime-Coat Touchup: Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible, rust-inhibitive, air-drying primer.

D. Factory-Applied Paint Touchup: Immediately after installation, repair damaged areas of factory-applied paint and touchup in accordance with manufacturer's written instructions.

E. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise defective.

1. Adjust seals to provide contact required to comply with assembly performance requirements.

F. Check and adjust seals, door bottoms, and other hardware items immediately before final inspection.

END OF SECTION 08 34 73 13

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SECTION 08 34 73 16 - WOOD SOUND CONTROL DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood sound control doors.

B. Related Requirements:

1. Section 083473.13 "Metal Sound Control Door Assemblies" for sound control assemblies with steel doors and steel frames.

1.2 COORDINATION

A. Coordinate installation of anchorages for sound control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages. Deliver sleeves, inserts, anchor bolts, and items with integral anchors to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review procedures for coordinating frame and anchor installation with wall construction.
2. Review required field quality-control procedures.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Wood sound control doors.

B. Product Data Submittals: Include sound ratings, construction details, material descriptions, core descriptions, [**fire-resistance rating,**][**temperature-rise ratings,**] and finishes.

C. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.
2. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
6. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

8. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
10. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
11. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings: For sound control door assemblies.

1. Include elevations of each door design.
2. Include details of sound control seals, door bottoms, and thresholds.
3. Include details of doors, including vertical- and horizontal-edge details and metal thicknesses.
4. Include frame details for each frame type, including dimensioned profiles and metal thicknesses.
5. Include locations of reinforcements and preparations for hardware.
6. Include details of each different wall opening condition.
7. Include details of anchorages, joints, field splices, and connections.
8. Include details of accessories.
9. Include details of moldings, removable stops, and glazing.
10. Include details of conduits and preparations for power, signal, and control systems.

E. Samples for Initial Selection: For units with factory-applied finishes.

F. Samples for Verification: For each type of exposed finish not less than **3 by 5 inches (76 by 127 mm)**.

1. Doors and Frames: Samples approximately **12 by 12 inches (305 by 305 mm)**.

a. Doors: Include section of vertical-edge, top, and bottom construction; automatic door bottom or gasket; core construction; [**glazing;**]and hinge and other applied hardware reinforcement.
b. Frames: Include profile, corner joint, floor and wall anchors, and seals.

G. Schedule: Provide a schedule of sound control door assemblies prepared using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**acoustical testing agency**].

B. Product Certificates: For each type of sound control door assembly.

C. Product Test Reports: For each sound control door assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound control door assemblies to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

F. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory according to the National Voluntary Laboratory Accreditation Program of NIST.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Avoid the use of nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch-(102-mm-)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wood sound control doors until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sound control door assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet sound rating requirements.
b. Faulty operation of sound seals.
c. Deterioration of metal frames, metal finishes, and other materials beyond normal use or weathering.
d. Wood doors that are warped (bow, cup, or twist) more than **1/4 inch (6 mm)** in a **42-by-84-inch (1067-by-2134-mm)** section, or show telegraphing of core construction in face veneers exceeding **0.01 inch in a 3-inch (0.25 mm in a 75-mm)** span.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sound Rating: Provide sound control door assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:

1. STC Rating: [**As indicated on Drawings**][**As indicated in the Door Schedule on the Drawings**] as calculated by ASTM E413 when tested in an operable condition in accordance with ASTM E90.

B. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings[**and temperature-rise limits**] indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.2 WOOD SOUND CONTROL DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMBICO Limited**]
2. [**Krieger Specialty Products Company**]
3. [**Overly Door Company**]

B. Source Limitations: Obtain wood sound control door assemblies, including doors, frames, sound control seals, hinges, thresholds, and other items essential for sound control, from single source from single manufacturer.

C. Certified Wood: Wood doors shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

D. Certified Wood: Wood doors shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Wood doors shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and

labeled according to the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Wood doors shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

G. Certified Wood: Wood doors shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

I. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Adhesives: Do not use adhesives that contain urea formaldehyde.

L. Adhesives: Do not use adhesives that contain urea formaldehyde.

M. Composite Wood Products: Products shall be made without urea formaldehyde.

N. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

O. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

P. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

Q. Composite Wood Products: Products shall be made without urea formaldehyde.

R. Doors: Flush-design sound control doors, [**1-3/4 inches (44 mm) thick**][**2 inches (51 mm) thick**][**2-1/4 inches (57 mm) thick**][**thickness as required to provide STC rating**]; with manufacturer's standard sound-retardant core as required to provide STC[**and fire**] rating indicated. Fabricate in accordance with WDMA 1.S.1-A.

S. Materials: Comply with [**Section 081416 "Flush Wood Doors"**][**Section 081433 "Stile and Rail Wood Doors"**] for grade, faces, veneer matching, fabrication, finishing, and other requirements unless otherwise indicated.

1. Glazing: As required by sound control door assembly manufacturer to comply with sound control[

and fire-rated-door labeling] requirements.

T. Finishes:

1. Factory finish sound control wood doors to match doors specified in [**Section 081416 "Flush Wood Doors."**][**Section 081433 "Stile and Rail Wood Doors."**]

2.3 SOUND CONTROL FRAMES

A. Frames: Fabricate sound control door frames with corners mitered, reinforced, and continuously welded the full depth and width of frame. Fabricate in accordance with NAAMM-HMMA 865.

1. Weld frames in accordance with NAAMM-HMMA 820.
2. Exterior Frames: Fabricate from metallic-coated steel sheet **0.079-inch (2.01-mm)** nominal thickness or thicker as required to provide STC rating indicated.
3. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, **0.075-inch (1.90-mm)** nominal thickness or thicker as required to provide STC rating indicated.
4. Hardware Reinforcement: Fabricate in accordance with NAAMM-HMMA 865 of same material as face sheets.
5. Head Reinforcement: Metallic-coated steel channel or angle stiffener, **0.108-inch (2.74-mm)** nominal thickness.
6. Jamb Anchors:

   a. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than **0.064-inch (1.63-mm)** nominal-thickness metallic-coated steel with corrugated or perforated straps not less than **2 inches (51 mm)** wide by **10 inches (254 mm)** long; or wire anchors not less than **0.156 inch (3.9 mm)** thick.
   b. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than **0.048-inch (1.21-mm)** nominal-thickness uncoated steel unless otherwise indicated.
   c. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum **3/8-inch- (9.5-mm-)** diameter, metallic-coated steel bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

7. Floor Anchors: Not less than **0.079-inch (2.01-mm)** nominal-thickness metallic-coated steel, and as follows:

   a. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   b. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than **2-inch (51-mm)** height adjustment. Terminate bottom of frames at finish floor surface.

8. Ceiling Struts: Minimum **3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-)** wide uncoated steel unless otherwise indicated.
9. Plaster Guards: Metallic-coated steel sheet, not less than **0.026 inch (0.6 mm)** thick.

B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B, with **G60 (Z180)** zinc (galvanized) or **A40 (ZF120)** zinc-iron-alloy (galvannealed) coating designation.

4. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls in accordance with ASTM A153/A153M, Class B.
5. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized in accordance with ASTM A153/A153M or ASTM F2329.
6. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching sound control door frames of type indicated.
7. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

C. Finishes:

1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

   a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with SDI A250.3 for performance and acceptance criteria.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE

A. Sound Control Door Hardware: Manufacturer's standard sound control system, including head and jamb seals, door bottoms, [**cam-lift hinges,**] and thresholds, as required by testing to achieve STC[**and fire**] rating indicated.

1. Head and Jamb Seals:[**One of the following:**]

   a. Neoprene Compression Seals: One-piece units consisting of closed-cell sponge neoprene seal held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.
   b. Silicone Compression Seals: One-piece units consisting of silicone compression bulb and stabilizer flange; attached to door frame adhesively.
   c. Magnetic Seals: One-piece units consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.

2. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

   a. Mounting: [Mortised or semimortised into bottom of door][surface mounted on face of door] as required by testing to achieve STC rating indicated.

3. Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
4. Cam-Lift Hinges: Full-mortise template type that raises door **1/2 inch (13 mm)** when door is fully open; with hardened pin; fabricated from stainless steel.
5. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from [**aluminum**][**stainless steel**][**solid wood matching wood door faces**].

a. Finish: [**Clear**][**Color**] anodic finish.
b. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

B. Other Hardware: Comply with requirements in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

2.5 SOUND CONTROL ACCESSORIES

A. Glazing: [**Manufacturers' standard factory-installed glazing.**][**Comply with requirements in Section 088000 "Glazing."**]

B. Grout: Comply with ASTM C476, with a slump of not more than **4 inches (102 mm)** as measured in accordance with ASTM C143/C143M.

C. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 FABRICATION

A. Wood Sound Control Door Fabrication: Factory fit doors to suit frame-opening sizes indicated, with uniform clearances and bevels in accordance with WDMA I.S.1-A unless otherwise indicated. Comply with final door hardware schedules and hardware templates.

1. Comply with requirements in NFPA 80 for fire-rated and smoke control doors.
2. Glazed Lites: Factory install glazed lites in accordance with requirements of tested assembly to achieve STC rating indicated.
3. Locate door hardware as indicated, or if not indicated, in accordance with DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

a. Coordinate measurements of hardware mortises in steel frames to verify dimensions and alignment before factory machining.

B. Sound Control Frame Fabrication: Fabricate sound control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

1. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:

1) Two anchors per jamb up to **60 inches (1524 mm)** in height.

2) Three anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.
3) Four anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** in height.
4) Four anchors per jamb plus one additional anchor per jamb for each **24 inches (610 mm)**, or fraction thereof, more than **96 inches (2438 mm)** in height.

b. Stud-Wall Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:

1) Three anchors per jamb up to **60 inches (1524 mm)** in height.
2) Four anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.
3) Five anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** in height.
4) Five anchors per jamb plus one additional anchor per jamb for each **24 inches (610 mm)**, or fraction thereof, more than **96 inches (2438 mm)** in height.
5) Two anchors per head for frames more than **42 inches (1066 mm)** wide and mounted in metal-stud partitions.

c. Postinstalled Expansion Type: Locate anchors not more than **6 inches (152 mm)** from top and bottom of frame. Space anchors not more than **26 inches (660 mm)** o.c.

5. Head Reinforcement: For grouted frames more than **48 inches (1219 mm)** wide, weld continuous head reinforcement to back of frame at head full width of opening.
6. Hardware Preparation: Factory prepare sound control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.

a. Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.

7. Plaster Guards: Weld guards to frame at back of hardware cutouts and glazing-stop screw and sound control seal preparations to close off interior of openings in frames to be grouted.
8. Tolerances: Fabricate frames to tolerances indicated in NAAMM-HMMA 865.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound control door frame connections before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace sound control door frames to the following tolerances:

1. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to

plane of wall.

3. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install sound control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.

B. Frames: Install sound control door frames in sizes and profiles indicated.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-rated openings, install frames in accordance with NFPA 80.
    b. At openings requiring smoke and draft control, install frames in accordance with NFPA 105.
    c. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.
    d. Install sound control frames with removable glazing stops located on secure side of opening.
    e. Remove temporary braces only after frames or bucks have been properly set and secured.
    f. Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Apply corrosion-resistant coating to backs of frames to be filled with mortar, grout, and plaster containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Fully fill frames with mineral-fiber insulation.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
6. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
7. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
8. Installation Tolerances: Adjust sound control door frames for squareness, alignment, twist, and plumbness to the following tolerances:

a. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a perpendicular line from head to floor.

C. Doors: Fit sound control doors accurately in frames, within clearances indicated below. Shim as necessary.

1. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:

a. Jambs: **1/8 inch (3 mm)**.
b. Head with Butt Hinges: **1/8 inch (3 mm)**.
c. Head with Cam-Lift Hinges: As required by manufacturer, but not more than **3/8 inch (9.5 mm)**.
d. Sill: Manufacturer's standard.
e. Between Edges of Pairs of Doors: **1/8 inch (3 mm)**.

2. Fire-Rated Doors: Install fire-rated doors with clearances in accordance with NFPA 80.

D. Sound Control Seals: Where seals have been factory prefit and preinstalled and subsequently removed for shipping, reinstall seals and adjust in accordance with manufacturer's written instructions.

E. Cam-Lift Hinges: Install hinges in accordance with manufacturer's written instructions.

F. Thresholds: Set thresholds in full bed of sealant complying with requirements in Section 079200 "Joint Sealants."

G. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with sound control door assembly manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than **9 inches (230 mm)** o.c. and not more than **2 inches (51 mm)** o.c. from each corner.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Perform testing for verification that assembly complies with STC rating requirements.

1. Acoustical testing and inspecting agency must select [**one**] sound control door(s) at random from sound control door assemblies that are completely installed for testing.
2. Field tests must be conducted in accordance with ASTM E336, with results calculated in accordance with ASTM E413. Acceptable field NIC values must be within 5 dB of laboratory STC values.
3. Inspection Report: Acoustical testing agency must submit report in writing to Architect and Contractor within 24 hours after testing, as directed by the Owner.
4. If tested door fails, replace or rework all sound control door assemblies to bring them into compliance at Contractor's expense.

a. Additional testing and inspecting at Contractor's expense will be performed to determine if

replaced or additional work complies with specified requirements.

C. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Final Adjustments: Check and adjust seals, door bottoms, and other sound control hardware items right before final inspection. Leave work in complete and proper operating condition.

B. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.

1. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.

C. Grouted Frames: Clean grout off sound control door frames immediately after installation.

D. Prime-Coat Touchup: Immediately after erection of frames, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible, rust-inhibitive, air-drying primer.

E. Metallic-Coated Surfaces: Clean abraded areas of frames and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

END OF SECTION 08 34 73 16

SECTION 08 35 13 00 - FOLDING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Accordion folding doors.
2. Panel folding doors.
3. Metal bifold doors.
4. Mirrored bifold doors.
5. Fire-rated folding doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for folding doors.

B. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Shop Drawings:

1. Include plans, elevations, sections, and installation details.
2. Include clearances required for operation, [**operating and control mechanisms,**][**access requirements,**][**storage pockets and pocket doors,**] and accessory items.
3. Fire-Release System: Describe system, including testing and resetting instructions for fire-rated folding doors.
4. Include diagrams for power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of hardware and accessories involving color and finish selection.

F. Samples for Verification: For each type of exposed finish.

1. Include Samples of hardware and accessories to verify color and finish selection.

G. Product Schedule: For folding doors.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each fire-rated folding door, for tests performed by a qualified testing agency.

C. Evaluation Reports: For fire-rated folding doors, from ICC-ES.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For folding doors to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of fire-rated folding doors.

B. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install folding doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants after completion of construction during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 ACCORDION FOLDING DOORS

A. Description: Top-supported, horizontal-sliding, manually operated accordion folding doors, with chain controlling the spacing and extension of pantographic or X-type accordion folding frames. Continuous inner and outer covers completely cover the folding frames and pleat as the door retracts.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Advanced Door Technologies**]
2. [**C.H.I. Overhead Doors, Inc.**]
3. [**KWIK-WALL Company**]
4. [**Moderco Inc**]
5. [**Modernfold, Inc**]

C. Covers: Attached to accordion folding frames with concealed fasteners at sufficient intervals to prevent the cover from sagging and separating from the frame. Fastened to allow on-site cover removal and repair. Covers fabricated from material indicated with vertical seams located in valleys of pleats, formed when door is retracted, and with bottom and top hems or bindings.

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**50**][**450**] or less.

2. Vinyl Cover Material: Reinforced with woven backing weighing not less than [**20 oz./linear yd. (567 g/m)**].

   a. Color, Texture, and Pattern: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Fabric Cover Material: Weighing not less than [**6.7 oz./linear yd. (208 g/m)**][**12 oz./linear yd. (372 g/m)**], treated to resist stains.

   a. Color, Texture, and Pattern: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Carpet Cover Material: Manufacturer's standard nonwoven carpet, needle punched with fused fibers to prevent unraveling.

   a. Color, Texture, and Pattern: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Sweep Seals: Manufacturer's standard top and bottom sweep seals on [**both sides**][**one side**] of door.

E. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation. Wheels are ball-bearing type and equipped with nylon tread and steel shafts.

F. Tracks: Manufacturer's standard metal track, made of extruded aluminum or formed steel with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support accordion folding doors; to enable their operation without damage to track, folding unit, or adjacent surfaces; and with the following features:

1. Mounting: [**Recessed**][**Surface**] mounted.
2. Ceiling Guard: Metal guard to protect adjacent ceiling surfaces from damage by door operation; with finish matching other exposed metal.
3. Center Stop: For center-opening doors.

4. Curved Track Sections: With ceiling clips to accommodate configuration indicated.
5. Glide Switch: To divert door to auxiliary track.
6. Pivot Switch: To change track direction.
7. Cross-Track Switch: To allow one door to cross another.

G. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:

1. Finish: [**Clear-anodized aluminum**][**Satin stainless steel**][**Dull chromium-finish brass**][**Dull chromium-finish steel**][**Manufacturer's standard**].
2. Latch: Operable from [**both sides**][**one side**] of closed door[**with coin-slot release on opposite side**].
3. Lock: [**Manufacturer's standard key-operated cylinder lock, operable from both sides**][**Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side**][**Deadlock to receive cylinder, operable from both sides. See Section 087100 "Door Hardware" for cylinder requirements**][**Deadlock to receive cylinder, operable from both sides. See Section 087111 "Door Hardware (Descriptive Specification)" for cylinder requirements**].
4. Foot Bolts: On lead post where indicated. Secure to post to avoid interference with seals.

H. Jamb Molding: Manufacturer's molding at closing jamb as required for light-tight jamb closure.

1. Jamb Strip: Nonferrous for end-opening doors to ensure tight closure by engaging rubber bumper on lead post.

I. Posts: Manufacturer's standard steel or extruded-aluminum posts formed for rigidity and to provide light seal at supporting construction.

1. Fixed Jamb Post: To anchor door to stack jamb.
2. Rolling Jamb Post: To allow door to disconnect from stack jamb.
3. Sliding Jamb: To allow door to stack in storage pocket.
4. Lead Post: At closing edge of door.

J. Tiebacks: To maintain door in stacked position.

K. Stacking Configuration: [**As indicated on Drawings**].

2.2 PANEL FOLDING DOORS

A. Description: Top-supported, horizontal-sliding, manually operated panel folding doors, with panels joined by continuous hinge connectors for the full height of panels.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Won-Door Corporation**]
2. [**Woodfold Manufacturing, Inc.**]

C. Certified Wood: Verify wood doors are certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Verify wood doors are labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or be certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

E. Certified Wood: Verify wood doors are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

F. Core Material and Thickness: Manufacturer's standard.

G. Nominal Panel Width: [**4 inches (100 mm)**][**5 inches (125 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**].

H. Panel Facing: Complying with the following:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**50**][**450**] or less.

2. Vinyl Facing: Factory bonded to core.

   a. Color and Texture: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Vinyl Facing with Woven Backing: Factory bonded to core.

   a. Color and Texture: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Plastic-Laminate Facing: Grade VGS, high-pressure plastic laminate complying with ISO 4586-3; adhesive applied under pressure to core.

   a. Color, Texture, and Pattern: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Wood-Veneer Facing: wood veneer, laminated to core, with manufacturer's standard [**clear**][**stained**] transparent finish.

   a. Stain Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.

1. Panels **5 Inches (125 mm)** Wide or Less: [**Nylon wheels and axles**][**Ball-bearing wheels with nylon tread and steel shafts**][**Manufacturer's standard wheels and axles**].
2. Panels More Than **5 Inches (125 mm)** Wide: Ball-bearing wheels with nylon tread and steel shafts.

J. Tracks: Manufacturer's standard metal track, made of extruded aluminum or formed steel with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support operation without damage to track, folding unit, or adjacent surfaces; and with the following features:

1. Mounting: [**Recessed**][**Surface**] mounted.
2. Ceiling Guard: Metal guard to protect adjacent ceiling surfaces from damage by door operation; with finish matching other exposed metal.
3. Center Stop: For center-opening doors.
4. Curved Track Sections: With ceiling clips to accommodate configuration indicated.
5. Glide Switch: To divert door to auxiliary track.
6. Pivot Switch: To change track direction.
7. Cross-Track Switch: To allow one door to cross another.

K. Hinge Connector: Manufacturer's standard extruded-vinyl hinge connector.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Match or coordinate with facing color**], as directed by the Owner.

L. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:

1. Finish: [**Clear-anodized aluminum**][**Satin stainless steel**][**Dull chromium-finish brass**][**Dull chromium-finish steel**][**Manufacturer's standard**].
2. Latch: Operable from [**both sides**][**one side**] of closed door.
3. Lock: [**Manufacturer's standard key-operated cylinder lock, operable from both sides**][**Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side**][**Deadlock to receive cylinder, operable from both sides. See Section 087100 "Door Hardware" for cylinder requirements**][**Deadlock to receive cylinder, operable from both sides. See Section 087111 "Door Hardware (Descriptive Specification)" for cylinder requirements**].
4. Foot Bolts: On lead post where indicated. Secure to post to avoid interference with seals.

M. Jamb Molding: Manufacturer's molding at closing jamb as required for light-tight jamb closure.

1. Material: [**Wood, matching species and finish of panel facing**][**Metal, in manufacturer's standard finish**].
2. Jamb Strip: Nonferrous for end-opening doors to ensure tight closure by engaging rubber bumper on lead post.

N. Wood Track Molding: Manufacturer's standard wood molding on each side of surface-mounted track to match species and finish of panel facings. Install with tight, hairline joints with all fasteners concealed.

O. Jambs and Posts: Manufacturer's standard steel or extruded-aluminum posts formed for rigidity and to provide light seal at supporting construction.

1. Fixed Jambs: For doors anchors anchored to stack jamb.
2. Double End Posts: To allow door to operate from both ends.
3. Rolling Jamb Post: To allow door to disconnect from stack jamb.
4. Sliding Jamb: To allow door to stack in storage pocket.
5. Lead Post: At closing edge of door.

P. Tiebacks: To maintain door in stacked position.

2.3 METAL BIFOLD DOORS

A. Description: Metal folding doors hinged together in pairs and supported on pivots at jamb, overhead track, and door guide pins.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dunbarton Corporation**]
2. [**Renin Corporation**]

C. Metal Panels: Formed from nominal **0.024-inch- (0.6-mm-)** thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel and channel-formed edges.

1. Surface Profile: [**As indicated on Drawings**][**Fully louvered**][**Flush**][**Paneled**][**Louvered and paneled**].
2. Configuration: [**As indicated on Drawings**][**Two-panel bifold doors for openings up to 36 inches (914 mm) wide**][**Four-panel bifold doors for openings greater than 36 inches (914 mm) wide**].
3. Sheet Metal Texture: [**Smooth**][**Simulated leather**].
4. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
5. Baked-Enamel Finish: Electrostatically applied, baked-on factory finish in [**white**][**ivory**][**custom color as selected by Architect**], as directed by the Owner.

D. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:

1. Hinges: Three self-aligning hinges per pair of doors.
2. Guides and Pivots: Not less than **9/16-inch- (14-mm-)** diameter, adjustable screw-type, weight-bearing, zinc-plated pivot rod held in place by nylon rod clamp assemblies; with not less than **1/4-inch- (6.4-mm-)** diameter, spring-loaded, self-aligning, zinc-plated steel guide rods and top pivot rods held in place by nylon sleeves.
3. Overhead Track: Extruded aluminum, **0.05 inch (1.3 mm)** thick, in mill finish.
4. Floor Guide: [**Extruded-aluminum track matching top track that retains bottom guide pin(s)**][**Mill-finish aluminum floor-mounted bracket retains bottom pivot; provide aligning bracket at leading edges of door pairs for four-panel doors**].

2.4 MIRRORED BIFOLD DOORS

A. Description: Mirrored folding doors hinged together in pairs and supported on pivots at jamb, with floor and overhead track and door guide pins.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Contractors Wardrobe, Inc.**]
2. [**Dunbarton Corporation**]
3. [**Sliding Door Company (The)**]

C. Steel-Panel Door Construction: Flush profile, formed from nominal **0.024-inch- (0.6-mm-)** thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel- and channel-formed edges. Attach mirrored glass facing to steel sheet dual-faced cushion tape. Protect bottom edge of mirror with steel channel.

1. Configuration: [**As indicated on Drawings**][**Two-panel bifold doors for openings up to 36 inches (914 mm) wide**][**Four-panel bifold doors for openings greater than 36 inches (914 mm) wide**].

2. Mirrored-Glass Edging: Mylar to match track and hardware finish.
3. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
4. Baked-Enamel Finish: Electrostatically applied, baked-on factory finish in [**white**][**ivory**][**black**][**custom color as selected by Architect**], as directed by the Owner.
5. Overhead Track: Extruded aluminum; **0.05 inch (1.3 mm)** thick; [**mill**][**chrome**] finish.
6. Floor Guide: [**Extruded-aluminum track matching top track that retains bottom guide pin(s)**][**Mill-finish aluminum floor-mounted bracket retains bottom pivot; provide aligning bracket at leading edges of door pairs for four-panel doors**].

D. Metal-Framed Door Construction: [**Aluminum**][**Steel**] stiles and mechanically fitted rails with screw-attached stiffeners and with mirrored-glass facing attached securely to frames.

1. Panel Style: [**Exposed frame**][**Concealed frame; mirrored glass with polished vertical edges**].
2. Configuration: [**As indicated on Drawings**][**Two-panel bifold doors for openings up to 36 inches (914 mm) wide**][**Four-panel bifold doors for openings greater than 36 inches (914 mm) wide**].
3. Steel, Enamel Finish: Electrostatically applied, baked-on factory finish in [**white**][**off-white**][**brown**][**black**][**custom color as selected by Architect**], as directed by the Owner.
4. Steel, Metallic Finish: [**Chrome**][**Satin gold**][**Bright gold**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Anodized Aluminum Finish: [**Satin brass**][**Bright brass**][**Satin chrome**][**Bright chrome**].
6. Track: Overhead and bottom track prefinished to match door.

E. Mirrored Glass: 3-mm thick, silvered, mirrored, film-backed safety glass, complying with 16 CFR 1201 for Category II safety glass and with ASTM C1036 for Type I (transparent, flat), Class 1 (clear), Quality q2 (mirror) annealed float glass.

F. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish to match door. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:

1. Hinges: Three self-aligning concealed hinges.
2. Guides and Pivots: Spring-loaded, zinc-plated steel guides and tops, and adjustable bottom pivot pins with nylon bushings and tips.

2.5 FIRE-RATED FOLDING DOORS

A. Description: [**Electrically**][**Gravity-**]operated folding-door assembly, automatic or self-closing, listed and labeled for fire-resistance ratings indicated by a qualified testing agency, top supported, and complete with hardware, seals, track, closing devices, releasing devices, controls, and accessories necessary for intended operation.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**McKeon Door Company**]
2. [**Won-Door Corporation**]

C. Listed Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing in accordance with [**NFPA 252**][**UL 10B**].

1. Oversize Doors: For units exceeding sizes of tested assemblies, provide certification by a

qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

D. Configuration: [**As indicated on Drawings**][**Side opening**][**Center opening**].

E. Features:

1. Track: [**Overhead track without floor guide**][**Overhead and floor tracks**].
2. Normal Position: Assembly's normal position is the open (stacked) position. Signal from fire-alarm system initiates self-closing operation.
3. Manual Operation: Allow manual operation in either conventional or emergency mode. When opened manually during emergency mode, control mechanism automatically closes assembly.
4. Access Control/Monitoring: [**Exit hardware does not respond until activated by signal from smoke detector or fire alarm**][**Electromagnetic lock resists manual opening until activated by a signal from fire alarm**][**Synchronized, computerized control system continuously controls and monitors up to 120 doors**].
5. Non-Sway Construction: To resist differential air pressure.

F. Fire Rating: [**1**][**1-1/2**][**3**] hour(s).

G. Panel Construction: [**Formed-galvanized-steel or formed-steel**][**Formed-stainless steel**] sheet panels connected by hinges of matching material.

H. Perimeter Seals and Closures: Manufacturer's standard vinyl or neoprene vertical seals, horizontal top and bottom seals, and closures identical to products tested for fire rating indicated, and forming an effective smoke and draft seal.

1. Points of Access to Elevators: Provide smoke seals that comply with requirements of authorities having jurisdiction for seals at points of access to elevators where indicated.

I. Track and Trolley System: Single or dual steel or aluminum track systems, with ball-bearing roller trolleys and adjustable steel hanger rods for overhead support; designed for type of operation, size, and weight of fire-rated folding door indicated. Provide a continuous system of track sections and accessories identical to products tested for fire rating indicated, to accommodate configuration and layout indicated for door operation and storage.

J. Lead Posts: Metal sheet material matching door-panel construction and connected to panels by specially adapted panels and equipped with manufacturer's standard handle on each side.

K. Electric Operators and Controls:

1. Operators: Factory-assembled power-drive unit consisting of motor,[**remote-located**] control panel, limit switches, torque-limiting devices, clutch, reversing magnetic motor operator, leading-edge obstruction detectors, and key-switch control for conventional operation.

   a. Motor: [**In horsepower required for proper operation of door height and weight**][**1/3 hp**][**1/2 hp**], controlled by reversing magnetic starter and equipped with overload protection.
   b. Limit Switches: To prevent overtravel.
   c. Roller Chain or Cable: Connected to lead posts by means of vertical stabilizer bar assembly.
   d. Drive Mechanism: Protected by torque limiter and emergency clutch.
   e. Travel Speed: **18 inches (450 mm)** per second, maximum; **6 inches (150 mm)** per second, minimum.

2. In case of fire, closing system is activated by building's fire- and smoke-detection equipment and

automatically closes fire-rated folding doors.

3. Electrical Service: Equip for [**120-V, single-phase, 60-cycle ac**].
4. Battery: Electrical current connects through relay to battery charger that continuously charges 12-V dc battery and automatically maintains battery at capacity. Automatic audible signal device sounds off if battery falls below or exceeds proper charge, power loss has occurred, or high-ac line voltage has been experienced.
5. Leading-Edge Obstruction Detector:

    a. Equip with pressure-sensitive leading edge that, on contact with an obstruction, causes door to stop and pause before attempting to re-close.
    b. Disable leading-edge obstruction detector until fire-rated folding door has opened swinging door on the storage pocket (pocket door).

6. Fire-rated folding doors can be manually opened by pushing against leading edge.
7. Audible alarm sounds at automatic closing of door.

L. Accessories:

1. Vision panels.
2. Exit Hardware: Located on both sides of fire-rated folding door. In emergency mode, slight pressure on hardware causes door to open a minimum of **32 inches (812 mm)**, pause for three seconds, and then automatically close. Furnish hardware that can be field programmable to allow automatic opening distances of up to the entire opening width. In conventional mode, hardware is used to operate door and move it back into storage pocket.
3. Swinging egress doors.

M. Finishes:

1. Factory-applied polyester or powder-coat finish for panels and hinges in [**manufacturer's standard color**][**colors as selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Manufacturer's standard finish for handles.

N. Pocket Door: Swinging door that closes to conceal the storage pocket.

1. Solid-core pocket doors with [**reverse-action spring**][**continuous**] hinge; 90-degree minimum swing.
2. Face Finish: [**Match adjacent finishes**].
3. Magnetic Catch: Holding force of no more than **30 lbf (133 N)**.
4. Maximum Opening Force: **50 lbf (222 N)**.
5. Bumper on interior side of pocket door as required by fire-rated folding-door manufacturer to prevent interference with opening or retracting operation of fire-rated folding door.
6. Coordinate pocket door sizes with fire-rated folding-door manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. For folding doors supported by or anchored to permanent construction, advise installers of specific requirements for placement of anchorage devices. Furnish installers of other work with templates and drawings indicating locations of anchorage devices and similar items.

B. Fire-Rated Folding Doors: Level floor with header in path of fire-rated folding doors to tolerance of plus or minus **1/16 inch (1.6 mm)** across opening; grind or fill floor as necessary.

3.3 INSTALLATION

A. General: Install folding doors complying with manufacturer's written installation instructions. Install track in one piece.

1. Fire-Rated Folding Doors: Comply with NFPA 80 requirements for installation.

B. Standard Floor Clearances: **1/4 to 3/4 inch (6.4 to 19 mm)** maximum (above floor finish).

C. Coordinate provisions for sensing devices[**electrical service,**] and final connections for fire-rated folding doors.

3.4 ADJUSTING

A. Adjust units to ensure smooth, quiet operation without warping or binding. Adjust hardware to function smoothly. Confirm that latches engage accurately and securely without forcing or binding.

1. Fire-Rated Folding Doors: Verify that all operations are functional and comply with requirements of authorities having jurisdiction.

B. Pocket Doors: Adjust to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain fire-rated folding doors.

END OF SECTION 08 35 13 00

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SECTION 08 35 13 13 - MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multipanel folding aluminum-framed glass doors.

B. Related Requirements:

1. Section 081816.16 "Multipanel Sliding Aluminum-Framed Glass Doors" for multipanel aluminum-framed glass doors that operate by sliding.
2. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units on the building exterior.
3. Section 085113 "Aluminum Windows" for coordinating finishes among aluminum fenestration units on the building exterior.
4. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hardware not specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Multipanel folding aluminum-framed glass doors.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for multipanel folding aluminum-framed glass doors.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

D. Shop Drawings:

1. Include plans, elevations, sections, and installation details.
2. Indicate dimensions, configuration of panels, and stacking layout.

E. Samples: For each multipanel folding aluminum-framed glass door and for each color specified, **12-inch-long (300-mm-long)** section with factory-applied color finish.

F. Samples for Initial Selection: For doors and hardware with factory-applied color finish.

G. Samples for Verification: For multipanel folding aluminum-framed glass doors and components required, prepared on Samples of size indicated below:

1. Main Framing Member: **12-inch-long (300-mm-long)** section with weather stripping, glazing

bead and factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.

H. Product Schedule: For multipanel folding aluminum-framed glass doors.[**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Product Test Reports: For each multipanel folding aluminum-framed glass door, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**]; and for each class and performance grade indicated, tested at AAMA gateway size.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data:

1. For multipanel folding aluminum-framed glass doors to include in maintenance manuals. Include finishes, weather stripping, operable panels, and operating hardware.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating multipanel folding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

B. Installer Qualifications: An installer acceptable to multipanel folding aluminum-framed glass door manufacturer for installation of units required for this Project.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup for multipanel folding aluminum-framed glass doors, as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace multipanel folding aluminum-framed glass doors that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excess deflection.

c. Excessive water leakage or air infiltration.
d. Faulty operation of movable panels and hardware.
e. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
f. Failure of insulating glass[**and laminated glass**].

2. Warranty Period:

a. Multipanel Folding Aluminum-Framed Glass Doors: [**Five**][**10**][**20**] year(s) from date of Substantial Completion.
b. Insulating-Glass Units: [**10**][**20**] years from date of Substantial Completion.
c. Laminated Glass: [**Five**] years from date of Substantial Completion.
d. Aluminum Finish: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Product Certification: AAMA certified with label attached to each door.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**Class R**][**Class LC**][**Class CW**][**Class AW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**Grade 15**][**Grade 20**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 45**][**Grade 50**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum total fenestration product U-factor of [**0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.83 W/sq. m x K)**][**0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.43 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum total fenestration product SHGC of [**0.40**][**0.30**][**0.27**].

E. Condensation-Resistance Factor (CRF): Provide multipanel folding aluminum-framed glass doors tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

F. Thermal Movements: Provide multipanel folding aluminum-framed glass doors, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C)**], material surfaces.

G. Sound Transmission Class (STC): Rated for not less than [**28**][**32**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

H. Outside-Inside Transmission Class (OITC): Rated for not less than [**23**][**27**][**29**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within **30 feet (9.1 m)** of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

2.2 MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Arcadia Inc.**]
2. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
3. [**Euro-Wall Systems, LLC**]
4. [**LaCantina Doors; a division of JELD-WEN**]
5. [**Lanai Doors**]
6. [**Milgard Manufacturing, LLC**]
7. [**Nana Wall Systems, Inc.**]
8. [**Panda Windows & Doors**]
9. [**Solar Innovations, Inc.**]

B. Multipanel Folding Aluminum-Framed Glass Doors: Provide extruded-aluminum-framed multipanel folding glass doors, complete with glazing, threshold, flashings, support, and anchorage devices.

1. Application: [**Exterior**][**Interior**], [**inward opening**][**outward opening**].
2. Stack Storage Configuration: [**Panels open from center to both sides**][**As shown on Drawings**].[**Hinge panels together in separate pairs.**]

C. Frames and Door Panels: Fabricated from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440. Provide factory-assembled door panels that are reglazable without dismantling panel framing, and [factory-assembled][field-assembled] frames.

1. Thermally Improved Construction: Fabricate frames and door panels with an integral, concealed, low-conductance thermal barrier located between exterior and interior surfaces in a manner that eliminates direct metal-to-metal contact.
2. Door Panel Design: [As indicated][Narrow stile][Medium stile][Wide stile] design[with 10-inch (254-mm) nominal height bottom rail].
3. Grilles (False Muntins): Provide between-glass grilles in designs indicated to each panel lite, with material and finish to match adjacent door panel finish.

   a. Bar Width: Not less than [**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1-1/8 inches (28 mm)**] wide.
   b. Bar Profile: [**Beveled**][**Ovolo**][**Square**].

2.3 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal. [**Comply with requirements for windborne-debris resistance**][**Comply with requirements indicated in Section 088000 "Glazing"**].

1. Glass: ASTM C1036, Type 1, q3; Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][the manufacturer]. Label must indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
4. Insulating-Glass Units: ASTM E2190[certified through IGCC as complying with requirements of IGCC].

   a. Filling: Fill space between glass lites with [**air**][**argon**].
   b. Lites: [**Two**][**Three**].
   c. Low-E Coating: [**Manufacturer's standard**][**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

2.4 HARDWARE

A. Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with door panels and other components, and complying with AAMA 907. Provide hardware designed to smoothly operate, tightly close, and securely lock multipanel folding aluminum-framed glass doors. Size hardware to accommodate panel weights and dimensions. Provide full-perimeter weatherstripping for each door panel.

B. Panel Support System: Provide panel support system designed for size, weight, and performance requirements of multipanel folding aluminum-framed glass doors indicated. Provide carriers with sealed ball bearings.

1. Overhead Supported: Provide multiwheeled overhead carriers suspended from steel or aluminum track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded.
2. Bottom Supported: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track.

3. Adjustment: Provide panel support system capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.
4. Threshold Configuration: Extruded-aluminum [thermally broken,] threshold with [raised, weather-resistant profile][low profile, compliant with United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines"][recessed flush profile][with concealed drainage system].

    a. Aluminum Finish: [**To match panel**][**Clear anodized**][**Dark bronze anodized**].

C. Panel Hinges: Stainless steel, multileaf hinge with painted finish to match exterior. Provide integral hangers and guides for hinges that engage panel support system.

D. Locking System:

1. Primary Entrance Panel: Provide manufacturer's standard keyed multipoint locking device, with lever handles on the interior and exterior that operate dead bolt and concealed top and bottom rods.
2. Secondary Entrance Panel: Provide [**dummy trim on interior and exterior with concealed automatic flush bolts**][**two-point locking device that operates concealed top and bottom rods**][**surface-mounted flush bolt**].
3. Panel Pairs: Provide manufacturer's [**standard handles**][**removable custodial handles**] and [**two-point locking device that operates concealed top and bottom rods**][**surface-mounted flush bolt**] at each panel pair.
4. Trim Design: [**As selected from manufacturer's full range**].

    a. Finish: [**As selected from manufacturer's full range of finishes**][**Polished brass**][**Antique brass**][**Satin chrome**][**Oil-rubbed bronze**][**Dark bronze**][**Painted white**].

5. Cylinders: [**Manufacturer's standard.**][**ANSI/BHMA A156.5, Grade 1.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

2.5 ACCESSORIES

A. Trim: Provide interior and exterior casings, jamb extensions, and other components in material and finish to match door frames.

B. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

C. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for multipanel folding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

1. Windborne-Debris Resistance: Provide anchors of same design used in windborne-debris resistance testing.

2.6 INSECT SCREENS

A. Screen Fabric: Provide screen mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; and complying with ASTM D3656/D3656M.

1. Fabric Color: [**Manufacturer's standard**][**Charcoal gray**][**Silver gray**].

B. Pleated Insect Screen: Screen suspended from the top, with bottom guide, and finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

C. Coiling Insect Screen: Coiling screen housed in jamb-mounted cartridge, guided by upper and lower tracks. Finish [**to match exterior door face**][**as selected from manufactures' standard colors**]. Provide single- or two-function operation with screen meeting rails at same location as primary entrance of door.

2.7 FABRICATION

A. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

B. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory.

2.8 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].

2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight hinged-door installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing multipanel folding aluminum-framed glass doors, hardware, accessories, and other components.

B. Windborne-Debris Resistance: Anchor multipanel folding aluminum-framed glass doors that have been tested for windborne-debris resistance to structure, using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris resistance testing.

C. Install multipanel folding aluminum-framed glass doors level, plumb, square, true to line; without distortion, warp, or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.

D. Set threshold members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Test and inspect installed multipanel folding aluminum-framed glass doors as follows:

1. Testing Methodology: Test multipanel folding aluminum-framed glass doors for air infiltration and water resistance in accordance with AAMA 502.
2. Air-Infiltration Testing:

   a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] multipanel folding aluminum-framed glass doors of each type as selected by Architect and a qualified independent testing and inspecting agency. Conduct tests after perimeter sealants have cured, as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Multipanel folding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING

A. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.

B. Adjust hardware and operable panels to function smoothly, and lubricate as recommended by manufacturer.

3.5 CLEANING

A. Clean exposed surfaces immediately after installation. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.6 PROTECTION

A. Protect multipanel folding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately according to manufacturer's written instructions.

B. Refinish or replace folding aluminum-framed glass doors with damaged finishes.

END OF SECTION 08 35 13 13

Task	Specification	Specification Description
08 35 13 13	08 35 13 00	Folding Doors

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SECTION 08 36 13 00 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sectional-door assemblies.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.
2. [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting"**] for finish painting of factory-primed steel doors.
3. Section 111200 "Parking Control Equipment" for parking control equipment interlocked to sectional doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
2. For power-operated doors, include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.

D. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed finish and for each color and texture required on the following components, in manufacturer's standard sizes:

1. Glazing.
2. Metal for door sections.
3. Hardware.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranties: For manufacturer's warranty [**and finish warranty**].

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sectional doors to include in maintenance manuals.

B. Manufacturer's warranty.

C. Finish warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Regulatory Requirements: Comply with provisions in the [**U.S. Department of Justice's "2010 ADA Standards for Accessible Design"**][**U.S. Department of Transportation's "ADA Standards for Transportation Facilities"**][**the United States Access Board's "Architectural Barriers Act (ABA) Standards"**][**41 CFR, Appendix A to Subpart 101-19.6, "Uniform Federal Accessibility Standards"**][**ICC A117.1**] applicable to sectional doors.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Failure of components or operators before reaching required number of operation cycles.
c. Faulty operation of hardware.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
e. Delamination of exterior or interior facing materials.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sectional doors from single source from single manufacturer.

1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction[**and without requiring temporary installation of reinforcing components**].

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: [**As indicated on Drawings**][**Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward**].
2. Testing: In accordance with ASTM E330/E330M[**or DASMA 108 for garage doors and complying with DASMA 108 acceptance criteria**].
3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.

   a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of door width.
   b. Deflection of horizontal track assembly shall not exceed 1/240 of door height.

4. Operability under Wind Load: Design sectional doors to remain operable under [**design**][**uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa)**][**uniform pressure (velocity pressure) of 30 lbf/sq. ft. (1436 Pa)**] wind load, acting inward and outward.

C. Windborne-Debris Impact Resistance: Provide sectional doors complying with the following requirements:

1. Glazed Openings: Pass ASTM E1886 Large Missile Test and cyclic-pressure tests in accordance with ASTM E1996 for [**basic**][**enhanced**] protection and Wind Zone [**applicable to basic design wind speed indicated on Drawings**].
2. Garage-Door Glazed Openings: Pass DASMA 115.

D. Seismic Performance: Provide sectional doors that withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Component Importance Factor: [**1.5**][**1.0**].

2.3 SECTIONAL-DOOR ASSEMBLY

A. Sectional Door: Provide [**steel**][**aluminum**] sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Amarr Company**]
b. [**Arm-R-Lite Manufacturing Co., Inc.**]
c. [**BP - Glass Garage Doors & Entry Systems, Inc**]
d. [**C.H.I. Overhead Doors, Inc.**]
e. [**Clopay Building Products**]
f. [**Fimbel Architectural Doors**]
g. [**Haas Door; a Nofziger Company**]
h. [**Hörmann LLC**]
i. [**Martin Door Manufacturing**]
j. [**Overhead Door Corporation**]
k. [**Raynor Garage Doors**]
l. [**Rite-Hite Holding Corporation**]
m. [**Wayne Dalton; a division of Overhead Door Corporation**]
n. [**Windsor Door**]

B. Operation Cycles: Door components and operators capable of operating for not less than [**10,000**][**25,000**][**50,000**][**75,000**][**100,000**] operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.

C. Air Infiltration: Maximum rate of [**0.4 cfm/sq. ft. (2.03 L/s per sq. m)**] when tested in accordance with ASTM E283 or DASMA 105.

D. U-Value: [**0.052 Btu/sq. ft. x h x deg F (0.295 W/sq. m x K)**][**0.130 Btu/sq. ft. x h x deg F (0.738 W/sq. m x K)**][**0.149 Btu/sq. ft. x h x deg F (0.845 W/sq. m x K)**].

E. Steel Door Sections: ASTM A653/A653M, zinc-coated (galvanized), cold-rolled, commercial steel sheet with [**G60 (Z180)**][**G90 (Z275)**] zinc coating.

1. Door-Section Thickness: [**1-3/8 inches (35 mm)**][**1-3/4 inches (44 mm)**][**2 inches (51 mm)**].
2. Section Faces:

a. Thermal-Break Construction: Provide sections with continuous thermal-break construction separating the exterior and interior faces of door.
b. Exterior Face: Fabricated from single sheets, not more than [**24 inches (610 mm)**] high; with horizontal meeting edges rolled to continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove, weather- and pinch-resistant seals and reinforcing flange return.

1) Steel Sheet Thickness: [**0.019-inch (0.48-mm)**][**0.022-inch (0.56-mm)**][**0.028-inch (0.71-mm)**][**0.040-inch (1.02-mm)**][**0.064-inch (1.63-mm)**] nominal coated thickness.
2) Surface: Manufacturer's standard, [**flat**][**grooved**][**ribbed**][**paneled**][**stucco embossed**][**wood-grain embossed**].

c. Interior Face: Enclose insulation completely within steel exterior facing and interior facing material, with no exposed insulation. Provide the following interior-facing material:

1) Zinc-Coated (Galvanized) Steel Sheet: With minimum nominal coated thickness of [**0.019 inch (0.48 mm)**][**0.022 inch (0.56 mm)**][**0.025 inch (0.64 mm)**][**0.028 inch (0.71 mm)**][**dimension recommended in writing by manufacturer to comply with performance requirements**].
2) Plastic: [**Manufacturer's standard vinyl material complying with DASMA 107 requirements**].

3. End Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than [**0.040-inch (1.02-mm)**][**0.064-inch (1.63-mm)**] nominal coated thickness and welded to door section.
4. Intermediate Stiles: Provide intermediate stiles formed from not less than [**0.040-inch- (1.02-mm-)**][**0.064-inch- (1.63-mm-)**] thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than [**48 inches (1219 mm)**] apart.
5. Section Reinforcing: Horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.[**Ensure that reinforcement does not obstruct vision lites.**]

    a. Bottom Section: Reinforce section with a continuous channel or angle conforming to bottom-section profile[**and allowing installation of astragal (weatherseal)**].
    b. Hardware Locations: Provide reinforcement for hardware attachment.

6. Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard [**CFC-free**] insulation of type indicated below:

    a. Board Insulation: [**Polystyrene**][**polyurethane**], secured to exterior face sheet.
    b. Foamed-in-Place Insulation: Polyurethane, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load.
    c. Fire-Resistance Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, in accordance with ASTM E84.

F. Aluminum Sections: **ASTM B221 (ASTM B221M)** extruded-aluminum stile and rail members of alloy and temper standard with manufacturer for type of use and finish indicated; [**in minimum thickness required to comply with requirements**]; with rail and stile dimensions and profiles indicated on Drawings; and with overlapped or interlocked weather- and pinch-resistant seal at meeting rails.

1. Door-Section Thickness: [**1-3/4 inches (44 mm)**][**2 inches (51 mm)**].
2. Section Reinforcing: Continuous horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.

    a. Hardware Locations: Provide reinforcement for hardware attachment.

3. Insulated Stiles and Rails: Fill stiles and rails [**manufacturer's standard polyurethane expanding foam**].
4. Glazed Panels: Manufacturer's standard, aluminum-framed section with glazing sealed with glazing tape and [**aluminum**][**matching vinyl**] glazing bead. Glazing as follows:

    a. Float Glass: 3 mm thick and complying with ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
    b. Tempered Glass: 3 mm thick and complying with ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (clear), Quality-Q3.
    c. Insulating Glass Units: Manufacturers' standard unit with [**float glass lites complying with ASTM C1036**][**tempered glass lites complying with ASTM C1048, Kind FT (fully tempered), Condition A (uncoated)**], Type I, Class 1 (clear), Quality-Q3.

5. Solid Aluminum Panels: **ASTM B209 (ASTM B209M)**, alloy and temper standard with manufacturer for use and finish indicated.

    a. Description: [**0.050 inch (1.3 mm) thick**][**1/2-inch- (12.7-mm-) thick overall insulated panel composed of 0.050-inch (1.3-mm) aluminum interior and exterior panels with an extruded polystyrene (EPS) core**].
    b. Attachment to Frame: Sealed with glazing tape and [**aluminum**][**matching vinyl**] glazing bead.
    c. Aluminum Surface: [**Stucco embossed**][**Smooth**].

6. Perforated Aluminum Panels: **ASTM B209 (ASTM B209M)**, alloy and temper standard with manufacturer for use and finish indicated.

   a. Description: [**0.50 inch (1.3 mm) thick, with mill finish, 0.312-inch (7.9-mm) square perforations on 0.5-inch (12.7-mm) centers, and a total open area of 39 percent**].
   b. Attachment to Frame: Sealed with glazing tape and [**aluminum**][**matching vinyl**] glazing bead.

G. Track: Manufacturer's standard, galvanized-steel, [**standard-lift**][**low-headroom**][**high-lift**][**vertical-lift**][**contour**] track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.

1. Material: Galvanized steel, ASTM A653/A653M, minimum **G60 (Z180)** zinc coating.
2. Size: [**As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings**][**2 inches (51 mm) wide**][**3 inches (76 mm) wide**].
3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced **2 inches (51 mm)** apart for door-drop safety device.

   a. Vertical Track: Incline vertical track to ensure weathertight closure at jambs. Provide [**continuous angle**][**continuous reverse angle**][**intermittent jamb brackets**] attached to track and wall.
   b. Horizontal Track: Provide continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.

H. Removable Center Posts: Manufacturer's standard [**carry-away**][**roll-away**][**swing-up**] type for multiple doors in one opening; provide in quantity and locations indicated on Drawings.

I. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom [**top**][**and**][**jambs**] of door.[**Provide combination bottom weatherseal and sensor edge for bottom seal.**]

J. Windows: Manufacturer's standard window units of shape and size and in locations indicated on Drawings. Set glazing in vinyl, rubber, or neoprene glazing channel. Provide removable stops of same material as door-section frames. Provide the following glazing:

1. Clear Float Glass: 3 mm thick and complying with ASTM C1036, Type I, Class 1, Quality-Q3.
2. Clear Acrylic Plastic: 3 mm thick, transparent, smooth or polished, and formulated to be UV resistant.[**Provide double insulating units.**]
3. Clear Polycarbonate Plastic: 3 mm thick, transparent, fire-retardant, UV-resistant, polycarbonate sheet manufactured by extrusion process.
4. Insulating Glass Units: [**Manufacturer's standard**].

K. Pass Door: Provide manufacturer's standard pass door in size and location indicated on Drawings; complete with glazing, operating hardware, and mortise lock; and with welded frame, exterior matching door face, and integral shiplap weather seal.

1. Hinges: [**Manufacturer's standard geared hinges**].
2. Door Closer: [**Manufacturer's standard pneumatic closer sized for swing door and mounted on interior**].
3. Lock Cylinders: Cylinders [**complying with Section 087100 "Door Hardware" requirements**][**complying with Section 087111 "Door Hardware (Descriptive Specification)" requirements**][**standard with manufacturer**].

a. Keying: [**Keyed to building keying system**].
b. Keys: [**Two**][**Three**] for each cylinder.

4. Features:

a. Rain Cap: To protect door from accumulated water.

L. Exhaust Port: [**Manufacturer's standard, installed in bottom section in location indicated on Drawings**].

M. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.

1. Hinges: Heavy-duty, galvanized-steel hinges of not less than **0.079-inch (2.01-mm)** nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.

a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.
b. Provide double-end hinges where required for doors more than **16 ft. (4.88 m)** wide unless otherwise recommended by door manufacturer in writing.

2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.

a. Roller-Tire Material: [**Case-hardened steel**][**Neoprene or bronze**][**Manufacturer's standard**].

3. Push/Pull Handles: Equip each door with galvanized-steel lifting handles on each side of door, finished to match door.
4. Mail Slot: [**Manufacturer's standard; brushed aluminum**].

N. Locking Device:

1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

a. Lock Cylinders: Cylinders [**complying with Section 087100 "Door Hardware" requirements**][**complying with Section 087111 "Door Hardware (Descriptive Specification)" requirements**][**standard with manufacturer**].
b. Keying: [**Keyed to building keying system**].
c. Keys: [**Two**][**Three**] for each cylinder.

3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

O. Counterbalance Mechanism:

1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.

a. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.
b. Provide one additional midpoint bracket for shafts up to **16 ft. (4.88 m)** long and two additional brackets at one-third points to support shafts more than **16 ft. (4.88 m)** long unless closer spacing is recommended in writing by door manufacturer.

3. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least [**5 to 1**][**7 to 1**].
4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

P. Manual Door Operator:

1. Push-Up Operation: Lift handles and pull rope for raising and lowering doors located on inside and outside of bottom section; with counterbalance mechanism designed so that required lift or pull for door operation does not exceed [**25 lbf (111 N)**].
2. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum [**25 lbf (111 N)**][**35 lbf (155 N)**] force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

Q. Electric Door Operator: Electric door operator assembly of size and capacity recommended by door manufacturer for door and operation cycles specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24 V ac or dc.
3. Safety: Listed in accordance with UL 325 by a qualified testing agency for commercial or industrial use[**moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. (2.4 m) or lower**].
4. Usage Classification: [**Heavy duty, 25 or more cycles per hour and more than 90 cycles per day**][**Standard duty, up to 25 cycles per hour and up to 90 cycles per day**][**Medium duty, up to 12 cycles per hour and up to 50 cycles per day**][**Light duty, up to 10 cycles per hour**].
5. Operator Type: [**Manufacturer's standard for door requirements**][**Trolley**][**Jackshaft, center mounted**][**Jackshaft, side mounted**][**As indicated on Drawings**].
6. Motor: Reversible-type [**with controller (disconnect switch)**] for [**interior, clean, and dry**][**exterior, dusty, wet, or humid**] motor exposure. Use adjustable motor-mounting bases for belt-driven operators.

a. Motor Size: [**As required to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor**][**1/3 hp (246 W)**][**1/2 hp (373 W)**][**3/4 hp (559 W)**][**1 hp (746 W)**][**3 hp (2238 W)**].
b. Electrical Characteristics:

1) Phase: [**Single phase**][**Polyphase**].
2) Volts: [**115**][**208**][**230**][**460**] V.

7. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

8. Obstruction Detection: Automatic external entrapment protection consisting of automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.

    a. Monitored Entrapment Protection: [**Photoelectric sensor**][**Electric sensor edge on bottom section**] designed to interface with door-operator control circuit to detect damage to or disconnection of sensor and complying with requirements in UL 325.
    b. Unmonitored Entrapment Protection: [**Pneumatic sensor edge, black, located within weatherseal mounted to bottom bar**][**Retro-reflective photo sensor**].

9. Control Station: [**Flush**][**Surface**] mounted, [**three-position (open, close, and stop)**][**two-position (open and close)**] control.

    a. Operation: [**Push button**][**Key**][**Push button interior and key exterior**].
    b. Interior-Mounted Unit: Full-guarded, surface-mounted, [**heavy-duty type, with general-purpose NEMA ICS 6, Type 1**][**standard-duty, weatherproof-type, NEMA ICS 6, Type 4**] enclosure.
    c. Exterior-Mounted Unit: Full-guarded, surface-mounted, [**standard-duty, weatherproof type, NEMA ICS 6, Type 4**] enclosure.
    d. Features: Provide the following:

        1) Vehicle detection operation.
        2) Radio-control operation.
        3) Card-reader control.
        4) Photocell operation.
        5) Door-timer operation.
        6) Explosion- and dust-ignition-proof control wiring.
        7) Audible and visual signals that comply with regulatory requirements for accessibility.

10. Emergency Manual Operation: [**Push-up**][**Chain**] type designed so required force for door operation does not exceed [**25 lbf (111 N)**][**35 lbf (155 N)**].
11. Emergency Operation Disconnect Device: Hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
12. Motor Removal: Design operator so motor can be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

R. Metal Finish: Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

1. Factory Prime Steel Finish: Compatible with field-applied finish and in manufacturer's standard color. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

    a. Aluminum Finish: Comply with [**AAMA 2603**][**AAMA 2604**] requirements for pigmented organic coatings applied to aluminum extrusions and panels.
    b. Color and Gloss: [**As indicated by manufacturer's designations**][**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Anodized Aluminum Finish: Noticeable variations in same piece are unacceptable. Variations in

appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1) Color: [**Bronze**][**Black**][**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. High-Performance, Organic, Aluminum Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Conversion coating; Organic Coating: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than [**50**][**70**] percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with [**AAMA 2604**][**AAMA 2605**] and with coating and resin manufacturers' written instructions.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range of industry colors and color densities**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.

B. Tracks:

1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than **24 inches (610 mm)** apart.
2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

D. Power-Operated Doors: Install[**automatic garage doors openers**] in accordance with UL 325.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.

D. Touchup Painting Galvanized Material: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

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Task	Specification	Specification Description
08 36 13 00	08 33 23 00	Overhead Coiling Doors

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SECTION 08 38 00 00 - TRAFFIC DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rigid, insulated traffic doors.
2. Rigid, polymer traffic doors.
3. Rigid, wood-core traffic doors.
4. Rigid, sheet metal traffic doors.
5. Flexible traffic doors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Dimensioned elevations, sections, and details of construction.
2. Locations of reinforcements and preparations for hardware.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: [**Manufacturers' standard size**].

E. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For traffic doors.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For traffic doors.

1.5 QUALITY ASSURANCE

A. NSF Certification: Provide traffic doors bearing NSF certification mark based on testing for compliance with requirements of NSF 2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in accordance with manufacturer's written instructions, on edge, upright, and under cover in manufacturer's unopened packaging until ready for installation.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of traffic doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failure of frames.
b. Faulty operation of traffic doors.
c. Deterioration of finishes and other materials beyond normal use.
d. Verify warranty periods.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain traffic doors from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Sanitation Requirements: Provide traffic doors that achieve USDA sanitation objectives contained in 9 CFR 416.

2.3 RIGID, INSULATED TRAFFIC DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allmark Door**]
2. [**Chase Doors; a Senneca Company**]
3. [**E S Robbins Corporation; ALECO**]
4. [**Eliason Corporation; a Senneca Company**]
5. [**National Access Design**]
6. [**Perma Tech Inc.**]
7. [**Super Seal Mfg. Ltd**]

B. Insulating Core:

1. Insulation: [**Manufacturer's standard high-density foam**][**Non-CFC urethane**][**Expanded polystyrene**].

   a. Minimum Total R-Value: [**9.86**][**10.83**][**25**] determined in accordance with ASTM C 518.

2. Internal Reinforcement: [**Manufacturer's standard**][**Tubular steel**][**Welded aluminum frame**][**Rubber frame**][**Extruded-PVC frame**][**Wood frame**].

C. Door Face Panels:

1. Rotationally Molded HDPE: [**1/4 inch (6 mm)**][**1/8 inch (3 mm)**] thick.

   a. Color: [**As selected by Architect from manufacturer's standard range**], as directed by the Owner.

2. ABS: [**1/8 inch (3 mm)**] thick.

   a. Color: [**As selected by Architect from manufacturer's standard range**], as directed by the Owner.

3. Metal: [**Stainless steel, 0.05 inch (1.27 mm) thick**][**Tempered aluminum top panels, 0.032 inch (0.81 mm) thick; stainless steel bottom plates, 0.05 inch (1.27 mm) thick**].
4. High-Pressure Decorative Laminate: ISO 4586-3 in color and pattern [**selected by Architect from manufacturer's standard range**][**matching Architect's sample**], as directed by the Owner.

D. Door Edges:

1. Edge Capping Material: [**Manufacturer's standard**].
2. Jamb-Edge Reinforcing Spine: [**Manufacturer's standard**][**Galvanized-steel sheet**][**Stainless steel**][**Aluminum sheet with black powder-coat finish**].
3. Perimeter Seals: [**Provide manufacturer's standard full-perimeter, replaceable gaskets/seals**].

E. Vision Lites:

1. Size: [**As indicated on Drawings**][**9 by 14 inches (229 by 356 mm)**].
2. Safety Glazing: [**Manufacturer's standard**][**1/8-inch- (3-mm-) thick polycarbonate,**][**1/4-inch- (6-mm-) thick acrylic,**][**1/4-inch- (6-mm-) thick glass,**] colorless, transparent glazing complying with testing requirements in 16 CFR 1201.

   a. Provide [**single glazing**][**double glazing**][**double glazing with security bars on 7-inch (178-mm) centers**][**triple glazing**][**insulating glass, triple glazed with argon fill**].

3. Frame: [**Manufacturer's standard**].

F. Double-Acting Hinges: V-cam hinge system.

1. Swing: [**90 by 90**][**90 by 180**][**120 by 120**] degrees.
2. Material: [**Manufacturer's standard corrosion-resistant material**][**Stainless steel**].
3. Spring Assist: [**None**][**Manufacturer's standard**].

G. Accessories:

1. Teardrop bumpers.
2. Cart guards.
3. Stainless steel push plates.
4. [**Stainless steel**][**ABS**][**HDPE**] impact plates.
5. [**Corrosion-resistant**][**Stainless steel**] bottom-hinge guard/cover.
6. [**Corrosion-resistant**][**Stainless steel**] top-hinge cover.
7. Door-swing limiting posts; HDPE with high-density foam core [**in color selected by Architect from manufacturer's full range**], as directed by the Owner.
8. Cane bolts.
9. Locking collars.

2.4 RIGID, POLYMER TRAFFIC DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chase Doors; a Senneca Company**]
2. [**Dortek Inc.**]
3. [**E S Robbins Corporation; ALECO**]
4. [**Eliason Corporation; a Senneca Company**]
5. [**National Access Design**]
6. [**Perma Tech Inc.**]

B. Door Panels:

1. ABS: [**1/8-inch- (3-mm-) thick ABS, bonded to a honeycomb polymer core**][**1/4 inch (6 mm) thick**].

   a. Color: [**As selected by Architect from manufacturer's standard range**], as directed by the Owner.

2. HDPE: [**1/2 inch (13 mm)**] thick.

   a. Color: [**As selected by Architect from manufacturer's standard range**], as directed by the Owner.

3. FRP: Minimum [**1-1/2 inches (38 mm)**] thick with gelcoat finish.

   a. Color: [**As selected by Architect from manufacturer's standard range**][**Match Architect's sample**], as directed by the Owner.

C. Door Edges:

1. Jamb-Edge Reinforcing Spine: [**Manufacturer's standard**][**Triple-layer spine with manufacturer's standard back channel**][**Galvanized-steel sheet with black powder-coat finish**][**Stainless steel**][**Extruded aluminum with black powder-coat finish**].
2. Perimeter Seals: [**None**][**Provide manufacturer's standard full-perimeter, replaceable gaskets/seals**].

D. Vision Lites:

1. Size: [**As indicated on Drawings**][**9 by 14 inches (229 by 356 mm)**].
2. Safety Glazing: [**Manufacturer's standard**][**1/4-inch- (6-mm-) thick acrylic**][**1/8-inch- (3-mm-)**

thick polycarbonate] complying with testing requirements in 16 CFR 1201.

a. Provide [**single glazing**][**double glazing**].

3. Frame: [**Manufacturer's standard**].

E. Double-Acting Hinges: [**Roller-and-cam hinge system with top-hinge cover and stabilizing bottom hinge pin**][**Manufacturer's standard spring hinges**].

1. Material: [**Manufacturer's standard corrosion-resistant material**][**Stainless steel**].

F. Accessories:

1. Teardrop bumpers.
2. Cart guards.
3. Jamb guards.
4. [**Stainless steel**][**ABS**][**HDPE**] impact plates.
5. [**Corrosion-resistant**][**Stainless steel**] bottom-hinge guard/cover.

2.5 RIGID, WOOD-CORE TRAFFIC DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chase Doors; a Senneca Company**]
2. [**E S Robbins Corporation; ALECO**]
3. [**Eliason Corporation; a Senneca Company**]
4. [**National Access Design**]
5. [**Perma Tech Inc.**]
6. [**Super Seal Mfg. Ltd**]

B. Wood Core: Solid, moisture-resistant [**plywood**][**composite wood**] cores.

1. Minimum Core Thickness: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**].

C. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

D. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

E. Door Face Panels: Permanently adhered to cores.

1. High-Pressure Decorative Laminate: ISO 4586-3 in color and pattern [**selected by Architect from manufacturer's standard range**][**matching Architect's sample**], as directed by the Owner.
2. ABS: [**1/8 inch (3 mm)**] thick.

a. Color: [**As selected by Architect from manufacturer's standard range**], as directed by the Owner.

3. Metal: [**Stainless steel, 0.05 inch (1.27 mm) thick**][**Aluminum sheet top panels, 0.032 inch (0.81 mm) thick, clear satin anodized; stainless steel bottom plates, 0.05 inch (1.27 mm) thick**].

F. Door Edges:

1. Edge Capping Material: [**Manufacturer's standard**][**Stainless steel**][**Extruded aluminum, clear satin anodized**].
2. Jamb-Edge Reinforcing Spine: [**Manufacturer's standard**][**Galvanized-steel sheet**][**Extruded aluminum, clear satin anodized**].
3. Perimeter Seals: [**None**][**Provide manufacturer's standard full-perimeter, replaceable gaskets/seals**].

G. Vision Lites:

1. Size: [**As indicated on Drawings**][**9 by 14 inches (229 by 356 mm)**].
2. Safety Glazing: [**Manufacturer's standard**][**1/4-inch- (6-mm-) thick acrylic,**][**1/8-inch- (3-mm-) thick polycarbonate,**] clear glazing complying with testing requirements in 16 CFR 1201.

a. Provide [**single glazing**][**double glazing**].

3. Glazing Frame: [**Manufacturer's standard**].

H. Double-Acting Hinges: Manufacturer's standard [**roller-and-cam**][**V-cam**] hinge system.

1. Swing: [**90 by 90**][**90 by 180**] degrees.
2. Material: [**Manufacturer's standard corrosion-resistant material**][**Stainless steel**].

I. Accessories:

1. Teardrop bumpers.
2. Cart guards.
3. Stainless steel push plates.
4. [**Stainless steel**][**ABS**] impact plates.
5. [**Corrosion-resistant**][**Stainless steel**] bottom-hinge guard/cover.

2.6 RIGID, SHEET METAL TRAFFIC DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**E S Robbins Corporation; ALECO**]
2. [**Eliason Corporation; a Senneca Company**]
3. [**National Access Design**]
4. [**World Manufacturing Inc.**]

B. Door Panels:

1. Aluminum Sheet: [**0.063 inch (1.6 mm)**] thick.

a. Finish: [**Manufacturer's standard clear satin anodized**][**High-pressure decorative laminate adhered to both sides in color and pattern selected by Architect from manufacturer's standard range**], as directed by the Owner.

2. Stainless Steel Sheet: [**0.05 inch (1.27 mm)**][**0.0625 inch (1.588 mm)**] thick.

C. Door Edges: Leading and jamb edges formed in triangular shape for stiffness and durability.

D. Vision Lites: Single glazed.

1. Size: [**As indicated on Drawings**][**9 by 14 inches (229 by 356 mm)**].
2. Safety Glazing: [**Manufacturer's standard**][**1/4-inch- (6-mm-) thick acrylic**][**1/8-inch- (3-mm-) thick polycarbonate**] complying with testing requirements in 16 CFR 1201.
3. Gasket Frame: [**Manufacturer's standard**].

E. Double-Acting Hinges: [**Manufacturer's standard roller-and-cam hinge system with corrosion-resistant finish**].

1. Upper Hinge Assembly: Provide with dust guard.
2. Bottom Pin: Provide with [**dust cover**][**jamb guard**].

F. Accessories:

1. Cart guards.
2. [**Stainless steel**][**ABS**] impact plates.

2.7 FLEXIBLE TRAFFIC DOORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chase Doors; a Senneca Company**]
2. [**E S Robbins Corporation; ALECO**]
3. [**National Access Design**]
4. [**Perma Tech Inc.**]
5. [**Super Seal Mfg. Ltd**]
6. [**World Manufacturing Inc.**]

B. Flexible Door Panels:

1. PVC: [**Single**][**Double**] ply.

a. Minimum Ply Thickness: [**0.080 inch (2.0 mm)**][**0.120 inch (3.0 mm)**][**0.125 inch (3.2 mm)**][**0.160 inch (4.1 mm)**][**0.250 inch (6.4 mm)**][**0.275 inch (7.0 mm)**][**0.394 inch (10.0 mm)**].
b. Color: [**Clear**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
c. PVC Formulation: Suitable for [**freezer**][**cooler**] applications.

2. Vinyl-Coated Nylon: [**40 oz./sq. yd. (1356 g/sq. m)**][**45 oz./sq. yd. (1526 g/sq. m)**].

a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Panel Edges:

1. Leading Edges: [**Manufacturer's standard**][**3-inch (76-mm)**] overlap.
2. Jamb Edges: [**Manufacturer's standard bulb seals**].
3. Top and Bottom Edges: [**Manufacturer's standard wiper seals**].

D. Flexible, Horizontal Panel Stays: Manufacturer's standard in [**one row**][**two rows**].

E. Hinge Bracket Pockets: [**Manufacturer's standard**].

F. Panel Weight Plates: [**Manufacturer's standard located at bottom of panels**].

G. Vision Lites: [**Manufacturer's standard**][**Clear PVC**][**1/8-inch- (3-mm-) thick polycarbonate**] complying with testing requirements in 16 CFR 1201.

H. Impact Plates: [**Manufacturer's standard**][**1/8-inch- (3-mm-) thick HDPE**].

I. Hardware: [**Top-mounted, double-acting gravity hinges with bracket arms and without bottom hinges**][**Full-length vertical frames with double-acting, adjustable-torsion spring hinges and top and bottom pivots**].

1. Duty Classification: Manufacturer's [**standard**][**heavy-duty**] hinge.
2. Swing: [**90 by 90**][**90 by 180**] degrees.
3. Material: [**Galvanized steel**][**Stainless steel**].
4. Accessories: [**Closing magnets**].

2.8 TRAFFIC DOOR FRAMES

A. Provide frames manufactured or recommended in writing by traffic door manufacturer for applications indicated on Drawings.

B. Flush, Hollow-Metal Frames: Provide frames without rabbets recommended in writing by manufacturer for light- to medium-duty traffic and reinforced internally for hardware installation.

1. Type: [**Knock-down construction with minimum two anchors per jamb**][**Fully welded for gypsum board construction with minimum of three sets of strap anchors per jamb**][**Fully welded for masonry construction with faces predrilled for anchoring to door opening with exposed fasteners**].
2. Material:

a. Galvanized-Steel Sheet: Minimum **0.064 inch (1.626 mm)** thick; [**factory primed for field painting**][**with manufacturer's standard factory powder-coat finish in color selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Stainless Steel Sheet: Minimum **0.0625 inch (1.588 mm)** thick.

3. Fasteners: Noncorrosive fasteners recommended in writing by manufacturer for supporting construction.

C. Channel Frames: Provide channel frames that wrap heads and jambs of supporting walls; recommended in writing by manufacturer for medium- to heavy-duty traffic; fabricated in three pieces with internal reinforcement plates for field assembly and hardware installation; and predrilled for hardware installation and fastening frame to supporting wall and to floor construction through two external floor flanges per jamb.

1. Material: [**Steel sheet, 0.1046-inch (2.657-mm) nominal thickness, factory powder coated in color selected by Architect from manufacturer's full range**][**Galvanized-steel sheet, 0.108-inch (2.743-mm) nominal thickness**][**Stainless steel sheet, 0.1094 inch (2.779 mm) thick**], as directed by the Owner.
2. Channel Dimensions: [**As indicated on Drawings**][**2 inches (51 mm) deep by width of supporting wall construction**].
3. Fasteners: Noncorrosive exposed fasteners recommended in writing by manufacturer for fastening frame.

D. Structural-Steel Tube Frames: Self-supporting, rectangular-tube frames recommended in writing by manufacturer for heavy-duty traffic; fabricated in three pieces for on-site assembly; with predrilled floor plates for bolting frames on both sides of each jamb to supporting floor construction; and with headers and jambs predrilled for fastening frames to wall construction and hardware installation.

1. Material: [**Steel tube with manufacturer's standard factory powder-coat finish in color selected by Architect from manufacturer's full range**][**Stainless steel tube**], as directed by the Owner.
2. Nominal Wall Thickness: [**As required to support door specified**][**3/16 inch (5 mm)**]
3. Tube Dimensions: [**As indicated on Drawings**][**2 by 4 by inches (51 by 102 mm)**][**2 by 6 inches (51 by 152 mm)**][**2 by 8 inches (51 by 203 mm)**].
4. Bolt Fasteners: Noncorrosive bolts recommended in writing by manufacturer.

2.9 MATERIALS

A. Steel Sheet: ASTM A1011/A1011M, hot-rolled, mild steel.

B. Galvanized-Steel Sheet: ASTM A653/A653M, galvanized by hot-dip process.

C. Steel Tube: ASTM A500/A500M.

D. Stainless Steel Sheet: ASTM A666, Type 304, No. 4 finish.

E. Stainless Steel Tube: ASTM A554, Type 304, No. 4 finish.

F. Aluminum Sheet and Plate: ASTM B209/B209M, alloy and temper standard with manufacturer for use and finish indicated.

G. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, alloy and temper to suit structural and finish requirements, but with not less than the strength and durability of Alloy 6063-T52.

H. Plastic Laminate: ISO 4586-3, high-pressure decorative laminate.

I. Glass: ASTM C1036, Type 1, q3.

J. Acrylic Glazing: ASTM D4802, Finish 1 (smooth or polished).

K. Polycarbonate Glazing: ASTM C1349, polished finish,

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DOOR FRAMES

A. Install door frames plumb, rigid, true in line, and securely fastened in place.

B. Installation Tolerances: Adjust frames to the following tolerances:

1. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.

C. Flush, Hollow-Metal Frames: Install in accordance with manufacturer's written instructions.

D. Channel Frames: Install in accordance with manufacturer's written instruction with channel flanges fastened to supporting construction with exposed fasteners.

E. Structural-Steel Tube Frames: Install in accordance with manufacturer's written instructions with floor plates bolted to floor construction.

3.3 INSTALLATION OF TRAFFIC DOORS

A. Install traffic doors and field-installed accessories in accordance with manufacturer's written instructions.

B. Install door panels plumb and true in line.

1. Align to provide effective seal at perimeters.

3.4 ADJUSTING AND CLEANING

A. Adjust hardware to function smoothly and open and close freely without binding; lubricate as recommended in writing by manufacturer.

B. Adjust doors to provide effective perimeter seal.

C. Clean surfaces as recommended in writing by manufacturer.

END OF SECTION 08 38 00 00

Task	Specification	Specification Description
08 38 13 00	08 38 00 00	Traffic Doors
08 38 16 00	08 38 00 00	Traffic Doors
08 38 19 00	08 38 00 00	Traffic Doors

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SECTION 08 42 13 00 - ALUMINUM-FRAMED ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed entrance door systems.

B. Related Requirements:

1. Section 019119.43 "Exterior Enclosure Commissioning" for additional field quality control testing requirements.
2. Section 084226 "All-Glass Entrances" for systems without aluminum support framing.
3. Section 081116.13 "Interior Aluminum Doors and Frames" for interior aluminum framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.3 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, full-size details, and attachments to other work.
2. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
3. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrance door systems, showing the following:

   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.

4. Include connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
5. Include point-to-point wiring diagrams showing the following:

   a. Power requirements for each electrically operated door hardware.
   b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

6. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: [**Manufacturers' standard size**].

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

G. Delegated Design Submittals: For aluminum-framed entrance door systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

H. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.
14. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

15. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.
    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

16. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

17. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: For aluminum-framed entrance door systems, accessories, and components, from manufacturer.

    1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance.

B. Product Test Reports: For aluminum-framed entrance door systems, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] .

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For Installer [**and field testing agency**][**and egress door inspector**] .

E. Delegated Design Engineer Qualifications: For aluminum-framed entrance door systems.

F. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts: For maintenance service agreement.

B. Operation and Maintenance Data: For aluminum-framed entrance door systems.

C. Warranty Documentation: For specified special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

    1. Fabricator of products.

2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer [**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**] .

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency Qualifications: Qualified in accordance with ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**] and acceptable, as directed by the Owner.

D. Egress Door Inspector Qualifications: Documented as complying with qualifications set forth in NFPA 101 [**and certified under DHI's certification program as a Certified Fire and Egress Door Assembly Inspector (CFDAI)**] .

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's written approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

1.7 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of aluminum-framed entrance door systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals [**metal finishes,**] and other materials beyond normal [**weathering**][**use**].

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of aluminum-framed entrance door systems, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrance door systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrance door systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].

D. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at [**150**] percent of positive and negative wind-load design pressures, entrance doors, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] percent of span.
2. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

E. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas of entrance doors when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

   a. Fixed Glazing and Framing Areas: U-factor for the system of not more than [**0.25 Btu/sq. ft. x h x deg F (1.42 W/sq. m x K)**][**0.28 Btu/sq. ft. x h x deg F (1.59 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.38 Btu/sq. ft. x h x deg F (2.16 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**] as determined in accordance with ANSI/NFRC 100.
   b. Entrance Doors: U-factor of not more than [**0.63 Btu/sq. ft. x h x deg F (3.57 W/sq. m x K)**][**0.68 Btu/sq. ft. x h x deg F (3.86 W/sq. m x K)**][**0.77 Btu/sq. ft. x h x deg F (4.37 W/sq. m x K)**][**0.83 Btu/sq. ft. x h x deg F (4.71 W/sq. m x K)**] as determined in accordance with ANSI/NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

   a. Fixed Glazing and Framing Areas: SHGC for the system of not more than [**0.23**][**0.25**][**0.30**][**0.35**][**0.40**][**0.48**] as determined in accordance with ANSI/NFRC 200.
   b. Entrance Doors: SHGC of not more than [**0.21**][**0.25**][**0.35**][**0.40**][**0.45**] as determined in accordance with ANSI/NFRC 200.

3. Air Leakage:

   a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with ASTM E283/E283M.
   b. Entrance Doors: Air leakage of not more than [**1.0 cfm/sq. ft. (5.08 L/s per sq. m)**] at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)** when tested in accordance with ASTM E283/E283M.

4. Condensation Resistance Factor (CRF):

   a. Fixed Glazing and Framing Areas: CRF for the system of not less than [**55**][**65**][**70**][**75**] as determined in accordance with AAMA 1503.
   b. Entrance Doors: CRF of not less than [**55**][**65**][**70**] as determined in accordance with AAMA 1503.

H. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.

1. Outdoor-Indoor Transmission Class: Minimum [**26**][**30**][**34**] .

I. Blast Resistance:

1. Hazard Rating: [**No Break**][**No Hazard**][**Minimal Hazard**][**Very Low Hazard**][**Low Hazard**][**High Hazard**] in accordance with ASTM F2912.
2. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

J. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

2.3 ALUMINUM-FRAMED ENTRANCE DOOR SYSTEMS

A. Aluminum-Framed Entrance Door System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Andersen Windows, Inc.; Andersen Corporation**]
   b. [**Arcadia Inc.**]
   c. [**Boyd Aluminum Mfg. Co.**]
   d. [**CMI Architectural Products, Inc.**]
   e. [**Coral Architectural Products; Coral Industries, Inc.**]
   f. [**EFCO Corporation; Architectural Metals; Apogee Enterprises, Inc.**]
   g. [**Kawneer Company, Inc.; Arconic Corporation**]
   h. [**Leed Himmel Industries, Inc.**]
   i. [**Manko Window Systems, Inc.**]
   j. [**OldCastle BuildingEnvelope (OBE)**]
   k. [**Pittco Architectural Metals, Inc.**]
   l. [**Reynaers North America**]
   m. [**Trulite Glass & Aluminum Solutions, LLC.**]
   n. [**Tubelite Inc.; Architectural Metals; Apogee Enterprises, Inc.**]
   o. [**U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
   p. [**YKK AP America Inc.**]

2. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or power operation.

   a. Door Construction: [**1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-)**][**2-inch (50.8-mm) overall thickness, with minimum 0.188-inch- (4.8-mm-)**][**2- to 2-5/8-inch (50.8- to 66.7-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-)**] thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

      1) Thermal Construction: [**Thermally broken**] .

   b. Door Design: [**As indicated**][**Ultra-narrow stile; 1-1/8-inch (29-mm) nominal width**][**Narrow stile; 2-1/8-inch (54-mm) nominal width**][**Medium stile; 3-1/2-inch (88.9-mm) nominal width**][**Wide stile; 5-inch (127-mm) nominal width**].
   c. Glazing Stops and Gaskets: [**Beveled**][**Square**], snap-on, extruded-aluminum stops and preformed gaskets.

      1) Provide nonremovable glazing stops on outside of door.

   d. Door Finish: [**Clear anodic**][**Color anodic**][**Baked-enamel or powder-coat**][**High-performance organic**][**Superior-performance organic**] finish.

3. Framing Members: Manufacturer's standard extruded aluminum, minimum **0.125 inch (3.2 mm)** thick and reinforced as required to support imposed loads.

   a. Nominal Size: [**1-3/4 by 4-1/2 inches (45 by 115 mm)**][**1-3/4 by 6 inches (45 by 150 mm)**][**As indicated on Drawings**].
   b. Exterior Framing Construction: [**Double thermally broken**][**Double thermally broken;**

dual pour-and-debridged system][**Double thermally broken; crimped-in-place polymer isolator system**][**Thermally broken**][**Thermally broken; pour-and-debridged system**][**Thermally broken; crimped-in-place polymer isolator system**][**Thermally improved**][**Nonthermal**].

c. Interior Vestibule Framing Construction: [**Nonthermal**] .

d. Finish: Match door finish.

4. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
5. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
6. Entrance Door Hardware:

a. Entrance Door Hardware: Hardware not specified in this Section is specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

b. General: Provide entrance door hardware and [**entrance door hardware sets indicated in door and frame schedule**][**entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article**] for each entrance door, to comply with requirements in this Section.

1) Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and [**named manufacturers' products**][**products equivalent in function and comparable in quality to named products**][**products complying with ANSI/BHMA standard referenced**] .

2) Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

3) Opening-Force Requirements:

a) Egress Doors: Not more than **15 lbf (67 N)** to release the latch and not more than **30 lbf (133 N)** to set the door in motion [**and not more than 15 lbf (67 N) to open the door to its minimum required width**] .

b) Accessible Interior Doors: Not more than **5 lbf (22.2 N)** to fully open door.

c. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

1) Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.

2) References to ANSI/BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

d. Pivot Hinges: ANSI/BHMA A156.4, Grade 1.

1) Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

e. Butt Hinges: ANSI/BHMA A156.1, Grade 1, radius corner.

1) Nonremovable Pins: Provide setscrew in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.

2) Exterior Hinges: [**Stainless steel, with stainless steel pin**][**Nonferrous**].
3) Quantities:

a) For doors up to [**87 inches (2210 mm)**] high, provide three hinges per leaf.
b) For doors more than [**87 and up to 120 inches (2210 and up to 3048 mm)**] high, provide four hinges per leaf.

f. Continuous-Gear Hinges: ANSI/BHMA A156.26.
g. Mortise Auxiliary Locks: ANSI/BHMA A156.5, Grade 1.
h. Manual Flush Bolts: ANSI/BHMA A156.16, Grade 1.
i. Automatic and Self-Latching Flush Bolts: ANSI/BHMA A156.3, Grade 1.
j. Panic Exit Devices: ANSI/BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.
k. Cylinders:

1) As specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]
2) BHMA A156.5, Grade 1.

a) Keying: [**No master**][**Master**] key system. Permanently inscribe each key with a visual key control number and include notation [**"DO NOT DUPLICATE"**][**to be furnished by the Owner**] .

l. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
m. Operating Trim: ANSI/BHMA A156.6.
n. Removable Mullions: ANSI/BHMA A156.3 extruded aluminum.

1) When used with panic exit devices, provide [**keyed**] removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305. Use only mullions that have been tested with exit devices to be used.

o. Closers: ANSI/BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
p. Concealed Overhead Holders and Stops: ANSI/BHMA A156.8, Grade 1.
q. Door Stops: ANSI/BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
r. Weather Stripping: Manufacturer's standard replaceable components.

1) Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
2) Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

s. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
t. Thresholds: ANSI/BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of **1/2 inch (12.7 mm)**.
u. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

7. Glazing: Comply with Section 088000 "Glazing."
8. Glazing Gaskets: [**Manufacturer's standard sealed-corner pressure-glazing system of black,**

resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.][**Comply with Section 088000 "Glazing."**]

9. Glazing Sealants: [**As recommended in writing by manufacturer.**][**Comply with Section 088000 "Glazing."**]

    a. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

2.4 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B209/B209M.
2. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.
3. Structural Profiles: ASTM B308/B308M.

B. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

C. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

D. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

E. Regional Materials: Aluminum-Framed Entrances shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Regional Materials: Verify Aluminum-Framed Entrances are manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.5 ACCESSORIES

A. Power Door Operators: [**Section 087113 "Power Door Operators."**][**Section 084229.33 "Swinging Automatic Entrances."**]

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads [**finished to match framing system**][**fabricated from 300 series stainless steel**] .

C. Anchors: Three-way adjustable anchors with minimum adjustment of [**1 inch (25.4 mm)**] that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

D. Concealed Flashing: [**Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**][**Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer**] .

E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.

F. Joint Sealants and Backings: Provide joint sealants, backings, and other related materials in accordance with Section 079200 "Joint Sealants."

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**] as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOOR SYSTEMS

A. General: Install aluminum-framed entrance door systems in accordance with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal perimeter and other joints watertight unless otherwise indicated.
3. Install components plumb and true in alignment with established lines and grades.

B. Anchorage:

1. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
2. Anchor aluminum-framed entrances and storefront systems that have been tested for [**windborne-debris impact**][**blast**] resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in testing.

C. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

D. Joint Sealants and Backings: Install in accordance with Section 079200 "Joint Sealants."

1. Set continuous sill members and flashing in full sealant bed.
2. Seal perimeter of framing members with sealant.

E. Entrance Doors: Install entrance doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

F. Glazing: Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Tests: Perform the following tests on aluminum-framed entrance door systems.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration as directed by the Owner.
2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than **0.09 cfm/sq. ft. (0.45 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.
3. Water Penetration: ASTM E1105 at a minimum [**uniform**][**and**][**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than **6.24 lbf/sq. ft. (300 Pa)**, and to not evidence water penetration.

C. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections.

D. Inspections:

1. Egress Door Inspections: Inspect each aluminum-framed entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101.

E. Aluminum-framed entrance door systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust hardware and operable components to function smoothly, and lubricate as recommended in writing by manufacturer.

3.5 MAINTENANCE SERVICE

A. Entrance Door Hardware Maintenance:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the Owner’s continued adjustment, maintenance, and removal and replacement of entrance door hardware.
2. Initial Maintenance Service: Beginning at Substantial Completion, provide [**six**] months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are manufacturer's authorized replacement parts and supplies.

END OF SECTION 08 42 13 00

SECTION 08 42 26 00 - ALL-GLASS ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior all-glass entrance and storefront systems.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for overhead-steel support for all-glass systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Exterior all-glass entrance and storefront systems.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.

C. Shop Drawings: For exterior all-glass entrance and storefront systems.

1. Plans, elevations, and sections.
2. Details of fittings and glazing, including isometric drawings of fittings.
3. Door hardware locations, mounting heights, and installation requirements.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of fitting, accessory fitting, glass, and door hardware.

E. Samples for Verification: Actual sample of finished products for each type of fitting, accessory fitting, glass showing exposed edge finish, and door hardware.

1. Size: [**Manufacturers' standard size**].

F. Fabrication Sample: [**Patch fitting at sill on pivot side only**][**Continuous rail fitting at bottom**], made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery.
2. Anchorage.
3. Glazing[**with butt glazing**].

G. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with all-glass entrance-system components, assemblies, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Delegated Design Submittals: For exterior all-glass entrance and storefront systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

I. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each exterior all-glass entrance and storefront system, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For exterior all-glass entrance and storefront systems.

C. Qualification Statements:

1. For Installer[**and testing agency**][**and egress door inspector**].

D. Delegated Design Engineer Qualifications: For exterior all-glass entrance and storefront systems.

E. Sample Warranties: For exterior all-glass entrance and storefront systems.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For exterior all-glass entrance and storefront systems.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer[**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

D. Egress Door Inspector Qualifications:

1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

1.7 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of exterior all-glass entrance and storefront systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection[air leakage, or water penetration].
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].

2. Warranty Period: [**Two**] years from date of Substantial Completion.

a. Concealed Floor Closers: [**Five**][**10**][**25**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of exterior all-glass entrance and storefront systems, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design exterior all-glass entrance and storefront systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of exterior all-glass entrance and storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: Deflection normal to glazing plane is limited to [**1 inch (25 mm)**][**1/175 of clear span or 3/4 inch (19 mm), whichever is smaller**].

D. Seismic Performance: All-glass entrance and storefront systems to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

E. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.3 EXTERIOR ALL-GLASS ENTRANCE AND STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**GGI; General Glass International**]
2. [**PRL Glass Systems Inc.**]

B. Fitting Configuration:

1. Manual-Swinging, All-Glass Entrance Doors: [**Patch fittings at head and sill on pivot side only (A-Style)**][**Patch fittings at head and sill on pivot side, and for lock at sill of swing side (F-Style)**][**Patch fitting at top and continuous rail fitting at bottom (BP-Style)**][**Continuous rail fitting at top and bottom (P-Style)**].
2. All-Glass Storefronts: [**Recessed glazing channel at top and continuous rail fitting at bottom**][**Recessed glazing channel at top and bottom**][**Continuous rail fitting at top and bottom**].

C. Fitting Material: [**Aluminum**][**Bronze-clad aluminum**][**Brass-clad aluminum**][**Stainless steel clad aluminum**].

D. Rail Fittings:

1. Height:

a. Top Rail: [**3-1/2 inches (89 mm)**][**As indicated**].
b. Bottom Rail: [**3-1/2 inches (89 mm)**][**10 inches (255 mm)**][**As indicated**].

2. Profile: [**Tapered**][**Tapered flat**][**Tapered at 60 degrees minimum from horizontal**][**Square**][**Curved**][**As indicated**].
3. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.

E. Accessory Fittings:

1. Overhead doorstop.
2. Center-housing lock.
3. U-channel.
4. Glass-support-fin brackets.

F. Anchors and Fastenings: Concealed.

G. Weather Stripping: Pile type; replaceable without removing all-glass entrance doors from pivots.

H. Materials:

1. Aluminum: **ASTM B221 (ASTM B221M)**, with strength and durability characteristics of not less than Alloy 6063-T5.

   a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
   b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.
   c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

2. Bronze Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

   a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**Statuary M31-C5**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

3. Brass Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

   a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

4. Stainless Steel Cladding: ASTM A240/A240M or ASTM A666, Type 304.

   a. Finish: [**ASTM A480/480M No. 4 directional satin finish**][**ASTM A480/480M No. 8 mirrorlike reflective, nondirectional polish**].

2.4 GLASS

A. Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Quality-Q3, tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.

1. Class 1: Clear monolithic.

   a. Thickness: [**10**][**12**][**16**][**19**] mm.
   b. Locations: [**As indicated**].

2. Class 2: Tinted monolithic.

   a. Color: [**Gray**][**Bronze**].
   b. Thickness: [**10**][**12**] mm.
   c. Locations: [**As indicated**].

3. Exposed Edges: Machine ground and flat polished.
4. Butt Edges: Flat ground.
5. Corner Edges: Lap-joint corners with exposed edges polished.

2.5 ENTRANCE DOOR HARDWARE

A. General: Entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of fittings.

B. Concealed Floor Closers and Top Pivots: Center hung; ANSI/BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation.

1. Swing: [**Single**][**Double**] acting.

a. Positive Dead Stop: Coordinated with hold-open angle if any, or at angle selected.

2. Hold Open: [**Automatic, at angle selected**][**Selective**][**None**].
3. Opening-Force Requirements:

a. Egress Doors: Not more than **15 lbf (67 N)** to release the latch and not more than **30 lbf (133 N)** to set the door in motion[**and not more than 15 lbf (67 N) to open the door to its minimum required width**].

C. Concealed Overhead Holder: ANSI/BHMA A156.8, Grade 1, with dead-stop setting coordinated with concealed floor closer.

D. Push-Pull Set: [**As selected from manufacturer's full range**][**As indicated**].

E. Single-Door and Active-Leaf Locksets: [**Center-housing deadbolt with pulls**][**Center-housing combination deadbolt and latchbolt with lever handles**][**Bottom-fitting or bottom-rail deadbolt**].

1. Deadbolt operated by key outside and [**key**][**thumbturn**] inside.

F. Inactive-Leaf Locksets: Bottom-fitting or bottom-rail deadbolt.

1. Deadbolt operated by key outside and [**key**][**thumbturn**] inside.

G. Cylinders: [**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**][**Six-pin cylinder, ANSI/BHMA A156.5, Grade 1.**]

H. Exit Devices: UL 305.

1. Function: Operation by push-pull when [**inside operator is locked down (dogged)**][**inside operator is locked down (dogged); outside operation by key**].
2. Latching: At [**threshold or floor plate**][**door head**][**threshold or floor plate and door head**].
3. Style: [**Exposed vertical rod**][**Concealed vertical rod in housing style indicated**].
4. Provide exit devices on both leaves of pairs of doors.

I. Threshold: Not more than **1/2 inch (12 mm)** high.

2.6 BUTT-GLAZING SEALANTS

A. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 25, for Uses NT, G, and A.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**The Dow Chemical Company**]
f. [**Tremco Incorporated**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.7 FABRICATION

A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.

B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EXTERIOR ALL-GLASS ENTRANCE AND STOREFRONT SYSTEMS

A. Install all-glass entrance and storefront systems and associated components according to

manufacturer's written instructions.

B. Set units level, plumb, and true to line, with uniform joints.

C. Maintain uniform clearances between adjacent components.

D. Lubricate hardware and other moving parts in accordance with manufacturer's written instructions.

E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

F. Install butt-joint sealants according to manufacturer's written instructions and as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Tests: Perform the following tests on [**representative areas of exterior all-glass storefront systems**][**mockups**].

1. Water-Spray Test: After completion of all-glass storefront installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test storefront for water leaks in accordance with AAMA 501.2.

a. Perform test for total areas [**as designated by Architect**], as directed by the Owner.

C. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections.

D. Inspections:

1. Egress Door Inspections: Inspect each exterior all-glass entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."

E. Exterior all-glass entrance and storefront systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING AND CLEANING

A. Adjust all-glass entrance doors and hardware to function smoothly and fit tightly at contact points and weather stripping.

1. For exterior all-glass entrance doors accessible to people with disabilities, adjust closers to provide a three-second closer sweep period for doors to move from a 70-degree open position to **3 inches (75 mm)** from the latch measured to the leading door edge.

B. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION 08 42 26 00

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SECTION 08 42 26 00A - ALL-GLASS ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior, manual-swinging, all-glass entrance systems.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for overhead-steel support for all-glass systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Exterior, manual-swinging, all-glass entrance systems.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings:

1. Plans, elevations, and sections.
2. Details of fittings and glazing, including isometric drawings of fittings.
3. Door hardware locations, mounting heights, and installation requirements.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of fitting, accessory fitting, glass, and door hardware.

E. Samples for Verification: Actual sample of finished products for each type of fitting, accessory fitting, glass, and door hardware

1. Size: [**Manufacturers' standard size**].

F. Fabrication Sample: [**Patch fitting at sill on pivot side only**][**Continuous rail fitting at bottom**], made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery.
2. Anchorage.
3. Glazing.

G. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with all-glass entrance-system components, assemblies, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Delegated Design Submittals: For all-glass entrance systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each exterior all-glass entrance system, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field quality-control reports: For exterior all-glass entrance systems.

C. Qualification Statements:

1. For Installer[**and egress door inspector**].

D. Delegated Design Engineer Qualifications: For exterior all-glass entrance systems.

E. Sample Warranties: For exterior all-glass entrance systems.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For exterior all-glass entrance systems. Furnish a complete set of specialized tools and maintenance instructions as required for the Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer[**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

B. Egress Door Inspector Qualifications:

1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

1.7 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of all-glass entrance systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].

2. Warranty Period: [**Two**] years from date of Substantial Completion.

a. Concealed Floor Closers: [**Five**][**10**][**25**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of exterior all-glass entrance systems, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design exterior all-glass entrance systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of exterior all-glass entrance systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].
3. Deflection Limits: Deflection normal to glazing plane is limited to [**1 inch (25 mm)**][**1/175 of clear span or 3/4 inch (19 mm), whichever is smaller**].

D. Seismic Performance: All-glass entrance systems must withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

E. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature

changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.3 EXTERIOR, MANUAL-SWINGING, ALL-GLASS ENTRANCE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
2. [**Coral Architectural Products; Coral Industries, Inc.**]
3. [**GGI; General Glass International**]
4. [**OldCastle BuildingEnvelope (OBE)**]
5. [**PRL Glass Systems Inc.**]
6. [**Trulite Glass & Aluminum Solutions, LLC.**]

B. Fitting Configuration:

1. Door Fittings: [**Patch fittings at head and sill on pivot side only (A-Style)**][**Patch fittings at head and sill on pivot side, and for lock at sill of swing side (F-Style)**][**Patch fitting at top and continuous rail fitting at bottom (BP-Style)**][**Continuous rail fitting at top and bottom (P-Style)**].
2. Sidelight Fittings: [**Recessed glazing channel at top and continuous rail fitting at bottom**][**Recessed glazing channel at top, side, and bottom**][**Continuous rail fitting at top and bottom**].

C. Fitting Material: [**Aluminum**][**Bronze-clad aluminum**][**Brass-clad aluminum**][**Stainless steel clad aluminum**].

D. Rail Fittings:

1. Height:

a. Top Rail: [**3-1/2 inches (89 mm)**][**As indicated**].
b. Bottom Rail: [**3-1/2 inches (89 mm)**][**10 inches (255 mm)**][**As indicated**].

2. Profile: [**Tapered**][**Tapered flat**][**Tapered at 60 degrees minimum from horizontal**][**Square**][**Curved**][**As indicated**].
3. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.

E. Accessory Fittings:

1. Overhead doorstop.
2. Center-housing lock.
3. U-channel.

F. Anchors and Fastenings: Concealed.

G. Weather Stripping: Pile type; replaceable without removing all-glass entrance doors from pivots.

H. Materials:

1. Aluminum: **ASTM B221 (ASTM B221M)**, with strength and durability characteristics of not less than Alloy 6063-T5.

    a. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
    b. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.
    c. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

2. Bronze Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

    a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**Statuary M31-C5**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

3. Brass Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

    a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

4. Stainless Steel Cladding: ASTM A240/A240M or ASTM A666, Type 304.

    a. Finish: [**ASTM A480/A480M No. 4 directional satin finish**][**ASTM A480/A480M No. 8 mirrorlike reflective, nondirectional polish**].

2.4 GLASS

A. Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Quality-Q3, tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.

1. Class 1: Clear monolithic.

    a. Thickness: [**10**][**12**][**16**][**19**] mm.
    b. Locations: [**As indicated**].

2. Class 2: Tinted monolithic.

    a. Color: [**Gray**][**Bronze**].
    b. Thickness: [**10**][**12**] mm.
    c. Locations: [**As indicated**].

3. Exposed Edges: Machine ground and flat polished.
4. Butt Edges: Flat ground.
5. Corner Edges: Lap-joint corners with exposed edges polished.

2.5 ENTRANCE DOOR HARDWARE

A. General: Entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of fittings.

B. Concealed Floor Closers and Top Pivots: Center hung; ANSI/BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation.

1. Swing: [**Single**][**Double**] acting.

a. Positive Dead Stop: Coordinated with hold-open angle if any, or at angle selected.

2. Hold Open: [**Automatic, at angle selected**][**Selective**][**None**].
3. Opening-Force Requirements:

a. Egress Doors: Not more than **15 lbf (67 N)** to release the latch and not more than **30 lbf (133 N)** to set the door in motion[**and not more than 15 lbf (67 N) to open the door to its minimum required width**].

C. Concealed Overhead Holder: ANSI/BHMA A156.8, Grade 1, with dead-stop setting coordinated with concealed floor closer.

D. Push-Pull Set: [**As selected from manufacturer's full range**][**As indicated**].

E. Single-Door and Active-Leaf Locksets: [**Center-housing deadbolt with pulls**][**Center-housing combination deadbolt and latchbolt with lever handles**][**Bottom-fitting or bottom-rail deadbolt**].

1. Deadbolt operated by key outside and [**key**][**thumbturn**] inside.

F. Inactive-Leaf Locksets: Bottom-fitting or bottom-rail deadbolt.

1. Deadbolt operated by key outside and [**key**][**thumbturn**] inside.

G. Cylinders: [**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**][**Six-pin cylinder, ANSI/BHMA A156.5, Grade 1.**]

H. Exit Devices: UL 305.

1. Function: Operation by push-pull when [**inside operator is locked down (dogged)**][**inside operator is locked down (dogged); outside operation by key**].
2. Latching: At [**threshold or floor plate**][**door head**][**threshold or floor plate and door head**].
3. Style: [**Exposed vertical rod**][**Concealed vertical rod in housing style indicated**].
4. Provide exit devices on both leaves of pairs of doors.

I. Threshold: Not more than **1/2 inch (12 mm)** high.

2.6 FABRICATION

A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.

B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EXTERIOR, MANUAL-SWINGING, ALL-GLASS ENTRANCE SYSTEMS

A. Install exterior all-glass entrance systems and associated components in accordance with manufacturer's written instructions.

B. Set units level, plumb, and true to line, with uniform joints.

C. Maintain uniform clearances between adjacent components.

D. Lubricate hardware and other moving parts in accordance with manufacturer's written instructions.

E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections.

B. Inspections:

1. Egress Door Inspections: Inspect each exterior all-glass entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."

C. Exterior all-glass entrance systems will be considered defective if they do not pass inspections.

D. Prepare inspection reports.

3.4 ADJUSTING AND CLEANING

A. Adjust all-glass entrance doors and hardware to function smoothly and fit tightly at contact points and weather stripping.

1. For exterior all-glass, entrance doors accessible to people with disabilities, adjust closers to provide a three-second closer sweep period for doors to move from a 70-degree open position to **3 inches (75 mm)** from the latch measured to the leading door edge.

B. Remove excess sealant and glazing compounds and dirt from surfaces.

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SECTION 08 42 29 23 - SLIDING AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sliding automatic entrances.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**installing recessed metal frames for control mats in concrete**][**and**][**forming recesses in concrete for recessed thresholds**].
2. Section 084243 "Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances" for swinging-sliding, manual ICU/CCU entrance door assemblies.
3. Section 087113 "Power Door Operators" for automatic door operators furnished separately from doors and frames.

1.2 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.

D. For automatic door terminology, see ANSI/BHMA A156.10 for definitions of terms.

1.3 COORDINATION

A. Coordinate sizes and locations of recesses in concrete floors for [**recessed sliding tracks**][**and**][**recessed control mats**] that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified elsewhere.

B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.

C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.

D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies[**and access-control system**][**and remote activation devices**][**and remote monitoring systems**].

E. System Integration: Integrate sliding automatic entrances with other systems as required for a complete working installation.

1. Provide electrical interface control capability for activation of sliding automatic entrances by security access system on doors with electric locking.
2. Provide electrical interface to deactivate door operators on activation of fire alarm system.
3. Provide electrical interface to allow for remote monitoring of automatic entrance door panel status.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Indicate locations of activation and safety devices.
5. Include hardware schedule and indicate hardware types, functions, quantities, and locations.

C. Samples for Initial Selection: Manufacturer's standard finish sheets, showing full range of available finishes for units with factory-applied [**color**][**and**][**metal-clad**] finishes.

1. Include Samples of hardware and accessories involving color or finish selection.

D. Samples for Verification: Actual samples of finished products for each type of exposed finish required.

1. Size: [**Manufacturer's standard size**].

E. Delegated Design Submittals: For automatic entrances, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): For each product.
4. Health Product Declaration (HPD): Provide HPD.
5. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.
6. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of automatic entrance.[**Include emergency-exit features of automatic entrances serving as a required means of egress.**]

B. Product Test Reports: For each type of automatic entrance, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

C. Field quality control reports: For automatic entrances.

D. Sample Warranties: For automatic entrances.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer with Company Certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project[**and who employs a Certified Inspector**].

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

C. Certified Inspector Qualifications: Certified by AAADM.

D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Faulty operation of operators, controls, and hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sliding [**folding**][**and**][**swinging**] automatic entrances from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Power-Operated Door Standard: ANSI/BHMA A156.10.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design automatic entrances.

D. Seismic Performance: Automatic entrances to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

G. Operating Temperature Range: Automatic entrances to operate within [**minus 20 to plus 122 deg F (minus 29 to plus 50 deg C)**].

H. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-Factor):

a. Entrance Doors: U-factor of not more than [**0.63 Btu/sq. ft. x h x deg F (3.58 W/sq. m x K)**][**0.68 Btu/sq. ft. x h x deg F (3.86 W/sq. m x K)**][**0.77 Btu/sq. ft. x h x deg F (4.37 W/sq. m x K)**][**0.83 Btu/sq. ft. x h x deg F (4.71 W/sq. m x K)**][**0.90 Btu/sq. ft. x h x deg F (5.11 W/sq. m x K)**] as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Entrance Doors: SHGC of not more than [**0.21**][**0.25**][**0.35**][**0.40**][**0.45**] as determined in accordance with NFRC 200.

3. Air Leakage:

a. Power-Operated Sliding Doors: Air leakage of not more than [**1.0 cfm/sq. ft. (5.1 L/s per sq. m)**] at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)** when tested in accordance with ASTM E283/E283M.

4. Condensation Resistance Factor (CRF):

a. Entrance Doors: CRF of not less than [**57**][**63**][**68**] as determined in accordance with AAMA 1503.

I. Opening Force:

1. Power-Operated Doors: Not more than **50 lbf (222 N)** required to manually set door in motion if power fails, and not more than **15 lbf (67 N)** required to open door to minimum required width.
2. Breakaway Device for Power-Operated Doors: Not more than **50 lbf (222 N)** required for a breakaway door or panel to open.

J. Entrapment-Prevention Force:

1. Power-Operated Sliding Doors: Not more than **30 lbf (133 N)** required to prevent stopped door from closing.

2.3 SLIDING AUTOMATIC ENTRANCES

A. General: Provide manufacturer's standard automatic entrances, including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.

B. Sliding, Power-Operated Automatic Entrances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
b. [**dormakaba USA Inc.**]
c. [**Gildor Automatic Doors**]
d. [**Horton Automatics; Overhead Door Corporation**]
e. [**NABCO Entrances, Inc**]
f. [**Record USA; ASSA ABLOY**]
g. [**STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]
h. [**TORMAX USA Inc.**]

2. Configuration:

   a. Single-Sliding: Single-sliding door with one sliding leaf[transom,][and][pocketed] sidelite.

      1) Traffic Pattern: [**One**][**Two**] way.
      2) Emergency Breakaway Capability: [**As indicated on Drawings**][**Sliding leaf only**][**Sliding leaf and sidelite**].
      3) Mounting: [**Between jambs**][**Surface**].

   b. Biparting-Sliding: Biparting-sliding doors with two sliding leaves[transom,][and][pocketed] sidelites on each side.

      1) Traffic Pattern: [**One**][**Two**] way.
      2) Emergency Breakaway Capability: [**As indicated on Drawings**][**Sliding leaves only**][**Sliding leaves and sidelites**].
      3) Mounting: [**Between jambs**][**Surface**].

   c. Telescoping: [Single-telescoping-sliding door with two][Biparting-telescoping-sliding doors with four] sliding leaves[transom,] and sidelite(s).

      1) Traffic Pattern: [**One**][**Two**] way.
      2) Emergency Breakaway Capability: [**As indicated on Drawings**][**Center leaves only**][**All leaves**].
      3) Mounting: Between jambs.

3. Operator Features:

   a. Power opening and closing.
   b. Drive System: [Chain][belt].
   c. Adjustable opening and closing speeds.
   d. Adjustable hold-open time between zero and 30 seconds.
   e. Obstruction recycle.
   f. On-off/hold-open switch to control electric power to operator[key operated].

4. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: Carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.

   a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.

5. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless steel, ball-bearing-center roller wheels.

   a. Configuration:

      1) Threshold: Saddle-type threshold across door opening and [**surface-mounted**][**recessed**] guide-track system at sidelites.
      2) No Threshold: No threshold across door opening and [**surface-mounted**][**recessed**] guide-track system at sidelites.

6. Controls: Activation and safety devices[**as indicated on Drawings and**] in accordance with cited ANSI/BHMA standards.

a. Activation Device:

1) Motion Sensor: Mounted on each side of door header to detect pedestrians in activating zone and to open door.
2) Activating Control Mat: Installed on ingress side of door to detect pedestrians in activating zone and to open door.
3) Switch: [**Push-plate switch**][**Push-button switch**][**Key switch**][**Touchless switch**][**on each side of door**] to activate door operator.

b. Safety Device:

1) Photoelectric Beam Presence Sensor: Two photoelectric beams mounted in sidelite jambs on each side of door to detect pedestrians in presence zone and to prevent door from closing; with presence sensor monitoring before each closing cycle.
2) Active Infrared-Based Presence Sensor Under Door Header and Photoelectric Beam Presence Sensor: Active infrared-based presence sensor mounted to underside of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing; with presence sensor monitoring before each closing cycle.
3) Active Infrared-Based Presence Sensor on Sides of Door Header and Photoelectric Beam Presence Sensor: Active infrared-based presence sensor mounted on each side of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing; with presence sensor monitoring before each closing cycle.
4) Safety Control Mat: Installed on egress side of door to detect pedestrians in presence and safety zones and to prevent door from closing; with presence sensor monitoring before each closing cycle.
5) Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening; with presence sensor monitoring before each closing cycle.
6) Opening-Width Control: Two-position switch that in the normal position allows sliding doors to travel to full opening width and in the alternate position reduces opening to a selected partial opening width.

7. Finish: Finish framing, door(s), and header with [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**baked-enamel or powder-coat finish**][**high-performance organic finish (two-coat fluoropolymer)**][**high-performance organic finish (three-coat fluoropolymer)**][**finish matching adjacent curtain wall**][**finish matching adjacent storefront**].

a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

8. Metal Cladding and Finish: Clad framing, door(s), and header with [**No. 4 directional-satin-finish stainless steel sheet**][**No. 8 mirrorlike reflective, nondirectional-polish-finish stainless steel sheet**][**satin-brass sheet**][**polished-brass sheet**][**satin-bronze sheet**][**polished-bronze sheet**][**metal sheet in finish matching Architect's sample**][**metal sheet in finish as selected by Architect from manufacturer's full range**][**metal sheet in finish matching adjacent storefront**], as directed by the Owner.

2.4 ENTRANCE COMPONENTS

A. Framing Members: Extruded aluminum, minimum **0.125 inch (3.2 mm)** thick and reinforced as required to support imposed loads.

1. Nominal Size: [**As indicated on Drawings**][**1-3/4 by 4-1/2 inches (45 by 115 mm)**][**1-3/4 by 6 inches (45 by 150 mm)**].
2. Extruded Glazing Stops and Applied Trim: Minimum **0.062-inch (1.6-mm)** wall thickness.

B. Stile and Rail Doors: **1-3/4-inch- (45-mm-)** thick, glazed doors with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.

1. Glazing Stops and Gaskets: [**Beveled**][**Square**], snap-on, extruded-aluminum stops and preformed gaskets.
2. Stile Design: [**As indicated on Drawings**][**Thin stile, less than 1-3/4-inch (45-mm) nominal width**][**Narrow stile, 2-1/8-inch (55-mm) nominal width**][**Medium stile, 3-1/2-inch (90-mm) nominal width**][**Wide stile, more than 4-inch (100-mm) nominal width**].
3. Rail Design: [**As indicated on Drawings**][**5-inch (125-mm) nominal height**][**6-1/2-inch (165-mm) nominal height**][**10-inch (254-mm) nominal height**].
4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.

C. All-Glass Sliding Doors: Fabricated from **1/2-inch- (13-mm-)** thick tempered glass, with polished vertical edges and minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum top and bottom rails.

1. Rail Design: [**3-1/2-inch (90-mm)**][**5-inch (125-mm)**] nominal height.

D. Sidelite(s): **1-3/4-inch- (45-mm-)** deep sidelite(s) with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members matching door design.

1. Glazing Stops and Gaskets: [**Same materials and design as for stile and rail door**][**Beveled, snap-on, extruded-aluminum stops and preformed gaskets**][**Square, snap-on, extruded-aluminum stops and preformed gaskets**].
2. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.

E. Transom: **1-3/4-inch- (45-mm-)** deep transom with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members matching door design.

1. Glazing Stops and Gaskets: [**Same materials and design as for stile and rail door**][**Beveled, snap-on, extruded-aluminum stops and preformed gaskets**][**Square, snap-on, extruded-aluminum stops and preformed gaskets**].

F. Headers: Fabricated from minimum **0.125-inch- (3.2-mm-)** thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

1. Mounting: [**Surface mounted**][**Concealed, with one side of header flush with framing**].
2. Capacity: Capable of supporting doors of up to [**175 lb (79 kg) per leaf over spans of up to 14 ft. (4.3 m)**] without intermediate supports.

   a. Provide sag rods for spans exceeding **14 ft. (4.3 m)**.

G. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.

H. Signage: As required by cited ANSI/BHMA standard.

1. Application Process: [**Decals**][**Silk-screened**][**Door manufacturer's standard process**].
2. Provide sign materials with instructions for field application after glazing is installed.

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: **ASTM B221 (ASTM B221M)**.
2. Sheet: ASTM B209/B209M.

B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.

C. Stainless Steel Bars: ASTM A276/A276M or ASTM A666, [**Type 304**][**Type 316**].

D. Stainless Steel Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**].

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.

F. Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in entrance manufacturer's standard thickness.

G. Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in entrance manufacturer's standard thickness.

H. Expanded Aluminum Mesh: [**Expanded**][**Expanded and flattened**] aluminum sheet in accordance with the geometry of ASTM F1267.

I. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.

J. Glazing: As specified in [**Section 088000 "Glazing."**][**Section 088853 "Security Glazing."**]

K. Sealants and Joint Fillers: Provide type recommended in writing by manufacturer for joint size and movement. Sealant to remain permanently elastic, nonshrinking, and nonmigrating.

L. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C1107/C1107M; of consistency suitable for application.

M. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

N. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.6 DOOR OPERATORS AND CONTROLS

A. General: Provide operators and controls, which include activation and safety devices, in accordance with cited ANSI/BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.

B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.

1. Door Operator Performance: Door operators to open and close doors and maintain them in fully

closed position when subjected to Project's design wind loads.

2. Electromechanical Operators: Concealed, self-contained, overhead units powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; complying with UL 325; and with manual operation with power off.

C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by their plastic housings; adjustable to provide detection-field sizes and functions required by ANSI/BHMA A156.10.

1. Provide capability for switching between bi- and unidirectional detection.
2. For one-way traffic, sensor on egress side to not be active when doors are fully closed.

D. Active Infrared-Based Presence Sensors: Self-contained, active-infrared scanner units; door mounted or overhead mounted; adjustable to provide detection-field sizes and functions required by ANSI/BHMA A156.10. Sensors remain active at all times.

E. Photoelectric Beam Presence Sensors: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams to not be active when doors are fully closed.

F. Presence Sensor Monitoring: Means to verify the functionality of each presence sensor in accordance with ANSI/BHMA A156.10. A detected fault condition of the presence sensor system will cause automatic operation to cease until fault is corrected.

G. Control Mats: **1/2-inch- (13-mm-)** thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements of ANSI/BHMA A156.10.

1. Frame: [**Recessed to fit flush with floor, with concealed anchors**][**Surface mounted, with tapered safety edge**].
2. Size: As indicated, but no smaller than required by ANSI/BHMA A156.10, including Appendix A.
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

H. Control Mat Monitoring: Means to verify the functionality of each safety control mat in accordance with ANSI/BHMA A156.10. A detected fault condition of the safety control mat will cause automatic operation to cease until fault is corrected.

I. Push-Plate Switch: Momentary-contact door-control switch with flat push-plate actuator[with contrasting-colored, engraved message].

1. Configuration:

a. Round Push Plate: With **4-by-4-inch (100-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Surface mounted on wall**].

b. Square Push Plate: With **4-by-4-inch (100-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Surface mounted on wall**].

c. Rectangular Push Plate: With **2-by-4-inch (50-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**].

2. Push-Plate Mounting Height: Operational height [**as indicated on Drawings**].
3. Push-Plate Material: [**Stainless steel**][**Plastic**], as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Message: [**Plain face with no message.**][**"Push to Open."**][**International symbol of accessibility.**][**International symbol of accessibility and "Push to Open."**]

J. Touchless Switch: Hands-free-activation door-control switch with flat motion sensor faceplate[**with contrasting-colored, engraved message**].

1. Configuration: [**6-inch (152.4-mm) round**][**4.56-by-4.56-inch (115.8-by-115.8-mm) (double gang) square**][**2.77-by-4.56-inch (70-by-115.8-mm) (single gang) rectangular**][**1.68-by-4.56-inch (42.6-by-115.8-mm) jamb-style**] faceplate.

a. Mounting: [**As indicated on Drawings**][**Recess mounted in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**].

2. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
3. Faceplate Material: [**Stainless steel**][**Plastic**][**Stainless steel with backlight acrylic window**], as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Message: [**"Wave to Open"**][**"Wave to Open" and wave symbol**][**International symbol of accessibility**][**International symbol of accessibility, "Wave to Open," and wave symbol**].

K. Push-Button Switch: Momentary-contact door-control switch with one red-button actuator; enclosed in nominal [**2-by-4-inch (50-by-100-mm)**][**4-by-4-inch (100-by-100-mm)**] junction box.

1. Provide faceplate engraved with "Press to Open" letters[**and international symbol of accessibility**] in contrasting color.
2. Provide blue plastic cover engraved with "Press Button to Open" in white letters and international symbol of accessibility.
3. Mounting: [**As indicated on Drawings**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**][**Recess mounted in wall**].
4. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
5. Faceplate Material: [**Stainless steel**][**Painted metal**], as selected by Architect from manufacturer's full range, as directed by the Owner.

L. Key Switch: Recess-mounted, door-control switch with key-controlled actuator; enclosed in **2-by-4-inch (50-by-100-mm)** junction box. Provide faceplate engraved with letters indicating switch functions.

1. Functions: [**On-off, momentary contact**][**On-off, maintained contact**][**Two-way automatic, hold open, one-way exit, and off**][**Two-way automatic, hold open, one-way exit, off, full open, and partial open**].
2. Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**][**Surface mounted on post**].
3. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
4. Faceplate Material: [**Stainless steel**][**Painted metal**], as selected by Architect from manufacturer's full range, as directed by the Owner.

M. Wireless or Remote Radio Control Switch: Auxiliary radio control system consisting of header-mounted receiver and [**wall-mounted**][**hand-held, battery-operated**] transmitter switch[**for each entrance**].

1. Wall-Mounted Transmitter Switch: One red-button, momentary-contact actuator enclosed in **4-by-4-inch (100-by-100-mm)** junction box. Provide blue plastic cover engraved with "Press Button to

Open" in white letters and international symbol of accessibility.

N. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.7 HARDWARE

A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish[**unless otherwise indicated**].

B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door to be as stipulated in "Performance Requirements" Article. Interrupt powered operation of door operator while in breakaway mode.

1. Include [**one adjustable detent device mounted at the top of each breakaway panel**][**two adjustable detent devices mounted in each breakaway panel; one top mounted and one bottom mounted**] to control breakaway force.

a. Panel Closer: Factory-installed concealed hydraulic door closer.
b. Limit Arms: Limit swing to 90 degrees, spring loaded with adjustable friction damping.

C. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum **1-inch- (25-mm-)** long throw bolt; ANSI/BHMA A156.5, Grade 1.

1. Cylinders: [**ANSI/BHMA A156.5, Grade 1, six-pin mortise type.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

a. Keying: [**No master**][**Integrate into building master**] key system.
b. Keys: [**Two**][**Three**] for each cylinder.

2. Deadbolts: [**Laminated-steel hook**][**Steel**], mortise type, ANSI/BHMA A156.5, Grade 1.
3. Two-Point Locking for Stile and Rail Sliding Doors: Mechanism in stile of active door leaf that automatically extends second lockbolt into [**overhead carrier assembly**][**threshold**].
4. Three-Point Locking for Stile and Rail Sliding Doors: Mechanism in stile of active door leaf that automatically extends lockbolts into overhead carrier assembly and threshold.
5. Lock/Unlock Indicator: Lock position indicators integrated with locking system. Stile is mounted on secure side of door. Visual display of lock position as follows: "OPEN" in black letters when unlocked, and "LOCKED" in red letters when locked.
6. Armored Strike: Reinforced security strike plate.

D. Automatic Locking: Electrically controlled device mounted in header that automatically locks sliding door in closed position, preventing door panels from sliding manually. Provide fail- [**secure**][**safe**] operation if power fails.

1. Power Interruption: [**Lock to be engaged, preventing doors from sliding manually**][**Lock to be disengaged, allowing doors to slide manually**].
2. Means of Egress: Standard breakaway feature.

E. Access-Control Locking: Electrically controlled device mounted in header that automatically locks sliding door in closed position, preventing door panels from sliding manually. Provide fail- [**secure**][**safe**] operation if power fails.

1. Include concealed, vertical-rod, tamper-proof exit devices, complying with UL 305, with latching into threshold and overhead carrier assembly and released by [**full-width panic bar**][**push paddle**], [**surface mounted**][**recessed**][**flush mounted and concealed within horizontal muntin bar**], prohibiting manual breakout of door(s) from exterior.
2. Power Interruption: [**Lock to be engaged, preventing doors from sliding manually**][**Lock to be disengaged, allowing doors to slide manually**].
3. Means of Egress: Vertical rod exit device.
4. Include locking devices for sidelites to prevent manual breakout.

F. Uninterrupted Power Supply: UL 1778, fully integrated unit mounted [**within header**][**above ceiling**].

1. Power Interruption: Supply power to operator, controls, activation device, and safety systems of sliding automatic door for up to [**1.5**] hours of normal operation.
2. Include low-battery shutdown feature to safely open or close door prior to complete battery discharge.
3. Include audible battery replacement alarm to indicate that battery will no longer accept a charge and replacement is required.

G. Dustproof Strikes for All-Glass Sliding Doors: [**Recessed, floor type, ANSI/BHMA A156.16, Grade 1, to receive deadbolt.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

H. Weather Stripping: Replaceable components.

1. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.8 ACCESSORIES

A. Guide Rails:

1. [Anodized aluminum][Baked-enamel or powder-coated aluminum][Stainless steel], fabricated from [bars][tubing], minimum 30 inches (762 mm) high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated[but not less than that required by ANSI/BHMA A156.10 for type of door and direction of travel]; with filler panel.

a. Filler Panel: [**Expanded aluminum mesh**][**Clear polycarbonate sheet**][**Colored polycarbonate sheet**].

1) Orient expanded aluminum mesh with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**].
2) Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

b. Mounting: [**As indicated on Drawings**][**Jamb and floor**][**Floor, freestanding**].
c. Aluminum Finish: [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**Baked-enamel or powder-coat finish**][**Finish matching door and frame**].

1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

d. Stainless Steel Finish: [**No. 4 directional-satin-finish stainless steel**][**Finish matching**

door and frame].

2. See [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

2.9 FABRICATION OF SLIDING AUTOMATIC ENTRANCES

A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

1. Form aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws[finished to match framing][fabricated from stainless steel].

   a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   b. Reinforce members as required to receive fastener threads.

4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.

1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
3. Form profiles that are sharp, straight, and free of defects or deformations.
4. Provide components with concealed fasteners and anchor and connection devices.
5. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
6. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
7. Allow for thermal expansion of exterior units.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Metal Cladding: Factory-fabricated and -installed metal cladding, completely covering all visible surfaces as part of prefabricated entrance assembly before shipment to Project site.

1. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
2. Form profiles that are sharp, straight, and free of defects or deformations.
3. Provide components with concealed fasteners and anchor and connection devices.
4. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
5. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Allow for thermal expansion at exterior entrances.

E. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.

F. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, in accordance with NGA's "GANA Glazing Manual."

G. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors[**and breakaway sidelites**].

H. Controls:

1. General: Factory install activation and safety devices in doors and headers as required by ANSI/BHMA A156.10 for type of door and direction of travel.
2. Install photoelectric beams in vertical jambs of sidelites, with dimension above finished floor as follows:

a. Top Beam: [**48 inches (1219 mm)**].
b. Bottom Beam: [**24 inches (610 mm)**].

2.10 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. High-Performance Organic Finish, Three-Coat: Fluoropolymer finish complying with AAMA 2605 and containing not less than [**50**][**70**] percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.

B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SLIDING AUTOMATIC ENTRANCES

A. General: Install automatic entrances in accordance with manufacturer's written instructions and cited ANSI/BHMA A156.10 for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.

1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.

B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.

1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
4. Level recesses for recessed thresholds using nonshrink grout.

C. Door Operators: Connect door operators to electrical power distribution system.

D. Access-Control Devices: Connect access-control devices to access-control system, as specified in Section 281300 "Access Control Software and Database Management."

E. Controls: Install and adjust activation and safety devices in accordance with manufacturer's written instructions and cited ANSI/BHMA standard for direction of pedestrian travel. Connect control wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Guide Rails: Install rails in accordance with ANSI/BHMA A156.10, including Appendix A, and manufacturer's written instructions unless otherwise indicated.

G. Glazing: Install glazing as specified in [**Section 088000 "Glazing."**][**Section 088853 "Security Glazing."**]

H. Sealants and Joint Fillers: Comply with requirements in Section 079200 "Joint Sealants" for installing sealants, fillers, and gaskets.

1. Set[**thresholds,**][**bottom-guide-track system,**] framing members and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

I. Signage: Apply signage on both sides of each door[**and breakaway sidelite**], as required by cited ANSI/BHMA standard for direction of pedestrian travel.

J. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: [**the Owner will engage**][**Engage**] a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable ANSI/BHMA standards.
2. Automatic entrances will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable ANSI/BHMA standards.

1. Adjust exterior doors for tight closure.

B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

C. Occupancy Adjustments: When requested within [**12**] months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to Project during other-than-normal occupancy hours for this purpose.

3.5 CLEANING

A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

1. Comply with requirements in [**Section 088000 "Glazing"**][**Section 088853 "Security Glazing"**] for cleaning and maintaining glass.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of automatic entrance Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.

1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to the Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 08 42 29 23

SECTION 08 42 29 33 - SWINGING AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Swinging automatic entrances.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing recessed metal frames for control mats in concrete.
2. Section 084243 "Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances" for swinging-sliding, manual ICU/CCU entrance door assemblies.
3. Section 087113 "Power Door Operators" for automatic door operators furnished separately from doors and frames.

1.2 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Double-Egress Doors: A pair of doors that simultaneously swing with the two doors moving in opposite directions, with no mullion between them.

D. Double-Swing Doors: A pair of doors that swing with the two doors moving in opposite directions, with a mullion between them; each door functioning as a single-swing door.

E. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.

F. For automatic door terminology, refer to [**ANSI/BHMA A156.10**][**and**][**ANSI/BHMA A156.19**] for definitions of terms.

1.3 COORDINATION

A. Coordinate sizes and locations of recesses in concrete floors for recessed control mats that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified elsewhere.

B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.

C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.

D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with

connections to power supplies[**and access-control system**][**and remote activation devices**][**and remote monitoring systems**].

E. System Integration: Integrate sliding automatic entrances with other systems as required for a complete working installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Indicate locations of activation and safety devices.
5. Include hardware schedule and indicate hardware types, functions, quantities, and locations.

C. Samples for Initial Selection: Manufacturer's standard finish sheets, showing full range of available finishes for units with factory-applied [**color**][**and**][**metal-clad**] finishes.

1. Include Samples of hardware and accessories involving color or finish selection.

D. Samples for Verification: Actual samples of finished products for each type of exposed finish required.

1. Size: [**Manufacturer's standard size**].

E. Delegated Design Submittals: For automatic entrances, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): For each product.
4. Health Product Declaration (HPD): Provide HPD.
5. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.
6. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of automatic entrance.[**Include emergency-exit features of automatic entrances serving as a required means of egress.**]

B. Product Test Reports: For each type of automatic entrance, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

C. Field quality control reports: For automatic entrances.

D. Qualification Statements: For [**manufacturer**][**Installer**][**Certified Inspector**].

E. Delegated Design Engineer Qualifications: For automatic entrances.

F. Sample Warranties: For automatic entrances.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer with Company Certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project[**and who employs a Certified Inspector**].

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

C. Certified Inspector Qualifications: Certified by AAADM.

D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Faulty operation of operators, controls, and hardware.
c. Deterioration of metals[metal finishes,] and other materials beyond normal weathering and use.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain swinging [**folding**][**and**][**sliding**] automatic entrances from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Power-Operated Door Standard: ANSI/BHMA A156.10.

B. Power-Assist and Low-Energy Door Standard: ANSI/BHMA A156.19.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design automatic entrances.

E. Seismic Performance: Automatic entrances to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

H. Operating Temperature Range: Automatic entrances operate within [**minus 20 to plus 122 deg F (minus 29 to plus 50 deg C)**].

I. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-Factor):

a. Entrance Doors: U-factor of not more than [**0.63 Btu/sq. ft. x h x deg F (3.58 W/sq. m x K)**][**0.68 Btu/sq. ft. x h x deg F (3.86 W/sq. m x K)**][**0.77 Btu/sq. ft. x h x deg F (4.37 W/sq. m x K)**][**0.83 Btu/sq. ft. x h x deg F (4.71 W/sq. m x K)**][**0.90 Btu/sq. ft. x h x deg F (5.11 W/sq. m x K)**] as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Entrance Doors: SHGC of not more than [**0.21**][**0.25**][**0.35**][**0.40**][**0.45**] as determined in accordance with NFRC 200.

3. Air Leakage:

a. Commercial Glazed Swinging Entrance Doors: Air leakage of not more than [**1.0 cfm/sq. ft. (5.08 L/s per sq. m)**] at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)** when tested in accordance with ASTM E283/E283M.

4. Condensation Resistance Factor (CRF):

a. Entrance Doors: CRF of not less than [**57**][**63**][**68**] as determined in accordance with AAMA 1503.

J. Opening Force:

1. Power-Operated Doors: Not more than **50 lbf (222 N)** required to manually set door in motion if power fails, and not more than **15 lbf (67 N)** required to open door to minimum required width.
2. Power-Operated Swinging Doors: Not more than **30 lbf (133 N)** required to manually open door if power fails.
3. Breakaway Device for Power-Operated Doors: Not more than **50 lbf (222 N)** required for a breakaway door or panel to open.
4. Power-Assist and Low-Energy Doors: Not more than **15 lbf (67 N)** required to release a latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door if power fails.
5. Accessible, Power-Assist Interior Doors: Not more than **5 lbf (22 N)** to push or pull door to fully open position.

K. Entrapment-Prevention Force:

1. Power-Operated Swinging Doors: Not more than **40 lbf (178 N)** required to prevent stopped door in the last 10 degrees of opening from moving in the direction of opening; not more than **30 lbf (133 N)** required to prevent stopped door from moving in direction of closing.
2. Low-Energy Doors: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.

2.3 SWINGING AUTOMATIC ENTRANCES

A. General: Provide manufacturer's standard automatic entrances, including doors, framing, headers, door operators, controls, and accessories required for a complete installation.

B. Swinging, Power-Operated Automatic Entrances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
   b. [**Horton Automatics; Overhead Door Corporation**]
   c. [**NABCO Entrances, Inc**]
   d. [**STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]
   e. [**TORMAX USA Inc.**]

2. Configuration:

   a. Single: Single-swinging door[**with transom**].

      1) Traffic Pattern: [**One**][**Two**] way.
      2) Mounting: [**Between jambs**][**Surface**].

   b. Pair: Pair of swinging doors[**with transom**].

      1) Traffic Pattern: [**One way**][**Two way**][**Double egress**][**Double swing**].
      2) Mounting: [**Between jambs**][**Surface**].

3. Operator Features:

   a. Power opening and[**power-assist**] spring closing.
   b. Adjustable opening and closing speeds.
   c. Adjustable hold-open time between zero and 30 seconds.
   d. Adjustable backcheck and latching.
   e. Obstruction recycle.
   f. Automatic door re-open if stopped while closing.
   g. On-off/hold-open switch to control electric power to operator[key operated].

4. Controls: Activation and safety devices[**as indicated on Drawings and**] in accordance with cited ANSI/BHMA standards.

   a. Activation Device:

      1) Motion Sensor: Mounted on ingress side of door header to detect pedestrians in activating zone and to open door.

2) Activating Control Mat: Installed on ingress side of door to detect pedestrians in activating zone and to open door.
3) Switch: [**Push-plate switch**][**Push-button switch**][**Key switch**][**Touchless switch**][**on each side of door**] to activate door operator.

b. Safety Device:

1) Active Infrared-Based Presence Sensor: Mounted on [**door header**][**horizontal door muntin**][**guide rail**] to detect pedestrians in presence zone and to prevent door from closing; with presence sensor monitoring before each closing cycle.
2) Photoelectric Beam Presence Sensor: One photoelectric beam mounted in guide rails to detect pedestrians in presence zone and to prevent door from closing; with presence sensor monitoring before each closing cycle.
3) Safety Control Mat : Installed on egress side of door to detect pedestrians in presence and safety zones and to prevent door from closing; with control mat monitoring before each closing cycle.

5. Finish: Finish framing, door(s), and header with [**clear anodic finish**][**color anodic finish**][**baked-enamel or powder-coat finish**][**high-performance organic finish**][**superior-performance organic finish**][**finish matching adjacent curtain wall**][**finish matching adjacent storefront**].
6. Metal Cladding and Finish: Clad framing, door(s), and header with [**No. 4 directional-satin-finish stainless steel sheet**][**No. 8 mirror finish stainless steel sheet**][**satin-brass sheet**][**polished-brass sheet**][**satin-bronze sheet**][**polished-bronze sheet**][**metal sheet in finish matching Architect's sample**][**metal sheet in finish as selected by Architect from manufacturer's full range**][**metal sheet in finish matching adjacent storefront**], as directed by the Owner.

C. Swinging, Power-Assist and Low-Energy, Power-Operated Automatic Entrances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Horton Automatics; Overhead Door Corporation**]
b. [**NABCO Entrances, Inc**]
c. [**STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]
d. [**TORMAX USA Inc.**]

2. Operation: [**Power Assist**][**Low-Energy, Power Operated**][**Low-Energy, Power Open**].
3. Configuration, Single: Single-swinging door[**with transom**].

a. Traffic Pattern: [**One**][**Two**] way.
b. Mounting: [**Between jambs**][**Surface**].

4. Configuration, Pair: Pair of swinging doors[**with transom**].

a. Traffic Pattern: [**One way**][**Two way**][**Double egress**][**Double swing**].
b. Mounting: [**Between jambs**][**Surface**].

5. Operator Features:

a. Power opening and[**power-assist**] spring closing.
b. Adjustable opening and closing speeds.
c. Adjustable hold-open time between zero and 30 seconds.
d. Adjustable backcheck and latching.

e. Obstruction recycle.
f. Automatic door re-open if stopped while closing.
g. On-off/hold-open switch to control electric power to operator[key operated].

6. Activation Device: [**Push-plate switch**][**Push-button switch**][**Key switch**][**Touchless switch**][**on each side of door**] to activate door operator.
7. Finish: Finish framing, door(s), and header with [**clear anodic finish**][**color anodic finish**][**baked-enamel or powder-coat finish**][**high-performance organic finish**][**superior-performance organic finish**][**finish matching adjacent curtain wall**][**finish matching adjacent storefront**].
8. Metal Cladding and Finish: Clad framing, door(s), and header with [**No. 4 directional-satin-finish stainless steel sheet**][**No. 8 mirror finish stainless steel sheet**][**satin-brass sheet**][**polished-brass sheet**][**satin-bronze sheet**][**polished-bronze sheet**][**metal sheet in finish matching Architect's sample**][**metal sheet in finish as selected by Architect from manufacturer's full range**][**metal sheet in finish matching adjacent storefront**], as directed by the Owner.

2.4 ENTRANCE COMPONENTS

A. Framing Members: Extruded aluminum, minimum **0.125 inch (3.2 mm)** thick and reinforced as required to support imposed loads.

1. Nominal Size: [**As indicated on Drawings**][**1-3/4 by 4-1/2 inches (45 by 115 mm)**][**1-3/4 by 6 inches (45 by 150 mm)**].
2. Extruded Glazing Stops and Applied Trim: Minimum **0.062-inch (1.6-mm)** wall thickness.

B. Stile and Rail Doors: **1-3/4-inch- (45-mm-)** thick, glazed doors with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.

1. Glazing Stops and Gaskets: [**Beveled**][**Square**], snap-on, extruded-aluminum stops and preformed gaskets.
2. Stile Design: [**As indicated on Drawings**][**Narrow stile, 2-1/8-inch (55-mm) nominal width**][**Medium stile, 3-1/2-inch (90-mm) nominal width**].
3. Rail Design: [**As indicated on Drawings**][**5-inch (125-mm) nominal height**][**6-1/2-inch (165-mm) nominal height**][**10-inch (254-mm) nominal height**].
4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.

C. Sidelite(s): **1-3/4-inch- (45-mm-)** deep sidelite(s) with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members matching door design.

1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
2. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.

D. Transom: **1-3/4-inch- (45-mm-)** deep transom with minimum **0.125-inch- (3.2-mm-)** thick, extruded-aluminum tubular stile and rail members matching door design.

1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.

E. Headers: Fabricated from minimum **0.125-inch- (3.2-mm-)** thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

1. Mounting: [**Surface mounted**][**Concealed, with one side of header flush with framing**].

F. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.

G. Signage: As required by cited ANSI/BHMA standard.

1. Application Process: [**Decals**][**Silk-screened**][**Door manufacturer's standard process**].
2. Provide sign materials with instructions for field application after glazing is installed.

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: **ASTM B221 (ASTM B221M)**.
2. Sheet: ASTM B209/B209M.

B. Steel Reinforcement Primer: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.

C. Stainless Steel Bars: ASTM A276/A276M or ASTM A666, [**Type 304**][**Type 316**].

D. Stainless Steel Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**].

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.

F. Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in entrance manufacturer's standard thickness.

G. Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in entrance manufacturer's standard thickness.

H. Expanded Aluminum Mesh: [**Expanded**][**Expanded and flattened**] aluminum sheet in accordance with the geometry of ASTM F1267.

I. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.

J. Glazing: As specified in [**Section 088000 "Glazing."**][**Section 088853 "Security Glazing."**]

K. Sealants and Joint Fillers: Provide type recommended in writing by manufacturer for joint size and movement. Sealant to remain permanently elastic, nonshrinking, and nonmigrating.

L. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

M. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.6 DOOR OPERATORS AND CONTROLS

A. General: Provide operators and controls, which include activation and safety devices, in accordance with cited ANSI/BHMA standards, for condition of exposure, and for long-term, maintenance-free

operation under normal traffic load for type of occupancy indicated.

B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.

1. Door Operator Performance: Door operators open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
2. Electromechanical Operators: Concealed, self-contained, overhead units powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; complying with UL 325; and with manual operation with power off.

C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by their plastic housings; adjustable to provide detection-field sizes and functions required by ANSI/BHMA A156.10.

1. Provide capability for switching between bi- and unidirectional detection.
2. For one-way traffic, sensor on egress side is not active when doors are fully closed.

D. Active-Infrared-based Presence Sensors: Self-contained, active-infrared scanner units; door mounted or overhead mounted; adjustable to provide detection-field sizes and functions required by ANSI/BHMA A156.10. Sensors remain active at all times.

E. Photoelectric Beam Presence Sensors: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams are not active when doors are fully closed.

F. Presence Sensor Monitoring: Means to verify the functionality of each presence sensor in accordance with ANSI/BHMA A156.10. A detected fault condition of the presence sensor system will cause automatic operation to cease until fault is corrected.

G. Control Mats: **1/2-inch- (13-mm-)** thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements of ANSI/BHMA A156.10.

1. Frame: [**Recessed to fit flush with floor, with concealed anchors**][**Surface mounted, with tapered safety edge**].
2. Size: As indicated, but no smaller than required by ANSI/BHMA A156.10, including Appendix A.
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

H. Control Mat Monitoring: Means to verify the functionality of each safety control mat in accordance with ANSI/BHMA A156.10. A detected fault condition of the safety control mat will cause automatic operation to cease until fault is corrected.

I. Push-Plate Switch: Momentary-contact door-control switch with flat push-plate actuator[with contrasting-colored, engraved message].

1. Configuration:

a. Round Push Plate: With **4-by-4-inch (100-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Surface mounted on wall**].

b. Square Push Plate: With **4-by-4-inch (100-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Surface mounted on wall**].

c. Rectangular Push Plate: With **2-by-4-inch (50-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in doorjamb**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**].

2. Push-Plate Mounting Height: Operational height [**as indicated on Drawings**].
3. Push-Plate Material: [**Stainless steel**][**Plastic**], as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Message: [**Plain face with no message.**][**"Push to Open."**][**International symbol of accessibility.**][**International symbol of accessibility and "Push to Open."**]

J. Touchless Switch: Hands-free-activation door-control switch with flat motion sensor faceplate[**with contrasting-colored, engraved message**].

1. Configuration: [**6-inch (152.4-mm) round**][**4.56-by-4.56-inch (115.8-by-115.8-mm) (double gang) square**][**2.77-by-4.56-inch (70-by-115.8-mm) (single gang) rectangular**][**1.68-by-4.56-inch (42.6-by-115.8-mm) jamb-style**] faceplate.

a. Mounting: [**As indicated on Drawings**][**Recess mounted in wall**][**Recess mounted in doorjamb**][**Surface mounted on wall**].

2. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
3. Faceplate Material: [**Stainless steel**][**Plastic**][**Stainless steel with backlight acrylic window**], as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Message: [**"Wave to Open"**][**"Wave to Open" and wave symbol**][**International symbol of accessibility**][**International symbol of accessibility, "Wave to Open," and wave symbol**].

K. Push-Button Switch: Momentary-contact door-control switch with one red-button actuator; enclosed in nominal [**2-by-4-inch (50-by-100-mm)**][**4-by-4-inch (100-by-100-mm)**] junction box.

1. Provide faceplate engraved with "Press to Open" letters[**and international symbol of accessibility**] in contrasting color.
2. Provide blue plastic cover engraved with "Press Button to Open" in white letters and international symbol of accessibility.
3. Mounting: [**As indicated on Drawings**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**][**Recess mounted in wall**].
4. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
5. Faceplate Material: [**Stainless steel**][**Painted metal**], as selected by Architect from manufacturer's full range, as directed by the Owner.

L. Key Switch: Recess-mounted, door-control switch with key-controlled actuator; enclosed in **2-by-4-inch (50-by-100-mm)** junction box. Provide faceplate engraved with letters indicating switch functions.

1. Functions: [**On-off, momentary contact**][**On-off, maintained contact**][**Two-way automatic, hold open, one-way exit, and off**][**Two-way automatic, hold open, one-way exit, off, full open, and partial open**].
2. Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in doorjamb**][**Surface mounted on wall**][**Surface mounted on post**].
3. Faceplate Mounting Height: Operational height [**as indicated on Drawings**].
4. Faceplate Material: [**Stainless steel**][**Painted metal**], as selected by Architect from

manufacturer's full range, as directed by the Owner.

M. Wireless or Remote Radio Control Switch: Auxiliary radio control system consisting of header-mounted receiver and [**wall-mounted**][**hand-held, battery-operated**] transmitter switch[**for each entrance**].

1. Wall-Mounted Transmitter Switch: One red-button, momentary-contact actuator enclosed in **4-by-4-inch (100-by-100-mm)** junction box. Provide blue plastic cover engraved with "Press Button to Open" in white letters and international symbol of accessibility.

N. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.7 HARDWARE

A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish[**unless otherwise indicated**].

B. Manual Opening for Power-Operated Swinging Doors: Provide hardware that, in a power failure, allows door to open with a manual force stipulated in "Performance Requirements" Article.

C. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door is as stipulated in "Performance Requirements" Article. Interrupt powered operation of door operator while in breakaway mode.

1. Include [**one adjustable detent device mounted at the top of each breakaway panel**][**two adjustable detent devices mounted in each breakaway panel; one top mounted and one bottom mounted**] to control breakaway force.

a. Panel Closer: Factory-installed concealed hydraulic door closer.
b. Limit Arms: Limit swing to 90 degrees, spring loaded with adjustable friction damping.

D. Manual Opening for Power-Assist and Low-Energy Doors: Provide hardware that, in a power failure, allows door to open with a manual force as stipulated in "Performance Requirements" Article.

E. Hinges:

1. Center-Pivot Sets: ANSI/BHMA A156.4, Grade 1, with exposed parts of cast-aluminum alloy.
2. Offset Pivots: ANSI/BHMA A156.4, Grade 1, with exposed parts of cast-aluminum alloy.
3. Butt Hinges: ANSI/BHMA A156.1, Grade 1, five-knuckle, **4-1/2-by-4-inch (114-by-102-mm)** ball-bearing butts.

a. Provide nonremovable pins at hinges exposed on outside of door.
b. Provide nonferrous hinges for doors exposed to weather.
c. Provide three hinges at each leaf for doors up to **36 inches (914 mm)** wide and **80 inches (2032 mm)** tall; provide four hinges at each leaf for wider or taller doors.

4. Continuous-Geared Hinges: ANSI/BHMA A156.26, Grade 1.

F. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum **1-inch- (25-mm-)** long throw bolt; ANSI/BHMA A156.5, Grade 1.

1. Cylinders: [**ANSI/BHMA A156.5, Grade 1, six-pin mortise type.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]

   a. Keying: [**No master**][**Integrate into building master**] key system.
   b. Keys: [**Two**][**Three**] for each cylinder.

2. Deadbolts: Laminated-steel hook, mortise type, ANSI/BHMA A156.5, Grade 1.
3. Two-Point Locking for Swinging Doors: Mechanism in stile of active door leaf that automatically extends second lockbolt into [**header**][**threshold**].

G. Push Bars: [**As selected by Architect from manufacturer's full range of full-door-width, single**][**Manufacturer's standard surface-mounted, aluminum**] push bars, as directed by the Owner.

H. Pull Handles: [**As selected by Architect from manufacturer's full range of pull handles and plates**][**Manufacturer's standard aluminum pull handles**], as directed by the Owner.

I. Thresholds: ANSI/BHMA A156.21, extruded-aluminum raised thresholds; with beveled edges with a slope of not more than 1:2 and a maximum height of **1/2 inch (13 mm)**. Provide cutouts as required for door operating hardware.

J. Weather Stripping: Replaceable components.

1. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
2. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
3. Weather Sweeps: Nylon brush sweep mounted to underside of door bottom.

K. Finger Guards: Collapsible neoprene or PVC gasket.

2.8 ACCESSORIES

A. Guide Rails:

1. [Aluminum][Stainless steel], fabricated from [bars][tubing], minimum 30 inches (762 mm) high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated[but not less than that required by ANSI/BHMA A156.10 for type of door and direction of travel]; with filler panel.

   a. Filler Panel: [**Expanded aluminum mesh**][**Clear polycarbonate sheet**][**Colored polycarbonate sheet**].

      1) Orient expanded aluminum mesh with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**].
      2) Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

   b. Provide intermediate rail in guide rail suitable for supporting photoelectric beams.
   c. Mounting: [**As indicated on Drawings**][**Jamb and floor**][**Floor, freestanding**].
   d. Aluminum Finish: [**Clear anodic finish**][**Color anodic finish**][**Baked-enamel or powder-coat finish**][**High-performance organic finish**][**Superior-performance organic finish**][**Finish matching door and frame**].
   e. Stainless Steel Finish: [**No. 4 directional-satin-finish stainless steel**][**Finish matching door and frame**].

2. See [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

2.9 FABRICATION OF SWINGING AUTOMATIC ENTRANCES

A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

1. Form aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws[finished to match framing][fabricated from stainless steel].

    a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
    b. Reinforce members as required to receive fastener threads.

4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.

1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
3. Form profiles that are sharp, straight, and free of defects or deformations.
4. Provide components with concealed fasteners and anchor and connection devices.
5. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
6. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
7. Allow for thermal expansion of exterior units.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Metal Cladding: Factory-fabricated and -installed metal cladding, completely covering all visible surfaces as part of prefabricated entrance assembly before shipment to Project site.

1. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
2. Form profiles that are sharp, straight, and free of defects or deformations.
3. Provide components with concealed fasteners and anchor and connection devices.
4. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
5. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
6. Allow for thermal expansion at exterior entrances.

E. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.

F. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, in accordance with NGA's "GANA Glazing Manual."

G. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors[**and breakaway sidelites**].
2. Provide compression-type weather stripping at fixed stops of exterior doors. At locations without fixed stops, provide sliding-type weather stripping retained in adjustable strip mortised into door edge.
3. Provide weather sweeps mounted to underside of door bottoms of exterior doors.
4. Provide finger guards at each swinging-door leaf that has clearance at hinge side greater than **1/4 inch (6 mm)** and less than **3/4 inch (19 mm)** with door in any position. Anchor guards to hinge-jamb frame.

H. Controls:

1. General: Factory install activation and safety devices in doors and headers as required by ANSI/BHMA A156.10 for type of door and direction of travel.
2. Install photoelectric beams in sides of guide rails, with dimension above finished floor not less than **24 inches (610 mm)**.

2.10 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.

B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SWINGING AUTOMATIC ENTRANCES

A. General: Install automatic entrances in accordance with manufacturer's written instructions and cited ANSI/BHMA A156.10 for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.

1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.

B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.

1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
2. Set headers, operating brackets, and guides level and true to location with anchorage for permanent support.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
4. Provide thresholds [**at exterior doors**][**and**][**where indicated**].

C. Door Operators: Connect door operators to electrical power distribution system.

D. Access-Control Devices: Connect access-control devices to access-control system as specified in Section 281300 "Access Control Software and Database Management."

E. Controls: Install and adjust activation and safety devices in accordance with manufacturer's written instructions and cited ANSI/BHMA standard for direction of pedestrian travel. Connect control wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Guide Rails: Install rails in accordance with ANSI/BHMA A156.10, including Appendix A, and manufacturer's written instructions unless otherwise indicated.

G. Glazing: Install glazing as specified in [**Section 088000 "Glazing."**][**Section 088853 "Security Glazing."**]

H. Sealants and Joint Fillers: Comply with requirements in Section 079200 "Joint Sealants" for installing sealants, fillers, and gaskets.

1. Set thresholds, framing members, and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

I. Signage: Apply signage on both sides of each door[**and breakaway sidelite**], as required by cited ANSI/BHMA standard for direction of pedestrian travel.

J. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: [**the Owner will engage**][**Engage**] a Certified Inspector to test and inspect

components, assemblies, and installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable ANSI/BHMA standards.
2. Automatic entrances will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable ANSI/BHMA standards.

1. Adjust exterior doors for tight closure.

B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

C. Occupancy Adjustments: When requested within [**12**] months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to Project during other-than-normal occupancy hours for this purpose.

3.5 CLEANING

A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

1. Comply with requirements in [**Section 088000 "Glazing"**][**Section 088853 "Security Glazing"**] for cleaning and maintaining glass.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of automatic entrance Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies are manufacturer's authorized replacement parts and supplies.

1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to the Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 08 42 29 33

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Task	Specification	Specification Description
08 42 29 33	08 42 33 00	Revolving Door Entrances

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SECTION 08 42 33 00 - REVOLVING DOOR ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual revolving door entrances.
2. Automatic revolving door entrances.
3. Manual access-control revolving door entrances.
4. Automatic access-control revolving door entrances.

B. Related Requirements:

1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for adjacent aluminum entrance doors and storefront framing.

1.2 COORDINATION

A. Recesses: Coordinate size and location of recesses in floor construction for [**recessed, floor-mounted speed-control units**][**pivot bearings**][**foot grilles**][**and**][**recessed mats**], including anchorages for frames and supports. Furnish setting drawings, templates, and directions for installing anchorages that are to be embedded into concrete. Deliver these items to Project site in time for installation.

B. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies[**and access-control system**][**and remote monitoring systems**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manual revolving door entrances.
2. Automatic revolving door entrances.
3. Manual access-control revolving door entrances.
4. Automatic access-control revolving door entrances.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for revolving door entrances.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.

4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

D. Shop Drawings: For revolving door entrances.

1. Include plans, elevations, sections, and attachment details.
2. Indicate enclosures, [**speed-control units**][**drive units**], and other components not in manufacturer's product data.
3. Indicate locations of activation and safety devices.
4. Include diagrams for power, signal, and control wiring.

E. Samples: For each exposed product and for each color and texture specified.

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (76 by 127 mm)**.
2. Glass Samples: For each type of tinted glass; **12 inches (305 mm)** square.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**Certified Inspector**].

B. Product Certificates: For each type of revolving door entrance.

C. Product Test Reports: For each type of revolving door entrance, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For revolving door entrances to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer with company certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project[**and who employs a Certified Inspector**].

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

C. Certified Inspector Qualifications: Certified by AAADM.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver revolving door entrance glass, decorative metalwork, and other exposed elements in padded blankets or other approved protective wrapping.

B. Protect finish surfaces from damage during handling and installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of revolving door entrances that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of speed-control unit.
b. Deterioration of metals[**metal finishes,**] and other materials beyond normal weathering and use.

2. Warranty Period for Overhead Speed-Control Units: [**10**] years from date of Substantial Completion.
3. Warranty Period for Floor Speed-Control Units: [**Five**] years from date of Substantial Completion.
4. Warranty Period for Finishes: [**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Revolving Door Entrance Standard: ANSI/BHMA A156.27.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-Factor):

a. Entrance Doors: U-factor of not more than [**0.63 Btu/sq. ft. x h x deg F (3.58 W/sq. m x K)**][**0.68 Btu/sq. ft. x h x deg F (3.86 W/sq. m x K)**][**0.77 Btu/sq. ft. x h x deg F (4.37 W/sq. m x K)**][**0.83 Btu/sq. ft. x h x deg F (4.71 W/sq. m x K)**][**0.90 Btu/sq. ft. x h x deg F (5.11 W/sq. m x K)**] as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Entrance Doors: SHGC of not more than [**0.21**][**0.25**][**0.35**][**0.40**][**0.45**] as determined in accordance with NFRC 200.

3. Air Leakage:

a. Revolving Doors: Air leakage of not more than [**1.0 cfm/sq. ft. (5.1 L/s per sq. m)**] at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

F. Seismic Performance: Revolving door entrances to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]:

G. Regulatory Requirements: Wings to be capable of breakout to provide minimum aggregate width of **36 inches (914 mm)** when breakout force of no more than [**130 lbf (572 N)**][**180 lbf (801 N)**] is applied within **3 inches (76 mm)** of outer edges and **40 inches (1020 mm)** above floor. Set maximum turning speed to comply with requirements of ANSI/BHMA A156.27.

H. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.

1. Safety-Glass Labeling: Where safety-glass labeling is indicated, permanently mark glass with certification label of the Safety Glazing Certification Council, another certification agency acceptable to authorities having jurisdiction, or the manufacturer. Label indicates manufacturer's

name, type of glass, thickness, and safety-glass standard with which glass complies.

2.2 SOURCE LIMITATIONS

A. Obtain all components of revolving door entrances from single source from single manufacturer.

2.3 MANUAL REVOLVING DOOR ENTRANCES

A. Manual Revolving Door Entrances : Manufacturer's standard [**three-wing**][**four-wing**] manual revolving door entrance, complete with center shaft, speed-control unit, wings, hardware, enclosure walls, canopy, glass and glazing, and accessories required for a complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
   b. [**Boon Edam, Inc.**]
   c. [**Crane Revolving Doors; dormakaba USA Inc.**]
   d. [**Horton Automatics; Overhead Door Corporation**]
   e. [**International Revolving Door**]
   f. [**STANLEY Rush; STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]

2. Manual Speed-Control Unit: Mechanical speed regulator that allows free rotation of wings up to a predetermined rate of speed and that engages a clutch-type brake to prevent rapid acceleration of wings.

   a. Location: [**Recessed, floor mounted**][**Overhead**].
   b. Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.

3. Power-Assist Operation: Drive unit will provide supplemental force, reducing the rotating resistance, when activated by pushing the door. When pushing force is released, door will automatically return to home position.
4. Stile-and-Rail Wings: Manufacturer's standard with **1-3/4-inch- (45-mm-)** thick, tubular stile-and-rail members.

   a. Stile Design: [**Narrow stile, 2-inch (51-mm) nominal width**][**Medium stile, 3-1/2-inch (89-mm) nominal width**][**Wide stile, 5-inch (127-mm) nominal width**][**As indicated on Drawings**].
   b. Rail Design: [**3-inch (76-mm) nominal height**][**4-inch (102-mm) nominal height**][**As indicated on Drawings**].
   c. Muntin Design: To match stile design.
   d. Glass: [**Clear**][**Tinted**], fully tempered float glass.

      1) Thickness: [**6 mm**][**8 mm**][**10 mm**].
      2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

5. All-Glass Wings: Manufacturer's standard all-glass wings with tubular metal top and bottom rail members.

a. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**12 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

6. Push Bars: Manufacturer's standard [**horizontal**][**vertical**] push bars, finished to match wings.

a. Shape: [**Round bars, 1 inch (25 mm) in diameter**][**Flat bars, 1/2 inch thick and 1-1/2 inches (13 mm thick and 38 mm) high**][**Manufacturer's standard**].

7. Locks: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance, finish to match wings.

a. Cylinders: Comply with requirements in Section 087100 "Door Hardware."
b. Mounting: [**Surface applied**][**Mortised**].
c. Location: Extend bolt from [**bottom of wing into floor**][**top of wing into ceiling**][**bottom of wing into base of wall enclosure**].

8. Enclosure Walls: Manufacturer's standard, with **1-3/4-inch- (45-mm-)** thick tubular framing members.

a. Configuration: [**Curved**][**Segmented**].
b. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**6 mm**][**8 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

c. Laminated Glass: [**Clear**][**Tinted**] consisting of two plies of fully tempered float glass with a PVB interlayer.

1) Thickness: [**Two 3 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 5 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 8 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**As indicated**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

d. Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

9. Canopy: Manufacturer's standard ceiling, fascia,[**roof,**] and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.

a. Metal-Clad Plywood: Fabricate from **3/4-inch- (19-mm-)** thick plywood clad with metal sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control unit or overhead pivot for recessed, floor-mounted speed-control unit.
b. Metal: Fabricate from minimum **0.125-inch- (3.18-mm-)** thick aluminum sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control unit or overhead pivot for recessed, floor-mounted speed-control unit.
c. Glass: [**Clear**][**Tinted**] laminated glass ceiling with two plies of heat-strengthened or tempered glass separated by a PVB interlayer.

1) Thickness: [**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**6 mm thick top lite and 12 mm thick bottom lite, 0.060-inch- (1.52-mm-) thick interlayer**][**As indicated**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

d. Ceiling Lights: Manufacturer's standard, consisting of two recessed LED fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
e. Canopy Roof: Manufacturer's standard construction, with material and finish matching enclosure walls where visible.
f. Recessed Grilles: Provide grille complete with floor pan[**and drainage fitting**] at entry segment only. Fabricate grille, using welded joints, from minimum **1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall)**, concentrically curved [**stainless steel**][**bronze**] bar stock with **1/4-inch (6-mm)** spacing.

B. Materials: [**Extruded aluminum**][**Stainless steel clad, extruded aluminum**][**Copper-alloy-clad, extruded aluminum**].

1. Main Extrusions and Tubing: Minimum wall thickness of **0.125 inch (3.18 mm)**.
2. Cladding: Minimum **0.04 inch (1.0 mm)** thick.

C. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

1. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

a. Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Section 088000 "Glazing." Provide minimum clearances for thickness and type of glass indicated in accordance with NGA's "GANA Glazing Manual."
b. Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
c. Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
d. Mechanically Joined Construction: Joints to be tightly bolted together. Glass stops to be snap-in type where possible.
e. Mechanically Joined Clad Construction: Joints to be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops to be snap-in type where possible.

2. Enclosure Walls and Canopy: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, in accordance with manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.

a. Exterior Framing: Fabricate components to drain water-passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

D. Aluminum Finishes: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**][**High performance, organic**].

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Stainless Steel Finishes: [**Directional satin finish, No. 4**][**Reflective, directional polish, No.**

7][**Mirrorlike reflective, nondirectional polish, No. 8**].

F. Copper-Alloy Finishes: [**Buffed finish**][**Medium-satin finish**].

2.4 AUTOMATIC REVOLVING DOOR ENTRANCES

A. Automatic Revolving Door Entrances : Manufacturer's standard [**two-wing**][**three-wing**][**four-wing**] automatic revolving door entrance, complete with [**center shaft**][**core**][**core with rotating glazed display case**], drive assembly, wings, hardware, enclosure walls, canopy, glass and glazing, activation devices, safety devices, and accessories required for a complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
   b. [**Boon Edam, Inc.**]
   c. [**Crane Revolving Doors; dormakaba USA Inc.**]
   d. [**Horton Automatics; Overhead Door Corporation**]
   e. [**International Revolving Door**]
   f. [**STANLEY Rush; STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]

2. Drive Assembly: Provide an electric drive unit with speed regulator to permit and control automatic rotation of wings. Drive unit allows for manual operation of door upon loss of power. Furnish power-operation equipment to suit current characteristics of building electrical service.
3. Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.
4. Electric Wing Locking: Provide fail-safe electromagnetic wing lock mechanism to prevent breakout of door wings when engaged. Loss of power or signal from building fire/smoke alarm will release electromagnetic lock, allowing for breakout.
5. Manual-Push Activation: Pushing wing activates unit and maintains rotation of wings for manufacturer's standard preset time. Provide signage on each wing visible in direction of traffic flow with instructions to start rotation.
6. Continuous Operation: Wings revolve continuously.
7. Signal Activation: Signal from activation device begins and maintains rotation of wings for manufacturer's standard preset time.

   a. Motion Detectors: Self-contained, K-band-frequency, microwave-scanner units with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions required by ANSI/BHMA A156.10. Mount centered on both sides of canopy fascia.
   b. Control Mats: **1/2-inch- (13-mm-)** thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and complying with performance requirements in ANSI/BHMA A156.10 including Appendix A.

      1) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
      2) Frame: [**Recessed to fit flush with floor; with concealed anchors**][**Surface mounted; with tapered safety edge**].

c. Push-Plate Switch: Momentary-contact control switch with flat push plate actuator[**with contrasting-colored, engraved message**].

1) Configuration: [**4.5-inch (114-mm)**], [**Round**][**Square**] push plate.

a) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

2) Configuration, Full Length: **36-inch (914-mm)** high-low push plate.

a) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

3) Push-Plate Material: [**Stainless steel**][**Plastic**] as selected by Architect from manufacturer's full range, as directed by the Owner.
4) Message: [**"Push to Open"**].

d. Touchless Switch: Hands-free-activated door-control switch with flat motion sensor faceplate[**with contrasting-colored, engraved message**].

1) Configuration: [**4.5-inch (114-mm)**], [**Round**][**Square**] faceplate.

a) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

2) Faceplate Material: [**Stainless steel**][**Plastic**][**Stainless steel with backlight acrylic window**] as selected by Architect from manufacturer's full range, as directed by the Owner.
3) Message: [**"Wave to Open"**][**"Wave to Open" and wave symbol**].

e. Push-Button Switch: Momentary-contact control switch with one red-button actuator. Provide blue plastic cover engraved with message "Press to Open" in white letters.

1) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

f. Key Switch: Recess-mounted control switch with key-controlled actuator. Provide faceplate engraved with letters indicating switch functions.

1) Functions: [**On-off**][**On-off, momentary contact**].
2) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

8. Communication System: Provide [**visual signal**][**and**][**digital field programmable voice messaging**].
9. Stile-and-Rail Wings: Manufacturer's standard with **1-3/4-inch- (45-mm-)** thick tubular stile-and-rail members.

a. Stile Design: [**Narrow stile, 2-inch (51-mm) nominal width**][**Medium stile, 3-1/2-inch (89-mm) nominal width**][**Wide stile, 5-inch (127-mm) nominal width**][**As indicated on Drawings**].

b. Rail Design: [**3-inch (76-mm) nominal height**][**4-inch (102-mm) nominal height**][**As indicated on Drawings**].
c. Muntin Design: To match stile design.
d. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**6 mm**][**8 mm**][**10 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

e. Signage: Provide signage on door visible from both sides of each wing indicating "Automatic Door," location as indicated on Drawings.

10. Push Bars: Manufacturer's standard [**horizontal**][**vertical**] push bars, finished to match wings.

a. Shape: [**Round bars, 1 inch (25 mm) in diameter**][**Flat bars, 1/2 inch thick and 1-1/2 inches (13 mm thick and 38 mm) high**][**Manufacturer's standard**].

11. Locking:

a. Electric Locking: Internal electromechanical lock.
b. Mechanical Locking: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance, finish to match wings.

1) Cylinders: Comply with requirements in Section 087100 "Door Hardware."
2) Mounting: [**Surface applied**][**Mortised**].
3) Location: Extend bolt from [**bottom of wing into floor**][**top of wing into ceiling**][**bottom of wing into base of wall enclosure**].

12. Enclosure Walls: Manufacturer's standard, with **1-3/4-inch- (45-mm-)** thick tubular framing members.

a. Configuration: [**Curved**][**Segmented**].
b. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**6 mm**][**8 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

c. Laminated Glass: [**Clear**][**Tinted**] consisting of two plies of fully tempered float glass with a PVB interlayer.

1) Thickness: [**Two 3 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 5 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 8 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**As indicated**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

d. Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

13. Canopy: Manufacturer's standard ceiling, fascia,[**roof,**] and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.

a. Metal-Clad Plywood: Fabricate from **3/4-inch- (19-mm-)** thick plywood clad with metal sheet. Provide ceiling-access panels for repairs to or maintenance of drive assembly.
b. Metal: Fabricate from minimum **0.125-inch- (3.18-mm-)** thick aluminum sheet. Provide ceiling-access panels for repairs to or maintenance of drive assembly.
c. Glass: [**Clear**][**Tinted**] laminated glass ceiling with two plies of heat-strengthened or

tempered glass separated by a PVB interlayer.

1) Thickness: [**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**6 mm thick top lite and 12 mm thick bottom lite, 0.060-inch- (1.52-mm)-thick interlayer**][**As indicated**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

d. Ceiling Lights: Manufacturer's standard, consisting of two recessed LED fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
e. Canopy Roof: Manufacturer's standard construction, with material and finish matching enclosure walls where visible.
f. Recessed Grilles: Provide grille complete with floor pan[**and drainage fitting**] at entry quadrant only. Fabricate grille, using welded joints, from minimum **1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall)**, concentrically curved [**stainless steel**][**bronze**] bar stock with **1/4-inch (6-mm)** spacing.

14. Rotating Glazed Display Case: Glazed enclosure incorporated into core, with framing matching wings and with panel on one side for access to display area.
15. Safety Devices: Manufacturer's standard safety devices as required to stop or slow rotation. Provide the following:

a. Emergency Stop Button: Momentary-contact, red push-button switch to immediately stop wing rotation[**and reverse direction to entry position**]. Provide sign indicating "Emergency Stop," location as indicated on Drawings.

1) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

b. Slow-Speed Operation Button: Momentary-contact push-button switch or plate to slow wing rotation by reducing rpm by one half. Include sign indicating operation, location as indicated on Drawings.

1) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

c. Vertical Safety Sensors:

1) End Wall Sensor Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch (sensor strip) encapsulated in a flexible housing. Mount on enclosure walls at vertical edge of entry.
2) Entry Point Sensor: Self-contained, active infrared sensor with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions, including presence sensor monitoring, required by ANSI/BHMA A156.27. Detectors remain active at all times. Mount recessed in canopy ceiling at right-hand side of opening.

d. Horizontal Safety Sensors:

1) Bottom Rail Sensor Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch (sensor strip) encapsulated in a flexible housing. Mount at bottom edge of each wing.
2) Wing Presence Sensor: Self-contained, active infrared sensor with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions,

including presence sensor monitoring, required by ANSI/BHMA A156.27. Detectors remain active at all times. Mount [**recessed in canopy ceiling**][**to top rail of each door wing**].

16. Signage: As required by ANSI/BHMA A156.27.

    a. Application Process: [**Decals**][**Silk-screened**][**Door manufacturer's standard process**].
    b. Provide sign materials with instructions for field application after glazing is installed.

B. Materials: [**Extruded aluminum**][**Stainless steel clad, extruded aluminum**][**Copper-alloy-clad, extruded aluminum**].

1. Main Extrusions and Tubing: Minimum wall thickness of **0.125 inch (3.18 mm)**.
2. Cladding: Minimum **0.04 inch (1.0 mm)** thick.

C. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

1. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

    a. Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Section 088000 "Glazing." Provide minimum clearances for thickness and type of glass indicated in accordance with NGA's "GANA Glazing Manual."
    b. Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
    c. Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
    d. Mechanically Joined Construction: Joints to be tightly bolted together. Glass stops to be snap-in type where possible.
    e. Mechanically Joined Clad Construction: Joints to be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops to be snap-in type where possible.

2. Enclosure Walls and Ceilings: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, in accordance with manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.

    a. Exterior Framing: Fabricate components to drain water-passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

D. Aluminum Finishes: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**][**High performance, organic**].

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Stainless Steel Finishes: [**Directional satin finish**][**Reflective, directional polish**][**Mirrorlike**

reflective, nondirectional polish].

F. Copper-Alloy Finishes: [**Buffed finish**][**Medium-satin finish**].

2.5 MANUAL ACCESS-CONTROL REVOLVING DOOR ENTRANCES

A. Manual Access-Control Revolving Door Entrances : Manufacturer's standard [**three-wing**][**four-wing**] manual access-control revolving door entrance, complete with center shaft, speed-control unit, wings, hardware, enclosure walls, canopy, glass and glazing, activation devices, safety devices, and accessories required for a complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Boon Edam, Inc.**]
   b. [**Crane Revolving Doors; dormakaba USA Inc.**]
   c. [**International Revolving Door**]
   d. [**STANLEY Rush; STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]

2. Manual Operation: Valid authorization signal from access-control system or emergency system will allow door to operate by manually pushing the door counter clockwise to allow single passage only; manufacturer's standard braking system to secure door.
3. Manual Speed-Control Unit: Mechanical speed regulator that allows free rotation of wings up to a predetermined rate of speed and that engages a clutch-type brake to prevent rapid acceleration of wings.

   a. Location: [**Recessed, floor mounted**][**Overhead**].

4. Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.
5. Electric Wing Locking: Provide manufacturer's standard programmable fail-secure or fail-safe electromagnetic wing lock mechanism to prevent breakout of door wings. Fail safe: Loss of power or signal from building fire/smoke alarm will release electromagnetic lock allowing for breakout. Fail secure: Loss of power will engage electromagnetic lock, preventing breakout.
6. Activation Devices: [**Keypads**][**Card readers**][**Biometric identity verification equipment**] as specified in [**Section 087100 "Door Hardware."**][**Section 281500 "Access Control Hardware Devices."**]

   a. Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

7. Communication System: Provide [**visual signal**][**and**][**digital field programmable voice messaging**].
8. Stile-and-Rail Wings: Manufacturer's standard with **1-3/4-inch- (45-mm-)** thick, tubular stile-and-rail members.

   a. Stile Design: [**Narrow stile, 2-inch (51-mm) nominal width**][**Medium stile, 3-1/2-inch (89-mm) nominal width**][**Wide stile, 5-inch (127-mm) nominal width**][**As indicated on Drawings**].
   b. Rail Design: [**3-inch (76-mm) nominal height**][**4-inch (102-mm) nominal height**][**As indicated on Drawings**].

c. Muntin Design: To match stile design.
d. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**6 mm**][**8 mm**][**10 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

9. Push Bars: Manufacturer's standard [**horizontal**][**vertical**] push bars, finished to match wings.

a. Shape: [**Round bars, 1 inch (25 mm) in diameter**][**Flat bars, 1/2 inch thick and 1-1/2 inches (13 mm thick and 38 mm) high**][**Manufacturer's standard**].

10. Locks: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance, finish to match wings.

a. Cylinders: Comply with requirements in Section 087100 "Door Hardware."
b. Mounting: [**Surface applied**][**Mortised**].
c. Location: Extend bolt from [**bottom of wing into floor**][**top of wing into ceiling**][**bottom of wing into base of wall enclosure**].

11. Enclosure Walls: Manufacturer's standard, with **1-3/4-inch- (45-mm-)** thick tubular framing members.

a. Configuration: [**Curved**][**Segmented**].
b. Glass: [**Clear**][**Tinted**], fully tempered float glass.

1) Thickness: [**6 mm**][**8 mm**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

c. Laminated Glass: [**Clear**][**Tinted**] consisting of two plies of fully tempered float glass with a PVB interlayer.

1) Thickness: [**Two 3 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 5 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 8 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**As indicated**].
2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

d. Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

12. Canopy: Manufacturer's standard ceiling, fascia,[**roof,**] and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.

a. Metal-Clad Plywood: Fabricate from **3/4-inch- (19-mm-)** thick plywood clad with metal sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control units.
b. Metal: Fabricate from minimum **0.125-inch- (3.18-mm-)** thick, aluminum sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control units.
c. Ceiling Lights: Manufacturer's standard, consisting of two recessed LED fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
d. Canopy Roof: Manufacturer's standard constructions, with material and finish matching enclosure walls where visible.
e. Recessed Grilles: Provide grille complete with floor pan[**and drainage fitting**] at entry quadrant only. Fabricate, using welded joints, from minimum **1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall)**, concentrically curved [**stainless steel**][**bronze**] bar stock with **1/4-inch (6-mm)** spacing.

B. Materials: [**Extruded aluminum**][**Stainless steel clad, extruded aluminum**][**Copper-alloy-clad, extruded aluminum**].

1. Main Extrusions and Tubing: Minimum wall thickness of **0.125 inch (3.18 mm)**.
2. Cladding: Minimum **0.04 inch (1.0 mm)** thick.

C. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

1. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

a. Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Section 088000 "Glazing." Provide minimum clearances for thickness and type of glass indicated in accordance with NGA's "GANA Glazing Manual."
b. Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
c. Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
d. Mechanically Joined Construction: Joints to be tightly bolted together. Glass stops to be snap-in type where possible.
e. Mechanically Joined Clad Construction: Joints to be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops to be snap-in type where possible.

2. Enclosure Walls and Ceilings: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, in accordance with manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.

a. Exterior Framing: Fabricate components to drain water-passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

D. Aluminum Finishes: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**][**High performance, organic**].

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Stainless Steel Finishes: [**Directional satin finish**][**Reflective, directional polish**][**Mirrorlike reflective, nondirectional polish**].

F. Copper-Alloy Finishes: [**Buffed finish**][**Medium-satin finish**].

2.6 AUTOMATIC ACCESS-CONTROL REVOLVING DOOR ENTRANCES

A. Automatic Access-Control Revolving Door Entrances : Manufacturer's standard [**four-wing**][**three-wing**] automatic access-control revolving door entrance, complete with [**center shaft**][**core**], drive assembly, wings, hardware, enclosure walls, canopy, glass and glazing, activation devices, safety devices, and

accessories required for a complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
    b. [**Boon Edam, Inc.**]
    c. [**Crane Revolving Doors; dormakaba USA Inc.**]
    d. [**Horton Automatics; Overhead Door Corporation**]
    e. [**International Revolving Door**]
    f. [**STANLEY Rush; STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]

2. Automatic Operation: Valid authorization signal from access-control system activates the unit and revolves the door up to one turn, then returns door wings to quarter-point position. Provide signage on door visible from both sides of each wing indicating "Automatic Door," location as indicated on Drawings.
3. Drive Assembly: Provide an electric drive unit with speed regulator to permit and control automatic rotation of wings. Drive unit allows for manual operation of door to the emergency egress position upon loss of power. Furnish power-operation equipment to suit current characteristics of building electrical service.
4. Fold-to-Side Mechanism: Manufacturer's standard overhead carriage, guide support track, pivot mechanism, and other components necessary to permit folded wings to be moved to one side of revolving door entrance enclosure.
5. Electric Wing Locking: Provide manufacturer's standard programmable fail-secure or fail-safe electromagnetic wing lock mechanism to prevent breakout of door wings. Fail safe: Loss of power or signal from building fire/smoke alarm will release electromagnetic lock allowing for breakout. Fail secure: Loss of power will engage electromagnetic lock, preventing breakout.
6. Activation Devices: [**Keypads**][**Card readers**][**Biometric identity verification equipment**] as specified in [**Section 087100 "Door Hardware."**][**Section 281500 "Access Control Hardware Devices."**]

    a. Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening.

7. Access-Control Operation: [**One way; access-controlled entry, free exit**][**One way; free entry, access-controlled exit**][**Two way; access-controlled entry and exit**][**As indicated on Drawings**].
8. Communication System: Provide [**visual signal**][**and**][**digital field programmable voice messaging**].
9. Stile-and-Rail Wings: Manufacturer's standard with **1-3/4-inch- (45-mm-)** thick, tubular stile-and-rail members.

    a. Stile Design: [**Narrow stile, 2-inch (51-mm) nominal width**][**Medium stile, 3-1/2-inch (89-mm) nominal width**][**Wide stile, 5-inch (127-mm) nominal width**][**As indicated on Drawings**].
    b. Rail Design: [**3-inch (76-mm) nominal height**][**4-inch (102-mm) nominal height**][**As indicated on Drawings**].
    c. Muntin Design: To match stile design.
    d. Glass: [**Clear**][**Tinted**], fully tempered float glass.

        1) Thickness: [**6 mm**][**8 mm**][**10 mm**].
        2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

10. Locking:

    a. Electric Locking: Internal electromechanical lock.
    b. Mechanical Locking: Manufacturer's standard deadbolt locks to receive cylinders; minimum of two for each revolving door entrance, finish to match wings.

        1) Cylinders: Comply with requirements in Section 087100 "Door Hardware."
        2) Mounting: [**Surface applied**][**Mortised**].
        3) Location: Extend bolt from [**bottom of wing into floor**][**top of wing into ceiling**][**bottom of wing into base of wall enclosure**].

11. Enclosure Walls: Manufacturer's standard, with **1-3/4-inch- (45-mm-)** thick tubular framing members.

    a. Configuration: [**Curved**][**Segmented**].
    b. Glass: [**Clear**][**Tinted**], fully tempered float glass.

        1) Thickness: [**6 mm**][**8 mm**].
        2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

    c. Laminated Glass: [**Clear**][**Tinted**] consisting of two plies of fully tempered float glass with a PVB interlayer.

        1) Thickness: [**Two 3 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 5 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 6 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**Two 8 mm thick lites, 0.060-inch- (1.52-mm-) thick interlayer**][**As indicated**].
        2) Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

    d. Muntin Bars: Horizontal tubular rail member for each enclosure wall; match stile design.

12. Canopy: Manufacturer's standard ceiling, fascia,[**roof,**] and framing with size, layout, materials, and exposed finishes matching enclosure walls unless otherwise indicated.

    a. Metal-Clad Plywood: Fabricate from **3/4-inch- (19-mm-)** thick plywood clad with metal sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control unit or overhead pivot for recessed, floor-mounted speed-control units.
    b. Metal: Fabricate from minimum **0.125-inch- (3.18-mm-)** thick, aluminum sheet. Provide ceiling-access panels for repairs to or maintenance of speed-control unit or overhead pivot for recessed, floor-mounted speed-control units.
    c. Ceiling Lights: Manufacturer's standard, consisting of two recessed LED fixtures within the ceiling of the revolving door entrance enclosure, complete with lamps and translucent lenses.
    d. Canopy Roof: Manufacturer's standard constructions, with material and finish matching enclosure walls where visible.
    e. Recessed Grilles: Provide grille complete with floor pan[**and drainage fitting**] at entry quadrant only. Fabricate, using welded joints, from minimum **1/4-inch-wide by 1-inch-tall (6-mm-wide by 25-mm-tall)**, concentrically curved [**stainless steel**][**bronze**] bar stock with **1/4-inch (6-mm)** spacing.

13. Safety Devices: Manufacturer's standard safety devices as required to stop or slow rotation. Provide the following:

    a. Emergency Stop Button: Momentary-contact, red push-button switch to immediately stop wing rotation[**and reverse direction to entry position**]. Provide sign indicating "Emergency Stop," location as indicated on Drawings.

1) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side of opening on secure side.

b. Slow-Speed Operation Button: Momentary-contact push-button switch or plate to slow wing rotation by reducing rpm by one half. Include sign indicating operation, location as indicated on Drawings.

1) Mounting: [**Recess mounted, semiflush in wall**][**Surface mounted on wall**][**Surface mounted on post**][**As indicated on Drawings**] on right-hand side on each side of opening.

c. Vertical Safety Sensors:

1) End Wall Sensor Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch (sensor strip) encapsulated in a flexible housing. Mount on enclosure walls at vertical edge of entry.

d. Horizontal Safety Sensors:

1) Bottom Rail Sensor Strip: Compressible safety switch consisting of an impact-pressure-activated, internal-contact switch (sensor strip) encapsulated in a flexible housing. Mount at bottom edge of each wing.
2) Wing Presence Sensor: Self-contained, active infrared sensor with metal or plastic housing; to provide adjustable detection-field sizes, patterns, and functions, including presence sensor monitoring, required by ANSI/BHMA A156.27. Detectors remain active at all times. Mount [**recessed in canopy ceiling**][**to top rail of each door wing**].

14. Security Devices:

a. Anti-Tailgating: Manufacturer's standard overhead sensors to monitor passage of authorized users.
b. Anti-Piggybacking: Manufacturer's standard overhead sensors to monitor passage of authorized users.

15. Signage: As required by ANSI/BHMA A156.27.

a. Application Process: [**Decals**][**Silk screened**][**Door manufacturer's standard process**].
b. Provide sign materials with instructions for field application after glazing is installed.

B. Materials: [**Extruded aluminum**][**Stainless steel clad, extruded aluminum**][**Copper-alloy-clad, extruded aluminum**].

1. Main Extrusions and Tubing: Minimum wall thickness of **0.125 inch (3.18 mm)**.
2. Cladding: Minimum **0.04 inch (1.0 mm)** thick.

C. Fabrication: Fabricate revolving door entrance components to designs, sizes, thicknesses, and configurations indicated with profiles that are sharp, straight, and free of defects or deformations. Accurately fit joints with ends coped or mitered to produce hairline joints free of burrs and distortion. Prefit all hardware at the factory. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

1. Wings: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

a. Glaze wings at the factory. Comply with glazing requirements specified in this Section and in Section 088000 "Glazing." Provide minimum clearances for thickness and type of glass indicated in accordance with NGA's "GANA Glazing Manual."
b. Provide sliding weather stripping, mortised into stiles and rails of wings, to be adjustable and replaceable without dismantling wings.
c. Welded Construction: Weld reinforcement firmly in place. Weld corners. Grind and polish welds to produce an invisible joint. Mechanically finish exposed surfaces after fabrication to eliminate surface blemishes caused by welding, rolling, bending, and forming.
d. Mechanically Joined Construction: Joints to be tightly bolted together. Glass stops to be snap-in type where possible.
e. Mechanically Joined Clad Construction: Joints to be tightly bolted together to produce hairline joints. Finish material before fabrication. Carefully assemble to prevent welds or adhesives from blemishing finished surfaces. Glass stops to be snap-in type where possible.

2. Enclosure Walls and Ceilings: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints, in accordance with manufacturer's standards and as specified. Provide subframes as required for a complete system to support required loads.

a. Exterior Framing: Fabricate components to drain water-passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

D. Aluminum Finishes: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**][**High performance, organic**].

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Stainless Steel Finishes: [**Directional satin finish**][**Reflective, directional polish**][**Mirrorlike reflective, nondirectional polish**].

F. Copper-Alloy Finishes: [**Buffed finish**][**Medium-satin finish**].

2.7 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.
2. Sheet and Plate: **ASTM B209 (ASTM B209M)**.

B. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**].

C. Plate, Sheet, Strip, and Bars; Bronze: ASTM B36/B36M, alloy UNS No. C28000 (muntz metal, 60 percent copper).

D. Steel: ASTM A36/A36M plate, shapes, and bars; or ASTM A1008/A1008M sheet.

E. Fasteners: Manufacturer's standard, of same basic metal as fastened metal, unless otherwise indicated.

F. Weather Stripping: Heavy-duty, single-piece rubber or combination of rubber and felt.

G. Nonshrink, Nonmetallic Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C1107/C1107M; of consistency suitable for application.

H. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

D. High-Performance Organic Finish: [**Two-coat**][**Three-coat**][**Four-coat**] fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2.9 STAINLESS STEEL FINISHES

A. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Directional Satin Finish: No. 4.
2. Reflective, Directional Polish: No. 7.
3. Mirrorlike Reflective, Nondirectional Polish: No. 8.

2.10 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: Buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: Directionally textured, medium satin).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install revolving door entrances in accordance with manufacturer's written instructions and ANSI/BHMA A156.27, including signage, controls, wiring, and connections to building power supply.

1. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement

joints. Seal joints watertight. Do not install damaged components.
2. Where aluminum contacts dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
3. Where aluminum contacts concrete or masonry, protect against corrosion by painting contact surfaces with corrosion-resistant coatings.

B. Recessed, Floor-Mounted Speed-Control Unit: Insert control unit in rough-in floor opening set on level bed of nonshrink, nonmetallic grout. Fill annular space between control unit and sides of recess with nonshrink, nonmetallic grout. Mix and place grout to comply with grout manufacturer's written instructions.

C. Overhead-Mounted Speed-Control Unit: Insert pivot bearing in rough-in floor opening set on level bed of nonshrink, nonmetallic grout. Fill annular space between pivot bearing and sides of recess with nonshrink, nonmetallic grout. Mix and place grout to comply with grout manufacturer's written instructions.

D. Overhead-Mounted Drive Unit: Insert pivot bearing in rough-in floor opening set on level bed of nonshrink, nonmetallic grout. Fill annular space between pivot bearing and sides of recess with nonshrink, nonmetallic grout. Mix and place grout to comply with grout manufacturer's written instructions.

E. Connect drive unit to electrical power-distribution system.

F. Install revolving door entrances plumb and true, without warp or rack of framing members and wings. Anchor securely in place.

1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
2. Install components to drain water-passing joints, condensation occurring within framing members, and moisture migrating within the assembly to exterior.
3. Cut and trim framing during installation only with approval of manufacturer.

a. Restore finish and remove and replace members, as directed, where cutting and trimming have impaired strength or appearance.
b. Do not install members that are warped, bowed, deformed, or otherwise damaged or defaced to such an extent as to impair strength or appearance. Remove and replace members that have been damaged during installation.

G. Activation and Safety Devices: Adjust devices to provide detection field and functions in compliance with ANSI/BHMA A156.27.

H. Sealants: Comply with requirements specified in Section 079200 "Joint Sealants" to provide weathertight installation.

1. Set continuous sill members and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

I. Signage: Apply signage as required by ANSI/BHMA A156.27.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: [**the Owner will engage**][**Engage**] a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service**

representative]:

1. Test and inspect each revolving door entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.

C. Revolving door entrances will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust wings to provide an even, tight fit at contact points and weather stripping for smooth operation and weathertight closure. Adjust wings to operate smoothly and rotate evenly, with hardware and operators functioning properly.

1. Lubricate operating hardware and other moving parts.
2. Adjust [**speed-control unit**][**drive unit speed regulator**] for rpm no greater than maximum allowable rpm, as specified in ANSI/BHMA A156.27.
3. Adjust pressure for collapse of wings for specified breakaway force.

B. Readjust wings and [**speed-control unit**][**drive unit speed regulator**] after three days' use by normal traffic. Lubricate hardware and other moving parts.

3.5 CLEANING AND PROTECTION

A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

1. Comply with requirements in Section 088000 "Glazing" for cleaning and maintaining glass.

B. Limit construction traffic during remainder of construction period.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of revolving door entrance Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard yearly maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to the Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, seven-day-per-week emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain revolving door entrances.

END OF SECTION 08 42 33 00

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SECTION 08 43 13 00 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.

B. Related Requirements:

1. Section 014339 "Mockups" for preconstruction laboratory mockup testing.
2. Section 019119.43 "Exterior Enclosure Commissioning" for additional field quality control testing requirements.
3. Section 084126 "All-Glass Entrances and Storefronts" for systems without aluminum support framing.
4. Section 081116.13 "Interior Aluminum Doors and Frames" for interior aluminum framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.3 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, full-size details, and attachments to other work.
2. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
3. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:

   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.

4. Include connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
5. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: [**Manufacturers' standard size**] .

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

F. Delegated Design Submittals: For aluminum-framed storefront systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Environmental Product Declaration (EPD): For each product.
12. Third-Party Certifications: For each product.
13. Third-Party-Certified Life-Cycle Assessment: For each product.
14. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.
15. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

16. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.
    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

17. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

18. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: For aluminum-framed storefront systems, accessories, and components, from manufacturer.

    1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed storefront system.

B. Product Test Reports: For aluminum-framed storefront systems, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] .

C. Preconstruction Test Reports: For aluminum-framed storefront systems.

    1. Testing Program: Developed specifically for Project.
    2. Test Reports: Prepared by a qualified preconstruction testing agency for each preconstruction test.
    3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.

D. Source Quality-Control Reports: For aluminum-framed storefront systems.

E. Field Quality-Control Reports: For specified tests and inspections.

F. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

G. Qualification Statements: For Installer [**and laboratory mockup testing agency**][**and field testing agency**] .

H. Delegated Design Engineer Qualifications: For aluminum-framed storefront systems.

I. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For aluminum-framed storefront systems.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

C. Warranty Documentation: For specified special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer [**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**] .

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E329 for testing indicated [**and accredited by the International Accreditation Service (IAS) or the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement as complying with ISO/IEC 17025**] .

D. Testing Agency Qualifications: Qualified in accordance with ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**] and acceptable, as directed by the Owner.

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction, as directed by the Owner.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's written approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

F. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems that include structural glazing.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups.

1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
2. Size and Configuration: As indicated on Drawings.
3. Notify Architect [**seven**] days in advance of the dates and times when preconstruction laboratory mockups will be tested, as directed by the Owner.

B. Preconstruction Laboratory Mockup Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

1. Test preconstruction laboratory mockups in accordance with requirements in "Performance Requirements" Article. Perform the following tests in the following order:

a. Structural, 50 Percent Outward-Acting: ASTM E330/E330M at 50 percent of negative test load.
b. Structural, 50 Percent Inward-Acting: ASTM E330/E330M at 50 percent of positive test load.
c. Air Leakage: ASTM E283/E283M.
d. Water Penetration under Static Pressure: ASTM E331.
e. Water Penetration under Dynamic Pressure: AAMA 501.1.
f. Structural, 50/100 Percent: ASTM E330/E330M at the following wind loads:

1) 50 percent of positive test load.
2) 100 percent of positive test load.
3) 50 percent of negative test load.
4) 100 percent of negative test load.

g. Repeat the following:

1) Air Leakage: ASTM E283/E283M.
2) Water Penetration under Static Pressure: ASTM E331.
3) Water Penetration under Dynamic Pressure: AAMA 501.1.

h. Thermal Cycling: AAMA 501.5. Repeat the following:

1) Air Leakage: ASTM E283/E283M.
2) Water Penetration under Static Pressure: ASTM E331.
3) Water Penetration under Dynamic Pressure: AAMA 501.1.

i. Structural, 75/150 Percent: ASTM E330/E330M at the following loads:

1) 75 percent of positive test load.
2) 150 percent of positive test load.
3) 75 percent of negative test load.
4) 150 percent of negative test load.

C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

1. Compatibility: Test materials or components using ASTM C1087.
2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
3. Submit no fewer than [**eight**] pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of aluminum-framed storefront systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Deterioration of metals [**metal finishes,**] and other materials beyond normal [**weathering**][**use**] .

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
    c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of aluminum-framed storefront system, including framing [**spandrel panels**][**venting windows**] and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed storefront systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed storefront systems to withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Seismic Performance: Aluminum-framed storefront systems to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement [**and 1.5 times the design displacement**] .

D. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**] .

E. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to [**1/175 of length of span of the framing member for lengths of up to 13 ft. 6 inches (4.1 m) and to 1/240 of length of span of the framing member plus 1/4 inch (6.35 mm) for lengths greater than 13 ft. 6 inches (4.1 m)**].
2. Deflection Parallel to Glazing Plane: Limited to [**amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm)**].

a. Operable Units: Provide a minimum **1/16-inch (1.6-mm)** clearance between framing members and operable units.

F. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies do not evidence deflection exceeding specified limits.
2. When tested at [**150**] percent of positive and negative wind-load design pressures, storefront assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] percent of span.
3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

G. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [**180 deg F (82 deg C)**].
b. Low Exterior Ambient-Air Temperature: [**0 deg F (minus 18 deg C)**].
c. Interior Ambient-Air Temperature at High Exterior Ambient-Air Temperature: [**75 deg F (24 deg C)**].
d. Interior Ambient-Air Temperature at Low Exterior Ambient-Air Temperature: [**70 deg F (21 deg C)**].

H. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

I. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].
2. Maximum Water Leakage: [**In accordance with AAMA 501.1**][**No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation**] . Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

   a. Fixed Glazing and Framing Areas: U-factor for the system of not more than [**0.25 Btu/sq. ft. x h x deg F (1.42 W/sq. m x K)**][**0.28 Btu/sq. ft. x h x deg F (1.59 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.38 Btu/sq. ft. x h x deg F (2.16 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**] as determined in accordance with ANSI/NFRC 100.
   b. Venting Windows: Whole window U-factor of not more than [**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K)**][**0.54 Btu/sq. ft. x h x deg F (3.06 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.40 W/sq. m x K)**][**0.62 Btu/sq. ft. x h x deg F (3.52 W/sq. m x K)**] as determined in accordance with ANSI/NFRC 100.
   c. Spandrel Panels: Whole spandrel panel U-factor of not more than [**0.167 Btu/sq. ft. x h x deg F (0.948 W/sq. m x K)**][**0.175 Btu/sq. ft. x h x deg F (0.993 W/sq. m x K)**][**0.189 Btu/sq. ft. x h x deg F (1.072 W/sq. m x K)**][**0.217 Btu/sq. ft. x h x deg F (1.231 W/sq. m x K)**][**0.234 Btu/sq. ft. x h x deg F (1.328 W/sq. m x K)**][**0.263 Btu/sq. ft. x h x deg F (1.492 W/sq. m x K)**][**0.285 Btu/sq. ft. x h x deg F (1.617 W/sq. m x K)**] as determined in accordance with ANSI/NFRC 100.

2. Solar Heat Gain Coefficient (SHGC):

   a. Fixed Glazing and Framing Areas: SHGC for the system of not more than [**0.23**][**0.25**][**0.30**][**0.35**][**0.40**][**0.48**] as determined in accordance with ANSI/NFRC 200.
   b. Venting Windows: Whole window SHGC of not more than [**0.21**][**0.25**][**0.35**][**0.40**][**0.45**] as determined in accordance with ANSI/NFRC 200.

3. Air Leakage:

   a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with ASTM E283/E283M.
   b. Venting Windows: Whole window air leakage of not more than [**0.3 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

4. Condensation Resistance Factor (CRF):

   a. Fixed Glazing and Framing Areas: CRF for the system of not less than [**55**][**65**][**70**][**75**] as determined in accordance with AAMA 1503.
   b. Venting Windows: Whole window CRF of not less than [**65**][**70**][**75**] as determined in accordance with AAMA 1503.

K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.

1. Outdoor-Indoor Transmission Class: Minimum [**26**][**30**][**34**].

L. Blast Resistance:

1. Hazard Rating: [**No Break**][**No Hazard**][**Minimal Hazard**][**Very Low Hazard**][**Low Hazard**][**Moderate Hazard**][**High Hazard**] in accordance with ASTM F2912, tested in accordance with ASTM F1642/F1642M.
2. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

M. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

N. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

O. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed storefront systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant to occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.3 ALUMINUM-FRAMED STOREFRONT SYSTEMS

A. Aluminum-Framed Storefront System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Arcadia Inc.**]
   b. [**Boyd Aluminum Mfg. Co.**]
   c. [**CMI Architectural Products, Inc.**]
   d. [**Coral Architectural Products; Coral Industries, Inc.**]
   e. [**EFCO Corporation; Architectural Metals; Apogee Enterprises, Inc.**]
   f. [**Kawneer Company, Inc.; Arconic Corporation**]
   g. [**Leed Himmel Industries, Inc.**]

h. [**Manko Window Systems, Inc.**]
i. [**OldCastle BuildingEnvelope (OBE)**]
j. [**Pittco Architectural Metals, Inc.**]
k. [**Trulite Glass & Aluminum Solutions, LLC.**]
l. [**Tubelite Inc.; Architectural Metals; Apogee Enterprises, Inc.**]
m. [**U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
n. [**YKK AP America Inc.**]

2. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

   a. Exterior Framing Construction: [**Double thermally broken**][**Double thermally broken; dual pour-and-debridged system**][**Double thermally broken; crimped-in-place polymer isolator system**][**Thermally broken**][**Thermally broken; pour-and-debridged system**][**Thermally broken; crimped-in-place polymer isolator system**][**Thermally improved**][**Nonthermal**] .
   b. Interior Vestibule Framing Construction: [**Nonthermal**].
   c. Glazing System: [**Retained mechanically with gaskets on four sides**][**Retained mechanically with gaskets on two sides and structural sealant on two sides**] .
   d. Glazing Plane: [**Front-set**][**Center-set**][**Back-set**].
   e. Finish: [**Clear anodic finish**][**Color anodic finish**][**Baked-enamel or powder-coat finish**][**High-performance organic finish**][**Superior-performance organic finish**] .
   f. Fabrication Method: Field-fabricated stick system.
   g. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   h. Steel Reinforcement: As required by manufacturer.

3. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
4. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
5. Insulated Spandrel Panels:

   a. Comply with Section 074213.19 "Insulated Metal Wall Panels."
   b. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.

      1) Overall Panel Thickness: [**As indicated on Drawings**][**1 inch (25.4 mm)**].
      2) Exterior Skin: Aluminum.

         a) Thickness: [**Manufacturer's standard for finish and texture indicated**].
         b) Finish: [**Match framing system**].
         c) Texture: [**Smooth**][**Embossed**].
         d) Backing Sheet: [**1/8-inch- (3.2-mm-) thick tempered hardboard**][**0.157-inch- (4-mm-) thick cement board**][**0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene**].

      3) Interior Skin: Aluminum.

         a) Thickness: [**Manufacturer's standard for finish and texture indicated**] .
         b) Finish: [**Matching storefront framing**][**Low-gloss, white baked enamel**][**Mill finish**].
         c) Texture: [**Smooth**][**Embossed**].
         d) Backing Sheet: [**1/8-inch- (3.2-mm-) thick tempered hardboard**][**0.157-**

inch- (4-mm-) **thick cement board**][1/2-inch- (12.7-mm-) **thick gypsum board with proprietary fire-resistance-rated core**][0.125-inch- (3.2-mm-) **thick, corrugated, high-density polyethylene**].

4) Thermal Insulation Core: Manufacturer's standard [**rigid, closed-cell, polyisocyanurate board**][**extruded-polystyrene board**][**expanded-perlite, mineral-insulation board**].
5) Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a) Flame-Spread Index: [**25**] or less.
b) Smoke-Developed Index: [**50**][**450**] or less.

6. Venting Windows:

a. As specified in Section 085113 "Aluminum Windows."
b. Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:

1) Window Type: [**Awning**][**Casement**][**As indicated on Drawings**].
2) Minimum Performance Class: [**CW**][**AW**].
3) Minimum Performance Grade: [**30**][**40**][**60**][**70**][**80**][**90**][**As indicated on Drawings**].
4) Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

a) Cam handle locking system.
b) Multipoint locking system.
c) Pole-operated, cam handle locking system, where rail is more than 72 inches (1830 mm) above floor.
d) Rotary operator.
e) Steel or bronze operating arms.

5) Hardware Limit Devices: [**Concealed friction adjustor and adjustable stay bar**] limit devices designed to restrict sash opening.

a) Limit clear opening to [4 inches (100 mm)] for ventilation; with custodial key release.

6) Weather Stripping: Provide full-perimeter weather stripping for each venting window sash unless otherwise indicated.
7) Insect Screens: Provide removable insect screen on each venting window exterior sash, with screen frame finished to match window unit, complying with SMA 1201, and as follows:

a) Aluminum Wire Fabric: 18-by-18, 18-by-16, or 18-by-14 mesh of 0.013-inch- (0.3-mm-) diameter, coated aluminum wire; [**natural bright**][**charcoal gray**][**black**] finish.
b) Glass-Fiber Mesh Fabric: 18-by-16 or 18-by-14 mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
c) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.

8) Glazing: [**Same as adjacent aluminum-framed storefront glazing**].
9) Finish: [**Match adjacent aluminum-framed storefront finish**].

7. Glazing: Comply with Section 088000 "Glazing."
8. Glazing Gaskets: [**Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.**][**Comply with Section 088000 "Glazing."**]
9. Glazing Sealants: [**As recommended in writing by manufacturer.**][**Comply with Section 088000 "Glazing."**]

    a. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

10. Structural Glazing Sealants: ASTM C1184 chemically curing silicone formulation that is compatible with system components with which it comes in contact; specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.

    a. Color: [**White**][**Black**][**Gray**][**As selected by Architect from manufacturer's full range of colors**] as directed by the Owner.
    b. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

11. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.

    a. Color: Match structural sealant.
    b. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

2.4 MATERIALS

A. Sheet and Plate: ASTM B209/B209M.

B. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: aluminum-framed storefronts shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
3. Regional Materials: Verify aluminum-framed storefronts are manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.5 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads [**finished to match framing system**][**fabricated from 300 series stainless steel**] .

B. Anchors: Three-way adjustable anchors with minimum adjustment of [**1 inch (25.4 mm)**] that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: [**Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**][**Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer**] .

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.

E. Joint Sealants and Backings: Provide joint sealants, backings, and other related materials in accordance with Section 079200 "Joint Sealants."

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from [**exterior**][**interior**][**interior for vision glass and exterior for spandrel glazing or metal panels**] .
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using [**shear-block system**][**screw-spline system**][**head-and-sill-receptor system with shear blocks at intermediate horizontal members**].

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**] as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

H. Superior Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.8 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ALUMINUM-FRAMED STOREFRONT SYSTEMS

A. General: Install aluminum-framed storefront systems in accordance with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal perimeter and other joints watertight unless otherwise indicated.
3. Install components plumb and true in alignment with established lines and grades.

B. Anchorage:

1. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
2. Anchor aluminum-framed storefront systems that have been tested for [**windborne-debris impact**][**blast**] resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in testing.

C. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

D. Joint Sealants and Backings: Install in accordance with Section 079200 "Joint Sealants."

1. Set continuous sill members and flashing in full sealant bed.
2. Seal perimeter of framing members with sealant.

E. Venting Windows: Install venting windows level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Glazing: Install glazing as specified in Section 088000 "Glazing."

G. Structural Glazing: Install structural glazing as follows:

1. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
2. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
3. Set glazing with proper orientation, so that coatings face exterior or interior as specified.
4. Hold glazing in place using temporary retainers of type and spacing recommended in writing by manufacturer, until structural sealant joint has cured.
5. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.
6. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
7. Allow structural sealant to cure in accordance with manufacturer's written instructions.
8. Clean and protect glass as indicated in Section 088000 "Glazing."
9. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.
10. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed storefront systems to comply with the following maximum tolerances:

1. Plumb: **1/8 inch in 10 ft. (3.2 mm in 3 m)**; **1/4 inch in 40 ft. (6.35 mm in 12.2 m)**.
2. Level: **1/8 inch in 20 ft. (3.2 mm in 6 m)**; **1/4 inch in 40 ft. (6.35 mm in 12.2 m)**.
3. Alignment:

   a. Where surfaces abut in line or are separated by reveal or protruding element up to **1/2 inch (12.7 mm)** wide, limit offset from true alignment to **1/16 inch (1.6 mm)**.
   b. Where surfaces are separated by reveal or protruding element from **1/2 to 1 inch (12.7 to 25.4 mm)** wide, limit offset from true alignment to **1/8 inch (3.2 mm)**.
   c. Where surfaces are separated by reveal or protruding element of **1 inch (25.4 mm)** wide or more, limit offset from true alignment to **1/4 inch (6 mm)**.

4. Location: Limit variation from plane to **1/8 inch in 12 ft. (3.2 mm in 3.6 m)**; **1/2 inch (12.7 mm)** over total length.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**as directed by the Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Tests: Perform the following test on [**representative areas of aluminum-framed storefront**

systems][**mockups**], as directed by the Owner.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration, as directed by the Owner.

    a. Perform a minimum of [**two**][**three**] tests in areas as directed by the Owner.
    b. Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**].

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than **0.09 cfm/sq. ft. (0.45 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.

    a. Perform a minimum of [**two**][**three**] tests in areas as directed by the Owner.
    b. Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**] .

3. Water Penetration: ASTM E1105 at a minimum [**uniform**][**and**][**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than **6.24 lbf/sq. ft. (300 Pa)**, and to not evidence water penetration.
4. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

    a. Test a minimum of [**two**][**four**][**six**] areas on each building facade.
    b. Repair installation areas damaged by testing.

C. Aluminum-framed storefront systems will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust hardware and operable components to function smoothly, and lubricate as recommended in writing by manufacturer.

END OF SECTION 08 43 13 00

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Task	Specification	Specification Description
08 43 19 00	01 22 00 00	No Specification Required

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SECTION 08 44 13 00 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Glazed aluminum curtain wall systems:

1. Conventionally glazed.
2. Two sided, structural sealant glazed.

B. Related Requirements:

1. Section 014339 "Mockups" for preconstruction laboratory mockup testing.
2. Section 019119.43 "Exterior Enclosure Commissioning."
3. Section 078443 "Joint Firestopping" perimeter fire-containment systems field installed with glazed aluminum curtain walls.
4. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
5. Section 084423 "Structural-Sealant-Glazed Curtain Walls" for four-sided structural-sealant-glazed curtain walls.
6. Section 084433 "Sloped Glazing Assemblies" for sloped glazing.
7. Section 088000 "Glazing" for curtain wall glazing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.

9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

C. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

G. Delegated Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Mockup Testing Submittals:

1. Testing Program: Developed specifically for Project.
2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.

B. Qualification Data:

1. For Installer[**and laboratory mockup testing agency**][**and field testing agency**].
2. For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

C. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

D. Product Test Reports: For glazed aluminum curtain walls, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors[**and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

B. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**] and acceptable to the Owner and Architect, as directed by the Owner.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

E. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed curtain wall assemblies.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups.

1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
2. Size and Configuration: As indicated on Drawings.
3. Notify Architect [**seven**] days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested, as directed by the Owner.

B. Preconstruction Laboratory Mockup Testing: Test preconstruction laboratory mockups according to requirements in "Performance Requirements" Article. Perform the following tests in the following order:

1. Structural, 50 percent: ASTM E330/E330M at 50 percent of positive test load.
2. Air Leakage: ASTM E283.
3. Water Penetration under Static Pressure: ASTM E331.
4. Water Penetration under Dynamic Pressure: AAMA 501.1.
5. Interstory Drift, 100 percent: AAMA 501.4 at 100 percent of design displacement. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.

6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.

7. Thermal Cycling: AAMA 501.5. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.

8. Structural, 100 percent: ASTM E330/E330M at 100 percent of positive and negative test loads. Repeat the following:

    a. Air Leakage: ASTM E283.
    b. Water Penetration under Static Pressure: ASTM E331.
    c. Water Penetration under Dynamic Pressure: AAMA 501.1.

9. Structural, 150 percent: ASTM E330/E330M at 150 percent of positive and negative test loads.
10. Interstory Drift, 150 percent: AAMA 501.4 at 150 percent of design displacement.

C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

1. Compatibility: Test materials or components using ASTM C1087.
2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
3. Submit no fewer than [**eight**] pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.8 WARRANTY

A. Special Assembly Warranty: [**Manufacturer**][**Installer**] agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals[metal finishes,] and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.
   e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to [**1/175 of length of span of the framing member for lengths of up to 13 feet 6 inches (4.1 m) and to 1/240 of length of span of the framing member plus 1/4 inch (6.35 mm) for lengths of greater than 13 feet 6 inches (4.1 m)**].
2. Deflection Parallel to Glazing Plane: Limited to [**amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm)**].

   a. Operable Units: Provide a minimum **1/16-inch (1.6-mm)** clearance between framing members and operable units.

3. Cantilever Deflection: Limited to 2/175 of the unsupported length.

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at [**150**] percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] percent of span.
3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than

[**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

2. Maximum Water Leakage: [**In accordance with AAMA 501.1**][**No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation**]. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.

H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: [**As indicated on Drawings**].
2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement[**and 1.5 times the design displacement**].

I. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement[**and 1.5 times the design displacement**].
2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.7 at design displacement[**and 1.5 times the design displacement**].

J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than [**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.38 Btu/sq. ft. x h x deg F (2.16 W/sq. m x K)**][**0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K)**][**0.46 Btu/sq. ft. x h x deg F (2.61 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**] as determined in accordance with NFRC 100.

b. Venting Windows: Whole window U-factor of not more than [**0.37 Btu/sq. ft. x h x deg F (2.10 W/sq. m x K)**][**0.43 Btu/sq. ft. x h x deg F (2.44 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.40 W/sq. m x K)**][**0.65 Btu/sq. ft. x h x deg F (3.69 W/sq. m x K)**] as determined in accordance with NFRC 100.

2. Solar Heat Gain Coefficient (SHGC):

a. Fixed Glazing and Framing Areas: SHGC for the system of not more than [**0.22**][**0.25**][**0.26**][**0.29**][**0.40**][**0.45**] as determined in accordance with NFRC 200.

b. Venting Windows: Whole-window SHGC of not more than [**0.22**][**0.27**][**0.30**][**0.40**] as determined in accordance with NFRC 200.

3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with ASTM E283.

b. Venting Windows: Whole-window air leakage of not more than [**0.3 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

4. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than [**29**][**55**][**65**][**80**] as

determined in accordance with AAMA 1503.

b. Venting Windows: Whole-window CRF of not less than [**45**][**52**][**55**] as determined in accordance with AAMA 1503.

K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:

1. Outdoor-Indoor Transmission Class: Minimum [**26**][**30**][**34**].
2. Sound Transmission Class: Minimum [**31**][**34**][**37**][**40**].

L. Blast Resistance:

1. Hazard Rating: [**No Break**][**No Hazard**][**Minimal Hazard**][**Very Low Hazard**][**Low Hazard**][**Moderate Hazard**][**High Hazard**] in accordance with ASTM F2912, tested in accordance with ASTM F1642/F1642M.
2. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

M. Ballistic Resistance, UL 752: [**Listed and labeled as**][**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 9**][**Level 10**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**][**Level 9-SG**][**Level 10-SG**] when tested in accordance with UL 752.

N. Ballistic Resistance, ASTM F1233: [**Class/Level HG1**][**Class/Level HG2**][**Class/Level HG3**][**Class/Level HG4**][**Class/Level SMG**][**Class/Level R1**][**Class/Level R2**][**Class/Level R3**][**Class/Level R4-AP**][**Class/Level R5**][**Class/Level SH1**][**Class/Level SH2**] when tested in accordance with ASTM F1233.

O. Ballistic Resistance, HPW-TP-0500.03: [**A**][**B**][**C**][**D**][**E**] when tested in accordance with HPW-TP-0500.03.

P. Ballistic Resistance, SD-STD-01.01: [**R**][**SH**] when tested in accordance with SD-STD-01.01.

Q. Ballistic Resistance, NIJ STD-0108.01: [**Level I**][**Level IIA**][**Level II**][**Level IIIA**][**Level III**][**Level IV**] when tested in accordance with NIJ STD-0108.01.

R. Windborne-Debris Impact Resistance: Pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.2 m)**] above grade.

S. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [**180 deg F (82 deg C)**].

b. Low Exterior Ambient-Air Temperature: [**0 deg F (minus 18 deg C)**].

T. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

U. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 SOURCE LIMITATIONS

A. Obtain all components of curtain-wall system[**and storefront system**], including framing [**spandrel panels**][**venting windows**][**entrances**][**sun control**] and accessories, from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Arcadia Inc.**]
2. [**Boyd Aluminum Mfg. Co.**]
3. [**Bruce Wall Systems Corporation**]
4. [**CMI Architectural Products, Inc.**]
5. [**Coral Architectural Products; Coral Industries, Inc.**]
6. [**EFCO Corporation**]
7. [**EXTECH/Exterior Technologies, Inc.**]
8. [**Graham Architectural Products Corporation**]
9. [**Kawneer Company, Inc.; Arconic Corporation**]
10. [**OldCastle BuildingEnvelope (OBE)**]
11. [**Pittco Architectural Metals, Inc.**]
12. [**Professional Grade Aluminum Corp**]
13. [**Shuco USA L.L.L.P.**]
14. [**Tingwall Inc.**]
15. [**TRACO, a division of Kawneer**]
16. [**Trulite Glass & Aluminum Solutions, LLC.**]
17. [**Tubelite Inc.**]
18. [**U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
19. [**Waltek Company, Ltd.**]
20. [**Wausau Window and Wall Systems; Apogee Wausau Group, Inc.**]
21. [**YKK AP America Inc.**]

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: [**Thermally broken**][**Thermally improved**][**Nonthermal**].
2. Glazing System: [**Retained mechanically with gaskets on four sides**][**Retained mechanically with gaskets on two sides and structural sealant on two sides**].
3. Glazing Plane: [**Front**].
4. Finish: [**Clear anodic finish**][**Color anodic finish**][**Baked-enamel or powder-coat finish**][**High-performance organic finish**][**Superior-performance organic finish**].

5. System: [**Either stick or unitized system**][**Stick system**][**Unitized system**].
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

C. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Insulated Spandrel Panels:

1. Comply with Section 074213.19 "Insulated Metal Wall Panels."
2. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.

a. Overall Panel Thickness: [**As indicated**][**1 inch (25.4 mm)**].
b. Exterior Skin: Aluminum.

1) Thickness: [**Manufacturer's standard for finish and texture indicated**].
2) Finish: [**Match framing system**].
3) Texture: [**Smooth**][**Embossed**].
4) Backing Sheet: [**1/8-inch- (3.2-mm-) thick, tempered hardboard**][**0.157-inch- (4-mm-) thick, cement board**][**0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene**].

c. Interior Skin: [**Aluminum**][**Manufacturer's standard galvanized-steel sheet**].

1) Thickness: [**Manufacturer's standard for finish and texture indicated**].
2) Finish: [**Matching curtain-wall framing**][**Low-gloss, white baked enamel**][**Mill finish**].
3) Texture: [**Smooth**][**Embossed**].
4) Backing Sheet: [**1/8-inch- (3.2-mm-) thick, tempered hardboard**][**0.157-inch- (4-mm-) thick, cement board**][**1/2-inch- (12.7-mm-) thick, gypsum board with proprietary fire-resistance-rated core**][**0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene**].

d. Thermal Insulation Core: Manufacturer's standard [**rigid, closed-cell, polyisocyanurate board**][**extruded-polystyrene board**][**expanded-perlite, mineral-insulation board**].
e. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: [**25**] or less.
2) Smoke-Developed Index: [**50**][**450**] or less.

F. Venting Windows:

1. As specified in Section 085113 "Aluminum Windows."
2. Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:

a. Window Type: [**Awning**][**Casement**][**As indicated on Drawings**].
b. Minimum Performance Class: [**CW**][**AW**].
c. Minimum Performance Grade: [**30**][**40**][**60**][**70**][**80**][**90**][**As indicated on Drawings**].

d. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

1) Cam handle locking system.
2) Multi-point locking system.
3) Pole-operated, cam handle locking system, where rail is more than **72 inches (1830 mm)** above floor.
4) Rotary operator.
5) Steel or bronze operating arms.
6) Limit Devices: [**Concealed friction adjustor and adjustable stay bar**] limit devices designed to restrict sash opening.

a) Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

e. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
f. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:

1) Aluminum Wire Fabric: 18-by-18, **0.0445-inch-by-0.0445-inch (1.1-by-1.1-mm)**; 18-by-16, **0.0445-inch-by-0.0515-inch (1.1-by-1.3-mm)**; or 18-by-14, **0.0445-inch-by-0.0624-inch (1.1-by-1.5-mm)** mesh of **0.013-inch- (0.3-mm-)** diameter, coated aluminum wire.
2) Glass-Fiber Mesh Fabric: 18-by-16, **0.0445-inch-by-0.0515-inch (1.1-by-1.3-mm)** or 18-by-14, **0.0445-inch-by-0.0624-inch (1.1-by-1.5-mm)** mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.

g. Glazing: [**As specified in Section 088000 "Glazing"**][**Same as adjacent glazed aluminum curtain-wall glazing**].
h. Finish: [**Match adjacent glazed aluminum curtain-wall finish**].

G. Entrance Door Systems: Comply with [**Section 084113 "Aluminum-Framed Entrances and Storefronts"**][**Section 084213 "Aluminum-Framed Entrances"**].

2.4 SUN CONTROL

A. Sunshades: Assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.

1. Orientation: [**Horizontal**][**Vertical**].
2. Projection from Wall: [**As indicated on Drawings**][**20 inches (508 mm)**][**25 inches (635 mm)**][**30 inches (762 mm)**][**35 inches (889 mm)**].
3. Outriggers: [**Straight with square edges**][**Straight with rounded edge**][**Curved**][**Wedge**].
4. Louvers:

a. Number: [**Three**][**Four**][**Five**] louvers per unit.
b. Shape: [**Planar**][**Arched**][**Circular**][**Airfoil**][**Square**].
c. Width: [**6 inches (152 mm)**][**8 inches (203 mm)**][**10 inches (254 mm)**].
d. Mounting Angle: [**25**][**30**][**35**] degrees.

5. Fasciae: [**Rectangular**][**Bullnose**][**Angular**][**Circular**].

6. Finish: [**Match adjacent glazed aluminum curtain wall**].
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

B. Light Shelves: Light-reflecting assemblies consisting of manufacturer's standard support brackets or channels, and aluminum tray, designed for attachment to interior of curtain wall with mechanical fasteners.

1. Projection from Wall: [**As indicated on Drawings**][**20 inches (508 mm)**][**25 inches (635 mm)**][**30 inches (762 mm)**][**35 inches (889 mm)**].
2. Finish: [**Match adjacent glazed aluminum curtain wall**].
3. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
4. Steel Reinforcement: As required by manufacturer.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. [**Manufacturer's standard**][**Compression-type, replaceable EPDM**][**Extruded silicone**][**Comply with Section 088000 "Glazing."**].

1. Color: [**Black**].

C. Glazing Sealants: [**As recommended by manufacturer.**][**Comply with Section 088000 "Glazing."**]

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

D. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.

1. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.

1. Color: Match structural sealant.

2.6 MATERIALS

A. Sheet and Plate: **ASTM B209 (ASTM B209M)**.

B. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

G. Regional Materials: Verify products are manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

H. Regional Materials: Verify products are manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads[finished to match framing system][fabricated from 300 series stainless steel].

B. Anchors: Three-way adjustable anchors with minimum adjustment of [**1 inch (25.4 mm)**] that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: [**Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**][**Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A240/A240M of type recommended by manufacturer**].

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from [**exterior**][**interior**][**interior for vision glass and exterior for spandrel glazing or metal panels**].
6. Provisions for safety railings mounted [**on interior face of mullions**][**between mullions at interior**].
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
8. Components curved to indicated radii.

D. Fabricate components to resist water penetration as follows:

1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using [**manufacturer's standard assembly method**][**shear-block system**][**screw-spline system**][**head-and-sill-receptor system with shear blocks at intermediate horizontal members**].

F. Factory-Assembled Frame Units:

1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact with structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
3. Seal joints watertight unless otherwise indicated.
4. Install glazing to comply with requirements in Section 088000 "Glazing."
5. Install structural glazing.

    a. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
    b. Set glazing with proper orientation so that coatings face exterior or interior as specified.
    c. Apply structural silicone sealant to completely fill cavity, in accordance with sealant manufacturers written instructions with the framing and glazing in a fully supported position.
    d. Brace or stiffen framing and glazing in such a manner to prevent undue stresses on the glass edge seal and structural joints or movement of the glazing, until sealant is fully cured in accordance with manufacturer's recommendations.
    e. After structural sealant has completely cured, insert backer rod between lites of glass as recommended by sealant manufacturer.
    f. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.
    g. Clean and protect glass as indicated in Section 088000 "Glazing."
    h. Retain bracing or stiffening until erected to prevent racking of units during transportation and erection.

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop

Drawings.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.10 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

3.4 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.5 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure in accordance with manufacturer's recommendations.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.6 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.7 ERECTION TOLERANCES

A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: **1/8 inch in 10 feet (3.2 mm in 3 m)**; **1/4 inch in 40 feet (6.35 mm in 12.2 m)**.
2. Level: **1/8 inch in 20 feet (3.2 mm in 6 m)**; **1/4 inch in 40 feet (6.35 mm in 12.2 m)**.
3. Alignment:

   a. Where surfaces abut in line or are separated by reveal or protruding element up to **1/2 inch (12.7 mm)** wide, limit offset from true alignment to **1/16 inch (1.6 mm)**.
   b. Where surfaces are separated by reveal or protruding element from **1/2 to 1 inch (12.7 to**

25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).

c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on [**one bay at least 30 feet (9.1 m), by one story**][**representative areas of glazed aluminum curtain walls**][**mockups**].

C. Field Quality-Control Testing: Perform the following test on [**representative areas of glazed aluminum curtain walls**][**mockups**].

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration, as directed by the Owner.

a. Perform a minimum of [**two**][**three**] tests in areas as directed by the Owner.
b. Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**].

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

a. Perform a minimum of [**two**][**three**] tests in areas as directed by the Owner.
b. Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**].

3. Water Penetration: ASTM E1105 at a minimum [**uniform**][**and**][**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.

D. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of [**two**][**four**][**six**] areas on each building facade.
2. Repair installation areas damaged by testing.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 08 44 13 00

SECTION 08 44 13 00A - SLOPED GLAZING ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sloped glazing assemblies.

B. Related Requirements:

1. Section 014339 "Mockups" for preconstruction laboratory mockup testing.
2. Section 084413 "Glazed Aluminum Curtain Walls" for vertical curtain walls.
3. Section 088000 "Glazing" for glass requirements.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

C. Shop Drawings: For sloped glazing assemblies. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

2. Include full-size isometric details of each type of vertical-to-horizontal intersection of sloped glazing assemblies, showing the following:

   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from **12-inch (300-mm)** lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

G. Delegated-Design Submittal: For sloped glazing assemblies, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Mockup Testing Submittals:

1. Testing Program: Developed specifically for Project.
2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Record Drawings: As-built drawings of preconstruction laboratory mockups, showing changes made during preconstruction laboratory mockup testing.

B. Qualification Data:

1. For Installer[**and laboratory mockup testing agency**][**and field testing agency**].
2. For professional engineer's experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

C. Energy Performance Certificates: For sloped glazing assemblies, accessories, and components from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each sloped glazing assembly.

D. Product Test Reports: For sloped glazing assemblies, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in

accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sloped glazing assemblies to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For sloped glazing assemblies with structural glazing, to include in maintenance manuals. Include ASTM C1401 recommendations for postinstallation-phase quality-control program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors[**and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

B. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**] and acceptable to the Owner and Architect, as directed by the Owner.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review, as directed by the Owner.

E. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed sloped glazing assemblies.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups.

1. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
2. Size and Configuration: As indicated on Drawings.

3. Notify Architect [**seven**] days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested, as directed by the Owner.

B. Preconstruction Laboratory Mockup Testing: Test preconstruction laboratory mockups in accordance with requirements in Part 2 "Performance Requirements" Article. Perform the following tests in the following order:

1. Structural, 50 percent: ASTM E330/E330M at 50 percent of positive test load.
2. Air Leakage: ASTM E283.
3. Water Penetration under Static Pressure: ASTM E331.
4. Water Penetration under Dynamic Pressure: AAMA 501.1.
5. Interstory Drift, 100 percent: AAMA 501.4 at 100 percent of design displacement. Repeat the following:

   a. Air Leakage: ASTM E283.
   b. Water Penetration under Static Pressure: ASTM E331.

6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:

   a. Air Leakage: ASTM E283.
   b. Water Penetration under Static Pressure: ASTM E331.

7. Thermal Cycling: AAMA 501.5. Repeat the following:

   a. Air Leakage: ASTM E283.
   b. Water Penetration under Static Pressure: ASTM E331.

8. Structural, 100 percent: ASTM E330/E330M at 100 percent of positive and negative test loads. Repeat the following:

   a. Air Leakage: ASTM E283.
   b. Water Penetration under Static Pressure: ASTM E331.
   c. Water Penetration under Dynamic Pressure: AAMA 501.1.

9. Structural, 150 percent: ASTM E330/E330M at 150 percent of positive and negative test loads.
10. Interstory Drift, 150 percent: AAMA 501.4 at 150 percent of design displacement.

C. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

1. Compatibility: Test materials or components using ASTM C1087.
2. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.
3. Submit no fewer than [**eight**] pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
6. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.8 WARRANTY

A. Special Assembly Warranty: [**Manufacturer**][**Installer**] agrees to repair or replace components of sloped glazing assemblies that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals[metal finishes,] and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sloped glazing assemblies.

B. General Performance: Comply with performance requirements specified, as determined by testing of sloped glazing assemblies representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Sloped glazing assemblies shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly

distributed and concentrated live loads.
2. Failure also includes the following:

   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: [**As indicated on Drawings**].

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to [**1/175 of length of span of the framing member for lengths of up to 13 feet 6 inches (4.1 m) and to 1/240 of length of span of the framing member plus 1/4 inch (6.35 mm) for lengths of greater than 13 feet 6 inches (4.1 m)**].
2. Deflection Parallel to Glazing Plane: Limited to [**amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm)**].
3. Cantilever Deflection: Limited to 2/175 of the unsupported length.

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at [**150**] percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] percent of span.
3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].
2. Maximum Water Leakage: [**In accordance with AAMA 501.1**][**No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation**]. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: [**As indicated on Drawings**].
2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement[**and 1.5 times the design**

displacement].

I. Seismic Performance: Sloped glazing assemblies shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement[**and 1.5 times the design displacement**].
2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.7 at design displacement[**and 1.5 times the design displacement**].

J. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than [**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.38 Btu/sq. ft. x h x deg F (2.16 W/sq. m x K)**][**0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K)**][**0.46 Btu/sq. ft. x h x deg F (2.61 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**] as determined in accordance with NFRC 100.

2. Solar Heat Gain Coefficient (SHGC):

a. Fixed Glazing and Framing Areas: SHGC for the system of not more than [**0.25**][**0.30**][**0.40**][**0.45**] as determined in accordance with NFRC 200.

3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft. (0.30 L/s per sq. m)**] at a static-air-pressure differential of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**] when tested in accordance with ASTM E283.

4. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than [**29**][**55**][**65**][**80**] as determined in accordance with AAMA 1503.

K. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:

1. Outdoor-Indoor Transmission Class (OITC): Minimum [**26**][**30**][**34**].
2. Sound Transmission Class (STC): Minimum [**31**][**34**][**37**][**40**].

L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [**180 deg F (82 deg C)**].
b. Low Exterior Ambient-Air Temperature: [**0 deg F (minus 18 deg C)**].

M. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

N. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by sloped glazing assemblies without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 SOURCE LIMITATIONS

A. Obtain all components of sloped glazing assemblies[**and glazed aluminum curtain walls**], including framing and accessories, from single manufacturer.

2.3 SLOPED GLAZING ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**EFCO Corporation**]
2. [**Gammans Skylight Systems**]
3. [**Kawneer Company, Inc.; Arconic Corporation**]
4. [**Linel; Mestek, Inc.**]
5. [**U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
6. [**Waltek Company, Ltd.**]
7. [**Wausau Window and Wall Systems; Apogee Wausau Group, Inc.**]
8. [**YKK AP America Inc.**]

B. Framing Members: Manufacturer's standard, formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: [**Thermally broken**][**Thermally improved**][**Nonthermal**].
2. Framing-Member Type: [**Self-supporting**][**Skin type, supported by structural-steel members indicated**].
3. Glazing System: [**Field-installed pressure caps on four sides**][**Field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters**].
4. Finish: [**Clear anodic finish**][**Color anodic finish**][**Baked-enamel or powder-coat finish**][**High-performance organic finish**][**Superior-performance organic finish**].
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

C. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 GLAZING

A. Comply with Section 088000 "Glazing."

B. Glazing Gaskets:

1. ASTM C509 or ASTM C864. [**Manufacturer's standard**][**Compression-type, replaceable EPDM**][**Extruded silicone**].

a. Color: [**Black**].

2. Comply with Section 088000 "Glazing."

C. Glazing Sealants:

1. As recommended by manufacturer.
2. Comply with Section 088000 "Glazing."
3. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

a. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
c. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

D. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in sloped glazing assembly indicated.

1. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and sloped glazing assembly manufacturers for this use.

1. Color: Match structural sealant.

2.5 MATERIALS

A. Sheet and Plate: **ASTM B209 (ASTM B209M)**.

B. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

G. Regional Materials: Verify products are manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

H. Regional Materials: Verify products are manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.6 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads[finished to match framing system][fabricated from 300 series stainless steel].

B. Anchors: Three-way adjustable anchors with minimum adjustment of [**1 inch (25.4 mm)**] that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: [**Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**][**Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A240/A240M of type recommended by manufacturer**].

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.

2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from [**exterior**][**interior**].
6. Provisions for safety railings mounted [**on interior face of mullions**][**between mullions at interior**].
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
8. Components curved to indicated radii.

D. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

E. Fabricate components with internal guttering system or other means to drain water-passing joints, condensation occurring within framing members, and moisture migrating within sloped glazing assemblies to exterior.

F. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Champagne**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

I. Install components to drain water-passing joints, condensation occurring within framing members, and moisture migrating within sloped glazing assemblies to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer and framing manufacturers written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure in accordance with manufacturer's recommendations.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.6 ERECTION TOLERANCES

A. Install sloped glazing assemblies to comply with the following maximum tolerances:

1. Plumb: **1/8 inch in 10 feet (3.2 mm in 3 m)**; **1/4 inch in 40 feet (6.35 mm in 12.2 m)**.
2. Level: **1/8 inch in 20 feet (3.2 mm in 6 m)**; **1/4 inch in 40 feet (6.35 mm in 12.2 m)**.
3. Alignment:

   a. Where surfaces abut in line or are separated by reveal or protruding element up to **1/2 inch (12.7 mm)** wide, limit offset from true alignment to **1/16 inch (1.6 mm)**.
   b. Where surfaces are separated by reveal or protruding element from **1/2 to 1 inch (12.7 to 25.4 mm)** wide, limit offset from true alignment to **1/8 inch (3.2 mm)**.
   c. Where surfaces are separated by reveal or protruding element of **1 inch (25.4 mm)** wide or more, limit offset from true alignment to **1/4 inch (6 mm)**.

4. Location: Limit variation from plane to **1/8 inch in 12 feet (3.2 mm in 3.6 m)**; **1/2 inch (12.7 mm)** over total length.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on [**one bay at least 30 feet (9.1 m), by one story**][**representative areas of sloped glazing assemblies**][**mockups**].

C. Field Quality-Control Testing: Perform the following test on [**representative areas of sloped glazing assemblies**][**mockups**].

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration, as directed by the Owner.

   a. Perform a minimum of [**two**][**three**] tests in areas as directed by the Owner.
   b. Perform tests in each test area, as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**].

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in Part 2 "Performance Requirements" Article but not more than **0.09 cfm/sq. ft. (0.45 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.

   a. Perform a minimum of [**two**][**three**] tests in areas, as directed by the Owner.
   b. Perform tests in each test area, as directed by the Owner. Perform at least three tests, prior to [**10, 35, and 70 percent completion**].

3. Water Penetration: ASTM E1105 at a minimum [**uniform**][**and**][**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in Part 2 "Performance Requirements" Article, but not less than **6.24 lbf/sq. ft. (300 Pa)**, and shall not evidence water penetration.

D. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of [**two**][**four**][**six**] areas on each building facade.
2. Repair installation areas damaged by testing.

E. Sloped glazing assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 08 44 13 00A

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SECTION 08 45 23 00 - FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes aluminum-framed assemblies incorporating fiberglass-sandwich panels as follows:

1. Wall assemblies.
2. Roof assemblies.
3. Skylight assemblies.
4. Canopy assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum components of panel assemblies.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel assemblies.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

D. Samples: In manufacturer's standard size.

1. For each type of fiberglass-sandwich panel.
2. For each type of exposed finish for framing members.

E. Fabrication Samples: Of each framing system intersection and adjacent panels, made from **12-inch (305-mm)** lengths of full-size framing members and showing details of the following:

1. Joinery.
2. Anchorage.
3. Expansion provisions.
4. Fiberglass-sandwich panels.
5. Flashing and drainage.

F. Delegated Design Submittals: For panel assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**Installer**][**manufacturer**][**testing agency**].

B. Product Test Reports: For each fiberglass-sandwich-panel assembly, for tests performed by a qualified testing agency.

C. Evaluation Reports: For fiberglass-sandwich-panel assemblies from ICC-ES.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For panel assemblies to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: For fiberglass-sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICC-ES AC04 or ICC-ES AC177.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical panel assemblies as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Deterioration of metals[**metal finishes,**] and other materials beyond normal weathering.
c. Water leakage.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace fiberglass-sandwich panels that exhibit defects in materials or workmanship within specified warranty period.

1. Defects include, but are not limited to, the following:

a. Fiberbloom.
b. Delamination of coating, if any, from exterior face sheet.
c. Color change exceeding requirements.
d. Delamination of panel face sheets from panel cores.

2. Warranty Period: [**10**] years from date of Substantial Completion.

C. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fiberglass-sandwich-panel assemblies.

B. Structural Loads: [**As indicated on Drawings**].

C. Deflection Limits:

1. Vertical Panel Assemblies: Limited to [**1/60**][**1/90**][**1/120**] of clear span for each assembly component.
2. Overhead Panel Assemblies: Limited to [**1/60**][**1/90**][**1/120**][**1/180**] of clear span for each assembly component.

D. Structural-Test Performance: Provide panel assemblies tested in accordance with ASTM E330, as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not show evidence of deflection exceeding specified limits.
2. When tested at [**150**] percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not show evidence of material failures, structural distress, and permanent deformation of main framing members exceeding [**0.2**] percent of span.
3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

F. Water Penetration under Static Pressure: Provide panel assemblies that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**][**10 lbf/sq. ft. (480 Pa)**][**15 lbf/sq. ft. (720 Pa)**].

G. Water Penetration under Dynamic Pressure: Provide panel assemblies that do not evidence water leakage through fixed glazing and framing areas when tested in accordance with AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**].

1. Maximum Water Leakage: [**According to AAMA 501.1**][**No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation**]. Water leakage does not include water that is controlled by flashing and gutters and drained to the exterior, or water that cannot damage adjacent materials or finishes.

H. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**], material surfaces.

I. Energy Performance: Provide panel assemblies with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below[**and certified and labeled according to NFRC**]:

1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas to have U-factor of not more than [**0.80 Btu/sq. ft. x h x deg F (4.54 W/sq. m x K)**][**0.65 Btu/sq. ft. x h x deg F (3.69 W/sq. m x K)**] as determined in accordance with NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas to have a SHGC of no greater than [**0.6**][**0.7**] as determined in accordance with NFRC 200.
3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of [**0.30 cfm/sq. ft. (1.50 L/s per sq. m)**] of fixed wall area as determined in accordance with ASTM E283 at a minimum static-air-pressure differential of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

2.2 FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

A. Fiberglass-Sandwich-Panel Assemblies: Translucent assemblies that are supported by aluminum framing and glazed with fiberglass-sandwich panels.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kalwall Corporation**]
b. [**Kingspan Light + Air LLC**]
c. [**Major Industries, Inc.**]

2.3 FIBERGLASS-SANDWICH PANELS

A. Fiberglass-Sandwich Panels: Uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer

face sheets bonded to both sides of a grid core.

1. Core Insulation: Fill panel cores with aerogel.

B. Panel Thickness: [**2-3/4 inches (70 mm)**][**1-1/2 to 1-9/16 inches (38 to 40 mm)**].

C. Grid Core: Mechanically interlocked, extruded-aluminum I-beams, with a minimum flange width of **7/16 inch (11.1 mm)**.

1. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, in alloy and temper recommended in writing by manufacturer.
2. I-Beam Construction: [**One piece, extruded aluminum**][**Thermally broken, extruded aluminum**].
3. Grid Pattern: [**Inline rectangle, nominal 12 by 24 inches (305 by 610 mm)**][**Staggered rectangle, nominal 12 by 24 inches (305 by 610 mm)**][**Square, nominal 12 inches (305 mm)**][**As indicated on Drawings**].

D. Exterior Face Sheet:

1. Thickness: [**0.070 inch (1.78 mm)**][**0.060 inch (1.52 mm)**][**0.052 inch (1.32 mm)**].
2. Color: [**White**][**Crystal**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Protective Weathering Surface: [**Manufacturer's standard**][**Integral, embedded-glass erosion barrier**][**Surface-applied, polyvinyl-fluoride film not less than 1.0 mil (0.03 mm) thick**].

E. Interior Face Sheet:

1. Thickness: [**0.045 inch (1.14 mm)**][**0.060 inch (1.52 mm)**].
2. Color: [**White**][**Crystal**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Fiberglass-Sandwich-Panel Adhesive: Manufacturer's standard for permanent adhesion of facings to cores.

G. Panel Strength:

1. Maximum Panel Deflection: **3-1/2 inches (89 mm)** when a **4-by-12-foot (1.2-by-3.6-m)** panel is tested in accordance with ASTM E72 at **34 lbf/sq. ft. (1.6 kPa)**, with a maximum **0.090-inch (2.3-mm)** set deflection after five minutes.
2. Panel Support Strength: Capable of supporting, without failure, a **300-lbf (1334-N)** concentrated load when applied to a **3-inch- (76-mm-)** diameter disk in accordance with ASTM E661.

H. Panel Performance:

1. Self-Ignition Temperature: **650 deg F (343 deg C)** or more in accordance with ASTM D1929.
2. Smoke-Developed Index: 450 or less in accordance with ASTM E84, or 75 or less in accordance with ASTM D2843.
3. Combustibility Classification: [**Class CC1**][**Class CC2**] based on testing in accordance with ASTM D635.
4. Roof-Covering Classification: [**Class B**][**Class B, Burning Brand Test**][**Class C**] in accordance with ASTM E108 or UL 790.
5. Interior Finish Classification: [**Class A**][**Class B**][**Class C**] based on testing in accordance with ASTM E84.
6. Color Change: Not more than 3.0 units Delta E, when measured in accordance with ASTM D2244, after outdoor weathering compliant with procedures in ASTM D1435.

a. Outdoor Weathering Conditions: Sixty months in southern Florida.

7. Impact Resistance: No fracture or tear at impact of [**60 ft. x lbf (81 J)**][**70 ft. x lbf (95 J)**][**230 ft. x lbf (312 J)**] by a **3-1/4-inch- (83-mm-)** diameter, **5-lb (2.3-kg)** freefalling ball in accordance with UL 972 test procedure.
8. Haze Factor: Greater than 90 percent when tested in accordance with ASTM D1003.

2.4 ALUMINUM FRAMING SYSTEMS

A. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.

1. Construction: [**One piece, extruded aluminum**][**Thermally broken, extruded aluminum**].

B. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.

1. Sheet and Plate: **ASTM B209 (ASTM B209M)**.
2. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.
3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
4. Structural Profiles: ASTM B308/B308M.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

D. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.

1. At closures, retaining caps, or battens, use ASTM A193/A193M, 300 series stainless steel screws.
2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M orASTM A153/A153Mrequirements.

F. Anchor Bolts: ASTM A307, Grade A, galvanized steel.

G. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

H. Exposed Flashing and Closures: Aluminum sheet not less than [**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] thick, finished to match framing.

I. Framing Gaskets: [**Manufacturer's standard**].

J. Frame-System Sealants: As [**recommended in writing by manufacturer.**][**specified in Section 079200 "Joint Sealants."**]

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of

Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

K. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION

A. Frame System Fabrication:

1. Fabricate components that, when assembled, have the following characteristics:

   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Internal guttering systems or other means to drain water passing through joints, and moisture migrating within assembly to exterior.

2. Fabricate sill closures with weep holes and for installation as continuous component.
3. Reinforce components as required to receive fastener threads.

B. Panel Fabrication: Factory assemble and seal panels.

1. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.

   a. White spots indicating lack of bond at intersections of grid-core members are limited in number to four for every **40 sq. ft. (3.7 sq. m)** of panel and limited in diameter to **3/64 inch (1.2 mm)**.

2. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
3. Fabricate panel to allow condensation within panel to escape.
4. Reinforce panel corners.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic Finish: [**Two**][**Three**]-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent [**PVDF**][**FEVE**] resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performing Organic Finish: [**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent [**PVDF**][**FEVE**] resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
3. Rigidly secure nonmovement joints.
4. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.
5. Seal joints watertight unless otherwise indicated.

B. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic

action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install components plumb and true in alignment with established lines and elevations.

D. Skylight Assemblies: Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed corners. Locate weep holes at rafters. Install components to drain water passing through joints and moisture migrating within assembly to exterior.

E. Erection Tolerances: Install panel assemblies to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to **1/32 inch (0.8 mm)** where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than **3 inches (76 mm)**; otherwise, limit offset to **1/8 inch (3.2 mm)**.
2. Location and Plane: Limit variation from true location and plane to **1/8 inch in 12 feet (3.2 mm in 3.7 m)**, but no greater than **1/2 inch (13 mm)** over total length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Water-Spray Test: Before installation of interior finishes has begun, panel assemblies to be tested in accordance with AAMA 501.2 and to not show evidence of water penetration.
2. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas to be tested in accordance with ASTM E1105.

a. Test Procedures: Test under [**uniform**][**and**][**cyclic**] static-air pressure.
b. Water Penetration: None.

B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

END OF SECTION 08 45 23 00

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Task	Specification	Specification Description
08 45 23 00	08 62 00 00	Unit Skylights
08 45 23 00	08 63 00 00	Metal-Framed Skylights

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SECTION 08 51 13 00 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum windows.

1.2 DEFINITIONS

A. Combination Assemblies: An assembly formed by a combination of two or more separate fenestration products whose frames are mulled together utilizing a combination mullion or reinforcing mullion.

B. Combination Mullions: A horizontal or vertical member formed by joining two or more individual fenestration units together without a mullion stiffener.

C. Reinforcing Mullions: A horizontal or vertical member with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.3 COORDINATION

A. Finish Matching: Coordinate all exposed exterior aluminum components and trim to ensure uniform and consistent color and appearance. Use products specified in [**this Section**] as a benchmark. Architect's decision will be final as to whether a proposed product matches, as directed by the Owner.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review and discuss finishing of aluminum windows that is required to be coordinated with finishing of other aluminum work for color and finish matching.
3. Review, discuss, and coordinate interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
4. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.
5. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:

1. Exposed Aluminum Finishes: [**Manufacturers' standard size**][**2 by 4 inches (50 by 100 mm)**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

F. Delegated Design Submittals: For reinforcing mullions, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Environmental Product Declaration: For each product.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Third-Party Certifications: For each product.
7. Third-Party Certified Life Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each aluminum window, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For aluminum windows.

C. Qualification Statements: For manufacturer and Installer.

D. Delegated Design Engineer Qualifications: For reinforcing mullions.

E. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: Authorized representative who is trained and approved by aluminum window manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Testing Agency Qualifications: An FGIA-accredited testing agency for testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver aluminum windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect aluminum windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle aluminum windows in a manner that prevents damage before, during, and after installation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install aluminum windows outside of limits recommended in writing by manufacturer.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excessive deflection, water leakage, condensation, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: [**Two**][**Five**][**10**] years from date of Substantial Completion.
b. Glazing Units: [**Five**][**10**] years from date of Substantial Completion.
c. Hardware: [**Three**] years from date of Substantial Completion.
d. Aluminum Finish: [**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain aluminum windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design reinforcing mullions.

B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: FGIA certified with label attached to each window.

C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**R**][**LC**][**CW**][**AW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**15**][**20**][**25**][**30**][**35**][**40**][**45**][**50**][**As indicated on Drawings**].
3. Mulled Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.

D. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

a. Fixed Windows: Not more than [**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.26 Btu/sq. ft. x h x deg F (1.48 W/sq. m x K)**].

b. Operable Windows: Not more than [**0.62 Btu/sq. ft. x h x deg F (3.52 W/sq. m x K)**][**0.60 Btu/sq. t. x h x deg F (3.41 W/sq. m x K)**][**0.54 Btu/sq. ft. x h x deg F (3.07 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**].

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:

a. Fixed Windows: Not more than [**0.23**][**0.25**][**0.36**][**0.38**][**0.40**].
b. Operable Windows: Not more than [**0.21**][**0.23**][**0.33**][**0.34**][**0.36**] as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

E. Thermal Movements: Provide aluminum windows, including anchorage, which allow for thermal

movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C) ambient; 180 deg F (100 deg C) material surfaces**].

F. Outdoor-Indoor Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

G. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located more than [**30 ft. (9.1 m)**] above grade.

H. Sustainable Design Features:

1. Adhesives: Use adhesives that comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Adhesives: Do not use adhesives that contain urea formaldehyde.
3. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

2.3 ALUMINUM WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All Seasons Architectural Windows Mfg., Inc.; All Seasons Commercial Division, Inc.**]
2. [**All Weather Architectural Aluminum**]
3. [**AluminTechno, LLC**]
4. [**Arcadia Inc.**]
5. [**Boyd Aluminum Mfg. Co.**]
6. [**Custom Window Systems, Inc.**]
7. [**DeSCo Architectural, Inc.**]
8. [**EFCO Corporation**]
9. [**Gerkin Windows & Doors**]
10. [**Graham Architectural Products Corporation**]
11. [**Kawneer Company, Inc.; Arconic Corporation**]
12. [**Kolbe Windows & Doors**]
13. [**Manko Window Systems, Inc.**]
14. [**Mannix**]
15. [**OldCastle BuildingEnvelope (OBE)**]
16. [**Peerless Products Inc**]
17. [**Quaker Windows and Doors**]
18. [**Thermal Windows, Inc.**]
19. [**Wausau Window and Wall Systems; Apogee Wausau Group, Inc.**]
20. [**Winco Window Company, Inc.**]
21. [**YKK AP America Inc.**]

B. Provide manufacturer's standard aluminum window assemblies consisting of frames, sashes, glass,

hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: [**Outswing**][**Inswing**].
2. Projected, awning.
3. Projected, hopper.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

D. Frames and Sashes: Aluminum extrusions of alloy, temper, and strength complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Broken Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

E. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered [**where indicated on Drawings**].

F. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172, with two plies of float glass.

1. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
2. Inner Ply: Clear.
3. Interlayer: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].
4. Outer Ply: [**Clear**][**Gray**][**Bronze**][**Green**].
5. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

G. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

   a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
   b. Kind: Fully tempered [**where indicated on Drawings**].

2. Lites: [**Two**][**Three**].
3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].
5. Integral Louver Blinds: Provide glass manufacturer's standard, horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between glass lites, and operated by hardware located on inside face of sash.

   a. Operation: [**Tilt only**][**Tilt, raising, and lowering**].
   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190, with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.

1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

    a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
    b. Kind: [**Heat strengthened**][**Fully tempered**].

2. Interior Lite: ASTM C1172, clear laminated glass with two plies of float glass.

    a. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
    b. Interlayer Thickness: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].

3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

I. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

1. Dual Glazing System:

    a. Interior Lite: [**Glass**].
    b. Exterior Lite: [**Glass**][**Insulating-glass unit**].

J. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Window Hardware: [**Casement**][**and**][**projected**].

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

    a. Type and Style: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

2. Hinges: [**Non-friction type, not less than two per sash**].
3. Lock: [**Lift-type throw, cam-action lock with keeper**][**Lever handle and cam-action lock with keeper**][**Dual lever handles, tie rod, and cam-action lock with keepers**][**Key-operated custodial lock with keeper and removable handle**][**Concealed multipoint lock operated by single lever handle or lift-type throw**].
4. Limit Devices: [**Concealed friction adjustor, adjustable stay bar**][**Concealed support arms with adjustable, limited, hold-open**] limit devices designed to restrict sash opening.

    a. Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

5. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

L. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide key-operated custodial locks.**]
3. Tilt Latch: Releasing latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

M. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**][**Manufacturer's standard**] of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide key-operated custodial locks.**]
3. Roller Assemblies: Low-friction design.

N. Weather Stripping: Provide manufacturer's standard full-perimeter weather stripping for each operable sash unless otherwise indicated.

O. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

P. Mullions: Provide manufacturer's standard combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.4 ACCESSORIES

A. Dividers (False Muntins): Provide manufacturer's standard extruded-aluminum divider grilles in designs indicated for each sash lite.

1. Type: [**Permanently located at exterior lite**][**Permanently located between insulating-glass lites**].
2. Pattern: [**As indicated on Drawings**].
3. Profile: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Subsills: [**Thermally broken**][**Nonthermal**], extruded-aluminum subsills in configurations indicated on Drawings.

C. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

D. Panning Trim: Profiles in sizes and configurations indicated on Drawings.

E. Nail Fins: Manufacturer's standard mounting flanges with holes pre-punched for mechanical fasteners.

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: [**Full, inside for outswing**][**Full, inside for projected, awning**][**Full, outside for inswing**][**Full, outside for projected, hopper**][**Full, outside for double-hung**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.

B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.

C. Glass-Fiber Mesh Fabric: [**18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm)**][**20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm)**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: [**Manufacturer's standard**].

D. Aluminum Wire Fabric: **18-by-16 (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

2.6 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Window Assemblies: [**Bow**][**Bay**][**Combination**]. Provide window units in configuration indicated on Drawings. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Exterior head and sill casings and trim.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: [**AAMA 2603**][**AAMA 2604**] except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Organic Coatings:

1. High-Performance Fluoropolymer Finish: Two coats complying with [**AAMA 2604,**][**AAMA 2605,**] containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Superior-Performance Fluoropolymer Finish: [**Three**][**Four**] coats complying with AAMA 2605, containing not less than [**50**][**70**] percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, [**vapor retarders,**]air and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

D. Install windows and components to drain water passing joints and condensation to the exterior.

E. Separate aluminum from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspection of installed windows as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance in accordance with AAMA 502.
2. Air-Infiltration Testing:

a. Test Pressure: As required to determine compliance in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for performance class indicated.
b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**One**][**Three**] window(s) of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows will be tested [**immediately after installation**][**at 5, 50, and 90 percent completion**], as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Tests and Inspections:

1. Windows will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.5 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Avoid damaging finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 08 51 13 00

SECTION 08 51 13 00a - ALUMINUM REPLACEMENT WINDOWS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum replacement windows. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Window Types: ANSI/AAMA 101.
   a. Horizontal Slider (HS): Primary horizontally operating window.
   b. Single Hung (SH): Primary vertically operating window with only one operable sash.
   c. Double Hung (DH): Primary vertically operating window with two operable sashes.
   d. Thermally Improved: Primary window with thermal break between interior and exterior metal surfaces both at frame and sash or panel members.
      1) Single Window Construction: Provide insulating glass.
      2) Thermally improved aluminum windows may use members with thermal breaks or be of dual window construction (i.e.. primary-secondary (storm) or primary-primary).
   e. Dual Window Construction (DW):
      1) Primary-Secondary: Primary window with either interior or exterior secondary (storm) window.
      2) Primary-Primary: Combination of two primary windows employing common frame.
2. Type of Stainless Steel Screens (Frames and Screening): Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
3. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

System Description

4. Performance Requirements: Comply with following:
   a. Aluminum Replacement Windows: HUD UM 39a.
   b. Aluminum Replacement Windows: ANSI/AAMA 101 (Including test size requirements):
      1) Horizontal Sliding Windows: HS C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      2) Single Hung and Double Hung Windows: DH C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      3) Single Hung and Double Hung Windows: DH C45.
         a) Water Resistance: ASTM E 547, no leakage at 323.4 Pa (6.75 PSF) test pressure.
      4) Air Infiltration: ASTM E 283, Not exceed 0.049 cu m/s/mm (0.34 CFM/ft) of crack length of operable sash at 75 Pa (1.57 PSF) test pressure.
      5) Dual Window Construction: DW.
   c. Aluminum Replacement Windows: ASTM F 588, Annex AI, forced entry resistance performance level 10.
   d. Thermally Improved Windows: AAMA 1504:
      1) Thermal Transmittance (U-Value): Maximum U70, 3.97 W/sq. m C (0.70 BTU/HR.FT.F) if not otherwise scheduled.

2) Condensation Resistance Factor (CRF): Minimum CRF C50 if not otherwise scheduled.

e. Sealed Insulating Glass: Tested and certified in accordance with HUD UM 82 complying with ASTM E 774, Class C.

Submittals

5. Product Data:
6. Shop Drawings:
   a. Include window elevations, installation details, anchorage details, clearance between frame and rough opening, hardware, glazing, and accessories.
7. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of aluminum replacement window with specified finish for acceptance. Include sample of trickle ventilator.
8. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written third party certification that aluminum windows meet or exceed HUD UM 39a. HUD 82, and ANSI/AAMA 101 and other specified requirements.
   b. Manufacturer's installation instructions.
9. Closeout Submittals
   a. Operation and maintenance data.
   b. Special warranty.

Quality Assurance

10. Regulatory Requirements:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Egress Requirements: Comply with applicable codes and regulations.
    c. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    d. Accessibility:
       1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) and HUD implementing regulations (24 CFR Part 40).
          a) Uniform Federal Accessibility Standards (UFAS).
       2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
       3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
       4) Americans with Disabilities Act of 1990 (ADA) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
11. Certifications: Comply with HUD UM 39a, HUD UM 82, ANSI Z34.1 and HUD 24 CFR 200.935.
12. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of aluminum replacement window with specified finish for acceptance.
    a. Location
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

13. Packing. Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Aluminum Replacement Windows: Label in accordance with HUD UM 39a attached signifying compliance with ANSI/AAMA 101 performance requirements.
    b. Thermally Improved Windows: Label in accordance with HUD UM 39a attached signifying compliance with specified AAMA 1504 performance requirements.
14. Acceptance at Site: Inspect aluminum replacement windows upon delivery. Replace damaged or defective materials before installation.
15. Storage and Protection: Store aluminum replacement windows in manner to protect from weather and other damage.

Project Conditions

16. Field Measurements: Field measure openings for aluminum replacement windows before start of fabrication.

Scheduling And Sequencing

17. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

18. Special Warranty: Provide one year written covering materials and installation for aluminum replacement windows.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening and glazing not included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement window, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement window.

PRODUCTS

Aluminum Replacement Windows

19. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware, anchors and equipment.

Materials

20. Aluminum Materials:
    a. Extruded Aluminum: ASTM B 221, Alloy 6063-T5 or stronger.
    b. Aluminum Alloys: Commercial quality and of proper alloy for window construction, free from defects impairing strength and/or durability.
        1) Wrought Aluminum Alloys: Alloying Elements: ANSI/AAMA 101.
    c. Window Members, Including Muntins: Aluminum except as allowed by ANSI/AAMA 101.
        1) Sill Members: Minimum 2.0 mm (0.078 inch) thick.
    d. Interlocks and mating fins may vary by tapering at maximum projected distance of 8 mm (5/16 inch) from edge.
        1) Other appendages may taper providing design results in net area of at least that calculated by using prescribed wall thickness for appendage length.
    e. Edge or Corner: May be eased with radius not to exceed wall thickness permitted for member.
    f. Glazing Legs, Channels or Glazing Bead Retainers, Serrated or Not: Minimum 1.3 mm (0.050 inch) thick for distance of not more than 13 mm (1/2 inch) each leg.
21. Other Metal Materials:
    a. Carbon Steel (reinforcing members): ASTM A 36, zinc coated in accordance with ASTM B 633 or cadmium coated in accordance with ASTM B 766.
    b. Stainless Steel: ASTM A 167, Type 302.
    c. Welding Filler Rods: AWS A5.3.
22. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Glass: ASTM C 1036, Type 1, Class 1, Glazing B Quality.
    b. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.
    c. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.

2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.

d. Insulating Glass Units: HUD UM 82 and ASTM E 774, Class CBA.
e. Glass Thickness: Determined in accordance with ANSI/AAMA 101 Appendix, minimum 3 mm (1/8 inch) (DS).
1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
f. Glass: Labeled to show name of manufacturer and type.

23. Glazing Materials: Particularly suited for use with aluminum and not require painting.
a. Make adequate provisions for use of glazing compound, if applicable.
b. Remove material from glazing surfaces to which glazing compound will not readily adhere.
c. Windows: May be either factory or field glazed by either channel-type gaskets or back-bedding materials.
d. Glazing Clips: Not required when face stops are used.

24. Glazing Beads or Retainers: Material compatible with aluminum, and 6 required to retain glass, of sufficient strength and fixation to serve this purpose.
a. Thickness of Glazing Beads: Optional except as otherwise specified.

25. Screens: Provide windows with screens as indicated, specified, or scheduled in manufacturer's standard approved design, applicable to specific aluminum windows.
a. Screen Frames: Extruded aluminum frames of suitable alloy and of sufficient rigidity, crossbraces, as required, to lie flat against window and to prevent excessive bow in frame members and sag in screening.
1) Frame Corners: Firmly joined in secure and rigid manner.
2) Screen Spline: Aluminum or a material compatible with aluminum.
b. Screening: One of following as indicated, specified, or scheduled:
1) Vinyl Coated Fibrous Glass Yam: ASTM D 3656, Class 1, 18 by 16 mesh, 0.29 mm (0.0115 inch) diameter yam.
2) Polyvinylidene Chloride or Polypropylene Filament: FS L-S-12513, Type I or III, Class 1 or 2, 18 by 18 mesh, 0.31 mm (0.012 inch) or 0.38 mm (0.015 inch) diameter filament.
3) Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) diameter wire.
4) Stainless Steel: Type 304 stainless steel:
a) Medium: ANSI/SMA 6001 Medium Type, 12 x 12 mesh 0.58 mm (0.023 inch) diameter wire.
b) Heavy: ANSI/SMA 6001 Heavy Type, 12 x 12 mesh 0.71 mm (0.028 inch) diameter wire, high tensile strength.
c) Screen Frames: ANSI/SMA 6001 performance requirements, minimum 1.6 mm (0.062 inch) aluminum extruded 6063-T5 alloy designed to accept stainless steel wire cloth.
d) Emergency Egress Windows: Design screen to be opened from interior only (to allow for egress to exterior).
c. Screening: Fastened to frame in manner to permit replacement of screening.
d. Screens: Provide with fastening devices, suited particularly for application to specific window made of aluminum or materials compatible with aluminum and of sufficient strength to perform satisfactorily.
e. Assembled Screen with Insect Screening and Spline in Place: Outside dimension as measured from midpoint of opposite framing members shall not vary more than 4.8 mm (3/16 Inch) from outside dimension as measured at extreme ends of framing members.
f. Screens: Comply with applicable fire codes for egress and fireman access.
1) Provide single point release as and where required by applicable codes and regulations.

2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.

g. Window Screens: Include warning label indicating that screen will not stop child from falling out of window in accordance with SMA 7001.

Accessories

26. Hardware: Designed to perform functions for which it is intended and securely attached to window.
27. Thermal Break Material: Urethane, PVC, ISP, vinyl, or other material suitable for application that is compatible with aluminum.
28. Fasteners: Comply with ANSI/AAMA 101.
29. Panning and Receptor Systems: Extruded aluminum designed to fit existing openings, to receive windows, and to withstand wind forces as required by applicable codes and regulation.
    a. Exterior Trim System: Designed to withstand expansion/contraction forces of trim material.
    b. Interior Snap Trim: Provide manufacturer's standard interior trim package.
    c. Extruded Aluminum Minimum Thickness: 1.57 mm (0.062 inches).
30. Thermal Insulation: Unfaced fiberglass batt insulation in accordance with ASTM C 665, Type 1.
    a. Vapor Barrier: ASTM D 4397, 4 mil polyethylene sheeting with pressure sensitive adhesive sealing tape.
31. Joint Sealants:
    a. Exterior Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.
    b. Back-up Material: Standard preformed and precompressed foam material, round rod or semi-circular type, permanently elastic, mildew resistant, nonmigratory, nonstaining, and compatible with joint substrates and with sealant.
        1) Materials impregnated with oil, solvents, or bituminous materials not allowed.
        2) Provide type as recommended by sealant manufacturer for particular installation.
        3) Material: Neoprene, butyl, polyurethane, vinyl, or polyethylene rod.
    c. Interior Joint Sealant: ASTM C 834, latex acrylic.

Fabrication

32. Windows: Assembled in secure manner to perform as specified and to provide neat, weather tight construction.
    a. Make permanent watertight joints at junctions of sill and jamb members.
    b. Joint Sealant at Mechanically Fixed Joints: AAMA 800, Type 803.3.
    c. Welding or Brazing Flux: Completely removed immediately upon completion of welding or brazing operation.
33. Mullions and Structural Members: Mullion (whether joined by integral mullions, independent mullions, or by combination of frame members): Capable of withstanding load outlined under Uniform Load in ANSI/AAMA 101, Section 2 without deflecting more than 1/175th of its span.
34. Fin Trim or Installation Fins: Aluminum or other suitable material compatible with aluminum and of sufficient strength and thickness to assure satisfactory installation.
    a. Nailing grooves and/or break off score lines in extrusions are acceptable.
    b. Applied fins or fin trim may be assembled to windows by interlocking with frame members or with fasteners located not over 400 mm (16 inches) OC.
35. Thermally Improved Windows: Single window construction with thermal breaks and insulating glass units or dual window construction.
    a. Thermal Break in Two Frame or One Frame Windows: Not bridged by any screws, fasteners, panning, etc., that would allow excessive heat transfer through window frame.
    b. Do not make structural connection in loading bearing member into thermal break material.
36. Sills: Provide weep holes in sill of glazing pocket to provide means for water to flow to exterior.
37. Trickle Ventilators: Type which fits within glazing channels of sash frame, and contains gasketed channel to accept sealed insulating glass used in window sash.
    a. Ventilator: Installed in top rail of upper sash, accurately sized to extend full width of sash, properly fit sash, and sash frame above and insulating glass below.
    b. Ventilator: Consist of two piece aluminum housing connected by, and separated by, PVC extrusion forming thermal break.

c. Gasketed Shutter: Operate Internal flap to open and close ventilator.
d. Unit: Complete with fly-screen.
e. Color: Selected from manufacturers standard colors.

38. Secondary Windows (Storm Windows): Comply with Division 8 Section “Aluminum Storm Windows.”
39. Windows: Comply with applicable fire codes for egress.

Finishes

40. Finish:
    a. Aluminum: Provide one of following finishes as specified or scheduled:
        1) Pigmented Organic Coating: Factory applied pigmented organic coating, AAMA 603.8.
            a) Color: As selected from manufacturers standard colors.
        2) High Performance Organic Coating: Factory applied pigmented organic coating, AAMA 605.2.
            a) Color: As selected from manufacturer's standard colors.
        3) Color Anodized: Factory applied anodic coating, AAMA 608.1, Class 1.
            a) Color: As scheduled.
        4) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.
41. Protective Coatings:
    a. Steel Subframes: Insulate surfaces of steel from direct contact with aluminum surfaces by heavy coat or alkali-resistant bituminous paint or zinc-chromate prime coat, or other coating suitable for this purpose.
    b. Wood Subframes: Properly treat with preservative which will not promote corrosion of aluminum.
    c. Steel or Wood Subframes: Do not leave exposed on exterior of building.

Source Quality Control

42. Fabrication Tolerances: Wall Thickness, Cross-sectional Size and Overall Size: In accordance with ANSI/AAMA 101.
43. Testing: Performed under Third Party Administrator who is in compliance with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

44. Site Verification of Conditions:
    a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Do not proceed with installation until conditions are satisfactory.

Preparation

45. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Adequately enclose and protect against weather any interior space where installation is incomplete at end of working day.
    c. Repair or replace damaged elements in accordance with Detailed Scope of Work.
46. Existing Widows: Remove existing windows and debris from site in accordance with Detailed Scope of Work.
47. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.

a. Existing Window Jambs: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new windows.
b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

48. General: Install In accordance with ASTM E 737 except as modified by ANSI/AAMA 101 Appendix, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten windows in place to straight, plumb and level condition, without distortion of window or window frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. Make proper allowance for expansion/contraction movement of aluminum.
    c. Panning and Receptor Systems: Install to ensure watertight seal at joints with existing opening and with new replacement window.
        1) Thermal Insulation: Fill voids in panning system with thermal insulation.
        2) Vapor Barrier: Apply vapor barrier on inside between panning and existing opening. Seal laps and terminations with pressure sensitive tape.
    d. Comply with applicable codes and regulations regarding egress requirements and fireman entry.
49. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing calking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of window frame and underlying or surrounding construction at
    e. Exterior and interior with joint sealant to accomplish weather-tight installation. Maximum Width of Sealed Joint: 13 mm (1/2 inch).
50. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration and galvanic action.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape. or gasket between surfaces.
    b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Field Ouality Control

51. Owners Field Testing: the Owner may have field testing of windows conducted by its own testing agency in accordance with AAMA 502.
    a. Tests: May include, but not limited to:
        1) Field Testing (Hose Test) for Water Leakage: AAMA 501.2.
        2) Field Testing (Air Pressure Difference) for Water Leakage: AAMA 502, Test Method B.
            a) Field Testing for Air Leakage: ASTM E 783.
            b) Field Testing for Water Determination: ASTM E 1105.
    b. Test Pressures: Comply with specified performance requirements.
    c. Contractor: Provide incidental labor facilities necessary to facilitate inspections and tests.
    d. Costs of Testing:
        1) By the Owner: Successful initial tests.
        2) By Contractor: Initial tests with failures and subsequent tests as required because of test failures. Costs shall include costs of the Owner and other consultants for observations of tests and corrective work.
    e. Corrective Measures: Meet standards of quality of specified window and subject to acceptance of the Owner.

Adjusting And Cleaning

52. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave windows and hardware in proper operating condition.
53. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean windows after installation is completed to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

54. Installed Work: Protect windows from damage after installation.

END OF SECTION 08 51 13 00a

SECTION 08 51 19 00 - STAINLESS STEEL WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless steel windows.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for borrowed-lite interior steel windows.
2. Section 085123.13 "Hot-Rolled Steel Windows" for steel windows fabricated from hot-rolled members.
3. Section 085123.23 "Cold-Rolled Steel Windows" for steel windows fabricated from cold-rolled members.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review requirements for cold-rolled, stainless steel windows, including, but not limited to, the following:

a. Coordinating cold-rolled, stainless steel windows with other exterior wall components, including anchorage, glazing, flashing, weeping, air barriers, sealants, and protection of finishes.
b. Sequencing work to construct a watertight and weathertight exterior building enclosure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.

B. Shop Drawings:

1. Plans, elevations, sections, and details.
2. Detail attachments to other work, and between units, if any.
3. Hardware and required clearances.
4. Mullion details, including reinforcement and stiffeners.
5. Flashing details.
6. Glazing details.
7. Accessories.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors or finishes for each type of exposed finish.

1. Include available color or finish selections for hardware and accessories.

D. Samples for Verification: Actual sample of finished products for each type of cold-rolled stainless steel window including weather stripping, glazing bead, and hardware.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For stainless steel windows.[**Use same designations indicated on Drawings.**]

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each stainless steel window, for tests performed by a qualified testing agency.

B. Field Quality-Control Reports: For stainless steel windows.

C. Qualification Statements: For [**Installer**][**manufacturer**][**and**][**testing agency**].

D. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For stainless steel windows.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A manufacturer capable of fabricating stainless steel windows that meets performance requirements indicated and of documenting performance by labels, test reports, and calculations.
2. Installers: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

1.7 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to

repair or replace components of stainless steel windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].

2. Warranty Period: [**Two**][**Three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain stainless steel windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. SWI Standards: Comply with applicable requirements in SWI's "Architect's Guide to Steel Windows and Doors" and "Specifications - Formed Cold Rolled Sections," except where more stringent requirements are indicated, as directed by the Owner.

B. Structural Wind Loads: As indicated on Drawings.

C. Deflection Limits: Design glass framing system to limit deflection of glass edges in a direction perpendicular to glass plane to less than 1/175 of glass-edge length for each individual glazing lite or **3/4 inch (19 mm)**, whichever is less, at design pressures.

D. Structural: Test in accordance with ASTM E330/E330M as follows:

   1. When tested at positive and negative wind-load design pressures, stainless steel windows do not evidence deflection exceeding specified limits.
   2. When tested at [**150**] percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] percent of span.
   3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

E. Air Leakage for Weather-Stripped Sash: Not more than [**0.37 cfm/ft. (0.18 L/s/m)**] of sash crack length at a differential pressure across the windows of [**6.24 lbf/sq. ft. (298 Pa)**] when tested in accordance with ASTM E283/E283M.

F. Water Penetration for Weather-Stripped Sash: No leakage for 15 minutes when window is subjected to a rate of flow of **5 gal./h/sq. ft. (0.05 L/s/sq. m)** with a differential pressure across the window of [**2.86 lbf/sq. ft. (137 Pa)**] when tested in accordance with ASTM E331.

G. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [**0.80 Btu/sq. ft. x h x deg F (4.54 W/sq. m x K)**][**0.27 Btu/sq. ft. x h x deg F (1.53 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.43 Btu/sq. ft. x h x deg F (2.44 W/sq. m x K)**].

H. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of [**0.70**][**0.40**][**0.25**][**0.19**][**0.15**].

I. Condensation Resistance: Provide stainless steel windows with a CR of [**33**][**34**][**35**] minimum, determined in accordance with NFRC 500.

J. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces**].

K. Forced-Entry Resistance: Comply with Performance [**Grade 10**] requirements when tested in accordance with ASTM F588.

L. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

2.3 STAINLESS STEEL WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Optimum Window Mfg Corp**]

B. Provide manufacturer's standard stainless steel window assemblies consisting of frames, sashes, hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following window operating types in locations indicated on Drawings:

1. Casement: [**Outswing**][**Inswing**].
2. Hung: [**Double**][**Single**].
3. Horizontal sliding.
4. Projected: [**Awning**][**Hopper**].
5. Fixed.

D. Frames and Sashes: Mechanically formed from cold-rolled, ASTM A240/A240M, austenitic stainless steel sheet, [**Type 304**][**Type 316**]. Comply with SWI specifications for combined weight of frame and sash members and front-to-back depth of frame or sash members.

1. Thermal Construction: Provide thermally [improved][broken] frame and sash members designed to isolate interior and exterior surfaces for improved thermal performance.

E. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

F. Window Finish: [**Directional Satin Finish: ASTM A480/A480M, No. 4**][**Dull Satin Finish: ASTM A480/A480M, No. 6**][**Mirror Finish: ASTM A480/A480M, No. 8**][**Cold-Rolled, Bright Finish: ASTM A480/A480M, No. 2B**].

G. Mullions: Formed of cold-rolled, stainless steel matching window units; with anchors for support to structure and for installation of window units and having sufficient strength to withstand design pressure indicated. Provide mullions of profile indicated and with cover plates. Allow for erection tolerances and

provide for movement of window units due to thermal expansion and building deflections.

H. Muntins: Cold-rolled, stainless steel, T-shaped sections mechanically fastened to perimeter frame with cross-notched intersections.

I. Sill Cap/Track: Designed to comply with performance requirements indicated and to drain to the exterior.

J. Glazing Stops: Provide [**screw-applied**][**snap-on**] glazing stops; coordinate with Section 088000 "Glazing" and with glazing system indicated. Provide glazing stops to match panel frames. Finish glazing stops to match window units if fabricated of steel; otherwise, provide manufacturer's standard finish.

K. Weather Stripping: Manufacturer's standard compressible weather stripping, complying with AAMA 701/702, ASTM C509, or ASTM C864 and designed for permanently resilient sealing under compression and for complete concealment when sash is closed.

L. Hardware, General: Provide manufacturer's standard [**nonremovable**], [**solid-bronze**][**malleable-iron**][**die-cast-metal**] hardware, with operating components of stainless steel, carbon steel complying with AAMA 907, brass, bronze, or other corrosion-resistant material designed to smoothly operate, tightly close, and securely lock stainless steel window sash; and sized to accommodate sash weight and dimensions.

M. Casement Window Hardware:

1. Operation:

a. Gear-Type Rotary Operator: Complying with AAMA 901 when tested in accordance with ASTM E405, Test Method A; located on jamb at sill.

1) Provide operating device that opens and closes sashes simultaneously, securely closing them at both jambs without use of additional manually controlled locking devices.
2) Roto Operator Handle Type and Style: [**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

b. Manually operated push/pull.

2. Hinges:

a. Friction Hinges: Concealed, four-bar friction hinges with adjustable slide shoes complying with AAMA 904; two per sash.
b. Friction Hinges for Emergency Escape and Rescue: Standard-duty, concealed, four-bar friction egress hinges with adjustable slide shoes; two per sash where indicated. Provide hinge designed to achieve 90-degree sash opening.
c. Butt Hinges: Heavy-duty, three-knuckle butt hinges with nylon bushings; two per sash.
d. Extension Hinges or Pivots: Nonfriction type; two per sash.

3. Locks:

a. Type: [**Cam handle with keeper**][**Lift-type, locking handle with keeper**][**Custodial cam-action lock with keeper**][**Linear operator with standard concealed multipoint lock**][**Linear operator with concealed multipoint lock with captive locking strike and head**].

1) Style: [**As selected by Architect from manufacturer's full range of styles**], as

directed by the Owner.

4. Control Devices:

a. Limit Device: Adjustable, concealed [**friction adjustor/stay-bar**][**friction adjustor/stay-bar with release key or tool**].

N. Hung Window Hardware:

1. Balances:

a. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
b. Counterbalance and Pulley: Two per sash to operate in unison with stainless steel cable sash cord.

1) Single-Hung Upper Sash Retainer: Manufacturer's standard.

2. Locks and Latches:

a. Type: [**Cam-action sweep lock and keeper on meeting rail; one per sash**][**Cam-action sweep lock and keeper on meeting rail; two per sash**].

1) Style: [**Manufacturer's standard**][**As selected by Architect from manufacturer's full range of styles**], as directed by the Owner.

3. Handles:

a. Type: [**Lift**][**Pull-down**] handle; [**one**][**two**] per sash.

1) Style: Manufacturer's standard.

O. Horizontal-Sliding Window Hardware:

1. Rollers: Steel, lubricated, ball-bearing rollers.
2. Lock:

a. Type: [**Manufacturer's standard, designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and to operate from the inside only**].

3. Control Device:

a. Limit Device: Manufacturer's standard.

4. Handle:

a. Pull Handle: Manufacturer's standard.

P. Projected Window Hardware:

1. Operation:

a. Operating Device: [Gear-type rotary complying with AAMA 901 when tested in accordance

with ASTM E405, Test Method A][Push-bar-type][underscreen] sash operator located at sill.

1) Style: [**As selected by Architect from manufacturer's full range of styles**], as directed by the Owner.

b. Manually operated push/pull.

2. Hinges:

a. Concealed, four-bar friction hinges with adjustable slide shoes complying with AAMA 904; two per sash.
b. Balance arms with adjustable, nonabrasive friction pivots; two per sash.
c. Balance arms with adjustable, nonabrasive friction shoes; two per sash.

1) Provide sash operation that permits cleaning of the outside glass face from the interior.
2) Provide jamb-mounted, sliding, brass friction shoes with screw adjusters.

3. Locks:

a. Type: [**Cam handle with keeper**][**Custodial cam-action lock with keeper**][**Linear operator with standard concealed multipoint lock**][**Linear operator with concealed multipoint lock with captive locking strike and head**][**Pole-operated spring catch lock**][**Pole-operated ring cam handle with keeper**].

1) Style: [**As selected by Architect from manufacturer's full range of styles**], as directed by the Owner.
2) Pole Operators: Tubular-shaped, anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

4. Control Device:

a. Limit Device: Adjustable, concealed [**friction adjustor/stay-bar**][**friction adjustor/stay-bar with release key or tool**][**support arms with adjustable, limited hold-open**].

2.4 INSECT SCREENS

A. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, fully integrated with window. Locate screens on [**inside**][**outside**] of window and provide for each operable exterior sash. Comply with SMA 1201.

B. Stainless Steel Screen Frames: Fabricate frames of tubular-shaped, nonmagnetic stainless steel members of **0.02-inch (0.5-mm)** minimum wall thickness; in [**ASTM A480/A480M, No. 2B cold-rolled, bright finish**][**finish to match cold-rolled, stainless steel window**].

C. Glass-Fiber Mesh Fabric: Complies with ASTM D3656/D3656M, [**18-by-14 or 18-by-16**][**20-by-20 or 20-by-30**] count per **sq. in. (645 sq. mm)** mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration.

1. Mesh Color: [**Gray**].

D. Aluminum Wire Fabric: 18-by-16 count per **sq. in. (645 sq. mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

E. Stainless Steel Wire Fabric: [**18-by-16**][**18-by-18**] count per **sq. in. (645 sq. mm)** mesh of **0.009-inch- (0.2-mm-)** minimum diameter, nonmagnetic stainless steel wire, Type 304 or 316.

F. Wickets: Provide [sliding][hinged] wickets, framed and trimmed for a tight fit and durability during handling.

2.5 INSTALLATION ACCESSORIES

A. Fasteners: Provide fasteners of bronze, brass, stainless steel, or other metal that are warranted by manufacturer to be noncorrosive and compatible with trim, hardware, anchors, and other components of stainless steel windows.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

B. Anchors, Clips, and Window Accessories: Provide units of stainless steel, hot-dip zinc-coated steel, bronze, brass, or iron complying with ASTM A123/A123M. Provide units with sufficient strength to withstand design pressure indicated.

1. Windborne-Debris-Impact Resistance: Provide anchors and clips of same design used to pass windborne-debris-impact-resistance testing.

C. Sealant: For sealants required within fabricated windows, provide manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

2.6 GLAZING

A. Glass and Glazing System: See Section 088000 "Glazing" for glass units and glazing requirements for stainless steel windows.

2.7 FABRICATION

A. Fabricate stainless steel windows of type and in sizes indicated to comply with SWI standards. Include a complete system for assembly of components and anchorage of window units.

B. Provide units that are reglazable without dismantling framing.

C. Prepare windows for field glazing.

D. Subframes and Operable Sash: Miter or cope corners, and [mechanically fasten and seal joints][weld and dress joints smooth].

E. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

F. Provide weep holes and internal water passages to conduct infiltrating water to the exterior.

G. Provide water-shed members above [**casement**][**horizontal-sliding**] sash.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough-opening dimensions, levelness of sill plate, and clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STAINLESS STEEL WINDOWS

A. SWI Publication: Comply with applicable requirements in SWI's "Guidelines on How to Install Steel Windows," except where more stringent requirements are indicated.

B. Comply with manufacturer's written installation instructions for installing windows, hardware, operators, accessories, and other components.

C. Windborne-Debris-Impact Resistance: Anchor stainless steel windows required to have windborne-debris resistance to structure using method, anchor type, and anchor spacing identical to that used in windborne-debris-impact-resistance testing.

D. Install windows level, plumb, square, true to line, without distortion or impediment to thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

E. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

F. Install windows and components to drain condensation, water-penetrating joints, and moisture migrating within windows to the exterior.

G. Install field glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Test windows for air leakage and water penetration in accordance with AAMA 502, Test Method [**A**][**B**], by applying same test pressures required for performance.
2. Testing Extent: [**Three**][**Three mockup**] windows as selected by Architect and a qualified independent testing and inspecting agency. Test windows immediately after installation, as directed by the Owner.
3. Windows will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust operating sashes, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts as recommended in writing by manufacturer.

3.5 CLEANING AND PROTECTION

A. Clean exposed stainless steel surfaces immediately after installing windows. Comply with manufacturer's written instructions for final cleaning and maintenance. Avoid damaging protective coatings and finishes.

B. Protect window surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 08 51 19 00

SECTION 08 51 69 00 - METAL STORM WINDOWS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum storm windows. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Aluminum Storm Window Configuration and Performance Classes: ANSI/AAMA 1002.10:
   a. VWE (15): Vertically operating insulating storm window for external application, Performance Class 15.
   b. VWE (45): Vertically operating insulating storm window for external application, Performance Class 45.
   c. HWE (15): Horizontally operating insulating storm window for external application, Performance Class 15.
   d. FWE (15): Fixed removable insulating storm window for exterior application, Performance Class 15
   e. FWI (15): Fixed removable insulation window for internal application, Performance Class 15.
   f. HWI (15): Horizontally operating insulating window for internal application, Performance Class 15.
2. Type of Stainless Steel Screens (Frames and Screening): Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
3. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination Freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.

System Desription

4. Performance Requirements: Comply with following:
   a. Storm Windows: HUD UM 39a.
   b. Storm Windows: ANSI/SMA 6001.
      1) Exterior Mounted Aluminum storm Windows for Normal Usage: Specification FWE, HWE, or VWE as applicable and Performance Class 15.
      2) Interior Mounted Aluminum Storm Windows for Normal Usage: Specification FWI, HWI, or VWI as applicable and Performance Class 15.
      3) High Rise Storm Windows: Specification VWE and Performance Class 45.

Submittals

5. Product Data.
6. Shop Drawings:
   a. Indicate fabrication of parts, metal thickness. installation details, fastening and sealing.
   b. Include sections of typical members and details of latching devices.
7. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of storm window with specified finish for acceptance.
8. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written third party certification that storm windows meet or exceed HUD UM 39a, ANSI/AAMA 1102.10, and other specified requirements.
   b. Manufacturer's installation instructions.

9. Closeout Submittals:
    a. Operation and maintenance data.
    b. Special warranty.

Quality Assurance

10. Regulatory Requirements:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Egress Requirements: Comply with applicable codes and regulations.
    c. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    d. Accessibility:
        1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
            a) Uniform Federal Accessibility Standards (UFAS).
        2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
        3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
        4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
11. Certifications: Comply with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.
12. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of storm window with specified finish for acceptance.
    a. Location: As directed.
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

13. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Aluminum Storm Windows: Label in accordance with HUD UM 39a attached signifying compliance with ANSI/AAMA 1002.10 performance requirements.
14. Acceptance at Site: Inspect storm windows upon delivery. Replace damaged or defective materials before installation.
15. Storage and Protection: Store storm windows in manner to protect from weather and other damage.

Project Conditions

16. Field Measurements: Field measure openings for storm windows before start of fabrication.

Scheduling And Sequencing

17. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

18. Special Warranty: Provide one year written covering materials and installation for storm windows.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening and glazing riot included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement window, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement window.

PRODUCTS

Aluminum Storm Windows

19. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware. anchors, and equipment.
20. Materials: ANSI/AAMA 1002.10.
    a. Extruded Aluminum: ASTM B 221, Alloy 60630-TS or stronger.
    b. Carbon Steel (reinforcing members): ASTM A 36, zinc coated in accordance with ASTM B 633 or cadmium coated in accordance with ASTM B 766.
    c. Stainless Steel: ASTM A 167, Type 302.
    d. Anti-galling Devices: Manufacturers standard non-corrosive material compatible with aluminum.
    e. Channel Gaskets: Manufacturer's standard flexible vinyl.
    f. Welding Filler Rods: AWS A5.3.
21. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Glass: ASTM C 1036, Type 1. Class 1, Glazing B Quality.
    b. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.
    c. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
        2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
        3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
        4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.
    d. Glass Thickness: Determined in accordance with ANSI/AAMA 1002.10 Appendix, minimum 3 mm (1/8 inch) (DS).
        1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
    e. Glass: Labeled to show name of manufacturer and type.
22. Insert Insect Screens: Provide storm windows with Screens as indicated, specified, or scheduled in manufacturer's standard approved design, applicable to specific storm windows.
    a. Screen Frames: Roll form aluminum frames of suitable alloy and of sufficient rigidity, crossbraces, as required, to lie flat against window and to prevent excessive bow in frame members and sag in screening.
        1) Frame Comers: Firmly joined in secured and rigid manner.
    b. Screening: One of following as indicated, specified, or scheduled:
        1) Vinyl Coated Fibrous Glass Yam: ASTM D 3656, Class 1, 18 by 16 mesh, 0.29 mm (0.0115 inch) diameter yam.
        2) Polyvinylidene Chloride or Polypropylene Filament: FS L-S-12513, Type I or III, Class 1 or 2, 18 by 18 mesh, 0.31 mm (0.012 inch) or 0.38 mm (0.015 inch) diameter filament.
        3) Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) diameter wire.
        4) Stainless Steel Medium: ANSI/SMA 6001 Medium Type, 12 x 12 mesh type 304 stainless steel 0.58 mm (0.023 inch) diameter wire.
        5) Stainless Steel Heavy: ANSI/SMA 6001 Heavy Type, 12 x 12 mesh type 304 high tensile strength stainless steel 0.71 mm (0.028 inch) diameter wire.
    c. Screening: Fastened to frame in manner to permit replacement of screening.
    d. Screens: Provide with fastening devices, suited particularly for application to specific window made of aluminum or materials compatible with aluminum and of sufficient strength to perform satisfactorily.
    e. Screens: Comply with applicable fire codes for egress and fireman access.
        1) Provide single point release as and where required by applicable codes and regulations.

2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.

f. Window Screens: Include warning label indicating that screen will not stop child from failing out of window in accordance with SMA 7001.

Accessories

23. Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.

Fabrication

24. General:
    a. Storm Windows: Conform to approved Shop Drawings.
    b. Storm Windows: Assembled securely to assure neat, weather resistant construction.
    c. Glazed Sash: Fabricated to permit reglazing without special tools.
    d. Remove flux and grind welds, flush with exposed surfaces, and polish to blend with ad surfaces.
    e. Sills: Provide weep holes to provide means for water to flow to exterior.
    f. Inserts:
        1) Removable to inside.
        2) Not operable or removable from outside when in closed and latched position.
        3) Glass Inserts: Weatherstripped to prevent metal-to-metal contact with main frame.
    g. Storm Windows: Comply with applicable fire codes for egress.
25. Vertically Sliding Storm Windows: Provide following features:
    a. Aluminum two-track or triple-track, self-storing, vertical-sliding combination storm and screen units with two glass insert panels and one screen insert panel, and two-track storm windows.
    b. Master Frame: Afford clearance for operation of prime window hardware.
    c. Equip units over 1 143 mm (45 inches) wide, 2 032 mm (80 inches) high or 3 175 mm (125 united inches) with extruded aluminum tie bar to ensure rigidity to main frame.
    d. Provide self-activating locks or latches designed to hold sash secure in locked and ventilating positions.
26. Horizontally Operating Storm Windows: Provide following features:
    a. Aluminum triple track, self-storing, horizontally operating, combination storm and screen unit.
    b. Glass Insert Panels: Operable and slide on rollers, rigid PVC or nylon glides.
    c. Equip with security lock to latch closed when in locked position.
    d. Master Frame: Afford clearance for operation of prime window hardware.
    e. Fixed Aluminum Vertical Tie Bar at Meeting Rails of Inserts: Ensure rigidity to main frame.
27. Fixed Picture Storm Windows: Provide following features:
    a. Divider on Storm Windows: Locate over meeting rail or prime window.
    b. When window is larger than 1500 mm (60 inches) in height or width, separate glass area into sections with one or more aluminum muntins to join pieces of glass.
    c. Picture Windows: Fixed but removable inserts either from inside or from outside.
        1) Glazing: Wrapped around marine type vinyl or drop in.

Finishes

28. Finish:
    a. Aluminum Finish: Provide one of following as specified or scheduled:
        1) Factory applied pigmented organic coating. AAMA 603-8.
            a) Color: As selected from manufacturer's standard colors.
        2) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.

Source Quality Control

29. Testing: Performed under Third Party Administrator who is in compliance with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

30. Site Verification of Conditions: indicated on Shop Drawings.
    a. Field Measurements: Verify field measurements are as
    b. Existing Conditions: Examine openings before beginning installation.
    c. Verify that surfaces to receive storm windows are clean.
    d. Do not proceed with installation until conditions are satisfactory.

Preparation

31. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
32. Existing Storm Widows: Remove existing storm windows and debris from site in accordance with Detailed Scope of Work.
33. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.
    a. Prime Window Jambs of Existing Prime Windows: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new storm windows.
    b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

34. General: Install in accordance with ASTM E 737, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten storm windows in place to straight, plumb and level condition, without distortion of window or window frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. Comply with applicable codes and regulations regarding egress requirements and fireman entry.
35. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing calking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturers recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of window frame and underlying or surrounding construction with joint sealant to accomplish weather-tight installation.
    e. Maximum Width of Sealed Joint: 13 mm (1/2 Inch).
36. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape, or gasket between surfaces.
    b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Adjusting And Cleaning

37. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave storm windows and hardware in proper operating condition.
38. Cleaning: Comply with requirements of Detailed Scope of Work.

a. Clean storm windows after installation is completed to remove foreign matter and surface blemishes.
b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

39. Installed Work: Protect storm windows from damage after installation

END OF SECTION 08 51 69 00

Task	Specification	Specification Description
08 51 69 00	08 51 13 00	Aluminum Windows

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SECTION 08 52 00 00 - WOOD WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unclad wood windows.
2. Aluminum-clad wood windows.
3. Vinyl-clad wood windows.
4. Fiberglass-clad wood windows.

1.2 DEFINITIONS

A. Combination Assemblies: Assemblies formed by a combination of two or more separate fenestration products whose frames are mulled together using a combination mullion or reinforcing mullion.

B. Combination Mullions: Horizontal or vertical members formed by joining two or more individual fenestration units together without a mullion stiffener.

C. Reinforcing Mullions: Horizontal or vertical members with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate interrelationship of wood windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, window rough openings, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: For units with factory-applied finishes, manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

1. Include Samples of hardware and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:

1. Exposed Finishes: [**Manufacturers' standard size**][**2 by 4 inches (50 by 100 mm)**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For wood windows. Use same designations indicated on Drawings.

F. Delegated Design Submittals: For [**reinforcing mullions**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each wood window, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For wood windows.

C. Qualification Statements: For manufacturer and Installer.

D. Delegated Design Engineer Qualifications: For [**reinforcing mullions**].

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating hinged wood-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: [**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Testing Agency Qualifications: WDMA-accredited testing agency for testing indicated.

E. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect wood windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle wood windows in a manner that prevents damage before, during, and after installation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install wood windows outside of limits recommended in writing by manufacturer.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excessive deflection, water leakage, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: [**Two**][**Five**][**10**] years from date of Substantial Completion.
b. Glazing Units: [**Five**][**10**] years from date of Substantial Completion.
c. Hardware: [**Three**] years from date of Substantial Completion.
d. Aluminum-Cladding Finish: [**10**][**20**] years from date of Substantial Completion.
e. Vinyl Cladding: Lifetime warranty.
f. Fiberglass Cladding: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain wood windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design [**reinforcing mullions**].

B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: WDMA certified with label attached to each window.

C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**R**][**LC**][**CW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**15**][**20**][**25**][**30**][**35**][**40**][**45**][**50**][**As indicated on Drawings**].
3. Mulled Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.

D. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

a. Fixed Windows: Not more than [**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.26 Btu/sq. ft. x h x deg F (1.48 W/sq. m x K)**].

b. Operable Windows: Not more than [**0.62 Btu/sq. ft. x h x deg F (3.52 W/sq. m x K)**][**0.60 Btu/sq. t. x h x deg F (3.41 W/sq. m x K)**][**0.54 Btu/sq. ft. x h x deg F (3.07 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**].

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:

a. Fixed Windows: Not more than [**0.23**][**0.25**][**0.36**][**0.38**][**0.40**].
b. Operable Windows: Not more than [**0.21**][**0.23**][**0.33**][**0.34**][**0.36**] as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located more than [**30 ft. (9.1 m)**] above grade.

2.3 WOOD WINDOWS, GENERAL

A. Provide manufacturer's standard wood window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

2.4 UNCLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**JELD-WEN, Inc.**]
2. [**Kolbe Windows & Doors**]
3. [**Marvin**]
4. [**Pella Corporation**]
5. [**Ply-Gem**]
6. [**Sierra Pacific Windows; Sierra Pacific Industries**]
7. [**Weather Shield Mfg., Inc**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: [**Manufacturer's standard paint-grade wood species**][**Pine**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Manufacturer's standard factory-applied primer**][**Manufacturer's standard factory-applied color-coated finish**][**Unfinished**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Mahogany**][**Fir**][**Alder**][**Oak**][**Cherry**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 ALUMINUM-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**JELD-WEN, Inc.**]
3. [**Kolbe Windows & Doors**]
4. [**Marvin**]
5. [**Pella Corporation**]
6. [**Ply-Gem**]
7. [**Sierra Pacific Windows; Sierra Pacific Industries**]
8. [**Weather Shield Mfg., Inc**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: [**Manufacturer's standard aluminum cladding**].

1. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry-film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and curing finish.

   a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Color and Gloss: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Fir**][**Alder**][**Oak**][**Cherry**][**Mahogany**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied primer for field painting**][**Manufacturer's standard factory-applied color-coated finish**][**Manufacturer's standard factory-applied stain and transparent finish**].

   a. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 VINYL-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Sierra Pacific Windows; Sierra Pacific Industries**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: Manufacturer's standard vinyl-cladding.

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Oak**][**Maple**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied color-coated white finish**].

2.7 FIBERGLASS-CLAD WOOD WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**Kolbe Windows & Doors**]

B. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.
2. Awning: Project out.
3. Hopper: Project in.
4. Single hung.
5. Double hung.
6. Horizontal sliding.
7. Fixed.

C. Exterior Surfaces: Manufacturer's standard fiberglass-clad frame.

1. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Interior Surfaces: [**Manufacturer's standard wood species**][**Pine**][**Oak**][**Maple**].

1. Visible Finger Joints: [**Allowed**][**Not allowed**].
2. Finish: [**Unfinished**][**Manufacturer's standard factory-applied color-coated white finish**].

2.8 WINDOW COMPONENTS

A. Frames and Sashes: Fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln

dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than **1/32 inch (0.8 mm)** deep by **2 inches (51 mm)** wide; water-repellent preservative treated.

2.9 GLASS AND GLAZING

A. True Divided Lites: Fabricate glazing with true muntins resulting in individually glazed lites; provide muntin configuration and profile indicated on Drawings.

B. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered [**where indicated on Drawings**].

C. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

1. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
2. Inner Ply: Clear.
3. Interlayer: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].
4. Outer Ply: [**Clear**][**Gray**][**Bronze**][**Green**].
5. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

D. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
b. Kind: Fully tempered [**where indicated on Drawings**].

2. Lites: [**Two**][**Three**].
3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

E. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.

1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
b. Kind: [**Heat strengthened**][**Fully tempered**].

2. Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.

a. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
b. Interlayer Thickness: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].

3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

F. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

1. Dual-Glazing System:

a. Interior Lite: [**Glass**].
b. Exterior Lite: [**Glass**][**Insulating-glass unit**].

2.10 HARDWARE

A. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type and Style: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

2. Hinges: [**Manufacturer's standard type for sash weight and size indicated**][**Stainless steel hinges with stainless steel-reinforced, sliding nylon shoes**].
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one arm on sashes up to **29 inches (735 mm)** tall and two arms on taller sashes.
4. Limit Devices: [**Concealed friction adjustor, adjustable stay bar**][**Concealed support arms with adjustable, limited, hold-open**] limit devices designed to restrict sash opening.

a. Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

5. Operator Stud Cover: Matching operator handle finish. Provide in locations where operator handle is removed for controlled access.
6. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

C. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Tilt Hardware: Releasing tilt latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

D. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**][**Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color**][**Manufacturer's standard**] of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Roller Assemblies: Low-friction design.

E. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

G. Mullions: Provide manufacturer's standard combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.11 ACCESSORIES

A. Dividers (False Muntins): Provide divider grilles in designs indicated for each sash lite.

1. Quantity and Type: [**One per sash, removable from exposed surface of interior lite**][**Two per sash, removable from exposed surfaces of interior and permanently located at exterior lite**][**Two per sash, permanently located at exterior and interior lites**][**One permanently located between insulating-glass lites**][**Three per sash, two permanently located at exterior and interior lites and one permanently located between insulating-glass lites**].
2. Material: [**Manufacturer's standard**].
3. Pattern: [**As indicated on Drawings**].
4. Profile: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Integral Horizontal Louver Blinds: Manufacturer's standard, horizontal louver blinds located between glazing units in a dual-glazed system. Provide blinds with aluminum slats and polyester fiber cords that are operated by hardware located on inside face of sash.

1. Operation: [**Tilt only**][**Tilt, raising, and lowering**].
2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Integral Fabric Shades: Manufacturer's standard, cellular pleated shades located between glazing units in a dual-glazed system. Provide shades with multiple fabric layers forming accordion folds that enclose airspaces between the fabric layers, with polyester fiber cords that are operated by hardware located on inside face of sash.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Jamb Extensions: [**Stain-grade Pacific Hemlock**].

E. Nail Fins: Manufacturer's standard mounting flanges with holes prepunched for mechanical fasteners.

2.12 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: [**Full, inside for project-out**][**Full, outside for double-hung**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.

B. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
2. Finish for Interior Screens: Baked-on organic coating in [**color selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Finish for Exterior Screens: [**Baked-on organic coating in color selected by Architect from manufacturer's full range**][**Matching color and finish of cladding**], as directed by the Owner.

C. Glass-Fiber Mesh Fabric: [**18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm)**][**20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm)**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: [**Manufacturer's standard**].

D. Aluminum Wire Fabric: **18-by-16 (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

2.13 FABRICATION

A. Fabricate wood windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze wood windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Window Assemblies: [**Bow**][**Bay**][**Combination**]. Provide window units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Clear [**pine**][**birch**] head and seat boards.
4. Top and bottom plywood platforms.
5. Exterior head and sill casings and trim.
6. Support brackets.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to

greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WOOD WINDOWS

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows must take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance to be performed in accordance with AAMA 502.
2. Air-Infiltration Testing:

a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**One**][**Three**] window(s) of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows to be tested [**immediately after installation**][**at 5, 50, and 90 percent completion**], as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.
6. Windows will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Remove excess sealants, glazing materials, dirt, and other substances.

   1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 08 52 00 00

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Task	Specification	Specification Description
08 52 11 00	08 52 00 00	Wood Windows
08 52 13 00	08 52 00 00	Wood Windows
08 52 16 00	08 52 00 00	Wood Windows
08 52 66 00	08 52 00 00	Wood Windows

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SECTION 08 53 13 00 - VINYL WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl windows.

1.2 DEFINITIONS

A. Combination Assemblies: An assembly formed by a combination of two or more separate fenestration products whose frames are mulled together utilizing a combination mullion or reinforcing mullion.

B. Combination Mullions: A horizontal or vertical member formed by joining two or more individual fenestration units together without a mullion stiffener.

C. Reinforcing Mullions: A horizontal or vertical member with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate interrelationship of vinyl windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:

1. Exposed Finishes: [**2 by 4 inches (50 by 100 mm)**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For vinyl windows. Use same designations indicated on Drawings.

F. Delegated Design Submittals: For reinforcing mullions, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
4. ENERGY STAR: Product data for indicated products, showing compliance with requirements for ENERGY STAR product labeling.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of vinyl window, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For vinyl windows.

C. Qualification Statements: For manufacturer and Installer.

D. Delegated Design Engineer Qualifications: For reinforcing mullions.

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating vinyl windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: Authorized representative who is trained and approved by vinyl window manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Testing Agency Qualifications: An FGIA-accredited testing agency for testing indicated.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace vinyl windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: [**Two**][**Five**][**10**] years from date of Substantial Completion.
b. Glazing Units: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain vinyl windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design reinforcing mullions.

B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: FGIA or WDMA certified with label attached to each window.

C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**R**][**LC**][**CW**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**15**][**20**][**25**][**30**][**35**][**40**][**45**][**50**][**As indicated on Drawings**].
3. Mulled Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.

D. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

a. Fixed Windows: Not more than [**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F**

(2.04 W/sq. m x K)][**0.34 Btu/sq. ft. x h x deg F**
(1.93 W/sq. m x K)][**0.29 Btu/sq. ft. x h x deg F**
(1.65 W/sq. m x K)][**0.26 Btu/sq. ft. x h x deg F (1.48 W/sq. m x K)**].

b. Operable Windows: Not more than [**0.62 Btu/sq. ft. x h x deg F**
(3.52 W/sq. m x K)][**0.60 Btu/sq. ft. x h x deg F**
(3.41 W/sq. m x K)][**0.54 Btu/sq. ft. x h x deg F**
(3.07 W/sq. m x K)][**0.45 Btu/sq. ft. x h x deg F**
(2.56 W/sq. m x K)][**0.42 Btu/sq. ft. x h x deg F**
(2.38 W/sq. m x K)][**0.36 Btu/sq. ft. x h x deg F**
(2.04 W/sq. m x K)][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**].

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200.

a. Fixed Windows: Not more than [**0.23**][**0.25**][**0.36**][**0.38**][**0.40**].
b. Operable Windows: Not more than [**0.21**][**0.23**][**0.33**][**0.34**][**0.36**] as determined in accordance with NFRC 200.

E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located more than [**30 ft. (9.1 m)**] above grade.

2.3 VINYL WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All Seasons Architectural Windows Mfg., Inc.; All Seasons Commercial Division, Inc.**]
2. [**Gerkin Windows & Doors**]
3. [**Intus Windows**]
4. [**JELD-WEN, Inc.**]
5. [**MI Windows and Doors, LLC**]
6. [**Milgard Manufacturing, LLC**]
7. [**Pella Corporation**]
8. [**PGT Custom Windows + Doors; PGT Innovations (PGTI)**]
9. [**Ply-Gem**]
10. [**Quaker Windows Products Co.**]
11. [**Shwinco Architectural Products LLC**]
12. [**Simonton Windows, Inc.**]
13. [**Thermal Windows, Inc.**]
14. [**Thermo-Tech Windows and Doors LLC.**]
15. [**VPI Quality Windows, Inc.; JELD-WEN Holding, Inc.**]

B. Provide manufacturer's standard vinyl window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project out.

2. Awning: Project out.
3. Single hung.
4. Double hung.
5. Horizontal sliding.
6. Fixed.

D. Frames and Sashes: Impact-resistant, UV-stabilized PVC complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Finish: Integral color, [**white**][**beige**][**sandstone**].
2. Gypsum Board Returns: Provide at interior face of frame.

E. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered [**where indicated on Drawings**].

F. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172, with two plies of float glass.

1. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
2. Inner Ply: Clear.
3. Interlayer: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].
4. Outer Ply: [**Clear**][**Gray**][**Bronze**][**Green**].
5. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

G. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

   a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
   b. Kind: Fully tempered [**where indicated on Drawings**].

2. Lites: [**Two**][**Three**].
3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].
5. Integral Louver Blinds: Glass manufacturer's standard, horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between glass lites, and operated by hardware located on inside face of sash.

   a. Operation: [**Tilt only**][**Tilt, raising, and lowering**].
   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190, with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.

1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

   a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
   b. Kind: [**Heat strengthened**][**Fully tempered**].

2. Interior Lite: ASTM C1172, clear laminated glass with two plies of float glass.

   a. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by**

performance requirements indicated].

b. Interlayer Thickness: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].

3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

I. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

1. Dual Glazing System:

a. Interior Lite: [**Glass**][**Insulating-glass unit**].
b. Exterior Lite: [**Glass**][**Insulating-glass unit**].

J. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type and Style: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

2. Hinges: [**Manufacturer's standard type for sash weight and size indicated**][**Stainless-steel hinges with stainless-steel-reinforced, sliding nylon shoes**].
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one arm on sashes up to **29 inches (735 mm)** tall and two arms on taller sashes.
4. Limit Devices: [**Concealed friction adjustor, adjustable stay bar**][**Concealed support arms with adjustable, limited, hold-open**] limit devices designed to restrict sash opening.

a. Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

5. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

L. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Tilt Hardware: Releasing tilt latch allows sash to pivot about horizontal axis to facilitate cleaning

exterior surfaces from the interior.

M. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**][**Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color**][**Manufacturer's standard**] of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Roller Assemblies: Low-friction design.

N. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

O. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

P. Mullions: Provide combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.4 ACCESSORIES

A. Dividers (False Muntins): Provide divider grilles in designs indicated for each sash lite.

1. Quantity and Type: [**One permanently located between insulating-glass lites**][**Three per sash, one permanently located between insulating-glass lites, and two permanently attached to the interior and exterior lites**].
2. Material: [**Manufacturer's standard**].
3. Pattern: [**As indicated on Drawings**].
4. Profile: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: [**Full, inside for project-out**][**Full, outside for double-hung**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.

B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
2. Finish for Interior Screens: Baked-on organic coating in [**color selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Finish for Exterior Screens: [**Baked-on organic coating in color selected by Architect from**

manufacturer's full range], as directed by the Owner.

C. Glass-Fiber Mesh Fabric: [**18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm)**][**20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm)**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: [**Manufacturer's standard**].

D. Aluminum Wire Fabric: **18-by-16 (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

2.6 FABRICATION

A. Fabricate vinyl windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze vinyl windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Hardware: Mount hardware through double walls of vinyl extrusions or provide corrosion-resistant reinforcement.

E. Window Assemblies: [**Bow**][**Bay**][**Combination**]. Provide window units in configuration indicated on Drawings. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Clear [**pine**] head and seat boards.
4. Top and bottom plywood platforms.
5. Support brackets.

F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings,[**vapor retarders,**] air and weather barriers, and other built-in components to

ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows to take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance will be performed in accordance with AAMA 502.
2. Air-Infiltration Testing:

   a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**One**][**Three**] window(s) of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows will be tested [**immediately after installation**][**at 5, 50, and 90 percent completion**], as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.

C. Test and Inspections:

1. Windows will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.5 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Remove excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 08 53 13 00

Task	Specification	Specification Description
08 53 66 00	08 53 13 00	Vinyl Windows

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SECTION 08 54 00 00 - COMPOSITE WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Composite windows.

B. Related Requirements:

1. Section 081674 "Sliding Composite-Framed Glass Doors" for related sliding doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of composite windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.3 ACTION SUBMITTALS

A. Product Data: Composite windows.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Composite Window Finishes: [**Manufacturers' standard size**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For composite windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of composite window, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For composite windows.

C. Sample Warranties: For composite windows.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to manufacturer of composite windows for installation of units required for this Project.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace composite windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including excessive deflection, water leakage, and air infiltration.
b. Faulty operation of moveable sash and hardware.
c. Deterioration of materials and finishes beyond normal weathering.
d. Failure of insulating glass units.

2. Warranty Period:

a. Composite Windows: [**10**] years from date of Substantial Completion.
b. Glazing Units: [**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Product Certification: WDMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: [**LC**][**As indicated on Drawings**].
2. Minimum Performance Grade: [**30**][**35**][**40**][**50**][**As indicated on Drawings**].

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [**0.27 Btu/sq. ft. x h x deg F (1.53 W/sq. m x K)**][**0.28 Btu/sq. ft. x h x deg F (1.59 W/sq. m x K)**][**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.30 Btu/sq. ft. x h x deg F (1.70 W/sq. m x K)**][**0.40 Btu/sq. ft. x h x deg F (2.27 W/sq. m x K)**].

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 whole-window SHGC of [**0.32 minimum**][**0.37 minimum**][**0.42 minimum**][**0.40 maximum**][**0.25 maximum**].

E. Sound Transmission Class (STC): Rated for not less than [**25**][**37**] STC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E413.

F. Outside-Inside Transmission Class (OITC): Rated for not less than [**21**][**28**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

2.2 COMPOSITE WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Andersen Windows, Inc.; Andersen Corporation**]
2. [**JELD-WEN, Inc.**]

B. Source Limitations: Obtain composite windows from single manufacturer.

C. Operating Types:

1. Projected: [**Casement**][**Awning**], project out.
2. Single Hung: With [**even**][**manufacturer's standard**] sight lines for bottom and top sash.
3. Horizontal sliding.
4. Fixed.

D. Frames and Sashes: Extruded profiles made from composite mix of reclaimed pre-consumer wood-based cellulosic fibers embedded in a thermoplastic polymer matrix.

1. Percent Reclaimed Wood-Based-Fiber Content: Minimum [**28**][**40**] percent by weight.

E. Exterior Finish: [**Manufacturer's standard finish in color selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Interior Finish: [**Manufacturer's standard finish matching exterior color**][**Manufacturer's standard finish in color contrasting exterior color as selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Attachment Flange: [**Manufacturer's standard**][**1-3/8-inch (3.5-mm) flange setback**][**1-inch (2.5-mm) flange setback with stucco key**][**No flange**].

H. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Manufacturer's standard tint designed to reduce heat gain**].
b. Kind: ASTM C1048, fully tempered Category II safety glass complying with testing requirements in 16 CFR 1201 [**where indicated on Drawings**].

2. Lites: [**Two**].
3. Filling: Fill space between glass lites with [air][argon].
4. Low-E Coating: [**Pyrolytic or sputtered on second surface**].
5. Film Pattern: [**None**][**Cascade**][**Fern**][**Obscure**][**Rain**][**Reed**][**Satin Etch**].

a. Location: [**Third**][**Fourth**] surface.

6. Glass-Spacer Color: [**Manufacturer's standard color**][**Black**][**Stainless steel**].
7. Dirt-Resistant Coating: Exterior coating that reduces surface friction to enhance water runoff and reduce water spots and dirt residue.

I. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

J. Dividers: Grilles permanently [**attached to exterior and interior of insulating-glass unit with spacer between lites matching color of insulating-glass spacer**][**attached to exterior and interior of insulating-glass unit, with no spacer between lites**][**attached to exterior and permanently installed between lites of insulating-glass unit**][**installed between lites of insulating-glass unit**].

1. Profile: [**Contoured**][**Flat**][**Putty**].
2. Width: [**Manufacturer's standard not more than 3/4 inch (19 mm) wide**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1-1/8 inches (29 mm)**][**2-1/4 inches (57 mm)**].
3. Pattern: [**As indicated on Drawings**].
4. Exterior Color: [**Matching window exterior**].
5. Interior Color: [**Matching window interior**].

K. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, or carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock composite windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

L. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type: [**Manufacturer's standard**][**Folding operating handle, polycarbonate with integral color**].

2. Hinge-Type Operators: [**Manufacturer's standard**].
3. Hinges: [**Manufacturer's standard**][**Stainless steel**][**Washability-type casement hinges**][**Egress-type casement hinges**][**In type indicated on Drawings**] sized for sash weight and size indicated.
4. Sash Locks: Operates positive-acting arms that pull sash into locked position.
5. Limit Devices: Restrict operable sash to less than **4-inch (10-mm)** clear opening dimension; [**releasable, complying with requirements of ASTM F2090 for emergency egress mechanisms**][**fixed**].

M. Single-Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Self-latching, polycarbonate with integral color that allow unobstructed movement of the operable sash across fixed sash and operated from the inside only.

a. Material: [**Polycarbonate with integral color**][**Corrosion-resistant metal with applied**

finish].

3. Lift: [**Manufacturer's standard**].

N. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Manufacturer's standard**] of dimensions and profile indicated on Drawings; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Self-latching that allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

   a. Material: [**Polycarbonate with integral color**][**Corrosion-resistant metal with applied finish**].

3. Roller Assemblies: [**Manufacturer's standard**][**Dual adjustable**] low-friction design.
4. Pull: [**Manufacturer's standard**].

O. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

P. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

Q. Accessories:

1. Extension jamb [**attachment flange**][**attachment flange and trim of depth indicated on Drawings**].
2. Drip caps.
3. Head expanders.
4. Exterior sill extender trim.
5. Gypsum board returns.

R. Mullions: Provide manufacturer's standard [**non-reinforced**][**reinforced**] fiberglass mullion system configured to be structurally sound.

S. Insect Screens: Provide screens for each operable sash. Wickets are not permitted.

1. Type and Location: [**Full, inside for project-out**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.
2. Frames: Roll-formed or extruded-aluminum alloy complying with requirements in SMA 1201; fabricated with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC splines/anchors concealing edge of frames and securing screen material.

   a. Finish and Color: Manufacturer's standard baked-on coating in color [**selected by Architect from manufacturer's full range**][**matching window exterior**], as directed by the Owner.

3. Glass-Fiber Mesh Fabric: [**Manufacturer's standard**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with requirements in ASTM D3656/D3656M.

   a. Mesh Color: [**Charcoal gray**][**Black**].

4. Aluminum Wire Fabric: [**Manufacturer's standard**] mesh of coated aluminum wire.

   a. Wire-Fabric Finish: [**Charcoal gray**].

5. Stainless Steel Wire Fabric: [**Manufacturer's standard**] mesh of coated, Type 300 series, stainless steel wire.

2.3 FABRICATION OF COMPOSITE WINDOWS

A. Fabricate composite windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze composite windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough-opening dimensions, levelness of sill plate, and operational clearance.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMPOSITE WINDOWS

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Testing Methodology: Testing of windows for air infiltration and water resistance is to be performed in accordance with AAMA 502.
2. Air-Infiltration Testing:

   a. Test Pressure: Pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**Three**][**Three mockup**] windows of each type as selected by Architect and a qualified testing and inspecting agency. Windows are to be tested after perimeter sealants have cured, as directed by the Owner.
5. Composite windows will be considered defective if they do not pass tests and inspections.

C. Prepare test reports in accordance with AAMA 502.

3.4 ADJUSTING

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.5 CLEANING

A. Clean exposed surfaces immediately after installing windows. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

3.6 PROTECTION

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

B. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

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SECTION 08 54 13 00 - FIBERGLASS WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiberglass windows.

1.2 DEFINITIONS

A. Combination Assemblies: Assemblies formed by a combination of two or more separate fenestration products whose frames are mulled together utilizing a combination mullion or reinforcing mullion.

B. Combination Mullions: Horizontal or vertical members formed by joining two or more individual fenestration units together without a mullion stiffener.

C. Reinforcing Mullions: Horizontal or vertical members with an added continuous mullion stiffener and joining two or more individual fenestration units along the sides of the mullion stiffener.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of fiberglass windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, window rough openings, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: For units with factory-applied finishes, manufacturer's standard color

sheets, showing full range of available colors for each type of exposed finish.

1. Include Samples of hardware and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:

1. Exposed Finishes: [**Manufacturers' standard size**][**2 by 4 inches (50 by 100 mm)**].
2. Exposed Hardware: Full-size units.

E. Product Schedule: For fiberglass windows. Use same designations indicated on Drawings.

F. Delegated Design Submittals: For [**reinforcing mullions**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each fiberglass window, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Field Quality-Control Reports: For fiberglass windows.

C. Qualification Statements: For manufacturer and Installer.

D. Delegated Design Engineer Qualifications: For [**reinforcing mullions**].

E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating fiberglass windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: An installer acceptable to fiberglass window manufacturer for installation of units required for this Project.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Testing Agency Qualifications: An FGIA- or WDMA-accredited testing agency for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fiberglass windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect fiberglass windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle fiberglass windows in a manner that prevents damage before, during, and after installation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install fiberglass windows outside of limits recommended in writing by manufacturer.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fiberglass windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures, including excessive deflection, water leakage, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: [**10**] years from date of Substantial Completion.
b. Glazing Units: [**Five**][**10**][**20**] years from date of Substantial Completion.
c. Hardware: [**Three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fiberglass windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**reinforcing mullions**].

B. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: FGIA or WDMA certified with label attached to each window.

C. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance:

   a. [**Class R**][**Class LC**][**Class CW**][**As indicated on Drawings**].
   b. [**Grade 15**][**Grade 20**][**Grade 25**][**Grade 30**][**Grade 35**][**Grade 40**][**Grade 45**][**As indicated on Drawings**].

2. Mulled Window Systems: Evaluate and rate combination assemblies as single systems as determined by AAMA 450 in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 requirements.

D. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

   a. Fixed Windows: Not more than [**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.34 Btu/sq. ft. x h x deg F (1.93 W/sq. m x K)**][**0.29 Btu/sq. ft. x h x deg F (1.65 W/sq. m x K)**][**0.26 Btu/sq. ft. x h x deg F (1.48 W/sq. m x K)**].
   b. Operable Windows: Not more than [**0.62 Btu/sq. ft. x h x deg F (3.52 W/sq. m x K)**][**0.60 Btu/sq. t. x h x deg F (3.41 W/sq. m x K)**][**0.54 Btu/sq. ft. x h x deg F (3.07 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.36 Btu/sq. ft. x h x deg F (2.04 W/sq. m x K)**][**0.32 Btu/sq. ft. x h x deg F (1.82 W/sq. m x K)**].

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:

   a. Fixed Windows: Not more than [**0.23**][**0.25**][**0.36**][**0.38**][**0.40**].
   b. Operable Windows: Not more than [**0.21**][**0.23**][**0.33**][**0.34**][**0.36**] as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of [**45**][**52**].

E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

F. Windborne-Debris-Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located more than [**30 ft. (9.1 m)**] above grade.

2.3 FIBERGLASS WINDOWS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accurate Dorwin Inc.**]
2. [**Alpen High Performance Products**]
3. [**Duxton Windows and Doors**]

4. [**Fibertec Window and Door Manufacturing**]
5. [**Milgard Manufacturing, LLC**]
6. [**Pella Corporation**]

B. General: Provide manufacturer's standard fiberglass window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Project [**out**][**in**].
2. Awning: Project out.
3. Single hung.
4. Double hung.
5. Horizontal sliding.
6. Fixed.

D. Frames and Sashes: Pultruded fiberglass[**with insulating foam inserts**] complying with AAMA/WDMA/CSA 101/I.S.2/A440 and with exposed exterior fiberglass surfaces finished with manufacturer's standard enamel coating complying with [**AAMA 613**][**AAMA 623**].

1. Exterior Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Interior Finish: [**Matching exterior color and finish**][**Matching exterior finish, in color selected by Architect from manufacturer's full range**][**Wood veneer clad, maple**][**Wood veneer clad, oak**], as directed by the Owner.

E. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered [**where indicated on Drawings**].

F. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

1. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
2. Inner Ply: Clear.
3. Interlayer: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].
4. Outer Ply: [**Clear**][**Gray**][**Bronze**][**Green**].
5. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

G. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

   a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
   b. Kind: Fully tempered [**where indicated on Drawings**].

2. Lites: [**Two**][**Three**].
3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

H. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Performance Requirements" Article.

1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

a. Tint: [**Clear**][**Gray**][**Bronze**][**Green**].
b. Kind: [**Heat strengthened**][**Fully tempered**].

2. Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.

a. Float Glass: [**Annealed**][**Heat strengthened**][**Fully tempered**][**As required by performance requirements indicated**].
b. Interlayer Thickness: [**0.090 inch (2.29 mm)**][**As required by performance requirements indicated**].

3. Filling: Fill space between glass lites with [**air**][**argon**].
4. Low-E Coating: [**Pyrolytic on second surface**][**Sputtered on second surface**][**Sputtered on third surface**][**Sputtered on second or third surface**].

I. Glazing System: [**Manufacturer's standard factory-glazing system that produces weathertight seal**].

J. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock fiberglass windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type and Style: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range of types and styles**], as directed by the Owner.

2. Hinges: [**Manufacturer's standard type for sash weight and size indicated**][**Stainless steel hinges with stainless steel-reinforced, sliding nylon shoes**].
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one arm on sashes up to **27-1/2 inches (700 mm)** tall and two arms on taller sashes.
4. Limit Devices: [**Concealed friction adjustor, adjustable stay bar**][**Concealed support arms with adjustable, limited, hold-open**] limit devices designed to restrict sash opening.

a. Limit clear opening to [**4 inches (100 mm)**] for ventilation; with custodial key release.

5. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; one pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.

L. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]

3. Tilt Hardware: Releasing tilt latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

M. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**][**Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color**][**Manufacturer's standard**] of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide custodial locks.**]
3. Roller Assemblies: Low-friction design.

N. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

O. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

P. Mullions: Provide combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

2.4 ACCESSORIES

A. Dividers (False Muntins): Provide divider grilles in designs indicated for each sash lite.

1. Quantity and Type: [**One per sash, removable from exposed surface of interior lite**][**Two per sash, removable from exposed surfaces of interior and permanently located at exterior lite**][**One permanently located between insulating-glass lites**].
2. Material: [**Manufacturer's standard**].
3. Pattern: [**As indicated on Drawings**].
4. Profile: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Jamb Extensions: [**Stain-grade Pacific Hemlock**].

C. Nail Fins: Manufacturer's standard mounting flanges with holes pre-punched for mechanical fasteners.

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: [**Full, inside for project-out**][**Full, outside for project-in**][**Full, outside for double-hung**][**Half, outside for single-hung**][**Full, outside for sliding**][**Half, outside for sliding**] sashes.

B. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1201.

Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
2. Finish for Interior Screens: Baked-on organic coating in [**color selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Finish for Exterior Screens: [**Baked-on organic coating in color selected by Architect from manufacturer's full range**][**Matching color and finish of cladding**], as directed by the Owner.

C. Glass-Fiber Mesh Fabric: [**18-by-14-inch (1.1-by-1.4-mm) or 18-by-16-inch (1.1-by-1.3-mm)**][**20-by-20-inch (0.85-by-0.85-mm) or 20-by-30-inch (0.85-by-0.42-mm)**] mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: [**Manufacturer's standard**].

D. Aluminum Wire Fabric: **18-by-16-inch (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [**Natural bright**][**Charcoal gray**][**Black**].

2.6 FABRICATION

A. Fabricate fiberglass windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze fiberglass windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Window Assemblies: Provide [**bow**][**bay**][**and**][**combination**] window units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Clear [**pine**] head and seat boards.
4. Top and bottom plywood platforms.
5. Exterior head and sill casings and trim.
6. Support brackets.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of

the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings,[**vapor retarders,**] water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FIBERGLASS WINDOWS

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Test and inspect installed windows as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance to be performed in accordance with AAMA 502.
2. Air-Infiltration Testing:

   a. Test Pressure: As required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
   b. Allowable Air-Leakage Rate: [**1.5**] times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

   a. Test Pressure: [**Two-thirds**] times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
   b. Allowable Water Infiltration: No water penetration.

4. Testing Extent: [**One**][**Three**] windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows to be tested [**immediately after installation**][**at 5 percent, 50 percent, and 90 percent completion**], as directed by the Owner.
5. Test Reports: Prepared in accordance with AAMA 502.
6. Windows will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 08 54 13 00

Task	Specification	Specification Description
08 54 13 00	08 53 13 00	Vinyl Windows
08 54 13 00	08 54 00 00	Composite Windows
08 54 66 00	08 53 13 00	Vinyl Windows
08 54 66 00	08 54 00 00	Composite Windows

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SECTION 08 56 19 00 - SECURITY WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vision security windows.
2. Fixed, transaction security windows.
3. Sliding, transaction security windows.

B. Related Requirements:

1. Section 119821 "Detention Windows" for windows where persons are forcibly detained.
2. Section 099113 "Exterior Painting" for field painting exterior security windows.
3. Section 099123 "Interior Painting" for field painting interior security windows.

1.2 COORDINATION

A. Coordinate installation of anchorages for security windows. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in adjacent construction.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, weights and finishes for window units.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of

transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration: For each product.
12. Health Product Declaration: For each product.
13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
14. Environmental Product Declaration: For each product.
15. Environmental Product Declaration: For each product.
16. Environmental Product Declaration: For each product.
17. Third-Party Certifications: For each product.
18. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: For security windows.

1. Include plans, elevations, sections, and attachment details.
2. Full-size section details of framing members, including internal armoring, reinforcement, and stiffeners.
3. Location of weep holes.
4. Hardware for sliding window units.
5. Glazing details.
6. Details of [**deal tray**][**transaction drawer**][**transaction counter**][**and**][**speaking aperture**].

D. Samples for Initial Selection: For frame members with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:

1. Framing: **12-inch- (305-mm-)** long sections of frame members.
2. Transaction Drawer: **6 inches (150 mm)** square.

F. Cutaway Sample: Corner of security window, made from **12-inch (305-mm)** lengths of full-size components, and showing details of the following:

1. Joinery.
2. Anchorage.
3. Glazing.
4. Flashing and drainage.

G. Delegated Design Submittal: For security windows indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing agency**].

B. Welding certificates.

C. Product Test Reports: For each type of security window and accessory indicated as [**ballistics**][**forced-entry**] resistant, for tests performed by a qualified testing agency.

D. Configuration Disclosure Drawing: For each type of forced-entry-resistant security window, complying

with ASTM F1233.

E. Examination reports documenting inspections of substrates, areas, and conditions.

F. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

G. Field quality-control reports documenting inspections of installed products.

1. Field quality-control certification signed by Contractor.

H. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation[**and maintenance**] of units required for this Project.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack security windows in wood crates for shipment. Crate glazing separate from frames unless factory glazed.

B. Label security window packaging with drawing designation.

C. Store crated security windows on raised blocks to prevent moisture damage.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 SEQUENCING

A. Field Painting: Except where security windows have been preglazed before installation, complete field painting of security windows before glazing installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace security windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including deflections exceeding **1/4 inch (6 mm)**.

b. Failure of welds.
c. Excessive air leakage.
d. Faulty operation of sliding window hardware.
e. Faulty operation of transaction drawers.
f. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: [**Three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Attack Resistance: Provide units identical to those tested for compliance with requirements indicated, and as follows:

1. Ballistics Resistance, UL 752: [**Listed and labeled as**][**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 9**][**Level 10**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**][**Level 9-SG**][**Level 10-SG**] in accordance with UL 752.
2. Ballistics Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
3. Ballistics Resistance, HPW-TP-0500.03: [**A**][**B**][**C**][**D**][**E**]in accordance with HPW-TP-0500.03.
4. Ballistics Resistance, SD-STD-01.01: [**R**][**SH**] in accordance with SD-STD-01.01.
5. Ballistics Resistance, NIJ STD-0108.01: [**Level I**][**Level IIA**][**Level II**][**Level IIIA**][**Level III**][**Level IV**] in accordance with NIJ STD-0108.01.

6. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
7. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
8. Forced-Entry Resistance, SD-STD-01.01: [**Five**][**15**][**60**]-minute protection level in accordance with SD-STD-01.01.

I. Structural Loads: Security windows withstand the effects of wind loads, with no permanent deformation or breakage of components within window assembly when tested in accordance with ASTM E330/E330M.

1. Wind Loads: As indicated on Drawings.

J. Air Leakage, Fixed Glazing and Framing: Provide windows with maximum air leakage through fixed glazing and framing areas of [**0.06 cfm/sq. ft. (0.03 L/s per sq. m)**] of fixed wall area when tested in accordance with ASTM E283 at a minimum static-air-pressure difference of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

K. Air Leakage, Operable Window: Not more than [**0.37 cfm/ft. (0.18 L/s per m)**] of sash crack length at an inward test pressure of [**6.24 lbf/sq. ft. (298 Pa)**] when tested in accordance with ASTM E283.

L. Water Penetration under Static Pressure, Fixed Glazing and Framing: Provide windows that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than [**6.24 lbf/sq. ft. (300 Pa)**].

M. Water Penetration under Static Pressure, Operable Windows: Provide windows that do not evidence water leakage through operable units for 15 minutes when window is subjected to a rate of flow of **5 gal./h per sq. ft. (0.05 L/s per sq. m)** with a differential pressure across the window of [**2.86 lbf/sq. ft. (137 Pa)**][**6.24 lbf/sq. ft. (298 Pa)**] when tested in accordance with ASTM E331.

N. Energy Performance: Provide windows with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below[**and certified and labeled in accordance with NFRC**]:

1. Thermal Transmittance (U-Factor): Glazing and framing areas as a whole have U-factor of not more than [**0.80 Btu/sq. ft. x h x deg F (4.54 W/sq. m x K)**][**0.65 Btu/sq. ft. x h x deg F (3.69 W/sq. m x K)**] as determined in accordance with NFRC 100.
2. Solar Heat-Gain Coefficient (SHGC): Glazing and framing areas as a whole have SHGC of no greater than [**0.6**][**0.7**] as determined in accordance with NFRC 200.

O. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

2.2 VISION SECURITY WINDOWS

A. Vision Security Windows: Provide vision security windows with framing on four sides and no operable

sash or ventilator.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Action Bullet Resistant Corp.**]
    b. [**American Vault Corporation**]
    c. [**Armortex**]
    d. [**Chicago Bullet Proof Systems**]
    e. [**Creative Industries, Inc**]
    f. [**Hamilton; Gunnebo Group**]
    g. [**Krieger Specialty Products Company**]
    h. [**National Bullet Proof, Inc**]
    i. [**Norshield Security Products, LLC**]
    j. [**Overly Door Company**]
    k. [**Quikserv, Inc.**]
    l. [**Ross Technology Company**]
    m. [**SABIC Innovative Plastics IP BV**]
    n. [**Seibold Security of Florida Inc.**]
    o. [**United States Bullet Proofing, Inc.**]

B. Framing: Fabricate perimeter framing, mullions, and glazing stops from [**steel**][**metallic-coated steel sheet**][**stainless steel**][**aluminum**] as follows:

1. Profile: [**Manufacturer's standard**][**Narrow**], with minimum face dimension indicated.

    a. Minimum Face Dimension: [**2 inches (50 mm)**][**1-1/4 inches (32 mm)**][**As indicated on Drawings**].

2. Depth: [**Manufacturer's standard**][**Adjustable, two-piece clamp**][**As indicated on Drawings**].
3. Provide [**thermally broken**][**thermally improved**] construction for aluminum framing.

C. Glazing and Glazing Materials: Comply with requirements in Section 088853 "Security Glazing."

D. Materials:

1. Mild Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating designation.
4. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
5. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].
6. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than **22,000-psi (150-MPa)** ultimate tensile strength.
7. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**.

2.3 FIXED, TRANSACTION SECURITY WINDOWS

A. Fixed, Transaction Security Windows: Provide fixed, transaction security windows with operable sash or ventilator capable of allowing transfer of currency and documents.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armortex**]
b. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
c. [**Chicago Bullet Proof Systems**]
d. [**Creative Industries, Inc**]
e. [**Krieger Specialty Products Company**]
f. [**National Bullet Proof, Inc**]
g. [**Norshield Security Products, LLC**]
h. [**Overly Door Company**]
i. [**Protective Structures, Ltd.**]
j. [**Quikserv, Inc.**]
k. [**Ready Access**]
l. [**Ross Technology Company**]
m. [**SABIC Innovative Plastics IP BV**]

B. Configuration: [**One fixed-glazed panel**][**Multiple fixed-glazed panels**][**As indicated on Drawings**].

C. Framing: Fabricate perimeter framing, mullions, and glazing stops from [**steel**][**metallic-coated steel sheet**][**stainless steel**][**aluminum**] as follows:

1. Profile: [**Manufacturer's standard**][**Narrow**], with minimum face dimension indicated.

a. Minimum Face Dimension: [**2 inches (50 mm)**][**1-1/4 inches (32 mm)**][**As indicated on Drawings**].

2. Depth: [**Manufacturer's standard**][**Adjustable, two-piece clamp**][**As indicated on Drawings**].
3. Provide [**thermally broken**][**thermally improved**] construction for aluminum framing.

D. Head and Jamb Framing: Designed for [**sealant glazing**][**gasket glazing**][**voice communication by speech at normal volume**].

E. Channel-Frame Sill: Formed from stainless steel and designed for sealant glazing.

1. Transaction Counter: Stainless steel, [**12 inches (305 mm)**][**18 inches (457 mm)**] deep by width of security window, with integral deal tray [**centered in opening**][**as indicated on Drawings**].
2. Transaction Counter: Stainless steel, **21 inches (533 mm)** deep by width of security window, with operable deal tray [**centered in opening**][**as indicated on Drawings**].

F. Voice-Communication-Type Sill: Formed from stainless steel and designed to allow passage of speech at normal speaking volume without distortion.

1. Sill Depth: [**12 inches (305 mm) deep**][**18 inches (457 mm) deep with 6-inch (152-mm) deep projection on attack side**][**21 inches (533 mm) deep with 6-inch (152-mm) deep projection on both sides**].
2. Transaction Counter: Stainless steel, [**12 inches (305 mm)**][**18 inches (457 mm)**] deep by width of security window, with integral deal tray [**centered in opening**][**as indicated on Drawings**].
3. Integral Transaction-Drawer Sill: Formed from [**stainless steel**][**framing to match head and**

jamb framing]; with transaction drawer integrated into framing and contained in a stainless steel housing that forms a transaction counter on [**secure side**][**attack side**][**both sides**] of opening. Drawer front is flush with housing when drawer is closed.

G. Glazing and Glazing Materials: Comply with requirements in Section 088853 "Security Glazing."

H. Glazing Meeting Edges: Polished glazing.

I. Materials:

1. Mild Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating designation.
4. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
5. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].
6. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than **22,000-psi (150-MPa)** ultimate tensile strength.
7. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**.

2.4 SLIDING, TRANSACTION SECURITY WINDOWS

A. Sliding, Transaction Security Windows: Provide sliding, transaction security windows.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Action Bullet Resistant Corp.**]
   b. [**Armortex**]
   c. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
   d. [**Creative Industries, Inc**]
   e. [**Krieger Specialty Products Company**]
   f. [**Protective Structures, Ltd.**]
   g. [**Quikserv, Inc.**]
   h. [**Ready Access**]
   i. [**SABIC Innovative Plastics IP BV**]

B. Configuration: [**One fixed-glazed panel and one horizontal-sliding glazed panel**][**Two glazed panels that slide horizontally and meet at center of security window**][**As indicated on Drawings**].

C. Operation: [**Manual open/manual closing**][**Manual open/self-closing**].

D. Framing: Fabricate perimeter framing, mullions, and glazing stops from [**steel**][**metallic-coated steel sheet**][**stainless steel**][**aluminum**] as follows:

1. Profile: [**Manufacturer's standard**][**Narrow**], with minimum face dimension indicated.

   a. Minimum Face Dimension: [**2 inches (50 mm)**][**1-1/4 inches (32 mm)**][**As indicated on**

Drawings].

2. Depth: [**Manufacturer's standard**][**Adjustable, two-piece clamp**][**As indicated on Drawings**].
3. Provide [**thermally broken**][**thermally improved**] construction for aluminum framing.

E. Head and Jamb Framing: Designed for [**sealant**][**gasket**] glazing. Removable header access panel on secure side.

F. Sill: Stainless steel channel frame designed for [**sealant**][**gasket**] glazing.

1. Shelf: Stainless steel, [**12 inches (305 mm)**][**18 inches (457 mm)**] deep by width of security window, with integral deal tray.

G. Sliding Window Hardware: Provide roller track designed for overhead support of [**two- or four-wheel carriage**][**heavy-duty, antilift ball-bearing carrier**][**manufacturer's standard carrier**] supporting horizontal-sliding glazed panel[**with manufacturer's standard self-closing mechanism mounted in header**]. Provide [**self-latching**][**and**][**self-locking**][**manufacturer's standard**] pull and lock with two keys for each horizontal-sliding glazed panel.

1. Provide weather stripping for exterior horizontal-sliding, transaction security windows.

H. Glazing and Glazing Materials: Comply with requirements in Section 088853 "Security Glazing."

1. Glazing Meeting Edges: Polished glazing.

I. Materials:

1. Mild Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating designation.
4. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
5. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].
6. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than **22,000-psi (150-MPa)** ultimate tensile strength.
7. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**.

2.5 FABRICATION

A. General: Fabricate security windows to provide a complete system for assembly of components and anchorage of window units.

1. Provide units that are reglazable from the secure side without dismantling the attack side of framing.
2. Prepare security windows for field glazing unless preglazing at the factory is indicated.

B. Provide weep holes and internal water passages for exterior security windows to conduct infiltrating water to the exterior.

C. Thermally Improved or Thermally Broken Construction: Fabricate framing with an integral, concealed, low-conductance thermal barrier, located between exterior materials and members exposed on interior

in a manner that eliminates direct metal-to-metal contact.

D. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.

1. Fabricate framing with manufacturer's standard, internal opaque armoring in thicknesses required for security windows to comply with ballistics-resistance performance indicated.

E. Glazing Stops: Finish glazing stops to match security window framing.

1. Attack-Side (Exterior) Glazing Stops: Welded or integral to framing.
2. Secure-Side (Interior) Glazing Stops: Removable, coordinated with glazing indicated.

F. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

H. Factory-cut openings in glazing for speaking apertures.

I. Preglazed Fabrication: Preglaze window units at factory, where required for applications indicated. Installation orientation of glazing to meet performance requirements. Comply with requirements in Section 088853 "Security Glazing."

J. Weather Stripping: Factory applied.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.8 METALLIC-COATED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the coating to be applied over it.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 STEEL FINISHES

A. Galvanizing: After fabrication, galvanize window components by chemical cleaning complying with SSPC-SP 1, "Solvent Cleaning," and pickling treatment complying with SSPC-SP 8, "Pickling," followed by hot-dip galvanizing complying with ASTM A123/A123M.

B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

C. Baked-Enamel or Power-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.10 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.

2.11 ACCESSORIES

A. Recessed Deal Trays: Formed from stainless steel[**with sliding stainless steel cover**]; fabricated in curved shape with exposed flanges for recessed installation into horizontal surface.

1. Clear Opening Size: [**12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high)**][**12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high)**][**16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high)**].

B. Recessed, Nonricochet Deal Trays: Formed from stainless steel; fabricated with recessed bullet trap to ricochet bullets away from secure side, with exposed flanges for recessed installation into horizontal surface[**and with sliding stainless steel cover**].

1. Clear Opening Size: [**10 inches wide by 7 inches deep by 1-1/2 inches high (254 mm wide by 178 mm deep by 38 mm high)**][**12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high)**][**12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high)**][**16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high)**].
2. Bullet Trap Location: [**Secure side**][**Both sides**].
3. Ballistics Resistance: [**UL Level 1**][**UL Level 3**][**Same as security window**].
4. Listed and labeled as bullet resisting in accordance with UL 752.

C. Rotating Deal Trays: Formed from stainless steel, with rotating recessed deal tray on each side of secure opening and with handle that rotates deal trays 180 degrees.

1. Mounting: [**Drop in**][**Countertop**].
2. Ballistics Resistance: [**UL Level 1**][**UL Level 3**][**Same as security window**].
3. Listed and labeled as bullet resisting in accordance with UL 752.

D. Transaction Drawers: Formed from [**stainless steel**][**steel**][**bullet-resistant armoring**]; with ball-bearing, telescoping sliding mechanism; with cover on secure side of top of drawer that automatically closes when drawer is extended to attack side.

1. Inside Dimensions: [**15-3/8 inches wide by 8-1/2 inches deep by 4-3/8 inches high (390 mm wide by 216 mm deep by 111 mm high)**][**13 inches wide by 22 inches deep by 6-1/2 inches high (330 mm wide by 559 mm deep by 165 mm high)**].
2. Operation: [**Manual**][**Electric, with sliding handle for emergency manual operation during lack of power. Provide individual switches for power and drawer movement on secure side and call button on attack side**].
3. Ballistics Resistance: [**UL Level 1**][**UL Level 3**][**Same as security window**].
4. Listed and labeled as bullet resisting in accordance with UL 752.

E. Speaking Apertures: Fabricate from [**stainless steel**][**security glazing**], designed to allow passage of speech at normal speaking volume without distortion.

1. Shape: [**Circular**][**Square**].
2. Ballistics Resistance: [**UL Level 1**][**UL Level 3**][**Same as security window**].
3. Listed and labeled as bullet resisting in accordance with UL 752.

F. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

G. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to [**four**] times the load imposed, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A27/A27M cast steel or ASTM A47/A47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

H. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

I. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

J. Glazing Strips and Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Molded EPDM or neoprene gaskets complying with ASTM D2000, Designations 2BC415 to 3BC620; molded PVC gaskets complying with ASTM D2287; or molded, expanded EPDM or neoprene gaskets complying with ASTM C509, Grade 4.
2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric backing.

K. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers and with a proven record of compatibility with surfaces contacted in installation.

1. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
2. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
3. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

L. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, complying with ASTM B633; provide sufficient strength to withstand design pressures indicated.

M. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

N. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant remains permanently elastic, nonshrinking, and nonmigrating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of security windows.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of security window connections before security window installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of security windows.

D. Inspect built-in and cast-in anchor installations, before installing security windows, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare anchor inspection reports.

E. For factory-installed glazing materials whose orientation (secure or attack side) is critical for performance, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other security window anchors whose installation is specified in other Sections.

1. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.

3.3 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing security windows to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.

1. Install an attached or integral flange to secure side of security windows extending over rough-in opening gap so that gap has same [**forced-entry-resistance**][**and**][**ballistics-resistance**] performance as security window.

B. Voice-Communication-Type Framing: Attach removable glass spacers to jambs and head of glazing, located not more than **6 inches (152 mm)** from each corner and spaced not more than **12 inches (305 mm)** o.c.

C. Glazed Framing: Provide [**sealant**][**gasket**]-glazed framing. Comply with installation requirements in Section 088853 "Security Glazing."

D. Removable Glazing Stops and Trim: Fasten components with security fasteners.

E. Fasteners: Install security windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials.[**Provide stainless steel fasteners in stainless steel materials.**]

F. Sealants: Comply with requirements in Section 079200 "Joint Sealants" for installing sealants, fillers, and gaskets.

1. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction unless otherwise indicated.
2. Seal frame perimeter with sealant to provide weathertight construction unless otherwise indicated.

G. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against

corrosion by painting contact surfaces with bituminous paint.

3.4 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

C. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.

3.5 ADJUSTING

A. Adjust horizontal-sliding, transaction security windows to provide a tight fit at contact points for smooth operation and a secure enclosure.

B. Adjust transaction drawers to provide a tight fit at contact points[**and weather stripping**] for smooth operation and[**weathertight and**] secure enclosure.

C. Remove and replace defective work, including security windows that are warped, bowed, or otherwise unacceptable.

3.6 CLEANING AND PROTECTION

A. Clean surfaces promptly after installation of security windows. Take care to avoid damaging the finish. Remove excess glazing and sealant compounds, dirt, and other substances.

1. Lubricate sliding security window hardware.
2. Lubricate transaction drawer hardware.

B. Clean glass of preglazed security windows promptly after installation. Comply with requirements in Section 088853 "Security Glazing" for cleaning and maintenance.

C. Provide temporary protection to ensure that security windows are without damage at time of Substantial Completion.

3.7 DEMONSTRATION

A. Train the Owner's maintenance personnel to adjust, operate, and maintain [**operable security windows**][**and**][**security windows with transaction drawers**].

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Task	Specification	Specification Description
08 56 49 00	13 49 00 00	Radiation Protection

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SECTION 08 62 00 00 - UNIT SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unit skylights.
2. Tubular daylighting devices.

B. Related Requirements:

1. Section 084513 "Structured-Polycarbonate-Panel Assemblies" for metal-framed skylights glazed with translucent insulating panels.
2. Section 084523 "Fiberglass-Sandwich-Panel Assemblies" for metal-framed skylights glazed with translucent insulating panels.
3. Section 086100 "Roof Windows" for flat, insulating-glass fenestration units installed in sloped ceiling areas and intended for in-reach operation.
4. Section 086300 "Metal-Framed Skylights" glass-glazed, site-erected, metal-framed skylights.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include product dimensions, construction details, material descriptions, dimensions and profiles of components, and finishes.
2. Include power requirements, ratings, characteristics, and mounting requirements for electrical components.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
5. Environmental Product Declaration (EPD): For each product.
6. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
7. Environmental Product Declaration: For each product.
8. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
9. Environmental Product Declaration: For each product.
10. Environmental Product Declaration: For each product.
11. Third-Party Certifications: For each product.
12. Third-Party Certified Life Cycle Assessment: For each product.

B. Shop Drawings:

1. Include plans, elevations, sections, mounting, and attachment details and methods of structural support.
2. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and finish specified.

D. Samples for Initial Selection: For each type of glazing and exposed factory-applied finish.

1. Include Samples of accessories involving color and finish selection.

E. Samples for Verification: For each product, as follows:

1. Glazing: [**In manufacturer's standard size**][**12 inches (305 mm) square**] and of same thickness indicated for the final Work.
2. Finishes: For each type and color of factory-applied exposed finish required, in manufacturer's standard size.
3. Interior Diffuser Lens for Tubular Daylighting Device: [**Full size**].

F. Product Schedule: For each type of product specified.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type and size of product, for tests performed by a qualified testing agency on specimens equal to or greater than sizes required for Project.

B. Evaluation Reports: [**Indicating product compliance with code requirements of authorities having jurisdiction**].

C. Field quality-control reports.

D. Sample Warranty: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For products and accessories to include in maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Water leakage not controlled by drainage features.
c. Deterioration of materials and finishes beyond normal weathering.
d. Yellowing of acrylic glazing.
e. Breakage of polycarbonate glazing.

f. Deterioration of insulating-glass units including failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating-glass units contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

2. Warranty Period:

a. Products and Accessories: [**Five**] years from date of Substantial Completion.
b. Insulating-Glass Units: [**10**][**20**] years from date of Substantial Completion.

B. Special Aluminum Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of finish deterioration within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, peeling, checking, or chipping.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Standard: Comply with AAMA/WDMA/CSA 101/1.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Minimum Performance Grade: PG [**30**][**50**][**70**][**90**][**125**][**165**].
2. Label Requirements: Label each product with names of manufacturer and labeling agency and AAMA/WDMA/CSA 101/1.S.2/A440 product designation, performance grade, and test specimen size equal to or greater than the size of the product.
3. Certification Requirements: Provide [**AAMA**][**WDMA**] certified products, with label attached to each.

B. Thermal Transmittance: NFRC 100 maximum U-factor of [**0.42 Btu/sq. ft. x h x deg F (2.38 W/sq. m x K)**][**0.45 Btu/sq. ft. x h x deg F (2.56 W/sq. m x K)**][**0.46 Btu/sq. ft. x h x deg F (2.61 W/sq. m x K)**][**0.48 Btu/sq. ft. x h x deg F (2.73 W/sq. m x K)**][**0.50 Btu/sq. ft. x h x deg F (2.84 W/sq. m x K)**][**0.53 Btu/sq. ft. x h x deg F (3.01 W/sq. m x K)**][**0.55 Btu/sq. ft. x h x deg F (3.12 W/sq. m x K)**][**0.60 Btu/sq. ft. x h x deg F (3.41 W/sq. m x K)**].

C. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum SHGC of [**0.40**][**0.35**][**0.28**].

D. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

E. Plastic Glazing:

1. Self-Ignition Temperature: **650 deg F (343 deg C)** or more for plastic sheets in thickness indicated when tested in accordance with ASTM D1929.
2. Smoke-Production Characteristics: Smoke-developed index of 450 or less when tested in accordance with ASTM E84, and smoke density of 75 or less when tested in accordance with ASTM D2843.
3. Combustibility Characteristics: Tested in accordance with ASTM D635 and classified for burning rate of nominal thickness of **0.060 inch (1.5 mm)** or thickness of plastic glazing indicated for use as follows:

    a. Class CC1: Burning rate of **1 inch (25 mm)** per minute or less.
    b. Class CC2: Burning rate of **2-1/2 inches (64 mm)** per minute or less.

F. Exterior Fire-Test Exposure: Provide products identical to those of assemblies tested for Class B fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Fall-Protection Performance: [**Installed assemblies are capable of safely supporting the greater of 400 lbs (181.4 kg) or twice the weight of employees, equipment, and materials that may be imposed on any 1 sq. foot (0.09 sq. m) of the assembly at any time**].

2.2 UNIT SKYLIGHTS

A. Factory-Assembled Skylight: Unit that includes glazing, extruded-aluminum glazing retainers, gaskets, and inner frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AES Sunoptics; Acuity Brands International, Inc.**]
    b. [**American Skylights, Inc.**]
    c. [**Birdview Skylights**]
    d. [**Dayliter Skylights Inc.**]
    e. [**Dome'l Inc.**]
    f. [**Dur-Red Products**]
    g. [**Energy-Glazed Systems, Inc.**]
    h. [**Exarc Skylights, Inc**]
    i. [**FAKRO America, LLC**]
    j. [**Kingspan Light + Air LLC**]
    k. [**Lane-Aire Manufacturing Corp.**]
    l. [**Major Industries, Inc.**]
    m. [**Plasteco, Inc**]
    n. [**Plastic Engineering Company of Tulsa, Inc.**]
    o. [**Skyline Sky-Lites, LLC**]
    p. [**Solar Industries, Inc.**]
    q. [**Sun-Tek Manufacturing, Inc.**]
    r. [**Sunglo Skylight Products**]
    s. [**Wasco Part of Velux Commercial; Velux America LLC**]
    t. [**Wisconsin Solar Design Inc**]

B. Product Type: AAMA/WDMA/CSA 101/1.S.2/A440 [**SKG, unit skylight - glass glazed**][**SKP, unit skylight - plastic glazed**].

1. Provide [**fixed (nonoperable)**][**venting (operable)**] units.

C. Outside-Inside Transmission Class (OITC): Rated for not less than [**22**][**26**][**30**] OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

D. Unit Shape and Size: [**As indicated**][**Square, 40-by-40-inch (1016-by-1016-mm) inside curb**][**Rectangular, 40-by-48-inch (1016-by-1219-mm) inside curb**][**Circular, 40-inch- (1016-mm-) diameter inside curb**].

E. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber); and Class CC2 based on testing in accordance with ASTM D635.

1. Single-Glazing Profile: [**Dome, 25 percent rise**][**Pyramid, 30-degree slope**].

a. Thickness: [**As indicated**][**Not less than thickness required to meet specified requirements**].
b. Color: [**Colorless, transparent**][**White, translucent**][**Bronze tinted, transparent**][**Gray tinted, transparent**].

2. Double-Glazing Profile: [**Dome, 25 percent rise**][**Pyramid, 30-degree slope**].

a. Thicknesses of Each Glazing Layer: [**As indicated**][**Not less than thicknesses required to meet specified requirements**].
b. Outer Glazing Color: [**Colorless, transparent**][**White, translucent**][**Bronze tinted, transparent**][**Gray tinted, transparent**].
c. Inner Glazing Color: [**Colorless, transparent**][**White, translucent**][**Bronze tinted, transparent**][**Gray tinted, transparent**].

F. Polycarbonate Glazing: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated in accordance with UL 972; with average impact strength of **12 to 16 ft-lb/in. (640 to 854 J/m)** of width when tested in accordance with ASTM D256, Test Method A (Izod); and Class CC1 based on testing in accordance with ASTM D635.

1. Single-Glazing Profile: [**Dome, 25 percent rise**][**Pyramid, 30-degree slope**].

a. Thickness: [**As indicated**][**Not less than thickness required to meet specified requirements**].
b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Double-Glazing Profile: [**Dome, 25 percent rise**][**Pyramid, 30-degree slope**].

a. Thicknesses of Each Glazing Layer: [**As indicated**][**Not less than thicknesses required to meet specified requirements**].
b. Inner Glazing Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
c. Outer Glazing Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's stand colors**], as directed by the Owner.

G. Insulating Glass: Sealed units that comply with Section 088000 "Glazing," in manufacturer's standard

overall thickness.

1. Exterior Lite: [**6-mm, tinted, fully tempered**][**6-mm, clear, heat-strengthened**] glass.
2. Interior Lite: [**Laminated glass; two plies of 3-mm clear heat-strengthened glass with 0.030-inch (0.76-mm) clear polyvinyl butyral interlayer**].
3. Interspace Content: [**Air**][**Argon**].
4. Low-Emissivity Coating: [**Manufacturer's standard**].

H. Polycarbonate-Insulating-Panel Glazing: Manufacturer's standard polycarbonate sheet with cellular cross section that provides isolated airspaces, coextruded with a UV-protective layer, and Class CC2 based on testing in accordance with ASTM D635.

1. Thickness: [**As indicated**][**Not less than thickness required to meet specified requirements**].
2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Fiberglass-Sandwich-Panel Glazing: Manufacturer's standard with uniformly colored, translucent, fiberglass-reinforced-polymer face sheets permanently adhered to a grid core; [**Class CC1**][**Class CC2**] based on testing in accordance with ASTM D635.

1. Thickness: [**As indicated**][**Not less than thickness required to meet specified requirements**].
2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Glazing Gaskets: [**Manufacturer's standard**][**EPDM, neoprene, partially vulcanized butyl tape, or liquid-applied elastomeric sealant**].

K. Integral Curb: [**Extruded-aluminum, ASTM B221 (ASTM B221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of Alloy 6063-T52**][**Manufacturer's standard vinyl profile**][**Manufacturer's standard reinforced-thermoset-fiberglass profile**], self-flashing type.

1. Height: [**As indicated on Drawings**][**8 inches (203 mm)**][**9 inches (229 mm)**][**12 inches (305 mm)**].
2. Construction: [**Single**][**Double**] wall.
3. Insulation: [**Manufacturer's standard rigid or semirigid type**].

   a. Exposed Insulation: Cover face of insulation exposed to interior of building with [**aluminum**][**vinyl**] liner.

L. Prefabricated Curb: As specified in Section 077200 "Roof Accessories."

M. Condensation Control: Fabricate unit skylights with integral internal gutters and nonclogging weeps to collect and drain condensation to the exterior.

N. Thermal Break: Fabricate unit skylights with thermal break separating exterior and interior metal framing.

O. Operator: Equip operable unit skylights with manufacturer's standard hinges, chain-driven operating hardware, and weather-sealing gaskets.

1. Manual Operator: Manufacturer's standard, rotary-crank extension device.

   a. Pole Operator: [**Manual, 60 inches (1524 mm) long**][**Manual, telescoping to 144 inches (3658 mm)**][**Rechargeable-motor, power-driven type, telescoping to 144 inches (3658**

mm)].

2. Motor Operator: Manufacturer's standard electronic control, including switch, transformer, low-voltage motor, cover, mounting hardware, and other components required for a complete installation.

   a. Provide motor of size and capacity recommended by unit skylight manufacturer to suit unit skylight indicated.
   b. Rain Sensors: Provide rain sensor that automatically closes operable unit when water is detected.
   c. Remote Control: Provide motor operator with portable remote-control device.

P. Accessories:

1. Security Grille: **1/2-inch- (13-mm-)** diameter, hardened steel bars spaced not more than [**5 inches (127 mm) o.c. in one direction and 16 inches (406 mm) o.c. in other direction**][**5 inches (127 mm) o.c. in both directions**].
2. Protective Screen: Manufacturer's standard to protect against [**falling glass**][**hail**].
3. Manual Blackout Shade: [**Manufacturer's standard sized to fit unit-skylight opening**].

Q. Aluminum Finishes:

1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
3. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

   a. Color: [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Champagne**], as directed by the Owner.
   b. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. High-Performance Organic Finish, Two-Coat: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. High-Performance Organic Finish, Three-Coat: Fluoropolymer finish complying with AAMA 2605 and containing not less than [**50**][**70**] percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

7. High-Performance Organic Finish, Four-Coat: Fluoropolymer finish complying with AAMA 2605 and containing not less than [**50**][**70**] percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 TUBULAR DAYLIGHTING DEVICES

A. Tubular Daylighting Device: Complete with exterior glazed opening, glazing retainers and gaskets, exterior flashing assembly, reflective tube, interior diffuser assembly, and components and accessories required to provide a complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AES Sunoptics; Acuity Brands International, Inc.**]
b. [**Solarise, Inc.**]
c. [**Solatube International, Inc.**]
d. [**Sun-Tek Manufacturing, Inc.**]
e. [**Tubular Skylight Inc.**]
f. [**Velux Commercial; Velux America LLC**]

B. Product Type: AAMA/WDMA/CSA 101/1.S.2/A440 [**TDDCC, tubular daylighting device - closed ceiling**][**TDDOC, tubular daylighting device - open ceiling**].

C. Nominal Reflective Tube Diameter: [**5-1/2 inches (140 mm)**][**8 inches (203 mm)**][**10 inches (254 mm)**][**13 inches (330 mm)**][**14 inches (356 mm)**][**21 inches (533 mm)**][**22 inches (559 mm)**][**29 inches (737 mm)**].

D. Exterior Glazing: Manufacturer's standard [**single dome**][**double dome**][**collector dome and cylinder**].

1. Size: [**As required to coordinate with reflective tube**].
2. Material:

a. Acrylic: ASTM D4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber); and Class CC2 based on testing in accordance with ASTM D635.
b. Polycarbonate: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated in accordance with UL 972; with average impact strength of **12 to 16 ft-lb/in. (640 to 854 J/m)** of width when tested in accordance with ASTM D256, Test Method A (Izod); and Class CC1 based on testing in accordance with ASTM D635.
c. Minimum Thickness: [**0.125 inch (3.18 mm)**][**As required to meet specified requirements**].

3. Seal: [**Manufacturer's standard**][**Adhesive-backed foam weatherstripping**].

4. Exterior Glazing Accessories:

   a. Fire-Protection Band: Dome edge-protection band matching flashing material and finish. Domes installed with fire-protection band pass Class B burning brand tests when tested in accordance with ASTM E108.
   b. Secondary Diffuser: [**Manufacturer's standard ASTM D4802 acrylic, Class CC2 based on testing in accordance with ASTM D635**].
   c. Security Bar: [**Manufacturer's standard ASTM A240/A240M Type 304 stainless steel bar across flashing diameter opening**].
   d. Security Grille: Manufacturer's standard [**powder-coated steel**][**stainless steel**] **1/8-inch-(3.2-mm-)** diameter rods formed into guard with maximum **8-inch (203-mm)** opening and fastened to curb-cap assembly.
   e. Security Kit: [**Manufacturer' standard rivets with nylon spacers to replace dome screws**].

E. Exterior Flashing: Manufacturer's standard [**one-piece, self-mounted**][**two-piece, self-mounted**][**one-piece, curb-cap**] type.

1. Size: [**As required to coordinate with exterior glazing and reflective tube**].
2. Base Pitch: [**None, flat**][**22.5-degree slope from horizontal**].
3. Base Height: [**Manufacturer's standard low-profile**][**4 inches (102 mm)**][**8 inches (203 mm)**][**11 inches (279 mm)**].
4. Prefabricated Curb: As specified in Section 077200 "Roof Accessories."
5. Material: [**Manufacturer's standard corrosion-resistant metal and finish**][**ASTM A 653/A 653M commercial steel or forming steel with G90 (Z275) hot-dip galvanized coating, 0.023 inches (0.58 mm) thick, finished with grey powder coat**].
6. Tube Attachment: Manufacturer's standard receiver attached to top of roof flashing and serving as mounting base for dome assembly; provides thermal break between flashing and reflective tube; configured to channel condensed moisture to the exterior.

   a. Seal: [**Manufacturer's standard**] that provides weathertight seal with roof flashing.

7. Flashing Accessories:

   a. Flashing Insulation: [**Manufacturer's standard thermal isolation material**].
   b. Turret Extension: Manufacturer's standard extension tube in length [**indicated on Drawings**].
   c. Roof-Membrane Counterflashing: [**Manufacturer's standard corrosion-resistant aluminum**].

F. Reflective Tube:

1. Flexible Tube: Reflective, metalized polyester, fiberglass scrim, and steel-wire spring tube.

   a. Length: [**As required to accommodate installation area**][**8 foot (2.4 m)**].

      1) Tube Extensions: Provide manufacturer's standard components as required to accommodate installation areas indicated.

2. Rigid Tube: Light shaft formed from aluminum sheet, **ASTM B209 (ASTM B209M)**, with [**manufacturer's standard specular interior finish**].

   a. Thickness: [**Manufacturer's standard**][**0.016 inch (0.41 mm)**][**0.018 inch (0.46 mm)**].
   b. Length and Configuration: [**As indicated on Drawings**].

      1) Tube Extensions: [**Provide manufacturer's standard components as required to**

accommodate installation areas indicated].

2) Tube Elbows: Provide angle adaptors adjustable to [**45**][**30**][**90**] degrees as required to accommodate installation areas indicated.
3) Rotating Couplers: Rotating adaptors allowing coupling of two elbows to create 90-degree transition of tube.

c. Color Rendition: When tested in accordance with ASTM E308, minimum L* axis value of 99 and a* (green to red) and b* (blue to yellow) axes values not more than [**1**][**2**] or less than minus [**1**][**2**] in accordance with CIELAB results.
d. Fastening System: [**Manufacturer's standard**] that provides tight mating of interconnecting tube component pieces.

3. Tube Accessories:

a. Suspension Wire: [**Manufacturer's standard to provide bracing of tube to structure as required for a fully supported installation**].
b. Extension Tube with Thermal Insulation Panel: [**Manufacturer's standard extension-tube assembly containing two light-transmitting, acrylic discs with an airspace between them and secured together by a plastic band to prevent conductive and convective heat transfer. Plastics are Class CC2 based on testing in accordance with ASTM D635**].
c. Ceiling Trim: [**Manufacturer's standard trim for ceiling opening**].
d. Trim Ring: [**Manufacturer's standard trim that covers the cut edge of the roof deck penetration**].

G. Interior Diffuser: Assembly attached to bottom of reflective tube, with high-visible-light-transmittance lens[**separated by airtight seals providing insulating airspace**].

1. Size: [**As required to coordinate with reflective tube**].
2. Lens Type: [**Round, prismatic lens, acrylic Class CC2 based on testing in accordance with ASTM D635**][**Round, Fresnel lens, acrylic Class CC2 based on testing in accordance with ASTM D635**][**Round, prismatic lens, polycarbonate Class CC1 based on testing in accordance with ASTM D635**][**Translucent white glass globe with metal trim ring**].

a. Metal Trim Finish: [**White**][**Brushed nickel**][**Polished brass**][**Oil-rubbed bronze**].

H. Accessories:

1. Daylight Dimmer: Manufacturer's standard dimmer baffle, [**electro-mechanical, and complete with power supply, switch, and daylight valve that adjusts daylight output when actuated**][**low-voltage, programmable, and complete with 12 V DC dimming control switch and 20 W low-voltage transformer**].
2. Light Kit: [**Supplemental electrical light fixture kit with fluorescent GU24 lamp base, 120 V AC, 60 Hz, maximum 26 W lamp**][**Light fixture kit for use with one 23 W LED lamp**].
3. Exhaust Fan: [**Manufacturer's standard 110 cfm (52 L/s) exhaust-fan assembly complete with separate exhaust duct, air-intake trim, exhaust vent cap, and permanently lubricated in-line fan motor**].
4. Manual Blackout Shade: [**Manufacturer's standard sized to fit ceiling diffuser opening**].

2.4 ACCESSORY MATERIALS

A. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal that is compatible with the materials being fastened and as recommended in writing by manufacturer. Finish exposed fasteners to match material being fastened.

1. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.

B. Bituminous Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNIT SKYLIGHTS

A. Coordinate installation of products and accessories with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.

B. Install products and accessories to comply with recommendations in AAMA 1607 and with manufacturer's written installation instructions.

C. Install products true to line and without distortion.

D. Anchor products securely to supporting substrates.

E. Where metal surfaces of products will contact other metal or corrosive substrates, such as preservative-treated wood, apply bituminous coating on concealed metal surfaces or provide other approved permanent separation recommended in writing by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. After completion of installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test for water leaks in accordance with AAMA 501.2.

C. Perform test for total area of each installed product.

D. Work will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.4 CLEANING AND ADJUSTING

A. Clean exposed product surfaces in accordance with manufacturer's written instructions. Touch up damaged metal coatings and finishes.

B. Remove excess sealants, glazing materials, dirt, and other substances.

C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect product surfaces from contact with contaminating substances resulting from construction operations.

E. Unit-Skylight Operating System: Clean and lubricate joints and hardware. Adjust for proper operation.

F. Daylight Dimmer Assemblies: Test and adjust dimmer assemblies in tubular daylighting devices for proper operation.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain the following:

1. Operating systems for unit skylights.
2. Daylight dimmer assemblies for tubular daylighting devices.

END OF SECTION 08 62 00 00

Task	Specification	Specification Description
08 62 23 00	08 62 00 00	Unit Skylights

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SECTION 08 63 00 00 - METAL-FRAMED SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Metal-framed skylights.

B. Related Requirements:

1. Section 084433 "Sloped Glazing Assemblies" for glazed curtain walls in which the glazed panels are primarily on a sloped plane.
2. Section 086200 "Unit Skylights" for skylights without framing except at the perimeter of the glazing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
2. Motors: Show nameplate data, power requirements, ratings, characteristics, and mounting arrangements.

B. Shop Drawings: For metal-framed skylights. Include the following information, as applicable:

1. Plans, elevations, sections, and attachment details.
2. Structural loadings and reactions to be transmitted to supporting curbs.
3. Details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
4. Full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:

   a. Joinery including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.

5. Manual Operators: Show locations, mounting, and details for installing operator components and controls.
6. Motor Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.

   a. Diagrams for power, signal, and control wiring for electric motors of operable metal-framed

skylights.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each framing intersection of assemblies, made from **12-inch (305-mm)** lengths of full-size components and showing details of the following:

1. Joinery including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

F. Delegated Design Submittals: For metal-framed skylights indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Sustainable Design Submittals:

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Compatibility and Adhesion Test Reports: For structural-sealant-glazed skylights, test reports from sealant manufacturer indicating that joint sealants have been tested for each material that will come in contact with sealants.

B. Product Test Reports: For metal-framed skylights, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Qualification Statements: For Installer.

E. Delegated Design Engineer Qualifications: For metal-framed skylights.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal-framed skylights [**and**][**metal-framed skylight operating system**].

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer for installation of metal-framed skylights required for this Project.

B. Structural-Sealant Glazing: Comply with recommendations in ASTM C1401 for joint design and quality-control procedures.

1. Joint designs are reviewed and approved by structural-sealant manufacturer.
2. Quality-control program development and reporting comply with ASTM C1401 recommendations for material qualification procedures, preconstruction sealant-testing program, and procedures and intervals for fabrication and installation reviews and checks.
3. Perform manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration caused by thermal movements.
c. Deterioration of metals[metal finishes,] and other materials beyond normal weathering.
d. Adhesive or cohesive sealant failures.
e. Water leakage.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal-framed skylights from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-framed skylights.

B. Structural Loads: [**As indicated on Drawings**].

C. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Glazing Plane: Limited to [**edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite**][**1/175 of clear span for spans up to 13 ft. 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans more than 13 ft. 6 inches (4.1 m)**] or an amount that restricts edge deflection of individual glazing lites to **3/4 inch (19.1 mm)**, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to [**L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller**][**amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm)**].

D. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.

E. Structural-Test Performance: Metal-framed skylights tested in accordance with ASTM E330/E330M, as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified deflection limits.
2. When tested at [**150**] percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding [**0.2**] percent of span.
3. Test Durations: As required by design wind velocity, but not less than [**10**] seconds.

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 ft. (9.1 m)** and [**60 ft. (18.3 m)**] above grade.

G. Air Leakage: Metal-framed skylights with maximum air leakage through fixed glazing and framing areas of [**0.06 cfm/sq. ft. (0.03 L/s per sq. m)**] of when tested in accordance with ASTM E283/E283M at a minimum static-air-pressure difference of [**1.57 lbf/sq. ft. (75 Pa)**][**6.24 lbf/sq. ft. (300 Pa)**].

H. Water Penetration under Static Pressure: Metal-framed skylights that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than

[**6.24 lbf/sq. ft. (300 Pa)**].

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

J. Condensation Resistance: Metal-framed skylights with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than [**45**][**53**] when tested in accordance with AAMA 1503.

1. Haze Factor: Greater than 90 percent when tested in accordance with ASTM D1003.

K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant occurs before adhesive failure.

L. Energy Performance: Provide metal-framed skylights with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below[**and certified and labeled in accordance with NFRC**]:

1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas have U-factor of not more than [**0.80 Btu/sq. ft. x h x deg F (4.54 W/sq. m x K)**][**0.65 Btu/sq. ft. x h x deg F (3.69 W/sq. m x K)**] as determined in accordance with NFRC 100.
2. Solar Heat-Gain Coefficient (SHGC): Fixed glazing and framing areas have a SHGC of no greater than [**0.6**][**0.7**] as determined in accordance with NFRC 200.

M. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 METAL-FRAMED SKYLIGHTS

A. Metal-Framed Skylights: Glazed skylight assemblies supported by aluminum framing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acurlite Structural Skylights, Inc.**]
b. [**Custom Designed Skylights, Inc.**]
c. [**Exarc Skylights, Inc**]
d. [**Gammans Skylight Systems**]
e. [**Kawneer Company, Inc.; Arconic Corporation**]
f. [**Kingspan Light + Air LLC**]
g. [**Linel; Mestek, Inc.**]
h. [**OldCastle BuildingEnvelope (OBE)**]
i. [**Skyline Sky-Lites, LLC**]
j. [**Solar Innovations, Inc.**]
k. [**Sunglo Skylight Products**]
l. [**Super Sky Products Enterprises, LLC**]
m. [**Sussman Architectural Products**]
n. [**Unicel Architectural Corp.**]
o. [**Wasco Part of Velux Commercial; Velux America LLC**]
p. [**Wisconsin Solar Design Inc**]

B. Aluminum Framing Systems: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.

C. Aluminum: Alloy and temper as recommended in writing by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B209/B209M.
2. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.
3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
4. Structural Profiles: ASTM B308/B308M.

D. Operable Systems: Equip operable metal-framed skylights with manufacturer's standard hinges, chain-driven operating hardware, and weather-sealing gaskets.

1. Manual Operator: Manufacturer's standard, rotary-crank extension device.

a. Pole Operator: [**Manual, 60 inches (1524 mm) long**][**Manual, telescoping to 144 inches (3658 mm)**][**Rechargeable-motor, power-driven type, telescoping to 144 inches (3658 mm)**].

2. Motor Operator: Manufacturer's standard electronic control, including switch, transformer, low-voltage motor, cover, and mounting hardware.

a. Provide motor of size and capacity recommended by metal-framed skylight manufacturer to suit metal-framed skylight indicated.
b. Rain Sensors: Provide rain sensor that automatically closes operable unit when water is detected.
c. Remote Control: Provide motor operator with portable remote-control device.

E. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners.

F. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

G. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. At pressure caps, use ASTM A193/A193M stainless steel screws.
2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
3. Reinforce members as required to receive fastener threads.
4. Use exposed fasteners with countersunk Phillips screw heads[finished to match framing system][fabricated from Series 300 stainless steel].

H. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

I. Anchor Bolts: ASTM A307, Grade A, galvanized steel.

J. Concealed Flashing: [**Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**][**Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A240/A240M of type recommended in writing by manufacturer**].

K. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than [**0.030 inch (0.762 mm)**][**0.040 inch (1.016 mm)**][**0.060 inch (1.524 mm)**] thick.

L. Framing Sealants: As [**recommended in writing by manufacturer.**][**specified in Section 079200 "Joint Sealants."**]

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

a. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
c. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

M. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.4 GLAZING

A. Glazing: As specified in [**Section 088000 "Glazing."**][**Section 088400 "Plastic Glazing."**]

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Spacers and Setting Blocks: [**Manufacturer's standard elastomeric types.**][**As specified in Section 088000 "Glazing."**][**As specified in Section 088400 "Plastic Glazing."**]

D. Glazing Sealants: As recommended in writing by manufacturer.

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

a. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
c. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. Structural Glazing Sealants:

1. Structural Sealant: ASTM C1184, neutral-curing silicone formulation compatible with system

components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in metal-framed skylights indicated.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Weatherseal Sealant: ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.

   a. Color: Matching structural sealant.

3. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

   a. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   b. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
   c. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

4. Bond-Breaker Tape: [**Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion**].

2.5 FABRICATION

A. Where practical, fit and assemble metal-framed skylights in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Fabricate aluminum components that, when assembled, have the following characteristics:

   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Internal guttering systems or other means to drain water passing joints and moisture migrating within skylight to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.

D. Reinforce aluminum components as required to receive fastener threads.

E. Factory-Glazed, Metal-Framed Skylights:

1. Factory install glazing to comply with requirements in [**Section 088000 "Glazing."**][**Section 088400 "Plastic Glazing."**]

F. Structural-Sealant-Glazed, Metal-Framed Skylights: Prepare surfaces that will contact structural sealant in accordance with structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. High-Performance Organic-Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Superior-Performance Organic-Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Superior-Performance Organic-Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic-Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic-Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.7 SOURCE QUALITY CONTROL

A. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL-FRAMED SKYLIGHTS

A. General: Comply with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
3. Rigidly secure nonmovement joints.
4. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
5. Seal joints watertight unless otherwise indicated.

B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with protective coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.

D. Install components to drain water passing joints and drain moisture migrating within skylight to exterior.

E. Install components plumb and true in alignment with established lines and elevations.

F. Glazing: Install glazing as specified in [**Section 088000 "Glazing."**][**Section 088400 "Plastic Glazing."**]

G. Structural-Sealant Glazing:

1. Prepare surfaces that will contact structural sealant in accordance with structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
2. Install weatherseal sealant in accordance with weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.

H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to **1/32 inch (0.8 mm)** where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than **3 inches (76 mm)**; otherwise, limit offset to **1/8 inch (3.2 mm)**.
2. Location and Plane: Limit variation from true location and plane to **1/8 inch in 12 ft. (3.2 mm in 3.7 m)**, but no greater than **1/2 inch (13 mm)** over total length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Water-Spray Test: Before installation of interior finishes has begun, skylights are tested in accordance with AAMA 501.2 and do not evidence water penetration.
2. Structural-Sealant Compatibility and Adhesion: Structural sealant is tested in accordance with ASTM C1401.

   a. Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C1401, Appendix X2, is used.

      1) A minimum of [**one**][**two**] area(s) on each skylight face is tested.
      2) Repair installation areas damaged by testing.

3. Structural-Sealant Glazing Inspection: After installation of metal-framed skylights is complete, structural-sealant glazing is inspected and evaluated in accordance with ASTM C1401 recommendations for quality-control procedures.

B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing skylights. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace [**glass**][**plastic glazing**] that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect skylights from contact with contaminating substances resulting from construction operations. If contaminating substances do contact skylight surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

D. Metal-Framed Skylight Operating System: Clean and lubricate joints and hardware. Adjust for proper operation.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain metal-framed skylight operating system.

END OF SECTION 08 63 00 00

Task	Specification	Specification Description
08 63 13 00	08 63 00 00	Metal-Framed Skylights
08 66 00 00	08 62 00 00	Unit Skylights

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SECTION 08 71 00 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hinges.
2. Self-closing hinges and pivots.
3. Center-hung and offset pivots.
4. Continuous, pin-and-barrel-type hinges.
5. Continuous, gear-type hinges.
6. Concealed hinges.
7. Bored locks.
8. Mortise locks.
9. Interconnected locks.
10. Roller latches.
11. Push-pull latches.
12. Bored auxiliary locks.
13. Mortise auxiliary locks.
14. Narrow-stile auxiliary locks.
15. Push-button combination locks.
16. Electric strikes.
17. Electromagnetic locks.
18. Delayed-egress electromagnetic locks.
19. Electromechanical locks.
20. Self-contained electronic locks.
21. Exit locks and alarms.
22. Surface bolts.
23. Manual flush bolts.
24. Automatic flush bolts.
25. Self-latching flush bolts.
26. Exit devices and auxiliary items.
27. Lock cylinders.
28. Key control cabinet.
29. Key lock boxes.
30. Key control system software.
31. Operating trim.
32. Surface closers.
33. Concealed closers.
34. Closer holder release devices.
35. Wall- and floor-mounted stops.
36. Electromagnetic door holders.
37. Overhead stops and holders.
38. Door gasketing.
39. Thresholds.
40. Sliding door hardware.
41. Folding door hardware.
42. Metal protective trim units.
43. Plastic protection plates.
44. Auxiliary door hardware.
45. Auxiliary electrified door hardware.

B. Related Requirements:

1. [**Section 064100 "Architectural Wood Casework"**][**Section 064101 "Architectural Wood Casework (NAAWS Standard)"**] for cabinet door hardware provided with cabinets.
2. Section 081113 "Hollow Metal Doors and Frames" [**for astragals provided as part of labeled fire-rated assemblies**][**and**][**for door silencers provided as part of hollow-metal frames**].
3. Section 081119 "Stainless-Steel Doors and Frames" [**for astragals provided as part of labeled fire-rated assemblies**][**and**][**for door silencers provided as part of stainless steel frames**].
4. Section 081173 "Sliding Metal Fire Doors" for door and track preparation, reinforcement, and motorized operators provided as part of automatic-closing assemblies.
5. Section 081213 "Hollow Metal Frames" [**for astragals provided as part of labeled fire-rated assemblies**][**and**][**for door silencers provided as part of hollow-metal frames**].
6. Section 081216 "Aluminum Frames" for door silencers provided as part of aluminum frames.
7. Section 081316.13 "Aluminum Terrace Doors" for entrance door hardware, [**except**][**including**] cylinders.
8. Section 081416 "Flush Wood Doors" for [**astragals**][**and**][**integral intumescent seals**] provided as part of labeled fire-rated assemblies.
9. Section 081433 "Stile and Rail Wood Doors" for [**astragals**][**and**][**integral intumescent seals**] provided as part of labeled fire-rated assemblies.
10. Section 081713 "Integrated Metal Door Opening Assemblies" for door hardware provided as part of integrated metal door opening assemblies.
11. Section 083113 "Access Doors and Frames" for access door hardware, [**except**][**including**] cylinders.
12. Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
13. Section 083326 "Overhead Coiling Grilles" for door hardware provided as part of overhead coiling grille assemblies.
14. [**Section 083473.13 "Metal Sound Control Door Assemblies"**][**and**][**Section 083473.16 "Wood Sound Control Door Assemblies"**] for hinges and gasketing provided as part of sound-rated door assemblies.
15. Section 083513 "Folding Doors" for pulls, latches, hinges, guides, and pivots provided as part of the folding door package.
16. Section 084113 "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, [**except**][**including**] cylinders.
17. Section 084126 "All-Glass Entrances and Storefronts" for entrance door hardware, [**except**][**including**] cylinders.
18. Section 084229.13 "Folding Automatic Entrances" for entrance door hardware, [**except**][**including**] cylinders.
19. Section 084229.23 "Sliding Automatic Entrances" for entrance door hardware, [**except**][**including**] cylinders.
20. Section 084229.33 "Swinging Automatic Entrances" for entrance door hardware, [**except**][**including**] cylinders.
21. Section 084233 "Revolving Door Entrances" for revolving door entrance hardware, [**except**][**including**] cylinders.
22. Section 084243 "Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances" for entrance door hardware, [**except**][**including**] cylinders.
23. Section 087113 "Power Door Operators" for low-energy power operators and low-energy power-assist operators.
24. Section 102213 "Wire Mesh Partitions" for door hardware for doors in wire mesh partitions, [**except**][**including**] cylinders.
25. Section 102600 "Wall and Door Protection" for plastic door protection units that match wall protection units.
26. Section 119812 "Detention Doors and Frames" for door silencers provided as part of detention frames.
27. Section 119814 "Detention Door Hardware" for hardware for detention doors.

28. Section 133419 "Metal Building Systems" for door hardware, [**except**][**including**] cylinders.
29. Section 134900 "Radiation Protection" for lead-lined astragals provided as part of labeled fire-rated assemblies.
30. Section 281000 "Access Control" for coordination of access control system components.
31. Section 281400 "Access Control System Hardware" for access control system units, power, battery chargers, and computer equipment.
32. Section 283100 "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion-detection system.
33. [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single- and Multiple-Station Alarms"**] for connections to building fire alarm system.

1.2 COORDINATION

A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.

1. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with the Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field-verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Conference participants must include Installer's Architectural Hardware Consultant[**and the Owner's security consultant**].

B. Keying Conference: Conduct conference at [**Project site**].

1. Conference participants must include Installer's Architectural Hardware Consultant[**and the Owner's security consultant**].
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system, including, but not limited to, the following:

a. Flow of traffic and degree of security required.
b. Preliminary key system schematic diagram.
c. Requirements for key control system.
d. Requirements for access control.
e. Address for delivery of keys.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.

1. Include diagrams for power, signal, and control wiring.
2. Include details of interface of electrified door hardware and building safety and security systems.

C. Samples: For each exposed product in each finish specified, in manufacturer's standard size.

1. Tag Samples with full product description to coordinate Samples with door hardware schedule.

D. Samples for Initial Selection: For each type of exposed finish.

E. Samples for Verification: For each type of exposed product, in each finish specified.

1. Sample Size: Full-size units or minimum **2-by-4-inch (51-by-102-mm)** Samples for sheet and **4-inch (102-mm)** long Samples for other products.

a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

2. Tag Samples with full product description to coordinate Samples with door hardware schedule.

F. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule [**after**][**concurrent with**] submissions of product data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format[**and use same door numbers**] as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
e. Fastenings and other installation information.
f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
g. Mounting locations for door hardware.
h. List of related door devices specified in other Sections for each door and frame.

G. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant,

detailing the Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**Architectural Hardware Consultant**].

B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final [**door hardware**][**and**][**keying**] schedule.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and the Owner about door hardware and keying, as directed by the Owner.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as [**a Door and Hardware Specification Consultant (DHSC)**][**an Architectural Hardware Consultant (AHC)**][**an Architectural Hardware Consultant (AHC) and an Electrified Hardware Consultant (EHC)**][**an Architectural Opening Consultant (AOC)**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lockup for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to the Owner.

D. Deliver keys[**and permanent cores**] to the Owner by registered mail or overnight package service.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: [**Three**] years from date of Substantial Completion unless otherwise indicated below:

a. Electromagnetic and Delayed-Egress Locks: [**Five**] years from date of Substantial Completion.
b. Exit Devices: [**Two**] years from date of Substantial Completion.
c. Manual Closers: [**10**] years from date of Substantial Completion.
d. Concealed Floor Closers: [**Five**][**10**][**25**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.

1. Air-Leakage Rate: Maximum air leakage of [**0.3 cfm per sq. ft. (3 cu. m per minute/sq. m)**] at

the tested pressure differential of [**0.3 inch wg (75 Pa)**] of water.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Means of Egress Doors: Latches do not require more than **15 lbf (67 N)** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the DOT's "ADA Standards for Transportation Facilities"**][**the ABA standards of the Federal agency having jurisdiction**][**ICC A117.1**][**HUD's "Fair Housing Accessibility Guidelines"**][**and**].

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf (22.2 N)**.
2. Comply with the following maximum opening-force requirements:

   a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf (22.2 N)** applied perpendicular to door.
   b. Sliding or Folding Doors: **5 lbf (22.2 N)** applied parallel to door at latch.
   c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch (13 mm)** high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 HINGES

A. Hinges: ANSI/BHMA A156.1.[**Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allegion plc**]
   b. [**Baldwin; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
   c. [**Bommer Industries, Inc**]
   d. [**Cal-Royal Products, Inc**]
   e. [**Design Hardware; Mesker Openings Group; dormakaba**]
   f. [**Don-Jo Mfg., Inc**]
   g. [**Hager Companies**]
   h. [**INOX; Unison Hardware, Inc**]
   i. [**Lawrence Hardware Inc.**]
   j. [**McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
   k. [**PAMEX Inc.**]
   l. [**PBB, Inc**]
   m. [**STANLEY; dormakaba USA, Inc.**]

2.4 SELF-CLOSING HINGES AND PIVOTS

A. Self-Closing Hinges and Pivots: ANSI/BHMA A156.17.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Bommer Industries, Inc**]
c. [**Cal-Royal Products, Inc**]
d. [**Design Hardware; Mesker Openings Group; dormakaba**]
e. [**Don-Jo Mfg., Inc**]
f. [**Hager Companies**]
g. [**McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
h. [**PBB, Inc**]
i. [**STANLEY; dormakaba USA, Inc.**]

2.5 CENTER-HUNG AND OFFSET PIVOTS

A. Center-Hung and Offset Pivots: ANSI/BHMA A156.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accurate Lock & Hardware Co.**]
b. [**Allegion plc**]
c. [**Architectural Builders Hardware Mfg., Inc**]
d. [**dormakaba USA Inc.**]
e. [**Hager Companies**]
f. [**INOX; Unison Hardware, Inc**]
g. [**Rixson Specialty Door Controls; ASSA ABLOY**]

2.6 CONTINUOUS HINGES

A. Continuous, Pin-and-Barrel-Type Hinges: ANSI/BHMA A156.26; minimum **0.120-inch- (3.0-mm-)** thick, hinge leaves with minimum overall width of **4 inches (102 mm)**; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Architectural Builders Hardware Mfg., Inc**]
c. [**Hager Companies**]
d. [**Lawrence Hardware Inc.**]
e. [**Markar Architectural Products, Inc.; ASSA ABLOY Accessories and Door Controls**

Group, Inc.; ASSA ABLOY]
f. [McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY]
g. [PBB, Inc]
h. [Select Products Limited]
i. [STANLEY; dormakaba USA, Inc.]
j. [Zero International; Allegion plc]

B. Continuous, Gear-Type Hinges: ANSI/BHMA A156.26; minimum **0.120-inch- (3.0-mm-)** thick, extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings. Minimum overall width of **4 inches (102 mm)**; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [Allegion plc]
b. [Architectural Builders Hardware Mfg., Inc]
c. [Bommer Industries, Inc]
d. [Cal-Royal Products, Inc]
e. [Hager Companies]
f. [Legacy Manufacturing]
g. [McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY]
h. [PBB, Inc]
i. [Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY]
j. [Select Products Limited]
k. [STANLEY; dormakaba USA, Inc.]
l. [Zero International; Allegion plc]

2.7 CONCEALED HINGES

A. Concealed Hinges: Fully concealed within mortises in the door edge and frame and allowing door to swing open 180 degrees.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY]
b. [Simonswerk North America, Inc.]
c. [SOSS Door Hardware; Universal Industrial Products, Inc.]
d. [Sugatsune America, Inc.]

2.8 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum **1/2-inch (13-mm)** latchbolt throw.
2. Mortise Locks: Minimum **3/4-inch (19-mm)** latchbolt throw.
3. Deadbolts: Minimum [**1-inch (25-mm)**][**1.25-inch (32-mm)**] bolt throw.

C. Lock Backset: **2-3/4 inches (70 mm)** unless otherwise indicated.

D. Lock Trim:

1. Description: [**As indicated on Drawings**].
2. Levers: [**Wrought**][**Forged**][**Cast**].
3. Escutcheons (Roses): [**Wrought**][**Forged**][**Cast**].
4. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

F. Bored Locks: ANSI/BHMA A156.2, [**Grade 1**][**Grade 2**], Series 4000.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Arrow USA; an ASSA ABLOY Group company**]
c. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
d. [**Cal-Royal Products, Inc**]
e. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
f. [**Design Hardware; Mesker Openings Group; dormakaba**]
g. [**dormakaba USA Inc.**]
h. [**Hager Companies**]
i. [**INOX; Unison Hardware, Inc**]
j. [**Lawrence Hardware Inc.**]
k. [**Marks USA; Napco Security Technologies, Inc.**]
l. [**PAMEX Inc.**]
m. [**PDQ Industries, Inc.**]
n. [**SARGENT Manufacturing Company; ASSA ABLOY**]
o. [**SOSS Door Hardware; Universal Industrial Products, Inc.**]
p. [**STANLEY; dormakaba USA, Inc.**]
q. [**Weiser; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
r. [**Yale Security Inc; ASSA ABLOY**]

G. Mortise Locks: ANSI/BHMA A156.13, [**Operational Grade 1**][**Security Grade 1**][**Operational Grade 2**][**Security Grade 2**]; stamped steel case with steel or brass parts; Series 1000.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Accurate Lock & Hardware Co.**]
   b. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
   c. [**Allegion plc**]
   d. [**Arrow USA; an ASSA ABLOY Group company**]
   e. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
   f. [**Cal-Royal Products, Inc**]
   g. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
   h. [**Design Hardware; Mesker Openings Group; dormakaba**]
   i. [**dormakaba USA Inc.**]
   j. [**Hager Companies**]
   k. [**INOX; Unison Hardware, Inc**]
   l. [**Lawrence Hardware Inc.**]
   m. [**Marks USA; Napco Security Technologies, Inc.**]
   n. [**RR Brink Locking Systems, Inc.**]
   o. [**SARGENT Manufacturing Company; ASSA ABLOY**]
   p. [**STANLEY; dormakaba USA, Inc.**]
   q. [**Yale Security Inc; ASSA ABLOY**]

H. Interconnected Locks: ANSI/BHMA A156.12, [**Grade 1**][**Grade 2**], Series 5000.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
   b. [**Allegion plc**]
   c. [**Cal-Royal Products, Inc**]
   d. [**dormakaba USA Inc.**]
   e. [**Hager Companies**]
   f. [**PAMEX Inc.**]
   g. [**STANLEY; dormakaba USA, Inc.**]

I. Roller Latches: ANSI/BHMA A156.16, Grade 1; rolling plunger that engages socket or catch, with adjustable roller projection.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allegion plc**]
   b. [**Architectural Builders Hardware Mfg., Inc**]
   c. [**Baldwin; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
   d. [**Burns Manufacturing Incorporated**]
   e. [**Don-Jo Mfg., Inc**]
   f. [**Door Controls International**]
   g. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
   h. [**INOX; Unison Hardware, Inc**]
   i. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls**

Group, Inc.; ASSA ABLOY]
j. [**Standard Metal Hardware Manufacturing LTD**]

J. Push-Pull Latches: [**Bored, ANSI/BHMA A156.2, Series 4000**][**Mortise, ANSI/BHMA A156.13**]; with paddle handles that retract latchbolt; capable of being mounted vertically or horizontally.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
b. [**Allegion plc**]
c. [**Architectural Builders Hardware Mfg., Inc**]
d. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
e. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
g. [**SOSS Door Hardware; Universal Industrial Products, Inc.**]
h. [**Trimco**]

2. [**Grade 1**][**Grade 2**].

2.9 AUXILIARY LOCKS

A. Bored Auxiliary Locks: ANSI/BHMA A156.36, [**Grade 1**][**Grade 2**]; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Arrow USA; an ASSA ABLOY Group company**]
c. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
d. [**Cal-Royal Products, Inc**]
e. [**Hager Companies**]
f. [**INOX; Unison Hardware, Inc**]
g. [**Lawrence Hardware Inc.**]
h. [**Marks USA; Napco Security Technologies, Inc.**]
i. [**Medeco Security Locks; an ASSA ABLOY Group company**]
j. [**PDQ Industries, Inc.**]
k. [**SARGENT Manufacturing Company; ASSA ABLOY**]
l. [**STANLEY; dormakaba USA, Inc.**]
m. [**Weiser; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
n. [**Yale Security Inc; ASSA ABLOY**]

B. Mortise Auxiliary Locks: ANSI/BHMA A156.36, [**Grade 1**][**Grade 2**]; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accurate Lock & Hardware Co.**]
b. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
c. [**Allegion plc**]
d. [**Arrow USA; an ASSA ABLOY Group company**]
e. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
f. [**Cal-Royal Products, Inc**]
g. [**Hager Companies**]
h. [**RR Brink Locking Systems, Inc.**]
i. [**SARGENT Manufacturing Company; ASSA ABLOY**]
j. [**STANLEY; dormakaba USA, Inc.**]
k. [**Yale Security Inc; ASSA ABLOY**]

C. Narrow-Stile Auxiliary Locks: ANSI/BHMA A156.36, [**Grade 1**][**Grade 2**]; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accurate Lock & Hardware Co.**]
b. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
c. [**Kaba Ilco Corp.**]

D. Push-Button Combination Locks: ANSI/BHMA A156.36, cylindrical, Grade 1; lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kaba Ilco Corp.**]

2.10 ELECTRIC STRIKES

A. Electric Strikes: ANSI/BHMA A156.31, [**Grade 1**][**Grade 2**]; with faceplate to suit lock and frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
b. [**Allegion plc**]
c. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
d. [**Dortronics Systems, Inc**]
e. [**DynaLock Corp**]
f. [**Hager Companies**]
g. [**Hanchett Entry Systems (HES), Inc.; ASSA ABLOY Group**]
h. [**PDQ Industries, Inc.**]
i. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
j. [**Security Door Controls**]
k. [**STANLEY; dormakaba USA, Inc.**]
l. [**Trine Access Technology**]

2.11 ELECTROMAGNETIC LOCKS

A. Electromagnetic Locks: ANSI/BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
c. [**Door Controls International**]
d. [**dormakaba USA Inc.**]
e. [**Dortronics Systems, Inc**]
f. [**DynaLock Corp**]
g. [**Hager Companies**]
h. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
i. [**Security Door Controls**]

B. Delayed-Egress Electromagnetic Locks: ANSI/BHMA A156.24; electrically powered; with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than three seconds initiates irreversible alarm and adjustable time delay for egress. When integrated with fire alarm, fire alarm voids time delay.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
c. [**Door Controls International**]
d. [**DynaLock Corp**]
e. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]

2.12 ELECTROMECHANICAL LOCKS

A. Electromechanical Locks: ANSI/BHMA A156.25, [**Grade 1**][**Grade 2**]; motor or solenoid driven; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
c. [**DynaLock Corp**]
d. [**Lawrence Hardware Inc.**]
e. [**Marks USA; Napco Security Technologies, Inc.**]
f. [**PDQ Industries, Inc.**]
g. [**RR Brink Locking Systems, Inc.**]

h. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
i. [**SARGENT Manufacturing Company; ASSA ABLOY**]
j. [**Security Door Controls**]
k. [**STANLEY; dormakaba USA, Inc.**]
l. [**Weiser; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
m. [**Yale Security Inc; ASSA ABLOY**]

2. Type: [**Bored**][**Mortise latchbolt**][**Mortise deadbolt**][**Mortise deadlocking latchbolt**].

2.13 SELF-CONTAINED ELECTRONIC LOCKS

A. Self-Contained Electronic Locks: ANSI/BHMA A156.25, [**bored**][**mortise**]; with internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case, and strike that suits frame. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
c. [**Kaba Ilco Corp.**]
d. [**Marks USA; Napco Security Technologies, Inc.**]
e. [**Onity; a Honeywell Company**]
f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
g. [**Yale Security Inc; ASSA ABLOY**]

2.14 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: ANSI/BHMA A156.29, Grade 1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow USA; an ASSA ABLOY Group company**]
b. [**Detex Corporation**]
c. [**Precision Hardware, Inc.; dormakaba Group**]
d. [**SARGENT Manufacturing Company; ASSA ABLOY**]

2.15 SURFACE BOLTS

A. Surface Bolts: ANSI/BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Burns Manufacturing Incorporated**]
c. [**Don-Jo Mfg., Inc**]
d. [**Door Controls International**]
e. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
f. [**Standard Metal Hardware Manufacturing LTD**]
g. [**Trimco**]

2.16 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: ANSI/BHMA A156.16; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
b. [**Allegion plc**]
c. [**Burns Manufacturing Incorporated**]
d. [**Don-Jo Mfg., Inc**]
e. [**Door Controls International**]
f. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
g. [**INOX; Unison Hardware, Inc**]
h. [**Standard Metal Hardware Manufacturing LTD**]
i. [**Trimco**]

2.17 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic Flush Bolts: ANSI/BHMA A156.3, Type 25; minimum **3/4-inch (19-mm)** throw; with dust-proof strikes; designed for mortising into door edge.[**Include wear plates.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Burns Manufacturing Incorporated**]
c. [**Cal-Royal Products, Inc**]
d. [**Don-Jo Mfg., Inc**]
e. [**Door Controls International**]
f. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
g. [**Standard Metal Hardware Manufacturing LTD**]
h. [**Trimco**]

B. Self-Latching Flush Bolts: ANSI/BHMA A156.3, Type 27; minimum **3/4-inch (19-mm)** throw; with dust-proof strikes; designed for mortising into door edge.[**Include wear plates.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Allegion plc**]
b. [**Burns Manufacturing Incorporated**]
c. [**Cal-Royal Products, Inc**]
d. [**Don-Jo Mfg., Inc**]
e. [**Door Controls International**]
f. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
g. [**Standard Metal Hardware Manufacturing LTD**]
h. [**Trimco**]

2.18 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: ANSI/BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adams Rite Manufacturing Company, an ASSA ABLOY Group company**]
b. [**Allegion plc**]
c. [**Arrow USA; an ASSA ABLOY Group company**]
d. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
e. [**Cal-Royal Products, Inc**]
f. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
g. [**Design Hardware; Mesker Openings Group; dormakaba**]
h. [**Detex Corporation**]
i. [**Door Controls International**]
j. [**dormakaba USA Inc.**]
k. [**Hager Companies**]
l. [**INOX; Unison Hardware, Inc**]
m. [**Lawrence Hardware Inc.**]
n. [**PAMEX Inc.**]
o. [**Precision Hardware, Inc.; dormakaba Group**]
p. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
q. [**SARGENT Manufacturing Company; ASSA ABLOY**]
r. [**STANLEY; dormakaba USA, Inc.**]
s. [**Yale Security Inc; ASSA ABLOY**]

2.19 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.[**Provide cylinder from same manufacturer of locking devices.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Arrow USA; an ASSA ABLOY Group company**]
c. [**ASSA, Inc.**]
d. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]

e. [**Cal-Royal Products, Inc**]
f. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
g. [**Hager Companies**]
h. [**Medeco Security Locks; an ASSA ABLOY Group company**]
i. [**PAMEX Inc.**]
j. [**PDQ Industries, Inc.**]
k. [**SARGENT Manufacturing Company; ASSA ABLOY**]
l. [**STANLEY; dormakaba USA, Inc.**]
m. [**Yale Security Inc; ASSA ABLOY**]

B. Standard Lock Cylinders: ANSI/BHMA A156.5, [**Grade 1**][**Grade 1A**][**Grade 2**] permanent cores; face finished to match lockset.

1. Core Type: [**Interchangeable**][**Removable**].

C. High-Security Lock Cylinders: ANSI/BHMA A156.30, [**Grade 1**][**Grade 2**][**Grade 3**] permanent cores that are removable; face finished to match lockset.

1. [**Type M, mechanical**][**Type E, electrical**].

D. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

E. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.20 KEYING

A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, appendix. Provide one extra key blank for each lock.[**Incorporate decisions made in keying conference.**]

1. No Master Key System: Only change keys operate cylinders.

a. Provide three cylinder change keys.

2. Master Key System: Change keys and a master key operate cylinders.

a. Provide three cylinder change keys and five master keys.

3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.

a. Provide three cylinder change keys and five each of master and grand master keys.

4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.

a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.

5. Existing System:

a. Master key or grand master key locks to the Owner's existing system.

b. Re-key the Owner's existing master key system into new keying system.

6. Keyed Alike: Key all cylinders to same change key.

B. Keys: [**Nickel silver**][**Brass**].

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: [**"DO NOT DUPLICATE."**][**Information to be furnished by the Owner.**]

2.21 KEY CONTROL SYSTEM

A. Key Control Cabinet: ANSI/BHMA A156.28; metal cabinet with baked-enamel finish, containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of [**150**] percent of the number of locks.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Key Boxes and Cabinets**]
b. [**HPC, a Hudson Lock Company**]
c. [**Interlogix; Carrier Global Corporation**]
d. [**Lund Equipment Co., Inc**]
e. [**MMF Industries**]
f. [**TelKee; Oasis International**]

2. Multiple-Drawer Cabinet: [**Grade 1**][**Grade 2**] cabinet with drawers equipped with key-holding panels, key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
3. Wall-Mounted Cabinet: [**Grade 1**][**Grade 2**] cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
4. Portable Cabinet: [**Grade 1**][**Grade 2**] tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.

B. Key Lock Boxes: Designed for storage of [**two**][**10**] keys.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HPC, a Hudson Lock Company**]
b. [**Kidde; Carrier Global Corporation**]
c. [**Knox Company**]

C. Key Control System Software: Multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**BEST Access Solutions, Inc.; dormakaba USA Inc.**]
c. [**HPC, a Hudson Lock Company**]
d. [**Interlogix; Carrier Global Corporation**]
e. [**TelKee; Oasis International**]

2.22 OPERATING TRIM

A. Operating Trim: ANSI/BHMA A156.6; [**aluminum**][**brass**][**bronze**][**stainless steel**] unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Burns Manufacturing Incorporated**]
c. [**Don-Jo Mfg., Inc**]
d. [**Forms+Surfaces**]
e. [**Hager Companies**]
f. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
g. [**INOX; Unison Hardware, Inc**]
h. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
i. [**Standard Metal Hardware Manufacturing LTD**]
j. [**Trimco**]

2.23 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: ANSI/BHMA A156.3; consisting of active-leaf, hold-open lever, and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release[**and with internal override**].

B. Carry-Open Bars: ANSI/BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: ANSI/BHMA A156.22.

2.24 SURFACE CLOSERS

A. Surface Closers: ANSI/BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Arrow USA; an ASSA ABLOY Group company**]
c. [**Cal-Royal Products, Inc**]
d. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
e. [**Design Hardware; Mesker Openings Group; dormakaba**]
f. [**dormakaba USA Inc.**]
g. [**Hager Companies**]
h. [**INOX; Unison Hardware, Inc**]
i. [**Norton Door Controls; ASSA ABLOY**]
j. [**PAMEX Inc.**]
k. [**Rixson Specialty Door Controls; ASSA ABLOY**]
l. [**SARGENT Manufacturing Company; ASSA ABLOY**]
m. [**STANLEY; dormakaba USA, Inc.**]
n. [**Yale Security Inc; ASSA ABLOY**]

2.25 CONCEALED CLOSERS

A. Concealed Closers: ANSI/BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**dormakaba USA Inc.**]
c. [**Norton Door Controls; ASSA ABLOY**]
d. [**Rixson Specialty Door Controls; ASSA ABLOY**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]

2.26 CLOSER HOLDER RELEASE DEVICES

A. Closer Holder Release Devices: ANSI/BHMA A156.15, Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door must become self-closing on interruption of signal to release device. Automatic release is activated by [**smoke detection system**][**loss of power**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
c. [**dormakaba USA Inc.**]
d. [**Norton Door Controls; ASSA ABLOY**]
e. [**Rixson Specialty Door Controls; ASSA ABLOY**]
f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
g. [**STANLEY; dormakaba USA, Inc.**]

2.27 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: ANSI/BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Architectural Builders Hardware Mfg., Inc**]
c. [**ASI-American Specialties, Inc.**]
d. [**Baldwin; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
e. [**Burns Manufacturing Incorporated**]
f. [**Cal-Royal Products, Inc**]
g. [**Don-Jo Mfg., Inc**]
h. [**Door Controls International**]
i. [**Hager Companies**]
j. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
k. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
l. [**Trimco**]

2.28 ELECTROMAGNETIC STOPS AND HOLDERS

A. Electromagnetic Door Holders: ANSI/BHMA A156.15, Grade 1; [**wall-mounted electromagnetic single**][**floor-mounted electromagnet single**][**floor-mounted electromagnet double**] unit with strike plate attached to swinging door; coordinated with fire detectors and interfaced with fire-alarm system for labeled fire-rated door assemblies.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Architectural Builders Hardware Mfg., Inc**]
c. [**dormakaba USA Inc.**]
d. [**Hager Companies**]
e. [**INOX; Unison Hardware, Inc**]
f. [**Lawrence Hardware Inc.**]
g. [**SARGENT Manufacturing Company; ASSA ABLOY**]

2.29 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: ANSI/BHMA A156.8.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Architectural Builders Hardware Mfg., Inc**]
c. [**dormakaba USA Inc.**]
d. [**Hager Companies**]
e. [**INOX; Unison Hardware, Inc**]
f. [**Rixson Specialty Door Controls; ASSA ABLOY**]
g. [**SARGENT Manufacturing Company; ASSA ABLOY**]
h. [**Standard Metal Hardware Manufacturing LTD**]

2.30 DOOR GASKETING

A. Door Gasketing: ANSI/BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hager Companies**]
b. [**Legacy Manufacturing**]
c. [**M-D Building Products, Inc**]
d. [**National Guard Products, Inc**]
e. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
f. [**Reese Enterprises, Inc**]
g. [**Sealeze**]
h. [**Zero International; Allegion plc**]

B. Maximum Air Leakage: When tested in accordance with ASTM E283/E283M with tested pressure differential of **0.3 inch wg (75 Pa)**, as follows:

1. Smoke-Rated Gasketing: **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** of door opening.
2. Gasketing on Single Doors: **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** of door opening.
3. Gasketing on Double Doors: **0.50 cfm per ft. (0.000774 cu. m/s per m)** of door opening.

2.31 THRESHOLDS

A. Thresholds: ANSI/BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hager Companies**]
b. [**Legacy Manufacturing**]
c. [**M-D Building Products, Inc**]
d. [**National Guard Products, Inc**]
e. [**Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
f. [**Reese Enterprises, Inc**]
g. [**Rixson Specialty Door Controls; ASSA ABLOY**]
h. [**Sealeze**]

i. [**Zero International; Allegion plc**]

2.32 SLIDING DOOR HARDWARE

A. Sliding Door Hardware: ANSI/BHMA A156.14; consisting of complete sets, including rails, hangers, supports, bumpers, floor guides, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arthur Cox & Sons, Inc.**]
b. [**Hager Companies**]
c. [**Hettich America L.P.**]
d. [**Johnson, L. E., Products, Inc**]
e. [**K.N. Crowder Mfg. Inc**]
f. [**PC Henderson Inc.**]
g. [**STANLEY; dormakaba USA, Inc.**]

2.33 FOLDING DOOR HARDWARE

A. Folding Door Hardware: ANSI/BHMA A156.14; complete sets, including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arthur Cox & Sons, Inc.**]
b. [**Johnson, L. E., Products, Inc**]
c. [**PC Henderson Inc.**]
d. [**STANLEY; dormakaba USA, Inc.**]

2.34 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: ANSI/BHMA A156.6; fabricated from **0.050-inch- (1.3-mm-)** thick [**aluminum**][**brass**][**bronze**][**stainless steel**]; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Burns Manufacturing Incorporated**]
c. [**Don-Jo Mfg., Inc**]
d. [**Hager Companies**]
e. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
f. [**INOX; Unison Hardware, Inc**]

g. [**inpro Corporation**]
h. [**Pawling Corporation**]
i. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
j. [**Standard Metal Hardware Manufacturing LTD**]
k. [**Trimco**]

2.35 PLASTIC PROTECTION PLATES

A. Plastic Protection Plates: ANSI/BHMA A156.6; fabricated with four sides beveled; [**plastic laminate; 1/8 inch (3.2 mm) thick; ISO 4586, Grade HGS**][**rigid plastic; 0.060-inch- (1.5-mm-) thick, PVC or acrylic-modified vinyl plastic**][**acrylic; 1/8 inch (3.2 mm) thick**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**American Floor Products Company, Inc**]
c. [**Burns Manufacturing Incorporated**]
d. [**Don-Jo Mfg., Inc**]
e. [**Hiawatha, Inc; a division of the Activar Construction Products Group**]
f. [**inpro Corporation**]
g. [**Pawling Corporation**]
h. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
i. [**Standard Metal Hardware Manufacturing LTD**]
j. [**Trimco**]

2.36 AUXILIARY DOOR HARDWARE

A. Auxiliary Door Hardware: ANSI/BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allegion plc**]
b. [**Baldwin; part of the Spectrum Brands Hardware and Home Improvement Group (HHI)**]
c. [**Cal-Royal Products, Inc**]
d. [**Don-Jo Mfg., Inc**]
e. [**Hager Companies**]
f. [**Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]
g. [**Trimco**]

2.37 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Auxiliary Electrified Door Hardware: ANSI/BHMA A156.35.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Allegion plc**]
    b. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
    c. [**Door Controls International**]
    d. [**dormakaba USA Inc.**]
    e. [**DynaLock Corp**]
    f. [**Hager Companies**]
    g. [**Interlogix; Carrier Global Corporation**]
    h. [**PAMEX Inc.**]
    i. [**PDQ Industries, Inc.**]
    j. [**Precision Hardware, Inc.; dormakaba Group**]
    k. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
    l. [**SARGENT Manufacturing Company; ASSA ABLOY**]
    m. [**Security Door Controls**]

2.38 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect, as directed by the Owner.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:

    a. Wood or Machine Screws: For the following:

        1) Hinges mortised to doors or frames[**use threaded-to-the-head wood screws for wood doors and frames**].
        2) Strike plates to frames.
        3) Closers to doors and frames.

    b. Steel Through Bolts: For the following unless door blocking is provided:

1) Surface hinges to doors.
2) Closers to doors and frames.
3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.39 FINISHES

A. Provide finishes complying with ANSI/BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.

B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION OF DOOR HARDWARE

A. Mounting Heights: Mount door hardware units at heights [**indicated on Drawings**][**to comply with the following**] unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and

fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every **30 inches (760 mm)** of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every **30 inches (760 mm)** of door height greater than **90 inches (2286 mm)**.

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as [**indicated in keying schedule**][**directed by the Owner**].
2. Furnish permanent cores to the Owner for installation.

F. Key Control System:

1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel, as directed by the Owner.
3. Key Control System Software: Set up multiple-index system based on final keying schedule.

G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, [**above accessible ceilings**][**in equipment room**]. Verify location with Architect, as directed by the Owner.

1. Configuration: Provide [**one power supply for each door opening**][**least number of power supplies required to adequately serve doors**] with electrified door hardware.

H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

I. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

J. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: [**the Owner will engage**][**Engage**] a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

B. Occupancy Adjustment: Approximately [**three**][**six**] months after date of Substantial Completion, Installer's Architectural Hardware Consultant is to examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for the Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, maintenance service is to include [**six**][**nine**][**12**] months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. [**Engage Installer to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain door hardware.

END OF SECTION 08 71 00 00

SECTION 08 71 11 00 - DETENTION DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Detention hinges.
2. Mechanical detention locks and latches.
3. Electromechanical detention locks and latches.
4. Pneumatic detention locks and latches.
5. Switches.
6. Detention operating trim.
7. Security door closers.
8. Detention door stops.
9. Sliding detention door device assemblies.
10. Key-control system.
11. Security fasteners.

B. Related Requirements:

1. Section 013513.16 "Special Project Procedures for Detention Facilities" for general requirements for detention work, including responsibilities of a detention specialist.
2. Section 119812 "Detention Doors and Frames" for door and frame preparation, reinforcement, and door silencers provided as part of hollow-metal detention doors and frames manufactured in accordance with HMMA 863. Section 119812 also includes astragals provided as part of fire-rated labeled assemblies.
3. Section 221513 "General-Service Compressed-Air Piping" and Section 221519 "General-Service Packaged Air Compressors and Receivers" for compressed-air piping for pneumatic detention door hardware.
4. Section 283100 "Intrusion Detection" for detection devices installed at detention door openings as part of an intrusion detection system.
5. Section 283121 "Area and Perimeter Intrusion Detection" for detection devices installed at detention gate openings as part of a perimeter security system.

1.2 COORDINATION

A. Templates: Obtain and distribute, to the parties involved, templates for detention doors, frames, and other work specified to be factory prepared for installing detention door hardware.

B. Electrical System Roughing-In: Coordinate layout and installation of electrically powered detention door hardware with connections to [**power supplies**][**perimeter security system**][**detention monitoring and control system**][**fire-alarm system and detection devices**][**and**][**building control system**].

C. Compressed-Air System Roughing-In: Coordinate layout and installation of pneumatic detention door hardware with connections to [**compressed-air supplies**][**detention monitoring and control system**][**fire-alarm system and detection devices**][**and**][**building control system**].

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss power and control system roughing-in and other preparatory work performed by other trades.
2. Review sequence of operation for each type of detention door hardware.
3. Review and finalize a construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Certifying procedures.

B. Detention Keying Conference: Conduct conference at [**Project site**].

1. Conference participants to include Installer.
2. Incorporate detention keying conference decisions into Project's final Detention Keying Schedule after reviewing detention door hardware keying system including, but not limited to, the following:

a. Preliminary key system schematic diagram.
b. Requirements for key-control system.
c. Requirements for access control.
d. Address for delivery of keys.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of detention door hardware.

B. Shop Drawings: For each type of detention door hardware.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring; differentiate between manufacturer-installed and field-installed wiring for detention door hardware. Include the following:

a. System schematic.
b. Point-to-point wiring diagram, including location of connections.
c. Riser diagram.
d. Elevation of each detention door type.

3. Compressed-Air System Diagrams: For compressed-air piping for door-control systems; differentiate between manufacturer-installed and field-installed piping for pneumatic detention door hardware. Include the following:

a. System schematic.
b. Point-to-point piping diagram.
c. Riser diagram.
d. Elevation of each detention door type.

4. Detail interface between electrically powered detention door hardware and [**perimeter security**][**detention monitoring and control**][**fire-alarm**][**and**][**building control**] system.
5. Detail interface between pneumatic detention door hardware and [**perimeter security**][**detention monitoring and control**][**fire-alarm**][**and**][**building control**] system.

C. Samples: Submit samples to Architect only upon request, as directed by the Owner.

1. Submit one sample of each hardware product requested, in finish specified.
2. Tag Sample with full product description to coordinate with Detention Door Hardware Schedule.
3. Samples will be returned to Supplier. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

D. Detention Door Hardware Schedule: Prepared by or under the supervision of Supplier, detailing fabrication and assembly of door hardware as well as installation procedures and wiring diagrams. Coordinate the Detention Door Hardware Schedule with detention doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of detention door hardware.

1. Integrate detention door hardware indicated in "Detention Door Hardware Schedule" Article into Project's final Detention Door Hardware Schedule, and indicate complete designations of every item required for each detention door and opening.
2. Keying Schedule: Coordinate detention keying with other door hardware in Project's final Detention Keying Schedule. Include floor plan of each floor, indicating keymarks, lock types, and key access sides required at each detention door and opening.
3. Indicate each detention lock and type of key cylinder using the following prefixes: "P" for paracentric, "M" for mogul, "HS" for high security, and "C" for commercial.
4. Indicate security level of each item.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of [**detention lock and latch**][**security door closer**][**and**][**sliding detention door device**], for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

B. Examination reports documenting inspections of substrates, areas, and conditions.

C. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

D. Field quality-control reports documenting inspections of installed products.

1. Field quality-control certification signed by Contractor[**and Detention Specialist**].

E. Qualification Statements: For [**Installer**][**Supplier**][**and**][**Architectural Hardware Consultant**].

F. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Maintenance service.

B. Operation and Maintenance Data: For detention door hardware to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Normal remote security operation.
b. Normal local security operation.
c. Emergency security operation.
d. Hardware schedules.
e. Catalog cuts for all hardware.
f. Templates.

C. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the Owner's continued adjustment, maintenance, and removal and replacement of detention door hardware.

B. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Security Fasteners: Furnish not less than one box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.
2. Tools: Provide [**two**] sets of tools for installing and removing security fasteners.

C. Schedule of maintenance material items.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer and an authorized representative of detention door hardware manufacturer for installation and maintenance of units required for this Project.
2. Suppliers: Detention Door Hardware Supplier with warehousing facilities in Project's vicinity who is, or employs, a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and the Owner about detention door hardware and keying, as directed by the Owner.

a. Detention Door Hardware Supplier Qualifications: An experienced Detention Door Hardware Supplier who has completed projects with electrically powered[**and pneumatic**] detention door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.

1) Engineering Responsibility: Prepare data for electrically powered[**and pneumatic**] detention door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
2) Scheduling Responsibility: Preparation of Detention Door Hardware and Keying schedules.

3. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for

detention door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

a. [**Architectural Hardware Consultant (AHC)**][**Architectural Hardware Consultant (AHC) who is also an Electrified Hardware Consultant (EHC)**][**Architectural Openings Consultant (AOC)**].

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inventory detention door hardware on receipt and provide secure lockup for detention door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the Detention Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver detention door keys to the Owner by registered mail or overnight package service[.][addressed as follows:]

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of detention door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of operators and detention door hardware.
b. Deterioration of metals, metal finishes, and other materials beyond normal [weathering][use].

2. Warranty Period: [**Three**] years from date of Substantial Completion.
3. Warranty Period for Continuous-Pin Detention Hinges: [**10**] years from date of Substantial Completion.
4. Warranty Period for Security Door Closers: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Swinging Detention Door Assemblies: Provide detention door hardware as part of a detention door assembly that complies with security grade indicated, when tested in accordance with ASTM F1450, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

1. Bullet Resistance: Comply with [**Level 3**] rating when tested in accordance with UL 752; where indicated [**on Drawings**][**in door schedule**].

a. Listed and labeled as bullet resistant by a testing agency acceptable to authorities having jurisdiction.

2. Tool-Attack Resistance: Comply with small-tool-attack-resistance rating when tested in accordance with UL 1034 and UL 437; where indicated [**on Drawings**][**in Detention Door Hardware Schedule**].

2.2 DETENTION DOOR HARDWARE, GENERAL

A. Provide detention door hardware for each door as scheduled in "Detention Door Hardware Schedule" Article to comply with requirements in this Section.

1. Detention Door Hardware Sets: Provide quantity, item, size, finish, or color indicated.
2. Sequence of Operation: Provide electrically powered detention door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Include all accessories and fasteners required for a complete installation.

B. Electrically Powered Detention Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Detention Door Hardware Control and Monitoring: Provide detention door hardware with features, functions, and internal equipment required to perform control and monitoring functions indicated in Section 285213 "Detention Monitoring and Control System and Interfaces."

D. Obtain mechanical detention door hardware from same manufacturer as that of electrically powered or pneumatic detention door hardware.

E. Regulatory Requirements:

1. Fire-Rated Detention Door Assemblies: Provide detention door hardware for assemblies complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
2. Where indicated to comply with accessibility requirements, comply with [the DOJ's "2010 ADA Standards for Accessible Design"][the ABA standards of the Federal agency having jurisdiction][ICC A117.1].

2.3 DETENTION HINGES

A. Standard for Electric Detention Hinges: UL 634.

B. Utility-Door Detention Hinges: Heavy weight, plain bearing; fabricated from cast iron or steel; **3/8-inch-(9.5-mm-)** diameter, case-hardened,[**fully welded,**] steel hinge pin; full surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Hager Companies**]
   c. [**RR Brink Locking Systems, Inc.**]
   d. [**Southern Folger Detention Equipment Company**]

2. Leaves: [**Drilled for countersunk security fasteners**][**Solid**].
3. Size: Minimum **3 by 4 by 0.200 inch (75 by 102 by 5 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 600.

C. Food-Pass Detention Hinges: Heavy weight, plain bearing; fabricated from cast iron or steel; **3/8-inch-(9.5-mm-)** diameter, case-hardened,[**fully welded,**] steel hinge pin; with applied stop preventing door from opening more than 90 degrees and supporting door in horizontal position as a shelf; full surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Hager Companies**]
   c. [**RR Brink Locking Systems, Inc.**]
   d. [**Southern Folger Detention Equipment Company**]
   e. [**STANLEY; dormakaba USA, Inc.**]

2. Leaves: [**Drilled for countersunk security fasteners**][**Solid**].
3. Size: Minimum **3 by 4 by 0.200 inch (75 by 102 by 5 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 600.

D. Full Mortise Hinges: Heavy weight; with welded hospital tips and two concealed maintenance-free ball bearings; fabricated from cast stainless steel; with integral security stud and non-removable stainless steel hinge pin.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]
   d. [**STANLEY; dormakaba USA, Inc.**]

2. Leaves: Drilled to ANSI/BHMA A156.7 template dimensions for countersunk security fasteners.
3. Size: Minimum **4-1/2 by 4-1/2 by 3/16 inch (102 by 102 by 4.76 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 630.

E. Full-Surface Detention Hinges: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; **3/4-inch- (19-mm-)** diameter, case-hardened, fully welded, steel hinge pin.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**brookfield industries, inc.**]
   c. [**Maximum Security Products Corp**]
   d. [**RR Brink Locking Systems, Inc.**]
   e. [**Southern Folger Detention Equipment Company**]

2. Leaves: [**Drilled for countersunk security fasteners**][**Solid**].
3. Size: Minimum **5 by 5-3/4 by 1/2 inch (127 by 146 by 13 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 600.

F. Half-Surface Detention Hinges: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel

ball bearings; fabricated from steel plate; **3/4-inch- (19-mm-)** diameter, case-hardened, fully welded, steel hinge pin.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**brookfield industries, inc.**]
   c. [**Maximum Security Products Corp**]

2. Leaves: [**Drilled for countersunk security fasteners**][**Solid**].
3. Size: Minimum **5 by 5-1/4 by 1/2 inch (127 by 133 by 13 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 600.

G. Gap-Mounted Detention Hinges: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; **3/4-inch- (19-mm-)** diameter, case-hardened, fully welded, steel hinge pin.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**brookfield industries, inc.**]
   c. [**Maximum Security Products Corp**]
   d. [**Southern Folger Detention Equipment Company**]

2. Leaves: [**Drilled for countersunk security fasteners**][**Solid**].
3. Size: Minimum **5 by 6 by 1/2 inch (127 by 152 by 13 mm)**.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
5. Finish: ANSI/BHMA 600.

H. Continuous-Pin Detention Hinges: Minimum **0.109-inch- (2.78-mm-)** thick, stainless steel hinge leaves with minimum overall width of **4 inches (102 mm)**; with **1/4-inch- (6-mm-)** diameter continuous pin; fabricated to full height of detention door and frame. Finish components after milling and drilling are complete. Fabricate continuous-pin detention hinges to template screw locations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Markar Architectural Products, Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY**]

2. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1758.
3. Finish: ANSI/BHMA 630.

2.4 MECHANICAL DETENTION LOCKS AND LATCHES

A. Lock Mountings:

1. Hollow-Metal Detention Doors: Mount detention lock to back of [**0.179-inch (4.56-mm) nominal-thickness steel**][**0.183-inch (4.65-mm) nominal-thickness, galvanized-steel**] cover plate for installation in lock pocket fabricated into detention door. Attach cover plate to hollow-metal detention door with security fasteners.
2. Bar-Grille Detention Doors: Mount detention lock to back of [**galvanized-**]steel enclosure welded to flat horizontal bars of bar-grille detention door; cover with [**0.179-inch (4.56-mm) nominal-thickness steel**][**0.183-inch (4.65-mm) nominal-thickness, galvanized-steel**] plate. Attach plate with security fasteners.
3. Steel-Plate Detention Doors: Mount detention lock to inside surface of [**0.179-inch (4.56-mm) nominal-thickness steel**][**0.134-inch (3.42-mm) nominal-thickness steel**][**0.183-inch (4.65-mm) nominal-thickness, galvanized-steel**][**0.138-inch (3.50-mm) nominal-thickness, galvanized-steel**] enclosure with integrally formed mounting flanges. Attach enclosure to steel-plate detention door with [**security fasteners**][**rivets**].

B. Utility-Door Mechanical Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Lockbolt retracted and extended by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].
3. Lockbolt: **1-1/2 inches high by 3/4 inch (38 mm high by 19 mm)** thick; **5/8-inch (16-mm)** throw.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

C. Utility-Door Mechanical Deadlocks, Mogul Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Lockbolt retracted and extended by mogul cylinder; keyed [**one side**][**two sides**].
3. Lockbolt: **1-1/2 inches high by 3/4 inch (38 mm high by 19 mm)** thick; **5/8-inch (16-mm)** throw.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

D. Utility-Door Mechanical Snaplatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]

c. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch when door is closed; latchbolt retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].
3. Latchbolt: **1 inch high by 7/16 inch (25 mm high by 11 mm)** thick; **5/16-inch (8-mm)** throw.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

E. Utility-Door Mechanical Snaplatches, Mogul Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch when door is closed; latchbolt retracted by mogul cylinder; keyed [**one side**][**two sides**].
3. Latchbolt: **1 inch high by 7/16 inch (25 mm high by 11 mm)** thick; **5/16-inch (8-mm)** throw.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

F. Mechanical Snaplatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch when door is closed; latchbolt retracted by five-tumbler paracentric cylinder; keyed one side. When closed, latch is concealed within lock case.
3. Latchbolt: **1 inch high by 7/16 inch (25 mm high by 11 mm)** thick; **7/16-inch (11-mm)** throw.
4. Provide angled strike.
5. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

G. Sliding-Door Mechanical Deadlatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Hookbolt snaplatches and automatically deadlocks through action of plunger pin when door is closed (slam locking); hookbolt raised by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].
3. Hookbolt: **1/2-inch- (13-mm-)** thick, case-hardened steel; **5/8-inch (16-mm)** lift.
4. Provide case-hardened-steel deadlock plunger pin.
5. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1643.

H. Sliding-Door Mechanical Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Hookbolt raised and lowered by [**five**][**six**]-tumbler paracentric cylinder (no slam locking); keyed [**one side**][**two sides**].
3. Hookbolt: **1/2-inch- (13-mm-)** thick, case-hardened steel; **5/8-inch (16-mm)** lift.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1643.

I. Mechanical Snaplatch/Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch when door is closed (slam locking) with key-operated deadlock; latchbolt retracted by half turn and extended by full turn in opposite direction of [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].

   a. Knob operation retracts latchbolt unless deadlocked. Locate knobs on [**one side**][**two sides**].

3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick steel, with two case-hardened-steel insert pins; **3/4-inch (19-mm)** throw; [**1/2-inch (13-mm)**][**1-1/4-inch (32-mm)**] bolt projection when retracted.
4. Listed and labeled for use on fire doors.
5. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

J. Mechanical Deadlatches/Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch and automatic deadlock through action of actuator when door is closed (slam locking); latchbolt retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].
3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick steel, with two case-hardened-steel insert pins; **3/4-inch (19-mm)** throw; [**1/2-inch (13-mm)**][**1-1/4-inch (32-mm)**] bolt

projection when retracted.
4. Deadlock Actuator: **3/4-inch-high by 3/4-inch- (19-mm-high by 19-mm-)** thick steel; **1/2-inch (13-mm)** throw.
5. Listed and labeled for use on fire doors.
6. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

K. Mechanical Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Deadlocked in both locked and unlocked position; latchbolt retracted and extended by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].
3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick steel, with two case-hardened-steel insert pins; **3/4-inch (19-mm)** throw; [**1/2-inch (13-mm)**][**1-1/4-inch (32-mm)**] bolt projection when retracted.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

L. Cremone Bolt Mechanical Snaplatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Automatic snaplatch and deadlocking when door is closed (slam locking); latchbolt retracted and extended by five-tumbler paracentric cylinder; keyed [**one side**][**two sides**]. Lever operation [**one side**][**two sides**] retracts head and foot rods, unless deadlocked, for three-point locking.
3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick steel, with two case-hardened-steel insert pins; **3/4-inch (19-mm)** throw.
4. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

M. Cremone Bolt Mechanical Deadlocks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Active leaf deadlocks when door is closed (no slam locking); active-leaf deadbolt retracted and extended by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**]. Active-leaf lever operation [**one side**][**two sides**] retracts active-leaf head and foot bolts unless deadlocked.

a. Inactive Leaf: Head and foot bolts deadlocked by [**five**][**six**]-tumbler, inactive-leaf paracentric cylinder. Inactive-leaf lever operation [**one side**][**two sides**] retracts inactive-leaf head and foot bolts unless deadlocked.

3. Deadbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick steel, with two case-hardened-steel insert pins; **3/4-inch (19-mm)** throw.
4. Head and Foot Bolts: **7/8-inch (22-mm)** diameter; **3/4-inch (19-mm)** throw.
5. Provide foot bolt receptacle(s).
6. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

N. Mechanical Head and Foot Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: [Head][Foot][Head and foot] bolt retracted and extended by [spanner-type key][five-tumbler paracentric cylinder][enclosed in iron or steel case with steel cover].
3. Latchbolt: **1-inch- (25-mm-)** diameter steel; **3/4-inch (19-mm)** throw.
4. Foot Bolt Receptacle: Spring-loaded mechanism; brass.
5. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

O. Institutional Mortise Locksets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Functions and keying, in accordance with ASTM F1577, as indicated in detention door hardware sets.
3. Cylinder: [**High-security builders**][**Mogul**].
4. Latchbolt: **1-1/8-inch-high by 3/4-inch- (29-mm-high by 19-mm-)** thick stainless steel; **3/4-inch (19-mm)** throw.
5. Deadbolt: **1-1/4-inch-high by 3/4-inch- (32-mm-high by 19-mm-)** thick stainless steel; **1-inch (25-mm)** throw.
6. Faceplate: Stainless steel.
7. Strike: Stainless steel.
8. Listed and labeled for use on fire doors.
9. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

2.5 ELECTROMECHANICAL DETENTION LOCKS AND LATCHES

A. Connectors: Provide electromechanical detention locks and latches with factory-wired plug connector with **6-inch (152-mm)** wire pigtail.

1. Provide security ring for installation of electromechanical detention lock in hollow-metal detention frame, welded to frame or access cover.
2. Equip direct-current, solenoid-operated detention locks and latches with diode transient voltage

protection at each locking device.

B. Solenoid-Operated Deadlatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**RR Brink Locking Systems, Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**]; if latchbolt is retracted by key, it remains retracted until relocked by key.

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated; latchbolt extends when power is discontinued**].
   b. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide roller-type deadlock actuator.
6. Voltage: 120 V ac.
7. Listed and labeled for use on fire doors.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

C. Motor-Operated Deadlatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**RR Brink Locking Systems, Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**]; if latchbolt is retracted by key, it remains retracted until relocked by key.

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated; latchbolt extends when power is discontinued**].
   b. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide roller-type deadlock actuator.
6. Voltage: [**120 V ac**][**24 V dc**].

7. Listed and labeled for use on fire doors.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

D. Sliding-Door, Motor-Operated Deadlatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric motor that raises hookbolt; spring-loaded actuator pin pushes door open **1 to 3 inches (25 to 75 mm)**; automatic latching and deadlocking when door is closed (slam locking). Hookbolt can be mechanically raised by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**]; if hookbolt is raised by key, it remains raised until relocked by key.

   a. Latchback: Hookbolt remains raised [**until door is opened 2 inches (51 mm), then lowers**][**as long as control switch is in open position; hookbolt lowers when control switch is moved to locked position**].
   b. If power fails, hookbolt automatically deadlocks (fail-secure).

3. Hookbolt: **1-3/4- by 1/2-inch- (44- by 13-mm-)** thick, case-hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide case-hardened-steel deadlock actuator.
6. Voltage: 120 V ac.
7. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

E. Solenoid-Operated Deadlatches, Mogul Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**RR Brink Locking Systems, Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed [**one side**][**two sides**].

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated; latchbolt extends when power is discontinued**].
   b. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically.
   c. Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key.
   d. Knob operation retracts latchbolt; always active.
   e. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-)** thick hardened steel; **1-inch (25-mm)** throw.
4. Provide internal deadlock indicator switch.

5. Provide roller-type deadlock actuator.
6. Voltage: 120 V ac.
7. Listed and labeled for use on fire doors.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

F. Motor-Operated Deadlatches, Mogul Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed [**one side**][**two sides**].

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is in open position; latchbolt extends when control switch is moved to locked position**].
   b. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically.
   c. Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key.
   d. Knob operation retracts latchbolt; always active.
   e. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-)** thick hardened steel; **1-inch (25-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide roller-type deadlock actuator.
6. Voltage: [**120 V ac**][**24 V dc**].
7. Listed and labeled for use on fire doors.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

G. Solenoid-Operated Deadlatches, Commercial Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**RR Brink Locking Systems, Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by [**high-security**]commercial cylinder; keyed [**one side**][**two sides**].

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated; latchbolt extends when power is discontinued**].
   b. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key

always operates lock manually and electrically.
c. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Deadlock Actuator: Stainless steel.
6. Strike: Stainless steel.
7. Voltage: 24 V dc.
8. Listed and labeled for use on fire doors.
9. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

H. Motor-Operated Deadlatches, Commercial Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by [**high-security**]commercial cylinder; keyed [**one side**][**two sides**].

   a. Latchback: Latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is in open position; latchbolt extends when control switch is moved to locked position**].
   b. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically.
   c. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Deadlock Actuator: Stainless steel.
6. Strike: Stainless steel.
7. Voltage: 24 V dc.
8. Listed and labeled for use on fire doors.
9. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

I. Institutional Electromechanical Mortise Lockset:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Functions and keying, in accordance with ASTM F1577, as indicated in detention door hardware sets.
3. Cylinder: [**High-security builders**][**Mogul**].
4. Latchbolt: **1-1/8-inches-high by 3/4-inch- (29-mm-high by 19-mm-)** thick stainless steel; **3/4-**

inch (19-mm) throw.
5. Faceplate: Stainless steel.
6. Strike: Stainless steel.
7. Voltage: 24 V dc.
8. Listed and labeled for use on fire doors.
9. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

J. Solenoid-Operated Gate Locks, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates electric solenoid that raises an internal bolt; automatic deadlocking when gate is closed. Bolt can be mechanically retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].

   a. Latchback: Bolt remains raised until gate is closed.
   b. If power fails, latchbolt automatically deadlocks (fail-secure).

3. Bolt: 5/8-inch- (16-mm-) diameter stainless steel; 1-inch (25-mm) throw.
4. Provide internal deadlock indicator switch.
5. Voltage: 120 V ac.
6. Finish: Galvanized.
7. Mounting: Mount lock to gate post; mount locking tongue to gate frame.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

2.6 PNEUMATIC DETENTION LOCKS AND LATCHES

A. Operation: Provide pneumatic detention locks and latches that operate when supplied with air between 40 psig (275 kPa) minimum and 100 psig (690 kPa) maximum.

B. Factory install quick-connect air fitting and factory-wired plug connector with 6-inch (152-mm) wire pigtail.

1. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover.

C. Pneumatic Deadlatches, Paracentric Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated**]; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can

be mechanically retracted by [**five**][**six**]-tumbler paracentric cylinder; keyed [**one side**][**two sides**].

a. If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **2-inch-high by 3/4-inch- (51-mm-high by 19-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide roller-type deadlock actuator.
6. Voltage: 24 V dc.
7. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

D. Pneumatic Deadlatches, Mogul Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated**]; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed [**one side**][**two sides**].

a. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically.
b. Knob on opposite side of cylinder retracts latchbolt.
c. If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-)** thick hardened steel; **1-inch (25-mm)** throw.
4. Provide internal deadlock indicator switch.
5. Provide roller-type deadlock actuator.
6. Voltage: 24 V dc.
7. Listed and labeled for use on fire doors.
8. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

E. Pneumatic Deadlatches, Commercial Cylinder:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Southern Folger Detention Equipment Company**]

2. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted [**until door is opened 2 inches (51 mm), then releases**][**as long as control switch is activated**]; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by [**high-security**]commercial cylinder; keyed [**one side**][**two sides**].

a. Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically.
b. If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).

3. Latchbolt: **1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-)** thick hardened steel; **3/4-inch (19-mm)** throw.
4. Faceplate: Stainless steel.
5. Provide internal deadlock indicator switch.
6. Provide roller-type deadlock actuator.
7. Voltage: 24 V dc.
8. Listed and labeled for use on fire doors.
9. Security Grade: [**1**][**2**][**3**][**4**] in accordance with ASTM F1577.

2.7 DETENTION LOCK TRIM

A. Levers: Solid stainless steel.

B. Knobs: [**Stainless steel**][**Brass**].

C. Escutcheons for Paracentric Locks: **0.125-inch- (3.18-mm-)** thick, **3-inch- (75-mm-)** diameter [**stainless steel with ANSI/BHMA 630**][**brass with ANSI/BHMA 606**] finish. Attach with security fasteners.

1. Style: [**Single wing**][**Double wing**][**Single or double wing as required by lock function**][**As indicated**].

D. Cylinder Shields for Paracentric Locks: **0.125-inch- (3.18-mm-)** thick, **3-inch- (75-mm-)** diameter [**stainless steel with ANSI/BHMA 630**][**brass with ANSI/BHMA 606**] finish and swinging cover to protect keyhole. Attach with security fasteners.

1. Style: [**Single wing**][**Double wing**][**Single or double wing as required by lock function**][**As indicated**].

2.8 DETENTION CYLINDERS AND KEYING

A. Source Limitations: Subject to compliance with requirements, provide cylinders and keying for paracentric and mogul cylinders by same manufacturer as for detention locks and latches.

B. Paracentric Cylinders: Manufacturer's standard lever-tumbler type, constructed from one-piece spring-tempered brass; with tumblers activated by phosphor bronze springs; five tumblers per lock.

C. Mogul Cylinders: Manufacturer's standard pin-tumbler type, minimum **2-inch (51-mm)** diameter; body constructed from brass or bronze, stainless steel, or nickel silver; with stainless steel tumblers and engaging cylinder balls; complying with the following:

1. Number of Pins: [**Five**][**Six**][**Seven**].
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

a. High-Security Grade: Listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).

3. Finish: [**ANSI/BHMA 606**][**ANSI/BHMA 626**][**ANSI/BHMA 630**].

D. Keying System: Provide a factory-registered keying system complying with the following requirements:

1. Paracentric cylinders operated by change keys only.
2. No Master Key System: Mogul cylinders operated by change keys only.
3. Master Key System: Mogul cylinders operated by a change key and a master key.
4. Grand Master Key System: Mogul cylinders operated by a change key, a master key, and a grand master key.
5. Great-Grand Master Key System: Mogul cylinders operated by a change key, a master key, a grand master key, and a great-grand master key.
6. Existing System: [**Master key or grand master key mogul-cylinder locks to the Ownerthe Owner's existing system**][**Re-key the Ownerthe Owner's existing master key system for mogul-cylinder locks into new keying system**].

E. Keys: Provide cast silicon-bronze copper alloy keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key-control number and include the following notation:

   a. [**"DO NOT DUPLICATE"**][**Information to be furnished by the Owner**].

2. Quantity: In addition to one extra blank key for each lock, provide the following:

   a. Cylinder Change Keys: [**Three**].
   b. Master Key(s): [**One**].
   c. Grand Master Key(s): [**One**].
   d. Great-Grand Master Key(s): [**One**].

2.9 SWITCHES

A. General: Provide switches configured with contact type required for functions indicated, including multiple circuiting where required by functional performance of Section 285213 "Detention Monitoring and Control System and Interfaces."

B. Concealed, Magnetic Door Position Switches: Consist of actuating magnet mortised into detention door and switch mortised into frame; with stainless steel faceplates; 24 V dc, factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**RR Brink Locking Systems, Inc.**]
   c. [**Southern Folger Detention Equipment Company**]

C. Concealed, Mechanical Door Position Switches: Consist of metal track mortised into head of detention door connected by steel actuator arm to steel actuator mortised into frame; switch fully concealed when door is in closed position; with stainless steel faceplate; 120 V ac; factory wired with plug connector. Action of door mechanically activates switch. Wire in series with lock monitors. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**RR Brink Locking Systems, Inc.**]
b. [**Southern Folger Detention Equipment Company**]

D. Surface-Mounted Door Position Switches: Switch enclosed in **0.134-inch (3.42-mm)** nominal-thickness steel enclosure, factory primed for painting; 120 V ac; factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**RR Brink Locking Systems, Inc.**]
b. [**Southern Folger Detention Equipment Company**]

2. Galvanize enclosure for exterior locations[**and where indicated**].

E. Strike Indicator Switches: Designed to be mortised behind strike and to indicate whether door is locked or unlocked; enclosed in metal strike box. Wire in series with door position switches. Attach with security fasteners.

1. Voltage: [**120 V dc**][**240 V ac**][**As indicated**].
2. Locations: [**At doors with mechanical detention lock**][**Where indicated**].
3. Manufacturer: Same as detention lock.

F. Inmate Door-Control Switches: [**Momentary**][**Maintained-contact**] push-button switch with metal faceplate. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**RR Brink Locking Systems, Inc.**]
c. [**Southern Folger Detention Equipment Company**]

2. Material and Finish: [**Brass with ANSI/BHMA 606**][**Brass with ANSI/BHMA 626**][**Stainless steel with ANSI/BHMA 630**] finish.
3. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.

G. Push-Button, Inmate Door-Control Switches: [**Momentary**][**Maintained-contact**] push-button switch for installation without faceplate. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**RR Brink Locking Systems, Inc.**]

b. [**Southern Folger Detention Equipment Company**]

2. Material and Finish: [**Brass with ANSI/BHMA 606**][**Brass with ANSI/BHMA 626**][**Stainless steel with ANSI/BHMA 630**] finish.
3. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.

2.10 DETENTION OPERATING TRIM

A. Standard: ANSI/BHMA A156.6, Grade 1.

B. Surface-Mounted Door Pulls: **8-3/4-inch (222-mm)** overall length and **2-1/4-inch (57-mm)** projection; attach to door with two security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Hager Companies**]
c. [**RR Brink Locking Systems, Inc.**]
d. [**Southern Folger Detention Equipment Company**]

2. Material: [**Cast bronze with ANSI/BHMA 606 finish**][**Cast bronze with ANSI/BHMA 626 finish**][**Cast stainless steel with ANSI/BHMA 630 finish**].

C. Round, Surface-Mounted Door Pulls: **7-inch (178-mm)** overall length by **1-inch- (25-mm-)** diameter solid bar, with **2-1/4-inch (57-mm)** projection; attach to door with two security through bolts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hager Companies**]

2. Material: [**Cast or extruded bronze with ANSI/BHMA 606 finish**][**Cast or extruded bronze with ANSI/BHMA 626 finish**][**Cast stainless steel with ANSI/BHMA 630 finish**].

D. Flush Door Pulls: **5 inches high by 4 inches wide by 1 inch deep (127 mm high by 102 mm wide by 25 mm deep)**, with **1/8-inch- (3-mm-)** thick faceplate; attach to door with four security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Hager Companies**]
c. [**RR Brink Locking Systems, Inc.**]
d. [**Southern Folger Detention Equipment Company**]

2. Material: [**Formed, wrought, or cast brass/bronze with ANSI/BHMA 606 finish**][**Formed, wrought, or cast brass/bronze with ANSI/BHMA 626 finish**][**Formed or cast stainless steel**

with ANSI/BHMA 630 finish].

E. Knob Pulls: **2-inch (51-mm)** diameter; fabricated from solid brass with [**ANSI/BHMA 606**][**ANSI/BHMA 626**] finish. Attach with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**RR Brink Locking Systems, Inc.**]
c. [**Southern Folger Detention Equipment Company**]

F. Lever-Handle Guides: Guide tracks [**and escutcheons**]that provide selective stopping of lever handle by use of an adjustable stop; fabricated from [**steel with ANSI/BHMA 633**][**stainless steel with ANSI/BHMA 630**] finish. Attach with security fasteners.

2.11 SECURITY DOOR CLOSERS

A. Standard: ANSI/BHMA A156.4, Grade 1.

1. Certified Products: Provide security door closers listed in ANSI/BHMA's "Directory of Certified Door Products."

B. Surface-Mounted Security Door Closers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**LCN; Allegion plc**]
c. [**Norton Door Controls; ASSA ABLOY**]
d. [**Yale Security Inc; ASSA ABLOY**]

2. Arms: Minimum **3/8-inch- (9.5-mm-)** thick by **1-1/8-inch- (29-mm-)** wide, rectangular steel main arm; **5/16-inch- (8-mm-)** thick by **1-inch- (25-mm-)** wide, rectangular steel secondary arm; full rack-and-pinion type; fabricated with orbital-riveted, pinned, or welded elbow and arm shoe/soffit plate joints designed to prevent disassembly with ordinary hand tools.
3. Cover: Heavy-duty metal, attached with four security fasteners.
4. Mounting: Attach security door closer with security fasteners.

C. Concealed Security Door Closers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LCN; Allegion plc**]
b. [**Norton Door Controls; ASSA ABLOY**]
c. [**SARGENT Manufacturing Company; ASSA ABLOY**]

2. Construction: Forged-steel arm; security roller; with track concealed in head of detention door, designed to eject foreign objects during opening and closing; fabricated with joints designed to prevent disassembly with ordinary hand tools. Closer arm and track fully concealed when door is closed.
3. Cover Plates: Heavy-duty metal, attached with security fasteners.
4. Provide door position switch integral to closer.

D. Unit Size: Comply with manufacturer's written recommendations for size of security door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to comply with field conditions and requirements for opening force.

2.12 DETENTION DOOR STOPS

A. Detention Floor Stops: **1-1/2-inch-high by 2-inch- (38-mm-high by 51-mm-)** diameter, rubber bumper mounted on steel lag bolt; ANSI/BHMA A156.16; install in floor with nonshrink grout; for detention doors unless wall or other type stops are indicated. Do not mount floor stops where they can impede traffic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burns Manufacturing Incorporated**]
   b. [**Hager Companies**]
   c. [**Trimco**]

B. Silencers for Detention Door Frames: ANSI/BHMA A156.16, Grade 1; neoprene or rubber, minimum **1/2-inch (13-mm)** diameter; fabricated for drilled-in application to detention door frame. Attach with security fasteners.

2.13 SLIDING DETENTION DOOR DEVICE ASSEMBLIES

A. Performance Requirements: Provide sliding detention door device assemblies, including locking device, receiver, overhead door hanger, bottom door guide, lock column, and enclosure, as a complete assembly, complying with [**Grade 1**][**Grade 2**] in accordance with ASTM F1643, as determined by testing manufacturers' standard units representing those indicated for Project.

B. Assembly Construction:

1. Enclosure: Fabricated from **0.179-inch (4.56-mm)** nominal-thickness steel plate, with **0.134-inch (3.42-mm)** nominal-thickness steel [**removable**][**hinged**] cover. Baffle openings in enclosure. Provide closures for ends of housings.

   a. Provide sloping-top housings.[**Flat-top housings may be provided for operators mounted to ceiling.**]

2. Lock Column: Vertical tube enclosure fabricated from **0.134-inch (3.42-mm)** nominal-thickness steel, providing mechanical locking control of detention sliding door at door location; operated by paracentric key. Doors are capable of being locked at top and bottom, at rear of door, in both open and closed positions, with no components projecting into door opening.
3. Receiver: Fabricated from **0.134-inch (3.42-mm)** nominal-thickness steel plate.
4. Hanger Assembly: Extend steel carrier full width of door plus full extent of door travel required for clear door opening. Provide antifriction ball-bearing steel rollers with hardened members and grease shield.

5. Finish: Factory prime painted.

C. Mechanical-Locking, Manual-Door-Movement, Sliding-Door Device Assemblies: Doors are manually opened and closed and mechanically locked by means of jamb-mounted mechanical detention lock specified elsewhere in this Section.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Maximum Security Products Corp**]
c. [**RR Brink Locking Systems, Inc.**]
d. [**Southern Folger Detention Equipment Company**]

D. Electromechanical-Locking, Manual-Door-Movement, Sliding-Door Device Assemblies: Operated from remote-control panel that activates electric motors to unlock sliding doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Provide factory-wired cable harness with plug connectors for each motor unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**RR Brink Locking Systems, Inc.**]
c. [**Southern Folger Detention Equipment Company**]

2. Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
3. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from [**mechanical-release cabinet at end of cell line**][**pilaster release adjacent to receiving jamb of each door operated by paracentric key**]; doors do not relock in any position.
4. Electric Key Switch: Operated by [**paracentric**][**mogul**] key and provides electric control of detention sliding-door operation at door location.

E. Electromechanical-Locking, Electromechanical-Door-Movement, Sliding-Door Device Assemblies: Operated from remote-control panel that activates electric motors to unlock sliding doors and motorized rack-and-pinion drive mechanisms to open and close doors. Doors lock in open position and deadlock when closed. Provide factory-wired cable harness with plug connectors for each motor unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
b. [**Maximum Security Products Corp**]
c. [**RR Brink Locking Systems, Inc.**]
d. [**Southern Folger Detention Equipment Company**]

2. Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
3. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from [**mechanical-release cabinet at end of cell line**][**pilaster release adjacent to receiving jamb of each door operated by paracentric key**]; doors do not relock in any position.
4. Electric Key Switch: Operated by [**paracentric**][**mogul**] key and provides electric control of detention sliding-door operation at door location.

F. Pneumatic-Locking, Manual-Door-Movement, Sliding-Door Device Assemblies: Operated from remote-control panel that activates pneumatic cylinders to unlock doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.

   a. Lock Control at Door: Mechanical key release adjacent to receiving jamb of each door, contained in pilaster and operated by paracentric key.

3. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from [**remotely located auxiliary pneumatic-release system**][**pilaster release adjacent to receiving jamb of each door operated by paracentric key**]; doors do not relock in any position.
4. Electric Key Switch: Operated by [**paracentric**][**mogul**] key and providing electric control of detention sliding-door operation at door location.

G. Pneumatic-Locking, Pneumatic-Door-Movement, Sliding-Door Device Assemblies: Operated from remote-control panel that activates pneumatic cylinder to unlock sliding doors and open and close doors. Doors lock in open position and deadlock when closed. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit; 24 V dc.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airteq Systems, Inc.; Cornerstone Inc.**]
   b. [**Southern Folger Detention Equipment Company**]

2. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
3. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or

unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from [**remotely located auxiliary pneumatic-release system**][**pilaster release adjacent to receiving jamb of each door operated by paracentric key**]; doors do not relock in any position.

4. Electric Key Switch: Operated by [**paracentric**][**mogul**] key and providing electric control of detention sliding-door operation at door location.
5. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover.

2.14 KEY-CONTROL SYSTEM

A. Security Key Cabinets: Metal cabinet for mounting [**150**][**300**] paracentric or mogul keys.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**Detention Device Systems (DDS); DDS Group**]
   c. [**Southern Folger Detention Equipment Company**]

2. Cabinet: Minimum **16 inches (406 mm)** wide by **24 inches (610 mm)** high by **6-1/2 inches (165 mm)** deep; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet. Provide **0.060-inch (1.52-mm)** nominal-thickness, steel-sheet interior panels, supported on pivots.
3. Doors: Formed from same material as cabinet, supported by heavy-duty, continuous, side hinge welded to cabinet and door; with tumbler deadlock.
4. Cross-Index System: Set up by detention key-control manufacturer; include labels, two sets of key tags with self-locking key holders, key-gathering envelopes, temporary and permanent markers, and the following:

   a. Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key-holding hook.
   b. Computer Software: Furnish cross-index software for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.

B. Finishes:

1. Steel Prime Finish: Clean, pretreat, and apply manufacturer's standard primer immediately after cleaning and pretreating.
2. Steel Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.15 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated

labels and as otherwise approved by Architect, as directed by the Owner.

B. Base Metals: Produce detention door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified detention door hardware units and ANSI/BHMA A156.18 finishes.

C. Fasteners: Provide flat-head security fasteners with finished heads to match surface of detention door hardware.

1. Security Fasteners: Fabricate detention door hardware using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials.[**Provide stainless steel security fasteners in stainless steel materials.**]
2. Concealed Fasteners: For detention door hardware units that are exposed when detention door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching detention door hardware. Where using through bolts on hollow-metal detention door and frame construction, provide sleeves for each through bolt.
3. Steel Machine Screws: For the following fire-rated applications:

   a. Mortise detention hinges to detention doors.
   b. Strike plates to detention frames.
   c. Security door closers to detention doors and frames.

4. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:

   a. Surface detention hinges to detention doors.
   b. Security door closers to detention doors and frames.

5. Spacers Bolts: For through bolting of hollow-metal detention doors.

D. Detention Lock Construction: Fabricate detention lock case and cover plate from steel plate. Fabricate bolts from solid sections; laminated construction is unacceptable.

2.16 HARDWARE FINISHES

A. Standard: Comply with ANSI/BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. ANSI/BHMA Designations: Comply with base material and finish requirements indicated by the following:

1. ANSI/BHMA 600: Primed for painting, over steel base metal.
2. ANSI/BHMA 606: Satin brass, clear coated, over brass base metal.
3. ANSI/BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
4. ANSI/BHMA 630: Stainless steel, satin, over stainless steel base metal.
5. ANSI/BHMA 633: Satin brass plated, clear coated, over steel base metal.
6. ANSI/BHMA 652: Satin chromium plated over nickel, over steel base metal.

2.17 SECURITY FASTENERS

A. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific fastener type. Provide drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
   b. [**Bryce Fastener Mfg., Inc.**]
   c. [**Safety Socket LLC**]
   d. [**Tamper-Pruf Screws**]
   e. [**Tamperproof Screw Co., Inc.**]

2. Drive-System Type: [**Pinned Torx-Plus**][**Pinned Torx**].
3. Fastener Strength: **120,000 psi (827 MPa)**.
4. Socket Button Head Fasteners:

   a. Heat-treated alloy steel, **ASTM F835**.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

5. Socket Flat Countersunk Head Fasteners:

   a. Heat-treated alloy steel, **ASTM F835**.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

6. Socket Head Cap Fasteners:

   a. Heat-treated alloy steel, **ASTM A574**.
   b. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

7. Protective Coatings for Heat-Treated Alloy Steel:

   a. Zinc and clear trivalent chromium where indicated.
   b. Zinc phosphate with oil, ASTM F1137/F1137M, Grade I, or black oxide unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine detention doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention door hardware connections before detention door hardware installation.

C. Inspect built-in and cast-in anchor installations, before installing detention door hardware, to verify that

anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work.

D. Verify locations of detention door hardware with those indicated on Shop Drawings.

E. Examine roughing-in for electrical power[**and pneumatic**] systems to verify actual locations of connections before detention door hardware installation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Detention Doors and Frames: Comply with ANSI/BHMA A156.115 Series.

1. Surface-Applied Detention Door Hardware: Drill and tap detention doors and frames in accordance with ANSI/SDI A250.6.

3.3 INSTALLATION OF DETENTION DOOR HARDWARE

A. Mounting Heights: Mount detention door hardware units at heights indicated in [**DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames"**].

B. Install each detention door hardware item to comply with Shop Drawings and manufacturer's written instructions. Where cutting and fitting are required to install detention door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

C. Hinge Installation:

1. Welding: Where indicated, weld hinges to detention doors and frames with continuous fillet weld around three sides of hinge perimeter.
2. Security Fasteners: Provide socket flat countersunk head machine screws; finish screw heads to match surface of detention hinges. Install into drilled and tapped holes.

D. Install interconnecting wiring and connectors between detention door hardware devices. Terminate device wiring for detention door hardware installed in [**swinging doors at a plug-type connector located in lock pocket or door frame junction box**][**and for**][**sliding doors at a junction box in door frame**].

E. Security Fasteners: Install detention door hardware using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials.

3.4 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Tests and inspections:

1. After installing electrically powered[**and pneumatic**] detention door hardware and after electrical circuitry has been energized[**and compressed-air system is functional**], test detention door hardware for compliance with requirements.

   a. Test: Operate lock of each door and group of doors in normal remote, normal local, and emergency operating modes. Verify that remote controls operate correct door locks and in correct sequence.

2. Verify that lock bolts engage strikes with required bolt projection.
3. Verify that detention door hardware is installed, connected, and adjusted in accordance with the Contract Documents.
4. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements.

C. Detention work will be considered defective if it does not pass tests and inspections.

D. Perform additional inspections to determine compliance of replaced or additional work.

E. Prepare field quality-control certification[endorsed by Detention Specialist,] that states installed products comply with requirements in the Contract Documents.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust and check each operating item of detention door hardware and each detention door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust detention door-control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by detention door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that detention door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, provide [**three**][**six**][**nine**][**12**] months' full

maintenance by skilled employees of detention door hardware Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper detention door hardware operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain detention door hardware and detention door hardware finishes.

3.9 DETENTION DOOR HARDWARE SCHEDULE

A. General: Provide detention door hardware for each detention door to comply with requirements in this Section and with detention door hardware sets indicated below.

END OF SECTION 08 71 11 00

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Task	Specification	Specification Description
08 71 11 00	01 22 00 00	No Specification Required
08 71 11 00	08 71 00 00	Door Hardware

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SECTION 08 71 13 00 - POWER DOOR OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power door operators for swinging doors.
2. Low-energy door operators for swinging doors.
3. Power-assist door operators for swinging doors.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing recessed metal frames for control mats in concrete.
2. Section 084229.33 "Swinging Automatic Entrances" for swinging doors and frames packaged with power door operators.

1.2 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Double-Egress (Doors): A pair of doors that simultaneously swing, with the two doors moving in opposite directions with no mullion between them.

D. Double-Swing (Doors): A pair of doors that swing, with the two doors moving in opposite directions with a mullion between them; each door functioning as a single-swing door.

E. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.

F. For automatic door terminology, see [**BHMA A156.10**][**and**][**BHMA A156.19**] for definitions of terms.

1.3 COORDINATION

A. Coordinate sizes and locations of recesses in concrete floors for recessed control mats that control power door operators. Concrete, reinforcement, and formwork requirements are specified elsewhere.

B. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing power door operators.

C. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.

D. Electrical System Roughing-in: Coordinate layout and installation of power door operators with connections to the following:

1. Power supplies.
2. Access-control system.
3. Remote activation devices.
4. Remote monitoring systems.

E. Pneumatic System Roughing-in: Coordinate layout and installation of power door operators and power units with compressed-air piping.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power door operators.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For power door operators.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Indicate locations of activation and safety devices.
4. Include diagrams for power, signal, and control wiring.
5. Include plans, elevations, sections, and attachment details for guide rails.

C. Samples: For each exposed product and for each color and texture specified, [**manufacturer's standard size**].

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**Certified Inspector**].

B. Product Certificates: For each type of power door operator.[**For each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.**]

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For power door operators, safety devices, and control systems, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project[**and who employs a Certified Inspector**].

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

B. Certified Inspector Qualifications: Certified by AAADM.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of power door operators that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty or sporadic operation of power door operator, including controls.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 POWER DOOR OPERATORS, GENERAL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASSA ABLOY Entrance Systems; ASSA ABLOY**]
2. [**Ditec; Entrematic; ASSA ABLOY**]
3. [**Door Motion Technologies, Inc.**]
4. [**dormakaba USA Inc.**]
5. [**Falcon; Allegion plc**]
6. [**Hager Companies**]
7. [**Horton Automatics; Overhead Door Corporation**]
8. [**KM Systems, Inc**]
9. [**LCN; Allegion plc**]
10. [**NABCO Entrances, Inc**]
11. [**record-usa**]
12. [**SARGENT Manufacturing Company; ASSA ABLOY**]
13. [**STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.**]

B. Source Limitations: Obtain power door operators, including activation and safety devices, from [**single source from single manufacturer.**][**same manufacturer as for hardware in Section 087100 "Door Hardware."**][**same manufacturer as for hardware in Section 087111 "Door Hardware (Descriptive Specification)."**]

C. General: Provide operators of size recommended by manufacturer for door size, weight, and movement;

for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and in accordance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.

1. Emergency Breakaway: Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to power door operator when door is in emergency breakaway position, to return door to closed position after breakaway, and to automatically reset.
2. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

D. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation, including spring closing when power is off.

E. Electrohydraulic Operating System: Self-contained, low-pressure unit; with separate cylinders for power and checking, connections for power and activation- and safety-device wiring, and manual operation, including spring closing when power is off.

F. Pneumatic Operating System: Pneumatic operator, air opened and spring closed; with checking in both cycles and manual operation when power is off.

1. Power Unit:

a. Control box and compressor unit, complete with tank, compressor, air line to operator, motor, regulator, safety valve, pressure cutoff switch, and automatic air-line filter drain.
b. Remote-control box powered by compressed-air system specified in Section 221513 "General-Service Compressed-Air Piping" and Section 221519 "General-Service Packaged Air Compressors and Receivers."

G. Hinges: See [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for hinge type for each door that door operator shall accommodate.

H. Housing for Overhead Concealed Operators: Fabricated from minimum **0.125-inch- (3.2-mm-)** thick, extruded or formed aluminum and extending full width of door opening, including door jambs, to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

I. Cover for Surface-Mounted Operators: Fabricated from **0.125-inch- (3.2-mm-)** thick, extruded or formed aluminum[**manufacturer's standard width**][**continuous over full width of operator-controlled door opening**][**continuous over full width of door opening, including door jambs**]; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

J. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.

K. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.

L. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 POWER DOOR OPERATORS FOR SWINGING DOORS

A. Standard: BHMA A156.10.

B. Performance Requirements:

1. Opening Force:

a. Power-Operated Doors: Not more than **50 lbf (222 N)** required to manually set door in motion if power fails; not more than **15 lbf (67 N)** required to open door to minimum required width.
b. Power-Operated Swinging Doors: Not more than **30 lbf (133 N)** required to manually open door if power fails.
c. Breakaway Device for Power-Operated Doors: Not more than **50 lbf (222 N)** required for breakaway door or panel to open.

2. Entrapment-Prevention Force: Not more than **40 lbf (178 N)** required to prevent stopped door in the last 10 degrees of opening from moving in the direction of opening; not more than **30 lbf (133 N)** required to prevent stopped door from moving in direction of closing.

C. Configuration: Operator to control [**single swinging door**][**pair of swinging doors**].

1. Traffic Pattern: [**One way**][**Two way**][**Double swing**][**Double egress**].
2. Operator Mounting: [**Surface**][**Overhead concealed**].

D. Operation: Power opening and[**power-assisted**] spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.10.

E. Operating System: [**Electromechanical**][**Electrohydraulic**][**Pneumatic**].

F. Microprocessor Control Unit: Solid-state controller.

G. Features:

1. Adjustable [**opening**][**and**][**closing**] speed.
2. Adjustable [**opening**][**and**][**closing**] force.
3. Adjustable backcheck.
4. Adjustable hold-open time from zero to 30 seconds.
5. Adjustable time delay.
6. Adjustable acceleration.
7. Adjustable limit switch.
8. Obstruction recycle.
9. Power door re-open if stopped while closing.
10. On-off/hold-open switch to control electric power to operator[**key operated**].

H. Controls: Activation and safety devices [**as indicated on Drawings and**]in accordance with BHMA standards.

1. Activation Device, Motion Sensor: Mounted on ingress side of door header to detect pedestrians in activating zone and to open door.
2. Activation Device, Control Mat: Installed on ingress side of door to detect pedestrians in activating zone and to open door.
3. Activation Device, Switch: [**Push-plate switch**][**Touchless switch**][**Push-button switch**][**Key switch**][**on each side of door**]to activate door operator.
4. Safety Device, Presence Sensor: Mounted on [**door header**][**horizontal door muntin**][**guide rail**] to detect pedestrians in presence zone and to prevent door from closing.

5. Safety Device, Photoelectric Beam: One photoelectric beam mounted in guide rails to detect pedestrians in presence zone and to prevent door from closing.
6. Safety Device, Control Mat(s): Installed on egress side of door to detect pedestrians in presence and safety zones and to prevent door from closing.

I. Exposed Finish: [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**Baked-enamel or powder-coat finish**][**Metal cladding**][**Finish matching door and frame**][**Finish matching door hardware**].

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Metal Cladding: [**No. 4, directional-satin-finish stainless steel**][**No. 8, mirrorlike-reflective, nondirectional-polish-finish stainless steel**][**Satin brass**][**Polished brass**][**Satin bronze**][**Polished bronze**].

2.3 LOW-ENERGY DOOR OPERATORS FOR SWINGING DOORS

A. Standard: BHMA A156.19.

B. Performance Requirements:

1. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
2. Entrapment-Prevention Force: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.

C. Configuration, Single: Operator to control single swinging door.

1. Traffic Pattern: [**One**][**Two**] way.
2. Operator Mounting: [**Surface**][**Overhead concealed**].

D. Configuration, Pair: Operator to control pair of swinging doors.

1. Traffic Pattern: [**One way**][**Two way**][**Double egress**][**Double swing**].
2. Operator Mounting: [**Surface**][**Overhead concealed**].

E. Operation: Power opening and[**power-assisted**] spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.

F. Operating System: [**Electromechanical**][**Electrohydraulic**][**Pneumatic**].

G. Microprocessor Control Unit: Solid-state controller.

H. Features:

1. Adjustable [**opening**][**and**][**closing**] speed.
2. Adjustable [**opening**][**and**][**closing**] force.
3. Adjustable backcheck.
4. Adjustable hold-open time from zero to 30 seconds.
5. Adjustable time delay.

6. Adjustable acceleration.
7. Obstruction recycle.
8. On-off/hold-open switch to control electric power to operator[**key operated**].

I. Activation Device: [**Push-plate switch**][**Touchless switch**][**Push-button switch**][**Key switch**][**on each side of door**] to activate door operator.

J. Exposed Finish: [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**Baked-enamel or powder-coat finish**][**Metal cladding**][**Finish matching door and frame**][**Finish matching door hardware**].

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Metal Cladding: [**No. 4, directional-satin-finish stainless steel**][**No. 8, mirrorlike-reflective, nondirectional-polish-finish stainless steel**][**Satin brass**][**Polished brass**][**Satin bronze**][**Polished bronze**].

2.4 POWER-ASSIST DOOR OPERATORS FOR SWINGING DOORS

A. Standard: BHMA A156.19.

B. Performance Requirements:

1. Opening Force:

a. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
b. Accessible Interior Doors: Not more than **5 lbf (22 N)** to push or pull door to fully open position.

2. Entrapment-Prevention Force: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.

C. Configuration, Single: Operator to control single swinging door.

1. Traffic Pattern: [**One**][**Two**] way.
2. Operator Mounting: [**Surface**][**Overhead concealed**].

D. Configuration, Pair: Operator to control pair of swinging doors.

1. Traffic Pattern: [**One way**][**Two way**][**Double egress**][**Double swing**].
2. Operator Mounting: [**Surface**][**Overhead concealed**].

E. Operation: Power-assisted opening that reduces the force to open door and[**power-assisted**] spring closing. Pushing or pulling on door activates operator. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.

F. Operating System: [**Electromechanical**][**Electrohydraulic**][**Pneumatic**].

G. Microprocessor Control Unit: Solid-state controller.

H. Features:

1. Adjustable [**opening**][**and**][**closing**] speed.
2. Adjustable [**opening**][**and**][**closing**] force.
3. Adjustable backcheck.
4. Adjustable hold-open time from zero to 30 seconds.
5. Adjustable time delay.
6. Adjustable acceleration.
7. Obstruction recycle.
8. On-off/hold-open switch to control electric power to operator[**key operated**].

I. Exposed Finish: [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**Baked-enamel or powder-coat finish**][**Metal cladding**][**Finish matching door and frame**][**Finish matching door hardware**].

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
2. Metal Cladding: [**No. 4, directional-satin-finish stainless steel**][**No. 8, mirrorlike-reflective, nondirectional-polish-finish stainless steel**][**Satin brass**][**Polished brass**][**Satin bronze**][**Polished bronze**].

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: **ASTM B221 (ASTM B221M)**.
2. Sheet: **ASTM B209 (ASTM B209M)**.

B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**], stretcher-leveled standard of flatness, in manufacturer's standard thickness.

C. Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper), in manufacturer's standard thickness.

D. Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper), in manufacturer's standard thickness.

E. Expanded Aluminum Mesh: [**Expanded**][**Expanded and flattened**] aluminum sheet in accordance with the geometry of ASTM F1267.

F. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.

G. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.6 CONTROLS

A. General: Provide controls, including activation and safety devices, in accordance with BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door

operator mechanisms.

B. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed in plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.

1. Provide capability for switching between bidirectional and unidirectional detection.
2. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.

C. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection field sizes and functions required by BHMA A156.10. Sensors shall remain active at all times.

D. Photoelectric Beams: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams shall not be active when doors are fully closed.

E. Control Mats: **1/2-inch- (13-mm-)** thick, synthetic-rubber or flexible-plastic mat in safety-ribbed surface pattern, with extruded-aluminum frame; with pressure switches for low-voltage control wiring; and in accordance with performance requirements in BHMA A156.10.

1. Frame: [**Recessed to fit flush with floor, with concealed anchors**][**Surface mounted, with tapered safety edge**].
2. Size: As indicated, but not smaller than required by BHMA A156.10, including Appendix A.
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

F. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator[**with contrasting-colored, engraved message**].

1. Configuration:

a. Round or Square Push Plate: **4-by-4-inch (100-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Surface mounted on wall**].

b. Rectangular Push Plate: **2-by-4-inch (50-by-100-mm)** junction box.

1) Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**].

2. Push-Plate Material: [**Stainless steel**][**Plastic**] as selected by Architect from manufacturer's full range, as directed by the Owner.
3. Message: [**Plain face with no message.**][**"Push to Open."**][**International symbol of accessibility.**][**International symbol of accessibility and "Push to Open."**]

G. Touchless Switch: Hands-free activation door-control switch with flat motion sensor face-plate[**with contrasting-colored, engraved message**].

1. Configuration: [**6-inch (152.4-mm) round**][**4.56-by-4.56-inch (115.8-by-115.8-mm) (double gang) square**][**2.77-by-4.56-inch (70-by-115.8-mm) (single gang) rectangular**][**1.68-by-4.56-inch (42.6-by-115.8-mm) jamb-style**] face plate.

a. Mounting: [**As indicated on Drawings**][**Recess mounted in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**].

2. Face-Plate Material: [**Stainless steel**][**Plastic**][**Stainless steel with backlight acrylic window**][**As selected by Architect from manufacturer's full range of options**], as directed by the Owner.
3. Message: [**"Wave to Open."**][**"Wave to Open" and wave symbol.**][**International symbol of accessibility.**][**International symbol of accessibility and "Wave to Open" and wave symbol.**]

H. Push-Button Switch: Momentary-contact door control switch with one red-button actuator; enclosed in nominal [**2-by-4-inch (50-by-100-mm)**][**4-by-4-inch (100-by-100-mm)**] junction box.

1. Provide faceplate engraved with "Press to Open" text[**and international symbol of accessibility**] in contrasting color.
2. Provide blue plastic cover engraved with "Press Button to Open" in white text and with international symbol of accessibility.
3. Mounting: [**As indicated on Drawings**][**Surface mounted on wall**][**Surface mounted on post**][**Surface mounted on guide rail**][**Recess mounted in wall**].
4. Faceplate Material: [**Stainless steel**][**Painted metal**] as selected by Architect from manufacturer's full range, as directed by the Owner.

I. Key Switch: Recess-mounted, door control switch with key-controlled actuator; enclosed in **2-by-4-inch (50-by-100-mm)** junction box. Provide faceplate engraved with text indicating switch functions.

1. Faceplate Material: [**Stainless steel**][**Painted metal**] as selected by Architect from manufacturer's full range, as directed by the Owner.
2. Functions: [**On-off, momentary contact**][**On-off, maintained contact**][**Two-way automatic, hold open, one-way exit, and off**][**Two-way automatic, hold open, one-way exit, off, full open, and partial open**].
3. Mounting: [**As indicated on Drawings**][**Recess mounted, semiflush in wall**][**Recess mounted in door jamb**][**Surface mounted on wall**][**Surface mounted on post**].

J. Wireless or Remote Radio-Control Switch: Radio-control system consisting of header-mounted receiver and [**wall-mounted**][**handheld, battery-operated**] transmitter switch.

1. Wall-Mounted Transmitter Switch: One red-button, momentary-contact actuator enclosed in **4-by-4-inch (100-by-100-mm)** junction box. Provide blue plastic cover engraved with "Press Button to Open" in white text and with international symbol of accessibility.

K. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.7 ACCESSORIES

A. Signage: As required by cited BHMA standard for type of door and its operation.

1. Application Process: [**Decals**][**Silk-screened**][**Operator manufacturer's standard process**].
2. Provide sign materials with instructions for field application when operators are installed.

B. Guide Rails:

1. [**Anodized aluminum**][**Baked-enamel or powder-coated aluminum**][**Stainless steel**], fabricated from [**bars**][**tubing**], minimum **30 inches (762 mm)** high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated, but not less than [**that required by BHMA A156.10 for type of door and direction of travel**]; with filler panel.

a. Filler Panel: [**Expanded aluminum mesh**][**Clear polycarbonate sheet**][**Colored polycarbonate sheet**].

1) Orient expanded aluminum mesh with long dimension of diamonds [**parallel**][**perpendicular**] to top rail.
2) Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

b. Provide intermediate guide rail suitable for supporting photoelectric beams.
c. Mounting: [**As indicated on Drawings**][**Jamb and floor**][**Floor, freestanding**].
d. Aluminum Finish: [**Class I, clear anodic finish**][**Class II, clear anodic finish**][**Class I, color anodic finish**][**Class II, color anodic finish**][**Baked-enamel or powder-coat finish**][**Finish matching door and frame**].

1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

e. Stainless Steel Finish: [**No. 4, directional-satin-finish stainless steel**][**Finish matching door and frame**].

2. See [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

2.8 FABRICATION

A. Factory fabricate power door operators to comply with indicated standards.

B. Form aluminum shapes before finishing.

C. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.

D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.

E. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

2.9 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary, protective covering before shipping.

B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.10 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of power door operators.

B. Examine roughing-in for electrical systems to verify actual locations of power connections before power door operator installation.

C. Examine roughing-in for compressed-air piping systems to verify actual locations of piping connections before power door operator installation.

D. Verify that full-height finger guards are installed at each door with pivot hinges, where door has a clearance at hinge side greater than **1/4 inch (6 mm)** and less than **3/4 inch (19 mm)** with door in any position.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install power door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.

1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.

B. Controls: Install activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Access-Control System: Connect operators to access-control system as specified in Section 281500 "Access Control Hardware Devices."

D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door

operator and direction of pedestrian travel.

E. Guide Rails: Install in accordance with BHMA A156.10, including Appendix A and manufacturer's written instructions unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: [**the Owner will engage**][**Engage**] a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and inspect each power door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.

C. Power door operators will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust power door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.

1. Adjust operators on exterior doors for tight closure.

B. After completing installation of power door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.

C. Readjust power door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

D. Occupancy Adjustment: When requested within [**12**] months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to Project during other-than-normal occupancy hours for this purpose.

3.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of power door operator Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to the Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain power door operators.

END OF SECTION 08 71 13 00

Task	Specification	Specification Description
08 72 33 00	08 14 16 00	Flush Wood Doors
08 72 33 00	08 71 00 00	Door Hardware
08 72 43 00	08 71 00 00	Door Hardware
08 75 13 00	08 71 00 00	Door Hardware
08 75 13 00	08 71 13 00	Power Door Operators
08 78 00 00	08 71 11 00	Detention Door Hardware

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SECTION 08 80 00 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Laminated glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing tapes.
6. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 057313 "Glazed Decorative Metal Railings" for glazing in railings.
2. Section 084126 "All-Glass Entrances and Storefronts."
3. Section 084233 "Revolving Door Entrances" for glass in revolving door entrances.
4. Section 084423 "Structural-Sealant-Glazed Curtain Walls" for glazing sealants used in structural-sealant-glazed curtain walls.
5. Section 088113 "Decorative Glass Glazing."
6. Section 088300 "Mirrors."
7. Section 088813 "Fire-Rated Glazing."
8. Section 088853 "Security Glazing."

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Glass Samples: For each type of [**glass product other than clear monolithic vision glass**][**the following products**]; **12 inches (300 mm)** square.

1. Tinted glass.
2. Coated glass.
3. Laminated glass.
4. Insulating glass.
5. Spandrel glass.

D. Glazing Accessory Samples: For [**sealants**][**and**][**colored spacers**], in **12-inch (300-mm)** lengths.[**Install sealant Samples between two strips of material representative in color of adjoining framing system.**]

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturers of fabricated glass units**][**glass testing agency**][**and**][**sealant testing agency**].

B. Product Certificates: For glass.

C. Product Test Reports: For [**fabricated glass**][**and**][**glazing sealants**], for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved[**and certified**] by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors[**and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in [**Section 084113 "Aluminum-Framed Entrances and Storefronts"**][**Section 085113 "Aluminum Windows"**][**Section 084413 "Glazed Aluminum Curtain Walls"**] to match glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than [**eight**] Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below **40 deg F (4.4 deg C)**.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: [**10**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: [**10**] years from date of Substantial Completion.

D. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Glass: Obtain [**tinted**][**and**][**coated**] glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from

single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: [**As indicated on Drawings**][**Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings**].

   a. Wind Design Data: As indicated on Drawings.
   b. Basic Wind Speed: [**85 mph (38 m/s)**][**90 mph (40 m/s)**][**100 mph (44 m/s)**][**110 mph (49 m/s)**].
   c. Importance Factor: [**1.0**].
   d. Exposure Category: [**B**][**C**][**D**].

2. Design Snow Loads: [**As indicated on Drawings**].
3. Probability of Breakage for Sloped Glazing: For glass sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or **1 inch (25 mm)**, whichever is less.
5. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

D. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites [**6 mm thick**][**of thickness indicated**].
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current

non-beta version of LBL's WINDOW computer program, expressed as **Btu/sq. ft. x h x deg F (W/sq. m x K)**.

5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

G. Acoustic Performance:

1. Exterior Glazing: [**28**][**33**][**35**] OITC.
2. Interior Glazing: [**35**][**37**][**41**] STC.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: [**"Laminated Glazing Reference Manual" and**]"Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][manufacturer]. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum.[**Provide glass that complies with performance requirements and is not less than thickness indicated.**]

1. Minimum Glass Thickness for Exterior Lites: [**6 mm**].
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass[**as needed to comply with "Performance Requirements" Article**]. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass[**as needed to comply with "Performance Requirements" Article**]. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Cardinal Glass Industries, Inc.**]
c. [**Guardian Glass LLC**]
d. [**Pilkington North America; NSG Group**]
e. [**Saint-Gobain Glass Corp**]
f. [**Vitro Architectural Glass**]

B. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent[**and SHGC of not less than 0.87**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

C. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGC Glass Company North America, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

E. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

F. Pyrolytic-Coated, Low-Maintenance Glass: Clear float glass with coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cardinal Glass Industries, Inc.**]
b. [**Pilkington North America; NSG Group**]
c. [**Saint-Gobain Glass Corp**]

G. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cardinal Glass Industries, Inc.**]
b. [**Guardian Glass LLC**]
c. [**Pilkington North America; NSG Group**]
d. [**Saint-Gobain Glass Corp**]
e. [**Vitro Architectural Glass**]

H. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

I. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

J. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dreamwalls by Gardner Glass Products**]
b. [**Guardian Glass LLC**]
c. [**ICD High Performance Coatings**]
d. [**OldCastle BuildingEnvelope (OBE)**]

K. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dreamwalls by Gardner Glass Products**]
b. [**Kuraray America, Inc.**]
c. [**Pilkington North America; NSG Group**]
d. [**Saflex; Eastman**]

2. Construction: Laminate glass with [polyvinyl butyral interlayer][ionoplast interlayer][cast-in-place and cured-transparent-resin interlayer] to comply with interlayer manufacturer's written

instructions.
3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
4. Interlayer Color: Clear unless otherwise indicated.

B. Windborne-Debris-Impact-Resistant Laminated Glass: Comply with requirements specified above for laminated glass except laminate glass with[**one of**] the following to comply with interlayer manufacturer's written instructions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Kuraray America, Inc.**]
   b. [**Saflex; Eastman**]

2. Construction: Laminate glass with [polyvinyl butyral interlayer reinforced with polyethylene terephthalate film][ionoplast interlayer][cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film] to comply with interlayer manufacturer's written instructions.
3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
4. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with [**manufacturer's standard**][**polyisobutylene and polysulfide**][**polyisobutylene and silicone**][**polyisobutylene and hot-melt butyl**][**polyisobutylene and polyurethane**] primary and secondary sealants.
2. Perimeter Spacer: [**Manufacturer's standard spacer material and construction**][**Aluminum with mill or clear anodic finish**][**Aluminum with black, color anodic finish**][**Aluminum with bronze, color anodic finish**][**Aluminum with powdered metal paint finish in color selected by Architect**][**Galvanized steel**][**Stainless steel**][**Polypropylene-covered stainless steel in color selected by Architect**][**Thermally broken aluminum**][**Nonmetallic laminate**][**Nonmetallic tube**][**Silicone with integral desiccant and vapor barrier**], as directed by the Owner.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Saint-Gobain Glass Corp**]
      2) [**Technoform Glass Insulation North America**]
      3) [**Thermix; a brand of Ensinger USA**]

3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
8. Colors of Exposed Glazing Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of industry colors**], as directed by the Owner.

B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
   b. [**Pecora Corporation**]
   c. [**Sika Corporation**]
   d. [**The Dow Chemical Company**]
   e. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

C. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sika Corporation**]
f. [**The Dow Chemical Company**]
g. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

D. Neutral-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Permathane; a Holcim brand**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**Sika Corporation**]
g. [**The Dow Chemical Company**]
h. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

E. Acid-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
d. [**Pecora Corporation**]
e. [**Permathane; a Holcim brand**]
f. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
g. [**Sika Corporation**]
h. [**The Dow Chemical Company**]
i. [**Tremco Incorporated**]

2. Applications: <**Describe types of glazing applications where sealant is required**>.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. [**Neoprene**] blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
2. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness per manufacturer's written instructions.
2. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than **50 inches (1270 mm)**.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide **1/8-inch- (3-mm-)** minimum bite of spacers on glass and use thickness equal to sealant

width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to

lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

B. Low-Iron Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

C. Pyrolytic-Coated, Low-Maintenance Glass Type : Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

1. Minimum Thickness: [**6 mm**].
2. Safety glazing required.

D. Tinted Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Minimum Thickness: [**6 mm**].
3. Safety glazing required.

E. Ceramic-Coated Vision Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Safety glazing required.

F. Reflective-Coated Vision Glass Type : [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Glass: [**Clear**][**Tinted**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Minimum Thickness: [**6 mm**].
7. Coating Location: [**First**][**Second**] surface.
8. Low-Maintenance Coating: Pyrolytic coating on first surface.
9. Safety glazing required.

G. Ceramic-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.

H. Silicone-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's**

samples], as directed by the Owner.
4. Minimum Thickness: [**6 mm**].
5. Coating Location: Second surface.
6. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.

I. Reflective-Coated Spandrel Glass Type : [**Heat-strengthened**][**Fully tempered**] float glass.

1. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
2. Coating Color: [**Gold**][**Pewter**][**Silver**].
3. Glass: [**Clear**][**Low-iron**][**Tinted**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Minimum Thickness: [**6 mm**].
6. Coating Location: [**First**][**Second**] surface.
7. Fallout Resistance: Passes fallout-resistance test in ASTM C1048 for an assembly of glass and adhered reinforcing material.
8. Factory apply manufacturer's standard opacifier of the following material to coated on second surface of lites, with resulting products complying with Specification No. 89-1-6 in NGA's "Engineering Standards Manual":

   a. Manufacturer's standard opacifier material.
   b. Polyester film laminated to glass with solvent-based adhesive.

3.9 LAMINATED GLASS SCHEDULE

A. Clear Laminated Glass Type : Two plies of [**annealed**][**heat-strengthened**][**fully tempered**][**low-iron annealed**][**low-iron heat-strengthened**][**low-iron fully tempered**] float glass.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Safety glazing required.

B. Laminated Tinted Glass Type : Two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass with outer ply tinted and inner ply clear.

1. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
3. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
4. Safety glazing required.

C. Tinted Interlayer Laminated Glass Type : Two plies of clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass and tinted interlayer.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Interlayer Color: [**Blue-green**][**Bronze light**][**Gray**].
4. Safety glazing required.

D. Ceramic-Coated, Laminated Vision Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Outer Ply: [**Clear**][**Low-iron**][**Tinted**] float glass.
2. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
3. Inner Ply: [**Clear**][**Low-iron**] float glass.
4. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full**

range][**Match Architect's samples**], as directed by the Owner.
5. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
6. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
7. Coating Location: [**Second**][**Third**][**Fourth**] surface.
8. Safety glazing required.

E. Reflective-Coated, Laminated Vision Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Outer Ply: [**Clear**][**Tinted**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
7. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
8. Coating Location: [**First**][**Second**][**Third**] surface.
9. Low-Maintenance Coating: Pyrolytic coating on first surface.
10. Safety glazing required.

F. Low-E-Coated, Laminated Vision Glass Type : Two plies of clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

1. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
4. Safety glazing required.

G. Reflective-Coated, Laminated Spandrel Glass Type : Two plies of [**heat-strengthened**][**fully tempered**] float glass.

1. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
2. Coating Color: [**Gold**][**Pewter**][**Silver**].
3. Outer Ply: [**Clear**][**Tinted**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
6. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
7. Coating Location: [**First**][**Second**][**Third**] surface.

3.10 INSULATING GLASS SCHEDULE

A. Clear Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Safety glazing required.

B. Low-Iron Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Low-iron [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Low-iron [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
6. Safety glazing required.

C. Pyrolytic-Coated, Low-Maintenance Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Safety glazing required.

D. Low-E-Coated, Clear Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
6. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

E. Pyrolytic-Coated, Low-Maintenance, Low-E-Coated, Clear Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Pyrolytic-coated, low-maintenance, clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: [**Annealed**][**Heat-strengthened**][**Fully tempered**] float glass.
6. Low-E Coating: [**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

F. Tinted Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
7. Safety glazing required.

G. Low-E-Coated, Tinted Insulating Glass Type :

1. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
2. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].

3. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Safety glazing required.

H. Ceramic-Coated, Insulating Vision Glass Type :

1. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
3. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Interspace Content: [**Air**][**Argon**].
7. Indoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
8. Coating Location: [**Second**][**Third**][**Fourth**] surface.
9. Safety glazing required.

I. Reflective-Coated Insulating Glass Type :

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Overall Unit Thickness: [**1 inch (25 mm)**][**5/8 inch (16 mm)**].
5. Minimum Thickness of Each Glass Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
6. Outdoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
7. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
8. Interspace Content: [**Air**][**Argon**].
9. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
10. Coating Location: [**First**][**Second**][**Third**] surface.
11. Low-Maintenance Coating: Pyrolytic coating on first surface.
12. Safety glazing required.

J. [**Ceramic**][**Silicone**]-Coated, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: [**Clear annealed**][**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron annealed**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
7. Coating Location: Fourth surface.

K. [**Ceramic**][**Silicone**]-Coated, Low-E, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Low-iron heat-strengthened**][**Low-iron fully tempered**] float glass.
7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Opaque Coating Location: Fourth surface.

L. [**Ceramic**][**Silicone**]-Coated, Tinted, Insulating Spandrel Glass Type :

1. Coating Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**], as directed by the Owner.
2. Overall Unit Thickness: [**1 inch (25 mm)**].
3. Minimum Thickness of Each Glass Lite: [**5 mm**][**6 mm**].
4. Outdoor Lite: Tinted [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
5. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Interspace Content: [**Air**][**Argon**].
7. Indoor Lite: Clear [**annealed**][**heat-strengthened**][**fully tempered**] float glass.
8. Coating Location: Fourth surface.

3.11 INSULATING-LAMINATED-GLASS SCHEDULE

A. Clear Insulating, Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Clear [**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

   a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
   b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

6. Safety glazing required.

B. Low-E-Coated, Clear Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Clear [**heat-strengthened**][**fully tempered**] float glass.
4. Interspace Content: [**Air**][**Argon**].
5. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

   a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
   b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29**

mm)].

6. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
7. Safety glazing required.

C. Tinted, Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

   a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
   b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

7. Safety glazing required.

D. Low-E-Coated, Tinted, Insulating Laminated Glass Type :

1. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**].
2. Minimum Thickness of Outdoor Lite: [**3 mm**][**4 mm**][**5 mm**][**6 mm**].
3. Outdoor Lite: Tinted [**heat-strengthened**][**fully tempered**] float glass.
4. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
5. Interspace Content: [**Air**][**Argon**].
6. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

   a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
   b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

7. Low-E Coating: [**Pyrolytic on second**][**Pyrolytic on third**][**Sputtered on second**][**Sputtered on third**][**Pyrolytic or sputtered on second or third**] surface.
8. Safety glazing required.

E. Reflective-Coated, Insulating Laminated Glass Type :

1. Kind CV (coated vision glass)[except that Kind CO (coated overhead glass) may be used where lower edge of glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m)].
2. Coating Type: [**Pyrolytic**][**Sputter-coating (vacuum deposition process)**].
3. Coating Color: [**Gold**][**Pewter**][**Silver**].
4. Overall Unit Thickness: [**1-3/16 inch (30 mm)**][**1 inch (25 mm)**].
5. Minimum Thickness of Outdoor Lite: [**6 mm**].
6. Outdoor Lite: [**Clear heat-strengthened**][**Clear fully tempered**][**Tinted heat-strengthened**][**Tinted fully tempered**] float glass.
7. Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
8. Interspace Content: [**Air**][**Argon**].
9. Indoor Lite: Clear laminated glass with two plies of [**annealed**][**heat-strengthened**][**fully tempered**] float glass.

a. Minimum Thickness of Each Glass Ply: [**3 mm**][**4 mm**][**5 mm**][**6 mm**][**As indicated**].
b. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].

10. Coating Location: [**First**][**Second**][**Third**] surface.
11. Low-Maintenance Coating: Pyrolytic coating on first surface.
12. Safety glazing required.

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Task	Specification	Specification Description
08 81 23 13	08 80 00 00	Glazing
08 81 23 23	08 80 00 00	Glazing

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SECTION 08 83 00 00 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silvered flat glass mirrors.

B. Related Requirements:

1. Section 088000 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
2. Section 102800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

C. Samples: For each type of the following:

1. Mirrors: **12 inches (300 mm)** square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.
3. Mirror Trim: **12 inches (300 mm)** long.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of mirror[**and mirror mastic**].

B. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.

C. Qualification Statements: For Installer.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.

1. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors in accordance with mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: [**Five**] years from date of [**Substantial Completion**][**manufacture**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

B. Source Limitations for Mirror Accessories: Obtain mirror-glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Avalon Glass and Mirror Company**]
2. [**Binswanger Glass Company, Inc.; a division of Vitro Architectural Glass**]
3. [**D & W Incorporated**]
4. [**Donisi Mirror Company**]
5. [**Dreamwalls by Gardner Glass Products**]
6. [**Dulles Glass & Mirror**]
7. [**Gardner Glass, Inc.**]
8. [**Gilded Mirrors, Inc**]
9. [**Glasswerks LA, Inc**]
10. [**Guardian Glass LLC**]
11. [**Head West**]
12. [**Independent Mirror Industries, Inc**]
13. [**Lenoir Mirror Company**]
14. [**National Glass Industries, Inc.**]
15. [**Stroupe Mirror Co., Inc**]
16. [**Sunshine Mirror**]
17. [**Trulite Glass & Aluminum Solutions, LLC.**]
18. [**Virginia Mirror Company, Inc**]
19. [**Walker Glass Co., Ltd**]

B. Mirrors, General: ASTM C1503[**manufactured using copper-free, low-lead mirror coating process**].

C. Annealed Monolithic Glass Mirrors: Mirror [**Select**][**Glazing**] Quality [**Q1 clear**][**Q2 low-iron float glass with a minimum 91 percent visible light transmission**][**Q2 tinted**].

1. Nominal Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**][**As indicated**].
2. Tint Color: [**Blue**][**Black**][**Bronze**][**Gold**][**Gray**][**Green**].

D. Tempered Glass Mirrors: Mirror Glazing Quality Q3 for blemish requirements and complying with ASTM C1048 for Kind FT, Condition A, tempered float glass before silver coating is applied; [**clear**][**tinted**].

1. Nominal Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**][**As indicated**].
2. Tint Color: [**Blue**][**Black**][**Bronze**][**Gold**][**Gray**][**Green**].

E. Laminated Mirrors: ASTM C1172, Type II.

1. Glass for Outer Lite: Annealed float glass, Mirror [**Select**][**Glazing**] Quality, [**clear**][**low-iron float glass with a minimum 91 percent visible light transmission**][**tinted**].

   a. Tint Color: [**Blue**][**Black**][**Bronze**][**Gold**][**Gray**][**Green**].

2. Nominal Thickness for Outer Lite: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**][**As indicated**].
3. Glass for Inner Lite: [**Annealed float glass; ASTM C1036, Type I (transparent flat glass), Quality Q1; Class 1 (clear)**][**Annealed float glass; ASTM C1036, Type I (transparent flat glass), Quality Q2; Class 1 (low-iron)**][**Annealed float glass; ASTM C1036, Type I (transparent flat glass), Quality Q2; Class 1 (tinted)**][**Heat-strengthened float glass; ASTM C1048, Type I; Quality Q3; Class I (clear) Kind HS, Condition A**][**Tempered float glass;**

ASTM C1048, Type I; Quality Q3; Class I (clear), Kind FT, Condition A].

4. Nominal Thickness: [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**][**As indicated**].
5. Interlayer: Mirror manufacturer's standard **0.030-inch- (0.76-mm-)** thick, clear polyvinyl-butyral interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.

F. Safety Glazing Products: For [**film-backed**][**laminated**][**tempered**] mirrors, provide products that comply with 16 CFR 1201, Category II.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
   b. [**Franklin International**]
   c. [**Liquid Nails; PPG Industries, Inc.**]
   d. [**OSI Sealants; Henkel Corporation**]
   e. [**Palmer Products Corporation**]
   f. [**Pecora Corporation**]
   g. [**Royal Adhesives & Sealants: H.B. Fuller Company**]
   h. [**Sommer & Maca Industries, Inc**]

2. Adhesives shall have a VOC content of [**70**] g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Aluminum J-Channel Bottom and Side Trim: J-channels formed with front leg and back leg not less than **3/8 and 7/8 inch (9.5 and 22 mm)** in height, respectively, and a thickness of not less than **0.04 inch (1.0 mm)**.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Andscot Company, Inc.**]
2) [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
3) [**Stylmark, Inc.**]

2. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than **5/8 and 1 inch (16 and 25 mm)** in height, respectively, and a thickness of not less than **0.04 inch (1.0 mm)**.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Andscot Company, Inc.**]
2) [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
3) [**Stylmark, Inc.**]

3. Finish: [**Clear**][**Gold**] bright anodized.

B. Aluminum J-Channels and Cleat: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Aluminum J-Channel and Cleat, Bottom and Side Trim: J-channels formed with front leg and back leg not less than **5/16 and 3/4 inch (7.9 and 19 mm)** in height, respectively.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]

2. Aluminum J-Channel and Cleat, Top Trim: Formed with front leg with a height matching bottom trim and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]

3. Finish: [**Clear**][**Gold**] bright anodized.

C. Mirror Bottom Clips: [**As indicated**].

D. Mirror Top Clips: [**As indicated**].

E. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.

1. Profile: As indicated.

F. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

G. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

A. Shop fabricate mirrors to greatest extent possible.

B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: [**Flat polished**][**Rounded polished**][**Flat high polished**][**Rounded high polished**][**Beveled polished edge of width shown**].

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION OF MIRRORS

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

1. NGA Publications: [**"Laminated Glazing Reference Manual,"**]"Glazing Manual" and "Installation Techniques Designed to Prolong the Life of Flat Glass Mirrors."

B. Provide a minimum airspace of **1/8 inch (3 mm)** between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Install mirrors with [**mastic and**]mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Aluminum J-Channels: Provide setting blocks **1/8 inch (3 mm)** thick by **4 inches (100 mm)** long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than **1/4 inch (6.4 mm)** wide by **3/8 inch (9.5 mm)** long at bottom channel.
2. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips [**where indicated**][**so they are symmetrically placed and evenly spaced**].
4. Install mastic as follows:

a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of **1/8 inch (3 mm)** between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION 08 83 00 00

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Task	Specification	Specification Description
08 83 13 00	08 80 00 00	Glazing
08 83 13 00	08 83 00 00	Mirrors

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SECTION 08 84 00 00 - PLASTIC GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Monolithic acrylic glazing.
2. Monolithic polycarbonate glazing.
3. Multiwalled structured polycarbonate glazing.
4. Glazing gaskets.
5. Glazing sealants.
6. Glazing tapes.
7. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 084513 "Structured-Polycarbonate-Panel Assemblies" for aluminum-framed assemblies glazed with multiwalled structured polycarbonate panels.
2. Section 088000 "Glazing" for glazing sealants installed with plastic glazing.
3. Section 088853 "Security Glazing" for [**laminated polycarbonate glazing**] [**and**] [**monolithic polycarbonate glazing**] for security applications.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on plastic glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**] [**by web conference**] .

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for plastic glazing during and after installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each plastic glazing material, gasket, and sealant.

C. Samples for Verification: Actual sample of each finished product.

1. Plastic Glazing Samples: For each color and finish of plastic glazing indicated, 12 inches (300 mm) square and of same thickness indicated for final Work.

2. Glazing Accessory Samples: For [**gaskets**] [**and**] [**sealants**], in 12-inch (300-mm) lengths.[**Install sealant Samples between two strips of material representative in color of the adjoining framing system.**]

D. Plastic Glazing Schedule: List plastic glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of plastic glazing and construction that receives plastic glazing, including clearances and glazing channel dimensions.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For plastic glazing and glazing products.

B. Product Test Reports: For [**plastic glazing**] [**glazing sealants**] [**and**] [**glazing gaskets**], for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

C. Preconstruction adhesion and compatibility test report.

D. Research Reports: For plastic glazing, from [**an agency acceptable to authorities having jurisdiction**] [**ICC-ES**] showing compliance with [**fire-test-response**] [**safety glazing**] [**and**] [**windborne-debris impact-resistance**] requirements.

E. Qualification Statements: For testing agency.

F. Sample Warranties: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For plastic glazing.

1.7 QUALITY ASSURANCE

A. Sealant Testing Agency Qualifications: An independent testing agency qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Install plastic glazing in mockups specified in [**Section 084113 "Aluminum-Framed Entrances and Storefronts"**] [**Section 085113 "Aluminum Windows"**] to match plastic glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each plastic glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and plastic glazing matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glazing, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than [**eight**] Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect plastic glazing materials in accordance with manufacturer's written instructions. Prevent damage to plastic glazing and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Maintain protective coverings on plastic glazing to avoid exposures to abrasive substances, excessive heat, and other sources of possible deterioration.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.12 WARRANTY

A. Manufacturer's Special Warranty for Abrasion- and UV-Resistant Polycarbonate: Manufacturer agrees to replace [**monolithic**] [**multiwalled structured**] polycarbonate products that break or develop defects from normal use that are attributable to manufacturing process and not to practices for maintaining and cleaning plastic glazing contrary to manufacturer's written instructions. Defects include coating delamination, haze, excessive yellowing, and loss of light transmission beyond the limits stated in plastic glazing manufacturer's standard form.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain plastic glazing from single source from single manufacturer. Obtain [**sealants**] [**and**] [**gaskets**] from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. Plastic glazing sheets and glazing materials to withstand normal temperature changes, wind, and impact loads without failure, including loss or breakage of plastic sheets attributable to failure of sealants or gaskets to remain watertight and airtight, deterioration of plastic sheet and glazing materials, or other defects in materials and installation.

B. Windborne-Debris Impact Resistance: Exterior plastic glazing to pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**] [**2**] [**3**] [**4**] for [**basic**] [**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 ft. (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between 30 ft. (9.1 m) and [**60 ft. (18.3 m)**] above grade.

C. Safety Glazing: Plastic glazing to comply with 16 CFR 1201, Category II.

1. Labeling: Permanently mark plastic glazing with certification label of an agency acceptable to authorities having jurisdiction. Label to indicate manufacturer's name, type of plastic, thickness, and safety glazing standard with which plastic glazing complies.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on plastic glazing and glazing framing members.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**] .

E. Fire-Test-Response Characteristics of Plastic Glazing: As determined by testing plastic glazing by a qualified testing agency acceptable to authorities having jurisdiction.

1. Self-ignition temperature of 650 deg F (343 deg C) or higher when tested in accordance with ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
2. Smoke density of 75 or less when tested in accordance with ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
3. Burning extent of 1 inch (25 mm) or less when tested in accordance with ASTM D635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work[**where Class CC1 is indicated**].
4. Burning rate of 2.5 in./min. (1.06 mm/s) or less when tested in accordance with ASTM D635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work[**where Class CC2 is indicated**].
5. Flame-spread index of not less than that indicated when tested in accordance with ASTM E84.

2.3 PLASTIC GLAZING, GENERAL

A. Glazing Publication: Comply with published instructions of plastic glazing manufacturers and with NGA's "GANA Glazing Manual" unless more stringent requirements are indicated. See this manual for definitions of glazing terms not otherwise defined in this Section or in other referenced standards.

B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

2.4 MONOLITHIC ACRYLIC GLAZING

A. Transparent Acrylic Sheet: ASTM D4802, [**Category A-1 (cell cast)**] [**Category A-2 (continuously cast)**] [**Category B-1 (continuously manufactured)**], Finish 1 (smooth or polished), Type UVF (UV filtering).
1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Color: [**Colorless**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Combustibility Class: CC2.

B. Coated Transparent Acrylic Sheet: ASTM D4802, [**Category A-1 (cell cast)**] [**Category A-2 (continuously cast)**] [**Category B-1 (continuously manufactured)**], Finish 3 (abrasion-resistant coating) with coating on [**one side**] [**both sides**], Type UVF (UV filtering).
1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Color: [**Colorless**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Combustibility Class: CC2.

C. Translucent Acrylic Sheet: ASTM D4802, [**Category A-1 (cell cast)**] [**Category A-2 (continuously cast)**] [**Category B-1 (continuously manufactured)**], Finish 1 (smooth or polished), Type UVF (UV filtering).
1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Color: [**White, with visible light transmittance of not more than 50 percent for 0.117-inch-(2.9-mm-) thick sheet, measured in accordance with ASTM D1003**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Combustibility Class: CC2.

D. Patterned Acrylic Sheet: ASTM D4802, Category A-1 (cell cast), Finish 2 (patterned), Type UVF (UV filtering).
1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Pattern: [**Matte finish**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Color: [**Transparent colorless**] [**Translucent white**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
4. Combustibility Class: CC2.

2.5 MONOLITHIC POLYCARBONATE GLAZING

A. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type I (standard, UV stabilized), with a polished finish.

1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Color: [**Transparent colorless**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Combustibility Class: CC1.
4. Flame-Spread Index: [**25**] [**75**] [**200**] or less.

B. Coated Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated mar-resistant, UV stabilized), with coating on both sides.
1. Nominal Thickness: [**0.093 inch (2.5 mm)**] [**0.118 inch (3 mm)**] [**0.177 inch (4.5 mm)**] [**0.236 inch (6 mm)**] .
2. Color: [**Transparent colorless**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Combustibility Class: CC1.
4. Flame-Spread Index: [**25**] [**75**] [**200**] or less.

2.6 MULTIWALLED STRUCTURED POLYCARBONATE GLAZING

A. Multiwalled Structured Polycarbonate Sheet: Manufacturer's standard polycarbonate extruded shape with smooth, flat exterior surfaces and internal ribbing.
1. Nominal Thickness: [**5/16 inch (8 mm)**] [**3/8 inch (10 mm)**] [**5/8 inch (16 mm)**] [**3/4 inch (20 mm)**] [**1 inch (25 mm)**] .
2. UV Resistance: [**Not required**] [**On outer surface**] [**On both surfaces**].
3. Color: [**Transparent colorless**] [**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
4. Combustibility Class: [**CC1**] [**CC2**].
5. Flame-Spread Index: [**25**] [**75**] [**200**] or less.

2.7 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets, [**EPDM, ASTM C864**] [**silicone, ASTM C1115**]; and of profile and hardness required to maintain watertight seal.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned [**EPDM**] [**silicone**] gaskets complying with ASTM C509, Type II, black; and of profile and hardness required to maintain watertight seal.

2.8 GLAZING SEALANTS

A. Glazing Sealants: [**As recommended by manufacturer.**][**Comply with Section 088000 "Glazing."**]

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including plastic glazing products and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and plastic glazing manufacturers' written instructions for selecting sealants suitable for applications indicated and for conditions existing at time of installation.

2.9 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.10 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide products of material, size, and shape complying with requirements of manufacturers of plastic glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by plastic glazing and sealant or gasket manufacturer.

C. Setting Blocks: EPDM or silicone as required for compatibility with glazing sealant and plastic glazing, and of hardness recommended by plastic glazing manufacturer for application indicated.

D. Compressible Filler Rods: Closed cell of waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5 to 10 psi (35 to 70 kPa) compression strength for 25 percent deflection.

2.11 FABRICATION

A. Sizes: Fabricate plastic glazing to sizes required for openings indicated. Allow for thermal expansion and contraction of plastic glazing without restraint and without withdrawal of edges from frames, with edge clearances and tolerances complying with plastic glazing manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plastic glazing framing, with glazing Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face or edge clearances.
3. Effective sealing between joints of plastic glazing framing members.

B. Proceed with glazing only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members immediately before glazing. Remove coatings not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of plastic glazing materials, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publication.

B. Glazing channel dimensions indicated on Drawings are designed to provide the necessary bite on plastic glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust plastic glazing lites during installation to ensure that bite is equal on all sides.

C. Sand or scrape cut edges of plastic glazing to provide smooth edges, free of chips and hairline cracks.

D. Remove burrs and other projections from glazing channel surfaces.

E. Protect plastic glazing surfaces from abrasion and other damage during handling and installation, in accordance with the following requirements:

1. Retain plastic glazing manufacturer's protective covering or protect by other methods in accordance with plastic glazing manufacturer's written instructions.
2. Remove covering at border of each piece before glazing; remove remainder of covering immediately after installation where plastic glazing is exposed to sunlight or where other conditions make later removal difficult.
3. Remove damaged plastic glazing sheets from Project site and legally dispose of off-site. Damaged plastic glazing sheets are those containing imperfections that, when installed, result in weakened glazing and impaired performance and appearance.

F. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

G. Install elastomeric setting blocks in sill channels, sized and located to comply with referenced glazing publication, unless otherwise instructed by plastic glazing manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

H. Provide edge blocking to comply with referenced glazing publication unless otherwise instructed by plastic glazing manufacturer.

I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

J. Square cut wedge-shaped gaskets at corners and install gaskets, as recommended in writing by gasket manufacturer, to prevent corners from pulling away; seal corner and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Install tapes continuously, but not in one continuous length. Do not stretch tapes to make them fit opening.

B. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

C. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant recommended by tape manufacturer.

D. Do not remove release paper from tape until immediately before each lite is installed.

E. Apply heel bead of glazing sealant.

F. Center plastic glazing lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of glazing sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between plastic glazing and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center plastic glazing lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in plastic glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers between plastic glazing lites and glazing stops to maintain plastic glazing face clearances and to prevent sealant from extruding into glazing channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to plastic glazing and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from plastic glazing.

3.7 CLEANING AND PROTECTION

A. Protect plastic glazing from contact with contaminating substances from construction operations. If, despite such protection, contaminating substances do come into contact with plastic glazing, remove immediately and wash plastic glazing in accordance with plastic glazing manufacturer's written instructions.

B. Remove and replace plastic glazing that is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.

C. Wash plastic glazing on both faces before date scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Wash plastic glazing in accordance with plastic glazing manufacturer's written instructions.

END OF SECTION 08 84 00 00

Task	Specification	Specification Description
08 87 13 00	08 80 00 00	Glazing
08 88 49 00	13 49 00 00	Radiation Protection

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SECTION 08 88 53 00 - SECURITY GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Laminated-glass security glazing
2. Polycarbonate security glazing.
3. Insulating security glazing.
4. Air-gap security glazing.

B. Related Requirements:

1. Section 085653 "Security Windows."
2. Section 119821 "Detention Windows."

1.2 DEFINITIONS

A. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.

B. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on security glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for security glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of [**glass tint**][**glass coating**][**colored interlayer**][**sealant**][**and**][**colored spacer**].

C. Samples for Verification:

1. Glazing: Actual sample of finished products for each type of security glazing.

a. Size: [**Manufacturers' standard size**].

2. Glazing Accessories: Actual sample of [**sealants**][**and**][**colored spacers**].[**Install sealant Samples between two strips of material representative in color of the adjoining framing system.**]
3. Size: [**Manufacturers' standard size**].

D. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.

E. Delegated Design Submittal: For security glazing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.6 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports:

a. For each type of security glazing, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].
b. For each type of glazing sealant, for tests performed by a qualified testing agency.

1) Provide test reports based on testing current sealant formulations within previous 36-month period.

2. Preconstruction Test Reports: For preconstruction adhesion and compatibility testing.

B. Qualification Statements: For [**installers**][**manufacturers of insulating or air-gap security glazing with sputter-coated, low-e coatings**][**glazing testing agency**][**and**][**sealant testing agency**].

C. Delegated design engineer qualifications.

D. Sample warranties.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: For insulating or air-gap security glazing units with sputter-coated, low-e coatings, a qualified insulating glazing manufacturer who is approved[**and certified**] by coated-glass manufacturer.
2. Installers: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and**

approved by manufacturer].

3. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of type indicated.
4. Security Glazing Testing Agency: Subject to compliance with requirements, testing agency is one of the following:

    a. Intertek.
    b. Underwriters Laboratories, Inc.
    c. Wiss, Janney, Elstner Associates, Inc.

5. Sealant Testing Agency: An independent testing agency qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data based on previous testing of current sealant products and glazing materials match those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than [**eight**] Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating security glazing and with air-gap security glazing manufacturers' written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below **40 deg F (4.4 deg C)**.

1.11 WARRANTY

A. Special Warranty, Coated Glass: Manufacturer agrees to replace coated glass that fails in materials or

workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Defects developed in coated glass from normal use that is not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

2. Warranty Period: [**10**] years from date of Substantial Completion.

B. Special Warranty, Laminated-Glass Security Glazing: Manufacturer agrees to replace laminated-glass security glazing that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated-glass security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

C. Special Warranty, Monolithic Polycarbonate Security Glazing: Manufacturer agrees to replace monolithic polycarbonate security glazing that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Defects developed from normal use that are not attributed to maintaining and cleaning monolithic polycarbonate security glazing contrary to manufacturer's written instructions. Defects include yellowing and loss of light transmission.

2. Warranty Period: [**10**] years from date of Substantial Completion.

D. Special Warranty, Laminated-Polycarbonate Security Glazing: Manufacturer agrees to replace laminated-polycarbonate security glazing that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Defects developed from normal use that are not attributed to maintaining and cleaning laminated-polycarbonate security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

E. Special Warranty, Glass-Clad Polycarbonate Security Glazing: Manufacturer agrees to replace glass-clad polycarbonate security glazing that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning glass-clad polycarbonate security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced polycarbonate standard, yellowing, and loss of light transmission.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

F. Special Warranty, Laminated-Glass and -Polycarbonate Security Glazing: Manufacturer agrees to replace laminated-glass and -polycarbonate security glazing that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
2. Defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated-glass and -polycarbonate security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced polycarbonate standard, yellowing, and loss of light transmission.
3. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

G. Special Warranty, Insulating Security Glazing: Manufacturer agrees to replace insulating security glazing that fails in materials and workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Defects in individual lites developed from normal use or failure of hermetic seal under normal use. Defects in individual lites or failure of hermetic seal that is attributed to glass breakage or to maintaining and cleaning insulating security glazing contrary to manufacturer's written instructions are not included.
b. Defects in coated-glass lites include peeling, cracking, and other indications of deterioration in coating.
c. Defects in laminated-glass lites include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
d. Defects in glass-clad polycarbonate lites include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
e. Evidence of hermetic seal failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glazing.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

H. Special Warranty, Air-Gap Security Glazing: Manufacturer agrees to replace air-gap security glazing that fails in materials and workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Defects in individual lites developed from normal use or failure of hermetic seal under normal use. Defects in individual lites or failure of hermetic seal that is attributed to glass breakage or to maintaining and cleaning air-gap security glazing contrary to manufacturer's written instructions are not included.
b. Defects in coated-glass lites include peeling, cracking, and other indications of deterioration in coating.
c. Defects in laminated-glass lites include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

d. Defects in laminated-polycarbonate lites include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.
e. Evidence of hermetic seal failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glazing.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of security glazing from single source from single manufacturer.

1. Obtain [**tinted**][**and**][**coated**] glass from single source from single manufacturer.

B. Obtain glazing [**sealants**][**and**][**gaskets**] from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General:

1. Installed security glazing will withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
2. Installed security glazing will withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design security glazing.

C. Structural Performance: Glazing will withstand the following design loads within limits and under conditions indicated.

1. Design Procedure for Glass: ASTM E1300 and the IBC.
2. Design Wind Pressures: [**As indicated on Drawings**][**Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings**].

a. Wind Design Data: As indicated on Drawings.
b. Basic Wind Speed: [**85 mph (38 m/s)**][**90 mph (40 m/s)**][**100 mph (44 m/s)**][**110 mph (49 m/s)**].
c. Exposure Category: [**B**][**C**][**D**].

3. Design Snow Loads: [**As indicated on Drawings**].
4. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

E. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

F. Windborne-Debris Impact Resistance: Exterior security glazing passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for [**Wind Zone 1**][**Wind Zone 2**][**Wind Zone 3**][**Wind Zone 4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

G. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.3 SECURITY GLAZING, GENERAL

A. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. AAMA Publications: AAMA GDSG-1 and AAMA TIR-A7.
2. IGMA Publication for Sloped Glazing: IGMA TB-3001.
3. IGMA Publication for Insulating Glass: SIGMA TM-3000.
4. NGA Publications: [**"Laminated Glazing Reference Manual" and**]"GANA Glazing Manual."

B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

C. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of [the Safety Glazing Certification Council][the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction][manufacturer]. Label will indicate manufacturer's name, type of glazing, glass thickness, and safety glazing standard with which glazing complies.

D. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council.

E. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

F. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.

1. Self-ignition temperature of **650 deg F (343 deg C)** or more when tested in accordance with ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
2. Smoke-Developed Index of 450 or less when tested in accordance with ASTM E84 or UL 723, or smoke density of 75 or less when tested in accordance with ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
3. Burning extent of **1 inch (25 mm)** or less when tested in accordance with ASTM D635 at a nominal thickness of **0.060 inch (1.52 mm)** or thickness indicated for the Work.

G. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on construction products indicated and on procedures indicated below:

1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current

non-beta version of LBL's WINDOW computer program, expressed as **Btu/sq. ft. x h x deg F (W/sq. m x K)**.
2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW 7.7 computer program.
3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.4 GLASS PRODUCTS

A. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For heat-strengthened float glass, comply with requirements for Kind HS.
3. For fully tempered float glass, comply with requirements for Kind FT.
4. For uncoated glass, comply with requirements for Condition A.
5. For coated vision glass, comply with requirements for Condition C (other coated glass).

C. Chemically Strengthened Glass: Annealed float glass is chemically strengthened to comply with ASTM C1422/C1422M, Surface Compression [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**] and Case Depth [**Level A**][**Level B**][**Level C**][**Level D**][**Level E**][**Level F**].

D. Reflective-Coated Vision Glass: ASTM C1376, Kind CV (coated vision glass), coated by [**pyrolytic process**][**vacuum deposition (sputter-coating) process**], and complying with other requirements specified.

2.5 LAMINATED-GLASS SECURITY GLAZING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dlubak Specialty Glass Corporation; Consolidated Glass Holdings, Inc.**]
2. [**Global Security Glazing; Consolidated Glass Holdings, Inc.**]
3. [**McGrory Glass, Inc**]
4. [**OldCastle BuildingEnvelope (OBE)**]
5. [**Standard Bent Glass Corp**]

B. Laminated-Glass Security Glazing: ASTM C1172. Two or more glass lites bonded with interlayer. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
2. Interlayer Color: Clear unless otherwise indicated.

2.6 POLYCARBONATE SECURITY GLAZING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dlubak Specialty Glass Corporation; Consolidated Glass Holdings, Inc.**]
2. [**Global Security Glazing; Consolidated Glass Holdings, Inc.**]
3. [**McGrory Glass, Inc**]
4. [**OldCastle BuildingEnvelope (OBE)**]
5. [**Palram Americas Ltd.**]
6. [**Plaskolite**]
7. [**Standard Bent Glass Corp**]
8. [**Total Security Solutions**]

B. Monolithic Polycarbonate Security Glazing: ASTM C1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on exposed surfaces and Type I, standard, UV-stabilized polycarbonate where no surfaces are exposed.

C. Laminated-Polycarbonate Security Glazing: Two or more polycarbonate sheets bonded with clear urethane interlayer that complies with ASTM C1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide laminated units that comply with requirements of ASTM C1349 for maximum allowable laminating process blemishes and haze.

D. Glass-Clad Polycarbonate Security Glazing: ASTM C1349. One or more cores of polycarbonate sheet, clad with glass, bonded with clear urethane interlayer. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

E. Laminated Glass and Polycarbonate: ASTM C1349. Two or more glass lites and polycarbonate bonded with interlayer. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

2.7 INSULATING SECURITY GLAZING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dlubak Specialty Glass Corporation; Consolidated Glass Holdings, Inc.**]
2. [**Global Security Glazing; Consolidated Glass Holdings, Inc.**]
3. [**McGrory Glass, Inc**]
4. [**Viracon, Inc.**]

B. Insulating Security Glazing: Factory-assembled units, consisting of sealed lites of glazing material indicated separated by a dehydrated interspace, qualified in accordance with ASTM E2190

1. Sealing System: Dual seal, with [**manufacturer's standard**][**polyisobutylene and polysulfide**][**polyisobutylene and silicone**][**polyisobutylene and hot-melt butyl**][**polyisobutylene and polyurethane**] primary and secondary sealants.
2. Spacer: [**Manufacturer's standard spacer material and construction**][**Aluminum with mill or clear anodic finish**][**Aluminum with black, color anodic finish**][**Aluminum with bronze, color anodic finish**][**Aluminum with powdered metal paint finish in color selected by Architect**][**Galvanized steel**][**Stainless steel**][**Polypropylene-covered stainless steel in color selected by Architect**][**Thermally broken aluminum**][**Nonmetallic laminate**][**Nonmetallic tube**], as directed by the Owner.
3. Desiccant: Molecular sieve or silica gel, or blend of both.

2.8 AIR-GAP SECURITY GLAZING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Global Security Glazing; Consolidated Glass Holdings, Inc.**]

B. Air-Gap Security Glazing: Factory-assembled units, consisting of sealed lites of glazing material indicated separated by a dehydrated interspace.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Spacer Specifications: Manufacturer's standard[**rigid**] spacer material and construction.

2.9 SPALL-RESISTANT FILM

A. Spall-Resistant Film: Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kuraray America, Inc.**]

B. Laminating Process: Factory laminate spall-resistant film to glazing assemblies to produce laminated lites free of foreign substances, air, and glass pockets.

2.10 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of

Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

8. Colors of Exposed Glazing Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of Industry colors**], as directed by the Owner.

B. Glazing Sealant:

1. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**Pecora Corporation**]
      3) [**Sika Corporation**]
      4) [**The Dow Chemical Company**]
      5) [**Tremco Incorporated**]

   b. Applications: <**Describe types of glazing applications where this sealant is required**>.

2. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Adfast**]
      2) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      3) [**Master Builders Solutions**]
      4) [**Pecora Corporation**]
      5) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      6) [**Sika Corporation**]
      7) [**The Dow Chemical Company**]
      8) [**Tremco Incorporated**]

   b. Applications: <**Describe types of glazing applications where this sealant is required**>.

3. Neutral-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Bostik; Arkema**]
      2) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      3) [**Permathane; a Holcim brand**]

4) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
5) [**Sika Corporation**]
6) [**The Dow Chemical Company**]
7) [**Tremco Incorporated**]

b. Applications: <**Describe types of glazing applications where this sealant is required**>.

4. Acid-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Bostik; Arkema**]
2) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
3) [**Master Builders Solutions**]
4) [**Pecora Corporation**]
5) [**Permathane; a Holcim brand**]
6) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
7) [**Sika Corporation**]
8) [**The Dow Chemical Company**]
9) [**Tremco Incorporated**]

b. Applications: <**Describe types of glazing applications where this sealant is required**>.

C. Security Sealant: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement complying with ASTM C920, Grade NS, Class 12.5 or 25, Use NT, and with a Shore A hardness of at least 45 when tested in accordance with ASTM C661.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]

2.11 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead

of liquid sealant.

2.12 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. [**Neoprene**] blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
2. Type recommended in writing by sealant or security glazing manufacturer.

E. Edge Blocks:

1. [**EPDM**][**Silicone**] with Shore A durometer hardness in accordance with manufacturer's written instructions.
2. Type recommended in writing by sealant or security glazing manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.13 FABRICATION OF SECURITY GLAZING

A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Grind smooth and polish exposed security glazing edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing for security glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Minimum required bite.
5. Effective sealing between joints of framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of it off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.

F. Provide spacers for security glazing lites where the length plus width is larger than **50 inches (1270 mm)**.

1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
2. Provide **1/8-inch (3-mm)** minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness of slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and in accordance with requirements in referenced glazing publications.

H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set coated security glazing with proper orientation so that coatings and films face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on

opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glazing unit and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers, or spacers and backings, in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from security glazing.

3.7 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. Examine security glazing surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer. Remove and replace security glazing that cannot be cleaned without damage.

C. Wash security glazing on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

3.8 LAMINATED-GLASS SECURITY GLAZING SCHEDULE

A. Security Glazing[**Type SG-1**]: [**Clear laminated glass**][**Tinted laminated glass**][**Clear reflective-coated laminated glass**][**Tinted reflective-coated laminated glass**].

1. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**] in accordance with ASTM F1233.
2. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**] in accordance with HPW-TP-0500.03.
3. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
4. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**] in accordance with UL 752.
5. Blast Resistance:

   a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
   b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

6. Number of Plies: [**Two**][**Three**].
7. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].
8. Core Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].

9. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].
10. Interlayer Material: [**Polyvinyl butyral**][**ionoplast**].
11. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].
12. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
13. Tinted Glass Location: Outer ply.
14. Coating Color: [**Gold**][**Pewter**][**Silver**].
15. Coating Location: [**Second**][**Third**][**Fifth**] surface.
16. Provide safety glazing labeling.

B. Security Glazing[**Type SG-2**]: Tinted[**reflective-coated**] laminated glass with clear glass and tinted interlayer.

1. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**] in accordance with ASTM F1233.
2. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**] in accordance with HPW-TP-0500.03.
3. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
4. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**] in accordance with UL 752.
5. Blast Resistance:

   a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
   b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

6. Number of Plies: [**Two**][**Three**].
7. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].
8. Core Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].
9. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].
10. Interlayer Material: [**Polyvinyl butyral**][**ionoplast**].
11. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].
12. Interlayer Color: [**Clear**][**Blue-green**][**Bronze light**][**Gray**].
13. Coating Color: [**Gold**][**Pewter**][**Silver**].
14. Coating Location: [**Second**][**Third**][**Fifth**] surface.
15. Provide safety glazing labeling.

3.9 MONOLITHIC POLYCARBONATE SECURITY GLAZING SCHEDULE

A. Security Glazing[Type SG-3]: Monolithic polycarbonate with mar-resistant coating on both surfaces.

1. Detention Security Grade: Grade 4 in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Thickness: [**3/8 inch (9.25 mm)**][**1/2 inch (12.7 mm)**].

3.10 LAMINATED-POLYCARBONATE SECURITY GLAZING SCHEDULE

A. Security Glazing[Type SG-4]: Laminated polycarbonate.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM

F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].

2. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
3. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
4. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
5. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**] in accordance with UL 752.
6. Blast Resistance:

    a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
    b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

7. Number of Plies: [**Two**][**Three**][**Four**].
8. Outer and Inner Plies: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
9. [**Core Ply**][**Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
10. Interlayer Material: Polyurethane.
11. Interlayer Thicknesses: [**0.025 inch (0.635 mm)**].

3.11 GLASS-CLAD POLYCARBONATE SECURITY GLAZING SCHEDULE

A. Security Glazing[**Type SG-5**]: [**Clear symmetrical glass-clad polycarbonate**][**Tinted symmetrical glass-clad polycarbonate**][**Clear reflective-coated symmetrical glass-clad polycarbonate**][**Tinted reflective-coated symmetrical glass-clad polycarbonate**].

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
3. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
4. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
5. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**] in accordance with UL 752.
6. Blast Resistance:

a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

7. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.
8. Single Core: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
9. Multiple Core:

a. Outer Core Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
b. [**Single Inner Core Ply**][**Double Inner Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.

10. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.
11. Interlayer Material: Polyurethane.
12. Interlayer Thickness: [**0.025 inch (0.635 mm)**][**0.050 inch (1.27 mm)**].
13. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
14. Tinted Glass Location: Outer ply.
15. Coating Color: [**Gold**][**Pewter**][**Silver**].
16. Coating Location: [**Second**][**Third**][**Fifth**] surface.
17. Provide safety glazing labeling.

3.12 LAMINATED-GLASS AND -POLYCARBONATE SECURITY GLAZING SCHEDULE

A. Security Glazing[**Type SG-6**]: Nonsymmetrical [**clear**][**tinted**][**reflective-coated**] laminated glass and polycarbonate with glass plies on the attack or threat side and polycarbonate plies on the witness side.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
3. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
4. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
5. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**] in accordance with UL 752.
6. Blast Resistance:

a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

7. Makeup:

a. Outer Glass Ply: [**3 mm**] heat-strengthened float glass.

1) Interlayer Thickness: [**0.025 inch (0.635 mm)**][**0.050 inch (1.27 mm)**].

b. First Inner Glass Ply: [**12 mm**] float glass.

1) Interlayer Thickness: [**0.025 inch (0.635 mm)**][**0.050 inch (1.27 mm)**].

c. Second Inner Glass Ply: [**10 mm**] float glass.

1) Interlayer Thickness: [**0.025 inch (0.635 mm)**][**0.050 inch (1.27 mm)**].

d. Inner Polycarbonate Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] Type I (standard, UV-stabilized) polycarbonate.

1) Interlayer Thickness: [**0.025 inch (0.635 mm)**][**0.050 inch (1.27 mm)**].

e. Outer Polycarbonate Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] Type II (coated, mar-resistant, UV-stabilized) polycarbonate.

8. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
9. Tinted Glass Location: Outer glass ply.
10. Coating Color: [**Gold**][**Pewter**][**Silver**].
11. Coating Location: [**Second**][**Third**][**Fifth**] surface.
12. Provide safety glazing labeling.

3.13 INSULATING SECURITY GLAZING SCHEDULE

A. Security Glazing[**Type SG-7**]: [**Clear insulating security glazing**][**Tinted insulating security glazing**][**Reflective-coated, clear insulating security glazing**][**Reflective-coated, tinted insulating security glazing**]. Outdoor lite is made of monolithic glass, and indoor lite is made of glass-clad polycarbonate.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Outdoor Lite: [**Float glass**][**Heat-strengthened float glass**][**Fully tempered float glass**].
3. Indoor Lite: Glass-clad polycarbonate.

a. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**][**fully tempered**] float glass.
b. Single Core: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
c. Multiple Core:

1) Outer Core Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
2) [**Single Inner Core Ply**][**Double Inner Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.

d. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**][**fully tempered**] float glass.

4. Interspace Content: [**Air**][**Argon**].
5. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].

6. Tinted Glass Location: Outdoor lite.
7. Coating Color: [**Gold**][**Pewter**][**Silver**].
8. Coating Location: [**Second**][**Third**][**Fifth**] surface.
9. Provide safety glazing labeling.

B. Security Glazing[**Type SG-8**]: [**Low-e-coated, clear insulating security glazing**][**Low-e-coated, tinted insulating security glazing**]. Outdoor lite is made of monolithic glass, and indoor lite is made of glass-clad polycarbonate.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Outdoor Lite: [**Float glass**][**Heat-strengthened float glass**][**Fully tempered float glass**].
3. Indoor Lite: Glass-clad polycarbonate.

   a. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**][**fully tempered**] float glass.
   b. Single Core: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
   c. Multiple Core:

      1) Outer Core Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
      2) [**Single Inner Core Ply**][**Double Inner Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.

   d. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**][**fully tempered**] float glass.

4. Interspace Content: [**Air**][**Argon**].
5. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
6. Tinted Glass Location: Outer lite.
7. Low-E Coating: [**Pyrolytic on second surface**][**Pyrolytic on third surface**][**Sputtered on second surface**][**Sputtered on third surface**].
8. Provide safety glazing labeling.

C. Security Glazing[**Type SG-9**]: [**Clear insulating security glazing**][**Tinted insulating security glazing**][**Reflective-coated, clear insulating security glazing**][**Reflective-coated, tinted insulating security glazing**]. Outdoor lite is made of laminated glass, and indoor lite is made of glass-clad polycarbonate with spall-resistant film on inside face.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Forced-Entry Resistance, ASTM F1233 [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
3. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
4. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
5. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level**

7][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**] in accordance with UL 752.

6. Blast Resistance:

    a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
    b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

7. Outdoor Lite: Laminated glass with [**two plies of heat-strengthened float glass**][**three plies of heat-strengthened float glass**][**two outer plies of heat-strengthened float glass and two inner plies of annealed float glass**].

    a. Outer Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    b. Core Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    c. Inner Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    d. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].

8. Indoor Lite: Glass-clad polycarbonate faced with a **0.037-inch- (0.94-mm-)** thick, spall-resistant polyester film laminated to indoor face.

    a. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.
    b. Single Core: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
    c. Multiple Core:

        1) Outer Core Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
        2) [**Single Inner Core Ply**][**Double Inner Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.

    d. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.

9. Interspace Content: [**Air**][**Argon**].
10. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
11. Tinted Glass Location: [**Outer**][**Inner**] ply of outdoor lite.
12. Coating Color: [**Gold**][**Pewter**][**Silver**].
13. Coating Location: [**Second**][**Third**][**Fifth**] surface.
14. Provide safety glazing labeling.

D. Security Glazing[**Type SG-10**]: [**Low-e-coated, clear insulating security glazing**][**Low-e-coated, tinted insulating security glazing**]. Outdoor lite is made of laminated glass, and indoor lite is made of glass-clad polycarbonate with spall-resistant film on inside face.

1. Detention Security Grade: [**Grade 1**][**Grade 2**][**Grade 3**][**Grade 4**] in accordance with ASTM F1915 [**cold-temperature impact test**][**warm-temperature impact test**][**and**][**torch and small blunt impactor test**].
2. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
3. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in

accordance with HPW-TP-0500.03.

4. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
5. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**] in accordance with UL 752.
6. Blast Resistance:

    a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
    b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

7. Outdoor Lite: Laminated glass with [**two plies of heat-strengthened float glass**][**three plies of heat-strengthened float glass**][**two outer plies of heat-strengthened float glass and two inner plies of annealed float glass**].

    a. Outer Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    b. Core Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    c. Inner Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    d. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].

8. Indoor Lite: Glass-clad polycarbonate faced with a **0.037-inch- (0.94-mm-)** thick, spall-resistant polyester film laminated to indoor face.

    a. Outer Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.
    b. Inner Ply: [**3 mm**][**5 mm**][**6 mm**][**heat-strengthened**][**chemically strengthened**] float glass.
    c. Single Core: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
    d. Multiple Core:

        1) Outer Core Ply: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
        2) [**Single Inner Core Ply**][**Double Inner Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.

9. Interspace Content: [**Air**][**Argon**].
10. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
11. Tinted Glass Location: Outer lite.
12. Low-E Coating: [**Pyrolytic on second surface**][**Pyrolytic on third surface**][**Sputtered on second surface**][**Sputtered on third surface**].
13. Provide safety glazing labeling.

3.14 AIR-GAP SECURITY GLAZING SCHEDULE

A. Security Glazing[**Type SG-11**]: [**Clear air-gap security glazing**][**Tinted air-gap security glazing**][**Clear reflective-coated air-gap security glazing**][**Tinted reflective-coated air-gap security glazing**]. Outdoor lite is made of laminated glass, and indoor lite is made of laminated polycarbonate.

1. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class**

4.2][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.

2. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
3. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
4. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-SG**][**Level 8-SG**] in accordance with UL 752.
5. Blast Resistance:

    a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
    b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

6. Outdoor Lite: Laminated glass with [**two**][**three**] plies of [**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].

    a. Outer Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    b. Core Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    c. Inner Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
    d. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].

7. Indoor Lite: Laminated polycarbonate with [**two**][**three**][**four**] polycarbonate plies.

    a. Outer and Inner Plies: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
    b. [**Core Ply**][**Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
    c. Interlayer Thicknesses: [**0.025 inch (0.635 mm)**].

8. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
9. Tinted Glass Location: [**Outer**][**Inner**] ply of outdoor lite.
10. Coating Color: [**Gold**][**Pewter**][**Silver**].
11. Coating Location: [**Second**][**Third**][**Fifth**] surface.
12. Provide safety glazing labeling.

B. Security Glazing[**Type SG-12**]: [**Low-e-coated, clear air-gap security glazing**][**Low-e-coated, tinted air-gap security glazing**]. Outdoor lite is made of laminated glass, and indoor lite is made of laminated polycarbonate.

1. Forced-Entry Resistance, ASTM F1233: [**Class 1.0**][**Class 1.1**][**Class 1.2**][**Class 1.3**][**Class 1.4**][**Class 1.5**][**Class 2.0**][**Class 2.1**][**Class 2.2**][**Class 2.3**][**Class 2.4**][**Class 2.5**][**Class 2.6**][**Class 2.7**][**Class 2.8**][**Class 3.0**][**Class 3.1**][**Class 3.2**][**Class 3.3**][**Class 3.4**][**Class 3.5**][**Class 3.6**][**Class 3.7**][**Class 3.8**][**Class 3.9**][**Class 3.10**][**Class 4.0**][**Class 4.1**][**Class 4.2**][**Class 4.3**][**Class 4.4**][**Class 4.5**][**Class 4.6**][**Class 4.7**][**Class 4.8**][**Class 4.9**][**Class 4.10**][**Class 4.11**][**Class 4.12**][**Class 4.13**][**Class 5.0**] in accordance with ASTM F1233.
2. Forced-Entry Resistance, HPW-TP-0500.03: [**Level I**][**Level II**][**Level III**][**Level IV**][**Level V**] in accordance with HPW-TP-0500.03.
3. Ballistic Resistance, ASTM F1233: [**Class HG1**][**Class HG2**][**Class HG3**][**Class HG4**][**Class SMG**][**Class R1**][**Class R2**][**Class R3**][**Class R4-AP**][**Class R5**][**Class SH1**][**Class SH2**] in accordance with ASTM F1233.
4. Ballistic Resistance, UL 752: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**][**Level 1-SG**][**Level 2-SG**][**Level 3-SG**][**Level 4-SG**][**Level 5-SG**][**Level 6-SG**][**Level 7-**

SG][**Level 8-SG**] in accordance with UL 752.

5. Blast Resistance:

   a. Hazard Rating: [**No hazard**][**Minimal hazard**][**Very low hazard**][**Low hazard**][**Moderate hazard**][**High hazard**] tested in accordance with ASTM F1642/1642M.
   b. Performance Condition: [**1**][**2**][**3a**][**3b**][**4**][**5**] in accordance with GSA-TS01.

6. Outdoor Lite: Laminated glass with [**two**][**three**] plies of [**float glass**][**heat-strengthened float glass**][**fully tempered float glass**][**chemically strengthened float glass**].

   a. Outer Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
   b. Core Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
   c. Inner Ply Thickness: [**3 mm**][**5 mm**][**6 mm**].
   d. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].

7. Indoor Lite: Laminated polycarbonate with [**two**][**three**][**four**] polycarbonate plies.

   a. Outer and Inner Plies: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
   b. [**Core Ply**][**Core Plies**]: [**0.118-inch (4.57-mm)**][**0.177-inch (2.97-mm)**][**0.236-inch (5.99-mm)**] polycarbonate.
   c. Interlayer Thicknesses: [**0.025 inch (0.635 mm)**].

8. Glass Tint Color: [**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
9. Tinted Glass Location: [**Outer**][**Inner**] ply of outdoor lite.
10. Low-E Coating: [**Pyrolytic on second surface**][**Pyrolytic on third surface**][**Sputtered on second surface**][**Sputtered on third surface**].
11. Provide safety glazing labeling.

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Task	Specification	Specification Description
08 88 53 00	08 80 00 00	Glazing

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SECTION 08 91 16 00 - OPERABLE WALL LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Operable, [**extruded-aluminum**][**and**][**formed-metal**] louvers.
2. Operable, [**extruded-aluminum**][**and**][**formed-metal**] insulated louvers.
3. Blank-off panels for louvers.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for field painting exterior louvers.
2. Section 099123 "Interior Painting" for field painting interior louvers.
3. Section 221513 "General-Service Compressed-Air Piping" for connecting pneumatic-operated louvers.

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.

8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration: For each product.
12. Health Product Declaration: For each product.
13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
14. Environmental Product Declaration: For each product.
15. Environmental Product Declaration: For each product.
16. Environmental Product Declaration: For each product.
17. Third-Party Certifications: For each product.
18. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized operable louvers.

D. Samples: For each type of metal finish required.

E. Delegated Design Submittal: For louvers indicated to comply with structural[**and seismic**] performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Sample Warranties: For manufacturer's special warranties.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain operable [**and fixed**] louvers from single source from single manufacturer[**where indicated to be of same type, design, or factory-applied color finish**].

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural[**and seismic**] performance requirements and design criteria indicated.

B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures to the face of the building are considered to act normal.

1. Wind Loads:

    a. Determine loads based on pressures as indicated on Drawings.
    b. Determine loads based on a uniform pressure of [**20 lbf/sq. ft. (957 Pa)**][**30 lbf/sq. ft. (1436 Pa)**], acting inward or outward.

C. Seismic Performance:

1. As indicated on Drawings.
2. Louvers, including attachments to other construction, withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

    a. Component Importance Factor: [**1.5**][**1.0**].

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

G. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

2.3 OPERABLE EXTRUDED-ALUMINUM LOUVERS

A. Louver Construction and Operation: Provide operable louvers with extruded-aluminum frames and blades of not less than **0.080-inch (2.03-mm)** nominal thickness, and with operating mechanisms to suit louver sizes.

1. Hand operation with push bars.
2. Crank operation with removable-crank operator in sill or jamb.
3. Chain operation with tension spring, wall clip, pull chain, and **160 deg F (71 deg C)** fusible link.
4. Motor operation with [**two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch**][**two-direction, 110-V, 60-Hz motor and limit switches**]; equipped with [**frame-mounted switch**][**remote-mounted switch with indicator light**][**terminals for controlling devices**].
5. Pneumatic piston operation for use with **80- to 100-psi (550- to 690-kPa)** compressed air for [**two-position**][**modulating**] operation; power open, power close[**with spring-return fail-safe**].

B. Operable, Extruded-Aluminum, Single-Blade Louver :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Balance; MESTEK, Inc.**]
b. [**Air Flow Company, Inc.**]
c. [**Airline Louvers; Mestek, Inc.**]
d. [**Airolite Company, LLC (The)**]
e. [**All-Lite Architectural Products**]
f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
g. [**Arrow United Industries; Mestek, Inc.**]
h. [**Carnes Company**]
i. [**Cesco Products; MESTEK, Inc.**]
j. [**Construction Specialties, Inc.**]
k. [**Greenheck Fan Corporation**]
l. [**Industrial Louvers Inc.**]
m. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
n. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
o. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
p. [**North East Louvers, Inc.**]

q. [**Pottorff**]
r. [**Reliable Products, Inc.**]
s. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
t. [**Safe Air - Dowco**]
u. [**United Enertech Corp.**]
v. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Blade Type: [**Drainable**][**Plain**].
4. Accessories: Equip louvers as follows:

   a. Vinyl blade-edge gaskets for each louver blade.
   b. [Stainless steel jamb seals][vinyl blade-end gaskets].

5. Louver Performance Ratings:

   a. Free Area: Not less than [**6.5 sq. ft. (0.60 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**][**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**500 fpm (2.5 m/s)**][**600 fpm (3.0 m/s)**][**700 fpm (3.6 m/s)**][**800 fpm (4.1 m/s)**][**900 fpm (4.6 m/s)**][**1000 fpm (5.1 m/s)**].
   c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**500-fpm (2.5-m/s)**][**600-fpm (3.0-m/s)**][**700-fpm (3.6-m/s)**][**800-fpm (4.1-m/s)**][**900-fpm (4.6-m/s)**] free-area [**exhaust**][**intake**] velocity.
   d. Air Leakage: Not more than [**3.5 cfm/sq. ft. (17.8 L/s per sq. m)**] of louver gross area at a differential static pressure of **0.15-inch wg (37 Pa)** with operable louver blades closed.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

C. Operable, Extruded-Aluminum, Dual-Blade Louver : Fixed drainable blades and operable plain blades combined in single frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Airline Louvers; Mestek, Inc.**]
   d. [**Airolite Company, LLC (The)**]
   e. [**All-Lite Architectural Products**]
   f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   g. [**Arrow United Industries; Mestek, Inc.**]
   h. [**Cesco Products; MESTEK, Inc.**]
   i. [**Construction Specialties, Inc.**]
   j. [**Greenheck Fan Corporation**]
   k. [**Industrial Louvers Inc.**]
   l. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
   m. [**Moffitt Corporation**]
   n. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
   o. [**North East Louvers, Inc.**]
   p. [**Pottorff**]
   q. [**Reliable Products, Inc.**]
   r. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   s. [**Safe Air - Dowco**]

t. [**United Enertech Corp.**]
u. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**], overall.
3. Fixed Drainable-Blade Angle: [**30**][**35**][**37.5**][**45**] degrees.
4. Louver Performance Ratings:

   a. Free Area: Not less than [**6.0 sq. ft. (0.56 sq. m)**][**6.5 sq. ft. (0.60 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**][**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**750 fpm (3.8 m/s)**][**800 fpm (4.1 m/s)**][**850 fpm (4.3 m/s)**][**900 fpm (4.6 m/s)**][**950 fpm (4.8 m/s)**][**1000 fpm (5.1 m/s)**].
   c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**750-fpm (3.8-m/s)**][**800-fpm (4.1-m/s)**][**850-fpm (4.3-m/s)**][**900-fpm (4.6-m/s)**] free-area [**exhaust**][**intake**] velocity.
   d. Air Leakage: Not more than [**1.5 cfm/sq. ft. (7.6 L/s per sq. m)**] of louver gross area at a differential static pressure of **0.15-inch wg (37 Pa)** with operable louver blades closed.

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 OPERABLE FORMED-METAL LOUVERS

A. Louver Operation: Provide operable louvers with operating mechanisms to suit louver sizes.

1. Hand operation with push bars.
2. Crank operation with removable-crank operator in sill or jamb.
3. Chain operation with tension spring, wall clip, pull chain, and **160 deg F (71 deg C)** fusible link.
4. Motor operation with [**two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch**][**two-direction, 110-V, 60-Hz motor and limit switches**]; equipped with [**frame-mounted switch**][**remote-mounted switch with indicator light**][**terminals for controlling devices**].
5. Pneumatic piston operation for use with **80- to 100-psi (550- to 690-kPa)** compressed air for [**two-position**][**modulating**] operation; power open, power close[**with spring-return fail-safe**].

B. Operable, Formed-Metal, Single-Blade Louver :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Airline Louvers; Mestek, Inc.**]
   d. [**Airolite Company, LLC (The)**]
   e. [**All-Lite Architectural Products**]
   f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   g. [**Arrow United Industries; Mestek, Inc.**]
   h. [**Carnes Company**]
   i. [**Cesco Products; MESTEK, Inc.**]
   j. [**Greenheck Fan Corporation**]
   k. [**Industrial Louvers Inc.**]
   l. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
   m. [**Metal Form Manufacturing LLC; United Enertech Corp.**]

n. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
o. [**North East Louvers, Inc.**]
p. [**Pottorff**]
q. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
r. [**Safe Air - Dowco**]
s. [**United Enertech Corp.**]
t. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Blade Type: [**Drainable**][**Plain**].
4. Frame and Blade Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades**][**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

5. Accessories: Equip louvers as follows:

   a. Vinyl blade-edge gaskets for each louver blade.
   b. [Stainless steel jamb seals][vinyl blade-end gaskets].

6. Louver Performance Ratings:

   a. Free Area: Not less than [**6.5 sq. ft. (0.60 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**][**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**500 fpm (2.5 m/s)**][**600 fpm (3.0 m/s)**][**700 fpm (3.6 m/s)**][**800 fpm (4.1 m/s)**][**900 fpm (4.6 m/s)**][**1000 fpm (5.1 m/s)**].
   c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**500-fpm (2.5-m/s)**][**600-fpm (3.0-m/s)**][**700-fpm (3.6-m/s)**][**800-fpm (4.1-m/s)**][**900-fpm (4.6-m/s)**] free-area [**exhaust**][**intake**] velocity.
   d. Air Leakage: Not more than [**3.5 cfm/sq. ft. (17.8 L/s per sq. m)**] of louver gross area at a differential static pressure of **0.15-inch wg (37 Pa)** with operable louver blades closed.

7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

C. Operable, Formed-Metal, Dual-Blade Louver : Fixed drainable blades and operable plain blades combined in single frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
   b. [**North East Louvers, Inc.**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. [**Safe Air - Dowco**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**], overall.
3. Fixed Drainable-Blade Angle: [**30**][**35**][**37.5**][**45**] degrees.
4. Frame and Blade Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades**][**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

5. Louver Performance Ratings:

   a. Air Leakage: Not more than [**1.5 cfm/sq. ft. (7.6 L/s per sq. m)**] of louver gross area at a differential static pressure of **0.15-inch wg (37 Pa)** with operable louver blades closed.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 OPERABLE INSULATED LOUVERS

A. Louver Operation: Provide operable louvers with operating mechanisms to suit louver sizes.

1. Hand operation with push bars.
2. Crank operation with removable-crank operator in sill or jamb.
3. Chain operation with tension spring, wall clip, pull chain, and **160 deg F (71 deg C)** fusible link.
4. Motor operation with [**two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch**][**two-direction, 110-V, 60-Hz motor and limit switches**]; equipped with [**frame-mounted switch**][**remote-mounted switch with indicator light**][**terminals for controlling devices**].
5. Pneumatic piston operation for use with **80- to 100-psi (550- to 690-kPa)** compressed air for [**two-position**][**modulating**] operation; power open, power close[**with spring-return fail-safe**].

B. Operable, Insulated, Extruded-Aluminum Louver : Single-blade, operable louver with gasketed, insulated blades. Frames and blade frames have urethane thermal break. Frames are made of extruded aluminum, not less than **0.080-inch (2.03-mm)** nominal thickness. Blade facings are made of aluminum sheet, not less than **0.032-inch (0.81-mm)** nominal thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airolite Company, LLC (The)**]
   b. [**Construction Specialties, Inc.**]
   c. [**North East Louvers, Inc.**]

2. Louver Depth: [**6 inches (150 mm)**][**9 inches (225 mm)**].
3. Insulation: [**Extruded-polystyrene foam, 2 inches (50 mm) thick**][**Foamed-in-place polyurethane**].

C. Operable, Insulated, Formed-Metal Louver : Single-blade, operable louver with gasketed, insulated blades.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airline Louvers; Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**North East Louvers, Inc.**]
   e. [**Vent Products Co., Inc**]

2. Louver Depth: [**6 inches (150 mm)**][**8 inches (200 mm)**].

3. Frame Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

4. Blade Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.028 inch (0.71 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.025 inch (0.64 mm)**][**0.038 inch (0.95 mm)**][**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

5. Insulation: [**Extruded-polystyrene foam, 1 inch (25 mm) thick**][**Rigid, glass-fiber-board insulation, 1 inch (25 mm) thick**][**Foamed-in-place polyurethane, 1/2 inch (13 mm) thick**].

2.6 LOUVER SCREENS

A. General: Provide screen at [**each exterior louver**][**louvers indicated**].

   1. Screen Location: [**Interior**][**Exterior**] face unless otherwise indicated.
   2. Screening Type: [**Bird screening**][**Bird screening, except where insect screening is indicated**][**Insect screening**].

B. Secure screen frames to louver frames with [**stainless steel machine screws**][**machine screws with heads finished to match louver**], spaced a maximum of **6 inches (150 mm)** from each corner and at **12 inches (300 mm)** o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

   1. Metal: Same type and form of metal as indicated for louver to which screens are attached.[**Reinforce extruded-aluminum screen frames at corners with clips.**]
   2. Finish: [**Same finish as louver frames to which louver screens are attached**][**Mill finish unless otherwise indicated**].
   3. Type: [**Rewirable frames with a driven spline or insert**][**Non-rewirable, U-shaped frames**].

D. Louver Screening for Aluminum Louvers:

   1. Bird Screening, Aluminum: **1/2-inch- (13-mm-)** square mesh, **0.063-inch (1.60-mm)** wire.
   2. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.
   3. Bird Screening, Flattened, Expanded Aluminum: **3/4 by 0.050 inch (19 by 1.27 mm)** thick.
   4. Insect Screening, Aluminum: **18-by-16 (1.4-by-1.6-mm)** mesh, **0.012-inch (0.30-mm)** wire.
   5. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

E. Louver Screening for Galvanized-Steel Louvers:

   1. Bird Screening, Galvanized Steel: **1/2-inch- (13-mm-)** square mesh, **0.041-inch (1.04-mm)** wire.
   2. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.
   3. Insect Screening, Galvanized Steel: **18-by-14 (1.4-by-1.8-mm)** mesh, **0.011-inch (0.28-mm)** wire.
   4. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

F. Louver Screening for Stainless Steel Louvers:

   1. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.

2. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

2.7 BLANK-OFF PANELS

A. Uninsulated Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than **0.050-inch (1.27-mm)** nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than [**0.040-inch (1.02-mm)**][**0.052-inch (1.32-mm)**] nominal thickness.
3. Stainless steel sheet for stainless steel louvers, not less than [**0.038-inch (0.95-mm)**][**0.050-inch (1.27-mm)**] nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: [**Same finish applied to louvers**][**Same finish type applied to louvers, but black color**].
5. Attach blank-off panels with [**clips**][**sheet metal screws**].

B. Insulated Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
2. Metal Facing Sheets, Aluminum: Not less than **0.032-inch (0.81-mm)** nominal thickness.
3. Metal Facing Sheets, Galvanized-Steel Sheet: Not less than **0.028-inch (0.71-mm)** nominal thickness.
4. Metal Facing Sheets, Stainless Steel Sheet: Not less than **0.031-inch (0.79-mm)** nominal thickness.
5. Insulating Core: [Rigid, glass-fiber-board insulation][extruded-polystyrene foam].
6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard [**extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness**][**channel frames**], with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: [**Same finish applied to louvers**][**Same finish type applied to louvers, but black color**].
9. Attach blank-off panels with [**clips**][**sheet metal screws**].

2.8 MATERIALS

A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, [**G60 (Z180)**][**G90 (Z275)**] zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, [**No. 2B finish**][**No. 2D finish**][**No. 4 finish, with grain running parallel to length of blades and frame members**][**No. 4 finish, with grain running perpendicular to length of blades and frame members**][**No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members**][**No. 6 finish**].

E. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use [**Phillips flat-head**][**hex-head or Phillips pan-head**][**tamper-resistant**] screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel

fasteners.
4. For fastening stainless steel, use 300 series stainless steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

I. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

J. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

K. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

L. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

M. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

N. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.9 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern [**unless horizontal mullions are indicated**][**where indicated**].
2. Horizontal Mullions: Provide horizontal mullions at joints [**unless continuous vertical assemblies are indicated**][**where indicated**].

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: [**Channel**][**Exterior flange**][**Interior flange**] unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or **72 inches (1830 mm)** o.c., whichever is less.

F. Provide [subsills made of same material as louvers][extended sills] for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds [concealed from view][threaded fasteners, or both, as standard with louver manufacturer] unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.10 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

D. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical conversion coated with acid chromate-fluoride-phosphate.

E. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than **2-mil (0.05-mm)** dry film thickness.

F. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 GALVANIZED-STEEL SHEET FINISHES

A. Finish louvers after assembly.

B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.12 STAINLESS STEEL SHEET FINISHES

A. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as directed by the Owner, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 16 00

SECTION 08 91 19 00 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed [**extruded-aluminum**][**and**][**formed-metal**] louvers.
2. Fixed formed-metal acoustical louvers.
3. Blank-off panels for louvers

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.
2. Section 081416 "Flush Wood Doors" for louvers in flush wood doors.
3. Section 099113 "Exterior Painting" for field painting exterior louvers.
4. Section 099123 "Interior Painting" for field painting interior louvers.

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).

C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.

F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for

each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration: For each product.
12. Health Product Declaration: For each product.
13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
14. Environmental Product Declaration: For each product.
15. Environmental Product Declaration: For each product.
16. Environmental Product Declaration: For each product.
17. Third-Party Certifications: For each product.
18. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

D. Samples: For each type of metal finish required.

E. Delegated Design Submittal: For louvers indicated to comply with structural[**and seismic**] performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Windborne-debris-impact-resistance test reports.

C. Sample Warranties: For manufacturer's special warranties.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fixed[**and operable**] louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural[**and seismic**] performance requirements and design criteria indicated.

B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.

1. Wind Loads:

a. Determine loads based on pressures as indicated on Drawings.

b. Determine loads based on a uniform pressure of [**20 lbf/sq. ft. (957 Pa)**][**30 lbf/sq. ft. (1436 Pa)**], acting inward or outward.

C. Windborne-Debris-Impact Resistance: Louvers located within **30 feet (9.1 m)** of grade pass [**basic**][**enhanced**] protection, when tested in accordance with AMCA 540.

D. Seismic Performance:

1. As indicated on Drawings.
2. Louvers, including attachments to other construction, withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

a. Component Importance Factor: [**1.5**][**1.0**].

E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

G. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Nondrainable-Blade Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Balance; MESTEK, Inc.**]
b. [**Air Flow Company, Inc.**]
c. [**Aire Technologies, Inc.; DMI Companies**]
d. [**Airline Louvers; Mestek, Inc.**]
e. [**Airolite Company, LLC (The)**]
f. [**All-Lite Architectural Products**]
g. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
h. [**Architectural Louvers Co.; Harray, LLC**]
i. [**Arrow United Industries; Mestek, Inc.**]
j. [**Carnes Company**]
k. [**Cesco Products; MESTEK, Inc.**]
l. [**Construction Specialties, Inc.**]
m. [**Greenheck Fan Corporation**]
n. [**Industrial Louvers Inc.**]
o. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
p. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
q. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
r. [**Pottorff**]
s. [**Reliable Products, Inc.**]

t. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
u. [**Safe Air - Dowco**]
v. [**United Enertech Corp.**]
w. [**Vent Products Co., Inc**]

2. Louver Depth: [**2 inches (50 mm)**][**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Blade Profile: [**Plain blade without**][**Blade with**] center baffle.
4. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**].
5. Mullion Type: [**Exposed**][**Semirecessed**][**Fully recessed**].
6. Louver Performance Ratings:

   a. Free Area: Not less than [**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**][**8.5 sq. ft. (0.79 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**700 fpm (3.6 m/s)**][**750 fpm (3.8 m/s)**][**800 fpm (4.1 m/s)**][**850 fpm (4.3 m/s)**][**900 fpm (4.6 m/s)**][**950 fpm (4.8 m/s)**].
   c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**650-fpm (3.3-m/s)**][**700-fpm (3.6-m/s)**][**750-fpm (3.8-m/s)**] free-area [**exhaust**][**intake**] velocity.

7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Horizontal Drainable-Blade Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Aire Technologies, Inc.; DMI Companies**]
   d. [**Airline Louvers; Mestek, Inc.**]
   e. [**Airolite Company, LLC (The)**]
   f. [**All-Lite Architectural Products**]
   g. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   h. [**Architectural Louvers Co.; Harray, LLC**]
   i. [**Arrow United Industries; Mestek, Inc.**]
   j. [**Carnes Company**]
   k. [**Cesco Products; MESTEK, Inc.**]
   l. [**Construction Specialties, Inc.**]
   m. [**DAMS Incorporated; D. Architectural Metal Solutions Incorporated**]
   n. [**Greenheck Fan Corporation**]
   o. [**Industrial Louvers Inc.**]
   p. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
   q. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
   r. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
   s. [**Pottorff**]
   t. [**Reliable Products, Inc.**]
   u. [**Ross Technology Company**]
   v. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   w. [**Safe Air - Dowco**]
   x. [**United Enertech Corp.**]
   y. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52**

mm) **for blades and** 0.080 inch (2.03 mm) **for frames**].

4. Mullion Type: Exposed.
5. Louver Performance Ratings:

   a. Free Area: Not less than [7.0 sq. ft. (0.65 sq. m)][7.5 sq. ft. (0.70 sq. m)][8.0 sq. ft. (0.74 sq. m)][8.5 sq. ft. (0.79 sq. m)] for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   b. Point of Beginning Water Penetration: Not less than [900 fpm (4.6 m/s)][950 fpm (4.8 m/s)][1000 fpm (5.1 m/s)][1050 fpm (5.3 m/s)][1100 fpm (5.6 m/s)].
   c. Air Performance:

      1) Not more than [0.10-inch wg (25-Pa)] static pressure drop at [700-fpm (3.6-m/s)][750-fpm (3.8-m/s)][800-fpm (4.1-m/s)][850-fpm (4.3-m/s)] free-area [**exhaust**][**intake**] velocity.
      2) Not more than [0.15-inch wg (37-Pa)] static pressure drop at [900-fpm (4.6-m/s)][950-fpm (4.8-m/s)][1000-fpm (5.1-m/s)] free-area [**exhaust**][**intake**] velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

C. Horizontal, Continuous-Line, Drainable-Blade Louver, Extruded Aluminum : Drainable-blade louver with blade gutters (drains) in rear two-thirds of blades only.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airline Louvers; Mestek, Inc.**]
   b. [**Airolite Company, LLC (The)**]
   c. [**All-Lite Architectural Products**]
   d. [**Architectural Louvers Co.; Harray, LLC**]
   e. [**Arrow United Industries; Mestek, Inc.**]
   f. [**Construction Specialties, Inc.**]
   g. [**Greenheck Fan Corporation**]
   h. [**Industrial Louvers Inc.**]
   i. [**Pottorff**]
   j. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   k. [**Safe Air - Dowco**]

2. Louver Depth: [6 inches (150 mm)].
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
4. Mullion Type: Semirecessed.
5. Louver Performance Ratings:

   a. Free Area: Not less than [7.8 sq. ft. (0.72 sq. m)] for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   b. Point of Beginning Water Penetration: Not less than [850 fpm (4.3 m/s)].
   c. Air Performance: Not more than [0.10-inch wg (25-Pa)] static pressure drop at [800-fpm (4.1-m/s)] free-area [**exhaust**][**intake**] velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

D. Horizontal, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Balance; MESTEK, Inc.**]
b. [**Air Flow Company, Inc.**]
c. [**Airline Louvers; Mestek, Inc.**]
d. [**Airolite Company, LLC (The)**]
e. [**All-Lite Architectural Products**]
f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
g. [**Architectural Louvers Co.; Harray, LLC**]
h. [**Arrow United Industries; Mestek, Inc.**]
i. [**Construction Specialties, Inc.**]
j. [**Greenheck Fan Corporation**]
k. [**Industrial Louvers Inc.**]
l. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
m. [**Pottorff**]
n. [**Reliable Products, Inc.**]
o. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
p. [**Safe Air - Dowco**]
q. [**United Enertech Corp.**]

2. Louver Depth: [**4 inches (100 mm)**][**5 inches (127 mm)**][**7 inches (175 mm)**][**8 inches (200 mm)**][**9 inches (225 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**].
4. Louver Performance Ratings:

   a. Free Area: Not less than [**5.0 sq. ft. (0.46 sq. m)**][**6.0 sq. ft. (0.56 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**600-fpm (3.0-m/s)**][**700-fpm (3.6-m/s)**][**800-fpm (4.1-m/s)**] free-area [**exhaust**][**intake**] velocity.
   c. Wind-Driven Rain Performance: Not less than [**99**][**95**][**80**] percent effectiveness when subjected to a rainfall rate of [**3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s)**][**8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s)**] at a core-area intake velocity of [**300 fpm (1.5 m/s)**][**400 fpm (2.0 m/s)**][**500 fpm (2.5 m/s)**].

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

E. Vertical, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Aire Technologies, Inc.; DMI Companies**]
   d. [**Airline Louvers; Mestek, Inc.**]
   e. [**Airolite Company, LLC (The)**]
   f. [**All-Lite Architectural Products**]
   g. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   h. [**Arrow United Industries; Mestek, Inc.**]
   i. [**Cesco Products; MESTEK, Inc.**]
   j. [**Construction Specialties, Inc.**]

k. [**Greenheck Fan Corporation**]
l. [**Industrial Louvers Inc.**]
m. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
n. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
o. [**Pottorff**]
p. [**Reliable Products, Inc.**]
q. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
r. [**United Enertech Corp.**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**][**9 inches (225 mm)**][**12 inches (300 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**].
4. Louver Performance Ratings:

   a. Free Area: Not less than [**5.0 sq. ft. (0.46 sq. m)**][**6.0 sq. ft. (0.56 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**600-fpm (3.0-m/s)**][**700-fpm (3.6-m/s)**][**800-fpm (4.1-m/s)**] free-area [**exhaust**][**intake**] velocity.
   c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of [**3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s)**][**8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s)**] at a core-area intake velocity of [**300 fpm (1.5 m/s)**][**400 fpm (2.0 m/s)**][**500 fpm (2.5 m/s)**].

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

F. Horizontal, Drainable-Blade, Windborne-Debris-Impact-Resistant Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aire Technologies, Inc.; DMI Companies**]
   b. [**Airolite Company, LLC (The)**]
   c. [**Greenheck Fan Corporation**]
   d. [**Reliable Products, Inc.**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**].
4. Mullion Type: Exposed.
5. Louver Performance Ratings:

   a. Free Area: Not less than [**8.5 sq. ft. (0.79 sq. m)**][**9.0 sq. ft. (0.84 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**1077 fpm (5.5 m/s)**][**1100 fpm (5.6 m/s)**].
   c. Air Performance:

      1) Not more than [**0.16-inch wg (40-Pa)**] static pressure drop at [**989-fpm (5.0-m/s)**] free-area [**exhaust**][**intake**] velocity.
      2) Not more than [**0.15-inch wg (37-Pa)**] static pressure drop at [**1077-fpm (5.5-m/s)**] free-area [**exhaust**][**intake**] velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

7. AMCA Rating: AMCA 540.

G. Vertical, Wind-Driven-Rain-Resistant, Windborne-Debris-Impact-Resistant Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airolite Company, LLC (The)**]
   b. [**All-Lite Architectural Products**]
   c. [**Greenheck Fan Corporation**]
   d. [**Pottorff**]

2. Louver Depth: [**5 inches (127 mm)**][**6 inches (150 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**][**0.060 inch (1.52 mm) for blades and 0.095 inch (2.41 mm) for frames**].
4. Louver Performance Ratings:

   a. Free Area: Not less than [**7.0 sq. ft. (0.65 sq. m)**][**8.5 sq. ft. (0.79 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Air Performance: Not more than [**0.18-inch wg (40-Pa)**] static pressure drop at [**1250-fpm (6.35-m/s)**] free-area [**exhaust**][**intake**] velocity.
   c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of [**3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s)**][**8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s)**] at a core-area intake velocity of [**782 fpm (4.0 m/s)**][**875 fpm (4.4 m/s)**][**989 fpm (5.0 m/s)**].

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
6. AMCA Rating: AMCA 540, AMCA 550.

H. Horizontal, Sightproof, Drainable-Blade Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Airline Louvers; Mestek, Inc.**]
   d. [**Airolite Company, LLC (The)**]
   e. [**All-Lite Architectural Products**]
   f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   g. [**Arrow United Industries; Mestek, Inc.**]
   h. [**Construction Specialties, Inc.**]
   i. [**Greenheck Fan Corporation**]
   j. [**Industrial Louvers Inc.**]
   k. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
   l. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
   m. [**Pottorff**]
   n. [**Reliable Products, Inc.**]
   o. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   p. [**Safe Air - Dowco**]
   q. [**United Enertech Corp.**]

2. Louver Depth: [**5 inches (127 mm)**].
3. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**].
4. Mullion Type: Exposed.
5. Louver Performance Ratings:

    a. Free Area: Not less than [**8.3 sq. ft. (0.77 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
    b. Point of Beginning Water Penetration: Not less than [**750 fpm (3.8 m/s)**][**950 fpm (4.8 m/s)**].
    c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**550-fpm (2.8-m/s)**] free-area [**exhaust**][**intake**] velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

I. Vertical Sightproof Louver, Extruded Aluminum :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Air Balance; MESTEK, Inc.**]
    b. [**Air Flow Company, Inc.**]
    c. [**Airline Louvers; Mestek, Inc.**]
    d. [**Airolite Company, LLC (The)**]
    e. [**All-Lite Architectural Products**]
    f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
    g. [**Arrow United Industries; Mestek, Inc.**]
    h. [**Cesco Products; MESTEK, Inc.**]
    i. [**Construction Specialties, Inc.**]
    j. [**Greenheck Fan Corporation**]
    k. [**Industrial Louvers Inc.**]
    l. [**Pottorff**]
    m. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
    n. [**Safe Air - Dowco**]
    o. [**United Enertech Corp.**]

2. Louver Depth: [**4 inches (100 mm)**].
3. Blade Profile: [**Chevron**][**Y**][**Labyrinth**]-shaped blade.
4. Frame and Blade Nominal Thickness: Not less than [**0.080 inch (2.03 mm)**][**0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames**].
5. Blade Spacing: [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
6. Mullion Type: [**Exposed**][**Semirecessed**][**Fully recessed**].

2.4 FIXED FORMED-METAL LOUVERS

A. Horizontal Nondrainable-Blade Louver, Formed Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Balance; MESTEK, Inc.**]
b. [**Air Flow Company, Inc.**]
c. [**Airline Louvers; Mestek, Inc.**]
d. [**Airolite Company, LLC (The)**]
e. [**All-Lite Architectural Products**]
f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
g. [**Arrow United Industries; Mestek, Inc.**]
h. [**Cesco Products; MESTEK, Inc.**]
i. [**Construction Specialties, Inc.**]
j. [**Greenheck Fan Corporation**]
k. [**Industrial Louvers Inc.**]
l. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
m. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
n. [**Pottorff**]
o. [**Ross Technology Company**]
p. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
q. [**Safe Air - Dowco**]
r. [**United Enertech Corp.**]
s. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Blade Profile: [**Plain blade without**][**Blade with**] center baffle.
4. Frame and Blade Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades**][**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

5. Mullion Type: [**Exposed**][**Semirecessed**][**Fully recessed**].
6. Louver Performance Ratings:

   a. Free Area: Not less than [**6.5 sq. ft. (0.60 sq. m)**][**7.0 sq. ft. (0.65 sq. m)**][**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**550 fpm (2.8 m/s)**][**600 fpm (3.0 m/s)**][**650 fpm (3.3 m/s)**][**700 fpm (3.6 m/s)**].
   c. Air Performance: Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**550-fpm (2.8-m/s)**][**600-fpm (3.0-m/s)**][**650-fpm (3.3-m/s)**][**700-fpm (3.6-m/s)**] free-area [**exhaust**][**intake**] velocity.

7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Horizontal Drainable-Blade Louver, Formed Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Balance; MESTEK, Inc.**]
   b. [**Air Flow Company, Inc.**]
   c. [**Airolite Company, LLC (The)**]
   d. [**All-Lite Architectural Products**]
   e. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   f. [**Arrow United Industries; Mestek, Inc.**]
   g. [**Cesco Products; MESTEK, Inc.**]

h. [**Construction Specialties, Inc.**]
i. [**Greenheck Fan Corporation**]
j. [**Industrial Louvers Inc.**]
k. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
l. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
m. [**Pottorff**]
n. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
o. [**Safe Air - Dowco**]
p. [**United Enertech Corp.**]
q. [**Vent Products Co., Inc**]

2. Louver Depth: [**4 inches (100 mm)**][**6 inches (150 mm)**].
3. Frame and Blade Material and Nominal Thickness:

   a. Galvanized-steel sheet, not less than [**0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades**][**0.052 inch (1.32 mm)**][**0.064 inch (1.63 mm)**].
   b. Stainless steel sheet, not less than [**0.050 inch (1.27 mm)**][**0.062 inch (1.59 mm)**].

4. Mullion Type: Exposed.
5. Louver Performance Ratings:

   a. Free Area: Not less than [**7.0 sq. ft. (0.65 sq. m)**][**7.5 sq. ft. (0.70 sq. m)**][**8.0 sq. ft. (0.74 sq. m)**][**8.5 sq. ft. (0.79 sq. m)**] for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
   b. Point of Beginning Water Penetration: Not less than [**800 fpm (4.1 m/s)**][**850 fpm (4.3 m/s)**][**900 fpm (4.6 m/s)**][**950 fpm (4.8 m/s)**][**1000 fpm (5.1 m/s)**].
   c. Air Performance:

      1) Not more than [**0.10-inch wg (25-Pa)**] static pressure drop at [**700-fpm (3.6-m/s)**][**750-fpm (3.8-m/s)**][**800-fpm (4.1-m/s)**][**850-fpm (4.3-m/s)**] free-area [**exhaust**][**intake**] velocity.
      2) Not more than [**0.15-inch wg (37-Pa)**] static pressure drop at [**900-fpm (4.6-m/s)**][**950-fpm (4.8-m/s)**][**1000-fpm (5.1-m/s)**] free-area velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 FIXED ACOUSTICAL LOUVERS

A. Acoustic Performance: Provide acoustical louvers complying with ratings specified, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width for [**airborne sound-transmission loss in accordance with ASTM E90**][**outdoor-indoor, sound-transmission loss in accordance with ASTM E966**].

B. Fixed, Acoustical Louver, Formed Metal : Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish as blade.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Air Balance; MESTEK, Inc.**]
      b. [**Air Flow Company, Inc.**]

c. [**Airline Louvers; Mestek, Inc.**]
d. [**Airolite Company, LLC (The)**]
e. [**All-Lite Architectural Products**]
f. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
g. [**Arrow United Industries; Mestek, Inc.**]
h. [**Construction Specialties, Inc.**]
i. [**Greenheck Fan Corporation**]
j. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
k. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
l. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
m. [**North East Louvers, Inc.**]
n. [**Pottorff**]
o. [**Reliable Products, Inc.**]
p. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
q. [**Safe Air - Dowco**]
r. [**United Enertech Corp.**]

2. Louver Depth: [**6 inches (150 mm)**][**8 inches (200 mm)**][**12 inches (300 mm)**].
3. Frame Material:

   a. Extruded aluminum or aluminum sheet, not less than **0.080-inch (2.03-mm)** nominal thickness.
   b. Galvanized-steel sheet, not less than [**0.052-inch (1.32-mm)**][**0.064-inch (1.63-mm)**] nominal thickness.

4. Blade Material:

   a. Aluminum sheet, not less than [**0.063-inch (1.60-mm)**][**0.080-inch (2.03-mm)**] nominal thickness.
   b. Galvanized-steel sheet, not less than [**0.034-inch (0.86-mm)**][**0.040-inch (1.02-mm)**][**0.052-inch (1.32-mm)**] nominal thickness.

5. Blade Shape: [**Straight**][**Airfoil**][**Chevron**].
6. Blade Angle: 45 degrees unless otherwise indicated.
7. Blade Spacing:

   a. **6 inches (150 mm)** o.c. for **6-inch- (150-mm-)** deep louvers.
   b. [**6 inches (150 mm)**][**8 inches (200 mm)**] o.c. for **8-inch- (200-mm-)** deep louvers.
   c. [**9 inches (225 mm)**][**12 inches (300 mm)**] o.c. for **12-inch- (300-mm-)** deep louvers.

8. Free Area: Not less than **4 sq. ft. (0.37 sq. m)** for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
9. Airborne Sound-Transmission Loss: [**STC 10**] in accordance with ASTM E413, determined by testing in accordance with ASTM E90.
10. Outdoor-Indoor, Sound-Transmission Loss: [**OITC 10**] in accordance with ASTM E1332, determined by testing in accordance with ASTM E966.

2.6 LOUVER SCREENS

A. General: Provide screen at [**each exterior louver**][**louvers indicated**].

   1. Screen Location for Fixed Louvers: Interior face.
   2. Screening Type: [**Bird screening**][**Bird screening, except where insect screening is indicated**][**Insect screening**].

B. Secure screen frames to louver frames with [**stainless steel machine screws**][**machine screws with heads finished to match louver**], spaced a maximum of **6 inches (150 mm)** from each corner and at **12 inches (300 mm)** o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached.[**Reinforce extruded-aluminum screen frames at corners with clips.**]
2. Finish: [**Same finish as louver frames to which louver screens are attached**][**Mill finish unless otherwise indicated**].
3. Type: [**Rewirable frames with a driven spline or insert**][**Non-rewirable, U-shaped frames**].

D. Louver Screening for Aluminum Louvers:

1. Bird Screening, Aluminum: **1/2-inch- (13-mm-)** square mesh, **0.063-inch (1.60-mm)** wire.
2. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.
3. Bird Screening, Flattened, Expanded Aluminum: **3/4 by 0.050 inch (19 by 1.27 mm)** thick.
4. Insect Screening, Aluminum: **18-by-16 (1.4-by-1.6-mm)** mesh, **0.012-inch (0.30-mm)** wire.
5. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

E. Louver Screening for Galvanized-Steel Louvers:

1. Bird Screening, Galvanized Steel: **1/2-inch- (13-mm-)** square mesh, **0.041-inch (1.04-mm)** wire.
2. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.
3. Insect Screening, Galvanized Steel: **18-by-14 (1.4-by-1.8-mm)** mesh, **0.011-inch (0.28-mm)** wire.
4. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

F. Louver Screening for Stainless Steel Louvers:

1. Bird Screening, Stainless Steel: **1/2-inch- (13-mm-)** square mesh, **0.047-inch (1.19-mm)** wire.
2. Insect Screening, Stainless Steel: **18-by-18 (1.4-by-1.4-mm)** mesh, **0.009-inch (0.23-mm)** wire.

2.7 BLANK-OFF PANELS

A. Uninsulated Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than **0.050-inch (1.27-mm)** nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than [**0.040-inch (1.02-mm)**][**0.052-inch (1.32-mm)**] nominal thickness.
3. Stainless steel sheet for stainless steel louvers, not less than [**0.038-inch (0.95-mm)**][**0.050-inch (1.27-mm)**] nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: [**Same finish applied to louvers**][**Same finish type applied to louvers, but black color**].
5. Attach blank-off panels with [**clips**][**sheet metal screws**].

B. Insulated Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
2. Metal Facing Sheets, Aluminum: Not less than **0.032-inch (0.81-mm)** nominal thickness.
3. Metal Facing Sheets, Galvanized Steel: Not less than **0.028-inch (0.71-mm)** nominal thickness.
4. Metal Facing Sheets, Stainless Steel: Not less than **0.031-inch (0.79-mm)** nominal thickness.
5. Insulating Core: [Rigid, glass-fiber-board insulation][extruded-polystyrene foam].

6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard [**extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness**][**channel frames**], with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: [**Same finish applied to louvers**][**Same type of finish applied to louvers, but black color**].
9. Attach blank-off panels with [**clips**][**sheet metal screws**].

2.8 MATERIALS

A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, [**G60 (Z180)**][**G90 (Z275)**] zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, [**No. 2B finish**][**No. 2D finish**][**No. 4 finish, with grain running parallel to length of blades and frame members**][**No. 4 finish, with grain running perpendicular to length of blades and frame members**][**No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members**][**No. 6 finish**].

E. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use [**Phillips flat-head**][**hex-head or Phillips pan-head**][**tamper-resistant**] screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
4. For fastening stainless steel, use 300 series stainless steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

I. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

J. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

K. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

L. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

M. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

N. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.9 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern [**unless horizontal mullions are indicated**][**where indicated**].
2. Horizontal Mullions: Provide horizontal mullions at joints [**unless continuous vertical assemblies are indicated**][**where indicated**].

C. Maintain equal louver blade spacing[including separation between blades and frames at head and sill,] to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: [**Channel**][**Exterior flange**][**Interior flange**] unless otherwise indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or **72 inches (1830 mm)** o.c., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades, so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
4. Exterior Corners: Prefabricated corner units with mitered [**and welded blades**][**blades with concealed close-fitting splices**] and with [**fully recessed**][**semirecessed**] mullions at corners.

G. Provide [subsills made of same material as louvers][extended sills] for recessed louvers.

H. Join frame members to each other and to fixed louver blades with fillet welds [concealed from view][threaded fasteners, or both, as standard with louver manufacturer] unless otherwise indicated or

size of louver assembly makes bolted connections between frame members necessary.

2.10 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

D. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical conversion coated with acid chromate-fluoride-phosphate.

E. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than **2-mil (0.05-mm)** dry film thickness.

F. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 GALVANIZED-STEEL SHEET FINISHES

A. Finish louvers after assembly.

B. Surface Preparation: Clean surfaces with nonpetroleum solvent, so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair in accordance with ASTM A780/A780M.

C. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.12 STAINLESS STEEL SHEET FINISHES

A. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as directed by the Owner, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 19 00

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Task	Specification	Specification Description
08 91 19 00	01 22 00 00	No Specification Required
08 95 13 00	01 22 00 00	No Specification Required

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SECTION 08 95 16 00 - WALL VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall vents.
2. Flood and air vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration: For each product.
12. Health Product Declaration: For each product.
13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
14. Environmental Product Declaration: For each product.
15. Environmental Product Declaration: For each product.
16. Environmental Product Declaration: For each product.
17. Third-Party Certifications: For each product.
18. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples: For each type of metal finish required.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For flood vents, from ICC-ES.

B. Sample Warranties: For manufacturer's special warranties.

1.4 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: [**Five**][**10**][**20**] years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain vents from single source from single manufacturer.

2.2 WALL VENTS (BRICK VENTS)

A. Extruded-Aluminum Wall Vents:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Flow Company, Inc.**]
b. [**Airolite Company, LLC (The)**]
c. [**Architectural Louvers Co.; Harray, LLC**]
d. [**Arrow United Industries; Mestek, Inc.**]
e. [**Construction Specialties, Inc.**]
f. [**Greenheck Fan Corporation**]
g. [**Hohmann & Barnard, Inc**]
h. [**Industrial Louvers Inc.**]
i. [**Louvers & Dampers, Inc.; Mestek, Inc.**]
j. [**Metal Form Manufacturing LLC; United Enertech Corp.**]

k. [**Nystrom, Inc.**]
l. [**Reliable Products, Inc.**]
m. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
n. [**Safe Air - Dowco**]
o. [**Sunvent Industries; Sylro Sales Corp.**]
p. [**United Enertech Corp.**]

2. Extruded-aluminum louvers and frames, not less than **0.125-inch (3.18-mm)** nominal thickness, assembled by welding; with **18-by-14- (1.4-by-1.8-mm-)** mesh, aluminum insect screening on inside face; incorporating weep holes, continuous drip at sill, and integral waterstop on inside edge of sill; of load-bearing design and construction.
3. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless steel components.
4. Finish: [**Mill**].

B. Cast-Aluminum Wall Vents:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airolite Company, LLC (The)**]
b. [**Greenheck Fan Corporation**]
c. [**Hohmann & Barnard, Inc**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. [**Sunvent Industries; Sylro Sales Corp.**]

2. One-piece, cast-aluminum louvers and frames; with **18-by-14- (1.4-by-1.8-mm-)** mesh, aluminum insect screening on inside face; incorporating integral waterstop on inside edge of sill; of load-bearing design and construction.
3. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless steel components.
4. Finish: Mill.

2.3 FLOOD AND AIR VENTS

A. Stainless Steel Flood and Air Vents: Type 316 stainless steel welded frame and flood door assembly, designed to automatically release under hydrostatic pressure or rising water level.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Smart Vent Products, Inc.**]
b. [**USA Foundation Flood Air Vents**]

2. Ventilation Area: [**0.354 sq. ft. (0.033 sq. m)**][**0.708 sq. ft. (0.658 sq. m)**][**1.417 sq. ft. (1.316 sq. m)**].
3. Flood Coverage: [**200 sq. ft. (18.6 sq. m)**][**400 sq. ft. (37.2 sq. m)**][**800 sq. ft. (74.3 sq. m)**].
4. Finish: [**Mill**].

2.4 MATERIALS

A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B26/B26M, Alloy 319.

D. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

G. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

H. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

I. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

J. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

K. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

L. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.5 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

C. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical

conversion coated with acid chromate-fluoride-phosphate.

D. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than **2-mil (0.05-mm)** dry film thickness.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**].
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Sheet and Plate Finishes:

1. Cold-Rolled, Bright Finish: ASTM A480/A480M, No. 2B.
2. Directional Satin Finish: ASTM A480/A480M, No. 4.

D. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's written instructions.

B. Locate and place vents level, plumb, and at indicated alignment with adjacent work.

C. Attach vents securely in place using fasteners supplied or approved by manufacturer.

D. Protect unpainted surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

E. Build vents into masonry work as construction progresses; comply with requirements in Section 042000 "Unit Masonry."

F. Provide perimeter reveals of uniform width for sealants and joint fillers, where indicated.

G. Use concealed anchorages.

3.2 ADJUSTING AND CLEANING

A. Adjust flood vents for proper operation.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore vents damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as directed by the Owner, remove damaged units and replace with new units.

END OF SECTION 08 95 16 00

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Task	Specification	Specification Description
08 95 16 00	01 22 00 00	No Specification Required
08 95 16 00	05 50 00 00	Metal Fabrications

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SECTION 09 01 20 00 - GYPSUM BOARD RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Submittals

2. Quality Assurance/Control Submittals
   a. Certificates: Manufacturer's written certification that gypsum products meet or exceed specified requirements.

Quality Assurance

3. Regulatory Requirements:
   a. Gypsum Board Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Gypsum Board Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire protective ratings as indicated or scheduled.
   c. Fire-Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Delivery, Storage, And Handling

4. Storage and Protection: Store wallboard off ground to protect it from weather and damage due to moisture damage.
   a. Wallboard: Dry, free of warpage, and have bundling tape intact immediately prior to use.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. During gypsum-panel application and finishing, maintain indoor temperatures within range of 13 degrees C (55 degrees F) to 21 degrees C (70 degrees F). Provide adequate ventilation to carry off excess moisture.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:

a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
   1) Generally, Contract Documents will not define products present in existing construction. Determine products by Inspection and any necessary testing.
   2) Patching, extending, and matching of existing work and systems shall result in a complete, finished system.
b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.

Metals

10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing or as indicated.
       1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission by resilient attachment of gypsum board, 13 mm (1/2 inch) deep.
    e. Sheet-Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Coiling Metals:
    a. Runner Channels: ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
       1) 50 mm (2 Inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
       2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
       3) 19 mm (3/4 Inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Furring Channels: Hat-shaped galvanized-steel furring channels, minimum 0.46 mm (25 gage).
    c. Steel Studs: Galvanized steel as specified above, minimum 0.46 mm (25 gage).
    d. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
       1) Hanger Wire: Minimum 4.1 mm (8 gage).
       2) Tie Wire: 6 mm (16 gage).

Gypsum Board And Related Materials

12. Gypsum Board: GA216 and ASTM C 36
    a. Size: 12.7 mm and 15.9 mm (1/2 inch and 5/8 inch) thick to match existing, as indicated or scheduled. Provide boards 1 200 mm (48 inches) wide by length required to minimize cross joints.
    b. Regular Tapered-edge gypsum panels.
       1) Provide Type X gypsum panels at fire-rated assemblies.
    c. Water-Resistant: ASTM C 630, paintable, tapered-edge gypsum panels.
       1) Provide Type X water-resistant gypsum panels at fire-rated assemblies.
13. Cementitious Backer Units (CBU): ANSI A118.9, nailable/screwable backer board composed of stable Portland cement, aggregates, and reinforcements with ability to remain unaffected by prolonged exposure to moisture, 12.7 mm (112 inch) thick.
14. Fasteners:
    a. Screws: ASTM C 1002, drywall screws, corrosion resistant. Provide types as recommended by manufacturer for each application.
       1) Wallboard to Metal Framing: Minimum 25 mm (1 inch), Type S.
       2) Wall board to Wood Framing: Minimum 32 mm (1-1/4 inch) Type W bugle head.

3) Wall board to Wallboard: Type G.
b. Nails: ASTM C 514.
15. Accessories: GA 216 and ASTM C 1047, galvanized steel.
a. Comer Bead: GA 216 Type CB-114 x 114.
b. Metal Trim (Casing Beads): GA 216 Type L, in depth to match gypsum-board thickness.
c. Control Joint: V-shaped control joint.
d. Adhesive: ASTM C 557 multi-purpose adhesive.
16. Finishing Materials: ASTM C 475.
a. Joint Tape: Provide type as recommended by panel manufacturer.
b. Joint Treatment: Joint compound, adhesive, water, and fasteners.
17. Sound-Isolation Materials:
a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral fiber blankets, 3.7 to 4.9 kg per sq m (3/4 to 1 PCF), thickness as indicated, scheduled, or required by fire-rated assembly.
b. Acoustical Sealant:
1) Concealed: ASTM C 919 nondrying, non-hardening, and non-skinning; non-bleeding; and non-staining.
2) Exposed: ASTM C 919 non-oxidizing and skinning; permanently elastic; and paintable.
c. Ductwork Penetrations Packing: Low-density fiberglass.

EXECUTION

Examination
18. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
a. Existing Conditions: Before beginning installation, examine substrates and framing to receive gypsum board for defects or conditions adversely affecting quality and execution of installation.

Preparation
19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during drywall finishing operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

Laying Out Work
23. Discrepancies: Verity dimensions and elevations indicated in layout of existing work.
a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner or adjustment before work affected is performed.
1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike mariner.
c. Contractor: Responsible for location and elevation of construction indicated by Construction Documents.

Performance

24. Patching: Patch and extend existing work using skilled mechanics capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
25. Damaged Surfaces: Comply with Detailed Scope of Work.
26. Transitions from Existing to New Work: Comply with Detailed Scope of Work.

Erection Of Drywall Stud Partitions

27. Reference Standard: Erect steel framing in accordance with ASTM C 754.
28. Layouts: Align partition studs accurately according to partition layout.
29. Anchoring: Anchor runner channels to concrete slabs with concrete stub nails or power-driven anchors at 600 mm (24 inches) OC. Anchor runner channels to coiling grid, where applicable, with stove bolts. Where studs extend above ceiling system, install headers where required to receive runners.
30. Studs: Position studs vertically in runners. Where studs are located adjacent to openings or partition intersections and comers. anchor studs to runners with manufacturer's metal lock fastener or with 13 mm (1/2 inch) Type S pan-head screws.
    a. Space studs at 400 mm (16 Inches) and 600 mm (24 inches) OC as indicated or scheduled.
        1) Cementitious Backer Units (CBU): Space studs at maximum of 400 mm (16 inches) OC.
        2) Limiting Heights: Comply with ASTM C 754 for transverse load of 240 Pa (5 lb-force/SF) without exceeding either allowable stress or deflection of L/240. Comers and Intersections: Locate studs no more than 50 mm (2 inches) from abutting partitions, comers, etc.
    b. Openings: Locate studs not more than 50 mm (2 inches) from opening frames. Anchor studs to frame anchor clips by bolt or screw attachment. Install headers over openings as recommended by the manufacturer.
        1) Solid-Core Wood Doors and Hollow Metal Doors: Provide two full-height studs at jambs fastened together back to back.
        2) Fire-Rated Openings: Comply with GA 219.
31. Bracing: Provide diagonal bracing at head of studs that terminate above the ceiling level. Bracing shall consist of metal studs bent to V-shape and extending at 45 degrees from partition head to structure above. Locate bracing 1 200 mm (48 inches) maximum OC.
32. Wood Blocking or Metal Reinforcement:
    a. Wood Blocking: See Division 6 Section "Rough Carpentry."
    b. Install metal reinforcement of size required for support of toilet and bath accessories, hardware, cabinets, shelving, counters, and other wall-mounted items.
    c. Set true to line, level, or plumb well-secured in stud wall and flush with back of drywall or other wall finish.
    d. Coordinate exact locations with other sections.

Miscellaneous Framing And Furring

33. General: Provide necessary framing and furring for special framing at recesses, offsets, specialty Items, and at wall-mounted casework, shelving, and equipment.
34. Furring Channels: Install furring channels over back-up material. Position channels vertically at 600 mm (24 inches) OC. Use power-activated fasteners or stub nails at 600 mm (24 Inches) OC along alternating flanges. Shim channels level as required.
    a. Cementitious Backer Units (CBU): Space furring at maximum of 400 mm (16 inches) OC.

35. Resilient Furring Channels: Screw-attach In accordance with manufacturer’s recommendations.
    a. Spacing: 600 mm (24 inches) OC for framing at 16 inches OC and 400 mm (16 inches) OC for framing at 24 Inches OC.

Ceiling Grillage Erection

36. Reference Standard: Erect steel framing In accordance with ASTM C 754.
37. Hangers: Install wire hangers spaced not over 1 200 mm (48 inches) OC in direction of 38 mm (1-1/2 inch) main runner channels and within 150 mm (6 inches) of ends of main runners or interruptions of ceiling continuity. Hang from structure above.
38. Runners: Place main runners not over 1 200 mm (48 inches) OC. Provide, position, and level hangers with hangers saddle-tied along runners. Space furring channels at 600 mm (24 inches) OC at right angles to runner channels and secure with furring channel clips.
39. Reinforcement: At light troffers or other openings, reinforce grillage with 19 mm (314 inch) cold-rolled channels wired atop and parallel to main runner channels.
    a. Provide lateral seismic bracing as required by code.
40. Special Shapes: Provide necessary framing and suspension for off sets, verticals, etc.

Insulation

41. Sound Insulation: Place sound Insulation blankets in partitions tight within spaces, around cut openings. behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
    a. Ductwork Penetrations: Provide one-inch wide clearance around ductwork and pack with fiberglass ready for joint sealers.

Installation Of Gypsum Drywall

42. Reference Standards: Apply and finish gypsum board in accordance with GA 216 and ASTM C 840.
43. Partition Gypsum Board Layout: Apply gypsum wallboard panels vertically with abutting ends and edges occurring over stud flanges or furring.
    a. Joints on Opposite Sides of Partitions: Stagger; joints shall not occur over same stud.
    b. Two Layer Construction: Stagger Joints between layers.
44. Ceiling Gypsum Board: Apply gypsum board of maximum practical length with long dimensions at right angles to furring channels. End and edge joints shall occur over furring channels with end joints staggered. Properly support gypsum board around cutouts and openings.
45. Fasteners: Apply board to studs or furring with drywall screws spaced 300 mm (12 inches) OC in field of board and 200 mm (8 inches) OC staggered along abutting edges.
46. Water-Resistant: Apply gypsum wallboard manufacturer's recommended sealant to raw cut edges and screw heads.
47. Cementitious Backer Units (CBU): Install in accordance with ANSI A108.11 and manufacturer's recommendations.
48. Accessories:
    a. Comer Bead: Apply as recommended by manufacturer at exposed outer corners.
    b. Trim (Casing Beads): Apply as recomrnended by manufacturer, where gypsum board abuts other materials, and as indicated.
    c. Control Joints: Comply with GA 216.
        1) Walls: Install at not more than 9 m (30 feet) OC.
        2) Ceilings: Install at not more than 15 m (50 feet) OC and where framing changes direction.
        3) Coordinate locations with the Owner.
49. Access Panels: Securely install access panels furnished under other sections. Set plumb and square to align with finish surface.

50. Acoustical Sealant: Seal perimeter and penetrations on both sides of sound-rated partitions and partitions with sound-attenuation blankets with minimum of single 6 mm (1/4 inch) bead of sealant
    a. Locations:
        1) Seal around gypsum-board perimeter in angle formed by gypsum-board panels and abutting dissimilar materials.
        2) Seal intersections of gypsum board with dissimilar materials.
        3) Seal pipe. conduit, ductwork, penetrations, etc.
        4) Seal around cutouts for lights, cabinets, pipes, ductwork, electrical boxes, etc.
        5) Seal gypsum board panel terminations in door and window frames.
        6) Seal control-joint locations before installing control Joints to panels.
    b. Installation: Comply with ASTM C 919 and requirements of indicated sound-rated assembly. Provide number and positions of beads to comply with sound rating of assembly.
51. Tolerances: Gypsum-board surface plane within plus or minus 3 mm in 3 000 mm (1/8 inch in 10 feet).
52. Finishing: Finish in accordance with GA 214.
    a. Concealed Locations (Not Exposed to View in Rooms): Level 1
    b. Beneath Tile: Level 2.
    c. Other Finished Areas: Level 4. Finish joints, trim, and fastener dimples. Sand smooth.
    d. Cementitious Backer Units (CBU): Treat joints in accordance with ANSI A108.11 and manufacturer's recommendations.

END OF SECTION 09 01 20 00

SECTION 09 01 20 91 - PLASTER RESTORATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for lath and plaster renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Quality Assurance

2. Regulatory Requirements:
   a. Plaster Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Plaster Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire-protective ratings as indicated or scheduled.
   c. Fire Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Submittals

3. Product Data: Submit in accordance with Detailed Scope of Work. Include each type of plaster material, metal lath. and lathing accessories to be installed.

Delivery, Storage, And Handling

4. General:
   a. Plastering Materials: Deliver in original unopened containers and store off ground and under cover.
   b. Metal Lath and Accessories: Protect from rusting during storage.
   c. Rusted or Water Damaged Materials: Subject to rejection before or after installation.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. Cold-Weather Protection: Do not apply plaster if ambient temperature is less than 4 degrees C (40 degrees F) or more than 26 degrees C (80 degrees F). Maintain this temperature range in all areas 7 days prior to application, during application, and for 7 days after plaster is set.
   b. Hot-Weather Protection: Protect plaster against uneven or excessive evaporation during dry, hot weather and from strong blasts of dry air, either natural or artificial.
   c. Ventilation: Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it sets.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.
   a. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:
   a. Provide same products or types of construction as existing structure, as needed to patch, extend, or match existing work.
      1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and any necessary testing, and workmanship by use of existing as sample of comparison.
      2) Patching, extending, and matching of existing work and systems shall result in complete, finished system.
   b. Presence of product, finish, or type of construction, requires that patching, extending, or matching shall be performed as necessary to make work complete and consistent.
10. Partition Metals: ASTM C 645, galvanized steel:
   a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing, or as indicated.
      1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
   b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
   c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
   d. Sheet Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Ceiling Metals:
   a. Main Runners (Primary Members): ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
      1) 50 mm (2 inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
      2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
      3) 19 mm (3/4 inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
   b. Cross Furring (Furring Channels): Hat-shaped galvanized steel furring channels, minimum 0.46 mm (25 gage).
   c. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
      1) Hanger Wire: Minimum 4.1 mm (8 gage).
      2) Tie Wire: 6 mm (16 gage).
12. Lath:
   a. Metal Lath: ASTM C 847, galvanized expanded metal.
      1) Weight: In compliance with ASTM C 841 for conditions and spacing of supports.
   b. Gypsum Lath: ASTM C 37, plain. Provide Type X at fire-rated assemblies.
      1) Thickness: As indicated or specified and in compliance with ASTM C 841 for conditions and spacing of supports.
13. Fasteners:
   a. Screws: ASTM C 1002, corrosion-resistant. Provide types as recommended by manufacturer for each application.
      1) To Metal Framing: Minimum 25 mm (1 inch), Type S.
      2) To Wood Framing: Minimum 32 mm (1-1/4 inch), Type W bugle head.
14. Accessories: ASTM C 841, galvanized steel.
   a. Comer Beads: Small nose with expanded flanges, unless otherwise indicated.
   b. Casing Beads: Square-edged style. with short or expanded flanges to suit kinds of plaster bases indicated.
   c. Control Joints: Prefabricated folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.
      1) Provide removable protective tape on plaster face of control joints.
   d. Cornerite: Galvanized expanded metal lath in accordance with ASTM C 841.
15. Gypsum Plaster Materials: ASTM C 28.
   a. Base Coat Plasters: One of following:
      1) Gypsum ready-mixed plaster with mill-mixed perlite aggregate.
      2) Gypsum wood-fibered plaster, ASTM C 28, Type N.
   b. Finish Coat Plasters: One of following:

1) Gypsum ready-mixed finished plaster, manufacturers standard mill-mixed gauged interior finish.
2) Gypsum Gauging Plaster: ASTM C 28, Type G.

c. Quicklime: ASTM C 5.
d. Sand: ASTM C 35.
e. Finishing Hydrated Limes: ASTM C 206, Type S, special hydrated lime for finishing purposes.
f. Bonding Compound for Gypsum Plaster: ASTM C 631.
g. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or substances that may be deleterious to plaster or metals in contact with plaster.

16. Sound-Isolation Materials:
    a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral-fiber blankets, 12 to 16 kg per cu m (0.75 to 1 PCF), thickness as indicated or scheduled, or required by fire-rated assembly.
    b. Acoustical Sealant:
        1) Concealed: ASTM C 919 nondrying, non-hardening, non-skinning, non-bleeding, and non-staining.
        2) Exposed: ASTM C 919 non-oxidizing and skinning, permanently elastic, and paintable.
    c. Ductwork Penetrations Packing: Low-density fiberglass.
17. Gypsum Plaster Mixes: As recommended by manufacturer:
    a. Scratch Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, neat or with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster, neat or with job-mixed sand.
    b. Brown Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand.
    c. Finish Coat: Proportion materials for finish coats to comply with ASTM C 842 for each type of finish coat and texture indicated.
        1) Gypsum Gauging Plaster 1 part plaster and 2 parts lime.
            a) Over lightweight aggregate base coats, add 15 L (1/2 cubic foot) of perlite fines or 23 kg (50 pounds) of No. 1 white silica sand per 45 kg (100 pounds) of plaster.
        2) Gypsum Ready-mixed Finish Plaster Neat.
    d. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

EXECUTION

Examination

18. Units, Spaces, and Areas to be renovated: Comply with Detailed Scope of Work.
    a. Verify that surfaces to receive rough carpentry are prepared to required grades and dimensions.

Preparation

19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
    a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during plastering operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

23. Surface Preparation: Clean projections, dust, loose particles, grease, bond breakers, and foreign matter from surfaces to receive plaster.
    a. Do not apply plaster directly to surfaces (1) of masonry or concrete that have been coated with bituminous compound or other waterproofing agents, or (2) that have been painted or previously plastered.
    b. Before plaster work is started, wet masonry and concrete surfaces thoroughly with fine fog spray of clean water to produce uniformly moist surface.
    c. Do not apply plaster to surfaces containing frost.

Laying-Out Work

24. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
    a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
    b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
        1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
25. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

Performance

26. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
27. Damaged Surfaces: Comply with Detailed Scope of Work.
28. Transitions from Existing to New Work: Comply with Detailed Scope of Work.
29. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

30. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
31. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
32. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers In accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
33. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

34. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
35. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
36. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

37. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer’s recommendations.
38. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
39. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.
40. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

41. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer’s recommendations and Reference Standards.
42. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
43. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers in accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
44. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

45. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
46. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
47. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

48. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.
49. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
50. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.

Lathing

51. Metal Lathing: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. At Metal Framing: Attach metal lath to furring channels with long dimension of sheet at right angles to furring channels with gage wire ties spaced not over 150 mm (6 inches) apart.
    b. At Wood Framing: Nail metal lath to wood framing with long dimension of sheet at right angles to framing member.
    c. Place ties where sides of sheets laps at supports and at side laps of sheets between supports. Lap metal lath not less than 13 mm (112 inch) at sides of sheets and 25 mm (1 inch) at ends of sheets.
    d. Suspended and Furred Ceilings: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
    e. Ceramic Tile Setting Beds: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
52. Gypsum Lath: Install in accordance with ASTM C 841.
    a. Wood Framing and Furrlng: Install lath as follows:
        1) With screws to comply with lath manufacturer's directions.
        2) With nails.
        3) Provide floating angle construction.
    b. Suspended and Furred Ceilings: Install lath to furring members with clips.
    c. Vertical Metal Framing and Furring: Install lath as follows:
        1) With screws.
        2) With clips, supplemented by screws where required by lath manufacturer.
        3) Where sound-rated partitions are indicated, attach lath with resilient clips.

Installation Of Accessories

53. Accessories: Install as required to repair area of work to match existing. Install in accordance with ASTM C 841. Miter or cope accessories at comers; Install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories In place and alignment during plastering.
54. Interior Corners: Apply cornerite.
55. Corner Beads: Install corner beads tightly secured to lath at exposed exterior corners.
56. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or metal frames act as casing beads.
57. Control Joints: Install at locations indicated or, if not indicated, at spacings and locations required by Reference Standards. Coordinate specific locations with the Owner.
58. Access Panels: Provide access panels as required for maintenance of concealed plumbing work in coordination with Division 15 Section "Plumbing." Tiled Areas: Coordinate with Division 9 Section "Ceramic Tile."
59. Sound-Rated Plaster Work: Where sound-rated plaster work is indicated by STC ratings or other notation:
    a. Acoustical Sealant: Seal work at perimeters, control joints, openings, and penetrations with continuous bead of acoustical sealant. Comply with ASTM C 919 and plastering manufacturer's recommendations for location of sealant beads.

b. Sound Insulation: Install insulation blankets within stud cavities of sound-rated partition assemblies where incated.

Plastering

60. Plastering: Comply with ASTM C 842 in thickness to match existing.
    a. Preparation: Remove loose, fractured, or separated plaster to face of substrate. repairing lath at substrate to ensure repair area bounded by solid and sound existing plaster construction.
        1) Prepare monolithic surfaces for bonded base coats and use bonding compound to comply with Reference Standards for conditioning of monolithic surfaces.
    b. Grout hollow metal frames, bases, and similar work with base-mat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm (6 inches) at each jamb anchor dip.
    c. Plaster flush with metal frames and other built-in metal items or accessories that act as plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at junctures with metal.
61. Preparation: Check metal grounds, comer beads, screeds, and other accessories carefully for alignment before starting plaster application. Check expansion and control joints and supporting metal structures to ensure that expansion and control joints can move unrestrained.
62. Plaster: Apply In accordance with ASTM C 842 in thickness to match existing:
    a. Use three-coat work over following plaster bases:
        1) Metal lath.
        2) Gypsum lath attached to ceiling supports by clips.
        3) Gypsum lath attached to ceiling supports spaced over 400 mm (16 inches) OC.
        4) Gypsum lath, 9.5 mm (3/8 inch) thick, with separate vapor retarder behind.
    b. Use two-coat work over following bases.
        1) Gypsum lath except for installations requiring three-coat work.
        2) Unit masonry.
        3) Concrete, cast-in-place or precast when surface condition complies with ASTM C 842 for plaster bonded to solid base.
    c. First Coat: Apply first coat of plaster with such force to secure good key.
    d. Finish Coats: Apply troweled finish coats unless otherwise indicated.
63. Workmanship: Perform work true to line, straight, and plumb.
    a. Finished Surfaces: Free from waves, dents, bumps, cracks, pits. checks, streaks, catfaces, blisters, or other defects. Cutout and property replace defective areas.
    b. Execute work to avoid any irregularity occurring at point or place where one section is joined to another.
    c. Arises and Angles: True and sharp.
64. Tolerances: Plaster surface plane within plus/minus 3 mm in 3 000 mm (1/8 inch in 10 feet).

Integrating Existing Work

65. Protection: Comply with Detailed Scope of Work.

Adjustments

66. Partition Removal: Comply with Detailed Scope of Work.

Dust Control

67. Dust: Comply with Detailed Scope of Work.

Patching And Cleaning

68. Cutting and Patching: Do necessary cutting, patching, and repairing and pointing up of plastering after other work is in place to restore defective areas. Repair or replace work to eliminate blisters, buckles, excessive crazing and check-cracking, dry outs, efflorescence, sweat-outs, and similar defects and where bond to substrate has failed.
    a. Sand smooth-troweled finishes lightly to remove trowel marks and arises.

69. Cleaning: As rapidly as plastering is completed in each space, clean up rubbish, utensils, and surplus material, sweep floor and leave in neat condition for work of others.
    a. When general plastering is concluded, remove plastering rubbish, equipment, and surplus materials from premises.
    b. Clean surfaces splattered with plaster.

END OF SECTION 09 01 20 91

Task	Specification	Specification Description
09 01 20 91	09 01 20 00	Gypsum Board Renovation
09 01 30 91	09 30 13 00	Ceramic Tiling
09 01 60 91	01 22 00 00	No Specification Required
09 01 60 91	07 92 00 00	Joint Sealants
09 01 60 91	09 66 13 00	Portland Cement Terrazzo Flooring
09 01 60 91	09 68 13 00	Tile Carpeting
09 01 60 91	09 68 16 00	Sheet Carpeting

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SECTION 09 01 90 52 - MAINTENANCE REPAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparatory cleaning materials.
2. Paint removers.
3. Paint materials.
4. Patching materials.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 040110 "Masonry Cleaning" for cleaning and removing paint from masonry.
3. Section 050170.51 "Decorative Metal Cleaning" for cleaning and removing paint from decorative metal.
4. [**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," Section 099300 "Staining and Transparent Finishing," and Section 099600 "High-Performance Coatings"**][**Section 099114 "Exterior Painting (MPI Standards)," Section 099124 "Interior Painting (MPI Standards)," Section 099301 "Staining and Transparent Finishing (MPI Standards)," and Section 099601 "High-Performance Coatings (MPI Standards)"**] for Paint materials and systems for new construction.
5. Section 099423 "Gilding" for oil gilding.

1.2 DEFINITIONS

A. DSD: Degree of surface deterioration.

B. Gloss Level G1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, in accordance with ASTM D523.

C. Gloss Level G2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

D. Gloss Level G3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

E. Gloss Level G4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.

F. Gloss Level G5: 35 to 70 units at 60 degrees, in accordance with ASTM D523.

G. Gloss Level G6: 70 to 85 units at 60 degrees, in accordance with ASTM D523.

H. Gloss Level G7: More than 85 units at 60 degrees, in accordance with ASTM D523.

I. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**] .

J. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa)**; **4 to 6 gpm (0.25 to 0.4 L/s)**] .

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.4 SEQUENCING

A. Perform maintenance repainting in the following sequence, which includes Work specified in this and other Sections.

1. Dismantle existing surface-mounted objects and hardware except items indicated to remain in place. Tag items with location identification and protect from damage.
2. Verify that temporary protections have been installed.
3. Examine condition of surfaces to be painted.
4. Remove existing paint to the degree required for each substrate and surface condition of existing paint.
5. Apply paint system.
6. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Samples: For each type of paint system and each pattern, color, and gloss; [**in sizes indicated below**][**minimum 6 inches (150 mm) long in least dimension, but not less than whole pattern**] .

1. Include stepped Samples defining each separate coat, including fillers and primers. Resubmit until each required sheen, color, and texture is achieved.
2. For each painted color being matched to a standardized color-coding system, include the color chips from the color-coding-system company with Samples.
3. Include a list of materials for each coat of each Sample.
4. Label each Sample for location and application.
5. Sample Size:

a. Painted Surfaces: [**4-by-8-inch (100-by-200-mm)**] Samples for each color and material, on hardboard.
b. Stained or Natural Wood: [**12-by-12-inch (300-by-300-mm)**] Samples of natural- or stained-wood finish, on representative surfaces.

C. Product List: For each paint product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each MPI-product category specified in paint systems, with the proposed product highlighted.
3. VOC content.

D. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

1.6 INFORMATIONAL SUBMITTALS

A. Color Matching Certificate: For computer-matched colors.

B. Preconstruction Test Reports: For cleaning materials, [**paint removers**][**and**][**paint coatings and systems**] .

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and location on building.

1. Quantity: Furnish the Owner with an additional [**3**][**5**][**7**] percent, but not less than **1 gal. (3.8 L)** or one case, as appropriate, of each material and color applied.

1.8 QUALITY ASSURANCE

A. Color Matching: Custom computer-match paint colors [**as indicated in a color schedule on Drawings**] .

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing of cleaning materials, [**paint removers**][**and**][**compatibility of paint coatings and systems**] for each [**indicated**] type of painted surface.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste daily.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with maintenance repainting only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are

between **50 and 95 deg F (10 and 35 deg C)**.

C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent that contains no ammonia, **5 quarts (5 L)** of 5 percent sodium hypochlorite bleach, and **15 quarts (15 L)** of warm water for every **5 gal. (20 L)** of solution required.

D. Mildewcide: Commercial proprietary mildewcide or a job-mixed solution prepared by mixing **1/3 cup (80 mL)** of household detergent that contains no ammonia, **1 quart (1 L)** of 5 percent sodium hypochlorite bleach, and **3 quarts (3 L)** of warm water.

E. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.3 PAINT REMOVERS

A. Paint Removers, General: Manufacturer's standard formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**Dumond Chemicals, Inc**]
e. [**EaCo Chem, Inc.**]

f. [**PROSOCO, Inc**]
g. [**Shore Corporation**]

B. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation; containing no methylene chloride.

C. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation; containing no methylene chloride.

D. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation.

E. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation; containing no methanol or methylene chloride.

F. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation; containing no methanol or methylene chloride.

2.4 PAINT MATERIALS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**] , as directed by the Owner.

C. MPI Standards: Provide products complying with MPI standards indicated in applicable maintenance repainting schedule articles and listed in the "MPI Approved Products List."

D. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

E. VOC Content: For field applications [**that are inside the weatherproofing system**] , verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Clear Wood Finishes, Varnishes: 275 g/L.
9. Clear Wood Finishes, Lacquers: 275 g/L.
10. Floor Coatings: 50 g/L.
11. Shellacs, Clear: 730 g/L.
12. Shellacs, Pigmented: 550 g/L.
13. Stains: 100 g/L.

F. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with one of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Nonflat - High-Gloss Coatings: 150 g/L.
   d. Concrete/Masonry Sealers: 100 g/L.
   e. Dry-Fog Coatings: 150 g/L.
   f. Floor Coatings: 100 g/L.
   g. Industrial Maintenance Coatings: 250 g/L.
   h. Low-Solids Coatings: 120 g/L.
   i. Mastic Texture Coatings: 100 g/L.
   j. Metallic Pigmented Coatings: 500 g/L.
   k. Pretreatment Wash Primers: 420 g/L.
   l. Primers, Sealers, and Undercoaters: 100 g/L.
   m. Reactive Penetrating Sealers: 350 g/L.
   n. Recycled Coatings: 250 g/L.
   o. Rust-Preventive Coatings: 250 g/L.

H. VOC Content: For field applications inside the building, verify wall paints comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Interior Flat Latex Wall Paint: 50 g/L.
2. Interior Nonflat Latex Wall Paint: 150 g/L.

I. VOC Emissions: For field applications inside the building, verify wall paints contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.5 PAINT MATERIALS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Benjamin Moore & Co.**]
2. [**Coronado Paint; Benjamin Moore & Co.**]
3. [**Insl-X Products; Benjamin Moore & Co.**]
4. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
5. [**Rodda Paint Co.**]

6. [**Rust-Oleum Corporation**]
7. [**Sherwin-Williams Company (The)**]
8. [**The Pittsburgh Paints Company**]
9. [**Valspar; a brand of The Sherwin-Williams Company**]

2.6 PATCHING MATERIALS

A. Patching Compound, General: Formulation specifically manufactured for repairs in damaged substrate materials as specified within tooling time required for the detail of work and site conditions; designed for filling voids that have deteriorated from weathering and decay, capable of filling deep holes, and spreading to feather edge.

B. Metal-Patching Compound: Two-part, polyester-resin, metal-patching compound; knife-grade formulation.

C. Cementitious Patching Compound: Repair materials specifically formulated and manufactured for filling type of cementitious substrates and for sanding or tooling prior to repainting; as recommended in writing by compound manufacturer for exposure to weather and traffic.

D. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Abatron, Inc**]
   b. [**Advanced Repair Technology, Inc.**]
   c. [**ConServ Epoxy LLC**]
   d. [**Gougeon Brothers, Inc.**]
   e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
   f. [**Protective Coating Company**]
   g. [**System Three Resins, Inc.**]

E. Gypsum-Plaster Patching Compound: Finish coat plaster and bonding compound in accordance with ASTM C842.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING SURFACES

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless the solutions will not damage adjacent surfaces. Use protective materials that are UV resistant and waterproof. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
3. Neutralize and collect alkaline and acid wastes before disposal.

4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 MAINTENANCE REPAINTING, GENERAL

A. Maintenance Repainting Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from building interior at [**5 ft. (1.5 m)**][**10 ft. (3 m)**] away from painted surface and from building exterior at [**20 ft. (6 m)**][**50 ft. (15 m)**] away from painted surface, as directed by the Owner.

B. Execution of the Work: In repainting surfaces, disturb them as minimally as possible and as follows:

1. Remove failed coatings and corrosion and repaint.
2. Verify that substrate surface conditions are suitable for repainting.
3. Allow other trades to repair items in place before repainting.

C. Mechanical Abrasion: Where mechanical abrasion is needed for the Work, use gentle methods, such as scraping and lightly hand sanding, that will not abrade softer substrates, reducing clarity of detail.

D. Heat Processes: Do not use torches, heat guns, or heat plates.

3.3 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for maximum moisture content and other conditions affecting performance of painting work. Comply with paint manufacturer's written instructions for inspection.

B. Maximum Moisture Content of Substrates: Do not begin application of coatings unless moisture content of exposed surface is below the maximum value recommended in writing by paint manufacturer and not greater than the following maximum values when measured with an electronic moisture meter appropriate to the substrate material:

1. Concrete: 12 percent.
2. Gypsum Board: 12 percent.
3. Gypsum Plaster: 12 percent.
4. Masonry (Clay and CMU): 12 percent.
5. Portland Cement Plaster (Stucco): 12 percent.
6. Wood: 15 percent.

C. Alkalinity: Do not begin application of coatings unless surface alkalinity is within range recommended in writing by paint manufacturer. Conduct alkali testing with litmus paper on exposed plaster, cementitious, and masonry surfaces.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

1. If existing surfaces cannot be prepared to an acceptable condition for proper finishing by using specified surface-preparation methods, notify Architect in writing, as directed by the Owner.

E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Application of coating indicates acceptance of surfaces and conditions.

3.4 APPLICATION OF PREPARATORY CLEANING MATERIALS

A. General: Use the gentlest, appropriate method necessary to clean surfaces in preparation for painting. Clean all surfaces, corners, contours, and interstices.

B. Detergent Cleaning: Wash surfaces by hand using clean rags, sponges, and bristle brushes. Scrub surface with detergent solution and bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet. Rinse with water applied by clean rags or sponges.

C. Solvent Cleaning: Use solvent cleaning to remove oil, grease, smoke, tar, and asphalt from painted or unpainted surfaces before other preparation work. Wipe surfaces with solvent using clean rags and sponges. If necessary, spot-solvent cleaning may be employed just prior to commencement of paint application, provided enough time is allowed for complete evaporation. Use clean solvent and clean rags for the final wash to ensure that all foreign materials have been removed. Do not use solvents, including primer thinner and turpentine, that leave residue.

D. Mildew Removal: Clean off existing mildew by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. Rinse with water applied by clean rags or sponges.

E. Chemical Rust Removal:

1. Remove loose rust scale with specified abrasives for ferrous-metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

F. Mechanical Rust Removal:

1. Remove rust with specified abrasives for ferrous-metal cleaning. Clean to bright metal.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.5 APPLICATION OF PAINT REMOVERS

A. General: Remove paint where indicated on Drawings. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.

1. Application: Apply paint removers in accordance with paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than recommended in writing by manufacturer.

a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
b. After work is complete, remove protection no longer required. Remove tape and adhesive

marks.

2. Brushes: Use brushes that are resistant to chemicals being used.

   a. Metal Substrates: If using wire brushes on metal, use brushes of same metal composition as metal being treated.
   b. Wood Substrates: Do not use wire brushes.

3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gauges.
   b. Unless otherwise indicated, hold spray nozzle at least **6 inches (150 mm)** from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
   c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with nozzle having a cone-shaped spray.
   d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
   e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

B. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, wire brushes, sandpaper, and metallic wool as appropriate for the substrate material.

C. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

D. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
8. For spots of remaining paint, apply alkaline paste paint remover in accordance with "Paint Removal with Alkaline Paste Paint Remover" Paragraph.

E. Paint Removal with Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paintbrush. Apply in one or two coats in accordance with manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

F. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

3.6 SUBSTRATE REPAIR

A. General: Repair substrate surface defects that are inconsistent with the surface appearance of adjacent materials and finishes.

B. Metal Substrates:

1. Preparation: Treat repair locations by wire-brushing and solvent cleaning. Use [chemical][mechanical] rust removal method to clean off rust.
2. Defects in Metal Surfaces: Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than [**1/16 inch (6 mm)**][**1/8 inch (3 mm)**] deep or [**1/2 inch (13 mm)**][**1 inch (25 mm)**] across and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners.
3. Priming: Prime iron and steel surfaces immediately after repair to prevent flash rusting. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats to surfaces that are inaccessible after completion of the Work.

C. Cementitious Material Substrates:

1. General: Repair defects including dents and chips more than [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**] in size and all holes and cracks by filling with cementitious patching compound and sanding smooth. Remove protruding fasteners.
2. New and Bare Portland Cement Plaster (Stucco): Neutralize surface of plaster with mild acid solution as recommended in writing by paint manufacturer. In lieu of acid neutralization, follow manufacturer's written instruction for primer or transition coat over alkaline plaster surfaces.

3. Existing Concrete, Cement Plaster, and Other Cementitious Substrates: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. If surfaces are too alkaline to paint, correct this condition before painting.

D. Wood Substrates:

1. Repair wood defects including dents and gouges more than [1/8 inch (3 mm)][1/4 inch (6 mm)] in size and all holes and cracks by filling with wood-patching compound and sanding smooth. Reset or remove protruding fasteners.
2. Where existing paint is allowed to remain, sand irregular buildup of paint, runs, and sags to achieve a uniformly smooth surface.

E. Gypsum-Plaster and Gypsum-Board Substrates:

1. Repair defects including dents and chips more than [1/8 inch (3 mm)][1/4 inch (6 mm)] in size and all holes and cracks by filling with gypsum-plaster patching compound and sanding smooth. Remove protruding fasteners.
2. Rout out surface cracks to remove loose, unsound material; fill with patching compound and sand smooth.

3.7 APPLICATION OF PAINT MATERIALS, GENERAL

A. Comply with manufacturers' written instructions for application methods unless otherwise indicated in this Section.

B. Prepare surfaces to be painted in accordance with the Surface-Preparation Schedule and with manufacturer's written instructions for each substrate condition.

C. Apply a transition coat over incompatible existing coatings.

D. Metal Substrates: Stripe paint corners, crevices, bolts, welds, and sharp edges before applying full coat. Apply two coats to surfaces that are inaccessible after completion of the Work. Tint stripe coat different than the main coating and apply with brush.

E. Blending Painted Surfaces: When painting new substrates patched into existing surfaces or touching up missing or damaged finishes, apply coating system specified for the specific substrate. Apply final finish coat over entire surface from edge to edge and corner to corner.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage paint-remover manufacturer's factory-authorized service representative for consultation and Project-site inspection and to provide on-site assistance when requested by Architect, as directed by the Owner.

B. Paint Material Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for composition and dry film thickness.

1. Paint Composition: The following procedure may be performed at any time and as often as the Owner deems necessary during the period when paints are being applied:

a. Testing agency will sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

b. Testing agency will perform tests for compliance of paint materials with product requirements.
c. If test results show materials being used do not comply with product requirements, Contractor will remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2. Dry Film Thickness:

a. Contractor will touch up and restore painted surfaces damaged by testing.
b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor will pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.9 CLEANING

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.10 PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.11 SURFACE-PREPARATION SCHEDULE

A. General: Before painting, prepare surfaces [**where indicated on Drawings**] for painting in accordance with applicable requirements specified in this schedule.

1. Examine surfaces to evaluate each surface condition in accordance with paragraphs below.
2. Where existing degree of soiling prevents examination, preclean surface and allow it to dry before making an evaluation.
3. Repair substrate defects in accordance with "Substrate Repair" Article.

B. Surface Preparation for Sound Surfaces: [**MPI DSD 0**] .

1. Surface Condition: Existing paint film in good condition and tightly adhered.
2. Paint Removal: Not required.
3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Roughen or degloss cleaned surfaces to ensure paint adhesion in accordance with paint manufacturer's written instructions.

C. Surface Preparation for Slightly Deteriorated Surfaces: [**MPI DSD 1**] .

1. Surface Condition: Paint film cracked or broken but adhered. Surface may include visual (aesthetic) defects that do not affect film's protective properties.
2. Paint Removal: Scrape by hand-tool cleaning methods to remove loose paint until only tightly adhered paint remains.
3. Preparation for Painting: Wash surface by detergent cleaning; use other cleaning methods for small areas of bare substrate if required. Roughen, degloss, and sand the cleaned surfaces to ensure paint adhesion and a smooth finish in accordance with paint manufacturer's written instructions.

D. Surface Preparation for Moderately Deteriorated Surfaces: [**MPI DSD 2**] .

1. Surface Condition: Paint film loose, flaking, or peeling. Surface may show fading such as gloss reduction, slight surface contamination, minor pin holes, scratches, or minor cosmetic defects such as runs or sags.
2. Paint Removal: Remove loose, flaking, or peeling paint film by hand-tool or chemical paint-removal methods.
3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Use other cleaning methods for small areas of bare substrate if required. Sand surfaces to smooth remaining paint film edges. Prepare bare cleaned surface to be painted in accordance with paint manufacturer's written instructions for substrate construction materials.

E. Surface Preparation for Severely Deteriorated Surfaces: [**MPI DSD 3**] .

1. Surface Condition: Paint film [**severely deteriorated**][**obscuring fine architectural detail work because of paint-layer buildup**][**and**][**surface indicated to have paint completely removed**] .
2. Paint Removal: Completely remove paint film by hand-tool or chemical paint-removal methods. Remove rust.
3. Preparation for Painting: Prepare bare cleaned surface in accordance with paint manufacturer's written instructions for substrate construction materials.

F. Surface Preparation for Damaged Substrate Surfaces: [**MPI DSD 4**] .

1. Surface Condition: Missing material, small holes and openings, and damaged or corroded substrate.
2. Substrate Preparation: Repair, replace, and treat substrate in accordance with "Substrate Repair" Article [**and requirements in other Specification Sections**] .
3. Preparation for Painting: Sand substrate surfaces to smooth remaining paint film edges and prepare in accordance with paint manufacturer's written instructions for substrate construction materials. Remove rust.
4. Painting: Paint as required for [**MPI DSD 2**] degree of surface degradation.

3.12 EXTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates:

1. Alkyd System: [**MPI REX 5.1D**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, metal, surface tolerant [MPI #23].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, metal, surface tolerant [MPI #23].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior (Gloss Level G5) [MPI #94] .
2) Alkyd, exterior (Gloss Level G6) [MPI #9] .

2. High-Performance, Pigmented-Polyurethane-over-Epoxy System: [**MPI REX 5.1H**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, epoxy, anti-corrosive, for metal [MPI #101].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, epoxy, anti-corrosive, for metal [MPI #101].

b. Intermediate Coat in Primed Areas: Epoxy, high build [MPI #108] .
c. Topcoat: Polyurethane, two-component, pigmented, Gloss Level G6 [MPI #72] .
d. Second Topcoat: Match topcoat.

B. Dimension Lumber Substrates:

1. Applications: Columns, beams, soffits, siding, and fencing.
2. Latex System: [**MPI REX 6.2A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for exterior wood [MPI #6].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for exterior wood [MPI #6].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, exterior, Gloss Levels G1-G2 [MPI #10] .
2) Latex, exterior, Gloss Levels G3-G4 [MPI #15] .
3) Latex, exterior, Gloss Level G5 [MPI #11] .
4) Latex, exterior, Gloss Level G6 [MPI #119] .

3. Alkyd System: [**MPI REX 6.2C**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior, Gloss Level G1 [MPI #8] .
2) Alkyd, exterior, Gloss Level G5 [MPI #94] .
3) Alkyd, exterior, Gloss Level G6 [MPI #9] .

C. Dressed Lumber Substrates:

1. Applications: Doors, windows, door and window frames, casings, and smooth fascia.
2. Latex System: [**MPI REX 6.3A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, exterior, Gloss Levels G1-G2 [MPI #10] .
2) Latex, exterior, Gloss Levels G3-G4 [MPI #15] .
3) Latex, exterior, Gloss Level G5 [MPI #11] .
4) Latex, exterior, Gloss Level G6 [MPI #119] .

3. Alkyd System: [**MPI REX 6.3B**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior, Gloss Level G1 [MPI #8] .
2) Alkyd, exterior, Gloss Level G5 [MPI #94] .
3) Alkyd, exterior, Gloss Level G6 [MPI #9] .

4. Varnish System (Clear): [**MPI REX 6.3F**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**] degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**] degree of surface degradation, fully prime coat with topcoat.

b. Intermediate Coat: Matching topcoat.

c. Topcoat:

1) Varnish, with UV inhibitor, exterior, Gloss Level G5 [MPI #30] .
2) Varnish, with UV inhibitor, exterior, Gloss Level G6 [MPI #29] .
3) Varnish, marine spar, exterior, Gloss Level G6 [MPI #28] .

D. Wood Decks and Stairs Substrates:

1. Latex Porch and Floor System over Alkyd Primer: [**MPI REX 6.5A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Floor paint, latex, low gloss [MPI #60] .
2) Floor paint, latex, gloss [MPI #68] .

d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Alkyd Floor Enamel System: [**MPI REX 6.5B**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**] degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**] degree of surface degradation, fully prime coat with topcoat.

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Floor enamel, alkyd, low gloss [MPI #59] .
2) Floor enamel, alkyd, gloss [MPI #27] .

d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

E. Wood Shingles and Shakes:

1. Latex System: [**MPI REX 6.6A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd,

for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, exterior, Gloss Levels G1-G2 [MPI #10] .
2) Latex, exterior, Gloss Levels G3-G4 [MPI #15] .
3) Latex, exterior, Gloss Level G5 [MPI #11] .
4) Latex, exterior, Gloss Level G6 [MPI #119] .

2. Alkyd System: [**MPI REX 6.6B**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, for exterior wood [MPI #5].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [MPI #5].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior, Gloss Level G1 [MPI #8] .
2) Alkyd, exterior, Gloss Level G5 [MPI #94] .
3) Alkyd, exterior, Gloss Level G6 [MPI #9] .

3.13 INTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates:

1. Latex System: [**MPI RIN 5.1N**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, metal, surface tolerant [MPI #23].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, anti-corrosive, for metal [MPI #79].
4) For [MPI DSD 2] degree of surface degradation, spot prime with primer, rust inhibitive, water based [MPI #107].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, metal, surface tolerant [MPI #23].
6) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, anti-corrosive, for metal [MPI #79].
7) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, rust inhibitive, water based [MPI #107].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .

3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .
6) Latex, interior, Gloss Level G6 [MPI #114] .

2. Alkyd System: [**MPI RIN 5.1E**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, metal, surface tolerant [MPI #23].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, alkyd, anti-corrosive, for metal [MPI #79].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, metal, surface tolerant [MPI #23].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, alkyd, anti-corrosive, for metal [MPI #79].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [MPI #49] .
2) Alkyd, interior, Gloss Level G3 [MPI #51] .
3) Alkyd, interior, Gloss Level G5 [MPI #47] .
4) Alkyd, interior, Gloss Level G6 [MPI #48] .

3. High-Performance, Pigmented-Polyurethane-over-Epoxy System: [**MPI RIN 5.1H**] system [**over a transition coat**] .

a. Prime Coat:

1) For [MPI DSD 1] degree of surface degradation, touch up with epoxy, gloss [MPI #77].
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, zinc rich, organic [MPI #18].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, zinc rich, epoxy [MPI #20].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, zinc rich, organic [MPI #18].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, zinc rich, epoxy [MPI #20].

b. Intermediate Coat in Primed Areas: Epoxy, gloss [MPI #77] .
c. Topcoat: Polyurethane, two-component, pigmented, Gloss Level G6 [MPI #72] .
d. Second Topcoat: Matching topcoat.

B. Dimension Lumber Substrates:

1. Applications: Columns, beams, exposed joists, and underside of decking.
2. Latex System over Latex Primer: [**MPI RIN 6.2D**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for

interior wood [MPI #39].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for interior wood [MPI #39].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .
3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .
6) Latex, interior, Gloss Level G6 [MPI #114] .

3. Latex System over Alkyd Primer: [**MPI RIN 6.2A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .
3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .
6) Latex, interior, Gloss Level G6 [MPI #114] .

4. Alkyd System: [**MPI RIN 6.2C**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [MPI #49] .
2) Alkyd, interior, Gloss Level G3 [MPI #51] .
3) Alkyd, interior, Gloss Level G5 [MPI #47] .
4) Alkyd, interior, Gloss Level G6 [MPI #48] .

C. Wood Dressed Lumber Substrates:

1. Applications: Doors, windows, door and window frames, and moldings.

2. Latex System over Latex Primer: [**MPI RIN 6.3U**] system [**over a transition coat**] .

   a. Prime Coat:

      1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
      2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for interior wood [MPI #39].
      3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for interior wood [MPI #39].

   b. Intermediate Coat: Matching topcoat.
   c. Topcoat:

      1) Latex, interior, Gloss Level G5 [MPI #54] .
      2) Latex, interior, Gloss Level G6 [MPI #114] .

3. Low-Odor Latex System over Latex Primer: [**MPI RIN 6.3V**] system [**over a transition coat**] .

   a. Prime Coat:

      1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
      2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for interior wood [MPI #39].
      3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for interior wood [MPI #39].

   b. Intermediate Coat: Matching topcoat.
   c. Topcoat:

      1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [MPI #143] .
      2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [MPI #144] .
      3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [MPI #145] .
      4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [MPI #146] .
      5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [MPI #147] .
      6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [MPI #148] .

4. Latex System over Alkyd Primer: [**MPI RIN 6.3A**] system [**over a transition coat**] .

   a. Prime Coat:

      1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
      2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
      3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

   b. Intermediate Coat: Matching topcoat.
   c. Topcoat:

      1) Latex, interior, Gloss Level G5 [MPI #54] .
      2) Latex, interior, Gloss Level G6 [MPI #114] .

5. Alkyd System: [**MPI RIN 6.3B**] system [**over a transition coat**] .

   a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G5 [MPI #47] .
2) Alkyd, interior, Gloss Level G6 [MPI #48] .

6. Alkyd Varnish System (Clear): [**MPI RIN 6.3J**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with shellac [MPI #88].
3) For [MPI DSD 2] degree of surface degradation, spot prime with alkyd, sanding sealer, clear [MPI #102].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with shellac [MPI #88].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with alkyd, sanding sealer, clear [MPI #102].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Varnish, interior, Gloss Level G1 [MPI #73] .
2) Varnish, interior, Gloss Level G5 [MPI #74] .
3) Varnish, interior, Gloss Level G6 [MPI #75] .

D. Wood Paneling, Casework, and Millwork:

1. Latex System over Latex Primer: [**MPI RIN 6.4T**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for interior wood [MPI #39].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for interior wood [MPI #39].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G5 [MPI #54] .
2) Latex, interior, Gloss Level G6 [MPI #114] .

2. Low-Odor Latex System over Latex Primer: [**MPI RIN 6.4D**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer, latex, for interior wood [MPI #39].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, latex, for interior wood [MPI #39].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [MPI #143] .
2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [MPI #144] .
3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [MPI #145] .
4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [MPI #146] .
5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [MPI #147] .
6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [MPI #148] .

3. Latex System over Alkyd Primer: [**MPI RIN 6.4A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .
3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .
6) Latex, interior, Gloss Level G6 [MPI #114] .

4. Alkyd System: [**MPI RIN 6.4C**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with undercoat, enamel, interior [MPI #46].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with undercoat, enamel, interior [MPI #46].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [MPI #49] .
2) Alkyd, interior, Gloss Level G3 [MPI #51] .
3) Alkyd, interior, Gloss Level G5 [MPI #47] .
4) Alkyd, interior, Gloss Level G6 [MPI #48] .

5. Alkyd Varnish System over Stain: [**MPI RIN 6.4F**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with stain, semi-transparent, for interior wood [MPI #90].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with stain, semi-transparent, for interior wood [MPI #90].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Varnish, interior, Gloss Level G1 [MPI #73] .
2) Varnish, interior, Gloss Level G5 [MPI #74] .
3) Varnish, interior, Gloss Level G6 [MPI #75] .

d. Stain Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**] , as directed by the Owner.

E. Wood Floors and Stairs Substrates:

1. Latex Porch and Floor System over Alkyd Primer: [**MPI RIN 6.5J**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer sealer, alkyd, interior [MPI #45].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer sealer, alkyd, interior [MPI #45].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Floor paint, latex, low gloss [MPI #60] .
2) Floor paint, latex, gloss [MPI #68] .

d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Alkyd Floor Enamel System: [**MPI RIN 6.5A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**] degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**] degree of surface degradation, fully prime coat with topcoat.

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Floor paint, alkyd, low gloss [MPI #59] .
2) Floor enamel, alkyd, gloss [MPI #27] .

d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

3. Polyurethane Varnish System (Clear): [**MPI RIN 6.5C**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**] degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**] degree of surface degradation, fully prime coat with topcoat.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, gloss [MPI #56] .

4. Two-Component Aliphatic Polyurethane System (Clear): [**MPI RIN 6.5G**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**] degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**] degree of surface degradation, fully prime coat with topcoat.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two-component [MPI #78] .

5. Moisture-Cured Polyurethane System (over Stain): [**MPI RIN 6.5L**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with stain, semi-transparent, for interior wood [MPI #90].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat with stain, semi-transparent, for interior wood [MPI #90].

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, Gloss Level G6 [MPI #31] .
d. Stain Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**] , as directed by the Owner.

F. Plaster Substrates:

1. Latex System over Waterborne Primer: [**MPI RIN 9.2A**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer sealer, latex, interior [MPI #50].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, stain blocking, water based [MPI #137].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer sealer, latex, interior [MPI #50].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, stain blocking, water based [MPI #137].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .
3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .
6) Latex, interior, Gloss Level G6 [MPI #114] .

2. Low-Odor Latex System over Waterborne Primer: [**MPI RIN 9.2M**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer sealer, latex, interior [MPI #50].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, stain blocking, water based [MPI #137].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer sealer, latex, interior [MPI #50].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, stain blocking, water based [MPI #137].

b. Topcoat:

1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [MPI #143] .
2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [MPI #144] .
3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [MPI #145] .
4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [MPI #146] .
5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [MPI #147] .
6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [MPI #148] .

3. Latex System over Alkyd Primer: [**MPI RIN 9.2K**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer sealer, alkyd, interior [MPI #45].
3) For [MPI DSD 3] degree of surface degradation, fully prime coat primer sealer, alkyd, interior [MPI #45].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [MPI #53] .
2) Latex, interior, Gloss Level G2 [MPI #44] .
3) Latex, interior, Gloss Level G3 [MPI #52] .
4) Latex, interior, Gloss Level G4 [MPI #43] .
5) Latex, interior, Gloss Level G5 [MPI #54] .

4. Alkyd System: [**MPI RIN 9.2C**] system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**] degree of surface degradation, touch up with topcoat.
2) For [MPI DSD 2] degree of surface degradation, spot prime with primer sealer, latex, interior [MPI #50].
3) For [MPI DSD 2] degree of surface degradation, spot prime with primer, stain blocking, water based [MPI #137].
4) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer sealer, latex, interior [MPI #50].
5) For [MPI DSD 3] degree of surface degradation, fully prime coat with primer, stain blocking, water based [MPI #137].

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [MPI #49] .
2) Alkyd, interior, Gloss Level G3 [MPI #51] .
3) Alkyd, interior, Gloss Level G5 [MPI #47] .
4) Alkyd, interior, Gloss Level G6 [MPI #48] .

END OF SECTION 09 01 90 52

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Task	Specification	Specification Description
09 01 90 52	03 01 30 00	Maintenance of Cast-in-Place Concrete

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SECTION 09 05 61 13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. MVE-control system - fluid applied.
2. MVE-control system - sheet membranes.

1.2 DEFINITIONS

A. MVE: Moisture vapor emission per ASTM F710, a term used by the flooring industry in the United States to measure moisture emission from concrete floors in pounds per 1000 sq. ft. during a 24-hour period (56.51 µg/(s m2) using the anhydrous calcium chloride test.

B. MVER: Moisture vapor emission rate per ASTM F1869, a term used to indicate the amount of water vapor in pounds emitted from a 1000 sq. ft. area of concrete flooring during a 24-hour period.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each MVE-control system, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

B. Preinstallation testing reports.

C. Field quality control reports.

D. Qualification Statements: For [**Installer**][**manufacturer**].

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

B. Installer Qualifications: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.

1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than **65 deg F (18 deg C)** and not more than **85 deg F (29.4 deg C)** at least 48 hours before use.
2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than **65 deg F (18 deg C)** or more than **85 deg F (29.4 deg C)** and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
3. Install MVE-control systems where concrete surface temperatures will remain a minimum of **5 deg F (3 deg C)** higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.9 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace the floor covering materials or floor coatings and the applied moisture vapor emission control system, that fails in materials and or workmanship within specified warranty period.

1. Warranty Period: [**5**][**10**][**20**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:

1. MVER: Maximum [**15 lb of water/1000 sq. ft.**

(6.80 kg of water/92.9 sq. m)][25 lb of water/1000 sq. ft. (11.34 kg of water/92.9 sq. m)][30 lb of water/1000 sq. ft. (13.61 kg of water/92.9 sq. m)] when tested in accordance with ASTM F1869.

2. Relative Humidity: Maximum [**100**][**90**] percent when tested in accordance with ASTM F2170 using in situ probes.

B. Water-Vapor Transmission: Through MVE-control system, maximum [0.10 perm (5.75 ng/Pa x s x sq. m)][0.02 perm (1.15 ng/Pa x s x sq. m)][0.05 perm (2.86 ng/Pa x s x sq. m)][0.06 perm (3.45 ng/Pa x s x sq. m)] when tested in accordance with ASTM E96/E96M.

C. Tensile Bond Strength: For MVE-control system, greater than [200 psi (1.38 MPa)] with failure in the concrete in accordance with ASTM D7234.

2.2 MVE-CONTROL SYSTEM - FLUID APPLIED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Advanced Moisture Control, Inc.**]
2. [**ARDEX Americas**]
3. [**Custom Building Products**]
4. [**Dependable, LLC**]
5. [**Floor Seal Technology, Inc.**]
6. [**H.B. Fuller Construction Products Inc. / TEC**]
7. [**KOSTER American Corporation**]
8. [**Laticrete International, Inc.**]
9. [**MAPEI Corporation**]
10. [**Maxxon Corporation**]
11. [**Schonox HPS North America, Inc.**]
12. [**Synthetics International**]
13. [**USG Corporation**]
14. [**Uzin Utz North America, Inc.**]

B. MVE-Control System:

1. ASTM F3513 compliant-qualified, fluid-applied, single-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
2. ASTM F3010 compliant-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
3. Water-based epoxy, fluid-applied, [**single**][**two**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
4. Polyurethane resin, fluid-applied, [**single**][**two**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
5. Acrylic-based, fluid-applied, [**two**][**three**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for

installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.

6. Silicate-based, fluid-applied, single-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
7. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 MVE-CONTROL SYSTEM - SHEET MEMBRANES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. MVE-Control System: Sheet membrane, mold and fungal resistance per ASTM D3273, loose laid applied system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.

2.4 ACCESSORIES

A. Patching and Repair Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [**3000 psi (20.68 MPa)**] compressive strength after 28 days when tested in accordance with ASTM C109/C109M.

B. Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [**3000 psi (20.68 MPa)**] compressive strength after 28 days when tested in accordance with ASTM C109/C109M.

C. Crack and Joint Repair Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

D. Substrate Primer: Provide MVE-control system manufacturer's substrate primer if required for system indicated by substrate conditions. Ensure adhesion of products to MVE-control system.

E. Cementitious Underlayment: [**Gypsum**][**Hydraulic**] cement-based underlayment. Provide product as recommended by MVE-control system manufacturer.

F. Seam Tapes: Double-sided tape to adhere to concrete surface and MVE-control sheet membrane surface with seal tape for seams.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Preinstallation Testing:

1. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.
2. Alkalinity Testing: Perform pH testing in accordance with flooring manufacturer's written instructions or, in the absence thereof, in accordance with ASTM F3441. Install MVE-control system in areas where pH readings are outside the acceptable range of the flooring materials to be installed.
3. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE-control system in locations where concrete substrate MVER exceeds flooring manufacturer's published limits.
   b. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity levels that exceed flooring manufacturer's published limits.

4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum [**100-sq. ft. (9.29-sq. m)**] area of MVE-control system to prepared concrete substrate and test in accordance with ASTM D7234.

   a. Proceed with installation only where tensile bond strength is greater than [**200 psi (1.38 MPa)**] with failure in the concrete.

B. Concrete Substrates: Prepare and clean substrates in accordance with MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.

1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Provide concrete surface profile CSP as described within ICRI 310.2R as required by the MVE control system, if any, by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete in accordance with MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and repair material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system

manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION OF MVE-CONTROL SYSTEM - FLUID APPLIED

A. Confirm that Architect approved mockups, as directed by the Owner.

B. Install MVE-control system - fluid applied in accordance with ASTM F3010 or ASTM F3513 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fisheyes, and voids.

1. Install primers as required to comply with manufacturer's written instructions.

C. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.

D. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.

E. Cure MVE-control system components in accordance with manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

F. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies in accordance with manufacturer's written instructions.

G. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.4 INSTALLATION OF MVE-CONTROL SYSTEM - SHEET MEMBRANES

A. Install MVE-control system - sheet membrane in accordance with manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fisheyes, and voids.

1. Install seam tapes required to comply with manufacturer's written instructions.
2. Per floor covering manufacturer's written instructions, finished floor covering requires at least 48 hours of acclimation in order to minimize expansion and contraction after installation. Do not install floor covering until proper acclimation occurs.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform installation inspections.

B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.

1. Verify that surface preparation meets requirements.
2. Verify that component coats and complete MVE-control-system film thicknesses comply with

manufacturer's written instructions.

3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired in accordance with manufacturer's written instructions.

C. MVE-control system will be considered defective if it does not pass inspections.

3.6 PROTECTION

A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 09 05 61 13

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Task	Specification	Specification Description
09 05 71 00	09 30 13 00	Ceramic Tiling
09 22 13 13	09 23 00 00	Gypsum Plastering
09 22 13 23	09 23 00 00	Gypsum Plastering

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SECTION 09 22 16 00 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstructural steel framing.
2. Grid suspension systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing, structural framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of nonstructural steel framing and fastening and anchorage details.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, and attachments to adjoining work.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For code-compliance certification of studs and track.

B. Evaluation Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with Project requirements, for the following:

1. Studs and track.
2. High-strength steel studs and track.
3. Equivalent corrosion-resistant coating on steel framing.
4. Firestop track.

5. Post-installed anchors.
6. Power-actuated anchors.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with product-certification program of [the Steel Framing Industry Association][the Steel Stud Manufacturers Association][the Supreme Steel Framing System Association] .

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Protect materials from corrosion, deformation, and other damage during delivery, storage, and handling in accordance with AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Where indicated on Drawings, provide assemblies incorporating nonstructural steel framing identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: Where indicated on Drawings, provide assemblies incorporating nonstructural steel framing identical to those of assemblies tested in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For [**composite**][**non-composite**] wall assemblies, limited to [**1/240**][**1/360**] of the wall height based on the following horizontal loading:

1. Horizontal Loading: [**As indicated on Drawings**][**5 lbf/sq. ft. (240 Pa)**][**10 lbf/sq. ft. (480 Pa)**] .

2.2 NONSTRUCTURAL STEEL FRAMING

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with requirements in AISI S220 for conditions indicated on Drawings.

1. Protective Coating: ASTM A653/A653M, [**G40 (Z120)**][**G60 (Z180)**] hot-dip galvanized or coating with demonstrated equivalent corrosion resistance. Galvannealed products are unacceptable.

a. Equivalent Corrosion-Resistant Coating: Evaluation report acceptable to authorities having jurisdiction demonstrates corrosion resistance equivalent to specified protective coating.

C. Studs and Track: Conventional members, roll-formed into standard shapes without surface deformations

to stiffen framing members.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CEMCO; California Expanded Metal Products Co.**]
   b. [**ClarkDietrich**]
   c. [**CRACO Mfg., Inc.**]
   d. [**Jaimes Industries, Inc.**]
   e. [**Marino\WARE**]
   f. [**MBA Building Supplies**]
   g. [**MBA Metal Framing**]
   h. [**MRI Steel Framing, LLC**]
   i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
   j. [**Steel Construction Systems; Stone Group of Companies**]
   k. [**Steel Network, Inc. (The)**]
   l. [**TELLING Industries**]
   m. [**UMS Metal Building Systems USA LLC**]
   n. [**US Frame Factory**]

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**As required by performance requirements for horizontal deflection**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**] .
3. Minimum Yield Strength: **33 ksi (230 MPa)**.
4. Depth: [**As indicated on Drawings**][**1-5/8 inches (41 mm)**][**2-1/2 inches (64 mm)**][**3-5/8 inches (92 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**] .

D. High-Strength Steel Studs and Track: Roll-formed into proprietary shapes incorporating ribs, embossment, knurling, or dimensional changes to stiffen framing members.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CEMCO; California Expanded Metal Products Co.**]
   b. [**ClarkDietrich**]
   c. [**CRACO Mfg., Inc.**]
   d. [**Marino\WARE**]
   e. [**MBA Building Supplies**]
   f. [**MBA Metal Framing**]
   g. [**MRI Steel Framing, LLC**]
   h. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
   i. [**Steel Construction Systems; Stone Group of Companies**]
   j. [**TELLING Industries**]
   k. [**The Mill Steel Co**]
   l. [**US Frame Factory**]

2. Minimum Base-Steel Thickness and Yield Strength: [**As indicated on Drawings**][**As required by horizontal deflection performance requirements**][**As required to provide equivalent capacity to conventional stud and track members specified and indicated on Drawings**][**0.0147 inch (0.373 mm) and 50 ksi (345 MPa)**][**0.0179 inch (0.455 mm) and 57 ksi (390 MPa)**] .
3. Depth: [**As indicated on Drawings**][**1-5/8 inches (41 mm)**][**2-1/2 inches (64 mm)**][**3-5/8 inches (92 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**] .

E. Moisture-Barrier Bottom Track: Proprietary roll-formed steel shapes with ledges that lift finish panels **2 inches (51 mm)** above the floor surface to prevent moisture damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**TELLING Industries**]

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**Matching studs**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**] .
3. Minimum Yield Strength: **33 ksi (230 MPa)**.
4. Depth: [**As indicated on Drawings**][**As required to accommodate studs**] .
5. Configuration: [**As indicated on Drawings**] .
6. Fire-Resistance-Rated Assemblies: Comply with requirements of assembly indicated on Drawings.

F. Slip-Type Head Joints: Where indicated on Drawings.

1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to track.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**CEMCO; California Expanded Metal Products Co.**]
      2) [**ClarkDietrich**]
      3) [**CRACO Mfg., Inc.**]
      4) [**Marino\WARE**]
      5) [**MBA Metal Framing**]
      6) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
      7) [**Steel Construction Systems; Stone Group of Companies**]
      8) [**Steel Network, Inc. (The)**]
      9) [**Super Stud Building Products Inc.**]
      10) [**US Frame Factory**]

   b. Minimum Allowable Vertical Movement: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**] .

2. Single Long-Leg Track: Top track with solid, deep flanges in base-steel thickness not less than that of studs, installed with studs friction fit into track and with continuous bridging located within **12 inches (305 mm)** of the top of studs to provide lateral bracing.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**CEMCO; California Expanded Metal Products Co.**]
      2) [**ClarkDietrich**]
      3) [**Jaimes Industries, Inc.**]
      4) [**Marino\WARE**]

5) [**MBA Building Supplies**]
6) [**MRI Steel Framing, LLC**]
7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
8) [**Steel Construction Systems; Stone Group of Companies**]
9) [**Steel Network, Inc. (The)**]
10) [**TELLING Industries**]
11) [**The Mill Steel Co**]
12) [**US Frame Factory**]

b. Flange Length: [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**] .

3. Slotted Deflection Track: Steel sheet top track manufactured with deep flanges that allow positive attachment to studs through long slots and prevent deflection of structure above from cracking finishes applied to framing; in base-steel thickness not less than that of studs and in width to accommodate depth of studs.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**CEMCO; California Expanded Metal Products Co.**]
2) [**ClarkDietrich**]
3) [**Jaimes Industries, Inc.**]
4) [**Marino\WARE**]
5) [**MBA Building Supplies**]
6) [**MRI Steel Framing, LLC**]
7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
8) [**Steel Construction Systems; Stone Group of Companies**]
9) [**Steel Network, Inc. (The)**]
10) [**TELLING Industries**]
11) [**The Mill Steel Co**]
12) [**US Frame Factory**]

b. Flange Length: [**2-1/2 inches (64 mm)**] .

4. Double-Track System: Top outer track sized to friction-fit over inner track and inner track with deep flanges in base-steel thickness not less than that of studs and fastened to studs.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**ClarkDietrich**]
2) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
3) [**Steel Construction Systems; Stone Group of Companies**]
4) [**US Frame Factory**]

b. Inner Track Flange Length: [**2 inches (51 mm)**] .

G. Firestop Track: Top track manufactured to allow partition heads to expand and contract with movement of structure above while maintaining continuity of fire-resistance-rated assembly indicated on Drawings; in base-steel thickness not less than that of studs and in width to accommodate depth of studs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Fire Trak Corp**]
d. [**Marino\WARE**]
e. [**Metal-Lite**]
f. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]
i. [**TELLING Industries**]

H. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Jaimes Industries, Inc.**]
d. [**Marino\WARE**]
e. [**MBA Building Supplies**]
f. [**MRI Steel Framing, LLC**]
g. [**Phillips Manufacturing Co**]
h. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
i. [**Steel Construction Systems; Stone Group of Companies**]
j. [**Steel Network, Inc. (The)**]
k. [**TELLING Industries**]
l. [**The Mill Steel Co**]
m. [**US Frame Factory**]

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch (0.455 mm)**][**0.0269 inch (0.683 mm)**][**0.0296 inch (0.752 mm)**][**0.0329 inch (0.836 mm)**] .

I. U-Channel: Cold-rolled steel, **0.0538-inch (1.367-mm)** minimum base-steel thickness, with minimum **1/2-inch- (13-mm-)** wide flanges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]

i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**UMS Metal Building Systems USA LLC**]
o. [**US Frame Factory**]

2. Depth:

a. Bridging: [**As indicated on Drawings**][**1-1/2 inches (38 mm)**] .
b. Suspended-Assembly Carrying Channels (Main Runners): [**As indicated on Drawings**][**2-1/2 inches (64 mm)**][**2 inches (51 mm)**][**1-1/2 inches (38 mm)**] .
c. Suspended-Assembly Furring Channels (Furring Members): [**3/4 inch (19 mm)**] .

3. Bridging Clip Angle: Not less than **1-1/2 by 1-1/2 inches (38 by 38 mm)**; **0.068-inch- (1.73-mm-)** base-steel thickness.

J. Rigid Hat-Shaped Furring Channels: Conventional members, roll-formed into standard shapes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**UMS Metal Building Systems USA LLC**]
p. [**US Frame Factory**]

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**][**0.0329 inch (0.836 mm)**] .
3. Depth: [**As indicated on Drawings**][**7/8 inch (22.2 mm)**][**1-1/2 inches (38 mm)**] .

K. Resilient Furring Channels: **1/2-inch- (13-mm-)** deep, steel sheet members designed to reduce sound transmission.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]

c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**US Frame Factory**]

2. Configuration: [Asymmetrical][hat shaped] .

L. Z-Shaped Furring: With slotted or nonslotted web, face flange of **1-1/4 inches (32 mm)**, wall attachment flange of **3/4 inch (19 mm)**, minimum base-steel thickness of **0.0179 inch (0.455 mm)**, and depth required to fit insulation thickness indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**US Frame Factory**]

2.3 GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armstrong World Industries**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Rockfon; ROCKWOOL International**]
d. [**USG Corporation**]

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Adjustable Wall-Furring Brackets: Steel sheet in minimum **0.0329-inch- (0.836-mm-)** base-steel thickness with serrated edges for attaching furring channels to exterior masonry or concrete walls.

1. Protective Coating: ASTM A653/A653M, [G40 (Z120)][G60 (Z180)] , hot-dip galvanized.

C. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.

1. Tire Wire for Adjustable Wall-Furring Brackets: Use minimum double strand of **0.0625-inch- (1.59-mm-)** diameter wire, or triple strand of **0.0475-inch- (1.21-mm-)** diameter wire to attach furring channels.
2. Tire Wire for Suspended-Ceiling Systems:

a. Splicing Carrying Channels and Furring Members: Use double loops of minimum **0.0625-inch- (1.59-mm-)** diameter wire.
b. Saddle Tying Main Runners and Cross Furring: Use minimum **0.0625-inch- (1.59-mm-)** diameter wire, or double strand of **0.0475-inch- (1.21-mm-)** diameter wire.

D. Post-Installed Anchors: Fastener systems with an evaluation report, acceptable to authorities having jurisdiction, as appropriate for the substrate.

1. Securing Hangers:

a. Acceptance Criteria: ICC-ES [AC01][AC193][AC58][AC308] .
b. Type: [Torque-controlled, expansion anchor][torque-controlled, adhesive anchor][adhesive anchor] .
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated on Drawings.
d. Stainless Steel Material for Exterior or Interior Locations: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

E. Power-Actuated Anchors: Fastener systems with an evaluation report, acceptable to authorities having jurisdiction, based on ICC-ES AC70.

F. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper.

1. Diameter: [**0.162 inch (4.12 mm)**] .

G. Flat Hangers: Steel sheet.

1. Protective Coating: ASTM A653/A653M, [G40 (Z120)][G60 (Z180)] , hot-dip galvanized.
2. Size and Length: [**In size indicated on Drawings**][**1 by 3/16 inch (25 by 5 mm) by length indicated on Drawings**] .

H. Isolation Strip at Exterior Walls: Provide [**one of**] the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, **1/8 inch (3.2 mm)** thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, substrates, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices required to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling track to surfaces indicated on Drawings to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches (610 mm)** o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of nonstructural steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated on Drawings. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION OF NONSTRUCTURAL STEEL FRAMING, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with framing members. Frame both sides of joints

independently.

3.4 INSTALLATION OF NONSTRUCTURAL STEEL FRAMING

A. Install framing system components at spacings indicated on Drawings, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**] unless otherwise indicated on Drawings.
2. Multilayer Application: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**] unless otherwise indicated on Drawings.
3. Tile Backing Panels: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**] unless otherwise indicated on Drawings.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install track at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated on Drawings to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

   a. Install two studs at each jamb unless otherwise indicated on Drawings.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum **1/2-inch (13-mm)** clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure unless otherwise indicated on Drawings.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated on Drawings. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated on Drawings and support closures to make partitions continuous from floor to underside of solid structure.

   a. Firestop Track: Install to maintain continuity of fire-resistance-rated assembly indicated on Drawings.

5. STC-Rated Partitions: Install framing to comply with STC-rated assembly indicated on Drawings.
6. Curved Partitions:

   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of at least two studs at ends of arcs, place studs **6 inches (152 mm)** o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.

F. Adjustable Wall-Furring Brackets: Install brackets with serrated edges facing upward spaced at minimum **48 inches (1219 mm)** o.c. vertically with **6 inches (152 mm)** maximum from floor and ceiling, and minimum **36 inches (914 mm)** o.c. horizontally with **4 inches (102 mm)** maximum from abutting construction, unless otherwise indicated on Drawings.

G. Z-Shaped Furring:

1. Install insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced [**24 inches (610 mm)**] o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches (305 mm)** from corner and cut insulation to fit.

H. Suspended Assemblies: Isolate suspension assemblies from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

1. Hangers: Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system spaced [**as indicated on Drawings**] .

   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

      1) Size supplemental suspension members and hangers to support ceiling loads within [**performance limits established by referenced installation standards**] .

   c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   e. Do not attach hangers to steel roof deck.
   f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   h. Do not connect or suspend framing from ducts, pipes, or conduit.

2. U-Channels: Carrying channels (main runners) spaced [**as indicated on Drawings**] .
3. Furring Channels (Furring Members): [**As indicated on Drawings**][**U-channels**][**Studs and track**][**High-strength steel studs and track**][**Rigid hat-shaped furring channels**][**Resilient furring channels**] .

a. Spacing: [**As indicated on Drawings**] .
b. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

4. Seismic Bracing: Sway-brace suspension systems [**with hangers used for support**] .

I. Installation Tolerances for Nonstructural Steel Framing:

1. Framing Members: Install each framing member so fastening surfaces vary not more than **1/8 inch (3.2 mm)** from the plane formed by faces of adjacent framing.
2. Suspended Assemblies: Install suspension systems that are level to within [**1/8 inch in 12 ft. (3.2 mm in 3.7 m)**] measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 INSTALLATION OF GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems: Install in accordance with manufacturer's written instructions. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

B. Installation Tolerances for Grid Suspension Systems: Install suspension systems that are level to within [**1/8 inch in 12 ft. (3.2 mm in 3.7 m)**] measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16 00

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Task	Specification	Specification Description
09 22 16 13	09 22 16 00	Non-Structural Metal Framing
09 22 36 13	09 23 00 00	Gypsum Plastering
09 22 36 23	09 23 00 00	Gypsum Plastering
09 22 36 33	09 23 00 00	Gypsum Plastering

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SECTION 09 23 00 00 - GYPSUM PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expanded metal lath.
2. Accessories.
3. Base-coat gypsum plaster materials.
4. Finish-coat gypsum plaster materials.

B. Related Requirements:

1. Section 092613 "Gypsum Veneer Plastering" for gypsum-based veneer plaster applied on gypsum base for veneer plaster, unit masonry, and monolithic concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, contamination, corrosion, construction traffic, and other causes.

1.5 FIELD CONDITIONS

A. Comply with ASTM C842 requirements or gypsum plaster manufacturer's written instructions, whichever are more stringent.

B. Room Temperatures: Maintain temperatures at not less than **55 deg F (13 deg C)** or greater than **80 deg F (27 deg C)** for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.

C. Avoid conditions that result in gypsum plaster drying out too quickly.

1. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
2. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain base- and finish-coat plasters from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated on Drawings, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

B. Sound-Transmission Characteristics: Where indicated on Drawings, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings in accordance with ASTM E90 and classified in accordance with ASTM E413 by a qualified testing agency.

2.3 EXPANDED METAL LATH

A. Expanded Metal Lath: ASTM C847; cold-rolled carbon-steel sheet, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMICO, a Gibraltar Industries company**]
   b. [**CEMCO; California Expanded Metal Products Co.**]
   c. [**ClarkDietrich**]
   d. [**Marino\WARE**]
   e. [**Phillips Manufacturing Co**]

2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
3. Flat Diamond-Mesh Lath: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**], unbacked.
4. Self-Furring Diamond-Mesh Lath: [**V-grooved**][**Dimpled**].

   a. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].

b. Paper Backing: Kraft paper factory bonded to back of lath.

5. 3/8-Inch (10-mm) Rib Lath: [**3.4 lb/sq. yd. (1.8 kg/sq. m)**][**4 lb/sq. yd. (2.2 kg/sq. m)**].

a. Paper Backing: Kraft paper factory bonded to back of lath.

2.4 ACCESSORIES

A. General: Comply with requirements in ASTM C841, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**CEMCO; California Expanded Metal Products Co.**]
c. [**ClarkDietrich**]
d. [**Marino\WARE**]
e. [**Phillips Manufacturing Co**]

2. Cornerite: Fabricated from expanded metal lath, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.
3. Striplath: Fabricated from expanded metal lath, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.
4. Cornerbeads: Fabricated from [zinc][zinc-coated (galvanized) steel].

a. Smallnose cornerbead with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**].
b. Smallnose cornerbead with perforated flanges; use [**on curved corners**][**at locations indicated on Drawings**].
c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use [**on columns and for finishing unit masonry corners**][**at locations indicated on Drawings**].
d. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum, with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**].

5. Casing Beads: Fabricated from [zinc][zinc-coated (galvanized) steel]; square-edged style; with expanded flanges.
6. Control Joints: Fabricated from [zinc][zinc-coated (galvanized) steel]; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
7. One-Piece Expansion Joints: Fabricated from [zinc][zinc-coated (galvanized) steel]; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
8. Two-Piece Expansion Joints: Fabricated from [zinc][zinc-coated (galvanized) steel]; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.

C. Plastic Accessories: Manufactured from high-impact PVC.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**ClarkDietrich**]
c. [**Plastic Components, Inc**]

2. Cornerbeads: With perforated flanges.

a. Smallnose cornerbead; use [**unless otherwise indicated**][**at locations indicated on Drawings**].
b. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum; use [**unless otherwise indicated**][**at locations indicated on Drawings**].

3. Casing Beads: Square-edge style, with perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
4. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
5. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**] wide reveal; with perforated concealed flanges.
6. Termination Reveal Trim: F-shaped, one-piece trim, formed to produce a [**1/2-inch- (13-mm-)**][**3/4-inch- (19-mm-)**][**1-inch- (25-mm-)**] wide reveal at the termination of plaster where it abuts other materials; with single, perforated concealed flange.

D. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brand X Metals, Inc**]
b. [**Flannery, Inc.**]
c. [**Fry Reglet Corporation**]
d. [**Gordon Inc.**]
e. [**Pittcon Industries**]

2. Aluminum: Alloy and temper with not less than the strength and durability properties of **ASTM B221 (ASTM B221M)**, Alloy 6063-T5.
3. Finish: [**Mill**][**Chemical-conversion coating, ASTM D1730, Type B, compatible with field-applied finish coatings specified**].

2.5 BASE-COAT GYPSUM PLASTER MATERIALS

A. Lightweight-Gypsum Ready-Mixed Plaster: ASTM C28/C28M, with factory-mixed perlite aggregate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]

B. Gypsum Neat Plaster: ASTM C28/C28M, for use with job-mixed aggregates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]

C. Gypsum Wood-Fibered Plaster: ASTM C28/C28M, for use as is or with the addition of job-mixed sand in up to equal proportions by weight.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]

D. High-Strength Gypsum Neat Plaster: ASTM C28/C28M, with a minimum, average, dry compressive strength of **2800 psi (19 MPa)** in accordance with ASTM C472 for a mix of **100 lb (45 kg)** of plaster and **2 cu. ft. (0.06 cu. m)** of sand.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]

E. Aggregates for Base-Coat Plasters: ASTM C35, [**sand**][**and**][**perlite**].

2.6 FINISH-COAT GYPSUM PLASTER MATERIALS

A. Gypsum Gauging Plaster: ASTM C28/C28M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]

B. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, factory-mixed, gaged, interior finish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]

C. High-Strength Gypsum Gauging Plaster: ASTM C28/C28M, with a minimum, average, dry compressive strength of **5000 psi (34 MPa)** in accordance with ASTM C472 for a neat mix.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]

D. Gypsum Keene's Cement: ASTM C61/C61M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]

E. Lime: ASTM C206, [Type S, special][Type N, normal] finishing hydrated lime.

F. Aggregates for Float Finishes: ASTM C35, [**sand**][**and**][**perlite for finish coats over base coats containing perlite**]; graded in accordance with ASTM C842.

2.7 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Bonding Compound: ASTM C631; recommended by plaster manufacturer for application indicated.

C. Fasteners for Attaching Metal Lath to Substrates: ASTM C841.

D. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch (1.21-mm)** diameter unless otherwise indicated.

E. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of rated assembly.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

F. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

G. Mix Additives: Use gypsum plaster accelerator and retarder products of plaster manufacturer if required by Project conditions. Use only additives that plaster manufacturer recommends in writing for use with plaster to which it is added.

2.8 PLASTER MIXES

A. Mixing: Comply with ASTM C842 and manufacturer's written instructions for applications indicated.

B. Mix Additives: Use accelerators and retarders, if required by Project conditions, in accordance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Reject plaster materials that are wet or moisture damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.3 INSTALLATION, GENERAL

A. Fire-Resistance-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

B. STC-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

C. Sound-Attenuation Blankets: Where [**indicated on Drawings**][**and**][**required by design designations from listing organization and publication indicated on Drawings**], install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

D. Acoustical Sealant: Where [**indicated on Drawings**][**and**][**required by design designations from listing organization and publication indicated on Drawings**], seal joints between edges of plasterwork and abutting construction with acoustical sealant.

3.4 INSTALLATION OF EXPANDED METAL LATH

A. Expanded Metal Lath: Install in accordance with ASTM C841.

1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
2. Flat-Ceiling and Horizontal Framing: Install [**flat diamond-mesh**][**3/8-inch (10-mm) rib**] lath.
3. Curved-Ceiling Framing: Install flat diamond-mesh lath.
4. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.
5. Channel-Stud Solid-Plaster Partitions: Where supported by channel studs and L-runners, install flat diamond-mesh lath.
6. Studless Solid-Plaster Partitions: Where supported by L-runners, install **3/8-inch (10-mm)** rib lath.

3.5 INSTALLATION OF ACCESSORIES

A. General: Install in accordance with ASTM C841.

B. Cornerbeads: Install at external corners.

C. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.

D. Control Joints: Locate as approved by Architect for visual effect and as follows:, as directed by the Owner

1. With spacing between joints in either direction not exceeding the following:

a. Partitions: **30 ft. (9 m)**.
b. Ceilings: [**50 ft. (15 m)**][**30 ft. (9 m)**].

2. Where furred or suspended ceilings abut columns, walls, beams, or other vertical elements.
3. Where ceiling framing or furring changes direction.
4. Where control joints occur in supporting construction.

E. Expansion Joints: Locate where an expansion joint occurs in supporting construction.

F. Aluminum Trim: Install in accordance with manufacturer's written instructions.

3.6 APPLICATION OF PLASTER

A. General: Comply with ASTM C842.

1. Do not deviate more than plus or minus **1/8 inch in 10 ft. (3 mm in 3 m)** from a true plane in finished plaster surfaces when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Bonding Compound: Apply on [**unit masonry**][**and**][**monolithic concrete**] substrates for direct application of plaster.

3.7 INSTALLATION OF BASE-COAT GYPSUM PLASTER MATERIALS

A. Over Expanded Metal Lath:

1. Scratch Coat: [**Gypsum neat plaster with job-mixed sand**][**Gypsum wood-fibered plaster; neat or with job-mixed sand**][**High-strength gypsum neat plaster with job-mixed sand**].
2. Brown Coat: [**Lightweight-gypsum ready-mixed plaster**][**Gypsum neat plaster with job-mixed sand**][**Gypsum neat plaster with job-mixed perlite**][**Gypsum wood-fibered plaster with job-mixed sand**][**High-strength gypsum neat plaster with job-mixed sand**].

B. Over Unit Masonry: [**Lightweight-gypsum ready-mixed plaster**][**Wood-fibered gypsum plaster with job-mixed sand**][**Gypsum neat plaster with job-mixed sand**].

C. Over Monolithic Concrete: [**Gypsum neat plaster with job-mixed sand**].

3.8 INSTALLATION OF FINISH-COAT GYPSUM PLASTER MATERIALS

A. Smooth-Troweled Finishes:

1. Materials: [**Gypsum gauging plaster and lime putty**][**Gypsum ready-mixed finish plaster**][**High-strength gypsum gauging plaster and lime putty**][**Gypsum Keene's cement and lime putty**].
2. Locations: Provide smooth-troweled finish [**unless otherwise indicated**][**where indicated on Drawings**].

B. Float Finishes:

1. Materials: [**Gypsum gauging plaster and lime putty**][**Gypsum Keene's cement and lime putty**].
2. Locations: Provide float finish [**unless otherwise indicated**][**where indicated on Drawings**].

C. Sprayed Finishes: [**Match Architect's sample**], as directed by the Owner.

1. Materials: [**Gypsum ready-mixed finish plaster**].
2. Locations: Provide sprayed finish [**unless otherwise indicated**][**where indicated on Drawings**].

D. Textured Finishes: [**Match Architect's sample**], as directed by the Owner.

1. Materials: [**Gypsum ready-mixed finish plaster**].
2. Locations: Provide textured finish [**unless otherwise indicated**][**where indicated on Drawings**].

E. Concealed Plaster:

1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.9 REPAIR

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.10 CLEANING

A. Remove temporary protection and enclosure of other work after plastering is complete.

B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.

C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 23 00 00

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Task	Specification	Specification Description
09 23 13 00	09 23 00 00	Gypsum Plastering

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SECTION 09 24 00 00 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal lath.
2. Accessories.
3. Base-coat cement plaster.
4. Cement plaster finish coats.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and finish texture specified.

D. Samples for Verification: For each type of factory-prepared finish coat and for each color and finish texture specified, **12 by 12 inches (305 by 305 mm)**, and prepared on rigid backing.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.5 FIELD CONDITIONS

A. Comply with ASTM C926 requirements.

B. Exterior Plasterwork:

1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
2. Apply plaster when ambient temperature is greater than **40 deg F (4.4 deg C)**.
3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

C. Interior Plasterwork: Maintain room temperatures at greater than **40 deg F (4.4 deg C)** for at least 48 hours before plaster application, and continuously during and after application.

1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

D. Factory-Prepared Finish Coats: Comply with manufacturer's written instructions for environmental conditions for applying finish coats.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated on Drawings, provide cement plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

2.2 METAL LATH

A. Expanded Metal Lath: ASTM C847; cold-rolled carbon steel sheet, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMICO, a Gibraltar Industries company**]
   b. [**CEMCO; California Expanded Metal Products Co.**]
   c. [**ClarkDietrich**]
   d. [**Marino\WARE**]
   e. [**Phillips Manufacturing Co**]

2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
3. Flat Diamond-Mesh Lath: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].

   a. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with [**10-minute**][**60-minute**]

water resistance.

1) Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**].

4. Self-Furring Diamond-Mesh Lath: [**V-grooved**][**Dimpled**].

a. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].
b. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with [**10-minute**][**60-minute**] water resistance.

1) Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**].

c. Kraft-Paper Backing: Factory bonded to back of lath.

1) Provide kraft-paper backing [**at interior locations**][**where indicated on Drawings**].

5. 3/8-Inch (10-mm) Rib Lath: [**3.4 lb/sq. yd. (1.8 kg/sq. m)**][**4 lb/sq. yd. (2.2 kg/sq. m)**].

a. Kraft-Paper Backing: Factory bonded to back of lath.

B. Wire-Fabric Lath:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ClarkDietrich**]
b. [**Davis Wire; a Heico Wire Group company**]
c. [**K-Lath; a Tree Island Steel Ltd. company**]
d. [**Structa Wire Corp.**]

2. Welded-Wire Lath: ASTM C933; self-furring, [**1.14 lb/sq. yd. (0.6 kg/sq. m)**][**1.95 lb/sq. yd. (1.1 kg/sq. m)**].
3. Woven-Wire Lath: ASTM C1032; self-furring, with stiffener wires, **1.4 lb/sq. yd. (0.8 kg/sq. m)**, with **1.5-inch (38-mm)** openings, and woven from **0.051-inch (1.30-mm)** diameter wire.
4. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and [**in double layer, each having 10-minute**][**with 10-minute**][**with 60-minute**] water resistance.

a. Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**].

2.3 ACCESSORIES

A. General: Comply with requirements in ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**Brand X Metals, Inc**]
c. [**CEMCO; California Expanded Metal Products Co.**]
d. [**ClarkDietrich**]
e. [**Flannery, Inc.**]
f. [**Marino\WARE**]
g. [**Phillips Manufacturing Co**]

2. Foundation Weep Screed: Fabricated from hot-dip-galvanized steel sheet with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Cornerite: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
4. External- (Outside-) Corner Reinforcement: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
5. Cornerbeads: Fabricated from [zinc][zinc-coated (galvanized) steel][anodized aluminum].

   a. Smallnose cornerbead with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**].
   b. Smallnose cornerbead with perforated flanges; use [**on curved corners**][**at locations indicated on Drawings**].
   c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use [**on columns and for finishing unit masonry corners**][**at locations indicated on Drawings**].
   d. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum, with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**].

6. Casing Beads: Fabricated from [zinc][zinc-coated (galvanized) steel][anodized aluminum]; square-edged style; with expanded flanges.
7. Control Joints: Fabricated from [zinc][zinc-coated (galvanized) steel]; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
8. One-Piece Expansion Joints: Fabricated from [zinc][zinc-coated (galvanized) steel]; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
9. Two-Piece Expansion Joints: Fabricated from [zinc][zinc-coated (galvanized) steel][anodized aluminum]; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.

C. Plastic Accessories: Manufactured from high-impact PVC.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMICO, a Gibraltar Industries company**]
   b. [**ClarkDietrich**]
   c. [**Plastic Components, Inc**]

2. Cornerbeads: With perforated flanges.

   a. Smallnose cornerbead; use [**unless otherwise indicated**][**at locations indicated on Drawings**].

b. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum; use [**unless otherwise indicated**][**at locations indicated on Drawings**].

3. Casing Beads: Square-edge style, with perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
4. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
5. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**] wide reveal; with perforated concealed flanges.

2.4 BASE-COAT CEMENT PLASTER

A. General: Comply with requirements in ASTM C926 for applications indicated.

1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed **1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m)** of cementitious materials.
2. Aggregate:

a. Sand: Use [**unless otherwise indicated**].
b. Perlite: Use [**where required by fire-resistance-rated design designations from listing organization and publication indicated on Drawings**].

B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and [**0 to 3/4**][**3/4 to 1-1/2**] parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and [**0 to 3/4**][**3/4 to 1-1/2**] parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

2. Masonry Cement Mixes:

a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

3. Portland and Masonry Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

4. Plastic Cement Mixes:

a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

5. Portland and Plastic Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

C. Base-Coat Mix for Use over Solid Plaster Bases: Single base (scratch) coat for two-coat plasterwork as follows:

1. Low-Absorption Unit Masonry and Concrete Substrates:

a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2. High-Absorption Unit Masonry and Concrete Substrates:

a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
c. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
d. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2.5 CEMENT PLASTER FINISH COATS

A. Job-Mixed Finish-Coat Mix: Comply with requirements in ASTM C926.

1. Aggregates:

a. Sand: Use over base coats containing sand.
b. Perlite: Use over base coats containing perlite.
c. Exposed Aggregates: Use [**where indicated on Drawings**].

2. Portland Cement Mix: For cementitious material, mix 1 part portland cement and [**3/4 to 1-1/2**][**1-1/2 to 2**] parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
3. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.
4. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
5. Plastic Cement Mix: Use 1 part plastic cement and 1-1/2 to 3 parts aggregate.

B. Ready-Mixed Finish-Coat Plaster: Factory-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**California Stucco Products Corp.**]

b. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
c. [**Florida Stucco**]
d. [**Omega Products International, Inc.**]
e. [**Parex, a Sika brand**]
f. [**Quikrete; The QUIKRETE Companies, LLC**]

2. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Source Limitations: Obtain ready-mixed finish-coat plaster from single source from single manufacturer.

C. Acrylic-Based Finish Coatings: Factory-mixed, acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**California Stucco Products Corp.**]
b. [**Dryvit Systems, Inc.**]
c. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
d. [**Finestone, a Sika brand**]
e. [**Master Wall Inc.**]
f. [**Omega Products International, Inc.**]
g. [**Senergy; a SIKA brand**]
h. [**Sto Corp.**]
i. [**Stuc-O-Flex International, Inc.**]

2. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Texture: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Source Limitations: Obtain acrylic-based finish coating from single source from single manufacturer.

2.6 PLASTER MATERIALS

A. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**].

1. Color for Finish Coats: [**White**][**Gray**].

B. Masonry Cement: ASTM C91/C91M, Type N.

1. Color for Finish Coats: [**White**][**Gray**].

C. Plastic Cement: ASTM C1328/C1328M.

D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color [**to match Architect's sample**], as directed by the Owner.

E. Lime: ASTM C206, Type S; or ASTM C207, Type S.

F. Sand Aggregate: ASTM C897.

1. Color for Job-Mixed Finish Coats: [**White**][**In color matching Architect's sample**], as directed by the Owner.

G. Perlite Aggregate: ASTM C35.

H. Exposed Aggregates for Finish Coats: [**For marblecrete finish, clean, sound, crushed marble matching color and size gradation of Architect's sample**], as directed by the Owner.

2.7 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, **1/2 inch (13 mm)** long, free of contaminants, manufactured for use in cement plaster.

C. Bonding Compound: ASTM C932.

D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.

E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch (1.21-mm)** diameter unless otherwise indicated.

F. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

G. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Reject plaster materials that are wet or moisture damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare smooth, solid substrates for plaster in accordance with ASTM C926.

3.3 INSTALLATION, GENERAL

A. Fire-Resistance-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

B. Sound-Attenuation Blankets: Where indicated on Drawings, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

C. Acoustical Sealant: Where indicated on Drawings, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

3.4 INSTALLATION OF METAL LATH

A. Metal Lath: Install in accordance with ASTM C1063.

1. Partition Framing and Vertical Furring: Install [**flat diamond-mesh**][**welded-wire**][**woven-wire**] lath.
2. Flat-Ceiling and Horizontal Framing: Install [**flat diamond-mesh**][**3/8-inch (10-mm) rib**][**welded-wire**][**woven-wire**] lath.
3. Curved-Ceiling Framing: Install [**flat diamond-mesh**][**welded-wire**][**woven-wire**] lath.
4. On Solid Surfaces, Not Otherwise Furred: Install [**self-furring diamond-mesh**][**welded-wire**][**woven-wire**] lath.

3.5 INSTALLATION OF ACCESSORIES

A. Install in accordance with ASTM C1063 and at locations indicated on Drawings.

B. Reinforcement for External (Outside) Corners:

1. Install [**lath-type, external-corner reinforcement**][**cornerbead**] at exterior locations.
2. Install cornerbead at interior locations.

C. Control Joints: Locate as approved by Architect for visual effect and as follows:, as directed by the Owner

1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:

   a. Vertical Surfaces: **144 sq. ft. (13.4 sq. m)**.
   b. Horizontal and Other Nonvertical Surfaces: **100 sq. ft. (9.3 sq. m)**.

2. At distances between control joints of not greater than **18 ft. (5.5 m)** o.c.
3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
4. Where control joints occur in surface of construction directly behind plaster.
5. Where plastered ceiling framing or furring changes direction.
6. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

D. Expansion Joints: Locate where expansion joints occur in supporting construction.

3.6 APPLICATION OF BASE-COAT CEMENT PLASTER

A. General: Comply with ASTM C926.

1. Install so that finished plaster surfaces will not deviate more than plus or minus **1/4 inch in 10 ft. (6 mm in 3 m)** from a true plane when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Install so finished plaster surfaces will be flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets.

B. Bonding Compound: Apply on [**unit masonry**][**and**][**concrete**] substrates for direct application of plaster.

C. Wall/Vertical Base Coats:

1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats having **3/4-inch (19-mm)** total thickness.
2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in [**3/8-inch (10-mm) thickness on masonry**][**1/4-inch (6-mm) thickness on concrete**].

D. Ceiling/Horizontal Base Coats:

1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats with [**1/2-inch (13-mm) total thickness**][**3/4-inch (19-mm) total thickness for metal lath on concrete**].
2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in **1/4-inch (6-mm)** thickness on concrete.

3.7 APPLICATION OF CEMENT PLASTER FINISH COATS

A. General: Comply with ASTM C926.

1. Do not deviate more than plus or minus **1/4 inch in 10 ft. (6 mm in 3 m)** from a true plane in finished plaster surfaces when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Plaster Finish Coats: Apply to provide [**float**][**dash**][**scraped trowel-textured**][**skip trowel-textured**][**brocade (knock-down dash)**][**trowel sweep**][**combed**][**sacked (California mission)**][**English**][**marblecrete**] finish to match Architect's sample, as directed by the Owner.

C. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, in accordance with manufacturer's written instructions.

D. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

E. Concealed Interior Plasterwork:

1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and

equipment, apply finish coat.

2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.8 REPAIR

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.9 CLEANING

A. Remove temporary protection and enclosure of other work after plastering is complete.

B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.

C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 24 00 00

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Task	Specification	Specification Description
09 24 13 00	09 23 00 00	Gypsum Plastering
09 24 13 00	09 24 00 00	Cement Plastering
09 24 23 00	09 24 00 00	Cement Plastering
09 24 33 00	09 24 00 00	Cement Plastering
09 28 13 00	09 29 00 00	Gypsum Board
09 28 13 00	09 30 13 00	Ceramic Tiling

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SECTION 09 29 00 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board.
3. Tile backing panels.
4. Texture finish.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior applications.
2. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for steel shaft wall framing, gypsum shaft liners, and other components of shaft wall assemblies.
4. Section 092216 "Non-Structural Metal Framing" for nonstructural steel framing and suspension systems that support gypsum board panels.
5. Section 092613 "Gypsum Veneer Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.
6. Section 093013 "Ceramic Tiling" for tile backing panels installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Samples for Initial Selection:

1. Trim Accessories: For [**aluminum trim**][**and**][**base-of-wall PVC moisture-barrier trim**] .
2. Texture Finish: For each type required.

D. Samples for Verification: Actual sample of finished products for the following:

1. Trim Accessories: Actual sample of finished products for each profile of [**aluminum trim**][**and**][**base-of-wall PVC moisture-barrier trim**] .

   a. Size: Full size profile, [**12 inches (305 mm)**] long.

2. Texture Finish: [**Manufacturer's standard size**] for each texture finish required and on same backing indicated for Work.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer

recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum board and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E119; tested by a qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E90 and classified in

accordance with ASTM E413; tested by a qualified testing agency.

C. Verify ceiling and wall materials comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Verify ceiling and wall materials comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

2.3 GYPSUM BOARD, GENERAL

A. Product Data: Verify materials were manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify materials were manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. Size: Provide panel products in maximum lengths and widths available that will minimize joints in each area and that correspond with support system specified or indicated on Drawings.

2.4 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**USG Corporation**]

2. Thickness: [**As indicated on Drawings**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

B. Lightweight Gypsum Wallboard: ASTM C1396/C1396M; manufactured to be lighter in weight and have greater sag resistance than traditional gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]

b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Thickness: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**] .
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

C. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Thickness: [**As indicated on Drawings**][**5/8 inch (15.9 mm)**][**3/4 inch (19.1 mm)**] .
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

D. Lightweight Gypsum Board, Type X: ASTM C1396/C1396M; manufactured to be lighter in weight than traditional Type X gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**USG Corporation**]

2. Thickness: [**As indicated on Drawings**][**5/8 inch (15.9 mm)**] .
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

E. Gypsum Board, Type C: ASTM C1396/C1396M; manufactured to have increased fire-resistive capability.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]

c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
4. Long Edges: Tapered.

F. Lightweight Gypsum Board, Type C: ASTM C1396/C1396M; manufactured to have increased fire-resistive capability and to be lighter in weight than traditional gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
c. [**USG Corporation**]

2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

G. Flexible Gypsum Board: ASTM C1396/C1396M; manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**PABCO Gypsum**]
c. [**Panel Rey**]
d. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/4 inch (6.4 mm); regular type**][**3/8 inch (9.5 mm); regular type**][**5/16 inch (7.9 mm); Type C as required by fire-resistance-rated assembly on Drawings; with ASTM D3273 mold-resistance score of 10 rated in accordance with ASTM D3274**] .
3. Long Edges: Tapered.

H. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]

f. [**Panel Rey**]
g. [**USG Corporation**]

2. Thickness: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**] .
3. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

I. Foil-Backed Gypsum Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
3. Long Edges: [**Tapered**] .

J. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M, tested in accordance with ASTM C1629/C1629M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**5/8 inch (15.9 mm), Type X**] .
3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
4. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
6. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
7. Long Edges: [**Tapered**] .

K. Impact-Resistant Gypsum Board: ASTM C1396/C1396M or ASTM C1658/C1658M, tested in accordance with ASTM C1629/C1629M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]

e. [**PABCO Gypsum**]
f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**5/8 inch (15.9 mm), Type X**] .
3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
4. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
6. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements in accordance with test in Annex A1.
7. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
8. Long Edges: [**Tapered**] .

L. Mold-Resistant Gypsum Board: ASTM C1396/C1396M; manufactured with moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**] .
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
4. Long Edges: [**Square**][**Tapered**] .

M. Lightweight Mold-Resistant Gypsum Board: ASTM C1396/C1396M; manufactured with moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**] .

N. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M; manufactured with fiberglass mat laminated to both sides and designed for interior use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**] .
3. Abuse and Impact Resistance:

a. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
b. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
c. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
d. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements in accordance with test in Annex A1.

4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
5. Long Edges: Tapered.

O. Acoustically Enhanced Gypsum Board: ASTM C1766; multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
c. [**PABCO Gypsum**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
3. Long Edges: Tapered.

P. Trim for Interior Gypsum Board: ASTM C1047.

1. Material: [**Galvanized-steel sheet or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet**][**Galvanized-steel sheet or aluminum-coated steel sheet or rolled zinc**][**Plastic**][**Paper-faced galvanized-steel sheet**][**PVC**] .
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.

e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Curved-Edge Cornerbead: With notched or flexible flanges.
g. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

Q. Base-of-Wall PVC Moisture-Barrier Trim: Proprietary extruded shapes that lifts finish panels above the floor surface to prevent moisture damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Waterguard**]

2. Height: [**1/2 inch (12.7 mm)**][**1-3/4 inches (44 mm)**][**3-1/2 inches (89 mm)**] .
3. Fire-Resistance-Rated Assemblies: Comply with requirements of assembly indicated on Drawings.

R. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Brand X Metals, Inc**]
b. [**Flannery, Inc.**]
c. [**Fry Reglet Corporation**]
d. [**Gordon Inc.**]
e. [**Pittcon Industries**]

2. Product Standard: Alloy and temper with not less than the strength and durability properties of **ASTM B221 (ASTM B221M)**, Alloy 6063-T5.
3. Finish: [**Corrosion-resistant primer compatible with joint compound and finish materials specified**] .

S. Joint Treatment Materials for Interior Gypsum Board: Comply with ASTM C475/C475M requirements.

1. Joint Tape: Paper.
2. Joint Compound: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

a. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant gypsum board products.
b. Prefilling: At open joints [rounded or beveled panel edges,] and damaged surface areas, use setting-type taping compound.
c. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use [**setting-type taping**][**drying-type, all-purpose**] compound.
d. Fill Coat: For second coat, use [**setting-type, sandable topping**][**drying-type, all-purpose**] compound.
e. Finish Coat: For third coat, use [**setting-type, sandable topping**][**drying-type, all-purpose**] compound.
f. Skim Coat: For final coat of Level 5 finish, use [**setting-type, sandable topping compound**][**drying-type, all-purpose compound**][**high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to**

produce Level 5 finish] .

2.5 EXTERIOR GYPSUM BOARD

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**] .

B. Trim for Exterior Gypsum Board: ASTM C1047.

1. Material: [**Hot-dip galvanized-steel sheet, plastic, or rolled zinc**] .
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Joint Treatment Materials for Exterior Gypsum Board: Comply with ASTM C475/C475M requirements.

1. Joint Tape: Paper.
2. Joint Compound: Use setting-type taping compound and setting-type, sandable topping compound.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]

d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), abuse resistant**] .
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

B. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

C. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**Panel Rey**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .

D. Joint Treatment Materials for Tile Backing Panels: Comply with ASTM C475/C475M requirements.

1. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant panel products.
2. Joint Tape: As recommended in writing by panel manufacturer.
3. Joint Compound for Tile Backing Panels:

a. Glass-Mat, Water-Resistant Gypsum Panel: As recommended in writing by panel manufacturer.
b. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: As recommended in writing by panel manufacturer.
c. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.7 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended in writing by manufacturer for directly adhering gypsum panels to continuous substrate.

1. Verify adhesives have a VOC content of [**50**] g/L or less.

C. Steel Drill Screws: ASTM C1002 unless otherwise specified or indicated on Drawings.

1. Use screws complying with ASTM C954 for fastening panels to steel members from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers as follows:

1. Non-Fire-Resistance-Rated Assemblies: [Glass][slag or rock wool] .
2. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

G. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

2.8 TEXTURE FINISH

A. Primer: As recommended in writing by texture finish manufacturer.

B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]

2. Texture: [**Fine**][**Medium**][**Coarse**] .

C. Aggregate Job-Mixed Finish: Water-based, drying-type texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
c. [**USG Corporation**]

2. Texture: [**Light spatter**][**Spatter knock-down**] .

D. Non-Aggregate Premixed Finish: Vinyl texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
c. [**USG Corporation**]

2. Texture: [**Orange peel**][**Spatter**][**Spatter knock-down**] .

E. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**International Cellulose Corp.**]

2. Application Thickness: [**1/2 inch (12.7 mm)**] .
3. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**5**] or less.
b. Smoke-Developed Index: [**5**] or less.

4. NRC: [**0.65**] in accordance with ASTM C423.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF GYPSUM BOARD, GENERAL

A. Comply with ASTM C840 requirements.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch (1.6 mm)** of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form expansion (control) joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft. (0.7 sq. m)** in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch- (6.4- to 9.5-mm-)** wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide **1/4- to 1/2-inch- (6.4- to 12.7-mm-)** wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 requirements and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound-attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated on Drawings.
2. On partitions/walls, apply gypsum panels [**vertically (parallel to framing)**][**horizontally (perpendicular to framing)**] unless otherwise specified or indicated on Drawings or required by

fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
b. At stairwells and other high walls, install panels horizontally unless otherwise indicated on Drawings or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, **16 inches (406 mm)** minimum, from parallel base-layer joints, unless otherwise indicated on Drawings or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over studs or furring members and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated on Drawings or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers [**and face layers separately to supports with screws**][**with screws; fasten face layers with adhesive and supplementary fasteners**] .

C. Application of Laminating Adhesive to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

D. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus **12-inch- (305-mm-)** long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws **16 inches (406 mm)** o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced **12 inches (305 mm)** o.c.

E. Trim for Interior Gypsum Board: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim in accordance with manufacturer's written instructions.

1. Cornerbead: Install at outside corners [**unless otherwise specified or indicated on Drawings**] .
2. Bullnose Bead: Install [**at outside corners**][**where indicated on Drawings**] .
3. LC-Bead: Install [**at exposed panel edges**] .
4. L-Bead: Install [**where indicated on Drawings**] .
5. U-Bead: Install [**at exposed panel edges**][**where indicated on Drawings**] .
6. Curved-Edge Cornerbead: Install at curved openings.
7. Expansion (Control) Joint: Install control joints [**at locations indicated on Drawings**][**in accordance with ASTM C840 and in specific locations approved by Architect for visual**

effect] , as directed by the Owner.

F. Base-of-Wall PVC Moisture Barrier Trim: Install at base of wall [**unless otherwise specified or indicated on Drawings**] .

G. Aluminum Trim: Install in locations [**indicated on Drawings**] .

H. Joint Treatment Materials for Interior Gypsum Board: Treat joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare panel surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

1. Prefill open joints [rounded or beveled edges,] and damaged surface areas.
2. Apply joint tape over panel joints, except for trim products specifically indicated as not intended to receive tape.

I. Finish interior gypsum board panels to comply with levels indicated below and in accordance with ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated on Drawings.
2. Level 2: [**Panels that are substrate for tile**][**Panels that are substrate for acoustical tile**][**Where indicated on Drawings**] .
3. Level 3: [**Where indicated on Drawings**] .

   a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

4. Level 4: [**At panel surfaces that will be exposed to view unless otherwise indicated**] .

   a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

5. Level 5: [**Where indicated on Drawings**] .

   a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

3.4 INSTALLATION OF EXTERIOR GYPSUM BOARD

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with **1/4-inch (6.4-mm)** open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

B. Trim for Exterior Gypsum Board: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use [**at exposed panel edges**] .
3. Expansion (Control) Joint: Install control joints [**at locations indicated on Drawings**][**in accordance with ASTM C840 and in specific locations approved by Architect for visual effect**] , as directed by the Owner.

C. Finish exterior gypsum board in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Gypsum Panel: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

B. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: Comply with manufacturer's written installation instructions and install at [**showers, tubs, and where indicated on Drawings**][**locations indicated to receive tile**] . Install with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

C. Water-Resistant Gypsum Backing Board: Install where indicated with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

E. Finish tile backing panels in accordance with manufacturer's written instructions.

3.6 APPLICATION OF TEXTURE FINISH

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finish. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture [**matching approved mockup and**] free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finish from contacting surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finish contacts these surfaces, immediately remove droppings and overspray to prevent damage in accordance with texture-finish manufacturer's written instructions.

3.7 PROTECTION

A. Protect adjacent surfaces from joint compound and promptly remove from floors and other non-gypsum board surfaces. Repair surfaces stained, marred, or otherwise damaged during gypsum board installation and finishing.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that have gotten wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00 00

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Task	Specification	Specification Description
09 29 10 00	01 22 00 00	No Specification Required
09 29 10 00	09 29 00 00	Gypsum Board
09 29 82 00	09 29 00 00	Gypsum Board

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SECTION 09 30 13 00 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quarry tiles.
2. Pressed floor tiles.
3. Porcelain tiles.
4. Ceramic mosaic tiles.
5. Glazed wall tiles.
6. Thresholds.
7. Tile backing panels.
8. Waterproof membranes.
9. Crack isolation membranes.
10. Setting materials.
11. Grout materials.
12. Metal flooring transitions.
13. Metal edge trim.

B. Related Requirements:

1. [**Section 071326 "Self-Adhering Sheet Waterproofing"**][**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**][**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**][**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing under thickset mortar beds.
2. Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.
3. Section 092400 "Cement Plastering" for scratch coat for thickset mortar setting-bed installations.
4. Section 092613 "Gypsum Veneer Plastering" for cementitious backer units.
5. Section 092900 "Gypsum Board" for tile backing panels.
6. Section 093023 "Glass Tiling."
7. Section 093033 "Stone Tiling."
8. Section 096340 "Stone Flooring" for stone thresholds.

1.2 DEFINITIONS

A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Face Size: Actual tile size, excluding spacer lugs.

C. Large Format Tile: Tile with at least one edge **15 inches (381 mm)** or longer.

D. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces. [**Show thresholds.**]

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection or shade variation.

D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required. [**For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.**][**For tile with aesthetic classification V3 or V4, provide 12 tiles from same production run.**]
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least [**12 inches (300 mm) square**][**36 inches (900 mm) square**] , but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory [**for each color and finish required**] .
4. Stone thresholds in **6-inch (152-mm)** lengths.
5. Metal flooring transitions **6-inch (152-mm)** lengths.

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Data: For adhesives, indicating VOC content.
13. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

B. Product Certificates: For each type of product, including product use classification.

C. Product Test Reports:

1. Tile-setting and -grouting products.
2. Certified porcelain tile.

D. Slip-Resistance Test Reports: For each type of floor tile, from a qualified independent testing agency.

E. Field Quality Control Reports: Water test reports of membrane in wet areas.

F. Qualification Statements: For Installer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to [**3**][**5**] percent of amount installed for each type, composition, color, pattern, and size specified.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated for Project.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is [a Five-Star member of the National Tile Contractors Association][a Trowel of Excellence member of the Tile Contractors' Association of America] .
2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
3. Installer employs only [Ceramic Tile Education Foundation Certified Installers][installers recognized by the U.S. Department of Labor as Journeyman Tile Layers] for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of [**mud floors**][**mud walls**][**membranes**][**shower receptors**][**and**][**large format tile**] .

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.10 WARRANTY

A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to repair and replace defective installation areas, material, and labor that fail under normal usage within specified warranty period.

1. Warranty Period: [**Five years**][**10 years**][**25 years**][**Lifetime**] from date of Product Purchase.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Tile: Obtain [**tile of each type and color or finish**][**tile of each type**][**tile of each color or finish**][**tile**] from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Tiling System: Obtain system products from single manufacturer and each aggregate from single source or producer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]

2. Obtain setting and grouting materials, except for unmodified portland cement and aggregate, from single manufacturer.
3. Obtain underlayment from manufacturer of setting and grouting materials.
4. Obtain waterproof membrane, crack isolation, and other required membranes from manufacturer of setting and grouting materials.
5. Obtain joint sealants from manufacturer of setting and grouting materials.

C. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.
2. Backer units.

2.2 CERAMIC TILE SYSTEM, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard Grade requirements [**unless otherwise indicated**] .

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation [in swimming pools][on exteriors][in wet areas] , do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 QUARRY TILES

A. Quarry Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Daltile; a brand of Dal-Tile Corporation**]
   c. [**Elgin Butler Company**]
   d. [**Florida Tile, Inc.**]
   e. [**Interceramic**]
   f. [**Metropolitan Ceramics**]
   g. [**Quarry Tile Company.**]
   h. [**Summitville Tiles, Inc.**]

2. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
3. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 3 inches (152 by 76 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**][**8 by 8 inches (200 by 200 mm)**] .
4. Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**][**3/4 inch (19 mm)**] .
5. Wearing Surface: [**Nonabrasive, smooth**][**Abrasive aggregate embedded in surface**] .
6. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
7. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
8. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
9. Precoat with temporary protective coating.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base: Coved [**with surface bullnose top edge**] , face size [**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**] .
b. Wainscot Cap: Surface bullnose, face size [**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**] .
c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

2.4 PRESSED FLOOR TILES

A. Pressed Floor Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Daltile; a brand of Dal-Tile Corporation**]
   c. [**Florim USA**]
   d. [**Interceramic**]
   e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   f. [**Vitromex USA, Inc.**]

2. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
3. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**7-3/4 by 3-7/8 inches (197 by 98 mm)**][**7-7/8 by 7-7/8 inches (200 by 200 mm)**][**11-13/16 by 11-13/16 inches (300 by 300 mm)**] .
4. Face Size Variation: [**Calibrated or rectified**][**Rectified**] .
5. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
6. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
7. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
8. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

   a. Base: Coved, module size [**same as adjoining flat tile**] .
   b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**] .
   c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**] .
   d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**] .
   e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**] .
   f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
   g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**] .
   h. External Corners for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**] .

i. Internal Corners:

1) Coved, module size [**same as adjoining flat tile**] .
2) Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

j. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.4 mm)** across nominal **4-inch (102-mm)** dimension.

2.5 PORCELAIN TILES

A. Porcelain Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Crossville, Inc.**]
c. [**Daltile; a brand of Dal-Tile Corporation**]
d. [**Florida Tile, Inc.**]
e. [**Florim USA**]
f. [**Interceramic**]
g. [**Iris Ceramics U.S., a division of Stonepeak Ceramics, Inc.**]
h. [**Marazzi USA; a brand of Dal-Tile Corporation**]
i. [**Portobello America, Inc.**]
j. [**Vitromex USA, Inc.**]

2. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
3. Certification: Tile certified by the Porcelain Tile Certification Agency.
4. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**7-3/4 by 3-7/8 inches (197 by 98 mm)**][**7-7/8 by 7-7/8 inches (200 by 200 mm)**][**11-13/16 by 11-13/16 inches (300 by 300 mm)**] .
5. Face Size Variation: Rectified.
6. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
7. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
8. Tile Color, Glaze, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
9. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
10. Precoat with temporary protective coating.
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base Cap: Surface bullnose, module size [**same as adjoining flat tile**] .
b. Wainscot Cap: Surface bullnose, module size [**same as adjoining flat tile**] .
c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
d. External Corners: Surface bullnose, module size [**same as adjoining flat tile**] .
e. Internal Corners: Field-butted square corners.

f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.4 mm)** across nominal **4-inch (102-mm)** dimension.

2.6 CERAMIC MOSAIC TILES

A. Ceramic Mosaic Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Crossville, Inc.**]
   c. [**Daltile; a brand of Dal-Tile Corporation**]
   d. [**Jeffrey Court Inc.**]
   e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   f. [**Portobello America, Inc.**]

2. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
4. Module Face Size: [**1 by 1 inch (25.4 by 25.4 mm)**][**1 by 2 inches (25.4 by 50.8 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**] .
5. Thickness: **1/4 inch (6.4 mm)**.
6. Face: [**Plain**][**Pattern of design indicated,**] with cushion edges.
7. Surface: [**Smooth, without**][**Slip resistant, with**] abrasive admixture.
8. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
9. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
10. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base: Coved, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**] .
    b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**] .
    c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**] .
    d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**] .
    e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**] .
    f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
    g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**] .
    h. External Corners for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**] .

i. Internal Corners:

1) Coved: Module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**] .
2) Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

j. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.4 mm)** across nominal **4-inch (102-mm)** dimension.

2.7 GLAZED WALL TILES

A. Glazed Wall Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Crossville, Inc.**]
c. [**Daltile; a brand of Dal-Tile Corporation**]
d. [**Interceramic**]
e. [**Jeffrey Court Inc.**]
f. [**Marazzi USA; a brand of Dal-Tile Corporation**]
g. [**Vitromex USA, Inc.**]

2. Module Face Size: [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 4-1/4 inches (152 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**] .
3. Face Size Variation: Rectified.
4. Thickness: **5/16 inch (8 mm)**.
5. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
6. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
7. Mounting: [**Loose tiles**][**Factory, back mounted**][**Pregrouted sheets of tile, factory assembled and grouted with manufacturer's standard white silicone rubber**] .
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base for Portland Cement Mortar Installations: Coved, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 3-3/4 inches (152 by 95 mm)**] .
b. Base for Thinset Mortar Installations: Straight, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**] .
c. Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**] .
d. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**] .
e. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
f. External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at

least 3/4 inch (19 mm) unless otherwise indicated.

g. External Corners for Thinset Mortar Installations: Surface bullnose; same size as adjoining flat tile.

h. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Accessories: Provide vitreous china accessories of type and size indicated; suitable for installing by same method as used for adjoining wall tile.

1. One soap holder [**with grab handle**] for each shower and tub indicated.
2. One paper holder at each water closet.
3. Color and Finish: [**Match adjoining glazed wall tile**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White, bright glaze**] , as directed by the Owner.

2.8 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Profile: Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.

B. Granite Thresholds: ASTM C615/C615M.

1. Finish: [**Polished**][**Honed**] .
2. Description:

a. Uniform, [**fine**][**medium**] -grained, [**white**][**gray**][**black**] stone without veining.

b. Match Architect's sample, as directed by the Owner.

C. Marble Thresholds: ASTM C503/C503M.

1. Finish: Honed.
2. Minimum Abrasion Resistance: [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
3. Description:

a. Uniform, fine- to medium-grained white stone with gray veining.

b. Match Architect's sample, as directed by the Owner.

D. Slate Thresholds: ASTM C629/C629M, with fine, even grain.

1. Finish: Honed.
2. Classification: [**I Exterior**][**II Interior**] .
3. Description:

a. Uniform, [**black**][**blue-black**][**gray**][**blue-gray**][**green**] stone [**and unfading**] .

b. Match Architect's sample, as directed by the Owner.

E. Solid-Surface Thresholds: Homogeneous-filled plastic resin complying with ISFA-02-01.

1. Type: Provide [**Standard**][**Special Purpose**] type.
2. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

2.9 TILE BACKING PANELS

A. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**][**Type C as required by fire-resistance-rated assembly indicated on Drawings**] .

B. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), abuse resistant**] .
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

C. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]

c. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

D. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges in maximum lengths available to minimize end-to-end butt joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C-Cure**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Custom Building Products**]
d. [**FinPan, Inc.**]
e. [**James Hardie Building Products, Inc.**]
f. [**PermaBASE Building Products, LLC provided by National Gypsum Company**]
g. [**USG Corporation**]

2. Thickness: [**1/4 inch (6.4 mm)**][**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

E. Joint Treatment Materials for Tile Backing Panels: Comply with ASTM C475/C475M requirements.

1. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant panel products.
2. Joint Tape: As recommended in writing by panel manufacturer.
3. Joint Compound for Tile Backing Panels: [**Use setting-type taping compound and setting-type, sandable topping compound**][**As recommended in writing by tile backing panel manufacturer**] .

2.10 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product [selected from the following,] that complies with ANSI A118.10 [and ANSI A118.12] and is recommended in writing by manufacturer for application indicated. Include reinforcement and accessories recommended in writing by manufacturer.

B. Waterproof Membrane, Sheet: Polyethylene sheet faced on one or both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Blanke Corporation**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Noble Company (The)**]
f. [**Schluter Systems L.P.**]

g. [**Schonox HPS North America, Inc.**]

2. Nominal Thickness: [**0.02 inch (0.5 mm)**][**0.03 inch (0.8 mm)**][**0.008 inch (0.2 mm)**] .

C. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**National Applied Construction Products, Inc.**]
j. [**Noble Company (The)**]
k. [**Parex, a Sika brand**]
l. [**Proflex USA**]
m. [**Schonox HPS North America, Inc.**]
n. [**Sika Corporation**]
o. [**Southern Grouts & Mortars, Inc**]

2. Reinforcement: [**Continuous fabric reinforcement**][**None**] .

2.11 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product [selected from the following,] that complies with ANSI A118.12 for [standard performance][high performance] and is recommended in writing by manufacturer for application indicated. Include reinforcement and accessories recommended in writing by manufacturer.

B. Crack Isolation Membrane, Polyethylene Sheet: Polyethylene faced on both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Custom Building Products**]
b. [**Laticrete International, Inc.**]
c. [**MAPEI Corporation**]
d. [**Noble Company (The)**]
e. [**Proflex USA**]
f. [**Schluter Systems L.P.**]

C. Crack Isolation Membrane, Asphaltic Sheet: Self-adhering, modified-asphalt sheet.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Custom Building Products**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]
e. [**National Applied Construction Products, Inc.**]
f. [**Sika Corporation**]

2. Facing: [**Fabric reinforcement**][**None**] .

D. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bostik; Arkema**]
b. [**C-Cure**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Jamo Inc**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Siena Tile & Stone Installation Products; Omega Products International**]
j. [**Sika Corporation**]
k. [**Southern Grouts & Mortars, Inc**]

2. Reinforcement: [**Continuous fabric reinforcement**][**None**] .

2.12 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062-inch (1.57-mm)** diameter; comply with ASTM A1064/A1064M except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.

a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
c. Configuration over Studs and Furring: Flat.
d. Configuration over Solid Surfaces: Self-furring.
e. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**] .

4. Latex Additive: [Manufacturer's standard][acrylic resin][styrene-butadiene-rubber] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended in writing by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Laticrete International, Inc.**]
   h. [**MAPEI Corporation**]
   i. [**Parex, a Sika brand**]
   j. [**Proflex USA**]
   k. [**Siena Tile & Stone Installation Products; Omega Products International**]
   l. [**Southern Grouts & Mortars, Inc**]
   m. [**Summitville Tiles, Inc.**]

2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.1.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Laticrete International, Inc.**]
   h. [**MAPEI Corporation**]
   i. [**Parex, a Sika brand**]
   j. [**Proflex USA**]
   k. [**Schluter Systems L.P.**]
   l. [**Siena Tile & Stone Installation Products; Omega Products International**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]

2. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [vinyl acetate][acrylic] additive to which only water must be added at Project site.
3. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.

D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**H.B. Fuller Construction Products Inc. / TEC**]
d. [**Laticrete International, Inc.**]
e. [**MAPEI Corporation**]
f. [**Parex, a Sika brand**]
g. [**Proflex USA**]
h. [**Siena Tile & Stone Installation Products; Omega Products International**]

2. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [vinyl acetate][acrylic] additive to which only water must be added at Project site.
3. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.15.

E. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thinset): ANSI A118.11.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**C-Cure**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Laticrete International, Inc.**]
f. [**MAPEI Corporation**]
g. [**Parex, a Sika brand**]
h. [**Proflex USA**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]

2. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [vinyl acetate][acrylic additive] to which only water must be added at Project site.
3. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.

F. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Atlas Minerals & Chemicals, Inc**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]

f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]

2. Verify adhesives have a VOC content of [**65**] g/L or less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
6. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to **140 and 212 deg F (60 and 100 deg C)**, respectively, and certified by manufacturer for intended use.

G. Organic Adhesive: ANSI A136.1, Type [**I**][**II**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Siena Tile & Stone Installation Products; Omega Products International**]
j. [**Southern Grouts & Mortars, Inc**]

2. Verify adhesives have a VOC content of [**65**] g/L or less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Chemical-Resistant Furan Mortar: ANSI A118.5.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Atlas Minerals & Chemicals, Inc**]
   b. [**Sauereisen**]
   c. [**Summitville Tiles, Inc.**]

2. Filler Material: [**Carbon**][**Silica**] .

2.13 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Laticrete International, Inc.**]
   h. [**MAPEI Corporation**]
   i. [**Parex, a Sika brand**]
   j. [**Sakrete; CRH Americas, Oldcastle APG**]
   k. [**Siena Tile & Stone Installation Products; Omega Products International**]
   l. [**Sika Corporation**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]

C. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Bostik; Arkema**]
   c. [**Custom Building Products**]
   d. [**H.B. Fuller Construction Products Inc. / TEC**]
   e. [**Laticrete International, Inc.**]
   f. [**MAPEI Corporation**]
   g. [**Parex, a Sika brand**]
   h. [**Proflex USA**]
   i. [**Southern Grouts & Mortars, Inc**]

j. [**Summitville Tiles, Inc.**]

2. Polymer Type: [**Dry, redispersible form, prepackaged with other dry ingredients**][**Liquid-latex form for addition to prepackaged dry-grout mix**] .

D. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sika Corporation**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

2. Maximum VOC Content: 65 g/L or less.
3. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to **140 and 212 deg F (60 and 100 deg C)**, respectively, and certified by manufacturer for intended use.

E. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atlas Minerals & Chemicals, Inc**]
b. [**Sauereisen**]
c. [**Summitville Tiles, Inc.**]

F. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

2.14 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, **4.0 mils (0.1 mm)** thick.

C. Metal Flooring Transitions: Profile designed specifically for flooring applications; height to match tile and setting-bed thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Blanke Corporation**]
b. [**Dural USA, Inc.**]
c. [**Profilitec Corp.**]
d. [**Progress Profiles America Inc.**]
e. [**Schluter Systems L.P.**]

2. Profile: [**L-shaped**][**Square**] .
3. Material and Finish: Metallic or combination of metal and PVC or neoprene base; [**chrome-plated brass**][**polished chrome anodized aluminum**][**polished nickel anodized aluminum**][**color-coated aluminum**][**half-hard brass**][**white zinc alloy**] exposed-edge material.

a. Color: [**Brown**][**White**][**Gray**] .

D. Metal Edge Trim: Profile designed for wall terminations and edge protection.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Blanke Corporation**]
b. [**Dural USA, Inc.**]
c. [**Profilitec Corp.**]
d. [**Progress Profiles America Inc.**]
e. [**Schluter Systems L.P.**]

2. Profile: [**L-shaped**][**Square**][**Beveled**] .
3. Terminations: [**End caps**][**Inside corners**][**Outside corners**] matching edge-protection profile.
4. Material and Finish: [**Chrome-plated brass**][**Polished chrome anodized aluminum**][**Polished nickel anodized aluminum**][**Color-coated aluminum**] exposed-edge material.

a. Color: [**Brown**][**White**][**Gray**] .

E. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.

F. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

G. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for

compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with [adhesives][bonded mortar bed][thinset mortar] comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect, as directed by the Owner.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with [adhesives][thinset mortar] with trowelable leveling and patching compound specifically recommended in writing by tile-setting material manufacturer.

C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped **1/4 inch per foot (1:50)** toward drains.

D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

E. Substrate Flatness:

1. For tile shorter than **15 inches (381 mm)**, confirm that structure or substrate is limited to variation of **1/4 inch in 10 ft. (6.4 mm in 3 m)** from the required plane, and no more than **1/16 inch in 12 inches (1.5 mm in 300 mm)** when measured from tile surface high points.
2. For large format tile, tile with at least one edge **15 inches (381 mm)** or longer, confirm that structure or substrate is limited to **1/8 inch in 10 ft. (3 mm in 3 m)** from the required plane, and no more than **1/16 inch in 24 inches (1.5 mm in 609 mm)** when measured from tile surface high points.

F. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM, GENERAL

A. Tile Backing Panels: Install backing panels and treat joints in accordance with ANSI A108.11 and

manufacturer's written instructions for type of application indicated.

B. Waterproof Membranes: Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Crack Isolation Membranes: Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

1. Allow crack isolation membrane to cure before installing tile or setting materials over it.

D. Setting and Grout Materials: Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

1. Add materials, water, and additives in accurate proportions.
2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

E. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

   a. Exterior tile floors and walls.
   b. Tile floors in wet areas.
   c. Tile swimming pool decks.
   d. Tile floors in laundries.
   e. Tile floors consisting of tiles **8 by 8 inches (200 by 200 mm)** or larger.
   f. Tile floors consisting of rib-backed tiles.

2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
4. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
5. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
6. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

   a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets, so joints between sheets are not apparent in finished Work.
   b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same

size, align joints.

c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

7. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

G. Thresholds: Install stone and solid surface thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in [**modified dry-set mortar (thinset)**][**improved modified dry-set mortar (thinset)**] .
2. Do not extend [cleavage membrane][waterproof membrane][crack isolation membrane] under thresholds set in [standard dry-set mortar (thinset)][modified dry-set mortar (thinset)][improved modified dry-set mortar (thinset)] . Fill joints between such thresholds and adjoining tile set on [cleavage membrane][waterproof membrane][crack isolation membrane] with elastomeric sealant.

H. Metal Flooring Transitions: Install [**at locations indicated**][**where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile**][**where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated**] .

I. Metal Wall Trim: Install at locations indicated on Drawings.

J. Grout Sealer: Apply grout sealer to [**cementitious**] grout joints [**in tile floors**] in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 FIELD QUALITY CONTROL

A. Water Test:

1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.

a. Perform test after 24 hours of waterproof membrane installation.
b. Insert test plug in drain or waste line.
c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
d. Check for leaks after 24 hours.

2. Test to be witnessed by [**Architect**][**authorities having jurisdiction**] , as directed by the Owner.

B. Nonconforming Work:

1. Waterproof membrane will be considered defective if water level has dropped.
2. Remove and replace defective components and retest.

3.5 ADJUSTING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

3.6 CLEANING

A. On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended in writing by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended in writing by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 EXTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Exterior Floor Installations:

1. TCNA F101: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) [**bonded to concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated**] .

a. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid applied**][**Fabric reinforced, fluid applied**] .
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
e. Movement Joints: Types located on Drawings.

2. TCNA F102: Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**] .

   a. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   d. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
   f. Movement Joints: Types located on Drawings.

B. Exterior Roof/Deck Floor Installations:

1. TCNA F103: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) [**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**] over drainage material on roof membrane.

   a. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
   e. Movement Joints: Types located on Drawings.

2. TCNA F104: Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**] .

   a. Thinset Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
f. Movement Joints: Types located on Drawings.

C. Exterior Wall Installations, Masonry or Concrete:

1. TCNA W201: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed on metal lath [**over waterproof membrane**][**over water-resistant barrier**][**over vapor-retarder membrane**] .

a. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .
b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
e. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
g. Movement Joints: Types located on Drawings.

2. TCNA W202E: Thinset mortar [**over waterproof membrane**][**over water-resistive barrier**][**over vapor retarder membrane**] .

a. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .
b. Grout: [**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
e. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
g. Movement Joints: Types located on Drawings.

D. Exterior Wall Installations, Wood or Metal Studs:

1. TCNA W244E: Thinset mortar [**over waterproof membrane on cementitious backer units**][**on cementitious backer units over vapor-retarder membrane**][**on cementitious backer units over water-resistive barrier**] .

   a. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   d. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
   e. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
   f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
   g. Movement Joints: Types located on Drawings.

3.9 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. TCNA F111: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane.

   a. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
   d. Movement Joints: Types located on Drawings.

2. TCNA F125-Full: Thinset mortar on crack isolation membrane.

   .
   a. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   b. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   c. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

B. Interior Floor Installations, Wood Subfloor:

1. TCNA F141: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane [**over waterproof membrane**] .

.

a. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Sand-portland cement**][**Standard cement grout**][**High-performance sanded cement**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended in writing by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
e. Movement Joints: Types located on Drawings.

2. TCNA F142: Organic adhesive on plywood underlayment.

a. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

b. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
c. Movement Joints: Types located on Drawings.

C. Interior Radiant Heat Floor Installations, Concrete Subfloor:

1. TCNA RH110: Thinset mortar [**on crack isolation membrane**] ; hydronic piping installed in concrete.

.

a. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
e. Movement Joints: Types located on Drawings.

2. TCNA RH115: Thinset mortar; electric radiant system encapsulated in thinset mortar.

.

a. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .

b. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

d. Movement Joints: Types located on Drawings.

D. Interior Radiant Heat Floor Installations, Wood Subfloor:

1. TCNA RH130: Thinset mortar on exterior-glue plywood; electric radiant system encapsulated in thinset mortar.

a. Mortar: [**EGP (exterior glue plywood) latex-portland cement mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .

b. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

d. Movement Joints: Types located on Drawings.

2. TCNA RH141: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane [**and waterproof membrane**] with hydronic piping installed in mortar bed.

a. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .

b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

E. Interior Wall Installations, Masonry or Concrete:

1. TCNA W202I: Thinset mortar [**over waterproof membrane**] .

a. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**][**Water-cleanable, tile-setting epoxy**] .

b. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

2. TCNA W211: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) bonded to substrate [**over waterproof membrane**] .

a. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .

b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

F. Interior Wall Installations, Wood or Metal Studs or Furring:

1. TCNA W242: Organic adhesive on gypsum board.

a. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

b. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

c. Movement Joints: Types located on Drawings.

2. TCNA W245: Thinset mortar on glass-mat, water-resistant gypsum backer board [**over waterproof membrane**] .

a. Mortar: [**Standard dry-set mortar**][**Modified dry-set mortar**][**Improved modified dry-set mortar**] .

b. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
e. Movement Joints: Types located on Drawings.

G. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs or Furring:

1. TCNA B413: [**Thinset mortar**][**Organic adhesive**] on [**water-resistant gypsum**][**coated glass-mat, water-resistant gypsum**] backer board.

a. Thinset Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Sand-portland cement grout**][**Standard sanded cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
d. Movement Joints: Types located on Drawings.

H. Bathtub/Shower Wall Installations:

1. TCNA B419: Thinset mortar [**over waterproof membrane**] on coated glass-mat, water-resistant gypsum backer board.

a. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .
e. Movement Joints: Types located on Drawings.

3.10 CHEMICAL-RESISTANT TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete:

1. TCNA F115: Thinset mortar [**over crack isolation membrane**] .

a. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
b. Grout: [**Water-cleanable epoxy grout**][**Chemical-resistant furan grout**] .
c. Crack Isolation Membrane: [**As recommended by setting material**

manufacturer][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

2. TCNA F131: Water-cleanable, tile-setting epoxy.

a. Grout: Water-cleanable epoxy grout.

b. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

c. Movement Joints: Types located on Drawings.

B. Interior Wall Installations, Masonry or Concrete:

1. TCNA W211: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) bonded to substrate [**over waterproof membrane**] .

a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Latex-**] portland cement mortar.

b. Grout: Water-cleanable epoxy.

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

C. Interior Wall Installations, Solid Backing:

1. TCNA W222: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . One-coat cement mortar bed (thickset) installed [**over cleavage membrane**][**over waterproof membrane**] on solid backing.

a. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .

b. Grout: Water-cleanable epoxy grout.

c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**] .

e. Movement Joints: Types located on Drawings.

END OF SECTION 09 30 13 00

Task	Specification	Specification Description
09 30 16 00	09 30 13 00	Ceramic Tiling

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SECTION 09 30 33 00 - STONE TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Granite tile.
2. Limestone tile.
3. Marble tile.
4. Quartz-based tile.
5. Slate tile.
6. Travertine tile.
7. Thresholds.
8. Tile backing panels.
9. Waterproof membranes.
10. Crack isolation membranes.
11. Setting materials.
12. Grout materials.

B. Related Requirements:

1. [**Section 035413 "Gypsum Cement Underlayment"**][**035416 "Hydraulic Cement Underlayment"**] for application below interior floor coverings.
2. [**Section 071326 "Self-Adhering Sheet Waterproofing"**][**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**][**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**][**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing under thickset mortar beds.
3. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in stone tile surfaces.
4. Section 092400 "Cement Plastering" for scratch coat over metal lath on wall surfaces.
5. Section 092613 "Gypsum Veneer Plastering" for cementitious backer units.
6. Section 092900 "Gypsum Board" for tile backing panels.
7. Section 096340 "Stone Flooring" for dimension stone flooring other than thin modular dimension stone tile.
8. Section 097519 "Stone Trim" for stone base in the form of running trim rather than tile.

1.2 DEFINITIONS

A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Dimension Stone Tile: Modular stone that has been selected and stock fabricated into units less than **3/4 inch (19 mm)** thick without any facial dimensions greater than **2 ft. (610 mm)**.

C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Granite tile.
2. Limestone tile.
3. Marble tile.
4. Quartz-based tile
5. Slate tile.
6. Travertine tile.
7. Thresholds.
8. Tile backing panels.
9. Waterproof membranes.
10. Crack isolation membranes.
11. Setting materials.
12. Grout materials.

B. Shop Drawings: Show locations of each type of stone tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in substrates and finished stone tile surfaces.[**Show stone thresholds.**]

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

D. Samples for Verification:

1. Full-size units of each type of stone tile[**in each finish required**].
2. Assembled Samples with grouted joints for each type of stone tile[**and for each finish required**], at least [**36 inches (900 mm) square**] and mounted on a rigid panel. Use grout of type and in color(s) approved for completed Work.
3. Range Samples consisting of at least [**two**][**three**][**four**][**five**] full-size units of each type of stone tile, exhibiting extremes of the full range of color and other visual characteristics expected. Range Samples establish the standard by which individual stone tiles[**and thresholds**] are judged.
4. Stone thresholds in **6-inch (150-mm)** lengths.
5. Metal flooring transitions in **6-inch (150-mm)** lengths.

E. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Product Data: For adhesives, indicating VOC content.
10. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

11. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports:

1. Tile-setting and -grouting products.
2. Slip-resistance test reports from qualified independent testing agency.

C. Field Quality-Control Reports: Water test reports of membrane in wet areas.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from same production run, to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Dimension Stone Tile: [**Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.**]
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is [a Five-Star member of the National Tile Contractors Association][a Trowel of Excellence member of the Tile Contractors' Association of America].
2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
3. Installer employs only [Ceramic Tile Education Foundation Certified Installers][installers recognized by the U.S. Department of Labor as Journeyman Tile Layers] for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of [**mud floors**][**mud walls**][**membranes**][**shower receptors**][**and**][**large format tile**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store stone tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install stone tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.10 WARRANTY

A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to remove and replace defective installation areas, material and labor, that fail under normal usage within specified warranty period.

1. Warranty Period: [**Five years**][**10 years**][**25 years**][**Lifetime**] from date of [**Product Purchase**][**Substantial Completion**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Stone Tile: Obtain [**tile of each type and color or finish**][**tile of each type**][**tile of each color or finish**][**tile**] from single source or producer.

1. Where two or more stone product types are identical, except for size or finish, provide same variety for each type.
2. Where threshold types are identical to stone tile types, except for size or finish, provide same variety.

B. Tiling System: Obtain system products from single manufacturer and each aggregate from single source or producer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]

2. Obtain setting and grouting materials, except for unmodified cement and aggregate, from single manufacturer.
3. Obtain waterproof, crack isolation and other required membranes from manufacturer of setting and grouting materials.
4. Obtain joint sealants from manufacturer of setting and grouting materials.

C. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.
2. Backer units.

2.2 PRODUCTS, GENERAL

A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

B. Pattern Orientation: For stone varieties with a directional pattern, provide tile with pattern [**oriented parallel to one side of tile**][**randomly oriented at various angles to sides of tiles**].

1. For stone varieties that exhibit a directional pattern, provide thresholds with pattern [**oriented parallel to**][**oriented at an angle of 45 degrees or less to**][**randomly oriented at various angles to**] long edges of thresholds.

2.3 GRANITE TILE

A. Granite Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**24 by 24 inches (609.6 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].
4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**12**][**25**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.4 LIMESTONE TILE

A. Limestone Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**24 by 24 inches (609.6 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].
4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.5 MARBLE TILE

A. Marble Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**24 by 24 inches (609.6 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].

4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.6 QUARTZ-BASED TILE

A. Quartz-Based Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**24 by 24 inches (609.6 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].
4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**8**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.7 SLATE TILE

A. Slate Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**18 by 24 inches (457 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].
4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**8**][**10**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.8 TRAVERTINE TILE

A. Travertine Tile Type :

1. Varieties and Sources: Subject to compliance with requirements, [**provide the following:**][**provide one of the following:**][**match Architect's sample for color, finish, and other characteristics relating to aesthetic effects.**], as directed by the Owner
2. Module Size: [**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (200 by 200 mm)**][**18 by 24 inches (457 by 609.6)**].
3. Nominal Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].
4. Abrasion Resistance of Stone Tile for Floors: Provide stone with a value of not less than [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.
5. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**].

2.9 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to **1/16 inch (1.5 mm)** above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to **1/2 inch (12.7 mm)** or less above adjacent floor surface.

B. Granite Thresholds: ASTM C615/C615M, with [**polished**][**honed**] finish.

1. Description:

a. Uniform, [**fine**][**medium**]-grained, [**white**][**gray**][**black**] stone without veining.
b. Match Architect's sample, as directed by the Owner.
c. Match adjacent stone tile flooring.
d. Provide[**one of**] the following:

C. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M and with honed finish.

1. Description:

a. Uniform, fine- to medium-grained white stone with gray veining.
b. Match Architect's sample, as directed by the Owner.
c. Match adjacent stone tile flooring.
d. Provide[**one of**] the following:

D. Slate Thresholds: ASTM C629/C629M, Classification [**I Exterior**][**II Interior**], with fine, even grain and honed finish.

1. Description:

a. Uniform, [**black**][**blue-black**][**gray**][**blue-gray**][**green**] stone[**and unfading**].
b. Match Architect's sample, as directed by the Owner.
c. Match adjacent stone tile flooring.
d. Provide[**one of**] the following:

E. Solid Surface Thresholds: Homogeneous-filled plastic resin complying with ISFA-02-01.

1. Description:

a. Type: Provide [**Standard**][**Special Purpose**] type.
b. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.10 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges in maximum lengths available to minimize end-to-end butt joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**C-Cure**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Custom Building Products**]
d. [**FinPan, Inc.**]
e. [**James Hardie Building Products, Inc.**]
f. [**PermaBASE Building Products, LLC provided by National Gypsum Company**]
g. [**USG Corporation**]

2. Thickness: [**1/4 inch (6.4 mm)**][**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**].
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

B. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**][**Type C as required by fire-resistance-rated assembly indicated on Drawings**].

C. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), abuse resistant**].
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

D. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**USG Corporation**]

2. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**].
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.11 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product[selected from the following,] that complies with ANSI A118.10 [and ANSI A118.12]and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Waterproof Membrane, Sheet: Polyethylene faced on both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**Blanke Corporation**]
    c. [**MAPEI Corporation**]
    d. [**Noble Company (The)**]
    e. [**Schluter Systems L.P.**]
    f. [**Schonox HPS North America, Inc.**]

C. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer[**with continuous fabric reinforcement**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**Boiardi Products Corporation; a QEP company**]
    c. [**Bostik; Arkema**]
    d. [**C-Cure**]
    e. [**Custom Building Products**]
    f. [**H.B. Fuller Construction Products Inc. / TEC**]
    g. [**Laticrete International, Inc.**]
    h. [**MAPEI Corporation**]
    i. [**National Applied Construction Products, Inc.**]
    j. [**Parex, a Sika brand**]
    k. [**Sika Corporation**]
    l. [**Southern Grouts & Mortars, Inc**]

2.12 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product[selected from the following,] that complies with ANSI A118.12 for [standard performance][high performance] and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Crack Isolation Membrane, Polyethylene Sheet: Polyethylene faced on both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Custom Building Products**]
b. [**Laticrete International, Inc.**]
c. [**MAPEI Corporation**]
d. [**Noble Company (The)**]
e. [**Schluter Systems L.P.**]

C. Crack Isolation Membrane, Asphaltic Sheet: Self-adhering, modified-asphalt sheet[**with fabric reinforcement facing**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Custom Building Products**]
c. [**MAPEI Corporation**]
d. [**National Applied Construction Products, Inc.**]
e. [**Sika Corporation**]

D. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer[**with continuous fabric reinforcement**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Siena Tile & Stone Installation Products; Omega Products International**]
k. [**Sika Corporation**]
l. [**Southern Grouts & Mortars, Inc**]

2.13 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062 inch (1.57 mm)** in diameter; comply with ASTM A1064/A1064M except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.

   a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
   b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
   c. Configuration over Studs and Furring: Flat.
   d. Configuration over Solid Surfaces: Self furring.
   e. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].

4. Latex Additive: [Manufacturer's standard][acrylic resin][styrene-butadiene-rubber] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**Laticrete International, Inc.**]
   g. [**MAPEI Corporation**]
   h. [**Parex, a Sika brand**]
   i. [**Siena Tile & Stone Installation Products; Omega Products International**]
   j. [**Southern Grouts & Mortars, Inc**]
   k. [**Summitville Tiles, Inc.**]

2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]

f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Siena Tile & Stone Installation Products; Omega Products International**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**H.B. Fuller Construction Products Inc. / TEC**]
d. [**Laticrete International, Inc.**]
e. [**MAPEI Corporation**]
f. [**Parex, a Sika brand**]
g. [**Siena Tile & Stone Installation Products; Omega Products International**]

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.

E. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Atlas Minerals & Chemicals, Inc**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]

2. Adhesives shall have a VOC content of [**65**] g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

F. Organic Adhesive: ANSI A136.1, [**Type I**][**Type II**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Bostik; Arkema**]
   c. [**C-Cure**]
   d. [**Custom Building Products**]
   e. [**H.B. Fuller Construction Products Inc. / TEC**]
   f. [**Laticrete International, Inc.**]
   g. [**MAPEI Corporation**]
   h. [**Parex, a Sika brand**]
   i. [**Siena Tile & Stone Installation Products; Omega Products International**]
   j. [**Southern Grouts & Mortars, Inc**]

2. Adhesives shall have a VOC content of [**65**] g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.14 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Siena Tile & Stone Installation Products; Omega Products International**]
l. [**Sika Corporation**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]

C. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Laticrete International, Inc.**]
f. [**MAPEI Corporation**]
g. [**Parex, a Sika brand**]
h. [**Southern Grouts & Mortars, Inc**]
i. [**Summitville Tiles, Inc.**]

2. Polymer Type:

a. Dry, redispersible form, prepackaged with other dry ingredients.
b. Liquid-latex form for addition to prepackaged dry-grout mix.

D. Water-Cleanable Epoxy Grout: ANSI A118.3[with a VOC content of 65 g/L or less].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]

i. [**Parex, a Sika brand**]
j. [**Siena Tile & Stone Installation Products; Omega Products International**]
k. [**Sika Corporation**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]

2.15 MISCELLANEOUS MATERIALS

A. Trowelable Underlayment and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, **4.0 mils (0.1 mm)** thick.

C. Metal Flooring Transitions: Profile designed specifically for flooring applications, height to match stone tile and setting-bed thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blanke Corporation**]
b. [**Dural USA, Inc.**]
c. [**Profilitec Corp.**]
d. [**Progress Profiles America Inc.**]
e. [**Schluter Systems L.P.**]

2. Description: [**L-shaped**][**Square**].
3. Material and Finish: Metallic or combination of metal and PVC or neoprene base; [**chrome-plated brass**][**polished chrome anodized aluminum**][**polished nickel anodized aluminum**][**color-coated aluminum**][**half-hard brass**][**white zinc alloy**] exposed-edge material.

a. Color: [**Brown**][**White**][**Gray**].

D. Metal Edge Trim: Profile designed for wall terminations and edge protection.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blanke Corporation**]
b. [**Dural USA, Inc.**]
c. [**Profilitec Corp.**]
d. [**Progress Profiles America Inc.**]
e. [**Schluter Systems L.P.**]

2. Description: [**L-shaped**][**Square**][**Beveled**].
3. Terminations: [**End caps**][**Inside corners**][**Outside corners**] matching edge-protection profile.
4. Material and Finish: [**Chrome-plated brass**][**Polished chrome anodized aluminum**][**Polished nickel anodized aluminum**][**Color-coated aluminum**] exposed-edge material.

a. Color: [**Brown**][**White**][**Gray**].

E. Temporary Protective Coating: Formulated to protect exposed surfaces of stone tile against adherence

of mortar and grout; compatible with stone, mortar, and grout products and easily removable after grouting is completed without damaging grout or stone tile.

F. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming stone tile and grout surfaces, specifically approved for materials and installations indicated by stone tile producers and grout manufacturers.

G. Grout Sealer: Grout manufacturer's standard product for stone type and application indicated that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where stone tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting stone tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for stone tile floors installed with [adhesives][bonded mortar bed][thinset mortar] comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind stone tile has been completed.
4. Verify that joints and cracks in stone tile substrates are coordinated with stone tile joint locations; if not coordinated, adjust joint locations in consultation with Architect, as directed by the Owner.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions in concrete substrates for stone tile floors installed with [adhesives][thinset mortar] with trowelable patching compound specifically recommended by tile-setting material manufacturer.

C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped **1/4 inch per foot (1:50)** toward drains.

D. Lay out stone tile patterns by marking joint lines on substrates to verify joint placement at edges, corners, doors, and other critical elements.

1. Notify Architect seven days in advance of dates and times when layout will be done, as directed by the Owner.
2. Obtain Architect's approval of layout before starting stone tile installation, as directed by the Owner.

E. Lay out stone tiles on substrates or on an adjacent surface to establish placement of individual stone tiles for balance of color and pattern variations.

1. Notify Architect seven days in advance of dates and times when layout will be done, as directed by the Owner.
2. Architect may relocate specific stone tiles with other stone tiles of same type and will determine final location of each stone tile within indicated patterns, as directed by the Owner.
3. Identify each stone tile with a temporary number marked on face of stone tile that corresponds with an identical number marked on a layout drawing, and obtain Architect's approval before starting stone tile installation, as directed by the Owner.

F. Substrate Flatness:

1. For stone tile shorter than **15 inches (0.38 m)**, confirm that structure or substrate is limited to variation of **1/4 inch in 10 ft. (6 mm in 3 m)** from the required plane, and no more than **1/6 inch in 12 inches (2 mm in 305 mm)** when measured from tile surface high points.
2. For stone tile with at least one edge **15 inches (0.38 m)** or longer, confirm that structure or substrate is limited to **1/8 inch in 10 ft. (3 mm in 3 m)** from the required plane, and no more than **1/6 inch in 24 inches (2 mm in 0.6 m)** when measured from tile surface high points.

G. Field-Applied Temporary Protective Coating: If indicated under stone tile type or needed to prevent grout from staining or adhering to exposed stone tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed stone tile surfaces.

3.3 INSTALLATION OF STONE TILE SYSTEM

A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

1. Allow crack isolation membrane to cure before installing tile or setting materials over it.

D. Mix mortars and grouts to comply with "Referenced Standards" Article in the Evaluations and mortar and grout manufacturers' written instructions.

1. Add materials, water, and additives in accurate proportions.
2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

E. Install stone tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in stone tile installation schedules. Comply with parts of the

ANSI A108 series that are referenced in TCNA installation methods specified in stone tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

    a. Exterior stone tile floors and walls.
    b. Stone tile floors in wet areas.
    c. Stone tile floors consisting of stone tiles **8 by 8 inches (200 by 200 mm)** or larger.

2. Wipe backs of stone tiles with a damp cloth to remove dirt and dust before units are installed.
3. Extend stone tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
4. Accurately form intersections and returns. Perform cutting and drilling of stone tile without marring visible surfaces. Carefully grind cut edges of stone tile abutting trim, finish, or built-in items for straight aligned joints. Fit stone tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap stone tile.
5. Finish cut stone tile edges that will not be concealed by other construction by grinding and honing cut surfaces [**and beveling edges**][**and easing edges**] to match factory-fabricated edges[**unless otherwise indicated**].
6. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
7. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
8. Jointing Pattern: Lay stone tile in grid pattern unless otherwise indicated. Lay out stone tile work and center stone tile fields in both directions in each space or on each wall area. Lay out stone tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

    a. Where adjoining stone tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
    b. Where stone tiles are specified or indicated to be whole integer multiples of adjoining stone tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

9. Lay out stone tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
10. Match stone tiles within each space by selecting tiles to achieve uniformity of color and pattern. Reject or relocate stone tiles that do not match color and pattern of adjacent tiles.
11. Mix stone tiles to achieve a uniformly random distribution of color shadings and patterns.
12. Pattern Orientation: For stone varieties with directional pattern, orient pattern as [**indicated on Drawings**][**directed by Architect**], as directed by the Owner.

F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and stone tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing stone tiles.

    1. Where joints occur in concrete substrates, locate joints in stone tile surfaces directly above them.

G. Thresholds: Install stone and solid surface thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

    1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in [**modified dry-set**][**improved modified dry-set**] mortar (thinset).
    2. Do not extend [cleavage membrane][waterproof membrane][crack isolation membrane] under

thresholds set in [standard dry-set][modified dry-set][improved modified dry-set] mortar. Fill joints between such thresholds and adjoining stone tile with elastomeric sealant.

H. Metal Flooring Transitions: Install [**at locations indicated**][**where exposed edge of stone tile flooring meets carpet, wood, or other flooring that finishes flush with top of stone tile**][**where exposed edge of stone tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of stone tile and no threshold is indicated**].

I. Metal Wall Trim: Install at locations indicated on Drawings.

J. Grout Sealer: Apply grout sealer to[**cementitious**] grout joints[**in tile floors**] in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 FIELD QUALITY CONTROL

A. Water Test:

1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.

   a. Perform test after 24 hours of waterproof membrane installation.
   b. Insert test plug in drain or waste line.
   c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
   d. Check for leaks after 24 hours.

2. Test to be witnessed by [**Architect**][**authorities having jurisdiction**], as directed by the Owner.

B. Nonconforming Work:

1. Waterproof membrane will be considered defective if water level has dropped.
2. Remove and replace defective components and retest.

3.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining stone tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean stone tile surfaces so they are free of foreign matter.

1. Remove grout residue from stone tile as soon as possible.
2. Clean grout smears and haze from stone tile in accordance with stone tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by stone tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of stone tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

A. Protect installed stone tile floors with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by stone tile manufacturer, apply coat of neutral protective cleaner to completed stone tile walls and floors.

B. Prohibit foot and wheel traffic from stone tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from stone tile surfaces.

3.7 EXTERIOR STONE TILE INSTALLATION SCHEDULE

A. Exterior Floor Installations:

1. TCNA F101 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) [**bonded to concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated**].

   a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

      1) Color: White.

   b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.

      1) Color: White.

   c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].

   d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].

   e. Movement Joints: Types located on Drawings.

2. TCNA F102 STONE : Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**].

   a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

      1) Color: White.

   b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.

   c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].

d. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
f. Movement Joints: Types located on Drawings.

B. Exterior Roof/Deck Floor Installations:

1. TCNA F103 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) [**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**] over drainage material on roof membrane.

a. Bond Coat for Cured-Bed Method: [**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

2. TCNA F104 STONE : Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**].

a. Thinset Mortar: [**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
f. Movement Joints: Types located on Drawings.

C. Exterior Wall Installations, Masonry or Concrete:

1. TCNA W201 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) on metal lath [**over waterproof membrane**][**over water-resistant barrier**][**over vapor-retarder membrane**].

a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Water-Resistive Barrier: Compliant with local code requirements [**and**][**specified in Division 07**].
e. Vapor Retarder: Compliant with local code requirements [**and**][**specified in Division 07**].
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
g. Movement Joints: Types located on Drawings.

2. TCNA W202E STONE : Thinset mortar [**over waterproof membrane**][**over water-resistive barrier**][**over vapor retarder membrane**].

a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Water-Resistive Barrier: Compliant with local code requirements [**and**][**specified in Division 07**].
e. Vapor Retarder: Compliant with local code requirements [**and**][**specified in Division 07**].
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
g. Movement Joints: Types located on Drawings.

D. Exterior Wall Installations, Wood or Metal Studs:

1. TCNA W244E STONE : Thinset mortar [**over waterproof membrane on cementitious backer units**][**on cementitious backer units over vapor-retarder membrane**][**on cementitious backer units over water-resistive barrier**].

a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Water-Resistive Barrier: Compliant with local code requirements [**and**][**specified in Division 07**].

e. Vapor Retarder: Compliant with local code requirements [**and**][**specified in Division 07**].
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
g. Movement Joints: Types located on Drawings.

3.8 INTERIOR STONE TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. TCNA F111 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) with cleavage membrane.

a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Modified dry-set mortar**][**Improved modified dry-set mortar**][**Water-cleanable, tile-setting epoxy**].

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**] grout.
c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
d. Movement Joints: Types located on Drawings.

2. TCNA F125-Full STONE : Thinset mortar on crack isolation membrane.

a. Thinset Mortar: [**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

B. Interior Floor Installations, Wood Subfloor:

1. TCNA F141 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) over cleavage membrane[**over waterproof membrane**].

a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Modified dry-set mortar**][**Improved modified dry-set mortar**][**Water-cleanable, tile-setting epoxy**].

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch**

(9.5 mm)].
e. Movement Joints: Types located on Drawings.

C. Interior Wall Installations, Masonry or Concrete:

1. TCNA W202I STONE : Thinset mortar[**over waterproof membrane**].

a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**][**Water-cleanable epoxy**] mortar.

1) Color: White.

b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded cement**][**High-performance unsanded cement**][**Water-cleanable epoxy**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

2. TCNA W211 STONE : Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**]. Cement mortar bed (thickset) bonded to substrate[**over waterproof membrane**].

a. Bond Coat for Cured-Bed Method: [**Dry-set**][**Modified dry-set mortar**][**Improved modified dry-set mortar**][**Water-cleanable, tile-setting epoxy**].

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

D. Interior Wall Installations, Wood or Metal Studs or Furring:

1. TCNA W243 STONE : [**Thinset mortar**][**Water-cleanable, tile-setting epoxy**] on gypsum board.

a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
d. Movement Joints: Types located on Drawings.

2. TCNA W245 STONE : [**Thinset mortar**][**Water-cleanable, tile-setting epoxy**] on glass-mat,

water-resistant gypsum backer board[**over waterproof membrane**].

a. Thinset Mortar: [**Dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

E. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs, or Furring:

1. TCNA B413 STONE : [**Thinset mortar**][**Water-cleanable, tile-setting epoxy**] on [**water-resistant gypsum board**][**coated glass-mat, water-resistant gypsum board**].

a. Thinset Mortar: [**Standard dry-set**][**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Sand-portland cement**][**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
d. Movement Joints: Types located on Drawings.

F. Bathtub/Shower Wall Installations:

1. TCNA B419 STONE : [**Thinset mortar**][**Water-cleanable, tile-setting epoxy**][**over waterproof membrane**] on coated glass-mat, water-resistant gypsum backer board.

a. Thinset Mortar: [**Modified dry-set**][**Improved modified dry-set**] mortar.

1) Color: White.

b. Grout: [**Standard sanded cement**][**Standard unsanded cement**][**High-performance sanded**][**High-performance unsanded**][**Water-cleanable epoxy**] grout.
c. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**].
d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
e. Movement Joints: Types located on Drawings.

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Task	Specification	Specification Description
09 34 00 00	09 30 13 00	Ceramic Tiling
09 39 00 00	09 30 13 00	Ceramic Tiling

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SECTION 09 51 13 00 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical panels.
2. Exposed metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with fully concealed suspension systems, stapling, or adhesive bonding.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of [**full-size**][**6-inch- (150-mm-) square**] Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of [**6-inch- (150-mm-)**] long Samples of each type, finish, and color.
3. Clips: Full-size [**hold-down**][**impact**][**and**][**seismic**] clips.

E. Delegated Design Submittals: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

3. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

16. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
17. Laboratory Test Reports: For ceiling products, indicating compliance with the VOC emissions evaluation.
18. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.
    g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: [**1/4 inch = 1 ft. (1:48)**][**1/8 inch = 1 ft. (1:96)**][**1:50**][**1:100**] .

B. Product Test Reports: For each acoustical panel ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**] .

C. Evaluation Reports: For each acoustical panel ceiling suspension system [**and anchor and fastener type**] , from ICC-ES.

D. Field Quality Control Reports: For specified tests and inspections.

E. Qualification Statements: For testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials [from the same production run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Panels: Full-size panels equal to [**2**] percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to [**2**] percent of quantity installed.
3. Hold-Down Clips: Equal to [**2**] percent of quantity installed.
4. Impact Clips: Equal to [**2**] percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Ceiling System: Obtain each type of acoustical panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class [**A**][**B**][**C**] in accordance with ASTM E1264.
2. Smoke-Developed Index: [**50**][**450**] or less.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

E. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

2.3 ACOUSTICAL PANEL CEILINGS

A. Acoustical Panels : Provide manufacturer's standard panels in accordance with ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**Armstrong World Industries**]
c. [**Cardinal Acoustics, Inc.**]
d. [**CertainTeed; SAINT-GOBAIN**]
e. [**Rockfon; ROCKWOOL International**]
f. [**USG Corporation**]

2. Classification: Provide [**fire-resistance-rated**] panels as follows:

   a. Type and Form, Type III: Mineral base with painted finish; [**Form 1, nodular**][**Form 2, water felted**][**Form 4, cast or molded**] .
   b. Type and Form, Type IV Form 1: Mineral base with membrane-faced overlay; Form 1, nodular; with [**glass-fiber cloth**][**washable vinyl-film**] overlay.
   c. Type and Form, Type IV Form 2: Mineral base with membrane-faced overlay; Form 2, water felted; with [**vinyl overlay on face**][**vinyl overlay on face and back**][**vinyl overlay on face, back, and sealed edges**][**fiberglass-fabric overlay on face**] .
   d. Type and Form, Type XII: Glass-fiber base with membrane-faced overlay; [**Form 1, plastic**][**Form 2, cloth**][**Form 3, other**] . Binder may not contain urea formaldehyde.
   e. Type and Form, Type XX: High-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
   f. Pattern: [**C (perforated, small holes)**][**CD (perforated, small holes and fissured)**][**CE (perforated, small holes and lightly textured)**][**D (fissured)**][**E (lightly textured)**][**F (heavily textured)**][**G (smooth)**][**GH (smooth and printed)**][**I (embossed)**][**J (embossed-in-register)**][**K (surface scored)**][**Z (other patterns as described)**][**and**][**as indicated by manufacturer's designation**] .

3. Color: [**White**][**As selected from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's designation**][**As indicated on Drawings**][**As indicated in a schedule**] , as directed by the Owner.
4. Light Reflectance (LR): Not less than [**LR indicated in a schedule**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**] .
5. Ceiling Attenuation Class (CAC): Not less than [**CAC indicated in a schedule**][**20**][**25**][**30**][**35**][**40**] .
6. Noise Reduction Coefficient (NRC): Not less than [**NRC indicated in a schedule**][**0.40**][**0.50**][**0.55**][**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**][**1.00**] .
7. Articulation Class (AC): Not less than [**AC indicated in a schedule**][**170**][**180**][**190**][**200**][**210**] .
8. Edge/Joint Detail: [**Square**][**Reveal sized to fit flange of exposed suspension-system members**][**Flush reveal sized to fit flange of exposed suspension-system members**][**Beveled, kerfed, and rabbeted long edges and square, butt-on short edges**][**As indicated by manufacturer's designation**] .
9. Thickness: [**5/8 inch (15 mm)**][**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**As indicated on Drawings**][**As indicated in a schedule**] .
10. Modular Size: [**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 72 inches (610 by 1830 mm)**][**24 by 96 inches (610 by 2440 mm)**][**48 by 48 inches (1220 by 1220 mm)**][**600 by 600 mm**][**600 by 1200 mm**][**As indicated on Drawings**][**As indicated in a schedule**] .
11. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.

B. Exposed Metal Suspension System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Armstrong World Industries**]
   b. [**Cardinal Acoustics, Inc.**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Cipriani USA**]
   e. [**Rockfon; ROCKWOOL International**]

f. [**USG Corporation**]

2. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories in accordance with ASTM C635/C635M and designated by type, structural classification, and finish indicated.

   a. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" in accordance with ASTM C635/C635M.

3. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished **15/16-inch- (24-mm-)** wide metal caps on flanges.

   a. Fire Rating: [**As indicated on Drawings**] .
   b. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
   c. End Condition of Cross Runners: [Override (stepped)][butt-edge] type.
   d. Face Design: Flat, flush.
   e. Cap Material: [Cold-rolled steel][aluminum] .
   f. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**] .

4. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished **9/16-inch- (15-mm-)** wide metal caps on flanges.

   a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
   b. End Condition of Cross Runners: [Override (stepped)][butt-edge] type.
   c. Face Design: [**Flat, flush**][**Flanges formed with an integral center reveal**] .
   d. Cap Material: [Cold-rolled steel][aluminum] .
   e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**] .

5. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished, cold-rolled, **9/16-inch- (15-mm-)** wide metal caps on flanges.

   a. Structural Classification: Intermediate-duty system.
   b. Face Design: Flat, flush.
   c. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**] .

6. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; to produce structural members with **9/16-inch- (15-mm-)** wide faces.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: [**With 1/8-inch- (3-mm-) wide, slotted, box-shaped flange**][**With 1/4-inch- (6-mm-) wide, slotted, box-shaped flange**][**Flanges formed in stepped design with a center protrusion projecting 19/64 inch (7.54 mm) below flange surfaces supporting panel faces and forming 3/16-inch- (4.76-mm-) wide reveals between edges of protrusion and those of panels**] .
c. Face Finish: Painted [**white**][**in color as selected from manufacturer's full range**][**to match color indicated by manufacturer's designation**][**to match color of acoustical unit**] .
d. Reveal Finish: Painted [**to match flange color**][**white**][**black**][**in color other than flange color as selected from manufacturer's full range of contrasting reveal colors**] .

7. Wide-Face, Aluminum-Capped, Double-Web, Hot-Dip Galvanized, G60 (Z180), Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized, **G60 (Z180)** coating designation; with prefinished, **15/16-inch- (24-mm-)** wide aluminum caps on flanges.

a. Fire Rating: [**As indicated on the Drawings**] .
b. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
c. Face Design: Flat, flush.
d. Cap Finish: [**Painted white**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Natural finish**] .

8. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.

a. Structural Classification: Heavy-duty system.
b. Face Finish: Painted [**white**][**black**] .

9. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from Type 304 or 316 stainless steel sheet, with prefinished **15/16-inch- (24-mm-)** wide, stainless steel caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.

10. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with **9/16-inch- (15-mm-)** wide faces.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: Screw-slot profile.
c. Face Finish: [**Painted white**][**Satin anodized in accordance with AAMA 611, AA-M12C22A31**] .
d. Reveal Finish: [**Match face finish**][**Painted white**][**Painted black**] .

11. Extra-Wide-Face, Metal Suspension System: Main and cross runners formed from [**extruded aluminum**][**aluminum-capped steel**][**steel-capped steel**] to produce structural members with [**1-1/2-inch- (38-mm-)**][**2-inch- (50-mm-)**] wide flanges.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: Flat, flush.
c. Face Finish: [**Painted white**][**Satin anodized in accordance with AAMA 611, AA-M12C22A31**] .
d. Gasket System: Clean-room type.

C. Metal Edge Moldings and Trim :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Armstrong World Industries**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Cipriani USA**]
   d. [**Rockfon; ROCKWOOL International**]
   e. [**USG Corporation**]

2. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

   a. Edge moldings to fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
   b. For lay-in panels with reveal edge details, provide [**stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member**] .
   c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

3. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
4. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
5. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. [**Comply with seismic design requirements.**]

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**five**] times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

   a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
   b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
   c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
   d. Corrosion Protection, Nickel-Copper Alloy: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**10**] times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**] diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

K. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including [**manufacturer's standard**][**closed-cell PVC**][**neoprene**][**antimicrobial**] gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.5 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation

tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF ACOUSTICAL PANEL CEILINGS

A. Install acoustical panel ceilings in accordance with ASTM C636/C636M [seismic design requirements,] and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems in accordance with tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required [**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance

limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Metal Edge Moldings and Trim: Install edge moldings and trim of type indicated at perimeter of acoustical panel ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

   a. As indicated on reflected ceiling plans.
   b. Install panels with pattern running in one direction parallel to [**long**][**short**] axis of space.
   c. Install panels in a basket-weave pattern.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install [**hold-down**][**impact**][**and**][**seismic**] clips in areas indicated; space in accordance with panel manufacturer's written instructions unless otherwise indicated.

   a. Hold-Down Clips: Space [**24 inches (610 mm)**] o.c. on all cross runners.

7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts in accordance with requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of [**1/8 inch in 12 ft. (3 mm in 3.6 m)**] , non-cumulative.

B. Metal Edge Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of [**1/8 inch in 12 ft. (3 mm in 3.6 m)**] , non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 bf (1957 N)** of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13 00

SECTION 09 51 23 00 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical tiles.
2. Metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Health Product Declaration (HPD): For each product.
13. Health Product Declaration (HPD): Provide HPD.
14. Health Product Declaration (HPD): Provide documentation confirming product compliance with

one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

15. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
16. Product Data: For adhesives, indicating VOC content.
17. Laboratory Test Reports: For ceiling products, indicating compliance with the VOC emissions evaluation.
18. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

D. Samples for Initial Selection: For components with factory-applied finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Tiles: Set of full-size Samples of each type, color, pattern, and texture.
2. Concealed Suspension-System Members: [**6-inch- (150-mm-)**] long Sample of each type.
3. Exposed Moldings and Trim: Set of [**6-inch- (150-mm-)**] long Samples of each type and color.
4. Seismic Clips: Full size.

F. Delegated Design Submittals: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

a. Lighting fixtures.
b. Diffusers.

c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.

7. Show operation of hinged and sliding components adjacent to acoustical tiles.
8. Minimum Drawing Scale: [**1/4 inch = 1 foot (1:48)**][**1/8 inch = 1 foot (1:96)**][**1:50**][**1:100**].

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical tile ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Evaluation Reports: For each acoustical tile ceiling suspension system[**and anchor and fastener type**], from ICC-ES.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same production run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size tiles equal to [**2**] percent of quantity installed.
2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to [**2**] percent of quantity installed.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical tiles, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Suspended Acoustical Tile Ceiling System: Obtain each type of acoustical ceiling tile and its suspension system from single source from single manufacturer.

B. Source Limitations for Directly Attached Acoustical Tile Ceiling Tile: Obtain each type of acoustical ceiling tile from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

D. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

E. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class [**A**][**B**][**C**] in accordance with ASTM E1264.
2. Smoke-Developed Index: [**50**][**450**] or less.

F. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL TILES

A. Acoustical Tiles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong World Industries, Inc**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Rockfon; ROCKWOOL International**]
   d. [**USG Corporation**]

2. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E1264 classifications as designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
3. Classification: Provide[**fire-resistance-rated**] tiles as follows:

   a. Type and Form, Type III: Mineral base with painted finish; [**Form 1, nodular**][**Form 2, water felted**][**Form 4, cast or molded**].
   b. Pattern: [**C (perforated, small holes)**][**CD (perforated, small holes and fissured)**][**CE (perforated, small holes and lightly textured)**][**D (fissured)**][**E (lightly textured)**][**F (heavily textured)**][**G (smooth)**][**I (embossed)**][**J (embossed-in-register)**][**and**][**as indicated by manufacturer's designation**].

4. Color: [**White**][**As selected from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's designation**][**As indicated on Drawings**][**As indicated in a schedule**], as directed by the Owner.
5. Light Reflectance (LR): Not less than [**LR indicated in a schedule**][**0.65**][**0.70**][**0.75**][**0.80**].
6. Ceiling Attenuation Class (CAC): Not less than [**CAC indicated in a schedule**][**20**][**25**][**30**][**35**][**40**].
7. Noise Reduction Coefficient (NRC): Not less than [**NRC indicated in a schedule**][**0.50**][**0.55**][**0.60**][**0.65**][**0.70**].
8. Articulation Class (AC): Not less than [**AC indicated in a schedule**][**170**][**180**][**190**][**200**][**210**].
9. Edge/Joint Detail: [**Square, kerfed, and rabbeted; tongue and grooved; or butt**][**Beveled, kerfed, and rabbeted; tongue and grooved; or butt**][**Beveled, kerfed, and rabbeted long edges and square, butt on short edges**][**As indicated by manufacturer's designation**].
10. Thickness: [**5/8 inch (15 mm)**][**3/4 inch (19 mm)**][**As indicated on Drawings**][**As indicated in a schedule**].
11. Modular Size: [**12 by 12 inches (305 by 305 mm)**][**300 by 300 mm**][**As indicated on Drawings**][**As indicated in a schedule**].
12. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.

2.4 METAL SUSPENSION SYSTEM

A. Concealed or Semi-Exposed Metal Suspension System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong Ceiling & Wall Solutions**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Rockfon; ROCKWOOL International**]
d. [**USG Corporation**]

2. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, fully concealed, metal suspension system and accessories of type, structural classification, and finish indicated that complies with applicable requirements in ASTM C635/C635M.

   a. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" in accordance with ASTM C635/C635M.

3. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation.

   a. Fire Rating: [**As indicated on Drawings**].
   b. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
   c. Access: [Upward][Downward] and [end pivoted][side pivoted], with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.

      1) Initial Access Opening: In each module, [**24 by 24 inches (610 by 610 mm)**][**As indicated on Drawings**].

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**five**] times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

   a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
   b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
   c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to [**10**] times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM

C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**] diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Metal Edge Moldings and Trim :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Ceiling & Wall Solutions**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Rockfon; ROCKWOOL International**]
   d. [**USG Corporation**]

2. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

   a. Edge moldings to fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
   b. For lay-in panels with reveal edge details, provide [**stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member**].
   c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
   d. Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**].

3. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

   a. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

b. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

2.8 MISCELLANEOUS MATERIALS

A. Acoustical Tile Adhesive: Type recommended in writing by acoustical tile manufacturer, bearing UL label for Class 0-25 flame spread.

1. Verify adhesives have a VOC content of [**50**] g/L or less.

B. Staples: **5/16-inch- (8-mm-)** long, divergent-point staples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Testing Substrates: Before adhesively bonding tiles to wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

C. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

A. Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M[seismic design requirements,] and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems in accordance with tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required[**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Arrange directionally patterned acoustical tiles as follows:

1. As indicated on reflected ceiling plans.
2. Install tiles with pattern running in one direction parallel to [**long**][**short**] axis of space.
3. Install tiles in a basket-weave pattern.

G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges of tiles so tile-to-tile joints are interlocked.

1. Fit adjoining tiles to form flush, tight joints. Scribe and cut tiles for accurate fit at borders and around penetrations through ceiling.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tiles and moldings, spaced **12 inches (305 mm)** o.c.
3. Protect lighting fixtures and air ducts in accordance with requirements indicated for fire-resistance-rated assembly.

3.4 INSTALLATION OF DIRECTLY ATTACHED ACOUSTICAL TILE CEILINGS

A. Adhesive Installation: Install acoustical tile by bonding to substrate, using acoustical tile adhesive and procedure recommended in writing by tile manufacturer and as follows:

1. Wipe and prime ceiling.
2. Remove loose dust from backs of tiles by brushing.
3. Install splines in joints between tiles and maintain bottom surface to a uniform level. Shim tile or correct substrate as required to maintain levelness.
4. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

B. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:

1. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
2. Maintain bottom surface of tiles to a uniform level. Shim tile or correct substrate as required to maintain levelness.
3. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

C. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.

D. Arrange directionally patterned acoustical tiles [**as indicated on Drawings**][**with pattern running in one direction parallel to long axis of space**][**with pattern running in one direction parallel to short axis of space**][**in a basket-weave pattern**].

3.5 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m)**], non-cumulative.

B. Directly Attached Ceilings: Install bottom surface of tiles to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6 mm) cumulatively**].

C. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m)**], non-cumulative.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the

following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical tile ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no tiles have been installed. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 lbf (1957 N)** of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical tile ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23 00

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SECTION 09 51 33 00 - ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum pans for acoustical metal pan ceiling.
2. Steel pans for acoustical metal pan ceiling.
3. Stainless steel pans for acoustical metal pan ceiling.
4. Metal suspension system for acoustical, standard-grid metal pan ceilings.
5. Metal suspension system for acoustical, snap-in metal pan ceilings.

B. Related Requirements:

1. Section 079219 "Acoustical Joint Sealants" for acoustical sealant for exposed and concealed joints.
2. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
3. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with concealed suspension systems, stapling, or adhesive bonding.
4. Section 095423 "Linear Metal Ceilings."
5. Section 095436 "Suspended Decorative Grids."
6. Section 095753 "Security Ceiling Assemblies" for downward-locking panel and plank ceilings for use in security or detention facilities.

C. Products furnished, but not installed, under this Section include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include procedure for cutting metal pans.

1. Aluminum pans for acoustical metal pan ceiling.
2. Steel pans for acoustical metal pan ceiling.
3. Stainless steel pans for acoustical metal pan ceiling.
4. Metal suspension system for acoustical, standard-grid metal pan ceilings.
5. Metal suspension system for acoustical, snap-in metal pan ceilings.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements

for low-emitting materials.
4. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
10. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
12. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
13. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
14. Environmental Product Declaration: For each product.
15. Health Product Declaration: For each product.
16. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
17. Environmental Product Declaration: For each product.
18. Environmental Product Declaration: For each product.
19. Environmental Product Declaration: For each product.
20. Third-Party Certifications: For each product.
21. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Metal Pans: Set of [**full-size**][**6-inch- (150-mm-) square**] Samples of each type, finish, color, pattern, and texture. Show pan edge profile.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of **6-inch- (150-mm-)** long Samples of each type, finish, and color.
3. Sound Absorber: Sample of each type matching size of Sample metal pan.

F. Delegated Design Submittals: For design of [**seismic restraints and**]attachment devices.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which suspension systems will be attached.
3. Size and location of access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

5. Perimeter moldings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical metal pan ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Evaluation Reports: For each acoustical metal pan ceiling suspension system[**and anchor and fastener type**].

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Metal Pans: Full-size units[**with sound absorber**] equal to [**2**] percent of quantity installed.
2. Suspension-System Components: Quantity of each grid, exposed molding, and trim equal to [**2**] percent of quantity installed.
3. Hold-Down Clips: [**Equal to 2 percent of quantity installed**].

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical metal pans, suspension-system components, and accessories to Project site in

original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle acoustical metal pans, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**seismic restraints and**]attachment devices.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E1264 for [**Class A**][**Class B**][**Class C**] materials.
2. Smoke-Developed Index: [**50**][**450**] or less.

2.2 ACOUSTICAL METAL PANS, GENERAL

A. Source Limitations: Obtain each type of acoustical metal ceiling pan and supporting suspension system from single source from single manufacturer.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

D. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.

G. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

I. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

J. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

K. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

L. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

M. Acoustical Panel Standard: Provide manufacturer's standard pans of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is **15-3/4 inches (400 mm)** away from test surface in accordance with ASTM E795.

N. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Rolled aluminum sheet, complying with **ASTM B209 (ASTM B209M)**; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C635/C635M.

   a. Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A879/A879M, **13Z (40G)** coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
   b. Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A1008/A1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

3. Stainless Steel Sheet: Complying with ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 430**].

O. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing in accordance with ASTM E84.

1. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.

P. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing in accordance with ASTM E84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C553, Type I, Type II, or

Type III, and as follows:

a. Mineral-Fiber Type and Thickness: Glass fiber; [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**3 inches (76 mm)**].
b. Mineral-Fiber Density: [**3/4 lb/cu. ft. (12 kg/cu. m)**][**1 lb/cu. ft. (16 kg/cu. m)**][**1-1/2 lb/cu. ft. (24 kg/cu. m)**].
c. Plastic Sheet Thickness and Color: Not less than **0.003 inch (0.076 mm)**; [**clear**][**flat black**][**white**].

2. Unwrapped, Glass-Fiber Insulation: Black coated, unfaced, complying with ASTM C553, Type I, Type II, or Type III; treated to be nondusting; [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] thick.
3. Spacer Grids: Provide manufacturer's standard [**aluminum**][**galvanized-steel**] grid units that provide an air cushion between metal pans and insulation pads and that act to improve sound absorption.

Q. Sound Attenuation Panels: Provide manufacturer's standard [**aluminum**][**galvanized-steel**] unperforated metal backing unit that acts as a sound attenuation pan to reduce sound travel through ceiling plenum into adjoining rooms.

1. Sound-Absorbent Pads: Provide secondary sound-absorbent pads, [**same as specified for primary sound-absorbent pads**], for placement over sound attenuation pan to reduce plenum sound.

R. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent [**fabric**][**and**][**pads**].

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.3 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]

4. [**Gage Corporation International (The)**]
5. [**Lindner Group**]
6. [**Rockfon; ROCKWOOL International**]
7. [**USG Corporation**]

B. Classification: Units complying with ASTM E1264 for [**Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated aluminum facing (pan) units**].

1. Pattern A: Perforated, regularly spaced large holes, arranged in [**diagonal**][**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**][**selected from manufacturer's full range**].
2. Pattern B: Perforated, small holes regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**][**selected from manufacturer's full range**].

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.

D. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.032 inch (0.8 mm)**][**0.040 inch (1.0 mm)**].

E. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**].

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 60 inches (610 by 1525 mm)**][**30 by 30 inches (760 by 760 mm)**][**30 by 60 inches (760 by 1525 mm)**][**As indicated on Drawings**].

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] ceiling units.

I. Pan Face Finish: [**Mill**][**Lacquered mill**][**Clear anodized**][**Clear mirror anodized**][**Painted white**][**Painted to match color indicated by product designation**][**Painted to match Architect's sample**][**Painted in color selected from manufacturer's full range**][**Bright-reflective metallic finish selected from manufacturer's full range**], as directed by the Owner.

J. Light Reflectance Coefficient: Not less than [**0.70**][**0.75**].

K. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**].

L. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**].

2.4 STEEL PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]
4. [**Lindner Group**]
5. [**Rockfon; ROCKWOOL International**]
6. [**USG Corporation**]

B. Classification: Units complying with ASTM E1264 for [**Type V, perforated steel facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated steel facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated steel facing (pan) units**].

1. Pattern A: (Perforated, regularly spaced large holes), arranged in [**diagonal**][**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**][**selected from manufacturer's full range**].
2. Pattern B: (Perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**][**selected from manufacturer's full range**].

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.

D. Pan Thickness: Not less than [**0.010 inch (0.25 mm)**][**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.030 inch (0.75 mm)**][**0.036 inch (0.9 mm)**].

E. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**].

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 60 inches (610 by 1525 mm)**][**30 by 30 inches (760 by 760 mm)**][**30 by 60 inches (760 by 1525 mm)**][**As indicated on Drawings**].

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] ceiling units.

I. Pan Face Finish: [**Painted white**][**Painted to match color indicated by product designation**][**Painted to match Architect's sample**][**Painted in color selected from manufacturer's full range**][**Plated with metallic finish, as selected from manufacturer's full range**][**Bright-reflective metallic finish**

selected from manufacturer's full range], as directed by the Owner.

J. Light Reflectance Coefficient: Not less than [**0.70**][**0.75**].

K. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**].

L. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**].

2.5 STAINLESS STEEL PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**Rockfon; ROCKWOOL International**]
3. [**USG Corporation**]

B. Classification: Units complying with ASTM E1264 for [**Type VI, perforated stainless steel facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated stainless steel facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated stainless steel facing (pan) units**].

1. Pattern A: (Perforated, regularly spaced large holes), arranged in parallel alignment to pan edge with uniform perforations of **0.109-inch (2.8-mm)** diameter, 1800 holes/sq. ft. or inch, and 11.8 percent open area.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.

D. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.030 inch (0.76 mm)**].

E. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

F. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**].

G. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**30 by 30 inches (760 by 760 mm)**][**As indicated on Drawings**].

H. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**] ceiling units.

I. Pan Face Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**][**Dull Satin Finish: ASTM A480/A480M No. 6**][**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**].

J. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**].

K. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**].

2.6 METAL SUSPENSION SYSTEMS, GENERAL

A. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635/C635M requirements.

G. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

H. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

I. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.

J. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

K. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel copper alloy for UNS No. N04400 alloy.
4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM

C635/C635M, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**] diameter wire.

L. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

M. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1.0-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

N. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

O. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

P. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.

Q. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place [**to molding and trim at perimeter**][**at each pan**].

R. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.7 METAL SUSPENSION SYSTEM FOR ACOUSTICAL, STANDARD-GRID METAL PAN CEILINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**CertainTeed; SAINT-GOBAIN**]
3. [**Rockfon; ROCKWOOL International**]
4. [**USG Corporation**]

B. Suspension System: For [**clip-in**][**lay-in**][**torsion-spring-hinged**] pans.

1. Wide-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized in accordance with ASTM A653/A653M, **G30 (Z90)** coating designation, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, sheet metal caps on flanges.

a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
b. End Condition of Cross Runners: [Override (stepped)][butt-edge] type.
c. Face Design: Flat, flush.
d. Cap Material: [Steel][aluminum] cold-rolled sheet.
e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of metal pan**][**Plated with metallic finish, as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's**

designation][**Natural finish for aluminum**].

2. Narrow-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized in accordance with ASTM A653/653M, **G30 (Z90)** coating designation, with prefinished, cold-rolled, **9/16-inch- (15-mm-)** wide, sheet metal caps on flanges.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. End Condition of Cross Runners: [Override (stepped)][butt-edge] type.
    c. Face Design: [**Flat, flush**][**Flanges formed with an integral center reveal**].
    d. Cap Material: [Steel][aluminum] cold-rolled sheet.
    e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of metal pan**][**Plated with metallic finish, as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**].

3. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with **9/16-inch- (15-mm-)** wide faces.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. Face Design: With [**1/8-inch- (3.2-mm-)**][**1/4-inch- (6.35-mm-)**] wide, slotted, box-shaped flange.
    c. Face Finish: Painted [**white**][**in color as selected from manufacturer's full range**][**to match color indicated by manufacturer's designation**][**to match color of metal pan**].

4. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized in accordance with ASTM A653/A653M, **G60 (Z180)** coating designation, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, aluminum caps on flanges.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. Face Design: Flat, flush.
    c. Face Finish: [**Painted white**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Natural finish**].

5. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from and capped with Type 304 or Type 316 stainless steel sheet, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, stainless steel caps on flanges.

    a. Structural Classification: Intermediate-duty system.
    b. Face Design: Flat, flush.
    c. Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**][**Dull Satin Finish: ASTM A480/A480M No. 6**][**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**].

6. Suspension System for Torsion-Spring-Hinged Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring-hinged attachment.

2.8 METAL SUSPENSION SYSTEM FOR ACOUSTICAL SNAP-IN METAL PAN CEILINGS

A. Snap-In Grid Suspension System: .

1. Manufacturers: Subject to compliance with requirements, provide products by snap-in metal pan ceiling manufacturer.

B. Indirect-Hung, Snap-in System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure, and complying with the following requirements:

1. Main Runners: Formed from the following metal:

a. Aluminum Sheet: Alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with **ASTM B209 (ASTM B209M)**.
b. Electrolytic Zinc-Coated Steel Sheet: ASTM A879/A879M, with not less than [**08Z (24G)**] zinc coating.
c. Hot-Dip Galvanized Steel: ASTM A653/A653M, with not less than [**G60 (Z180)**] zinc coating.
d. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 302 or Type 304, stretcher leveled, with cold-rolled mill finish.
e. Metal Sheet: Metal as standard with ceiling system manufacturer, with factory-applied protective finish complying with ASTM C635/C635M.

2. Carrying Channels:

a. Same member and metal as indicated for main runners.
b. Cold-rolled steel, not less than **0.060-inch (1.5-mm)** nominal thickness of base (uncoated) metal and **7/16-inch- (11-mm-)** wide flanges, [**protected with rust-inhibitive paint**][**hot-dip galvanized in accordance with ASTM A653/A653M, G60 (Z180) coating designation**], and as follows:

1) Depth and Weight: [**1-1/2 inches and 475 lb/1000 feet (38 mm and 215 kg/305 m)**][**2 inches and 590 lb/1000 feet (51 mm and 268 kg/305 m)**].

C. Direct-Hung, Snap-in System: Designed to support metal pans that snap into main runners, consisting of main runners supported by hangers attached directly to building structure, and complying with the following requirements:

1. Hangers: Angles or channels, as standard with ceiling system manufacturer, formed from same metal as main runners.
2. Main Runners: Rolled aluminum sheet; alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with **ASTM B209 (ASTM B209M)**.

D. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units, accessible by [**key or tool**][**two access knobs; place one access knob at each end of panel near corners**].

1. Access Key or Tool: Provide manufacturer's standard key or tool for opening access panels; [**one**][**two**].

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

2.10 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Humidity Finish: Comply with ASTM C635/C635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

2.11 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).

B. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).

1. Organic Coating: Manufacturer's standard clear organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.

E. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

F. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.12 METALLIC-COATED STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

2.13 STEEL SHEET FINISHES

A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.

B. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of

blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.14 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical metal pan ceilings.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 INSTALLATION OF ACOUSTICAL METAL PAN CEILINGS

A. General: Install acoustical metal pan ceiling assemblies to comply with ASTM C636/C636M[seismic design requirements,] and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required[**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members[**or carrying channels**] and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not

deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Secure flat, angle, channel, and rod hangers to ceiling suspension members[**or carrying channels**] and to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members[**or carrying channels**] and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3.2 mm in 3.6 m)**. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet. Cut and treat edges to comply with manufacturer's written instructions.

G. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with manufacturer's installation tolerances.

1. For lay-in, square-edge pans, install pans with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For lay-in, reveal-edge pans on suspension-system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
3. For lay-in, reveal-edge pans on suspension-system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
4. For [**clip-in**][**torsion-spring-hinged**] pans, position pans in accordance with manufacturer's written instructions.
5. For snap-in pans, fit adjoining units to form flush, tight joints.

6. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
7. Fit adjoining units to form flush, tight joints.
8. Install directionally patterned or textured metal pans in directions indicated.
9. Install sound-absorbent fabric layers in, and bond to, perforated metal pans.
10. Install sound-absorbent pads in perforated metal pans[**over metal spacer grids**].

H. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.

I. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Seismic design compliance.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical metal panel ceiling hangers, anchors, and fasteners in successive stages. Do not proceed with installations of acoustical metal panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed.

a. Within each test area, testing agency selects one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and tests them for **200 lbf (890 N)** of tension; it also selects one of every two postinstalled anchors used to attach bracing wires to concrete and tests them for **440 lbf (1957 N)** of tension.
b. When tested fasteners and anchors do not comply with requirements, testing agency tests those fasteners and anchors not previously tested until 20 pass consecutively and then resumes initial testing frequency.

D. Acoustical metal panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 51 33 00

Task	Specification	Specification Description
09 51 33 13	09 51 33 00	Acoustical Metal Pan Ceilings
09 51 33 23	09 51 33 00	Acoustical Metal Pan Ceilings
09 51 33 33	09 51 33 00	Acoustical Metal Pan Ceilings
09 53 23 00	09 51 13 00	Acoustical Panel Ceilings

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SECTION 09 54 00 00 - STRETCHED-FABRIC CEILING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Stretched-fabric ceiling systems.

B. Related Requirements:

1. Section 095446 "Fabric-Wrapped Ceiling Panels" for decorative, fabric-wrapped ceiling panels that are not required to be tested for acoustical performance[**and for coordinated requirements for fabric**].
2. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
3. Section 097713 "Stretched-Fabric Wall Systems" for site-upholstered systems applied to walls[**and for coordinated requirements for fabric**].
4. Section 098436 "Sound-Absorbing Ceiling Units" for shop-fabricated, acoustical ceiling panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound absorption average.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For stretched-fabric ceiling systems.

1. Include[**fabric facing,**] frame edge and trim, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.

7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
8. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
10. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each stretched-fabric system.

1. Include the following:

a. Reflected ceiling plans, elevations, sections, and installation and system details.
b. Details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate frame-edge profile and core materials.
c. Details at cutouts and penetrations for other work.
d. Direction of fabric weave and pattern matching.

2. Show sewn-seam locations, types, and methods.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include accessories involving color or finish selection.

E. Samples for Verification: For the following:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**] long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Frame System: **12-inch- (300-mm-)** square Sample(s) showing each edge profile and corner.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Assembled System: Approximately **36 by 36 inches (900 by 900 mm)**, including joints[**and seams**] in mockup.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets.
2. Suspended ceiling components above stretched-fabric systems.
3. Structural members to which suspension devices will be attached.
4. Items penetrating or covered by stretched-fabric systems including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.

5. Show operation of hinged and sliding components covered by or adjacent to stretched-fabric systems.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of stretched-fabric system.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stretched-fabric systems to include in maintenance manuals. Include fabric manufacturer's written cleaning, stain-removal, restretching, and reupholstering instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, furnish length equal to [**10**] percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**], full width of bolt.
2. Framing and Related Installation Items: Furnish manufacturer's full-length units equal to [**5**] percent of amount installed, but no fewer than [**5**] units, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical ceiling area[**as shown on Drawings**][**96 inches (2400 mm) wide by full width of ceiling**].[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and stretched-fabric system manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install stretched-fabric systems until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install stretched-fabric systems until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**] is provided on surfaces to receive stretched-fabric systems.

C. Air-Quality Limitations: Protect stretched-fabric systems from exposure to airborne odors, such as tobacco smoke, and install systems under conditions free from odor contamination of ambient air.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of stretched-fabric systems that fail in performance, materials, or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Acoustical performance.
b. Fabric sagging, distorting, or releasing from panel edge.
c. Warping of core.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain stretched-fabric ceiling systems specified in this Section[**and stretched-fabric wall systems specified in Section 097713 "Stretched-Fabric Wall Systems"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Stretched-fabric ceiling systems comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency on systems prepared in accordance with ASTM E2573. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 286.

2.3 STRETCHED-FABRIC CEILING SYSTEMS

A. Stretched-Fabric Ceiling System : Manufacturer's standard system consisting of facing material stretched tightly over a frame[**and core material**] and secured in the frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Accutrack Systems, LLC**]
   b. [**Acoustical Fabric Systems Inc**]
   c. [**Novawall Systems, Inc**]
   d. [**SnapTex International LLC**]
   e. [**SoftWalls, Inc.**]
   f. [**Whisper Walls**]

2. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber board**][**Cementitious-fiber board**][**Medium-density fiberboard**][**Particleboard**].

   a. Nominal Core Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

3. Core Overlay: Polyester batting [**1/2 inch (13 mm) thick**][**Manufacturer's standard thickness**].
4. Frame Edge: [**Chamfered (beveled)**][**Radiused (bullnosed)**][**Square**] profile.

   a. Fabric-Insertion Point: [**Bottom load**][**Side load**][**Top load**].
   b. Nominal Frame Thickness: [**Match nominal core thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

5. Frame Color: [**Natural**][**Black**][**White**][**Prepainted color as selected by Architect from full range of manufacturer's colors**], as directed by the Owner.
6. Reveals between Panels: [**Recessed**][**Flush**][**Projecting**] reveals [**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.
7. Facing Material: [**the Owner-furnished material**][**As indicated on Drawings**].
8. Acoustical Performance: Sound absorption [NRC][SAA] of [0.50 to 0.90][0.60 to 0.70][0.65 to 0.75][not less than 0.65][not more than 0.35] in accordance with ASTM C423 for [Type A] mounting in accordance with ASTM E795.
9. Nominal Overall System Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

2.4 MATERIALS

A. Sustainable Design Requirements:

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612, of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**], unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Glass-Fiber Blanket: ASTM C553, ASTM C612, or ASTM C665; of type standard with manufacturer; nominal density of [**3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)**]; flexible; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13 lb/cu. ft. (208 kg/cu. m)**][**20 lb/cu. ft. (320 kg/cu. m)**], and with perforated surface.
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**].
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**].

    a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less when tested in accordance with ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**].

    a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested in accordance with ASTM E84 or UL 723.

7. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.

C. Frame Construction: Manufacturer's standard, continuous, extruded plastic frame (track).

D. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's**

designations][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Fiber Content: [**100**] percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**acoustically transparent vinyl**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**flame retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**].
4. Light Reflectance: Average value not less than [**0.75**] when tested in accordance with ASTM E1477.
5. Lining Material: [**Manufacturer's standard fabric for each use indicated**].

E. Lining Material : Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Color: [**White**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**].

F. Trim Strip : Fabric [**matching facing material except as follows**].

1. Color: [**White**].

2.5 INSTALLATION MATERIALS

A. Installation Products: Concealed on back of system, recommended by stretched-fabric system manufacturer to support weight of system, fabric tension, and as follows:

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
7. Fasteners: [**Manufacturer's standard**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, materials, substrates, areas, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of stretched-fabric systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each area and establish layout of panels and joints of [**uniform size with balanced borders at opposite edges**][**sizes indicated on Drawings**] within a given area.

B. Before installation, allow fabric to adjust and become stable in spaces where it will be installed according to stretched-fabric system manufacturer's written instructions. Acclimatize fabric for minimum of [**24**] hours at ambient temperature and humidity conditions indicated for spaces when occupied for their intended use.

3.3 INSTALLATION OF STRETCHED-FABRIC CEILING SYSTEMS

A. Install stretched-fabric ceiling systems according to system manufacturer's written instructions.

1. Provide continuous perimeter frames of each profile indicated, designed to be inconspicuous when covered by fabric facing, with smooth edges, and with surface finish that will not telegraph through fabric facing.
2. Install framing around penetrations.
3. Tightly fit framing to adjacent construction and securely attach to substrate.
4. Install core material with full coverage, flush with face of stretched-fabric system frame.
5. Attach frame and core to substrate with adhesive or fasteners, or both, to support system and prevent deformation of components.
6. Install stretched-fabric systems true in plane and with fabric square to the grain.
7. Install jointed panels with [**butt joints**][**and**][**reveals**] as indicated.

B. Fabric Installation: Apply fabric monolithically in continuous run over area, without joints or reveals, except where panel joints or midspan frames are indicated.

1. Fabric Direction: Run fabric [**as indicated on Drawings**].
2. Fabric Sequence: Maintain sequence of fabric drops; match and level fabric pattern and grain.
3. Fabric Alignment: Install fabric with patterns or directional weaves so pattern or weave [**aligns with adjacent panels**][**varies from adjacent panels as indicated on Drawings**].
4. Fabric Seams:

   a. Sewn seams are not permitted.
   b. [**Manufacturer's standard**][**Flat standard**][**French**][**Welt-trimmed**] sewn seams, straight and parallel; seam dimensions and locations as indicated on Drawings.

5. Core Overlay: Evenly stretch over core face and edges; free from puckers, ripples, wrinkles, and sags.
6. Stretch and secure fabric to frame edges and so frame and frame attachment method are

concealed by fabric unless otherwise indicated.

7. Stretch fabric tightly and square without puckers, ripples, or distortions. Acclimatize and restretch if recommended by stretched-fabric system manufacturer. Repair distortions, wrinkles, and sagging.
8. Trim Strip: Back-wrap trim strip fabric from the fabric-insertion point over the exposed part of the frame edge where indicated, resulting in a contrasting fabric along the edge.

3.4 INSTALLATION TOLERANCES

A. Edge Straightness: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**.

B. Variation from Alignment with Surfaces: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**, noncumulative.

C. Variation from Level or Slope: Plus or minus [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**].

D. Variation of Joint Width: Not more than [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)** from [**hairline**][**reveal line**], noncumulative.

3.5 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 09 54 00 00

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SECTION 09 54 00 00A - FABRIC-WRAPPED CEILING PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Shop-fabricated, fabric-wrapped ceiling panels.

B. Related Requirements:

1. Section 095443 "Stretched-Fabric Ceiling Systems" for site-upholstered systems applied to ceilings[**and for coordinated requirements for fabric**].
2. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
3. Section 098436 "Sound-Absorbing Ceiling Units" for shop-fabricated, acoustical ceiling panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each product.

1. Include[**fabric facing,**] panel edge, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
5. Chain-of-Custody Qualification Data: For manufacturer and vendor.
6. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel assembly and installation.

1. Include reflected ceiling plans, elevations, sections, and mounting devices and details.
2. Include details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate panel edge profile and core materials.
3. Include direction of fabric weave and pattern matching.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of hardware and accessories involving color or finish selection.

E. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**] long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: **12-inch- (300-mm-)** long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately **36 by 36 inches (900 by 900 mm)**, including joints and mounting methods.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets.
2. Suspended ceiling components above ceiling panels.
3. Structural members to which suspension devices will be attached.
4. Items penetrating or covered by panels including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.

5. Show operation of hinged and sliding components covered by or adjacent to panels.

B. Product Certificates: For each type of panel.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of panel to include in maintenance manuals. Include fabric manufacturer's written cleaning and stain-removal instructions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged

with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, furnish length equal to [**10**] percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**], full width of bolt.
2. Mounting Devices: Full-size units equal to [**5**] percent of amount installed, but no fewer than [**five**] devices.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical ceiling area[**as shown on Drawings**][**96 inches (2400 mm) wide by full width of ceiling**].[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install panels until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install fabric-wrapped ceiling panels until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**] is provided on surfaces to receive the panels.

C. Air-Quality Limitations: Protect panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify panel locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace panels and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Fabric sagging, distorting, or releasing from panel edge.
b. Warping of core.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabric-wrapped ceiling panels[**and fabric-wrapped wall panels specified in Section 097723 "Fabric-Wrapped Panels"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Panels are to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 286.

2.3 SHOP-FABRICATED FABRIC-WRAPPED CEILING PANELS

A. Fabric-Wrapped Ceiling Panel : Manufacturer's standard panel construction consisting of facing material [**laminated to front face, edges, and back edge border of core**][**stretched over front face of edge-framed core and bonded or attached to edges and back of frame**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Acoustical Panel Systems (APS, Inc.)**]
b. [**Acoustical Solutions**]
c. [**Armstrong Ceiling & Wall Solutions**]
d. [**Armstrong World Industries**]
e. [**AVL Systems, Inc**]
f. [**Benton Brothers Solutions, Inc.**]
g. [**Conwed**]
h. [**Decoustics; CertainTeed Architectural Products; a Saint Gobain company**]
i. [**Essi Acoustical Products**]
j. [**G&S Acoustics**]
k. [**Lamvin, Inc**]
l. [**MBI Products Company, Inc**]
m. [**Perdue Acoustics**]
n. [**Sound Concepts**]
o. [**Sound Management Group LLC**]
p. [**Wenger Corporation**]

2. Panel Shape: [**Flat**][**As indicated on Drawings**].
3. Mounting: Back mounted with manufacturer's standard [**metal clips**][**suspension system**][**suspension system with stiffening, back-support angles**], secured to substrate.
4. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber board**][**Cementitious-fiber board**][**Medium-density fiberboard**][**Particleboard**].
5. Core Overlay: Polyester batting [**1/2 inch (13 mm) thick**][**manufacturer's standard thickness**].
6. Edge Construction: Manufacturer's standard [**chemically hardened core with no frame**][**extruded-aluminum or zinc-coated, rolled-steel frame**][**extruded PVC frame**][**wood frame, rabbeted, and splined with glued joints and machined corners**].
7. Edge Profile: [**Chamfered (beveled)**][**Eased (small radius)**][**Mitered (beveled to a point)**][**Radiused (bullnosed)**][**Square**][**Custom profile as indicated on Drawings**].
8. Corner Detail in Elevation: [**Square**][**Round, radius as indicated on Drawings**][**Custom as indicated on Drawings**] with continuous edge profile indicated.
9. Reveals between Panels: [**Recessed**][**Flush**][**Projecting**] reveals [**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.
10. Facing Material: [**the Owner-furnished material**][**As indicated on Drawings**].
11. Nominal [**Core**][**Overall Panel**] Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].
12. Panel Width: [**24 inches (610 mm)**][**30 inches (762 mm)**][**48 inches (1220 mm)**][**As indicated on Drawings**].
13. Panel Height: [**72 inches (1829 mm)**][**96 inches (2438 mm)**][**108 inches (2743 mm)**][**120 inches (3048 mm)**][**As indicated on Drawings**].

2.4 MATERIALS

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

H. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

I. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

J. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

K. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

L. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

M. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

N. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

O. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

P. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612, of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**], unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2. Glass-Fiber Blanket: ASTM C553, ASTM C612, or ASTM C665; of type standard with manufacturer; nominal density of [**3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)**]; flexible; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13-lb/cu. ft. (208-kg/cu. m)**][**20-lb/cu. ft. (320-kg/cu. m)**].
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**].
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**].

    a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less when tested in accordance with ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**].

    a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested in accordance with ASTM E84 or UL 723.

7. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.
8. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

    a. Fire-retardant treated by pressure process with a flame spread index of 25 or less when tested in accordance with ASTM E84 or UL 723, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

        1) Treated material is to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity.
        2) Kiln-dry material after treatment to 19 percent or less for lumber and 15 percent or less for plywood.

Q. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Fiber Content: [**100**] percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**vinyl**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**flame-retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**].
4. Light Reflectance: Average value not less than [**0.75**] when tested in accordance with ASTM E1477.
5. Lining Material: [**Manufacturer's standard fabric for each use indicated**].

R. Lining Material : Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Color: [**White**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**].

S. Mounting Devices: Concealed on back of panel, recommended by manufacturer to support weight of panel.

2.5 FABRICATION

A. Standard Construction: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Measure each area and establish layout of panels and joints of [**uniform size with balanced borders at opposite edges**][**sizes indicated on Drawings**] within a given area.

C. Edge Hardening: For [**glass-fiber board**][**and**][**mineral-fiber board**] cores, chemically harden core edges and areas of core where mounting devices are attached.

D. Core Overlay: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

E. Facing Material[**and Lining Material**]: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.[**Heat seal vinyl fabric seams at corners.**]
2. Radius and Other Nonsquare Corners: Attach material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches adjacent panels.

F. Dimensional Tolerances of Finished Panels: Plus or minus **1/16 inch (1.6 mm)** for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated panels, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting panel performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panels in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with panel manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.

C. Align fabric pattern and grain[**with adjacent panels**][**as shown on Drawings**].

3.3 INSTALLATION TOLERANCES

A. Variation from Alignment with Surfaces: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**, noncumulative.

B. Variation from Level or Slope: Plus or minus [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**].

C. Variation of Joint Width: Not more than [**1/16 inch (1.6 mm)**][**1/32 inch (0.79 mm)**] wide from [**hairline**][**reveal line**] in **48 inches (1200 mm)**, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 09 54 00 00A

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Task	Specification	Specification Description
09 54 16 00	09 54 00 00	Stretched-Fabric Ceiling Systems
09 54 16 00	09 54 00 00a	Fabric-Wrapped Ceiling Panels

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SECTION 09 54 23 00 - LINEAR METAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Linear metal ceilings.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 COORDINATION

A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.5 ACTION SUBMITTALS

A. Product Data: For linear metal ceilings.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For linear metal ceilings.

1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:

a. Linear ceiling patterns and joints.
b. Ceiling suspension members.
c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.

e. Ceiling perimeter and penetrations through ceiling; trim and moldings.

D. Samples: For each exposed product and for each type, color, and finish specified, **12 inches (305 mm)** long in size.

E. Samples for Initial Selection: For units with factory-applied colors and finishes.

1. Include Samples of accessories involving color and finish selections.

F. Samples for Verification: For the following products:

1. Linear Metal Pans: **12 inches (305 mm)** long by full-width Samples of each type, color, and finish and a **12-inch- (305-mm-)** long spliced section.
2. Suspension-System Members: **12-inch- (305-mm-)** long Sample of each type.
3. Exposed Molding and Trim: **12-inch- (305-mm-)** long Samples of each type, color, and finish.
4. Filler Strips: **12-inch- (305-mm-)** long Samples of each type, color, and finish.
5. Sound Absorbers: **12 inches (305 mm)** long by full width.
6. End Caps: Full size.

G. Delegated Design Submittals: For design of[**seismic restraints and**] attachment devices.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.

C. Evaluation Reports: For linear-metal-ceiling framing systems.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Linear-Metal-Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to [**2**] percent of quantity installed.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of each type of linear metal ceiling as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

D. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

F. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle ceiling components and accessories in a manner that prevents damage.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements" to design [**seismic restraints and**]attachment devices.

B. Structural Performance: Exterior linear metal ceilings to withstand exterior exposure, the effects of gravity loads, and the following loads and stresses without showing permanent deformation of ceiling system components, including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:

1. Wind Load: Uniform pressure [**indicated on Drawings**], acting inward or outward.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces**].

D. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of

earthquake motions in accordance with [**ASTM E580/E580M**][**CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2"**][**CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4"**][**ASCE/SEI 7**]<**Insert requirements**> and requirements of authorities having jurisdiction.

E. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 LINEAR METAL CEILINGS

A. Pans and Suspension System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Decorative Ceilings, Inc.**]
   b. [**Armstrong Ceiling & Wall Solutions**]
   c. [**B+N Industries, Inc.**]
   d. [**Rockfon; ROCKWOOL International**]
   e. [**USG Corporation**]

B. Metal Pans: Complying with ASTM E1264 for [**Type XIII**][**Type XX**] and formed to snap on to carriers securely, without separate fasteners.

1. Surface-Burning Characteristics: For metal-pan assemblies, including backings, determined by testing in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**50**][**55**] or less.

2. Metal: [**Aluminum sheet, ASTM B209 (ASTM B209M), alloy and temper recommended by producer and finisher for type of use and finish indicated**][**Electrolytic zinc-coated steel sheet, ASTM A879/A879M, 04Z (12G) coating; surface treatment as recommended by finish manufacturer for type of use and painted finish indicated**].
3. Form: [**Perforated**][**Nonperforated**].

   a. Perforation Pattern: [**As indicated by manufacturers designation**].

4. Noise Reduction Coefficient (NRC) Rating: Not less than [**0.70**][**0.75**][**0.85**][**1.00**] when tested in accordance with ASTM C423.
5. Backing: [**Manufacturer's standard to provide NRC rating indicated for perforation pattern indicated**][**Nonwoven black fabric**][**Nonwoven black fabric with 1-inch- (25-mm-) thick glass fiber, 1 lb/cu. ft. (16 kg/cu. m) density, enclosed in black polyethylene**][**1-inch- (25-mm-) thick glass fiber, 1 lb/cu. ft. (16 kg/cu. m) density, enclosed in black polyethylene**].
6. Pan Thickness: Not less than [**0.020 inch (0.51 mm)**][**0.025 inch (0.64 mm)**][**0.028 inch (0.71 mm)**][**0.040 inch (1.02 mm)**].
7. Pan Edge Detail: [**Beveled**][**Square**][**Round**][**Manufacturer's standard**].
8. Pan Width: [**2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width**][**4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width**][**6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width**][**8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width**][**As indicated on Drawings**].

9. Pan Depth: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**As indicated on Drawings**].
10. Metal-Pan Finish: Protected on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping and as follows:

    a. Aluminum Anodic Finish: [**Clear finish, AAMA 611, AMP 500 AA-M12C22A31, Class II, 0.010 mm or thicker**][**Clear, mirror finish, AMP 500 AA-M21C12A212, 0.005 mm or thicker**].
    b. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

        1) Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's product designation**], as directed by the Owner.
        2) Light Reflectance (LR) Coefficient: Not less than [**0.61**][**0.77**][**0.81**] LR when tested in accordance with ASTM E1477.

    c. Laminated-Film Finish: Provide [**manufacturer's standard**][**vinyl**][**PVC-free**] film permanently bonded to metal pan with adhesive.

        1) Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's product designation**], as directed by the Owner.

    d. Wood-Veneer Finish: [**Match Architect's sample**][**As indicated by manufacturer's product designation**][**Wood veneer in species and finish selected by Architect from manufacturer's full range**]; permanently bonded to metal pan with adhesive, as directed by the Owner.
    e. Finish Bonding Adhesive: Manufacturer's standard that permanently bonds finish to aluminum.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

D. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Wood products shall be labeled according to the AFPA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

G. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AFPA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

I. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Adhesives: Do not use adhesives that contain urea formaldehyde.

L. Adhesives: Do not use adhesives that contain urea formaldehyde.

M. Pan Splices: Formed for snap fit into butt-cut pans, [**4 inches (102 mm)**][**8 to 12 inches (203 to 305 mm)**] long.

1. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**].

N. End Caps: Manufacturer's standard material fabricated to fit and conceal exposed ends of pans.

1. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**].

O. Filler Strips: Manufacturer's standard, fabricated to close voids between pans.

1. Type: [**Recessed**][**Flush**][**Integral extension of pan profile**][**Expansion, for use with expansion carriers**][**Slotted, for air diffusion**].
2. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**].

P. Moldings and Trim: Manufacturer's standard for exposed members, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

Q. Carrier Suspension System: Manufacturer's standard complying with requirements in ASTM C635/C635M for applications indicated; complete with carriers, splice sections, stabilizing components, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.

1. Material: [**ASTM A653/A653M, hot-dip galvanized, cold-rolled sheet steel, G60 (Z180) coating designation**][**ASTM A879/A879M, electrolytic zinc-coated, cold-rolled steel, 08Z (24G) coating designation**][**ASTM B209 (ASTM B209M) aluminum**].
2. Structural Classification: [**Heavy-duty**] system.
3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
4. Flexible Radial Carriers: Manufacturer's standard radial carriers.
5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
6. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers.
7. Carrier Splices: Same metal, profile, and finish as for carriers.
8. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
9. Carrier Finish: [**Flat black**].

2.3 CARRIER-SYSTEM HANGERS, BRACES, AND TIES

A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.

1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**5**] times that imposed by ceiling construction as determined by testing in accordance with ASTM E488/E488M or ASTM E1512, as applicable, conducted by a qualified testing and inspecting agency.

a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
b. Corrosion Protection:

1) Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
2) Stainless steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
3) Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to [**10**] times that imposed by ceiling construction as determined by testing in accordance with ASTM E1190 conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provides not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**] diameter wire.

C. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed from **0.04-inch- (1.0-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

E. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.

F. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A653/A653M, **G60 (Z180)** coating designation; size and profile as required to withstand wind load.

2.4 ACCESSORIES

A. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors permitting upward or downward opening.

1. Size: [**As indicated on Drawings**][**24 inches (610 mm) square**].

B. Air-Distribution Devices: Where indicated on Drawings, provide independently suspended air-distribution devices that are relocatable and adjustable from below finished ceiling, that do not interrupt ceiling components, and that are fully concealed by and integrated with ceiling system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of linear metal pans.

1. Balance border widths at opposite edges of each ceiling.
2. Avoid using less-than-half-width pans at borders.

3.3 INSTALLATION OF LINEAR METAL CEILINGS

A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in **3 inches (76 mm)**. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts[power-actuated fasteners,] or postinstalled mechanical or adhesive anchors that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1219 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (203 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in **1-1/2 inches (38 mm)**. Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.

1. Screw attach moldings to substrate at intervals of not more than **16 inches (406 mm)** o.c. and not more than **3 inches (76 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3 mm in 3.7 m)**. Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system carriers so they are aligned and securely interlocked with one another.

1. Install stabilizer channels, tees, and bars at regular intervals to stabilize carriers and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated.
2. Remove and replace dented, bent, or kinked members.

F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness.

G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.

1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated on Drawings.
2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.

   a. Install pans with butt joints [**aligned**][**aligned, every other pan length**][**staggered a minimum of 12 inches (305 mm)**][**randomly aligned**][**aligned as indicated on Drawings**] using internal pan splices.

3. Install directionally textured or patterned metal pans in directions indicated.
4. Where metal pan ends are visible, install end caps unless trim is indicated.
5. Install filler strips where indicated [**on Drawings**].
6. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.

H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**the Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers, anchors, and fasteners to take place in successive stages, in test areas and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before pans have been installed.

a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 lbf (1957 N)** of tension.
b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Linear metal ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 54 23 00

Task	Specification	Specification Description
09 54 23 00	09 51 33 00	Acoustical Metal Pan Ceilings
09 54 23 00	09 54 00 00	Stretched-Fabric Ceiling Systems
09 54 23 00	09 54 00 00a	Fabric-Wrapped Ceiling Panels

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SECTION 09 63 13 00 - BRICK FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick flooring set on thickset mortar bed.
2. Brick flooring set in thinset mortar directly on concrete.

B. Related Requirements:

1. [**Section 071326 "Self-Adhering Sheet Waterproofing"**][**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**][**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**][**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing under brick flooring.
2. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in brick flooring.
3. Section 096313.35 "Chemical-Resistant Brick Flooring" for brick flooring set with chemical-resistant materials.
4. Section 321400 "Unit Paving" for brick pavers installed in pavement applications (exterior) rather than as flooring (interior).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

a. Brick.
b. Packaged mortar mixes.
c. Packaged grout mixes.
d. Mortar and grout additives.
e. Sealer.
f. Floor polish.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means

of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.

C. Samples for Initial Selection: For each type of brick[**and for grout and accessories involving color selection**].

D. Samples for Verification: Full-size units of each type of brick[**with joints grouted and cured**].

1. Seal and polish Samples on one-half of exposed traffic surface.

1.4 INFORMATIONAL SUBMITTALS

A. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply sealer and floor polish over one-half of mockup's traffic surface.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store bricks on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Deliver, store, and handle bricks that have temporary protective coating, with coated surfaces placed against other coated surfaces. Do not allow coated surfaces to come in contact with uncoated surfaces.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and where contamination can be avoided.

E. Store liquids in tightly closed containers protected from freezing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not set brick flooring when air temperature or material temperature is below **40 deg F (4.4 deg C)**. Maintain minimum ambient temperature of **40 deg F (4.4 deg C)** during installation and for 48 hours after completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of brick and joint material from single source from single manufacturer or producer.

2.2 BRICK PAVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Brick Company**]
2. [**Belden Brick Company (The)**]
3. [**Boral Bricks, Inc; Boral Limited**]
4. [**Endicott Clay Products Co**]
5. [**General Shale, Inc.**]
6. [**Glen-Gery Corporation**]
7. [**Hastings Pavement Company, LLC**]
8. [**I-XL Industries Ltd.**]
9. [**Interstate Brick; Basalite Concrete Products, LLC; Pacific Coast Building Products, Inc.**]
10. [**Pine Hall Brick Company**]
11. [**Redland Brick Inc.**]
12. [**Whitacre Greer Company**]

B. Brick Pavers: Light-traffic paving brick complying with ASTM C902, [**Class SX**][**Class MX**][**Class NX**], [**Type I**][**Type II**][**Type III**], [**Application PS**][**Application PX**][**Application PA**], without frogs or cores in surfaces exposed to view in the completed Work.

C. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)**

of Project site.

F. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Size: [**As indicated.**][**Actual dimensions as follows:**]

1. Thickness: [**1-1/4 inches (32 mm)**][**1-5/8 inches (41 mm)**][**2-1/4 inches (57 mm)**].
2. Face Dimensions: [**3-5/8 by 7-5/8 inches (92 by 194 mm)**][**4 by 8 inches (102 by 203 mm)**][**3-5/8 by 11-5/8 inches (92 by 295 mm)**][**7-5/8 by 7-5/8 inches (194 by 194 mm)**].

I. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Temporary Protective Coating: Precoat exposed surfaces of brick pavers[**at factory**] with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

B. Hydrated Lime: ASTM C207, Type S.

C. Aggregate: ASTM C144.

D. Latex Additive: [Manufacturer's standard][acrylic resin][styrene-butadiene-rubber] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

E. Cleavage Membrane: Asphalt-saturated felt, ASTM D226/D226M, Type I (No. 15); or polyethylene sheeting, ASTM D4397, **4.0 mils (0.1 mm)** thick.

F. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062 inch (1.57 mm)** in diameter; in compliance with ASTM A1064/A1064M.

G. Thinset Mortar: Latex-portland-cement mortar complying with ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Parex, a Sika brand**]
k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
l. [**Sakrete; CRH Americas, Oldcastle APG**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with [acrylic resin][styrene-butadiene-rubber] liquid-latex additive at Project site.
4. Provide product that is approved by manufacturer for application thickness of [**5/8 inch (16 mm)**].

2.4 GROUT MATERIALS

A. Sand-Portland-Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in portland-cement grout.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]

B. Standard Cement Grout: ANSI A118.6, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]

j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]

C. High-Performance Tile Grout: ANSI A118.7, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

2. Polymer Type:

a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
b. [Acrylic resin][styrene-butadiene rubber] in liquid-latex form for addition to prepackaged dry-grout mix.

D. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Water: Potable.

2.5 MISCELLANEOUS MATERIALS

A. Expansion- and Control-Joint-Filler Strips: ASTM D1752, cork or self-expanding cork.

B. Sealer: Colorless, stain- and slip-resistant sealer, not affecting color or physical properties of brick and grout surfaces and specifically recommended by sealer manufacturer for use indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Custom Building Products**]
b. [**Hillyard, Inc.**]
c. [**HMK Stone Care System; ACI International**]
d. [**Summitville Tiles, Inc.**]

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Floor Polish: ASTM D4078, formulated for use over sealer indicated, acceptable to sealer manufacturer, and specifically recommended by floor-polish manufacturer for use indicated.

1. Slip Resistance: Floor polish to have a static coefficient of friction of at least 0.5 when tested according to ASTM D2047.
2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout when they have reached their initial set.

B. Portland-Cement-Lime Setting-Bed Mortar: ASTM C270, [**Type S**][**Type N**], Proportion Specification.

C. Latex-Modified Portland-Cement Setting-Bed Mortar: Proportion and mix according to written instructions of liquid-latex manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive brick.

D. Mortar-Bed Bond Coat: Mix neat cement and [**latex additive**][**water**] to a creamy consistency.

E. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

F. Portland-Cement Bond Coat: Mix neat cement and water to a creamy consistency.

G. Thinset Mortar: Proportion and mix according to manufacturer's written instructions.

H. Job-Mixed Grout: Proportion and mix portland cement and aggregate grout to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.

1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

I. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive brick flooring, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF SUBFLOOR

A. Sweep subfloor to remove dirt, dust, debris, and loose particles.

B. Remove substances from subfloor that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

3.3 INSTALLATION, GENERAL

A. Do not use bricks with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in the finished Work.

B. Mix bricks from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut bricks with motor-driven masonry saw to provide clean, sharp, unchipped edges. Hammer cutting is not acceptable. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

D. Joint Pattern: [**Running bond**][**Herringbone**][**Basket weave**][**As indicated**][**Match existing brick flooring joint pattern**].

E. Hand-Tight Joints: Set brick with hand-tight joints[**where indicated**].

F. Spaced Joint Widths: Provide nominal [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**] joint width with variations not exceeding plus or minus [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**][**unless otherwise indicated**].

G. Finished-Surface Tolerances:

1. Do not exceed **1/32-inch (1-mm)** brick-to-brick offset from flush (lippage) or **1/8 inch in 10 feet (3 mm in 3 m)** from level, or indicated slope, for finished surface of brick flooring.
2. Do not exceed **1/16-inch (1.5-mm)** brick-to-brick offset from flush (lippage) nor **1/8 inch in 24 inches (3 mm in 600 mm)** and **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of brick flooring.

H. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide joint filler as backing for sealant-filled joints where indicated. Install joint filler before setting brick flooring. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

3.4 THICKSET BRICK FLOORING

A. Apply mortar bed to concrete subfloors to comply with the following requirements:

1. Saturate concrete subfloor with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subfloor about 15 minutes before placing mortar bed. Do not exceed **1/16-inch (1.6-mm)** thickness. Limit area of mortar-bed bond coat to avoid its drying out before placing setting bed.
3. Place reinforcing wire fabric over mortar-bed bond coat, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately **1/2 inch (13 mm)**.
4. Apply mortar bed immediately after applying mortar-bed bond coat. Spread and screed setting bed to uniform thickness at elevations required for accurate setting of brick to finished elevations indicated.
5. Brick Wet Set on Workable Mortar Bed: Mix and place only that amount of mortar bed that can be covered with brick before initial set. Cut back, bevel edge, and discard setting-bed material that has reached initial set before placing brick.
6. Brick Set on Cured Mortar Bed: Cure mortar bed for not less than 20 hours at **70 deg F (21 deg C)**.

B. Apply mortar bed over [**cleavage membrane**][**waterproofing**] to comply with the following requirements:

1. Place cleavage membrane over subfloor surfaces indicated to receive brick flooring, lapped at least **4 inches (100 mm)** at joints.
2. Place reinforcing wire fabric over membrane, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately **1/2 inch (13 mm)**.
3. Place mortar bed over cleavage membrane with reinforcing wire fabric fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at elevations required for accurate setting of brick to finished elevations indicated.
4. Brick Wet Set on Workable Mortar Bed: Mix and place only that amount of mortar bed that can be covered with brick before initial set. Cut back, bevel edge, and discard setting-bed material that has reached initial set before placing brick.
5. Brick Set on Cured Mortar Bed: Cure mortar bed for not less than 20 hours at **70 deg F (21 deg C)**.

C. Install brick either in workable mortar bed or over cured mortar bed at Contractor's option.

D. Install brick in workable mortar bed to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)**

per minute when tested according to ASTM C67. Allow brick to absorb the water so it is damp but not wet at the time of laying.

2. Place brick before initial set of mortar takes place. Immediately before placing brick on setting bed, apply uniform **1/16-inch- (1.6-mm-)** thick bond coat to mortar bed or to back of each brick with a flat trowel.
3. Tamp or beat brick with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each brick in a single operation before initial set of mortar; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

E. Install brick over cured mortar bed to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested according to ASTM C67. Allow brick to absorb the water so it is damp but not wet at the time of laying.
2. Apply thinset mortar to setting bed with notched trowel complying with manufacturer's specifications for notch depth and configuration and in heavy enough layer to provide a minimum mortar-bed thickness of **3/32 to 1/8 inch (2.5 to 3 mm)** after bricks are fully embedded. Key the mortar into setting bed with flat side of trowel and comb with notched side of trowel in one direction. Apply only as much mortar as can be covered with brick before initial set (15 to 30 minutes).
3. Place brick while thinset mortar is still tacky and before initial set takes place. Immediately before placing brick on setting bed, apply skim coat of thinset mortar to back of brick. Place brick by sliding in direction perpendicular to combed ridges, and tamp or beat brick with a small beating block to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

3.5 THINSET BRICK FLOORING

A. Install brick flooring on concrete subfloor with thinset mortar to comply with the following requirements:

1. Wet brick before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested according to ASTM C67. Allow brick to absorb the water, so it is damp but not wet at the time of laying.
2. Apply thinset mortar to subfloor with notched trowel complying with manufacturer's specifications for notch depth and configuration and in heavy enough layer to provide a minimum mortar-bed thickness of **3/32 to 1/8 inch (2.5 to 3 mm)** after bricks are fully embedded. Key the mortar into substrate with flat side of trowel and comb with notched side of trowel in one direction. Apply only as much mortar as can be covered with brick before initial set (15 to 30 minutes).
3. Place brick while mortar is still tacky and before initial set takes place. Immediately before placing brick, apply skim coat of thinset mortar to back of brick. Place brick by sliding in direction perpendicular to combed ridges, and tamp or beat brick with a small beating block to obtain full contact with mortar and to bring finished surfaces within indicated tolerances; do not return to areas already set and disturb bricks for purposes of realigning finished surfaces or adjusting joints.

3.6 JOINT TREATMENT

A. Hand-Tight Joints: Sweep dry mixture of portland cement and sand into joints, then fog surface with water to set mixture.

B. Grouted Joints: Grout brick joints complying with ANSI A108.10.

C. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining brick and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free from drying cracks.

D. Cure grout by maintaining it in a damp condition for seven days unless otherwise recommended by grout manufacturer.

E. Movement Joints: Provide expansion, control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and brick. Do not saw-cut joints after installing brick flooring. Keep joint free of mortar and other rigid materials.

1. Where joints occur in concrete substrates, locate joints in brick flooring directly above them.

3.7 REPAIR, POINTING, CLEANING, AND PROTECTION

A. Remove and replace bricks that are loose or damaged or that do not match other bricks. Provide new bricks to match adjoining bricks and install in same manner as original bricks, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess mortar and grout from exposed brick surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to brick and grout manufacturers. Trap and remove coating to prevent it from clogging drains.

D. Sealing and Polishing: After floor has been cleaned and is thoroughly dry, seal and polish traffic surface of brick flooring in a manner that results in a clear, uniform appearance. Apply sealer and floor polish in the number of coats and by application methods that comply with written directions of manufacturer of each product. Do not apply floor polish until sealer has dried.

END OF SECTION 09 63 13 00

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Task	Specification	Specification Description
09 63 43 00	09 67 23 00	Resinous Flooring

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SECTION 09 64 00 00 - WOOD FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-wood flooring.
2. Solid-wood parquet flooring.
3. Engineered-wood flooring.
4. Engineered-wood parquet flooring.
5. Field finishes.
6. Sound control underlayment.

B. Related Requirements:

1. Section 096436 "Bamboo Flooring" for solid-bamboo and engineered-bamboo flooring.
2. Section 096466 "Wood Athletic Flooring" for resilient-wood flooring systems used in sports-activity areas.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review methods and procedures related to resilient athletic flooring installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for wood flooring.
2. Include manufacturer's written installation instructions for each type of substrate.

B. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.

C. Samples: For each exposed product and for each color and texture specified, approximately [**12 inches (300 mm) long**] and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and finishes available for wood flooring.

1. Include Samples of accessories involving color and finish selection.

E. Samples for Verification: For each type of wood flooring and accessory, with stain color and finish required, approximately [**12 inches (300 mm) long**] and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

F. Sustainable Design Submittals:

1. Product Data: Verify compliance with requirements for Forest Stewardship Council U.S. (FSC).
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Laboratory Test Reports: Verify compliance with VOC emissions evaluation criteria.
5. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation criteria.
6. Product Data: For installation adhesives, indicating VOC content.
7. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For installation adhesives, indicating compliance with VOC emissions evaluation criteria.
9. Product Data: For coatings, indicating VOC content.
10. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
11. Product Data: For coatings, indicating compliance with VOC emissions evaluation criteria.
12. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.
13. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

14. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.
    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

15. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

16. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment

completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wood flooring and finish systems.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wood Flooring: Equal to [**1**] percent of amount installed for each type, color, and finish of wood flooring indicated.

1.6 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood flooring materials in unopened cartons or bundles.

B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet-work is complete and dry.

C. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

1.8 FIELD CONDITIONS

A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.

1. Environmental Conditioning: Maintain ambient temperature between **65 and 75 deg F (18 and 24 deg C)** and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.
2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.

a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.

B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sound Transmission Characteristics (STC): Provide wood flooring and sound control underlayment systems identical to those of assemblies laboratory tested for STC [**50**] and Impact Insulation Class (IIC) [**50**] ratings in accordance with ASTM E90 and ASTM E492 by a qualified testing agency.

B. Field Sound Transmission Class (FSTC): Unless otherwise noted, provide wood floor and ceiling assembly with minimum FSTC rating of [**45**] between housing units for each assembly indicated. Sound transmission loss is to be measured in accordance with ASTM E336, with calculation procedures as defined in ASTM E413.

C. Field Impact Isolation Classification (FIIC): Unless otherwise noted, provide wood floor and ceiling assembly with minimum FIIC rating of [**45**] between housing units for each assembly indicated. Transmission of impact sound is to be measured in accordance with ASTM E1007. Minimum Impact Insulation Class (IIC) of [**50**][**55**] when tested in accordance with ASTM E492.

D. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

F. Verify flooring products comply with VOC emissions evaluation criteria.

G. Certified Wood: Verify product is certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Verify product is labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

I. Certified Wood: Verify product is certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

J. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

L. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

M. Verify products comply with VOC emissions evaluation criteria.

2.2 SOLID-WOOD FLOORING

A. Solid-Wood Flooring, Field Finished: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AHF Products**]
b. [**Appalachian Flooring**]
c. [**Carlisle Wide Plank Floors**]
d. [**Oregon Lumber Company**]
e. [**Somerset Hardwood Flooring**]
f. [**WD Flooring, LLC**]

2. Performance Requirements:

a. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

1) Certification: Provide flooring that carries NWFA grade stamp on each bundle or piece.

b. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.

1) Certification: Provide flooring that carries MFMA mark on each bundle or piece.

c. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

3. Grade and Species: [**Clear red oak**][**Select red oak**][**No. 1 Common red oak**][**No. 2 Common red oak**][**MFMA-RL First Grade hard maple**][**MFMA-RL Second and Better Grade hard maple**][**Grade C & BTR - Flooring Douglas fir**][**Grade D - Flooring Douglas fir**].
4. Cut: [**Plain sawn**][**Quarter/rift sawn**][**Edge grain**][**Vertical grain**].
5. Thickness: [**25/32 inch (20 mm)**][**3/4 inch (19 mm)**].
6. Face Width: [**2-1/4 inches (57 mm)**][**3-1/4 inches (83 mm)**][**5-1/8 inches (130 mm)**].
7. Lengths: [**Manufacturer's standard**][**Random-length strips complying with applicable grading rules**][**Lengths required to form pattern indicated**].
8. Simulated Wood Pegs: Contrasting wood pegs at ends of flooring pieces.
9. Finish: Field-applied urethane finish system.

B. Solid-Wood Flooring, Factory Finished: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AHF Products**]
b. [**Anderson Tuftex**]
c. [**Appalachian Flooring**]
d. [**Carlisle Wide Plank Floors**]
e. [**Somerset Hardwood Flooring**]

2. Performance Requirements:

a. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

1) Certification: Provide flooring that carries NWFA grade stamp on each bundle or piece.

b. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.

1) Certification: Provide flooring that carries MFMA mark on each bundle or piece.

c. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

3. Species: [**Red oak**][**White oak**][**Ash**][**Birch**][**Maple**][**Black cherry**][**Hickory**][**Walnut**].
4. Cut: [**Plain sawn**][**Quarter/rift sawn**][**Edge grain**][**Vertical grain**].
5. Thickness: [**3/4 inch (19 mm)**][**25/32 inch (20 mm)**].
6. Face Width: [**2-1/4 inches (57 mm)**][**3-1/4 inches (83 mm)**][**5-1/8 inches (130 mm)**].
7. Lengths: [**Random-length strips complying with applicable grading rules**][**Lengths required to form pattern indicated**].
8. Edge Style: [**Square**][**Beveled (eased)**].
9. Finish: UV urethane.

a. Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.3 SOLID-WOOD PARQUET FLOORING

A. Solid-Wood Parquet Flooring, Field Finished: Kiln dried to 6 to 9 percent maximum moisture content.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle Wide Plank Floors**]

2. Performance Requirements:

a. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

1) Certification: Provide flooring that carries NWFA grade stamp on each bundle or piece.

b. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.

1) Certification: Provide flooring that carries MFMA mark on each bundle or piece.

c. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

3. Species: [**Red oak**][**White oak**][**Ash**][**Maple**][**Black cherry**].
4. Thickness: [**5/16 inch (8 mm)**][**11/16 inch (17 mm)**][**1/4 inch (6 mm)**].
5. Finish: Field-applied urethane finish system.

B. Solid-Wood Parquet Flooring, Factory Finished: Kiln dried to 6 to 9 percent maximum moisture content.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle Wide Plank Floors**]

2. Performance Requirements:

a. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

1) Certification: Provide flooring that carries NWFA grade stamp on each bundle or piece.

b. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.

1) Certification: Provide flooring that carries MFMA mark on each bundle or piece.

c. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

3. Species: [**Red oak**].
4. Thickness: [**5/16 inch (8 mm)**][**11/16 inch (17 mm)**][**1/4 inch (6 mm)**].
5. Finish: [**UV urethane**][**Acrylic impregnated**] .

a. Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.4 ENGINEERED-WOOD FLOORING

A. Engineered-Wood Flooring, Field Finished: HPVA EF [**complying with requirements for composite wood products**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle Wide Plank Floors**]
b. [**Oregon Lumber Company**]

2. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

3. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

4. Composite Wood Products: Verify products comply with formaldehyde emissions evaluation criteria.
5. Species: [**Red oak**][**White oak**][**Ash**][**Beech**][**Maple**][**Black cherry**].
6. Thickness: [**1/2 inch (13 mm)**][**3/8 inch (10 mm)**].
7. Construction: [**Five**][**Three**] ply.
8. Face Width: [**2-1/4 inches (57 mm)**][**3 inches (76 mm)**].
9. Length: Manufacturer's standard.
10. Finish: Field-applied urethane finish system.

B. Engineered-Wood Flooring, Factory Finished: HPVA EF [**complying with requirements for composite wood products**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**AHF Products**]
   b. [**Anderson Tuftex**]
   c. [**Boen**]
   d. [**Carlisle Wide Plank Floors**]
   e. [**Johnsonite; a Tarkett company**]
   f. [**Mannington Mills, Inc**]
   g. [**Nydree Flooring**]
   h. [**Oregon Lumber Company**]

2. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
3. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

4. Composite Wood Products: Verify products comply with formaldehyde emissions evaluation criteria.
5. Species: [**Red oak**][**White oak**][**Ash**][**Beech**][**Birch**][**Maple**][**Black cherry**][**Hickory**][**Walnut**].
6. Thickness: [**1/2 inch (13 mm)**][**3/8 inch (10 mm)**].
7. Construction: [**Five**][**Three**] ply.
8. Face Width: [**2-1/4 inches (57 mm)**][**3 inches (76 mm)**].
9. Length: Manufacturer's standard.
10. Edge Style: [**Square**][**Beveled (eased)**].
11. Finish: [**UV urethane**][**Acrylic impregnated**] .

a. Color: [**As selected by Architect in manufacturer's full range**] as directed by the Owner.

2.5 ENGINEERED-WOOD PARQUET FLOORING

A. Engineered-Wood Parquet Flooring, Factory Finished: HPVA EF [**complying with requirements for composite wood products**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Boen**]
   b. [**Carlisle Wide Plank Floors**]
   c. [**Johnsonite; a Tarkett company**]

2. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
3. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

4. Composite Wood Products: Verify products comply with formaldehyde emissions evaluation criteria.
5. Species: [**Red oak**][**Ash**][**Beech**][**Maple**][**Walnut**].
6. Thickness: [**3/8 inch (10 mm)**][**1/2 inch (13 mm)**].
7. Construction: [**Five**][**Three**] ply.
8. Finish: UV urethane.

   a. Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.6 FIELD FINISHES

A. Urethane Finish System: Complete [**solvent-based, oil-modified**][**water-based**] system of compatible components that is recommended by finish manufacturer for application indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Absolute Coatings, Inc.**]
   b. [**Basic Coatings**]
   c. [**Bona US**]
   d. [**Dura Seal**]
   e. [**Hillyard, Inc.**]
   f. [**MAPEI Corporation**]
   g. [**PoloPlaz**]

2. VOC Content: Provide coating with VOC content of 275 g/L or less.
3. VOC Content: Provide coating with VOC content of 100 g/L or less.
4. Stain: Penetrating and nonfading type.

    a. Color: [**Match sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

5. Floor Sealer: Pliable, penetrating type.
6. Finish Coats: Formulated for multicoat application on wood flooring.

B. Wood Filler: Compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved Samples, provide pigmented filler.

2.7 SOUND CONTROL UNDERLAYMENT

A. Sound Control Underlayment: Sound-reducing underlayment consisting of impact-absorbing materials.

1. Material: [**Recycled rubber**][**Polyurethane foam**][**Cork**][**Wood fiber**][**Wood fiber complying with requirements for composite wood products**].
2. Thickness: [**3/4 inch (19 mm)**][**1/2 inch (13 mm)**][**3/8 inch (10 mm)**][**1/4 inch (6 mm)**][**5/32 inch (4 mm)**].

2.8 ACCESSORY MATERIALS

A. Wood Sleepers and Subfloor: [**As specified in Section 061000 "Rough Carpentry" and Section 061600 "Sheathing."**].

B. Wood Underlayment: [**As specified in Section 061600 "Sheathing."**].

C. Vapor Retarder: ASTM D4397, polyethylene sheet not less than [**6.0 mils (0.15 mm)**][**8.0 mils (0.2 mm)**] thick.

D. Asphalt-Saturated Felt: ASTM D4869/D4869M, Type II.

E. Wood Flooring Adhesive: Mastic recommended in writing by flooring and adhesive manufacturers for application indicated.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
4. Verify adhesive complies with VOC emissions evaluation criteria.
5. Verify adhesive has a VOC content of [**100**] g/L or less.
6. Verify adhesives have a VOC content of [**30**] g/L or less.

F. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.

G. Fasteners: As recommended in writing by manufacturer, but not less than that recommended in [**NWFA's "Wood Flooring Installation Guidelines."**].

H. Thresholds and Saddles: To match wood flooring. Tapered on each side.

I. Reducer Strips: To match wood flooring; [**2 inches (51 mm)**] wide, tapered, and in thickness required to match height of flooring.

J. Cork Expansion Strip: Composition cork strip.

K. Feature Strips: [**2-inch- (51-mm-) wide, square-edged walnut strips**], furnished in lengths as long as practical and in thickness to match wood flooring.

L. Metal Feature Strips: [**1/8-by-1/8-inch (3-by-3-mm) solid-brass strips**], designed for inlaying into routed reveal in wood flooring surface.

M. Wood Air Vents and Grilles: To match wood flooring and in sizes and design indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Concrete Slabs: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels in accordance with manufacturer's written installation instructions.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**] and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**][**4.5 lb of water/1000 sq. ft. (2.04 kg of water/92.9 sq. m)**] in 24 hours.
   b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**80**][**75**] percent relative humidity level measurement.
   c. Perform additional moisture tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. Concrete Slabs:

1. Grind high spots and fill low spots to produce a maximum **1/8-inch (3-mm)** deviation in any

direction when checked with a **10 ft. (3 m)** straight edge.

2. Use trowelable leveling and patching compounds, in accordance with manufacturer's written installation instructions, to fill cracks, holes, and depressions in substrates.
3. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

B. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF WOOD FLOORING

A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in [**NWFA's "Wood Flooring Installation Guidelines."**].

B. Wood Sleepers and Subfloor: [**Install in accordance with requirements in Section 061000 "Rough Carpentry" and Section 061600 "Sheathing."**].

C. Wood Underlayment: [**Install in accordance with requirements in Section 061600 "Sheathing."**].

D. Provide expansion space at walls and other obstructions and terminations of flooring [**as indicated on Drawings**][**of not less than 3/4 inch (19 mm)**].

E. Vapor Retarder: Comply with the following for vapor retarder installation:

1. Wood Flooring Nailed to Wood Subfloor: Install flooring over a layer of asphalt-saturated felt.
2. Wood Flooring Nailed to Sleepers over Concrete: Install flooring over a layer of polyethylene sheet with edges overlapped over sleepers and turned up behind baseboards.
3. Wood Flooring Installed Directly on Concrete: Install a layer of polyethylene sheet in accordance with flooring manufacturer's written installation instructions.

F. Sound Control Underlayment: Install over vapor retarder in accordance with manufacturer's written installation instructions.

G. Solid-Wood Flooring: Blind nail or staple flooring to substrate.

1. Plank Flooring: For flooring of face width more than **3 inches (76 mm)**.

a. Hardwood: Install countersunk screws at each end of each piece in addition to blind nailing. Cover screw heads with wood plugs glued flush with flooring.
b. Softwood: Install no fewer than two countersunk nails at each end of each piece, spaced not more than **16 inches (406 mm)** along length of each piece, in addition to blind nailing. Fill holes with matching wood filler.

H. Solid-Wood Parquet Flooring: Set in adhesive in pattern indicated on Drawings.

I. Engineered-Wood Flooring: [**Set in adhesive**][**Nail or staple**][**Install floating floor**] .

J. Engineered-Wood Parquet Flooring: [**Set in adhesive**][**Install floating floor**] .

3.4 APPLICATION OF FIELD FINISHES

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that are noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

1. Comply with applicable recommendations in [**NWFA's "Wood Flooring Installation Guidelines."**].

B. Fill [**open-grained hardwood**].

C. Fill and repair wood flooring defects.

D. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and [**three**] finish coats.

1. Apply stains to achieve an even color distribution matching approved Samples.
2. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.

E. Cover wood flooring before finishing.

F. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

3.5 PROTECTION

A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.

1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 09 64 00 00

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Task	Specification	Specification Description
09 64 13 00	09 64 00 00	Wood Flooring
09 64 23 00	09 64 00 00	Wood Flooring
09 64 23 00	09 64 66 00	Wood Athletic Flooring
09 64 29 00	09 64 00 00	Wood Flooring
09 64 29 00	09 64 66 00	Wood Athletic Flooring

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SECTION 09 64 66 00 - WOOD ATHLETIC FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Wood athletic flooring system including, but not limited to, the following:

1. Flooring materials.
2. Subfloor materials.
3. Finish system.

B. Related Requirements:

1. Section 096400 "Wood Flooring" for traditional solid-wood and engineered-wood, strip, plank, and parquet flooring.

1.2 COORDINATION

A. Coordinate layout and installation of slab depressions to accommodate layout and height of wood athletic flooring system.

B. Coordinate layout and installation of flooring with floor inserts for gymnasium equipment.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to resilient athletic flooring installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for wood athletic flooring.

B. Shop Drawings: For each type of floor system, include the following:

1. Plans, sections, and attachment details.
2. Details of concrete-slab depressions.
3. Locations of different grades of wood flooring.
4. Expansion provisions and trim details.
5. Layout, colors, widths, and dimensions of game lines and markers.

6. Locations of floor inserts for athletic equipment installed through flooring system.

C. Samples: For each exposed product and for each color and texture specified, approximately [**12 inches (305 mm) long**] in size.

1. Include Sample sets showing the full range of normal color and texture variations expected in wood flooring.
2. Include Sample sets showing finishes[**and game-line and marker paints**] applied to wood flooring.

D. Samples for Initial Selection: For each type of wood athletic flooring and accessory in each type of exposed color and finish.

1. Include manufacturer's color charts showing colors and glosses available for the following:

a. Floor finishes.
b. Game-line and marker paints.

E. Samples for Verification: For each type of wood athletic flooring and accessory required; approximately [**12 inches (300 mm) long**] and of same thickness and material indicated for the Work.

1. Include Sample sets showing the full range of normal color and texture variations expected in wood flooring.
2. Include Sample sets showing finishes[**and game-line and marker paints**] applied to wood flooring.

F. Sustainable Design Submittals:

1. Laboratory Test Reports: Verify compliance with VOC emissions evaluation.
2. Product Data: For installation adhesives, indicating VOC content.
3. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
4. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
5. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
6. Product Data: Verify compliance with requirements for Forest Stewardship Council U.S. (FSC).

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each wood athletic flooring system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wood athletic flooring and finish systems.

1.7 QUALITY ASSURANCE

A. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-

accredited certification body.

B. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Installer Qualifications: A firm or individual that has been approved by MFMA as an accredited Installer in accordance with the MFMA Accreditation Program.

1. Installer responsibilities include installation and field finishing of wood athletic flooring components and accessories, and application of game lines and markers.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver floor system materials in unopened cartons or bundles.

B. Protect wood from exposure to moisture. Do not deliver wood components until after concrete, masonry, plaster, ceramic tile, and similar wet-work is complete and dry.

C. Store wood components in a dry, warm, well-ventilated, weathertight location and in a horizontal position.

1.9 FIELD CONDITIONS

A. Conditioning period begins not less than seven days before wood athletic flooring installation, is continuous through installation, and continues not less than seven days after installation.

1. Environmental Conditioning: Maintain ambient temperature between **65 and 75 deg F (18 and 24 deg C)** and relative humidity planned for building occupants, but not less than 35 percent or more than 50 percent, in spaces to receive wood athletic flooring during the conditioning period.
2. Wood Flooring Conditioning: Move wood components into spaces where they will be installed, no later than beginning of the conditioning period.

a. Do not install wood athletic flooring until wood components adjust to relative humidity of, and are at same temperature as, spaces where they are to be installed.
b. Open sealed packages to allow wood components to acclimatize immediately on moving wood components into spaces in which they will be installed.

B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

C. Install wood athletic flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Certified Wood: Verify product is certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

B. Certified Wood: Verify product is labeled in accordance with the AF&PA's Sustainable Forestry Initiative,

certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

C. Certified Wood: Verify product is certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Verify adhesive has a VOC content of [**100**] g/L or less.

D. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

E. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

2.2 WOOD ATHLETIC FLOORING SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aacer Sports Flooring, an Infinity Wood Floors Company**]
2. [**Action Floor Systems, LLC**]
3. [**Connor Sports**]
4. [**Horner Sports Flooring**]
5. [**Robbins Sports Surfaces**]
6. [**WD Flooring, LLC**]

B. System Type: [**Floating**][**Fixed**][**Anchored resilient**][**Portable**].

C. Overall System Height: [**As indicated on Drawings**][**2-1/8 inches (54 mm)**][**2-1/4 inches (57 mm)**][**2-1/2 inches (64 mm)**].

2.3 FLOORING MATERIALS

A. Maple Flooring: Comply with MFMA grading rules for species, grade, and cut.

1. Certification: Provide flooring that carries MFMA mark on each bundle or piece.

B. Random-Length Strip Flooring: Northern hard maple (Acer saccharum), kiln dried, random length, tongue and groove, and end matched.

1. Grade: MFMA-RL [**First**][**Second and Better**][**Third and Better**].

a. Exception: For areas under stacked portion of telescoping bleachers that are normally concealed from view, provide Third and Better Grade.

2. Cut: [**Edge**][**Flat**].
3. Thickness: [**25/32 inch (20 mm)**][**33/32 inch (26 mm)**].
4. Face Width: [**2-1/4 inches (57 mm)**][**1-1/2 inches (38 mm)**].

C. Finger-Jointed Strip Flooring: Northern hard maple (Acer saccharum), kiln dried, random length, tongue and groove, and end matched.

1. Grade: MFMA-FJ [**First**][**Second and Better**][**Third and Better**].

   a. Exception: For areas under stacked portion of telescoping bleachers that are normally concealed from view, provide Third and Better Grade.

2. Cut: [**Edge**][**Flat**].
3. Thickness: [**25/32 inch (20 mm)**][**33/32 inch (26 mm)**].
4. Face Width: [**2-1/4 inches (57 mm)**][**1-1/2 inches (38 mm)**].

D. Parquet Flooring: Northern hard maple (Acer saccharum), kiln dried, edge grain, and square edge.

1. Grade: MFMA-PQ [**Second and Better**][**Third and Better**].
2. Thickness: Not less than [**5/16 inch (8 mm)**][**3/8 inch (10 mm)**][**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**11/16 inch (17 mm)**].
3. Picket Dimensions:

   a. Width: [7/8 inch (22 mm)][1-1/8 inches (29 mm)].
   b. Length: [**6 inches (152 mm)**][**9 inches (229 mm)**].

2.4 SUBFLOOR MATERIALS

A. Board Underlayment: Nominal **1-by-6-inch (25-by-152-mm)** graded boards; of SPIB No. 2 Southern pine, WCLIB Construction grade (any species), or WWPA No. 3 (any species), dried to 15 percent moisture content.

B. Plywood Underlayment: APA rated, C-D plugged, exterior glue, tongue and groove, [**15/32 inch (12 mm)**][**23/32 inch (18 mm)**] thick.

C. Wood Sleepers: Standard grade; **48 inches (1200 mm)** long; kiln-dried Eastern hemlock, fir, pine, or spruce.

1. Size: Nominal [**2 by 3 inches (51 by 76 mm)**][**2 by 4 inches (51 by 102 mm)**].
2. Sleeper Anchors: Manufacturer's standard drive pins recommended by anchor manufacturer to achieve minimum **900 lbf (4000 N)** pullout strength in **3000 psi (20.7 MPa)** concrete.
3. Sleeper Shims: In size and type recommended in writing by flooring manufacturer for application indicated.
4. Asphalt Primer: ASTM D41/D41M.
5. Asphalt Mastic: ASTM D312, Type I, cold-applied dead-level asphalt or Type III, hot-applied steep asphalt, as recommended in writing by manufacturer.

D. Channels: [**Manufacturer's standard as indicated by product designation above**].

1. Channel Anchors: Manufacturer's standard, but not less than modified steel drive pins recommended by anchor manufacturer to achieve minimum **900 lbf (4000 N)** pullout strength.
2. Clips: [**Manufacturer's standard as indicated by product designation above**].

E. Resilient Pads: With air voids for resiliency and installed at manufacturer's standard spacing for product designation indicated above.

1. Material: [**PVC**][**Rubber**][**Neoprene**].
2. Thickness: [**3/8 inch (10 mm)**][**7/16 inch (11 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].

F. Resilient Underlayment: Flexible, multicellular, closed-cell, expanded polyethylene-foam sheet; nominal **2 lb/cu. ft. (32 kg/cu. m)** density.

1. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].

2.5 FINISH SYSTEM

A. Floor-Finish System: System of compatible components recommended in writing by flooring manufacturer, and MFMA approved.

1. Floor-Sealer Formulation: Pliable, penetrating type from MFMA Group 1, Sealers.
2. Finish-Coat Formulation: Formulated for gloss finish indicated and multicoat application.

a. Type: [**MFMA Group 3, Gymnasium-Type Surface Finishes**][**MFMA Group 5, Water-Based Finishes**].

3. Game-Line and Marker Paint: Industrial enamel compatible with finish coats and recommended in writing by manufacturers of finish coats, and paint for this use.
4. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.

2.6 ACCESSORIES

A. Vapor Retarder: ASTM D4397, polyethylene sheet not less than **6 mils (0.15 mm)** thick.

B. Resilient Wall Base: Molded, vented, rubber or vinyl cove base; **4 by 3 by 48 inches (102 by 76 by 1200 mm)**; with premolded outside corners.

1. Color: [**Black**][**Brown**].

C. Wood Wall Base: [**Nominal 1-by-3-inch (25-by-76-mm) wood base**][**Built-up wood base as indicated on Drawings**] matching species, grade, and cut of wood flooring.

D. Thresholds: [**As specified in Section 087100 "Door Hardware."**]

E. Fasteners: Type and size recommended by manufacturer, but not less than those recommended by MFMA for application indicated.

F. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood athletic flooring manufacturer.

G. Adhesives: Manufacturer's standard for application indicated.

1. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Concrete Slabs: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels in accordance with manufacturer's written installation instructions.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**][**4.5 lb of water/1000 sq. ft. (2.04 kg of water/92.9 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**80**][**75**] percent relative humidity level measurement.
c. Perform additional moisture tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. Concrete Slabs:

1. Grind high spots and fill low spots on concrete substrates to produce a maximum **1/8-inch (3-mm)** deviation in any direction when checked with a **10 ft. (3 m)** straight edge.
2. Use trowelable leveling and patching compounds, in accordance with manufacturer's written installation instructions, to fill cracks, holes, and depressions in substrates.
3. Remove coatings, including curing compounds and other substances, on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone; use mechanical methods recommended by manufacturer. Do not use solvents.

B. Broom and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF WOOD ATHLETIC FLOORING

A. Comply with wood athletic flooring manufacturer's written installation instructions, but not less than written recommendations of MFMA applicable to flooring type indicated.

B. Pattern: Lay flooring parallel with long dimension of space to be floored unless otherwise indicated.

C. Expansion Spaces: Provide as indicated, but not less than that required by manufacturer's written installation instructions and MFMA's written recommendations at walls and other obstructions, and at interruptions and terminations of flooring.

1. Cover expansion spaces with base molding, trim, and saddles, as indicated on Drawings.

D. Vapor Retarder: Cover entire slab area beneath wood flooring. Install with joints lapped a minimum of **6 inches (152 mm)** and sealed.

E. Underlayment: Install perpendicular to direction of flooring, staggering end joints in adjacent rows.

F. Sleepers:

1. Prime entire slab beneath wood floor area with asphalt primer at coverage rate recommended by manufacturer.
2. Install sleepers perpendicular to direction of flooring, staggering end joints a minimum of [**24 inches (610 mm)**].
3. Space [**at spacing recommended by manufacturer for system components indicated**][**12 inches (305 mm) o.c.**][**9 inches (229 mm) o.c.**][**8 inches (203 mm) o.c.**].
4. Shim and level sleepers and install anchors at spacing recommended by manufacturer, but not less than **30 inches (760 mm)** o.c.
5. Pour asphalt mastic to **1/8 inch (3 mm)** above the level of shims.
6. Anchor predrilled sleepers through resilient pads.

G. Channels: Anchor channels to substrate in accordance with manufacturer's written installation instructions.

1. Install wood strip flooring across channels.
2. Insert steel clip at each intersection of a flooring strip with a channel.

H. Strip Flooring: Mechanically fasten perpendicular to supports.

I. Parquet Flooring: Adhere to substrates in accordance with manufacturer's written installation instructions.

J. Installation Tolerances: **1/8 inch in 10 ft. (3 mm in 3 m)** of variance from level.

3.4 SANDING AND FINISHING

A. Allow installed flooring to acclimate to ambient conditions before sanding.

B. Follow applicable recommendations in MFMA's "Industry Recommendations for Sanding, Sealing, Court Lining, Finishing, and Resurfacing of Maple Gym Floors."

C. Machine sand with coarse, medium, and fine grades of sandpaper to achieve a level, smooth, uniform surface without ridges or cups. Remove sanding dust by tack or vacuum.

D. Finish: Apply seal and finish coats of finish system in accordance with finish manufacturer's written installation instructions. Provide no fewer than [**four**] coats total and no fewer than [**two**] finish coats.

1. Water-Based Finishes: Use finishing methods recommended by finish manufacturer to reduce grain raise and sidebonding effect.
2. Game-Line and Marker Paint: Apply game-line and marker paint between final seal coat and first finish coat in accordance with paint manufacturer's written installation instructions.

a. Mask flooring at game lines and markers, and apply paint to produce lines and markers with sharp edges.

b. Where game lines cross, break minor game line at intersection; do not overlap lines.
c. Apply game lines and markers in widths and colors in accordance with [**requirements indicated on Drawings**].
d. Apply finish coats after game-line and marker paint is fully cured.

3.5 PROTECTION

A. Protect wood athletic flooring during remainder of construction period to allow finish to cure and to ensure that flooring and finish are without damage or deterioration at time of Substantial Completion.

1. Do not cover flooring after finishing until finish reaches full cure and not before seven days after applying last finish coat.
2. Do not move heavy and sharp objects directly over flooring. Protect fully cured floor finishes and surfaces with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 09 64 66 00

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Task	Specification	Specification Description
09 64 66 00	09 64 00 00	Wood Flooring

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SECTION 09 65 13 00 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoset rubber base.
2. Thermoplastic rubber base.
3. Vinyl base.
4. Rubber stair treads.
5. Vinyl stair treads.
6. Rubber molding accessories.
7. Vinyl molding accessories.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096516 "Resilient Sheet Flooring" for resilient rolled flooring.
3. Section 096519 "Resilient Tile and Plank Flooring" for modular resilient flooring.
4. Section 096543 "Linoleum Flooring" for modular and sheet linoleum flooring.
5. Section 096813 "Tile Carpeting" for modular carpet tile flooring.
6. Section 096816 "Sheet Carpeting" for tufted and woven carpet flooring.
7. Section 104513 "Photoluminescent Egress Path Markings" for luminous stair accessories.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1. Review methods and procedures related to resilient base and accessory installation including, but not limited to, the following:

   a. Delivery, storage, and handling procedures.
   b. Ambient conditions and ventilation procedures.
   c. Subfloor preparation procedures for resilient stair accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation instructions for each type of substrate.

B. Samples: For each exposed product and for each color and texture specified, not less than **12 inches (300 mm)** long.

C. Samples for Initial Selection: For each type of exposed product.

D. Samples for Verification: For each type of exposed product indicated and for each color, texture, and

pattern required in manufacturer's standard-size Samples, but not less than **12 inches (300 mm)** long.

E. Product Schedule: For resilient base and accessory products. [**Use same designations indicated on Drawings.**]

F. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For resilient base and accessory products, for tests performed by a qualified testing agency.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than [**10 linear ft. (3 linear m)**] for every [**500 linear ft. (150 linear m)**] or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F (10 deg C)** or more than **90 deg F (32 deg C)**.

1.7 FIELD CONDITIONS

A. Installation Temperature Requirements: Maintain ambient temperatures within range recommended by manufacturer, but not less than [**70 deg F (21 deg C)**] or more than [**95 deg F (35 deg C)**] , in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Post-Installation Temperature Requirements: After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than [**55 deg F (13 deg C)**] or more than [**95 deg F (35 deg C)**] .

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: As determined by testing identical products in accordance with ASTM E648 or ASTM E662 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 RESILIENT BASE

A. Thermoset Rubber Base :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Mannington Mills, Inc**]
   b. [**Roppe Corporation; Roppe Holding Company**]
   c. [**Tarkett USA**]

2. Classification: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
3. Style and Location:

   a. Style A, Straight: [**Provide in areas with carpet**] .
   b. Style B, Cove: [**Provide in areas with resilient floor coverings**] .

4. Thickness: [**0.125 inch (3.2 mm)**][**0.25 inch (6.4 mm)**][**0.375 inch (9.6 mm)**] .
5. Height: [**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**4-1/2 inches (114 mm)**][**5 inches (127 mm)**][**5-1/2 inches (140 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**] .
6. Lengths: [**Cut lengths 48 inches (1219 mm) long**][**Coils in manufacturer's standard length**][**Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length**] .
7. Outside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .
8. Inside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .

9. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**] , as directed by the Owner.

B. Thermoplastic Rubber Base :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Allstate Flooring**]
   b. [**Armstrong Flooring, Inc.**]
   c. [**Flexco Corporation**]
   d. [**Forbo Flooring Systems**]
   e. [**Roppe Corporation; Roppe Holding Company**]
   f. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   g. [**Tarkett USA**]
   h. [**VPI Corporation**]

2. Classification: ASTM F1861, Type TP (rubber, thermoplastic), Group [I (solid, homogeneous)][II (layered)] .
3. Style and Location:

   a. Style A, Straight: [**Provide in areas with carpet**] .
   b. Style B, Cove: [**Provide in areas with resilient floor coverings**] .

4. Thickness: [**0.125 inch (3.2 mm)**][**0.25 inch (6.4 mm)**][**0.375 inch (9.6 mm)**] .
5. Height: [**2-1/2 inches (64 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**] .
6. Lengths: [**Cut lengths 48 inches (1219 mm) long**][**Coils in manufacturer's standard length**][**Cut lengths 98 inches (2438 mm) long or coils in manufacturer's standard length**] .
7. Outside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .
8. Inside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .
9. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**] , as directed by the Owner.

C. Vinyl Base :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexco Corporation**]
   b. [**Mannington Mills, Inc**]
   c. [**Mohawk Group**]
   d. [**Roppe Corporation; Roppe Holding Company**]
   e. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   f. [**Tarkett USA**]
   g. [**VPI Corporation**]

2. Classification: ASTM F1861, Type TV (vinyl, thermoplastic), Group [I (solid, homogeneous)][II (layered)] .
3. Style and Location:

a. Style A, Straight: [**Provide in areas with carpet**] .
b. Style B, Cove: [**Provide in areas with resilient floor coverings**] .

4. Minimum Thickness: [**0.125 inch (3.2 mm)**][**0.080 inch (2.0 mm)**] .
5. Height: [**2-1/2 inches (64 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**] .
6. Lengths: [**Cut lengths 48 inches (1219 mm) long**][**Coils in manufacturer's standard length**][**Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length**] .
7. Outside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .
8. Inside Corners: [**Job formed**][**Preformed**][**Job formed or preformed**] .
9. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**] , as directed by the Owner.

2.3 RESILIENT STAIR ACCESSORIES

A. Rubber Stair Treads :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Biltrite**]
b. [**Flexco Corporation**]
c. [**Mannington Mills, Inc**]
d. [**Mohawk Group**]
e. [**Roppe Corporation; Roppe Holding Company**]
f. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
g. [**The R.C. Musson Rubber Co.**]
h. [**VPI Corporation**]

2. Classification: ASTM F2169, Type [TS (rubber, vulcanized thermoset)][TP (rubber, thermoplastic)] .

a. Class: [**1 (smooth, flat)**][**2 (pattern; embossed, grooved, or ribbed)**] .
b. Group: [**1 (embedded abrasive strips)**][**2 (with contrasting color for the visually impaired)**] .

3. Nosing Style: [**Square, adjustable to cover angles between 60 and 90 degrees**][**Square**][**Round**] .
4. Nosing Height: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-3/16 inches (56 mm)**] .
5. Thickness: [**1/4 inch (6 mm) and tapered to back edge**] .
6. Size: Lengths and depths to fit each stair tread in [**one piece**][**one piece or, for treads exceeding maximum lengths manufactured, in equal-length units**] .

B. Vinyl Stair Treads :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flexco Corporation**]
b. [**Roppe Corporation; Roppe Holding Company**]
c. [**Tarkett USA**]

d. [**VPI Corporation**]

2. Classification: ASTM F2169, Type TV (vinyl, thermoplastic).

   a. Class: [**1 (smooth, flat)**][**2 (pattern; embossed, grooved, or ribbed)**] .
   b. Group: [**1 (embedded abrasive strips)**][**2 (with contrasting color for the visually impaired)**] .

3. Nosing Style: [**Square, adjustable to cover angles between 60 and 90 degrees**][**Square**][**Round**] .
4. Nosing Height: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-3/16 inches (56 mm)**] .
5. Thickness: [**1/4 inch (6 mm) and tapered to back edge**] .
6. Size: Lengths and depths to fit each stair tread in [**one piece**][**one piece or, for treads exceeding maximum lengths manufactured, in equal-length units**] .

C. Integral Risers: Smooth, flat; in height that fully covers substrate.

D. Separate Risers: Smooth, flat; in height that fully covers substrate; produced by same manufacturer who produced treads and recommended by manufacturer for installation with treads.

1. Style: [**Coved toe, 7 inches (178 mm) high by length matching treads**][**Toeless, by length matching treads**] .
2. Thickness: [**0.125 inch (3.2 mm)**][**Manufacturer's standard**] .

E. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer who produced treads, and recommended by manufacturer for installation with treads.

1. Thickness: [**0.125 inch (3.2 mm)**][**0.080 inch (2.0 mm)**][**Manufacturer's standard**] .

F. Landing Tile: [**Matching treads; produced by same manufacturer who produced treads and recommended by manufacturer for installation with treads**] .

G. Locations: [**Provide resilient stair accessories in areas indicated on Drawings**] .

H. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**] , as directed by the Owner.

2.4 RESILIENT MOLDING ACCESSORIES

A. Rubber Molding Accessories :

1. Accessory Description: [**Stair-tread nosing**][**cap for cove carpet**][**cap for cove resilient floor covering**][**carpet bar for tackless installations**][**carpet edge for glue-down applications**][**nosing for carpet**][**nosing for resilient floor covering**][**reducer strip for resilient floor covering**][**joiner for tile and carpet**][**transition strips**] .
2. Profile and Dimensions: [**As indicated on Drawings**] .

B. Vinyl Molding Accessories :

1. Accessory Description: [**Stair-tread nosing**][**cap for cove carpet**][**cap for cove resilient floor covering**][**carpet bar for tackless installations**][**carpet edge for glue-down applications**][**nosing for carpet**][**nosing for resilient floor covering**][**reducer strip for**

resilient floor covering][**joiner for tile and carpet**][**transition strips**] .

2. Profile and Dimensions: [**As indicated on Drawings**] .

C. Locations: [**Provide resilient molding accessories in areas indicated on Drawings**] .

D. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**] , as directed by the Owner.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended in writing by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Metal Edge Strips: Nominal **2 inches (51 mm)** wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

1. Material: [**Extruded aluminum with mill finish**] .

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates in accordance with manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than [**9**][**10**] pH.
4. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**] , and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 INSTALLATION OF RESILIENT BASE

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than [**3 inches (76 mm)**] in length.

   a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than [**3 inches (76 mm)**] in length.

   a. [**Miter**][**Cope**][**Miter or cope**] corners to minimize open joints.

3.4 INSTALLATION OF RESILIENT STAIR ACCESSORIES

A. Comply with manufacturer's written instructions for installing resilient stair accessories.

B. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.

C. Tightly adhere to substrates throughout length of each piece.

D. For treads installed as separate, equal-length units, install to produce a flush joint between units.

3.5 INSTALLATION OF RESILIENT MOLDING ACCESSORIES

A. Comply with manufacturer's written instructions for installing resilient molding accessories.

B. Butt resilient molding accessories to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.6 CLEANING

A. Comply with manufacturer's written instructions for cleaning resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.

1. Apply [**one**][**two**][**three**] coat(s).

3.7 PROTECTION

A. Comply with manufacturer's written instructions for protecting resilient products.

B. After post-installation cleaning, immediately protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13 00

Task	Specification	Specification Description
09 65 13 13	09 65 13 00	Resilient Base and Accessories
09 65 13 23	09 65 13 00	Resilient Base and Accessories
09 65 13 33	01 22 00 00	No Specification Required
09 65 13 33	09 65 13 00	Resilient Base and Accessories
09 65 13 33	09 65 16 00	Resilient Sheet Flooring
09 65 13 33	09 65 43 00	Linoleum Flooring
09 65 13 36	09 65 13 00	Resilient Base and Accessories

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SECTION 09 65 16 00 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unbacked vinyl sheet flooring.
2. Vinyl sheet flooring with backing.
3. Unbacked rubber sheet flooring.
4. Rubber sheet flooring with backing.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096513 "Resilient Base and Accessories" for wall base and accessories installed with resilient sheet flooring.
3. Section 096519 "Resilient Tile and Plank Flooring" for modular resilient flooring.
4. Section 096543 "Linoleum Flooring" for modular and sheet linoleum flooring.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review methods and procedures related to resilient sheet flooring installation including, but not limited to, the following:

a. Delivery, storage, and handling procedures.
b. Ambient conditions and ventilation procedures.
c. Subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation instructions for each type of substrate.

B. Shop Drawings: For each type of resilient flooring type required.

1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

C. Samples: For each resilient flooring product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than [**6-by-9-inch (152-by-230-mm)**] sections.

1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than [**9 inches (230 mm)**] long, of each color required.

D. Samples for Initial Selection: For each type of resilient flooring product required.

E. Samples for Verification: For each type of resilient flooring product, in manufacturer's standard size, but not less than [**6-by-9-inch (152-by-230-mm)**] sections of each color, texture, and pattern required.

1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than [**9 inches (230 mm)**] long, of each color required.

F. Welded-Seam Samples: For seamless-installation technique indicated and for each resilient flooring product, color, and pattern required; with seam running lengthwise and in center of [**6-by-9-inch (152-by-230-mm)**] Sample applied to a rigid backing and prepared by Installer for this Project.

G. Product Schedule: For each type of resilient flooring product required.[**Use same designations indicated on Drawings.**]

H. Sustainable Design Submittals:

1. Laboratory Test Reports: Verify compliance with VOC emissions evaluation.
2. Product Data: For installation adhesives, indicating VOC content.
3. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For resilient sheet flooring, for tests performed by a qualified testing agency.

B. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient sheet flooring to include:

1. Methods for maintaining resilient sheet flooring, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to resilient sheet flooring.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Sheet Flooring: Full-width rolls equal to [**5**] percent of amount installed for each type, color, and pattern indicated, but not less than **10 sq. yd. (8.3 sq. m)**.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming methods indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturers' labels indicating brand name and directions for storing.

B. Store resilient sheet flooring and accessory materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F (10 deg C)** or more than **90 deg F (32 deg C)**. Store rolls upright.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install resilient flooring until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

B. Do not install resilient flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by resilient flooring manufacturer.

C. Adhesively Applied Products:

1. Maintain temperatures during installation within range recommended in writing by manufacturer, but not less than [**70 deg F (21 deg C)**] or more than [**95 deg F (35 deg C)**], in spaces to receive flooring 48 hours before installation, during installation, and 48 hours after installation unless longer period is recommended in writing by manufacturer.
2. After postinstallation period, maintain temperatures within range recommended in writing by manufacturer, but not less than [**55 deg F (13 deg C)**] or more than [**95 deg F (35 deg C)**].
3. Close spaces to traffic during flooring installation.
4. Close spaces to traffic for 48 hours after flooring installation unless manufacturer recommends longer period in writing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products in accordance with ASTM E648 or ASTM E662 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 RESILIENT SHEET FLOORING

A. Unbacked Vinyl Sheet Flooring : Resilient sheet flooring product with wear layer that is printed or decorated, composed of fillers, pigments, and vinyl binders[and protected by a clear specialty performance top layer].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Flooring, Inc.**]
   b. [**Forbo Flooring Systems**]
   c. [**Gerflor USA**]
   d. [**Mannington Mills, Inc**]
   e. [**Roppe Corporation; Roppe Holding Company**]

2. Classification: ASTM F1913.
3. Thickness: [**0.080 inch (2.0 mm)**].
4. Wearing Surface: [**Smooth**][**Embossed**].
5. Sheet Width: [**As standard with manufacturer**][**6 ft. (1.8 m)**][**6.6 ft. (2.0 m)**].
6. Seamless Installation Method: [**Heat welded**][**Chemically bonded**].
7. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**], as directed by the Owner.

B. Vinyl Sheet Flooring with Backing : Resilient sheet flooring product with wear layer that is printed or decorated, composed of fillers, pigments, and vinyl binders[and protected by a clear specialty performance top layer] with backing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altro**]
   b. [**Armstrong Flooring, Inc.**]
   c. [**Congoleum Flooring**]
   d. [**Forbo Flooring Systems**]
   e. [**Gerflor USA**]

f. [**Mannington Mills, Inc**]
g. [**Mohawk Group**]
h. [**Roppe Corporation; Roppe Holding Company**]
i. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]

2. Classification: ASTM F1303, Type [**I, minimum binder content of 90 percent**][**II, minimum binder content of 34 percent**], Grade 1.

   a. Overall Thickness: [**As standard with manufacturer**].
   b. Interlayer Material: [**Foamed plastic**][**None**].
   c. Backing Class: [**A (fibrous)**][**B (nonfoamed plastic)**][**C (foamed plastic)**].

3. Wearing Surface: [**Smooth**][**Embossed**][**with embedded abrasives**].
4. Sheet Width: [**As standard with manufacturer**][**5 ft. (1.5 m)**][**6 ft. (1.8 m)**][**6.6 ft. (2.0 m)**][**12 ft. (3.6 m)**].
5. Seamless Installation Method: [**Heat welded**][**Chemically bonded**].
6. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**], as directed by the Owner.

C. Unbacked Rubber Sheet Flooring : Resilient sheet flooring product with vulcanized rubber wear layer that is colored or patterned.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Biltrite**]
   b. [**Flexco Corporation**]
   c. [**Mannington Mills, Inc**]
   d. [**Mondo**]
   e. [**Nora by Interface**]
   f. [**Roppe Corporation; Roppe Holding Company**]

2. Classification: ASTM F1859, Type [**I, homogeneous rubber sheet floor covering**][**II, heterogeneous (layered) rubber sheet floor covering**].
3. Thickness: [**As standard with manufacturer**].
4. Hardness: [**Not less than required by ASTM F1859**][**Manufacturer's standard hardness, measured using Shore, Type A durometer in accordance with ASTM D2240**].
5. Wearing Surface: [**Smooth**][**Textured**][**Molded pattern**].
6. Molded-Pattern Figure: [**Raised discs**][**Raised squares**].
7. Sheet Width: [**As standard with manufacturer**][**3.0 ft. (0.9 m)**][**3.3 ft. (1.0 m)**][**4.0 ft. (1.2 m)**][**5 ft. (1.5 m)**][**6.3 ft. (1.9 m)**].
8. Seamless Installation Method: [**Heat welded**][**Chemically bonded**].
9. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**], as directed by the Owner.

D. Rubber Sheet Flooring with Backing : Resilient sheet flooring product with vulcanized rubber wear layer that is colored or patterned and backing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Nora by Interface**]

2. Classification: ASTM F1860, Type [**I, Homogeneous**][**II, Heterogeneous**].
3. Wear-Layer Thickness: [**As standard with manufacturer**].
4. Overall Thickness: [**As standard with manufacturer**].
5. Interlayer Material: [**As standard with manufacturer**][**None**].
6. Backing: [**Grade 1, Fibrous**][**Grade 2, Foamed rubber**].
7. Hardness: [**Not less than required by ASTM F1860**][**Manufacturer's standard hardness, measured using Shore, Type A durometer in accordance with ASTM D2240**].
8. Wearing Surface: [**Smooth**][**Textured**][**Molded pattern**].
9. Sheet Width: [**As standard with manufacturer**][**3.3 ft. (1.0 m)**].
10. Seamless Installation Method: [**Heat welded**][**Chemically bonded**].
11. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**], as directed by the Owner.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended in writing by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

C. Seamless Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.

   a. Colors: [**As selected by Architect from manufacturer's full range to contrast with flooring**][**Match flooring**], as directed by the Owner.

2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

D. Integral-Flash-Cove-Base Accessories:

1. Cove Strip: **1-inch (25-mm)** radius provided or approved by resilient sheet flooring manufacturer.
2. Cap Strip: [**Square metal, vinyl, or rubber cap**][**Tapered vinyl cap**] provided or approved by resilient sheet flooring manufacturer.
3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient flooring products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates in accordance with resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than [**9**][**10**] pH.
4. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 INSTALLATION OF RESILIENT SHEET FLOORING

A. Comply with manufacturer's written installation instructions.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least **6 inches (152 mm)** away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

J. Integral-Flash-Cove Base: Cove resilient sheet flooring [**6 inches (152 mm)**][**to dimension indicated**] up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.

B. Perform the following operations immediately after completing resilient sheet flooring installation:

1. Remove adhesive and other blemishes from surfaces.

2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

1. Apply [**one**][**two**][**three**] coat(s).

E. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION 09 65 16 00

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Task	Specification	Specification Description
09 65 16 23	09 65 16 00	Resilient Sheet Flooring

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SECTION 09 65 19 00 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid vinyl floor tiles.
2. Commercial luxury vinyl floor tiles.
3. Commercial luxury vinyl floor planks.
4. Rigid polymeric core floor tiles.
5. Rigid polymeric core floor planks.
6. Rubber floor tiles.
7. Vinyl composition floor tiles.
8. Resilient terrazzo floor tiles.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096513 "Resilient Base and Accessories" for wall base and accessories installed with resilient tile and plank flooring.
3. Section 096516 "Resilient Sheet Flooring" for resilient rolled flooring.
4. Section 096543 "Linoleum Flooring" for modular and sheet linoleum flooring.

1.2 DEFINITIONS

A. LVP: Luxury vinyl planks. A marketing term that is applied to modular resilient floor plank products.

B. LVT: Luxury vinyl tiles. A marketing term that is applied to modular resilient floor tile products.

C. VCT: Vinyl composition tiles. A modular resilient floor tile product composed of binder, fillers, and pigments.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1. Review methods and procedures related to resilient tile and plank flooring installation including, but not limited to, the following:

   a. Review delivery, storage, and handling procedures.
   b. Review ambient conditions and ventilation procedures.
   c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include manufacturers' written data on physical characteristics, durability, and fade resistance.
2. Include manufacturers' written installation instructions for each type of substrate.

B. Shop Drawings: For each type of resilient flooring type required.

1. Include flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

C. Samples: Full-size units of each color, texture, and pattern of resilient flooring type required.

D. Samples for Initial Selection: For each type of resilient flooring product required.

E. Samples for Verification: Full-size units of each color and pattern of resilient flooring type required.

F. Product Schedule: For each type of resilient flooring product required. [**Use same designations indicated on Drawings.**]

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: Verify compliance with VOC emissions evaluation.
3. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Product Data: For adhesives, indicating VOC content.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Health Product Declaration (HPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Environmental Product Declaration (EPD): For each product.
12. Third-Party Certifications: For each product.
13. Third-Party-Certified Life-Cycle Assessment: For each product.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For resilient flooring, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient flooring product type to include the following:

1. Methods for maintaining resilient flooring, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to resilient flooring.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Tile and Plank Flooring: Furnish no fewer than [**1 box for each 50 boxes**] or fraction thereof, of each type, color, pattern, and size of resilient flooring product installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient flooring installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient flooring manufacturer for installation techniques required.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturers' labels indicating brand name and directions for storing.

B. Store resilient flooring and accessory materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F (10 deg C)** or more than **90 deg F (32 deg C)**. Store resilient flooring on flat surfaces.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install resilient flooring until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

B. Do not install resilient flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by resilient flooring manufacturer.

C. Adhesively Applied Products:

1. Maintain temperatures during installation within range recommended in writing by manufacturer, but not less than [**70 deg F (21 deg C)**] or more than [**95 deg F (35 deg C)**] , in spaces to receive flooring 48 hours before installation, during installation, and 48 hours after installation unless longer period is recommended in writing by manufacturer.
2. After postinstallation period, maintain temperatures within range recommended in writing by manufacturer, but not less than [**55 deg F (13 deg C)**] or more than [**95 deg F (35 deg C)**] .
3. Close spaces to traffic during flooring installation.
4. Close spaces to traffic for 48 hours after flooring installation unless manufacturer recommends longer period in writing.

1.11 WARRANTY

A. Special Warranty for Resilient Flooring Products: Manufacturer agrees to repair or replace components

of flooring installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of flooring due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Warranty Period: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products in accordance with ASTM E648 or ASTM E662 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

G. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.

2.2 RESILIENT TILE AND PLANK FLOORING

A. Solid Vinyl Floor Tiles : Resilient tile flooring product composed of binder, fillers, and pigments compounded with suitable stabilizers and processing aids.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Altro**]
b. [**American Biltrite**]
c. [**Flexco Corporation**]
d. [**Mohawk Group**]
e. [**Roppe Corporation; Roppe Holding Company**]
f. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
g. [**van Gelder, Inc**]
h. [**VPI Corporation**]

2. Classification: ASTM F1700, Class [**I, Monolithic Vinyl Tile**][**II, Surface-Decorated Vinyl Tile**][**III, Printed Film Vinyl Tile**][**As indicated by product designations**] .

   a. Type: [**A, Smooth Surface**][**B, Embossed Surface**] .

3. Thickness: [**0.080 inch (2.0 mm)**][**0.100 inch (2.5 mm)**][**0.120 inch (3.0 mm)**][**0.125 inch (3.2 mm)**] .
4. Size: [**12 by 12 inches (305 by 305 mm)**][**18 by 18 inches (457 by 457 mm)**][**24 by 24 inches (610 by 610 mm)**][**36 by 36 inches (914 by 914 mm)**][**3 by 36 inches (76 by 914 mm)**] .
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.

B. Commercial Luxury Vinyl Floor Tiles : Solid, resilient tile flooring product composed of binder, fillers, and pigments compounded with suitable stabilizers and processing aids; marketed as luxury vinyl tiles (LVT).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Altro**]
   b. [**American Biltrite**]
   c. [**Armstrong Flooring, Inc.**]
   d. [**Flexco Corporation**]
   e. [**Gerflor USA**]
   f. [**Mannington Mills, Inc**]
   g. [**Mohawk Group**]
   h. [**Roppe Corporation; Roppe Holding Company**]
   i. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   j. [**Tarkett USA**]
   k. [**van Gelder, Inc**]

2. Classification: ASTM F1700, Class [**II, Surface-Decorated Vinyl Tile**][**III, Printed Film Vinyl Tile**] .

   a. Type: [**A, Smooth Surface**][**B, Embossed Surface**] .

3. Overall Thickness: [**0.080 inch (2.0 mm)**][**0.100 inch (2.5 mm)**][**0.120 inch (3.0 mm)**][**0.125 inch (3.2 mm)**] including manufacturer's standard clear wear layer and UV-cured polyurethane topcoat.
4. Nominal Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**18 by 18 inches (457 by 457 mm)**][**24 by 24 inches (610 by 610 mm)**][**36 by 36 inches (914 by 914 mm)**][**3 by 36 inches (76 by 914 mm)**][**6 by 48 inches (150 by 1220 mm)**][**9 by 60 inches (230 by 1525 mm)**] .

5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Commercial Luxury Vinyl Floor Planks : Solid, resilient plank flooring product composed of binder, fillers, and pigments compounded with suitable stabilizers and processing aids; marketed as luxury vinyl planks (LVP).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Altro**]
   b. [**American Biltrite**]
   c. [**Armstrong Flooring, Inc.**]
   d. [**Flexco Corporation**]
   e. [**Gerflor USA**]
   f. [**Mannington Mills, Inc**]
   g. [**Mohawk Group**]
   h. [**Roppe Corporation; Roppe Holding Company**]
   i. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   j. [**Tarkett USA**]
   k. [**van Gelder, Inc**]

2. Classification: ASTM F1700, Class III, Printed Film Vinyl Tile.

   a. Type: [**A, Smooth Surface**][**B, Embossed Surface**] .

3. Overall Thickness: [**0.080 inch (2.0 mm)**][**0.100 inch (2.5 mm)**][**0.120 inch (3.0 mm)**][**0.125 inch (3.2 mm)**] including manufacturer's standard clear wear layer and UV-cured polyurethane topcoat.
4. Nominal Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**18 by 18 inches (457 by 457 mm)**][**24 by 24 inches (610 by 610 mm)**][**36 by 36 inches (914 by 914 mm)**][**3 by 36 inches (76 by 914 mm)**][**6 by 48 inches (150 by 1220 mm)**][**9 by 60 inches (230 by 1525 mm)**] .
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

D. Rigid Polymeric Core Floor Tiles : Resilient flooring product with rigid polymeric core that is surface-decorated or -printed and protected by a clear wear layer [marketed as luxury vinyl tiles (LVT),] with worked edges that allow the product to be joined or butted together to form a larger integral unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Biltrite**]
   b. [**Gerflor USA**]
   c. [**Mannington Mills, Inc**]
   d. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]

e. [**Tarkett USA**]

2. Classification: ASTM F3261, Class I, printed with clear transparent/translucent wear layer.

   a. Type: [**A, Smooth Surface**][**B, Embossed Surface**] .
   b. Grade: [**1**][**2**] .
   c. Backing Class: [**A, no attached underlay backing**][**B, with attached underlay backing**] .

3. Overall Thickness: [**0.2 inch (5 mm)**][**0.236 inch (6 mm)**][**0.25 inch (6.5 mm)**][**0.28 inch (7 mm)**] including manufacturer's standard clear wear layer and UV-cured polyurethane topcoat.
4. Nominal Size: [**6 by 48 inches (152 by 1219 mm)**][**7 by 60 inches (178 by 1524 mm)**][**8.85 by 60 inches (225 by 1524 mm)**][**9 by 60 inches (225 by 1524 mm)**][**9 by 72 inches (229 by 1829 mm)**] .
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

E. Rigid Polymeric Core Floor Planks : Resilient flooring product with rigid polymeric core that is surface-decorated or -printed and protected by a clear wear layer [marketed as luxury vinyl planks (LVP),] with worked edges that allow the product to be joined or butted together to form a larger integral unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Biltrite**]
   b. [**Gerflor USA**]
   c. [**Mannington Mills, Inc**]
   d. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   e. [**Tarkett USA**]

2. Classification: ASTM F3261, Class I, printed with clear transparent/translucent wear layer.

   a. Type: [**A, Smooth Surface**][**B, Embossed Surface**] .
   b. Grade: [**1**][**2**] .
   c. Backing Class: [**A, no attached underlay backing**][**B, with attached underlay backing**] .

3. Overall Thickness: [**0.2 inch (5 mm)**][**0.236 inch (6 mm)**][**0.25 inch (6.5 mm)**][**0.28 inch (7 mm)**] including manufacturer's standard clear wear layer and UV-cured polyurethane topcoat.
4. Nominal Size: [**6 by 48 inches (152 by 1219 mm)**][**7 by 60 inches (178 by 1524 mm)**][**8.85 by 60 inches (225 by 1524 mm)**][**9 by 60 inches (225 by 1524 mm)**][**9 by 72 inches (229 by 1829 mm)**] .
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

F. Rubber Floor Tiles : Resilient flooring product consisting of modular rubber tiles with smooth square edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Allstate Flooring**]
b. [**Altro**]
c. [**American Biltrite**]
d. [**Flexco Corporation**]
e. [**Mannington Mills, Inc**]
f. [**Mondo**]
g. [**Nora by Interface**]
h. [**PRF USA Inc**]
i. [**Roppe Corporation; Roppe Holding Company**]
j. [**Tarkett USA**]

2. Classification: ASTM F1344, Type [**I-A, Homogeneous Rubber Tile, solid color**][**I-B, Homogeneous Rubber Tile, through mottled**][**II-A, Heterogeneous (Layered) Rubber Tile, solid-color wear layer**][**II-B, Heterogeneous (Layered) Rubber Tile, mottled wear layer**] .
3. Hardness: [**Grade 1, minimum hardness of 85**][**Grade 2, minimum hardness of 70**][**Manufacturer's standard hardness**] , when measured using Shore, Type A durometer in accordance with ASTM D2240.
4. Wearing Surface: [**Smooth**][**Embossed**][**Molded pattern**] .

   a. Molded-Pattern Figure: [**Raised discs**][**Raised squares**] .

5. Thickness: [**0.125 inch (3.2 mm)**] .
6. Size: [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**] .
7. Seamless-Installation Method: [**Heat welded**][**Chemically bonded**] .
8. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
9. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

G. Vinyl Composition Floor Tiles : Resilient flooring product composed of binder, fillers, and pigments compounded with suitable stabilizers and processing aids.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Armstrong Flooring, Inc.**]
   b. [**Tarkett USA**]

2. Classification: ASTM F1066, Class [**1, solid color**][**2, through pattern**][**3, surface pattern**] .
3. Wearing Surface: [**Smooth**][**Embossed**] .
4. Thickness: [**0.125 inch (3.2 mm)**] .
5. Size: **12 by 12 inches (305 by 305 mm)**.
6. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.
7. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

H. Resilient Terrazzo Floor Tiles: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Floorazzo Tile, LLC**]
b. [**Nurrazzo**]

2. Thickness: [**1/8 inch (3.0 mm)**][**3/16 inch (4.8 mm)**] .
3. Size: [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1219 mm)**] .
4. Seamless-Installation Method: Chemically bonded.
5. Accessories:

   a. Base: [**3 inches (76 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**] tall.

      1) Type: [**Sanitary, coved**][**Straight**] .

   b. Divider strips.

6. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**] , as directed by the Owner.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended in writing by floor tile and adhesive manufacturers for substrate and conditions indicated.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

C. Vapor Retarder: ASTM D4397, polyethylene sheet not less than [**6.0 mils (0.15 mm)**][**8.0 mils (0.2 mm)**] thick.

D. Asphalt-Saturated Felt: ASTM D4869/D4869M, Type II.

E. Seamless-Installation Accessories: Manufacturer's standard product for chemically bonding seams.

F. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

G. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade recommended in writing by floor tile manufacturer to suit application.

1. Joint-Sealant Color: [**White**][**As selected by Architect from manufacturer's full range to match floor tile**][**Match floor tile**] , as directed by the Owner.
2. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Products recommended by floor tile manufacturer to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient flooring products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates in accordance with manufacturer's written installation instructions to ensure adhesion of flooring.

B. Concrete Substrates: Prepare in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient flooring manufacturer. Do not use solvents.
3. Alkalinity Testing: Perform pH testing in accordance with ASTM F710. Proceed with installation only if pH readings are not less than [**7.0**] and not greater than [**8.5**] .
4. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**] and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft.**

(1.36 kg of water/92.9 sq. m)] in 24 hours.

b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Move flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation unless manufacturer recommends a longer period in writing.

1. Do not install flooring until it is the same temperature as space where it is to be installed.

E. Sweep and vacuum clean substrates to be covered by flooring immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF RESILIENT TILE AND PLANK FLOORING

A. Comply with manufacturer's written installation instructions.

B. Discard broken, cracked, chipped, or deformed tiles.

C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles [**square with room axis**][**at a 45-degree angle with room axis**][**in pattern indicated**] .

D. Tile Matching: Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered.

1. Lay tiles [**with grain running in one direction**][**with grain direction alternating in adjacent tiles (basket-weave pattern)**][**in pattern of colors and sizes indicated**] .

E. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

F. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

H. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

I. Adhered Floor Tile: Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written installation instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times, to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

J. Floating Floor Tile: Install LVT floor tiles in accordance with flooring manufacturer's written installation instructions.

K. Seamless Installation: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

L. Resilient Terrazzo Accessories: Install in accordance with manufacturer's written instructions.

3.4 CLEANING

A. Comply with manufacturer's written instructions for cleaning flooring.

B. Perform the following operations immediately after completing flooring installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

1. Apply [**one**][**two**][**three**] coat(s).

D. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.

E. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.

1. Sealer: Apply two base coats of liquid sealer.
2. Finish: Apply [**two**][**three**] coats of liquid floor finish.

a. Apply finish in accordance with manufacturer's written installation instructions to produce a sealed surface that is ready for use. Do not cover flooring after finishing until finish reaches full cure.

3.5 PROTECTION

A. Comply with manufacturer's written instructions for protecting flooring.

B. After post-installation cleaning, immediately protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

C. Cover resilient flooring until Substantial Completion.

END OF SECTION 09 65 19 00

Task	Specification	Specification Description
09 65 19 19	09 65 19 00	Resilient Tile Flooring
09 65 19 23	09 65 19 00	Resilient Tile Flooring
09 65 19 33	09 65 19 00	Resilient Tile Flooring
09 65 19 43	09 65 19 00	Resilient Tile Flooring
09 65 23 00	09 65 16 00	Resilient Sheet Flooring

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SECTION 09 65 43 00 - LINOLEUM FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Linoleum tile flooring.
2. Linoleum sheet flooring.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096513 "Resilient Base and Accessories" for wall base and accessories installed with linoleum flooring.
3. Section 096516 "Resilient Sheet Flooring" for resilient rolled flooring.
4. Section 096519 "Resilient Tile and Plank Flooring" for modular resilient flooring.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review methods and procedures related to linoleum flooring installation including, but not limited to, the following:

a. Delivery, storage, and handling procedures.
b. Ambient conditions and ventilation procedures.
c. Subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation instructions for each type of substrate.

B. Shop Drawings: For each type of linoleum flooring.

1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

C. Samples: For each exposed product and for each color and pattern specified in manufacturer's standard size, but not less than [**6-by-9-inch (152-by-230-mm)**] sections.

1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than [**9 inches (230 mm)**] long, of each color required.

D. Samples for Initial Selection: For each type of linoleum flooring indicated.

E. Samples for Verification: For each type of linoleum flooring, in manufacturer's standard size, but not less than [**6-by-9-inch (152-by-230-mm)**] sections of each different color and pattern required.

1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than [**9 inches (230 mm)**] long, of each color required.

F. Heat-Welded Seam Samples: For each linoleum flooring product and welding bead color and pattern combination required; with seam running lengthwise and in center of [**6-by-9-inch (152-by-230-mm)**] Sample applied to rigid backing and prepared by Installer for this Project.

G. Product Schedule: For linoleum flooring.[**Use same designations indicated on Drawings.**]

H. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: Verify compliance with VOC emissions evaluation.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For linoleum flooring, for tests performed by a qualified testing agency.

B. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of linoleum flooring.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile Flooring: Furnish one box for every [**50**] boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
2. Sheet Flooring: Furnish not less than [**10 linear ft. (3 linear m)**] for every [**500 linear ft. (150 linear m)**] or fraction thereof, in roll form and in full roll width for each type, color, and pattern of sheet flooring installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for linoleum flooring installation and seaming methods indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by flooring manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **65 deg F (18 deg C)** or more than **90 deg F (32 deg C)**.

1. Tile Flooring: Store on flat surfaces.
2. Sheet Flooring: Store rolls upright.

1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than [**70 deg F (21 deg C)**] or more than [**95 deg F (35 deg C)**], in spaces to receive flooring during the following periods:

1. 72 hours before installation.
2. During installation.
3. 72 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than [**55 deg F (13 deg C)**] or more than [**95 deg F (35 deg C)**].

C. Close spaces to traffic during flooring installation.

D. Close spaces to traffic for 72 hours after flooring installation.

E. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For linoleum flooring, as determined by testing identical products in accordance with ASTM E648 or ASTM E662 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Verify flooring products comply with requirements of the California Department of Public Health's

"Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 LINOLEUM FLOORING

A. Linoleum Tile Flooring:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Forbo Flooring Systems**]

2. Classification: ASTM F2195, Type [**I, linoleum floor tile with fibrous backing**][**II, linoleum floor tile with special backing**][**III, linoleum floor tile without backing**].
3. Nominal Floor Tile Size: [**Manufacturer's standard**][**13 by 13 inches (330 by 330 mm)**][**20 by 20 inches (500 by 500 mm)**][**24 by 24 inches (610 by 610 mm)**].
4. Thickness: [**0.08 inch (2.0 mm)**][**0.10 inch (2.5 mm)**].
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**], as directed by the Owner.

B. Linoleum Sheet Flooring:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Forbo Flooring Systems**]
   b. [**Gerflor USA**]

2. Classification: ASTM F2034, Type [**I, linoleum sheet with backing**][**III, linoleum sheet with special backing**].
3. Roll Size: In manufacturer's standard length, but not less than [**78 inches (1980 mm)**] wide.
4. Thickness: [**0.080 inch (2.0 mm)**][**0.10 inch (2.5 mm)**][**0.125 inch (3.2 mm)**][**0.137 inch (3.5 mm)**].
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**], as directed by the Owner.

2.3 ACCESSORY MATERIALS

A. Heat-Welding Bead: For seamless installation, solid-strand product of linoleum flooring manufacturer.

1. Colors: [**As selected by Architect from manufacturer's full range to contrast with linoleum flooring**][**Match linoleum flooring**], as directed by the Owner.

B. Integral-Flash-Cove-Base Accessories:

1. Cove Strip: **1-inch (25-mm)** radius, provided or approved by flooring manufacturer.
2. Cap Strip: [**Square metal, vinyl, or rubber cap**][**Tapered vinyl cap**] provided or approved by flooring manufacturer.

C. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by flooring manufacturer for applications indicated.

D. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit products and substrate conditions indicated.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of linoleum flooring products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates in accordance with flooring manufacturer's written instructions to ensure adhesion of flooring.

B. Concrete Substrates: Prepare in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with flooring adhesives

and that contain soap, wax, oil, or silicone, using mechanical methods recommended by linoleum flooring manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than [**9**][**10**] pH.
4. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install linoleum flooring until materials are the same temperature as space where they are to be installed.

1. At least 72 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.

3.3 INSTALLATION OF LINOLEUM FLOORING, GENERAL

A. Comply with manufacturer's written instructions for installing linoleum flooring.

B. Scribe and cut linoleum flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, thresholds, door frames, and nosings.

C. Extend flooring into toe spaces, door reveals, closets, and similar openings.

D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on linoleum flooring as marked on substrates. Use chalk or other nonpermanent marking device.

E. Install linoleum flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

F. Adhere linoleum flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

G. Heat-Welded Seams: For seamless installation, comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.

3.4 INSTALLATION OF LINOLEUM TILE FLOORING

A. Lay out linoleum tile flooring from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay floor tiles [**square with room axis**][**at a 45-degree angle with room axis**][**in pattern indicated**].

B. Match linoleum floor tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

1. Lay floor tiles [**with grain running in one direction**][**with grain direction alternating in adjacent floor tiles (basket-weave pattern)**][**in pattern of colors and sizes indicated**].

3.5 INSTALLATION OF LINOLEUM SHEET FLOORING

A. Unroll linoleum sheet flooring and allow it to stabilize before cutting and fitting.

B. Lay out linoleum sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least **6 inches (152 mm)** away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.
5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

C. Integral-Flash-Cove Base: Cove flooring [**6 inches (152 mm)**][**to dimension indicated**] up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

3.6 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting linoleum flooring.

B. Perform the following operations immediately after completing linoleum flooring installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect linoleum flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from linoleum flooring surfaces before applying liquid floor polish.

1. Apply [**two**][**three**] coat(s).

E. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover linoleum flooring until Substantial Completion.

END OF SECTION 09 65 43 00

Task	Specification	Specification Description
09 65 43 00	09 65 16 00	Resilient Sheet Flooring

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SECTION 09 65 66 00 - RESILIENT ATHLETIC FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient athletic tile flooring.
2. Resilient athletic sheet flooring.

B. Related Requirements:

1. Section 096513 "Resilient Base and Accessories" for wall base and accessories installed with resilient athletic flooring.

1.2 COORDINATION

A. Coordinate layout and installation of flooring with floor inserts and junction boxes for gymnasium and fitness equipment.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to resilient athletic flooring installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation instructions for each type of substrate.

B. Shop Drawings: Show installation details and locations of the following:

1. Border tiles.
2. Floor patterns.
3. Layout, colors, widths, and dimensions of game lines and markers.
4. Locations of floor inserts for athletic equipment installed through flooring.
5. Locations of junction boxes for fitness equipment installed through flooring.
6. Seam locations for resilient athletic sheet flooring.

C. Samples: For each exposed product and for each type, color, and pattern specified, [**6-inch- (150-mm-)**]

square in size and of the same thickness indicated for the Work.

1. Game-Line- and Marker-Paint Samples: Include Sample sets showing game-line- and marker-paint colors applied to flooring.
2. Seam Samples: For each type of resilient athletic sheet flooring color and pattern required; with seam running lengthwise and in center of [**6-by-9-inch (150-by-230-mm)**] Sample applied to a rigid backing and prepared by Installer for this Project.

D. Samples for Initial Selection: For each type of resilient athletic flooring.

1. Game-Line and Marker Paint: Include charts showing available colors and glosses.

E. Samples for Verification: For each type, color, and pattern of flooring specified, [**6-inch- (150-mm-)**] square in size and of same thickness and material indicated for the Work.

1. Game-Line- and Marker-Paint Samples: Include Sample sets showing game-line- and marker-paint colors applied to flooring.
2. Seam Samples: For each type of resilient athletic sheet flooring color and pattern required; with seam running lengthwise and in center of [**6-by-9-inch (150-by-230-mm)**] Sample applied to a rigid backing and prepared by Installer for this Project.

F. Product Schedule: For resilient athletic flooring. Use same designations indicated on Drawings.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: Verify compliance with VOC emissions evaluation.
3. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Product Data: For adhesives, indicating VOC content.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For resilient athletic flooring, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resilient athletic flooring.

1. Methods for maintaining resilient athletic flooring, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to resilient athletic flooring.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Athletic Tile Flooring: Furnish no fewer than [**1 box for each 50 boxes**] or fraction thereof, of each type, color, pattern, and size of tile flooring installed.
2. Resilient Athletic Sheet Flooring: Furnish full-width rolls of not less than [**10 linear feet (3 linear m) for each 500 linear feet (150 linear m)**] or fraction thereof, of each type, color, and pattern of sheet flooring installed.

1.8 QUALITY ASSURANCE

A. Resilient Athletic Sheet Flooring Installer Qualifications: An experienced installer who has completed resilient athletic sheet flooring installations using seaming methods indicated for this Project and similar in material, design, and extent to that indicated for this Project; who is acceptable to manufacturer; and whose work has resulted in installations with a record of successful in-service performance.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storing.

B. Store materials to prevent deterioration.

1. Store tiles on flat surfaces.
2. Store rolls upright.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install resilient athletic flooring until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

B. Do not install resilient athletic flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by resilient athletic flooring manufacturer.

C. Adhesively Applied Products:

1. Maintain temperatures during installation within range recommended in writing by manufacturer, but not less than [**70 deg F (21 deg C)**] or more than [**95 deg F (35 deg C)**], in spaces to receive flooring 48 hours before installation, during installation, and 48 hours after installation unless longer period is recommended in writing by manufacturer.
2. After postinstallation period, maintain temperatures within range recommended in writing by manufacturer, but not less than [**55 deg F (13 deg C)**] or more than [**95 deg F (35 deg C)**].
3. Close spaces to traffic during flooring installation.
4. Close spaces to traffic for 48 hours after flooring installation unless manufacturer recommends longer period in writing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

F. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

1. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.

2.2 RESILIENT ATHLETIC TILE FLOORING

A. Interlocking, Rubber Floor Tile : Resilient athletic flooring consisting of modular rubber tiles with precision cut, interlocking edges, for free-lay installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Action Floor Systems, LLC**]
b. [**Amarco Products**]
c. [**American Floor Products Company, Inc**]
d. [**Connor Sports**]
e. [**Dinoflex**]
f. [**Flexco Corporation**]
g. [**Horner Sports Flooring**]
h. [**Johnsonite; a Tarkett company**]
i. [**Mateflex**]
j. [**Mondo**]
k. [**Pawling Corporation**]

l. [**REGUPOL AMERICA, LLC**]
m. [**Robbins Sports Surfaces**]
n. [**Roppe Corporation; Roppe Holding Company**]
o. [**Tarkett Sports; a division of the Tarkett Group**]
p. [**van Gelder, Inc**]

2. Material: [**Rubber**][**Recycled-rubber compound**].
3. Tile Interlock: [**Visible**][**Hidden**].
4. Traffic-Surface Texture: [**Smooth**][**Nondirectional, stipple texture**][**Textured**].
5. Provide reversible tiles (with traffic-surface texture on both sides).
6. Size: [**Manufacturer's standard-size square tile**][**24 inches (610 mm) square**].
7. Thickness: [**3/8 inch (9.5 mm)**][**7/16 inch (11.1 mm)**][**1/2 inch (13 mm)**][**9/16 inch (14.3 mm)**][**3/4 inch (19 mm)**].
8. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.
9. Border: Interlocking, beveled-edge tiles, of same material as floor tile; with bevels that transition from thickness of floor tile to surface below it; with straight outside edges; for use where flooring corners and edges do not abut vertical surfaces.

   a. Border Color and Pattern: [**Matching floor tile**][**As selected by Architect from manufacturer's full range to contrast with floor tile**][**As indicated by manufacturer's designations**], as directed by the Owner.

B. Rubber Floor Tile : Resilient athletic flooring consisting of modular rubber tiles with smooth square edges for adhered application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aacer Sports Flooring, an Infinity Wood Floors Company**]
   b. [**Action Floor Systems, LLC**]
   c. [**Amarco Products**]
   d. [**American Floor Products Company, Inc**]
   e. [**Connor Sports**]
   f. [**Dinoflex**]
   g. [**Flexco Corporation**]
   h. [**Horner Sports Flooring**]
   i. [**Johnsonite; a Tarkett company**]
   j. [**Mateflex**]
   k. [**Matter Surfaces**]
   l. [**Mondo**]
   m. [**Nora by Interface**]
   n. [**REGUPOL AMERICA, LLC**]
   o. [**Robbins Sports Surfaces**]
   p. [**Roppe Corporation; Roppe Holding Company**]
   q. [**Sport Court, a Gerflor Company**]
   r. [**Tarkett Sports; a division of the Tarkett Group**]
   s. [**The R.C. Musson Rubber Co.**]
   t. [**van Gelder, Inc**]

2. Material: [**Rubber**][**Recycled-rubber compound**][**Rubber wear layer and rubber shock-absorbent layer, vulcanized together**].
3. Traffic-Surface Texture: [**Smooth**][**Nondirectional, stipple texture**][**Textured**].
4. Size: [**Manufacturer's standard-size square tile**][**18 inches (457 mm) square**][**24 inches**

(610 mm) **square**][36 inches (914 mm) **square**].

5. Thickness: [5/32 inch (4 mm)][1/4 inch (6.4 mm)][3/8 inch (9.5 mm)][1/2 inch (13 mm)].
6. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.
7. Border: Interlocking, beveled-edge tiles, of same material as floor tile; with bevels that transition from thickness of floor tile to surface below it; with straight outside edges; for use where flooring corners and edges do not abut vertical surfaces.

    a. Border Color and Pattern: [**Matching floor tile**][**As selected by Architect from manufacturer's full range to contrast with floor tile**][**As indicated by manufacturer's designations**], as directed by the Owner.

C. Rubber-Strip Floor Tile : Modular, close-nap, carpetlike tiles of rubber-fabric strips; made from recycled tires; bonded to a backing; for adhered installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amarco Products**]
    b. [**American Floor Products Company, Inc**]
    c. [**Flexco Corporation**]
    d. [**Johnsonite; a Tarkett company**]
    e. [**The R.C. Musson Rubber Co.**]

2. Materials: Recycled rubber.
3. Fire-Test-Response Characteristics: Passing 16 CFR 1630 (DOC FF-1-70).
4. Size: 12 inches (305 mm) square.
5. Thickness: 3/8 inch (9.5 mm).
6. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.

D. Rubber Mats : Individual rubber mats specifically designed for free-lay athletic flooring applications.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amarco Products**]
    b. [**American Floor Products Company, Inc**]
    c. [**Matter Surfaces**]
    d. [**Pawling Corporation**]
    e. [**The R.C. Musson Rubber Co.**]

2. Material: Recycled-rubber compound.
3. Traffic-Surface Texture: Smooth.
4. Size: [48 by 72 inches (1219 by 1829 mm)].
5. Thickness: [3/8 inch (9.5 mm)][1/2 inch (13 mm)].
6. Color: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.

E. Interlocking, Suspended, Polymer Floor Tile : Athletic flooring consisting of modular, polymer tiles raised above substrate on gusseted ribs or posts; with hidden, interlocking connectors; for free-lay installation[

over adhered rubber sheet underlayment].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amarco Products**]
    b. [**Mateflex**]
    c. [**Matter Surfaces**]
    d. [**Sport Court, a Gerflor Company**]

2. Material: [**Solid polypropylene**][**Polypropylene supports with vinyl insert**].
3. Tile Interlock: Manufacturer's standard.
4. Traffic-Surface Texture: [**Solid**][**Raised disc**].
5. Size: [**Manufacturer's standard-size square tile**][**12 inches (305 mm) square**][**9.8 inches (250 mm) square**].
6. Thickness: [**1/2 inch (13 mm)**].
7. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.
8. Border: Interlocking, beveled-edge tiles, of same material as floor tile; with bevels that transition from thickness of floor tile to surface below it; with straight outside edges; for use where flooring corners and edges do not abut vertical surfaces.

    a. Border Color and Pattern: [**Matching floor tile**][**As selected by Architect from manufacturer's full range to contrast with floor tile**][**As indicated by manufacturer's designations**], as directed by the Owner.

F. Interlocking, Open-Grid, Vinyl Floor Tile : Athletic flooring consisting of modular, polymer tiles with openings to permit free drainage of water; with hidden, interlocking connectors; for free-lay installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amarco Products**]
    b. [**American Floor Products Company, Inc**]
    c. [**Mateflex**]
    d. [**Matter Surfaces**]

2. Material: [**Vinyl**][**Recycled-vinyl compound**].
3. Tile Interlock: Manufacturer's standard.
4. Size: **12 inches (305 mm)** square.
5. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**7/16 inch (11.1 mm)**][**3/4 inch (19 mm)**].
6. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.
7. Border: Interlocking, beveled-edge tiles, of same material as floor tile; with bevels that transition from thickness of floor tile to surface below it; with straight outside edges; for use where flooring corners and edges do not abut vertical surfaces.

    a. Border Color and Pattern: [**Matching floor tile**][**As selected by Architect from manufacturer's full range to contrast with floor tile**][**As indicated by manufacturer's designations**], as directed by the Owner.

2.3 RESILIENT ATHLETIC SHEET FLOORING

A. Rubber Sheet Flooring : Rubber athletic flooring provided as rolled goods for adhered installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aacer Sports Flooring, an Infinity Wood Floors Company**]
   b. [**Action Floor Systems, LLC**]
   c. [**Amarco Products**]
   d. [**American Floor Products Company, Inc**]
   e. [**Connor Sports**]
   f. [**Flexco Corporation**]
   g. [**Horner Sports Flooring**]
   h. [**Johnsonite; a Tarkett company**]
   i. [**Mondo**]
   j. [**Nora by Interface**]
   k. [**REGUPOL AMERICA, LLC**]
   l. [**Robbins Sports Surfaces**]
   m. [**Roppe Corporation; Roppe Holding Company**]
   n. [**Sport Court, a Gerflor Company**]
   o. [**Surface America, Inc.**]
   p. [**Tarkett Sports; a division of the Tarkett Group**]
   q. [**van Gelder, Inc**]

2. Material: [**Recycled-rubber compound**][**Rubber wear layer and rubber shock-absorbent layer, vulcanized together**].
3. Traffic-Surface Texture: [**Smooth**].
4. Roll Size: [**Not less than 48 inches (1219 mm)**] wide by longest length that is practical to minimize splicing during installation.
5. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**].
6. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.
7. Border: Interlocking, beveled-edge tiles, of same material as sheet flooring; with bevels that transition from thickness of sheet flooring to surface below it; with straight outside edges; for use where flooring corners and edges do not abut vertical surfaces.

   a. Border Color and Pattern: [**Matching sheet flooring**][**As selected by Architect from manufacturer's full range to contrast with floor tile**][**As indicated by manufacturer's designations**], as directed by the Owner.

B. Sheet Vinyl Flooring : Sheet vinyl flooring specifically designed for adhered athletic flooring applications.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aacer Sports Flooring, an Infinity Wood Floors Company**]
   b. [**Action Floor Systems, LLC**]
   c. [**Amarco Products**]
   d. [**Connor Sports**]
   e. [**Gerflor USA**]

f. [**Johnsonite; a Tarkett company**]
g. [**Lonseal, Inc**]
h. [**Matter Surfaces**]
i. [**Mondo**]
j. [**Tarkett Sports; a division of the Tarkett Group**]

2. Unbacked Sheet Vinyl Flooring: ASTM F1913, [**0.08 inch (2 mm)**] thick.

   a. Separate underlayment pad of bonded recycled rubber and polyurethane particles.

3. Sheet Vinyl Flooring with Backing: ASTM F1303.

   a. Type (Binder Content): [**Type I, minimum binder content of 90 percent**][**Type II, minimum binder content of 34 percent**].
   b. Wear-Layer Thickness: Grade 1.
   c. Interlayer Material: [**Foamed plastic**][**None**].
   d. Backing Class: [**Class B (nonfoamed plastic)**][**Class C (foamed plastic)**].

4. Seaming Method: [**Heat welded**][**Chemically bonded**].
5. Traffic-Surface Texture: [**Smooth**][**Embossed**].
6. Applied Finish: [**Factory-applied UV urethane**][**Field-applied polyurethane**].
7. Roll Size: [**Not less than 48 inches (1219 mm)**] wide by longest length that is practical to minimize splicing during installation.
8. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's designations**], as directed by the Owner.

2.4 ACCESSORIES

A. Underlayment: [**Manufacturer's standard rubber sheet**][**Recycled-rubber sheet**].

   1. Thickness: [**0.08 inch (2 mm)**][**0.12 inch (3 mm)**].

B. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.

C. Adhesives: Water-resistant type recommended in writing by manufacturer for substrate and conditions indicated.

   1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
   3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

D. Game-Line and Marker Paint: Complete system including primer, if any, compatible with flooring and recommended in writing by flooring and paint manufacturers for use indicated.

E. Verify products comply with requirements of the California Department of Public Health's "Standard

Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

G. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates in accordance with manufacturer's written installation instructions to ensure adhesion of flooring.

B. Concrete Substrates: Prepare in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity Testing: Perform pH testing in accordance with ASTM F710. Proceed with installation only if pH readings are not less than [**7.0**] and not greater than [**8.5**].
3. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**] and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by manufacturer. Do not use solvents.

D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.

E. Move flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation unless manufacturer recommends a longer period in writing.

1. Do not install flooring until it is the same temperature as space where it is to be installed.

F. Sweep and vacuum clean substrates to be covered by flooring immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF RESILIENT ATHLETIC FLOORING, GENERAL

A. Comply with manufacturer's written installation instructions.

B. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces, equipment anchors, floor outlets, and other interruptions of floor surface.

C. Extend flooring into toe spaces, door reveals, closets, and similar openings unless otherwise indicated.

D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating subfloor markings on flooring. Use nonpermanent, nonstaining marking device.

3.4 INSTALLATION OF RESILIENT ATHLETIC TILE FLOORING

A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles [**square with room axis**][**at a 45-degree angle with room axis**][**in pattern indicated**].

B. Discard broken, cracked, chipped, or deformed tiles.

C. Tile Matching: Match tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged if so numbered.

1. Lay tiles [**with grain running in one direction**][**with grain direction alternating in adjacent tiles (basket-weave pattern)**][**in pattern of colors and sizes indicated**].

D. Adhered Floor Tile: Adhere products to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written installation instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.

1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

E. Free-Lay Tile: Place flooring at locations indicated with units securely interconnected and fully seated on substrate to form a smooth, level surface.

3.5 INSTALLATION OF RESILIENT ATHLETIC SHEET FLOORING

A. Unroll sheet flooring and allow it to stabilize before cutting and fitting.

B. Lay out sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least **6 inches (150 mm)** away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Locate seams in accordance with approved Shop Drawings.

C. Adhere products to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written installation instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.

1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

D. Vinyl Sheet Flooring Seams: Prepare and finish seams to produce surfaces flush with adjoining flooring surfaces.

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and use welding bead to permanently fuse sections into a seamless flooring.
2. Chemically Bonded Seams: Comply with ASTM F693. Seal seams to prevent openings from forming between cut edges and to prevent penetration of dirt, liquids, and other substances into seams.

3.6 GAME LINES AND MARKERS

A. Mask flooring at game lines and markers and apply paint to produce sharp edges. Where crossing, break minor game line at intersection; do not overlap lines.

B. Apply game lines and markers in widths and colors in accordance with [**requirements indicated on Drawings**].

3.7 FIELD-APPLIED FINISHES

A. Apply finish after game-line and marker paint is fully cured.

B. Apply finish in accordance with manufacturer's written installation instructions to produce a sealed surface that is ready for use.

C. Do not cover flooring after finishing until finish reaches full cure.

3.8 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing flooring installation:

1. Remove adhesive and other blemishes from flooring surfaces.
2. Sweep and vacuum flooring thoroughly.
3. Damp-mop flooring to remove marks and soil after time period recommended in writing by manufacturer.

B. Protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

1. Do not move heavy and sharp objects directly over flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

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SECTION 09 66 13 00 - PORTLAND CEMENT TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Poured-in-place portland cement terrazzo flooring.
2. Poured-in-place rustic terrazzo flooring.
3. Precast terrazzo units.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealants installed with terrazzo.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns.
d. Review procedures for coping with unfavorable forecasted weather conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Expansion-joint strips.
4. Accessory strips.

5. Abrasive strips.
6. Stair treads, risers, and landings.
7. Precast terrazzo jointing and edge configurations.
8. Terrazzo patterns.

D. Samples: For each exposed product and for each color and texture specified, [**6 inches (150 mm)**] in size.

E. Samples for Initial Selection: NTMA's "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.

F. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:

1. Terrazzo: [**6-inch- (150-mm-)**] square Samples.
2. Precast Terrazzo: [**6-inch- (150-mm-)**] square Samples.
3. Accessories: [**6-inch- (150-mm-)**] long Samples of each exposed strip item required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of terrazzo material or product.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer who is a contractor member of NTMA.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for each type of terrazzo including accessories.

a. Size: Minimum **100 sq. ft. (9 sq. m)** of typical poured-in-place flooring condition for each color and pattern [**in locations indicated**][**in locations directed by Architect**], as directed by the Owner.
b. Include [**base**][**first three stair treads**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area

protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Maintain interior ambient temperature above **50 deg F (10 deg C)** for 48 hours before and during terrazzo installation.

B. Weather Limitations: Proceed with rustic terrazzo installation only when forecasted weather conditions permit work to be performed according to NTMA's written recommendations and when temperatures remain above **45 deg F (7.2 deg C)**.

C. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

D. Provide permanent interior lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

E. Close spaces to traffic during terrazzo installation and for not less than 24 hours after installation unless manufacturer recommends a longer period.

F. Control and collect water and dust produced by portland cement terrazzo grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.3 PORTLAND CEMENT TERRAZZO

A. Portland Cement Terrazzo System : [**Sand cushion**][**Bonded**][**Monolithic**].

1. Underbed Thickness: [**As indicated on Drawings**].
2. Terrazzo Topping Thickness: [**As indicated on Drawings**].

B. Materials:

1. Portland Cement: ASTM C150/C150M, Type 1.

a. Color for Terrazzo Matrix: [**As required by mix indicated**].

2. Water: Potable.

3. Sand: ASTM C33/C33M.
4. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

    a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M[**and ASTM C535 for large-size coarse aggregates**].
    b. 24-Hour Absorption Rate: Less than 0.75 percent.
    c. Dust Content: Less than 1.0 percent by weight.

5. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight, and compatible with terrazzo matrix.
6. Underbed Bonding Agent: Neat portland cement paste.
7. Topping Bonding Agent: Neat portland cement paste, or epoxy or acrylic bonding agents formulated for use with monolithic terrazzo.
8. Underbed Reinforcement: Galvanized welded-wire reinforcement, wire **2 by 2 inches (51 by 51 mm)** by **0.062 inch (1.57 mm)** in diameter, complying with ASTM A1064/A1064M, except for minimum wire size.
9. Isolation Membrane: Polyethylene sheeting, ASTM D2103, Type 13300, **4 mils (0.1 mm)** thick; or unperforated asphalt felt, ASTM D226/D226M, Type I (No. 15).

C. Mixes:

1. Underbed Mix: One part portland cement to four parts sand and sufficient water to provide workability at as low a slump as possible.
2. Terrazzo Topping Mix: One **94-lb (42.6-kg)** bag of portland cement per [**200 lb (90.7 kg)**] of aggregate, matrix pigment if required by mix color, and sufficient water to produce a workable mix.

2.4 RUSTIC TERRAZZO

A. Rustic Terrazzo System : [**Bonded**][**Monolithic**].

1. Underbed Thickness: [**As indicated on Drawings**].
2. Terrazzo Topping Thickness: [**As indicated on Drawings**].

B. Materials:

1. Portland Cement: ASTM C150/C150M, Type 1.

    a. Color for Terrazzo Matrix: [**As required by mix indicated**].

2. Water: Potable.
3. Sand: ASTM C33/C33M.
4. Aggregates: As required for mix indicated, in sizes comply with NTMA gradation standards, with maximum 24-hour absorption rate of 0.25 percent, and containing no deleterious or foreign matter.
5. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight and weather, and compatible with matrix binder.
6. Air-Entraining Admixture: ASTM C260/C260M.
7. Underbed Bonding Agent: Neat portland cement paste.
8. Topping Bonding Agent: Neat portland cement paste, or epoxy or acrylic bonding agents formulated for use with topping indicated.

C. Mixes:

1. Underbed Mix: One part portland cement to four parts sand and sufficient water to provide workability at as low a slump as possible and air entrainment agent to produce 6 percent plus or minus 1 percent air content at point of delivery.
2. Terrazzo Topping Mix: One **94-lb (42.6-kg)** bag of portland cement per [**200 lb (90.7 kg)**] of aggregate, matrix pigment if required by mix color, and sufficient water to produce a workable mix.

2.5 PRECAST TERRAZZO

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Precast Terrazzo Enterprises, Inc**]
2. [**Romoco Precast Terrazzo Products; a subsidiary of Roman Mosaic & Tile Company**]
3. [**Wausau Tile, Inc.**]

B. Precast Terrazzo Base : Minimum **3/4-inch- (19-mm-)** thick, reinforced, portland cement terrazzo units cast in maximum lengths possible, but not less than **36 inches (900 mm)**. Comply with NTMA's written recommendations for fabricating precast terrazzo base units in sizes and profiles indicated.

1. Type: [**As indicated**][**Coved with minimum 3/4-inch (19-mm) radius**][**Straight**][**Splayed**].
2. Top Edge: [**Straight, unfinished**][**Beveled with polished top surface**][**Radius edge with polished top surface**].
3. Metal Toe Strip: [**Zinc**][**Brass**].
4. Outside Corner Units: With finished returned edges at outside corner.
5. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**], as directed by the Owner.

C. Precast Terrazzo Units : Minimum [**2-inch- (51-mm-)**] thick, reinforced, portland cement terrazzo units. Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to **1/8-inch (3.2-mm)** radius.

1. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**], as directed by the Owner.

2.6 STRIP MATERIALS

A. Standard Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in substrate.

1. Material: [**As indicated**][**White-zinc alloy**][**Brass**].
2. Depth: [**As indicated**][**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].
3. Width: [**As indicated**][**0.05 inch (1.27 mm)**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**].

B. Heavy-Top Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in substrate.

1. Base-Section Material: [**As indicated**][**White-zinc alloy**][**Galvanized steel**].
2. Top-Section Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Plastic, in color selected from full range of industry colors**].
3. Depth: [**As indicated**][**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].

4. Top-Section Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**][**1/2 inch (12.7 mm)**].

C. Heavy-Top Angle Divider Strips: One-piece, L-type angle strips with anchoring device and in depth required for topping thickness indicated.

1. Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Plastic, in color selected from full range of industry colors**].
2. Top-Section Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].

D. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

E. Expansion-Joint Strips: [**Brass**][**Plastic strips in color selected from full range of industry colors**], with removable zip-strip top for installing sealant.

1. Width: [**As indicated**][**Minimum 1/2 inch (12.7 mm)**].

F. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:

1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.

G. Abrasive Strips: [**Three-line**][**Two-line**][**One-line**][**Abrasive nosing strip and two-line**] abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.

1. Width: [**1/2 inch (12.7 mm)**].
2. Depth: As required by terrazzo thickness.
3. Length: [**4 inches (100 mm) less than stair width**][**As indicated**].
4. Color: [**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.7 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Recommended by manufacturer for this use.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and non-outgassing in unruptured state; butyl rubber; rubber; or cork; [**in width indicated**][**minimum 1/2 inch (12.7 mm) wide**].

E. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.

F. Rustic Terrazzo Cleaner: Solution of 1 part muriatic acid and 10 parts water.

G. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; is recommended by sealer manufacturer; and complies with NTMA's written recommendations for terrazzo type indicated.

1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Rustic Terrazzo: Use solvent acrylic-type sealer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

1. Roughen concrete substrates before installing terrazzo system according to NTMA's written recommendations.

B. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.

1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 INSTALLATION, GENERAL

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Installation Tolerance: Limit variation in terrazzo surface from level to [**1/4 inch in 10 feet (6.4 mm in 3 m)**]; noncumulative.

C. Rustic Terrazzo: Install isolation and expansion material where abutting adjacent construction and directly above substrate expansion joints.

D. Underbed:

1. Comply with NTMA's written recommendations for underbed installation.
2. Sand-Cushion Portland Cement Terrazzo:

a. Cover entire surface to receive terrazzo with dusting of sand.
b. Install isolation membrane over sand, overlapping ends and edges a minimum of **3 inches (75 mm)**.
c. Install welded-wire reinforcement, overlapping at edges and ends at least two squares.[**Stop mesh a minimum of 1 inch (25 mm) short of expansion joints.**]

3. Bonded [**Portland Cement**][**Rustic**] Terrazzo:

a. Saturate structural concrete substrate with water, and slush and broom with underbed bonding agent.

4. Place underbed and screed to elevation indicated below finished floor elevation.

E. Strip Materials:

1. Divider and Control-Joint Strips:

a. Locate divider strips [**directly over breaks and control joints in concrete slabs**][**in locations indicated**].

b. Install control-joint strips [**back to back and directly above concrete-slab control joints**][**in locations indicated**].

1) Install control-joint strips with [**1/4-inch (6.4-mm)**] gap between strips, and install sealant in gap.

c. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.

2. Expansion-Joint Strips: Form expansion joints using divider strips and install directly above concrete-slab expansion joints.
3. Accessory Strips: Install as required to provide a complete installation.
4. Abrasive Strips: Install with surface of abrasive strip positioned [**1/16 inch (1.6 mm)**] higher than terrazzo surface.

3.4 POURED-IN-PLACE TERRAZZO INSTALLATION

A. Underbed Preparation:

1. Sand-Cushion Portland Cement Terrazzo: Saturate underbed with water to produce a cement slurry.
2. Bonded [**Portland Cement**][**Rustic**] Terrazzo: Dampen underbed with water.

B. Monolithic [**Portland Cement**][**Rustic**] Terrazzo: Apply topping bonding agent on concrete substrate.

C. Place terrazzo mixture in panels formed by divider strips and trowel mixture to top of strips. Seed additional aggregates in matrix to uniformly distribute granular material and produce a surface with a minimum of 70 percent aggregate exposure. Roll and compact surface until excess cement and water have been extracted.

1. Portland Cement Terrazzo: Trowel to a dense, uniform, flat surface disclosing lines of divider strips.

D. Portland Cement Terrazzo Stairs: Install and finish stairs at the same time that adjacent flooring is installed.

E. Portland Cement Terrazzo Base: Install and finish base at the same time that adjacent flooring is installed.

F. Portland Cement Terrazzo Finishing: Cover terrazzo topping with moisture-retaining cover and cure until topping develops sufficient strength to prevent lifting or pulling of aggregate during grinding.

1. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond plates.
2. Grouting: After rough grinding, clean terrazzo topping with water and rinse away residue. Remove excess rinse water, apply matrix mix to grout surface, and fill voids. After grouting, cover surface with moisture-retaining cover to cure grout until ready for fine grinding.
3. Fine Grinding and Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with [**80**][**120**]-grit stones or with comparable diamond abrasives until grout is removed from surface.

G. Rustic Terrazzo Finishing: Expose aggregate by hosing or other means recommended in writing by NTMA. Cure the terrazzo topping by flooding with water or covering with moisture-retaining cover.

3.5 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.

B. Do not install units that are chipped, cracked, discolored, or improperly finished.

C. Seal joints between units with [**cement grout matching precast terrazzo matrix**][**joint sealant**].

3.6 REPAIR

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect, as directed by the Owner.

3.7 CLEANING AND PROTECTION

A. Terrazzo Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner immediately after final cleaning of terrazzo flooring according to both NTMA's and manufacturer's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Rustic Terrazzo Cleaning: Clean surfaces with rustic terrazzo cleaner. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow them to dry thoroughly.

C. Sealing:

1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

D. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 66 13 00

Task	Specification	Specification Description
09 66 13 13	09 66 13 00	Portland Cement Terrazzo Flooring
09 66 13 16	09 66 13 00	Portland Cement Terrazzo Flooring
09 66 13 19	09 66 13 00	Portland Cement Terrazzo Flooring
09 66 16 13	09 66 13 00	Portland Cement Terrazzo Flooring

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SECTION 09 66 23 00 - RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring.
2. Precast epoxy-resin terrazzo units.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealants installed with terrazzo.
2. Section 096723 "Resinous Flooring" for decorative resinous flooring systems applied as self-leveling slurries or as troweled or screeded mortars.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Accessory strips.
4. Abrasive strips.

5. Stair treads, risers, and landings.
6. Precast terrazzo jointing and edge configurations.
7. Terrazzo patterns.

D. Samples: For each exposed product and for each color and texture specified, [**6 inches (150 mm)**] in size.

E. Samples for Initial Selection: NTMA's "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.

F. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:

1. Terrazzo: [**6-inch- (150-mm-)**] square Samples.
2. Precast Terrazzo: [**6-inch- (150-mm-)**] square Samples.
3. Accessories: [**6-inch- (150-mm-)**] long Samples of each exposed strip item required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of terrazzo material or product.

C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

D. Preinstallation moisture-testing reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer who is a contractor member of NTMA.
2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for terrazzo including accessories.

a. Size: Minimum **100 sq. ft. (9 sq. m)** of typical poured-in-place flooring[**and base**] condition for each color and pattern [**in locations indicated**][**in locations directed by Architect**], as directed by the Owner.
b. Include [**base**][**first three stair treads**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations, General: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

B. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

B. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Flooring products shall comply with the requirements of the California Department of Public Health's

"Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

E. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 EPOXY-RESIN TERRAZZO

A. Epoxy-Resin Terrazzo : Comply with manufacturer's written instructions for matrix and aggregate proportions and mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crossfield Products Corp**]
b. [**Hi-Tek Polymers,Inc**]
c. [**Key Resin Company**]
d. [**Master Terrazzo Technologies LLC**]
e. [**Sherwin-Williams High Performance Flooring**]
f. [**Terrazzco Brand; Concord Terrazzo Company, Inc.**]
g. [**Terrazzo & Marble Supply Companies**]

B. Materials:

1. Moisture-Vapor-Emission-Control Membrane: Two-component, high-solids, high-density, low-odor, epoxy-based membrane-forming product produced by epoxy terrazzo manufacturer that reduces moisture emission from concrete substrate to not more than **3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)** in 24 hours.
2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D412.

a. Reinforcement: Fiberglass scrim.

3. Primer: [**Manufacturer's product recommended for substrate and use indicated**].
4. Epoxy-Resin Matrix: [**Manufacturer's standard recommended for use indicated**] and in color required for mix indicated.

a. Physical Properties without Aggregates:

1) Hardness: 60 to 85 per ASTM D2240, Shore D.
2) Minimum Tensile Strength: **3000 psi (20.7 MPa)** per ASTM D638 for a **2-inch (51-mm)** specimen made using a "C" die per ASTM D412.
3) Minimum Compressive Strength: **10,000 psi (6.9 MPa)** per ASTM D695, Specimen B cylinder.
4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D1308.

a) Distilled water.
b) Mineral water.
c) Isopropanol.
d) Ethanol.
e) 0.025 percent detergent solution.
f) 1.0 percent soap solution.
g) 5 percent acetic acid.
h) 10 percent sodium hydroxide.
i) 10 percent hydrochloric acid.
j) 30 percent sulfuric acid.

b. Physical Properties with Aggregates: For terrazzo blended according to manufacturer's recommendations with one part epoxy resin with three parts marble aggregate consisting of 60 percent No. 1 chips and 40 percent No. 0 chips that is ground and grouted to a **1/4-inch (6.35-mm)** nominal thickness, and cured for 7 days at **75 deg F (24 deg C)** plus or minus **2 deg F (1 deg C)** and at 50 percent plus or minus 2 percent relative humidity.

1) Flammability: Self-extinguishing, maximum extent of burning **1/4 inch (6.35 mm)** according to ASTM D635.
2) Thermal Coefficient of Linear Expansion: **0.0025 inch/inch per deg F (0.0025 mm/mm per 0.5556 deg C)** according to ASTM C531.

5. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.

6. Finishing Grout: Resin based.

2.4 PRECAST EPOXY-RESIN TERRAZZO

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Precast Terrazzo Enterprises, Inc**]
2. [**Romoco Precast Terrazzo Products; a subsidiary of Roman Mosaic & Tile Company**]
3. [**Wausau Tile, Inc.**]

B. Precast Terrazzo Base : Minimum **3/8-inch- (10-mm-)** thick, epoxy terrazzo units cast in maximum lengths possible, but not less than **36 inches (900 mm)**. Comply with manufacturer's written instructions for fabricating precast terrazzo base units in sizes and profiles indicated.

1. Type: [**As indicated**][**Coved with minimum 3/4-inch (19-mm) radius**][**Straight**][**Splayed**].
2. Top Edge: [**Straight, unfinished**][**Beveled with polished top surface**][**Radius edge with polished top surface**].
3. Metal Toe Strip: [**Zinc**][**Brass**].
4. Outside Corner Units: With finished returned edges at outside corner.
5. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**], as directed by the Owner.

C. Precast Terrazzo Units : Minimum [**3/4-inch (19-mm)**] thick, epoxy terrazzo units. Comply with

manufacturer's written instructions for fabricating precast units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to **1/8-inch (3.2-mm)** radius.

1. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**], as directed by the Owner.

2.5 STRIP MATERIALS

A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Aluminum**][**Plastic, in color selected from full range of industry colors**].
2. Top Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**].

B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Bottom-Section Material: [**As indicated**][**Galvanized steel**][**Matching top-section material**].
2. Top-Section Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Aluminum**][**Plastic, in color selected from full range of industry colors**].
3. Top-Section Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**].

C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:

1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.

E. Abrasive Strips: [**Three-line**][**Two-line**][**One-line**][**Abrasive nosing strip and two-line**] abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.

1. Width: [**1/2 inch (12.7 mm)**].
2. Depth: As required by terrazzo thickness.
3. Length: [**4 inches (100 mm) less than stair width**][**As indicated**].
4. Color: [**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.6 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

E. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

F. Sealer: [**Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer**][**Acrylic**][**Urethane**][**Chemical-resistant epoxy**][**Water based**].

1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:

1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.

   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written instructions.
   c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

D. Preinstallation Moisture Testing:

1. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests.
2. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Moisture-Vapor-Emission Test: Maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**] in 24 hours when tested according to ASTM F1869 using anhydrous calcium chloride.
   b. Relative Humidity Test: Maximum [**75**] percent relative humidity measurement when tested according to ASTM F2170 using in-situ probes.

3. Proceed with terrazzo installation only after concrete substrates pass moisture testing[**or after installation of moisture-vapor-emission-control membrane on substrate areas that fail testing**].

E. Moisture-Vapor-Emission-Control Membrane: Install according to manufacturer's written instructions.

1. Install on concrete substrates that incorporate lightweight aggregates.
2. Install concrete substrates that fail preinstallation moisture testing.

F. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer's written instructions.

1. Prepare and prefill substrate cracks with membrane material.
2. Install membrane [**at substrate cracks**][**to produce full substrate coverage**] in areas to receive terrazzo.
3. Reinforce membrane with fiberglass scrim.

G. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.

1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Strip Materials:

1. Divider and Control-Joint Strips:

a. Locate divider strips [**in locations indicated**].
b. Install control-joint strips [**back to back and directly above concrete-slab control joints**][**in locations indicated**].
c. Install control-joint strips with [**1/4-inch (6.4-mm)**] gap between strips, and install sealant in gap.
d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.

2. Accessory Strips: Install [**as required to provide a complete installation**][**in locations indicated**].
3. Abrasive Strips: Install with surface of abrasive strip positioned [**1/16 inch (1.6 mm)**] higher than terrazzo surface.

C. Apply primer to terrazzo substrates according to manufacturer's written instructions.

D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions.

1. Installed Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**As indicated on Drawings**] nominal.
2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.

a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with [**80**][**120**]-grit stones or with comparable diamond abrasives until grout is removed from surface.

3. Installation Tolerance: Limit variation in terrazzo surface from level to [**1/4 inch in 10 feet (6.4**

mm in 3 m)]; noncumulative.

E. Install and finish poured-in-place terrazzo stairs at the same time the adjacent terrazzo flooring is installed.

F. Install and finish poured-in-place terrazzo base at the same time the adjacent terrazzo flooring is installed.

3.4 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.

B. Do not install units that are chipped, cracked, discolored, or improperly finished.

C. Seal joints between units with [**joint compound matching precast terrazzo matrix**][**joint sealant**].

3.5 REPAIR

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect, as directed by the Owner.

3.6 CLEANING AND PROTECTION

A. Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Sealing:

1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 66 23 00

Task	Specification	Specification Description
09 66 23 16	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 13	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 16	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 66 33 19	09 66 23 00	Resinous Matrix Terrazzo Flooring
09 67 00 00	09 67 23 00	Resinous Flooring
09 67 16 00	09 67 23 00	Resinous Flooring

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SECTION 09 67 23 00 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resinous flooring.
2. Integral cove base accessories.

B. Related Sections:

1. Section 071800 "Traffic Coatings" for vehicular-traffic-bearing, elastomeric flooring systems.
2. Section 096623 "Resinous Matrix Terrazzo Flooring" for thinset, epoxy-matrix terrazzo.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
2. Review details of integral cove bases.
3. Review manufacturer's written instructions for installing resinous flooring systems.
4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.

B. Samples for Initial Selection: For each type of exposed finish required.

C. Samples for Verification: For each resinous flooring system required and for each color and texture specified, **6 inches (150 mm)** square, applied to a rigid backing by Installer for this Project.

D. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.

10. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.
11. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.
12. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
14. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
15. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.
16. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.
17. Laboratory Test Reports: Verify compliance with VOC emissions evaluation criteria.
18. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
19. Verify products comply with VOC emissions evaluation criteria.
20. Laboratory Test Reports: For adhesives, indicating compliance with VOC requirements in the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
21. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
22. Laboratory Test Reports: For adhesives, indicating compliance with formaldehyde emissions evaluation criteria.
23. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.
24. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

25. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.
    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

26. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent

(100 ppm) and certification expiration date.

27. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each resinous flooring component.

B. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.

C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

1.9 WARRANTY

A. Special Warranty for Resinous Flooring Products: Manufacturer agrees to repair or replace components of flooring installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of flooring due to unusual traffic, failure of

substrate, vandalism, or abuse.

2. Warranty Period: [**5**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Verify flooring products comply with VOC emissions evaluation criteria.

D. Flammability: Self-extinguishing in accordance with ASTM D635.

2.2 RESINOUS FLOORING

A. Resinous Flooring System : Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor [**and integral cove base**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aeroflex USA**]
b. [**Arizona Polymer Flooring, Inc**]
c. [**Cornerstone Flooring**]
d. [**Crossfield Products Corp**]
e. [**Crown Polymers Corporation**]
f. [**Delta Polymers, Inc.**]
g. [**Dudick Inc.**]
h. [**Dur-A-Flex; a Sherwin Williams Company**]
i. [**Elite Crete Systems**]
j. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
k. [**Everlast Epoxy Systems, Inc.**]
l. [**FLEXMAR Coatings, Inc.**]
m. [**Florock; Crawford Laboratories Inc.**]
n. [**GacoFloor; Amrize Building Envelope LLC**]
o. [**Garland Company, Inc. (The)**]
p. [**Key Resin Company**]
q. [**KOSTER American Corporation**]
r. [**Kretus**]
s. [**Laticrete International, Inc.**]
t. [**Milamar Coatings, LLC**]
u. [**Multicoat Products Inc.**]
v. [**Neogard; Hempel Group**]

w. [**Niagara Machine**]
x. [**Northern Industries, Inc.**]
y. [**Nox-Crete, Inc.**]
z. [**Polymerica, Incorporated**]
aa. [**PPG Industries**]
bb. [**Rock-Tred Corporation**]
cc. [**Rust-Oleum Corporation**]
dd. [**Sauereisen**]
ee. [**Sherwin-Williams High Performance Flooring**]
ff. [**Sika Corporation**]
gg. [**SIMIRON Inc.**]
hh. [**Stonhard, Inc.**]
ii. [**Tennant Coatings**]
jj. [**Terrazzo & Marble Supply Companies**]
kk. [**Tnemec Company, Inc.**]
ll. [**Tufco International Inc.**]

2. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.
3. System Characteristics:

   a. Color and Pattern: [**As selected by Architect from manufacturer's full range**][**As indicated by manufacturer's product designation**][**Match Architect's sample**] as directed by the Owner.
   b. Wearing Surface: [**Textured for slip resistance**][**Orange-peel texture**][**Smooth**][**Manufacturer's standard wearing surface**].
   c. Overall System Thickness: [**20 mils (0.5 mm)**][**40 mils (1.0 mm)**][**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**].

4. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested in accordance with test methods indicated:

   a. Compressive Strength: In accordance with ASTM C579.
   b. Tensile Strength: In accordance with ASTM C307.
   c. Flexural Modulus of Elasticity: In accordance with ASTM C580.
   d. Water Absorption: In accordance with ASTM C413.
   e. Shrinkage: In accordance with ASTM C531.
   f. Indentation: In accordance with MIL-D-3134J.
   g. Impact Resistance: No chipping, cracking, or delamination and not more than **1/16-inch (1.6-mm)** permanent indentation in accordance with MIL-D-3134J.
   h. Resistance to Elevated Temperature: No slip or flow of more than **1/16 inch (1.6 mm)** in accordance with MIL-D-3134J.
   i. Abrasion Resistance: In accordance with ASTM D4060.
   j. Hardness: Shore D in accordance with ASTM D2240.
   k. Critical Radiant Flux: [**0.45 W/sq. cm**][**0.22 W/sq. cm**] or greater in accordance with NFPA 253.

5. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested in accordance with [**ASTM D1308 for 50 percent immersion**][**ASTM D543, Procedure A, for immersion**][**ASTM C267 for immersion**]
6. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

a. Formulation Description: [**100 percent solids**][**High solids**][**Water based**].

7. Waterproofing Membrane: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

   a. Formulation Description: [**100 percent solids**][**High solids**].

8. Reinforcing Membrane: Flexible resin formulation that is recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated and that inhibits substrate cracks from reflecting through resinous flooring.

   a. Formulation Description: [**100 percent solids**][**High solids**].

      1) Provide fiberglass scrim embedded in reinforcing membrane.

9. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.
10. Body Coats:

   a. Resin: [**Epoxy**][**Urethane**][**Epoxy novolac**][**Vinyl ester**][**Methyl methacrylate**][**Polyaspartic**].
   b. Formulation Description: [**100 percent solids**][**High solids**][**Water based**].
   c. Type: [**Clear**][**Pigmented**].
   d. Installation Method: [**Self-leveling slurry with broadcast aggregates**][**Self-leveling slurry**][**Troweled or screeded**] .
   e. Number of Coats: [**One**][**Two**].
   f. Thickness of Coats: [**8 mils (0.2 mm)**][**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**].
   g. Aggregates: [**Manufacturer's standard**][**Colored quartz (ceramic-coated silica)**][**Vinyl flakes**][**Granite**][**Natural silica**].

11. Grout Coat:

   a. Resin: [**Epoxy**][**Urethane**][**Epoxy novolac**][**Vinyl ester**][**Methyl methacrylate**][**Polyaspartic**].
   b. Formulation Description: [**100 percent solids**][**High solids**][**Water based**].
   c. Type: [**Clear**][**Pigmented**].
   d. Thickness of Coat: [**8 mils (0.2 mm)**][**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**].

12. Topcoats: Sealing or finish coats.

   a. Resin: [**Epoxy**][**Urethane**][**Epoxy novolac**][**Vinyl ester**][**Methyl methacrylate**][**Polyaspartic**].
   b. Formulation Description: [**100 percent solids**][**High solids**][**Water based**].
   c. Type: [**Clear**][**Pigmented**].
   d. Number of Coats: [**One**][**Two**].
   e. Thickness of Coats: [**8 mils (0.2 mm)**][**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**].
   f. Finish: [**Matte**][**Gloss**] .

2.3 INTEGRAL COVE BASE ACCESSORIES

A. Precast, Integral Cove Base: Impact-resistant, polymer-resin, cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**SpeedCove, Inc.**]

2. Radius Cove: Cove molding with approximately **1-inch (25-mm)** radius for adhesive installation at floor-to-wall joint as substrate to receive resinous flooring system to form an integral cove base.
3. Radius Cove Base: [**4-inch- (102-mm-)**][**6-inch- (152-mm-)**][**8-inch- (203-mm-)**] high base molding that provides approximately **1-inch (25-mm)** radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.

a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and [**square**][**3/4- to 1-inch (19- to 25-mm) bullnose**] outside corners.

B. Installation Adhesive: As recommended in writing by accessory manufacturer.

1. Adhesives: Comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Adhesives: Do not use adhesives that contain urea formaldehyde.
3. Adhesives: Comply with VOC emissions evaluation criteria.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 3 or greater in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
3. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**], and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)**][**5 lb of water/1000 sq. ft. (2.27 kg of water/92.9 sq. m)**] in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than [**6**] or more than [**8**] pH unless otherwise recommended in writing by flooring manufacturer,

C. Patching and Fill Material: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.3 INSTALLATION OF RESINOUS FLOORING

A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.

1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.

C. Waterproofing Membrane: Apply waterproofing membrane [**where indicated on Drawings**][**over entire substrate surface**], in thickness recommended in writing by manufacturer.

1. Apply waterproofing membrane to integral cove base substrates.

D. Reinforcing Membrane: Apply reinforcing membrane to [**substrate cracks**][**entire substrate surface**].

E. Integral Cove Base Accessories: Adhesively install precast accessories before applying flooring coats and in accordance with manufacturer's written instructions.

F. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping,

mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: [**4 inches (100 mm)**] high.

G. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness specified for flooring system.

1. Aggregates: Broadcast aggregates at rate recommended in writing by manufacturer. After resin is cured, remove excess aggregates to provide surface texture indicated.

H. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness specified for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended in writing by manufacturer.

I. Grout Coat: Apply grout coat to fill voids in surface of final body coat.

J. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.

3.4 FIELD QUALITY CONTROL

A. Material Sampling: the Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.

1. the Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.

B. Core Sampling: At the Owner’s direction and at locations, as directed by the Owner, take one core sample per **1000 sq. ft. (92.9 sq. m)** of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.5 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

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SECTION 09 68 13 00 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carpet tiles.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. [**Section 096513 "Resilient Base and Accessories"**][**Section 096519 "Resilient Tile Flooring"**] for resilient wall base and accessories installed with carpet tile.
3. Section 096816 "Sheet Carpeting" for carpet roll goods.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**] .

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

   a. Review delivery, storage, and handling procedures.
   b. Review ambient conditions and ventilation procedures.
   c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available

colors for each type of carpet tile.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

D. Samples for Verification: Actual Sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: **12-inch- (300-mm-)** long Samples.

E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Health Product Declaration (HPD): Provide product's Material Health Certificate or Cradle to Cradle certification.
3. Declare, Action Submittals: Provide product's Declare product label, designated as "Red List Free," Declare, or Living Building Challenge (LBC) compliant to 0.1 percent.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Facts, Action Submittals: Provide product's Facts - NSF/ANSI 336, "Sustainability Assessment for Commercial Furnishings Fabric," certification.
14. Health Product Declaration (HPD): For each product.
15. Health Product Declaration (HPD): Provide HPD.
16. Life-Cycle Impact-Reduction Action Plan, Action Submittals: Provide product-specific, Life-Cycle Assessment (LCA) complying with EN 15804 or ISO 21930.
17. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.
18. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For carpet tile.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to [**5**] percent of amount installed for each type indicated, but no fewer than 10 full-size units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the [**Commercial II**][**Master II**] certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.9 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
b. Loss of tuft-bind strength.
c. Excess static discharge.
d. Delamination.
e. Dimensional instability.

3. Warranty Period: [**10**][**15**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILES

A. Carpet Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Bentley Mills, Inc.**]
   b. [**Engineered Floors**]
   c. [**Interface, Inc.**]
   d. [**J&J Flooring Group LLC**]
   e. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
   f. [**Mohawk Group**]
   g. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
   h. [**StaticSmart; Julie Industries**]
   i. [**Tarkett USA**]
   j. [**van Gelder, Inc**]

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3. Pattern: [**Match Architect's samples**] , as directed by the Owner.
4. Fiber Content: [**100 percent nylon 6,6**][**100 percent nylon 6**][**100 percent polypropylene**][**100 percent wool**][**80 percent wool; 20 percent nylon 6,6**][**80 percent wool; 20 percent nylon 6**] .
5. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**] pile.
6. Pile Thickness: for finished carpet tile [**in accordance with ASTM D6859**] .
7. Primary Backing/Backcoating: [**Manufacturer's standard composite materials**] .
8. Secondary Backing: [**Manufacturer's standard material**] .
9. Size: [**18 by 18 inches (457 by 457 mm)**][**24 by 24 inches (610 by 610 mm)**][**18 by 36 inches (457 by 914 mm)**][**36 by 36 inches (914 by 914 mm)**] .
10. Applied Treatments:

    a. Soil-Resistance Treatment: [**Manufacturer's standard treatment**] .
    b. Antimicrobial Treatment: [**Manufacturer's standard treatment**] that protects carpet tiles as follows:

       1) Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

11. Sustainable Design Requirements:

    a. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
    b. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    c. Verify flooring products comply with requirements of the California Department of Public

Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

d. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
f. Life-Cycle Analysis: Provide documentation indicating product contribution to reduction in global warming potential, depletion of the stratospheric ozone layer, acidification of land and water sources, eutrophication, formation of tropospheric ozone, and depletion of nonrenewable energy resources.
g. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

12. Performance Characteristics:

a. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**] minimum in accordance with ASTM D7330.
b. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
c. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
d. Tuft Bind: Not less than [**3 lbf (13 N)**][**5 lbf (22 N)**][**6.2 lbf (28 N)**][**8 lbf (36 N)**][**10 lbf (45 N)**] in accordance with ASTM D1335.
e. Delamination: Not less than [**3.5 lbf/in. (0.6 N/mm)**][**4 lbf/in. (0.7 N/mm)**] in accordance with ASTM D3936.
f. Dimensional Tolerance: Within **1/32 inch (0.8 mm)** of specified size dimensions, as determined by physical measurement.
g. Noise Reduction Coefficient (NRC): in accordance with ASTM C423.
h. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
i. Colorfastness to Light: Not less than 4 after [**40**][**60**] AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
j. Electrostatic Propensity: Less than [**3.5**][**2**] kV in accordance with AATCC 134.

2.2 ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Extruded aluminum with [**mill**] finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (20 sq. m)**][**1000 sq. ft. (100 sq. m)**] , and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Wood Subfloors: Verify the following:

1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. Metal Subfloors: Verify the following:

1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

F. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer. Verify the following:

1. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than [**1/8 inch (3 mm)**] , protrusions more than **1/32 inch (0.8 mm)**, and substances that may interfere with adhesive bond or show through surface.

G. Access Flooring Systems: Verify the following:

1. Access floor substrate is compatible with carpet tile and adhesive if any.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

B. Trowelable Leving and Patching Compounds: Use trowelable leveling and patching compounds in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)** unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are

incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION OF CARPET TILES

A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: [**As recommended in writing by carpet tile manufacturer**][**Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive**][**Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive**][**Free lay; install carpet tiles without adhesive**] .

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns [**indicated on Drawings**][**recommended in writing by carpet tile manufacturer**] .

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING

A. Perform cleaning operations immediately after installing carpet tile as follows:

1. Remove excess adhesive and other surface blemishes using cleaner recommended in writing by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

3.5 PROTECTION

A. Protect installed carpet tile to comply with CRI 104, Section 13.7.

B. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13 00

SECTION 09 68 16 00 - SHEET CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tufted carpet.
2. Woven carpet.
3. Carpet cushion.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. [**Section 096513 "Resilient Base and Accessories"**][**Section 096519 "Resilient Tile Flooring"**] for resilient wall base and accessories installed with carpet.
3. Section 096813 "Tile Carpeting" for modular carpet tiles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to carpet installation including, but not limited to, the following:

   a. Review delivery, storage, and handling procedures.
   b. Review ambient conditions and ventilation procedures.
   c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet installation, showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
2. Carpet type, color, and dye lot.
3. Locations where dye lot changes occur.
4. Seam locations, types, and methods.
5. Type of subfloor.
6. Type of installation.
7. Pattern type, repeat size, location, direction, and starting point.
8. Pile direction.
9. Type, color, and location of insets and borders.
10. Type, color, and location of edge, transition, and other accessory strips.

11. Transition details to other flooring materials.
12. Type of carpet cushion.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

D. Samples for Verification: Actual sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet: **12-inch- (300-mm-)** square Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: **12-inch- (300-mm-)** long Samples.
3. Carpet Cushion: **6-inch- (150-mm-)** square Sample.
4. Carpet Seam: **6-inch (150-mm)** Sample.
5. Mitered Carpet-Border Seam: **12-inch- (300-mm-)** square Sample. Show carpet pattern alignment.

E. Product Schedule: For carpet[**and carpet cushion**]. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Health Product Declaration (HPD): Provide product's Material Health Certificate or Cradle to Cradle certification.
6. Declare, Action Submittals: Provide product's Declare product label, designated as "Red List Free," Declare or Living Building Challenge (LBC) compliant to 0.1 percent.
7. Environmental Product Declaration: For each product.
8. Health Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Environmental Product Declaration: For each product.
11. Environmental Product Declaration: For each product.
12. Third-Party Certifications: For each product.
13. Third-Party Certified Life Cycle Assessment: For each product.
14. Facts, Action Submittals: Provide product's Facts - NSF/ANSI 336, "Sustainability Assessment for Commercial Furnishings Fabric," certification.
15. Health Product Declaration (HPD): For each product.
16. Health Product Declaration (HPD): Provide HPD.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet[**and carpet cushion**], for tests performed by a qualified testing

agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For sheet carpeting.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet. Include the following:

1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet[**and carpet cushion**].

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet: Full-width rolls equal to [**5**] percent of amount installed for each type indicated, but not less than **10 sq. yd. (8.3 sq. m)**.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the [**Commercial II**][**Master II**] certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

B. Deliver carpet in original mill protective covering with mill register numbers and tags attached.

1.9 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet[**and carpet cushion**] until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet[**and carpet cushion**] over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended in writing by carpet manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.10 WARRANTY

A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
b. Loss of tuft-bind strength.
c. Excess static discharge.
d. Delamination.

3. Warranty Period: [**10**][**15**] years from date of Substantial Completion.

B. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.

1. Warranty includes removal and replacement of carpet and accessories required by replacement of carpet cushion.
2. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
3. Failure includes, but is not limited to, permanent indentation or compression.
4. Warranty Period: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Beaulieu International Group**]
2. [**Bentley Mills, Inc.**]
3. [**Couristan, Inc.**]
4. [**Interface, Inc.**]
5. [**J&J Flooring Group LLC**]
6. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
7. [**Mohawk Carpet, LLC; The Mohawk Group**]
8. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
9. [**Tarkett USA**]

B. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Pattern: [**Match Architect's samples**], as directed by the Owner.

D. Fiber Content: [**100 percent nylon 6,6**][**100 percent nylon 6**][**100 percent polypropylene**].

E. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**][**Multilevel-loop**][**Level tip shear**][**Random**

shear][**Frieze**][**Sculptured**] pile.

F. Pile Thickness: for finished carpet[**in accordance with ASTM D6859**].

G. Primary Backing: [**Manufacturer's standard material**][**Woven polypropylene**][**Nonwoven, polypropylene or polyester**].

H. Secondary Backing: [**Manufacturer's standard material**][**Woven polypropylene**][**Nonwoven, polypropylene or polyester**][**Woven jute**][**Fiberglass**].

I. Backcoating: [**Manufacturer's standard material**][**SBR latex**].

J. Roll Width: [**12 ft. (3.7 m)**][**6 ft. (1.8 m)**][**13.5 ft. (4.1 m)**][**15 ft. (4.6 m)**].

K. Applied Treatments:

1. Applied Soil-Resistance Treatment: [**Manufacturer's standard material**].
2. Antimicrobial Treatment: [**Manufacturer's standard material**].

   a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

L. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Verify Adhesives have a VOC content of [**50**] g/L or less.
6. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
7. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

M. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**] minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
3. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
4. Tuft Bind: Not less than [**3 lbf (13 N)**][**5 lbf (22 N)**][**6.2 lbf (28 N)**][**8 lbf (36 N)**][**10 lbf (45 N)**] in accordance with ASTM D1335.
5. Delamination: Not less than [**2.5 lbf/in. (0.4 N/mm)**][**3.5 lbf/in. (0.6 N/mm)**][**4 lbf/in. (0.7 N/mm)**] in accordance with ASTM D3936.
6. Noise Reduction Coefficient (NRC): in accordance with ASTM C423.
7. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.

8. Colorfastness to Light: Not less than 4 after [**40**][**60**] AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
9. Electrostatic Propensity: Less than [**3.5**][**2**] kV in accordance with AATCC 134.

2.2 WOVEN CARPET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Axminster Carpets**]
2. [**Bentley Mills, Inc.**]
3. [**Bloomsburg Carpet Industries, Inc.**]
4. [**Couristan, Inc.**]
5. [**Langhorne Carpet Company**]
6. [**Mohawk Carpet, LLC; The Mohawk Group**]
7. [**Prestige Mills, Inc.**]
8. [**Stanton Carpet Corporation**]
9. [**Tarkett USA**]

B. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Pattern: [**Match Architect's samples**], as directed by the Owner.

D. Fiber Content: [**100 percent wool**][**80 percent wool; 20 percent nylon 6,6**][**80 percent wool; 20 percent nylon 6**].

E. Face Construction: [**Axminster**][**Wilton**][**Velvet**].

F. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**] pile.

G. Pile Thickness: for finished carpet[**in accordance with ASTM D6859**].

H. Applied Treatments:

1. Applied Soil-Resistance Treatment: [**Manufacturer's standard material**].
2. Antimicrobial Treatment: [**Manufacturer's standard material**].

   a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

I. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
6. Life-Cycle Analysis: Provide documentation indicating product contribution to reduction in global warming potential, depletion of the stratospheric ozone layer, acidification of land and water sources, eutrophication, formation of tropospheric ozone, and depletion of nonrenewable energy resources.
7. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

J. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**] minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
3. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
4. Noise Reduction Coefficient (NRC): in accordance with ASTM C423.
5. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
6. Colorfastness to Light: Not less than 4 after [**40**][**60**] AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
7. Electrostatic Propensity: Less than [**3.5**][**2**] kV in accordance with AATCC 134.

2.3 CARPET CUSHION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carpenter Co.**]
2. [**Dalton Foam; Barnhardt Manufacturing Company**]
3. [**Dura Undercushions Ltd.**]
4. [**Foam Products Corporation**]
5. [**TredMOR by SCI; Leggett & Platt, Inc.**]

B. Traffic Classification: Carpet Cushion Council's [**Class I, moderate**][**Class II, heavy**][**Class III, extra-heavy**] traffic.

C. Fiber Cushion: [**Rubberized hair, mothproofed and sterilized**][**Rubberized jute, mothproofed and sterilized**][**Synthetic**][**Resinated, recycled textile**].

D. Rubber Cushion: [**Flat**][**Rippled waffle**][**Textured flat**][**Reinforced**].

1. Compression Resistance: at [**25**][**65**] percent in accordance with ASTM D3676.

E. Polyurethane-Foam Cushion: [**Grafted prime**][**Densified**][**Bonded**][**Mechanically frothed**].

1. Compression Force Deflection at 65 Percent: in accordance with ASTM D3574.

F. Performance Characteristics:

1. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.

2. Noise Reduction Coefficient (NRC): in accordance with ASTM C423.

G. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by [**carpet**][**carpet cushion**] manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet and that are recommended in writing or provided by [**carpet manufacturer**][**carpet and carpet cushion manufacturers**].

C. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104.

D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended in writing by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

E. Metal Edge/Transition Strips: Extruded aluminum with [**mill**] finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.

B. Examine carpet for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (20 sq. m)**][**1000 sq. ft. (100 sq. m)**], and perform no fewer than three tests in each installation

area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**] in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**] percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by [**adhesive and carpet**][**adhesive, carpet cushion, and carpet**] manufacturers. Proceed with installation only after substrates pass testing.

D. Wood Subfloors: Verify the following:

1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)**, unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by [**adhesive and carpet**][**adhesive, carpet, and carpet cushion**] manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

A. Comply with CRI 104 and [**carpet manufacturer's**][**carpet and carpet cushion manufacturers'**] written installation instructions for the following:

1. Direct-glue-down installation.
2. Double-glue-down installation.
3. Carpet with attached-cushion installation.
4. Preapplied adhesive installation.
5. Hook-and-loop installation.
6. Stretch-in installation.
7. Stair installation.

B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

1. Stretch-in Carpet Installation: Install carpet cushion seams at 90-degree angle with carpet seams.

C. Install [**pattern parallel to walls and borders**][**as indicated on Drawings**].

D. Install borders with mitered corner seams.

E. Do not bridge building expansion joints with carpet.

F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet manufacturer.

G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended in writing by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.
3. Vacuum carpet using commercial machine with face-beater element.

B. Protect installed carpet to comply with CRI 104, Section 13.7.

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer [**and carpet cushion manufacturer**][**and carpet adhesive manufacturer**][**and carpet cushion and adhesive manufacturers**].

END OF SECTION 09 68 16 00

Task	Specification	Specification Description
09 68 16 00	09 68 13 00	Tile Carpeting

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SECTION 09 69 00 00 - ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cementitious-core steel panel access flooring.
2. Wood-core steel panel access flooring.
3. Unfilled steel panel access flooring.
4. Aluminum panel access flooring.
5. Access-floor coverings.
6. Accessories.

1.2 DEFINITIONS

A. ESD: Electrostatic discharge. The transfer of electric charge between bodies at different potentials, from panel surface to raised access-floor substructure.

B. UFAD: Underfloor air distribution.

1.3 COORDINATION

A. Coordinate locations, layout, and installation of electrical and mechanical work in underfloor cavity to prevent interference with access flooring.

1. Mark pedestal locations on subfloor to enable mechanical and electrical work to proceed without interfering with access-flooring pedestals installed after mechanical and electrical work.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review connections between access flooring and mechanical and electrical systems.
2. Review requirements related to sealing the plenum.
3. Review procedures for keeping underfloor space clean.

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include loading capacities.

B. Shop Drawings:

1. Layout of access flooring and relationship to adjoining Work based on field-verified dimensions.
2. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish:

D. Samples for Verification: For the following products:

1. Exposed Metal Accessories: Approximately **10 inches (250 mm)** in length.
2. One full-size floor panel, pedestal, and understructure unit for each type of access flooring required.
3. Access-Floor Coverings: Full-size units for each color and texture specified.

E. Delegated Design Submittals: For seismic design of access flooring, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Laboratory Test Reports: For adhesives, indicating compliance with VOC requirements in California Department of Public Health (CDPH) Standard Method v1.2-2017.
3. Product Data: For adhesives, indicating that product contains no urea formaldehyde.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of access flooring.

B. Product Test Reports: For each type of access-flooring panel material[**and floor covering**], for tests performed by a qualified testing agency.

C. Preconstruction Test Reports: For preconstruction adhesive field test.

D. Qualification Statements: For [**Installer**][**delegated design engineer**][**and**][**testing agency**].

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Panels: [**with each type floor covering specified**].

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type

indicated.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on field mockups.

1. Use personnel, materials, and methods of construction that will be used at Project site.
2. Notify Architect [**seven**] days in advance of the dates and times when laboratory mockups will be tested, as directed by the Owner.

B. Preconstruction Adhesive Field Test: Before installing pedestals, field test their adhesion to subfloor surfaces by doing the following:

1. In areas representative of each subfloor surface, set typical pedestal assemblies in same adhesive, and use methods required for the completed Work.
2. Allow test installation to cure for manufacturer's recommended cure time, with a pressure of **25 lbf (111 N)** applied vertically to pedestals during this period.
3. After curing, apply lateral load against a straight steel bar inserted **2 inches (51 mm)** into pedestal stems. Measure the force needed to cause adhesive failure of pedestal base.
4. Remove and discard failed pedestals and clean pedestals of adhered residue.
5. Proceed with installation only after tests show compliance with performance requirement specified for pedestals' capability to resist overturning moment.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install access flooring until spaces are enclosed,[**subfloor has been sealed,**] ambient temperature is between **50 and 90 deg F (10 and 32 deg C)**, and relative humidity is not less than 20 and not more than 70 percent.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain products from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design access flooring for seismic performance, including loads imposed on the access flooring by items and equipment installed on the access flooring.

B. Seismic Performance: Access flooring to withstand the effects of earthquake motions determined [in accordance with ASCE/SEI 7][as indicated on Drawings][including loads imposed on the access flooring by items and equipment installed on the access flooring].

C. Structural Performance: Provide access flooring capable of complying with the following performance requirements in accordance with testing procedures in CISCA's "Recommended Test Procedures for Access Floors":

1. Concentrated Loads: [900 lbf (4003 N)][1000 lbf (4448 N)][1250 lbf (5560 N)][1500 lbf (6672 N)][2000 lbf (8896 N)] with the following deflection and permanent set:

   a. Top-Surface Deflection: [0.10 inch (2.54 mm)].
   b. Permanent Set: [0.010 inch (0.25 mm)].

2. Ultimate Loads: [1800 lbf (8006 N)][2000 lbf (8896 N)][2500 lbf (11 121 N)][3000 lbf (13 345 N)][4000 lbf (17 793 N)].
3. Rolling Loads: With local or overall deformation not to exceed 0.040 inch (1.02 mm).

   a. CISCA Wheel 1: 10 passes at [400 lbf (1779 N)][500 lbf (2224 N)][600 lbf (2669 N)][800 lbf (3559 N)][1000 lbf (4448 N)][1200 lbf (5338 N)][1250 lbf (5560 N)][2000 lbf (8896 N)].
   b. CISCA Wheel 2: 10,000 passes at [400 lbf (1779 N)][500 lbf (2224 N)][600 lbf (2669 N)][800 lbf (3559 N)][1000 lbf (4448 N)][1250 lbf (5560 N)][1750 lbf (7784 N)][2000 lbf (8896 N)].

4. Stringer Load Test: [75 lbf (334 N)][225 lbf (1001 N)][350 lbf (1557 N)][450 lbf (2002 N)] at center of span with a permanent set not to exceed 0.010 inch (0.254 mm).
5. Pedestal Axial Load Test: [5000 lbf (22 240 N)][6000 lbf (26 690 N)].
6. Pedestal-Overturning-Moment Test: [1000 lbf x inches (113 N x m)].
7. Uniform Load Test: [200 lbf/sq. ft. (9.6 kPa)][250 lbf/sq. ft. (12.0 kPa)][300 lbf/sq. ft. (14.4 kPa)][400 lbf/sq. ft. (19.2 kPa)][500 lbf/sq. ft. (23.9 kPa)] with a maximum top-surface deflection not to exceed 0.040 inch (1.02 mm) and a permanent set not to exceed 0.010 inch (0.254 mm).
8. Drop Impact Load Test: [75 lb (34.0 kg)][100 lb (45.5 kg)][125 lb (56.7 kg)][150 lb (68.0 kg)][175 lb (79.4 kg)].

D. Fire Performance:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**50**][**450**] or less.

E. Sustainable Design Requirements:

1. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 CEMENTITIOUS-CORE STEEL PANEL ACCESS FLOORING

A. Provide panels fabricated from cold-rolled steel sheet, with die-cut flat top sheet and die-formed and

stiffened bottom pan welded together. Protect metal surfaces against corrosion using manufacturer's standard factory-applied finish. Completely fill internal spaces of completed units with manufacturer's standard cementitious material.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASM Modular Systems, Inc.**]
2. [**Computer Environments, Inc.**]
3. [**Global IFS**]
4. [**Netfloor USA**]
5. [**Tate Access Floors, Inc**]

C. Configuration: Provide modular panels with nominal size of [**24 by 24 inches (610 by 610 mm)**], interchangeable with other field panels without disturbing adjacent panels or understructure.

D. Attachment to Understructure: [**Bolted**][**By gravity**].

E. Perforated Panels: Panels with perforated top surfaces, with [**holes**][**slots**] of number, spacing, and size standard with manufacturer to produce a nominal open area of [**23**][**24**][**25**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

F. Grates: Panels with grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of [**45**][**50**][**56**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

2.4 WOOD-CORE STEEL PANEL ACCESS FLOORING

A. Provide panels fabricated with **1-inch- (25-mm-)** thick, particleboard core laminated to top and bottom steel face sheets, and with a flame-spread index of 25 or less in accordance with ASTM E84. Provide core edges enclosed with upturned, die-formed, bottom-sheet edge or with perimeter steel channel welded to top sheet and welded or bonded to bottom sheet. Protect metal surfaces against corrosion by manufacturer's standard factory-applied finish.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bergvik North America, Inc.**]
2. [**Computer Environments, Inc.**]

C. Configuration: Provide modular panels with nominal size of [**24 by 24 inches (610 by 610 mm)**], interchangeable with other field panels without disturbing adjacent panels or understructure.

D. Attachment to Understructure: [**Bolted**][**By gravity**].

E. Laboratory Test Reports: For particleboard, indicating compliance with requirements for low-emitting materials.

F. Product Data: For hardwood plywood, indicating compliance with requirements for formaldehyde as specified in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products."

G. Product Data: For particleboard, indicating that product contains no urea formaldehyde.

H. Perforated Panels: Panels with perforated top surfaces, with [**holes**][**slots**] of number, spacing, and size standard with manufacturer to produce a nominal open area of [**23**][**24**][**25**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

I. Grates: Panels with grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of [**45**][**50**][**56**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

2.5 UNFILLED STEEL PANEL ACCESS FLOORING

A. Provide panels fabricated from cold-rolled steel sheet, with die-cut flat top sheet and die-formed and stiffened bottom pan welded together. Protect metal surfaces against corrosion by manufacturer's standard factory-applied finish.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASM Modular Systems, Inc.**]
2. [**Tate Access Floors, Inc**]

C. Configuration: Provide modular panels with nominal size of [**24 by 24 inches (610 by 610 mm)**], interchangeable with other field panels without disturbing adjacent panels or understructure.

D. Attachment to Understructure: [**Bolted**][**By gravity**].

E. Perforated Panels: Panels with perforated top surfaces, with [**holes**][**slots**] of number, spacing, and size standard with manufacturer to produce a nominal open area of [**23**][**24**][**25**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

F. Grates: Panels with grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of [**45**][**50**][**56**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

2.6 ALUMINUM PANEL ACCESS FLOORING

A. Provide panels fabricated from manufacturer's standard aluminum alloy with equivalent strength and corrosion resistance to Alloy UNS No. A03830 or UNS No. A03840 in accordance with ASTM B85/B85M. Provide flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASM Modular Systems, Inc.**]
2. [**Maxcess Aluminum Floors; a Computer Environments Company**]

C. Configuration: Provide modular panels with nominal size of [**24 by 24 inches (610 by 610 mm)**], interchangeable with other field panels without disturbing adjacent panels or understructure.

D. Attachment to Understructure: [**Bolted**][**By gravity**].

E. Epoxy Finish: [**Conductive epoxy**][**Epoxy**] powder coating with a minimum average thickness of **2.5 mils (0.064 mm)** and in color selected from manufacturer's full range.

F. Plated Finish: Nickel-chrome electrodeposited plating, **0.000005-inch (0.000127-mm)** chrome over **0.0008-inch (0.02-mm)** nickel, without copper or brass strike, to produce complete coverage over significant surfaces with a matte metallic appearance.

G. Perforated Panels: Panels with perforated top surfaces, with [**holes**][**slots**] of number, spacing, and size standard with manufacturer to produce a nominal open area of [**16.5**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

H. Grates: Panels with grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of [**55**] percent.[**Provide mechanical dampers with each panel unit.**]

1. Quantity: [**As indicated on Drawings**].
2. Finish: [**Manufacturer's standard**][**To match solid panels**].

2.7 ACCESS-FLOOR COVERINGS

A. Provide factory-applied floor finish fabricated in one piece to cover entire panel face; with [**integral trim**][**applied perimeter plastic**] edging.

B. High-Pressure Plastic Laminate Tile: ISO 4586-5, Abrasion [**Class AC3**][**Class AC4**][**Class AC5**].

1. Electrical Resistance: Average no less than 1 megohm and no more than 20 000 megohms when installed floor coverings are surface-to-ground tested in accordance with NFPA 99.
2. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Static-Dissipative Vinyl Tile: ASTM F1700, Class I (monolithic vinyl tile), Type A (smooth surface).

1. Electrical Resistance: Average no less than 1 megohm and no more than 1000 megohms when

installed floor coverings are surface-to-ground tested in accordance with ASTM F150 with 100 V applied voltage.
2. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Conductive Vinyl Tile: ASTM F1700, Class I (monolithic vinyl tile), Type A (smooth surface).

1. Electrical Resistance: Average no less than 25 000 ohms and no more than 1 megohm when installed floor coverings are surface-to-ground tested in accordance with ASTM F150 with 100 V applied voltage.
2. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Carpet Tile: Manufacturer's standard tufted, modular carpet tile product.

1. Electrostatic Propensity: Less than 3.5 kV when tested in accordance with AATCC 134.
2. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Terrazzo Tile: Manufacturer's standard terrazzo tile product.

1. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Rubber Tile: Manufacturer's standard rubber tile product.

1. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Porcelain Tile: Manufacturer's standard porcelain tile product.

1. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Hardwood Tile: Manufacturer's standard hardwood tile product.

1. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.8 FABRICATION

A. Fabrication Tolerances:

1. Panel Size: Plus or minus **0.020 inch (0.50 mm)** of required size.
2. Squareness: Plus or minus **0.015 inch (0.38 mm)** between diagonal measurements across top of panel.
3. Flatness: Plus or minus **0.035 inch (0.89 mm)**, measured on a diagonal on top of panel.

B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.

C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.

1. Captive Fasteners: Provide fasteners held captive to panels.

D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.

1. Number, Size, Shape, and Location: As indicated on Drawings.
2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange.[**Furnish removable covers for grommets.**]
3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.

2.9 ACCESSORIES

A. Pedestal System Understructure: System consisting of base, column with provisions for height adjustment, and head (cap); made of [steel][stainless steel][aluminum].

1. Base: Square or circular base with not less than [**16 sq. in. (103 sq. cm)**] of bearing area.
2. Column: Of height required to bring finished floor to elevations indicated. Weld column to base plate.
3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than [**2 inches (51 mm)**] and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
4. Head: Designed to support the floor panel indicated.

a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.

B. Stringer System Understructure: Modular [steel][stainless steel][aluminum] stringer systems designed to bolt to pedestal heads and form a grid pattern.[Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.]

1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.

C. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

D. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide [**two**][**four**] post-installed [**expansion anchors**][**threaded concrete screws**] made from carbon steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5 (5 microns) for Class SC 1 (Mild), with the capability to sustain, without failure, a load equal to [**1.5**] times the loads imposed by pedestal-overturning moment on

fasteners, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

E. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:

1. Structural Performance: Cover capable of supporting a [**300 lbf (1334 N)**][**800 lbf (3559 N)**][**1000 lbf (4448 N)**] concentrated load.
2. Cover and Box Type: [**Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles**][**Grommet with twist-close cover and including steel junction box for electrical receptacle with provision for telephone connectors and signal cables**].
3. Location: In center of panel quadrant unless otherwise indicated.
4. Receptacles and Wiring:

   a. Electrical receptacles and wiring for service outlets are specified elsewhere.
   b. Equip each service outlet with power receptacles to comply with the following requirements:

      1) Type of Receptacle: Heavy-duty duplex, two-pole, three-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R unless otherwise indicated.
      2) Number of Receptacles for Outlet: [**One**][**Two**][**Four**].
      3) Factory Wired: For field hardwiring with armored cable, containing three insulated 12 AWG solid-copper conductors, terminated with a [**6-inch- (152-mm-)**] long pigtail.
      4) Power-in Connectors: Built into outlet housing, of type to fit power-in and power-out connectors of branch-circuit cables supplied with building electrical system.

F. Occupant Adjustable Diffusers: Manufacturer's standard round diffusers, [**4 inches (102 mm)**][**8 inches (203 mm)**] in diameter, formed from [**aluminum**][**polycarbonate plastic**] to produce a removable one-piece unit complete with diffuser, manually adjustable flow regulator, dirt and dust receptacle, trim ring, and underfloor compression mounting ring; precisely fitted in factory-prepared openings of standard field panels and complying with the following requirements:

1. Air-Distribution Characteristics: [**100 cfm (47 L/s)**] at [**0.096 inch wg (24 Pa)**] static pressure and a maximum noise criterion rating of [**15**].
2. Structural Performance: Capable of supporting a [**600 lbf (2669 N)**] concentrated load.
3. Fire-Test-Response Characteristics: Classified 94V-0 in accordance with UL 94.

G. Floor Grilles: Standard load-bearing grilles formed from [**aluminum**][**polycarbonate plastic**] to produce removable one-piece unit precisely fitted in factory-prepared openings of standard field panels, [**with adjustable/removable**][**without**] dampers and complying with the following requirements:

1. Air-Distribution Characteristics: **468 cfm at 0.10 inch wg (221 L/s at 25 Pa)** static pressure.
2. Structural Performance: Capable of supporting a **1000 lbf (4448 N)** concentrated load.
3. Fire-Test-Response Characteristics: Classified 94V-0 in accordance with UL 94.

H. Plenum-Wall Brush Grommets: Self-sealing cable brush grommet with [**4-by-13-inch (102-by-330-mm) rectangular**][**3-inch (76-mm) round**][**5-inch (127-mm) round**] usable area for passage of power and signal cables through plenum walls. Provide [**ABS plastic**][**aluminum**] frame with passageway of interwoven nylon filaments and intermediate layer of EPDM.[**Provide units with plastic cable tray for support of cables and protection of wallboard.**]

I. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.

J. Fascia Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal closure plates with [**manufacturer's standard finish**].

K. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, with raised-disc or textured rubber or vinyl-tile floor coverings, and of same materials, performance, and construction requirements as access-flooring understructure.

L. Steps: Manufacturer's standard steps of size and arrangement indicated with floor coverings to match adjacent access-flooring panels. Apply nonslip nosings to treads unless otherwise indicated.

M. Railings: Manufacturer's standard railings at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.

1. Provide railings that comply with structural performance requirements specified in [**Section 055213 "Pipe and Tube Railings."**][**Section 057300 "Decorative Metal Railings."**]

N. Panel Lifting Device: Panel manufacturer's standard portable lifting device for each type of panel required[**for each computer room**].

O. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer and manufacturer's authorized representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of conditions and deleterious substances that might interfere with attachment of pedestals.
2. Verify that concrete floor sealer and finish have been applied and cured.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than **6 inches (152 mm)**.

B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

A. Install access flooring and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.

B. Adhesive Attachment of Pedestals: Set pedestals in adhesive, in accordance with access-flooring manufacturer's written instructions, to provide full bearing of pedestal base on subfloor[and as required to meet seismic design requirements].

C. Mechanical Attachment of Pedestals: Attach pedestals to subfloor with post-installed mechanical anchors in accordance with access-flooring manufacturer's written instructions[**as required to meet seismic design requirements**].

D. Adjust pedestals so installed panels are flat, level, and at the proper height.

E. Stringer Systems: Secure stringers to pedestal heads in accordance with access-flooring manufacturer's written instructions.

F. Install flooring panels securely in place, leaving them properly seated with panel edges flush. Do not force panels into place.

G. Scribe perimeter panels to provide a close fit, with adjoining construction having no voids greater than **1/8 inch (3 mm)** where panels abut vertical surfaces.

1. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by access-flooring manufacturer.

H. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under installed access flooring.

I. Grounded Access Flooring: Ground in accordance with access-flooring manufacturer's written instructions and as needed to comply with performance requirements for electrical resistance of floor coverings.

1. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.

J. Underfloor Dividers: Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.

K. Closures: Scribe closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.

L. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.

M. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage, in accordance with manufacturer's written instructions.

N. Install access flooring without change in elevation between adjacent panels and within the following tolerances:

1. Plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**] in any **10 ft. (3 m)** distance.
2. Plus or minus [**1/8 inch (3 mm)**][**1/4 inch (6.5 mm)**] from a level plane over entire access-flooring area.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect access-flooring components, assemblies, and equipment installations, including connections.

B. Prepare test and inspection reports.

3.5 PROTECTION

A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for [**72**] hours after installation, to allow pedestal adhesive to set.

B. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

3.6 DEMONSTRATION AND TRAINING

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain access flooring.

B. Schedule demonstration and training session within [**60 to 90**]<**Inset number**> days after date of Substantial Completion.

END OF SECTION 09 69 00 00

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Task	Specification	Specification Description
09 69 13 00	09 69 00 00	Access Flooring
09 69 53 00	09 69 00 00	Access Flooring
09 70 00 00	09 72 00 00	Wall Coverings

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SECTION 09 72 00 00 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl wall covering.
2. Thermoplastic-polyolefin wall covering.
3. Woven glass-fiber wall covering.
4. Textile wall covering.
5. Heavy-duty, synthetic-textile wall covering.
6. Wood-veneer wall covering.
7. Wallpaper.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Show location and extent of each wall-covering type. Indicate [**pattern placement**][**veneer matching**] seams and termination points.

D. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by [**36 inches (914 mm)**] long in size.

1. Wall-Covering Sample: From same production run to be used for the Work, with specified [**treatments**][**paint**] applied.

a. Show complete pattern repeat.
b. Mark top and face of fabric.

2. Wood-Veneer Wall-Covering Sample: From same flitch to be used for the Work, with specified finish applied.

E. Samples for Initial Selection: For each type of wall covering.

F. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by [**36 inches (914 mm)**] long in size.

1. Wall-Covering Sample: From same production run to be used for the Work, with specified [**treatments**][**paint**] applied.

a. Show complete pattern repeat.
b. Mark top and face of fabric.

2. Wood-Veneer Wall-Covering Sample: From same flitch to be used for the Work, with specified finish applied.

G. Product Schedule: For wall coverings.[**Use same designations indicated on Drawings.**]

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, color, texture, and finish, full width by length to equal to [**5**] percent of amount installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.

1. Build mockups for each type of wall covering on each substrate required. Comply with

requirements in ASTM F1141 for appearance shading characteristics.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.

1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**] or less.
b. Smoke-Developed Index: [**50**][**450**] or less.

2. Fire-Growth Contribution: No flashover and heat and smoke release when tested in accordance with [**NFPA 265**][**NFPA 286**].

2.2 VINYL WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Arc-Com Fabrics, Inc.**]
2. [**Avery Dennison**]
3. [**Designtex; Design Tex Group Inc. (The)**]
4. [**F. Schumacher & Co.**]
5. [**Fidelity Wallcoverings Inc.**]
6. [**Innovations USA**]
7. [**Knoll, Inc.**]
8. [**Len-Tex Corporation**]
9. [**Maharam Fabric Corporation; Herman Miller, Inc.**]
10. [**MDC Interior Solutions**]
11. [**Roysons Corporation**]
12. [**US Vinyl Manufacturing Corporation**]
13. [**Versa Wallcovering**]
14. [**Vescom America Inc.**]
15. [**Wolf-Gordon Inc.**]

B. Description: Provide vinyl products in rolls from same production run and complying with the following:

1. [**FS CCC-W-408D**][**and**][**Wallcovering Association's W-101**] for [**Type I, Light**][**Type II, Medium**][**Type III, Heavy**] Duty.
2. ASTM F793/F793M for [**peelable**][**strippable**] wall coverings.

a. Category: [**I, Decorative Only**][**II, Decorative with Medium Serviceability**][**III, Decorative with High Serviceability**][**IV, Type I, Commercial Serviceability (Vinyl Coated)**][**V, Type II, Commercial Serviceability (Vinyl Coated)**][**VI, Type III, Commercial Serviceability (Vinyl Coated)**].

C. Width: [**27 inches (686 mm)**][**54 inches (1372 mm)**].

D. Backing: [**Scrim**][**Osnaburg**][**Drill**][**Nonwoven**] fabric.

1. Fiber Content: [**Cotton**][**Polyester**][**Polycotton**][**Polyester cellulose**].

E. Repeat: [**Random**].

F. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.

G. Features:

1. Antimicrobial.
2. Water-based inks.
3. Phthalate free.
4. Heavy-metals free.
5. Halogenated-fire-retardant free.
6. Microvented.

H. Colors, Textures, and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 THERMOPLASTIC-POLYOLEFIN WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carnegie Fabrics, LLC.**]
2. [**Knoll, Inc.**]

B. Description: Provide products complying with Wallcoverings Association's W-101; free of PVC, chlorine, plasticizers, formaldehyde, heavy metals, and halogenated fire retardants; with water-based inks and coatings; with antimicrobial additives; and in rolls from same production run.

1. Type: [**Type I, Light**][**Type II, Medium**][**Type III, Heavy**] Duty.

C. Width: [**52 inches (1321 mm)**].

D. Backing: [**Woven**][**Nonwoven**] fabric.

1. Fiber Content: [**Polyester cellulose**].

E. Repeat: [**Random**].

F. Features:

1. Microvented.

G. Colors, Textures, and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 WOVEN GLASS-FIBER WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Johns Manville; a Berkshire Hathaway company**]
2. [**Newtex Industries, Inc.**]
3. [**Roos International LTD. USA**]

B. Description: Provide woven glass-fiber wall covering with paintable exposed surface in rolls from same production run.

C. Width: [**39 inches (991 m)**].

D. Textures and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 TEXTILE WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carnegie Fabrics, LLC.**]
2. [**Designtex; Design Tex Group Inc. (The)**]
3. [**F. Schumacher & Co.**]
4. [**Hytex Industries Inc.**]
5. [**Innovations USA**]
6. [**Knoll, Inc.**]
7. [**Maharam Fabric Corporation; Herman Miller, Inc.**]
8. [**MDC Interior Solutions**]
9. [**Vescom America Inc.**]
10. [**Wolf-Gordon Inc.**]

B. Description: Provide wall coverings in rolls from same production run and that comply with the following:

1. ASTM F793/F793M: [**Category I, Decorative Only**][**Category II, Decorative with Medium Serviceability**][**Category III, Decorative with High Serviceability**][**Category IV, Type I, Commercial Serviceability (Vinyl Coated)**][**Category V, Type II, Commercial Serviceability (Vinyl Coated)**][**Category VI, Type III, Commercial Serviceability (Vinyl Coated)**].
2. Wallcoverings Association's W-101: [**Type I, Light Duty (Polyolefin Coated)**][**Type II, Medium Duty (Polyolefin Coated)**][**Type III, Heavy Duty (Polyolefin Coated)**].

C. Test Responses:

1. Colorfastness to Wet and Dry Crocking: [**Complies with AATCC 8, Grade 3, minimum**].
2. Colorfastness to Light: [**Complies with AATCC 16.2 Test Option 1 or AATCC 16.3 Test Option 3, Class L4, minimum, at 40 hours**].
3. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.

D. Repeat: [**Random**].

E. Applied Backing Material: [**Acrylic**][**Paper**].

F. Features:

1. Tackable.
2. [**Peelable**][**Strippable**].
3. Antimicrobial.
4. Water-based inks.
5. PVC free.
6. Phthalate free.
7. Heavy-metals free.

8. Halogenated-fire-retardant free.

G. Colors, Textures, and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 HEAVY-DUTY, SYNTHETIC-TEXTILE WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carnegie Fabrics, LLC.**]
2. [**Designtex; Design Tex Group Inc. (The)**]
3. [**Hytex Industries Inc.**]
4. [**Innovations USA**]
5. [**Knoll, Inc.**]
6. [**Maharam Fabric Corporation; Herman Miller, Inc.**]
7. [**MDC Interior Solutions**]
8. [**Vescom America Inc.**]
9. [**Wolf-Gordon Inc.**]

B. Description: Provide wall coverings in rolls from same production run and that comply with the following:

1. ASTM F793/F793M: [**Category IV, Type I, Commercial Serviceability (Vinyl Coated)**][**Category V, Type II, Commercial Serviceability (Vinyl Coated)**][**Category VI, Type III, Commercial Serviceability (Vinyl Coated)**].
2. Wallcoverings Association's W-101: [**Type I, Light Duty (Polyolefin Coated)**][**Type II, Medium Duty (Polyolefin Coated)**][**Type III, Heavy Duty (Polyolefin Coated)**].

C. Test Responses:

1. Colorfastness to Wet and Dry Crocking: [**Complies with AATCC 8, Class 3, minimum**].
2. Colorfastness to Light: [**Complies with AATCC 16.2 Test Option 1 or AATCC 16.3 Test Option 3, Class L4, minimum, at 40 hours**].
3. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.

D. Width: [**54 inches (1372 mm)**][**60 inches (1524 mm)**].

E. Applied Backing Material: [**Acrylic**].

F. Features:

1. Tackable.
2. Antimicrobial.
3. Water-based inks.
4. PVC free.
5. Phthalate free.
6. Heavy-metals free.
7. Halogenated-fire-retardant free.
8. Microvented.

G. Colors, Textures, and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.7 WOOD-VENEER WALL COVERING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**D. L. Couch**]
2. [**Flexible Materials Incorporated**]
3. [**Jacaranda Inc.**]
4. [**Misumaru USA Corporation**]
5. [**Roos International LTD. USA**]
6. [**SR Wood, Inc.**]
7. [**Wolf-Gordon Inc.**]

B. Description: Provide wood-veneer wall covering in rolls from same production run.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

D. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Wood products shall be labeled according to the AFPA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

G. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AFPA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. Sheet Size: [**24 by 96 inches (610 by 2438 mm)**][**48 by 96 inches (1219 by 2438 mm)**][**48 by 120 inches (1219 by 3048 mm)**].

I. Veneer Construction: [**Single-ply veneer**][**Two veneer plies assembled perpendicular to one another**].

J. Wood Species: [**Red oak**][**Maple**][**Cherry**].

K. Veneer Match: [**Book**][**Slip**][**Random**].

L. Sheet Match: [**Running**][**Balance**][**Center**][**Sequence, as indicated on Drawings**][**Blueprint, as indicated on Drawings**].

M. Applied Backing Material: [**Fabric**].

N. Finish: [**Factory**][**Field**] applied using wall-covering manufacturer's standard [**stain and polyurethane**] system.

1. Colors: [**Match Architect's samples**][**As selected by Architect from manufacturer's full**

range], as directed by the Owner.

2.8 WALLPAPER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**F. Schumacher & Co.**]
2. [**Roysons Corporation**]

B. Description: Provide wallpaper in rolls from same production run and that complies with ASTM F793/F793M.

1. Category: [**I, Decorative Only**][**II, Decorative with Medium Serviceability**][**III, Decorative with High Serviceability**][**I, Decorative Only (Vinyl Coated)**][**II, Decorative with Medium Serviceability (Vinyl Coated)**][**III, Decorative with High Serviceability (Vinyl Coated)**].

C. Width: [**20-1/2 inches (521 mm)**][**28 inches (711 mm)**].

D. Repeat: [**Random**].

E. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.

F. Features:

1. [**Peelable**][**Strippable**].

G. Colors, Textures, and Patterns: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining[strippable] adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of [**50**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m

and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Primer/Sealer: Mildew resistant, complying with [**requirements in Section 099123 "Interior Painting"**] and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

C. Metal Primer: Interior ferrous metal primer complying with [**requirements in Section 099123 "Interior Painting"**] and recommended in writing by primer and wall-covering manufacturers for intended substrate.

D. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of [**50**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
2. Plaster: Allow plaster to cure for at least 90 days. Neutralize areas of high alkalinity. Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
3. Metals: If not factory primed, clean and apply metal primer as recommended in writing by metal-primer manufacturer and wall-covering manufacturer.
4. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
5. Painted Surfaces:

a. Check for pigment bleeding. Apply primer/sealer to areas susceptible to pigment bleeding as recommended in writing by primer/sealer manufacturer.
b. Sand gloss, semigloss, and eggshell finishes with fine sandpaper.

D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION OF WALL LINER

A. Install wall liner, without gaps or overlaps. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.4 INSTALLATION OF WALL COVERING

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Match pattern [**72 inches (1828 mm)**] above the finish floor.

F. Install seams vertical and plumb at least **6 inches (152 mm)** from outside corners and [**3 inches (76 mm)**][**6 inches (152 mm)**] from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.5 FIELD FINISHING OF WOOD-VENEER WALL COVERINGS

A. Apply specified finish system according to coating manufacturer's written instructions to produce finish that is consistent in color and gloss and matches approved Samples.

B. Apply no fewer than [**two**][**three**] finish coats.

3.6 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00 00

Task	Specification	Specification Description
09 72 13 00	09 72 00 00	Wall Coverings
09 72 16 00	09 72 00 00	Wall Coverings
09 72 16 13	09 72 00 00	Wall Coverings
09 72 23 00	09 72 00 00	Wall Coverings
09 73 00 00	09 68 16 00	Sheet Carpeting
09 73 00 00	09 72 00 00	Wall Coverings
09 74 00 00	09 72 00 00	Wall Coverings
09 74 16 00	09 72 00 00	Wall Coverings

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SECTION 09 77 00 00 - STRETCHED-FABRIC WALL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes site-upholstered wall systems.

B. Related Requirements:

1. Section 095443 "Stretched-Fabric Ceiling Systems" for site-upholstered systems applied to ceilings[**and for coordinated requirements for fabric**].
2. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
3. Section 097723 "Fabric-Wrapped Panels" for decorative, fabric-wrapped wall panels that are not required to be tested for acoustical performance[**and for coordinated requirements for fabric**].
4. Section 098433 "Sound-Absorbing Wall Units" for shop-fabricated, acoustical wall panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include[**fabric facing,**] frame edge and trim, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
7. Product Data: For composite wood products, indicating that product contains no urea

formaldehyde.
8. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
10. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each stretched-fabric system.

1. Include plans, elevations, sections, and installation and system details.
2. Include details at head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate frame-edge profile and core materials.
3. Include details at cutouts and penetrations for other work.
4. Include direction of fabric weave and pattern matching.
5. Show sewn-seam locations, types, and methods.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of accessories involving color or finish selection.

E. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**] long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Frame System: **12-inch- (300-mm-)** square Sample(s) showing each edge profile and corner.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Assembled System: Approximately **36 by 36 inches (900 by 900 mm)**, including joints[**and seams**] in mockup.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by stretched-fabric systems including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to stretched-fabric systems.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of stretched-fabric system.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stretched-fabric systems to include in maintenance manuals. Include fabric manufacturer's written cleaning, stain-removal, restretching, and reupholstering instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, furnish length equal to [**10**] percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**], full width of bolt.
2. Framing and Related Installation Items: Furnish manufacturer's full-length units equal to [**5**] percent of amount installed, but no fewer than [**five**] units, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area [**as shown on Drawings**][**48 inches (1200 mm) wide by full height**].[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and stretched-fabric system manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install stretched-fabric systems until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install stretched-fabric systems until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**] is provided on surfaces to receive stretched-fabric systems.

C. Air-Quality Limitations: Protect stretched-fabric systems from exposure to airborne odors such as tobacco smoke, and install systems under conditions free from odor contamination of ambient air.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of stretched-fabric systems that fail in performance, materials, or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Acoustical performance.
b. Fabric sagging, distorting, or releasing from panel edge.
c. Warping of core.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain stretched-fabric wall systems specified in this Section[**and stretched-fabric systems specified in Section 095443 "Stretched-Fabric Ceiling Systems"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Stretched-fabric wall systems are to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency on systems prepared according to ASTM E2573. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.3 STRETCHED-FABRIC WALL SYSTEMS

A. Stretched-Fabric Wall System : Manufacturer's standard system consisting of facing material stretched tightly over a frame[**and core material**] and secured in the frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Accutrack Systems, LLC**]
   b. [**Acoustical Fabric Systems Inc**]
   c. [**Acoustical Solutions**]
   d. [**DFB Sales, Inc.**]
   e. [**Fabricmate Systems, Inc.**]
   f. [**FabriTrak Systems, Inc**]
   g. [**Novawall Systems, Inc**]
   h. [**SnapTex International LLC**]
   i. [**SoftWalls, Inc.**]
   j. [**Wallmate; Fabric Wallmount Systems, Inc.**]
   k. [**Whisper Walls**]

2. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber board**][**Cementitious-fiber board**][**Medium-density fiberboard**][**Particleboard**].[**Provide wood or plywood nailing strips in core where indicated.**]

   a. Core-Face Layer: Manufacturer's standard [**tackable, impact-resistant, high-density board**][**impact-resistant, acoustically transparent, copolymer sheet**].
   b. Nominal Core Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

3. Core Overlay: Polyester batting [**1/2 inch (13 mm) thick**][**Manufacturer's standard thickness**].
4. Frame Edge: [**Chamfered (beveled)**][**Radiused (bullnosed)**][**Square**] profile.

   a. Fabric-Insertion Point: [**Bottom load**][**Side load**][**Top load**].
   b. Nominal Frame Thickness: [**Match nominal core thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

5. Frame Color: [**Natural**][**Black**][**White**][**Prepainted color as selected by Architect from full range of manufacturer's colors**], as directed by the Owner.
6. Reveals between Panels: [**Recessed**][**Flush**][**Projecting**] reveals [**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.
7. Facing Material: [**the Owner-furnished material**][**As indicated on Drawings**].
8. Acoustical Performance: Sound absorption [NRC][SAA] of [0.50 to 0.90][0.60 to 0.70][0.65 to 0.75][not less than 0.65][not more than 0.35] according to ASTM C423 for [Type A] mounting according to ASTM E795.
9. Nominal Overall System Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].

2.4 MATERIALS

A. Sustainable Design Requirements:

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612; of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**], unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Glass-Fiber Blanket: ASTM C553, ASTM C612, or ASTM C665; of type standard with manufacturer; nominal density of [3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)]; flexible[with tackable, thermally bonded white glass-fiber mat facing;] and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13 lb/cu. ft. (208 kg/cu. m)**][**20 lb/cu. ft. (320 kg/cu. m)**], and with perforated surface.
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**].
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**].

    a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**].

    a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84 or UL 723.

7. Tackable, Impact-Resistant, High-Density Board for Face Layer: **1/8-inch- (3.2-mm-)** thick layer of compressed molded glass-fiber board with a nominal density of **16 to 18 lb/cu. ft. (256 to 288 kg/cu. m)** laminated to face of core.
8. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.
9. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: **1/16- to 1/8-inch- (1.6- to 3.2-mm-)** thick layer of perforated, noncombustible, copolymer sheet laminated to face of

core.

10. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

    a. Fire-retardant treated by pressure process with a flame-spread index of 25 or less when tested according to ASTM E84 or UL 723, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

        1) Treated material is to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity.
        2) Kiln-dry material after treatment to 7 to 13 percent or less for lumber and 15 percent or less for plywood.

C. Frame Construction: Manufacturer's standard, continuous, extruded plastic frame (track).

D. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Fiber Content: [**100**] percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**acoustically transparent vinyl**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**flame retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**].
4. Lining Material: [**Manufacturer's standard fabric for each use indicated**].

E. Lining Material : Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Color: [**White**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**].

F. Trim Strip : Fabric [**matching facing material except as follows**].

1. Color: [**White**].

2.5 INSTALLATION MATERIALS

A. Installation Products: Concealed on back of system, recommended by stretched-fabric system manufacturer to support weight of system, fabric tension, and as follows:

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall

not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
7. Fasteners: [**Manufacturer's standard**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, materials, substrates, areas, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of stretched-fabric systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each area and establish layout of panels and joints of [**uniform size with balanced borders at opposite edges**][**sizes indicated on Drawings**] within a given area.

B. Before installation, allow fabric to adjust and become stable in spaces where it will be installed according to stretched-fabric system manufacturer's written instructions. Acclimatize fabric for minimum of [**24**] hours at ambient temperature and humidity conditions indicated for spaces when occupied for their intended use.

3.3 INSTALLATION

A. Install stretched-fabric systems according to system manufacturer's written instructions.

1. Provide continuous perimeter frames of each profile indicated, designed to be inconspicuous when covered by fabric facing, with smooth edges, and with surface finish that will not telegraph through fabric facing.
2. Install framing around penetrations.
3. Tightly fit framing to adjacent construction and securely attach to substrate.
4. Install core material with full coverage, flush with face of stretched-fabric system frame.
5. Attach frame and core to substrate with adhesive or fasteners or both to support system and prevent deformation of components.
6. Install stretched-fabric systems level and plumb unless otherwise indicated, true in plane, and with fabric square to the grain.
7. Install jointed panels with [**butt joints**][**and**][**reveals**] as indicated.
8. Provide wood or plywood nailing strips and blocking as indicated on Drawings.
9. Provide continuous **6-inch- (150-mm-)** wide by [**1-inch- (25-mm-) thick, wood**][**3/4-inch- (19-mm-) thick, plywood**] nailing strips and blocking attached to supporting substrate with suitable fasteners for hanging artwork, centered at **60 inches (1524 mm)** above finish floor, unless otherwise indicated.

B. Fabric Installation: Apply fabric monolithically in continuous run over area, without joints or reveals, except where panel joints or midspan frames are indicated.

1. Fabric Direction: Run fabric [**railroaded**][**up the bolt**].
2. Fabric Sequence: Maintain sequence of fabric drops; match and level fabric pattern and grain.
3. Fabric Alignment: Install fabric with patterns or directional weaves so pattern or weave [**aligns with adjacent panels**][**varies from adjacent panels as indicated on Drawings**].
4. Fabric Seams:

   a. Sewn seams are not permitted.
   b. [**Manufacturer's standard**][**Flat standard**][**French**][**Welt-trimmed**] sewn seams, straight and parallel; seam dimensions and locations as indicated on Drawings.

5. Core Overlay: Evenly stretch over core face and edges; free from puckers, ripples, wrinkles, and sags.
6. Stretch and secure fabric to frame edges and so frame and frame attachment method are concealed by fabric unless otherwise indicated.
7. Stretch fabric tightly and square without puckers, ripples, or distortions. Acclimatize and restretch if recommended by stretched-fabric system manufacturer. Repair distortions, wrinkles, and sagging.
8. Trim Strip: Back-wrap trim strip fabric from the fabric-insertion point over the exposed part of the frame edge where indicated, resulting in a contrasting fabric along the edge.

3.4 INSTALLATION TOLERANCES

A. Edge Straightness: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**.

B. Variation from Level and Plumb: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**, noncumulative.

C. Variation of Joint Width: Not more than [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)** from [**hairline**][**reveal line**], noncumulative.

3.5 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

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SECTION 09 77 00 00A - FABRIC-WRAPPED PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes shop-fabricated, fabric-wrapped wall panels.

B. Related Sections:

1. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
2. Section 097713 "Stretched-Fabric Wall Systems" for site-upholstered systems applied to walls[**and for coordinated requirements for fabric**].
3. Section 098433 "Sound-Absorbing Wall Units" for shop-fabricated, acoustical wall panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include[**fabric facing,**] panel edge, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
12. Chain-of-Custody Qualification Data: For manufacturer and vendor.
13. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
14. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting

materials.
15. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
16. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
17. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
18. Product Data: For installation adhesives, indicating VOC content.
19. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
20. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
21. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
22. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
23. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
24. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
25. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
26. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
27. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
28. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel assembly and installation.

1. Include plans, elevations, sections, and mounting devices and details.
2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
3. Include details at cutouts and penetrations for other work.
4. Include direction of fabric weave and pattern matching.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of hardware and accessories involving color or finish selection.

E. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**] long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: **12-inch- (300-mm-)** long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately **36 by 36 inches (900 by 900 mm)**, including joints and mounting methods.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by panels including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Alarms.
    e. Sprinklers.
    f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to panels.

B. Product Certificates: For each type of panel.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of panel to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to [**10**] percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**], full width of bolt.
2. Mounting Devices: Full-size units equal to [**5**] percent of amount installed, but no fewer than [**five**] devices, including unopened adhesives.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area [**as shown on Drawings**][**48 inches (1200 mm) wide by full height**].[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install panels until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install panels until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**] is provided on surfaces to receive the panels.

C. Air-Quality Limitations: Protect panels from exposure to airborne odors such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify panel locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace panels and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Fabric sagging, distorting, or releasing from panel edge.
b. Warping of core.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabric-wrapped wall panels[**and fabric-wrapped ceiling panels specified in Section 095446 "Fabric-Wrapped Ceiling Panels"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Panels shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.3 FABRIC-WRAPPED WALL PANELS

A. Fabric-Wrapped Wall Panel : Manufacturer's standard panel construction consisting of facing material [**laminated to front face, edges, and back edge border of core**][**stretched over front face of edge-framed core and bonded or attached to edges and back of frame**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acoustical Panel Systems (APS, Inc.)**]
b. [**Acoustical Solutions**]
c. [**Armstrong Ceiling & Wall Solutions**]
d. [**Armstrong World Industries**]
e. [**AVL Systems, Inc**]
f. [**Benton Brothers Solutions, Inc.**]
g. [**Brejtfus Acoustical Interiors**]
h. [**Conwed**]
i. [**Decoustics; CertainTeed Architectural Products; a Saint Gobain company**]
j. [**Essi Acoustical Products**]
k. [**G&S Acoustics**]
l. [**Lamvin, Inc**]
m. [**MBI Products Company, Inc**]
n. [**Panel Solutions, Inc**]
o. [**Perdue Acoustics**]
p. [**Pinta Acoustic, Inc.**]
q. [**Sound Concepts**]
r. [**Sound Management Group LLC**]

s. [**Wenger Corporation**]

2. Panel Shape: [**Flat**][**As indicated on Drawings**].
3. Mounting:

   a. Edge mounted with splines secured to substrate.

      1) Finish Color at Exposed Edges: [**White**][**Black**][**Match color of facing material**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

   b. Back mounted with manufacturer's standard [**adhesive**][**adhesive tape strips**][**hook-and-loop strips**][**impaling clips**][**magnetic devices**][**metal clips or bar hangers**], secured to substrate.

4. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber board**][**Cementitious-fiber board**][**Medium-density fiberboard**][**Particleboard**].[**Provide wood or plywood nailing strips in core where indicated.**]

   a. Core-Face Layer: Manufacturer's standard [**tackable, impact-resistant, high-density board**][**impact-resistant, copolymer sheet**][**cork**].

5. Core Overlay: Polyester batting [**1/2 inch (13 mm) thick**][**manufacturer's standard thickness**].
6. Edge Construction: Manufacturer's standard [**chemically hardened core with no frame**][**extruded-aluminum or zinc-coated, rolled-steel frame**][**extruded PVC frame**][**wood frame, rabbeted, and splined with glued joints and machined corners**].
7. Edge Profile: [**Long edges kerfed and rabbeted to receive splines**][**Chamfered (beveled)**][**Eased (small radius)**][**Mitered (beveled to a point)**][**Radiused (bullnosed)**][**Square**][**Custom profile as indicated on Drawings**].
8. Corner Detail in Elevation: [**Square**][**Round, radius as indicated on Drawings**][**Custom as indicated on Drawings**] with continuous edge profile indicated.
9. Reveals between Panels: [**Recessed**][**Flush**][**Projecting**] reveals [**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.
10. Facing Material: [**the Owner-furnished material**][**As indicated on Drawings**].
11. Nominal [**Core**][**Overall Panel**] Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**].
12. Panel Width: [**24 inches (610 mm)**][**30 inches (762 mm)**][**48 inches (1220 mm)**][**As indicated on Drawings**].
13. Panel Height: [**72 inches (1829 mm)**][**96 inches (2438 mm)**][**108 inches (2743 mm)**][**120 inches (3048 mm)**][**As indicated on Drawings**].

2.4 MATERIALS

A. Sustainable Design Requirements:

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following

when tested according to ASTM D 6007 or ASTM E 1333:

a. Hardwood Plywood: 0.05 ppm.
b. Particleboard: 0.09 ppm.
c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
7. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site.
8. Regional Materials: Products shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
9. Indigenous Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
10. Regional Materials: Products shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
11. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
12. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
13. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
14. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
15. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

B. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612; of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**], unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Glass-Fiber Blanket: ASTM C612, ASTM C553, or ASTM C665; of type standard with manufacturer; nominal density of [3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)]; flexible[with tackable, thermally bonded, white glass-fiber mat facing;] and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13 lb/cu. ft. (208 kg/cu. m)**][**20 lb/cu. ft. (320 kg/cu. m)**].
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**].
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**].

a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant

chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**].

   a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84 or UL 723.

7. Tackable, Impact-Resistant, High-Density Board for Face Layer: **1/8-inch- (3.2-mm-)** thick layer of compressed, molded glass-fiber board with a nominal density of **16 to 18 lb/cu. ft. (256 to 288 kg/cu. m)** laminated to face of core.
8. Impact-Resistant, Copolymer Sheet for Face Layer: **1/16- to 1/8-inch- (1.6- to 3.2-mm-)** thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
9. Cork for Face Layer: Single **1/8-inch- (3.2-mm-)** thick seamless sheet of compressed fine-grain cork, bulletin board quality.
10. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.
11. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

    a. Fire-retardant treated by pressure process with a flame-spread index of 25 or less when tested according to ASTM E84 or UL 723, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

       1) Treated material are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity.
       2) Kiln-dry material after treatment to 19 percent for lumber and 15 percent or less for plywood.

C. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Fiber Content: [**100**] percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**vinyl**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**flame-retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**].
4. Lining Material: [**Manufacturer's standard fabric for each use indicated**].

D. Lining Material : Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**], as directed by the Owner.

1. Color: [**White**].
2. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**].
3. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**].

E. Mounting Devices: Concealed on back of panel, recommended by manufacturer to support weight of panel, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the panel, with other moldings and trim for interior corners, exterior corners, and exposed

edges, with factory-applied finish on exposed items.
2. Adhesives shall have a VOC content of [**70**] g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
8. Adhesive Tape Strips: [**Manufacturer's standard 1/16-inch- (1.6-mm-) thick, double-sided foam tape**].
9. Hook-and-Loop Strips: [**Manufacturer's standard**].
10. Impaling Clips: [**Manufacturer's standard**].
11. Magnetic Strip or Devices: [**Manufacturer's standard**].
12. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of panel and the other part to substrate, designed to permit unit removal.

2.5 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Edge Hardening: For [**glass-fiber board**][**and**][**mineral-fiber board**] cores, chemically harden core edges and areas of core where mounting devices are attached.

C. Core-Face Layer[**and Core Overlay**]: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

D. Facing Material[**and Lining Material**]: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.[**Heat-seal vinyl fabric seams at corners.**]
2. Radius and Other Nonsquare Corners: Attach material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.

E. Dimensional Tolerances of Finished Panels: Plus or minus **1/16 inch (1.6 mm)** for the following:

1. Thickness.
2. Edge straightness.

3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated panels, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting panel performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panels in locations indicated. Unless otherwise indicated, install panels with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.

C. Align fabric pattern and grain [**with adjacent panels**][**as indicated on Drawings**].

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus [**1/16 inch (1.6 mm)**] in **48 inches (1200 mm)**, noncumulative.

B. Variation of Joint Width: Not more than [**1/16 inch (1.6 mm)**][**1/32 inch (0.79 mm)**] wide from [**hairline**][**reveal line**] in **48 inches (1200 mm)**, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 09 77 00 00A

Task	Specification	Specification Description
09 77 00 00	09 72 00 00	Wall Coverings
09 77 11 00	09 77 00 00	Stretched-Fabric Wall Systems
09 77 11 00	09 77 00 00a	Fabric-Wrapped Panels
09 78 00 00	09 72 00 00	Wall Coverings
09 84 13 00	09 29 00 00	Gypsum Board

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SECTION 09 91 13 00 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of exterior substrates and application of the following:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.

B. Related Requirements:

1. [**Section 051200 "Structural Steel Framing"**] [**Section 051213 "Architecturally Exposed Structural Steel Framing"**] for shop priming structural steel substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.
4. Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.
5. Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.
6. Section 055213 "Pipe and Tube Railings" for shop [**priming**] [**painting**] pipe and tube railings.
7. [**Section 055313 "Bar Gratings"**] [**Section 055316 "Plank Gratings"**] [**Section 055319 "Expanded Metal Gratings"**] for shop priming metal gratings.
8. Section 099123 "Interior Painting."
9. Section 099300 "Staining and Transparent Finishing" for surface preparation and application of wood stains and transparent finishes on exterior wood substrates.
10. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit [**actual paint drawdowns as specified below**] [**paint manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable exterior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 EXTERIOR PAINTS, GENERAL

A. Exterior Paints: Subject to compliance with requirements, [**provide product**] [**provide one of the products**] [**available products that may be incorporated into the Work include but are not limited to products**] listed in product types below and applicable exterior painting schedule articles for the paint category indicated.

B. Material Compatibility:

1. Materials for use within each paint system must be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

C. Colors: [**As selected by Architect from manufacturer's full range**] [**Match Architect's samples**] [**As indicated in a color schedule on Drawings**] , as directed by the Owner.

1. [**10**] [**20**] [**30**] percent of surface area will be painted with deep tones.

2.3 PRIMERS

A. Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline substrates.

B. Exterior Wood Preservative: Solvent-based, zinc or copper napthenate, penetrating antifungal treatment for exterior wood.

C. Exterior, Latex Wood Primer: White, waterborne-emulsion primer formulated for resistance to extractive bleeding, mold, and microbials; for hiding stains; and for use on exterior wood substrates.

D. Exterior, Alkyd/Oil Wood Primer: Solvent-based primer formulated for resistance to extractive bleeding, sag, mold, and microbials; for hiding stains; and for use on exterior wood substrates.

E. Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

F. Water-Based Bonding Primer: Water-based-emulsion primer formulated to promote adhesion of subsequent specified coatings.

G. Solvent-Based Bonding Primer: Solvent-based primer formulated to seal substrates and promote adhesion of specified subsequent coatings.

H. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

I. Zinc-Rich, Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer formulated for use on prepared ferrous metal substrates subject to severe industrial or marine environments.

1.

J. Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on structural steel and metal fabrications that have been minimally prepared.

K. Quick-Drying, Alkyd Metal Primer: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, ferrous metal substrates.

L. Alkyd Metal Primer: Corrosion-resistant, solvent-based, alkyd primer formulated for use on prepared ferrous metal substrates subject to industrial and light marine environments.

M. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched galvanized metal substrates to prepare it for subsequent water-based coatings.

N. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anti-corrosive primer; formulated for use on ferrous and galvanized metal substrates.

O. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid-wash primer formulated for use over cleaned ferrous metal substrates and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.

P. Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared aluminum substrates.

Q. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.

2.4 WATER-BASED FINISH COATINGS

A. Exterior Latex Paint: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior substrates.
   1. Gloss and Sheen: Manufacturer's standard [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

B. Exterior, High-Build Latex Paint: Water-based, high-build, pigmented, emulsion coating; is formulated for abrasion, mold, microbial, and wind-driven rain resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard.

C. Textured Latex Coating: Water-based, pigmented, self-priming coating that contains sand or other hard aggregate for selected texture and is formulated for use on concrete and masonry substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**flat**] [**nonflat**].
   2. Texture: [**Manufacturer's standard**] [**Fine**] [**Medium**] [**Coarse**].

D. Exterior, Water-Based, Light Industrial Coating: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**low-sheen**] [**semigloss**] [**gloss**].

E. Exterior, Water-Based Alkyd Paint: Water-based, pigmented, low-VOC alkyd paint formulated for flash rust and water resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**low sheen**] [**semigloss**] [**gloss**].

F. Exterior, High-Performance Architectural Latex: Water-based, pigmented, low VOC, emulsion coating formulated for use on exterior substrates.
   1. Gloss Level: Manufacturer's standard [**low sheen**] [**semigloss**].

2.5 SOLVENT-BASED FINISH COATINGS

A. Exterior Alkyd Paint: Solvent-based, pigmented, alkyd coating formulated for mold, microbial, and water resistance and for use on exterior substrates.
   1. Gloss and Sheen Level: Manufacturer's standard [**flat**] [**semigloss**] [**gloss**].

B. Quick-Drying Alkyd Paint: Solvent-based, alkyd or modified-alkyd coating formulated for quick-drying capabilities and for use on exterior substrates.
   1. Gloss Level: Manufacturer's standard [**semigloss**] [**gloss**].

C. Aluminum Paint: Aliphatic, solvent-based coating consisting of varnish or alkyd binder combined with aluminum pigment that is formulated for use as a stain-blocking coating and sealer, is able to be recoated with conventional alkyd and latex paints, and for use on wood, metal, bituminous-coated, and prepared masonry substrates.

2.6 FLOOR SEALERS AND PAINTS

A. Concrete Stain: Penetrating semitransparent stain specifically manufactured for interior and exterior concrete horizontal and vertical surfaces.

B. Latex Floor Enamel: Water-based, pigmented coating formulated to hide stains, for alkali and incidental water resistance, and for use on concrete and primed-wood substrates subject to low to medium foot traffic.
   1. Gloss and Sheen Level: Manufacturer's standard [**low gloss**] [**gloss**].
   2. Slip-Resistant Aggregate: Manufacturer's standard.

C. Latex Deck Coating: Water-based, high-solids, acrylic-emulsion coating; formulated for use on exterior substrates subject to low to medium foot traffic.
   1. Gloss Level: Manufacturer's standard.
   2. Surface Texture: [**Smooth**] [**Slip resistant**].

D. Alkyd Floor Enamel: Solvent-based, pigmented coating; self-priming where applied to bare wood; formulated to hide stains, for durability, for microbial and abrasion resistance, and for exterior substrates subject to low to medium foot traffic.
   1. Gloss Level: Manufacturer's standard [**low gloss**] [**gloss**].
   2. Slip-Resistant Aggregate: Manufacturer's standard additive.

E. Water-Based, Concrete-Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic substrates.

F. Solvent-Based, Concrete-Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   1. Concrete: 12 percent.
   2. Cementitious Composition Board: 12 percent.
   3. Masonry (Clay and CMU): 12 percent.
   4. Wood: 15 percent.
   5. Portland Cement Plaster (Stucco): 12 percent. Verify that plaster is fully cured.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

   1. Application of coating indicates acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer[**.**][**but not less than the following:**]

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed substrates.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
2. Sand surfaces that will be exposed to view and remove sanding dust.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Canvas and Cotton Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

L. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION OF EXTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint [**both sides**] [**exterior side**] and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in applicable exterior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting, Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards[**and switch gear**].
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Exterior, high-build latex paint.

2. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. High Performance Architectural Latex System:

   a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

4. High Performance Architectural Latex over Latex Aggregate System:

   a. Prime Coat: Textured coating, latex, flat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Horizontal (Traffic) Surfaces:

1. Latex Floor Enamel System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].

2. Latex Deck Coating System:

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Latex deck coating.

3. Alkyd Floor Enamel System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
   d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Solvent-Based Concrete Floor Sealer System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Solvent-based, concrete-floor sealer.

5. Water-Based Concrete Floor Sealer System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Water-based, concrete-floor sealer.

6. Latex Zone/Traffic-Marking Paint System:

   a. Traffic-marking paint, latex.

7. Alkyd Zone/Traffic-Marking Paint System:

   a. Traffic-marking paint, solvent-based.

3.7 EXTERIOR PAINTING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**] [**Trim**] [**Panels**] .

1. Latex System:

   a. Prime Coat: Matching topcoat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Latex Aggregate System:

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Exterior, textured coating, latex [**flat**] [**nonflat**].

4. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Exterior, high-build latex paint.

5. Water-Based, Light Industrial Coating System:

    a. Prime Coat: Alkali-resistant, water-based primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

6. Alkyd System:

    a. Prime Coat: Exterior, latex wood primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

7. High Performance Architectural Latex System:

    a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Portland Cement Plaster (Stucco) Substrates:

1. Latex System:

    a. Prime Coat: [**Matching topcoat**] [**Alkali-resistant, water-based primer**].
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Exterior, high-build latex paint.

3. Water-Based, Light Industrial Coating System:

    a. Prime Coat: Alkali-resistant, water-based primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

    a. Prime Coat: Alkali-resistant, water-based primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Exterior water-based alkyd enamel, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Alkali-resistant, water-based primer**] [**As recommended in writing by topcoat manufacturer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.8 EXTERIOR PAINTING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

3. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Exterior, high-build latex paint.

4. Water-Based, Light Industrial Coating System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

5. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

6. High Performance Architectural Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. CMU Substrates:

1. Latex System:

a. Prime Coat: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkali-Resistant Primer System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

4. High-Build Latex System: . Dry film thickness of not less than 10 mils (0.25 mm).

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Exterior, high-build latex paint.

5. Water-Based, Light Industrial Coating System:

a. Prime Coat: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

6. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

7. High Performance Architectural Latex System:

a. Prime Coat: [**Alkali-resistant, water-based primer**] [**Latex block filler**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.9 EXTERIOR PAINTING SCHEDULE, METAL SUBSTRATES

A. Steel and Iron Substrates:

1. Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Zinc-rich, inorganic primer**] [**Alkyd metal primer**] [**Acrylic metal primer**] [**Epoxy metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating over Epoxy System:

a. Prime Coat: Epoxy metal primer.
b. Intermediate Coat: High-build epoxy paint, low gloss.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: [**Alkyd metal primer**] [**Surface-tolerant metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Alkyd metal primer**] [**Quick-dry, alkyd metal primer**] [**Surface-tolerant metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Quick-Dry Enamel System:

a. Prime Coat: Quick-dry, alkyd metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Quick-dry alkyd enamel, [**semigloss**] [**gloss**].

6. Aluminum Paint System:

a. Prime Coat: [**Alkyd metal primer**] [**Shop primer specified in Section in which substrate is specified**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

B. Galvanized Metal Substrates:

1. Latex System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.

2. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Water-based, galvanized-metal primer**] [**Epoxy metal primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System: <**Insert drawing designation**>

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

7. Bituminous Coating System: <**Insert drawing designation**>

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Bituminous coating.

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Latex System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Pretreatment Coat: Vinyl wash primer.
b. Prime Coat: Quick-dry aluminum primer.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Quick-dry aluminum primer**] [**Vinyl wash primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

a. Pretreatment Prime Coat: Vinyl wash primer.
b. Prime Coat: Quick-dry aluminum primer.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Aluminum paint.

7. Bituminous Coating System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Bituminous coating.

D. Copper Substrates:

1. Latex System:

   a. Prime Coat: Quick-dry aluminum primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Quick-dry aluminum primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

   a. Pretreatment Coat: [**Vinyl wash**] [**Quick-dry aluminum**] primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

   a. Prime Coat: [**Quick-dry aluminum primer**] [**Vinyl wash primer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

   a. Prime Coat: Quick-dry aluminum primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Aluminum paint.

7. Bituminous Coating System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Bituminous coating.

E. Stainless Steel Substrates:

1. Latex System:

   a. Prime Coat: Solvent-based bonding primer.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Quick-dry aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Solvent-based bonding primer**] [**Alkyd metal primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

6. Aluminum Paint System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

3.10 EXTERIOR PAINTING SCHEDULE, WOOD SUBSTRATES

A. Glue-Laminated Wood Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Exposed Wood-Framed Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

C. Dressed-Wood Substrates: [**Wood trim**] [**Architectural woodwork**] [**Doors**] [**Windows**] [**Wood board siding**] [**Railings**] [**and**] [**Fences**] .

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

   a. Prime Coat: Exterior, alkyd wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Water-Based, Light Industrial Coating System:

   a. Prime Coat: Exterior, alkyd wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

4. Alkyd System:

   a. Prime Coat: Exterior, alkyd wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

5. Water-Based Alkyd System:

   a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

6. High Performance Architectural Latex System:

   a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

D. Wood-Based Panel Substrates:

1. Latex over Latex Primer System:

   a. Prime Coat: Exterior, latex wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

   a. Prime Coat: Exterior, alkyd wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

   a. Prime Coat: Exterior, alkyd wood primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

   a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
   b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

E. Wood-Board, Traffic-Surface Substrates: [**Lumber decking**] [**and**] [**stairs**]

1. Latex Porch and Floor Enamel over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Latex Porch and Floor Enamel over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

3. Latex Deck Coating System (for Plywood Decks):

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommending in writing by topcoat manufacturer.
c. Topcoat: Latex deck coating.
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Alkyd Floor Enamel System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

5. Alkyd Floor Enamel over Wood Preservative System:

a. Preservative Coat: Exterior wood preservative.
b. Prime Coat: Matching topcoat.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Alkyd floor enamel, [**low gloss**] [**gloss**].
e. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

F. Wood Shingle and Shake Siding Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Exterior, latex wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex over Alkyd Primer System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior, alkyd wood primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Exterior, latex wood primer**] [**Exterior, alkyd wood primer**].
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

3.11 EXTERIOR PAINTING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Latex System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: Solvent-based bonding primer.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

B. Plastic Trim Fabrication Substrates:

1. Latex System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. High Performance Architectural Latex System:

a. Prime Coat: [**Solvent**] [**Water**]-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

C. Exterior Canvas and Cotton Substrates:

1. Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Water-Based, Light Industrial Coating System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior, water-based, light industrial coating, [**low sheen**] [**semigloss**] [**gloss**].

3. Alkyd System:

a. Prime Coat: Exterior latex paint, flat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

   a. Prime Coat: Exterior latex paint, flat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

   a. Prime Coat: Exterior latex paint, flat.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System:

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

D. Exterior Bituminous-Coated Substrates:

1. Latex System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior latex paint, [**flat**] [**low sheen**] [**semigloss**] [**gloss**].

2. Latex Aggregate System:

   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: Textured latex coating, [**flat**] [**nonflat**].

3. Alkyd System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior alkyd paint, [**flat**] [**semigloss**] [**gloss**].

4. Water-Based Alkyd System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior water-based alkyd paint, [**low sheen**] [**semigloss**] [**gloss**].

5. Aluminum Paint System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Aluminum paint.

6. High Performance Architectural Latex System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.

c. Topcoat: Exterior, high performance architectural latex, [**low sheen**] [**semigloss**].

END OF SECTION 09 91 13 00

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Task	Specification	Specification Description
09 91 13 00	01 22 00 00	No Specification Required
09 91 13 00	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 91 23 00 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of interior substrates and application of the following:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.
5. Dry fall coatings.

B. Related Requirements:

1. [**Section 051200 "Structural Steel Framing"**][**Section 051213 "Architecturally Exposed Structural Steel Framing"**] for shop priming structural steel substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.
4. Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.
5. Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.
6. Section 055213 "Pipe and Tube Railings" for shop [**priming**][**painting**] pipe and tube railings.
7. [**Section 055313 "Bar Gratings"**][**Section 055316 "Plank Gratings"**][**Section 055319 "Expanded Metal Gratings"**] for shop priming metal gratings.
8. Section 099113 "Exterior Painting."
9. Section 099300 "Staining and Transparent Finishing" for surface preparation and application of wood stains and transparent finishes on interior wood substrates.
10. Section 099600 "High-Performance Coatings" for tile-like coatings.
11. Section 321723 "Pavement Markings" for pavement-marking paints.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit [**actual paint drawdowns as specified below**][**paint manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on rigid backing, **8 inches (200 mm)** square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable interior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

F. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 INTERIOR PAINTS, GENERAL

A. Interior Paints: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include but are not limited to products**] listed in product types below and applicable interior painting schedule articles for the paint category indicated.

B. Material Compatibility:

1. Materials for use within each paint system must be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

C. VOC Content: For field applications [**that are inside the weatherproofing system**] , verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
6. Pretreatment Wash Primers: 420 g/L.
7. Floor Coatings: 50 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with either of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Nonflat - High-Gloss Coatings: 150 g/L.
   d. Concrete/Masonry Sealers: 100 g/L.
   e. Floor Coatings: 100 g/L.
   f. Industrial Maintenance Coatings: 250 g/L.
   g. Low-Solids Coatings: 120 g/L.
   h. Mastic Texture Coatings: 100 g/L.
   i. Metallic Pigmented Coatings: 500 g/L.
   j. Pretreatment Wash Primers: 420 g/L.
   k. Primers, Sealers, and Undercoaters: 100 g/L.
   l. Reactive Penetrating Sealers: 350 g/L.
   m. Recycled Coatings: 250 g/L.

n. Rust-Preventive Coatings: 250 g/L.

F. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**] , as directed by the Owner.

1. [**10**][**20**][**30**] percent of surface area will be painted with deep tones.

2.3 PRIMERS

A. Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Rust-Oleum Corporation**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]
f. [**Valspar; a brand of The Sherwin-Williams Company**]

B. Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**McCormick Paints**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]

C. Interior Latex Primer Sealer: Pigmented, water-based latex sealer; formulated to reduce porosity of substrate for finish coats; for use on new interior plaster, concrete, and gypsum board substrates. Not intended for use on wood or previously painted surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Hempel (USA), Inc.**]
d. [**McCormick Paints**]
e. [**Rodda Paint Co.**]
f. [**Sherwin-Williams Company (The)**]
g. [**The Pittsburgh Paints Company**]

D. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**McCormick Paints**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]

E. Interior, Latex Primer for Wood: Waterborne-emulsion primer formulated for resistance to extractive bleeding, mold, and microbials; for hiding stains; and for use on interior wood substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**KILZ (Behr Paint Company)**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]
g. [**Valspar; a brand of The Sherwin-Williams Company**]

F. Interior Alkyd Primer Sealer: Solvent-based, alkyd-type, primer/sealer for new interior wood, plaster, and porous surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]

G. Water-Based Alkyd Primer Sealer: Waterborne-emulsion primer/sealer formulated for new interior gypsum board and plaster substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Rodda Paint Co.**]
    d. [**Sherwin-Williams Company (The)**]
    e. [**The Pittsburgh Paints Company**]

H. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Sherwin-Williams Company (The)**]
    d. [**The Pittsburgh Paints Company**]

I. Quick-Drying, Alkyd Metal Primer: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, ferrous metal substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**Hempel (USA), Inc.**]
    c. [**Sherwin-Williams Company (The)**]
    d. [**The Pittsburgh Paints Company**]

J. Alkyd Metal Primer: Corrosion-resistant, solvent-based, alkyd primer formulated for use on prepared ferrous metal substrates subject to industrial and light marine environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**Hempel (USA), Inc.**]
    c. [**McCormick Paints**]
    d. [**Sherwin-Williams Company (The)**]
    e. [**The Pittsburgh Paints Company**]

K. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anticorrosive primer; formulated for use on ferrous and galvanized metal substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**Carboline Company; a subsidiary of RPM International**]
    c. [**Diamond Vogel Paint Company**]
    d. [**Hempel (USA), Inc.**]
    e. [**Sherwin-Williams Company (The)**]
    f. [**The Pittsburgh Paints Company**]

L. Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on structural steel and metal fabrications that have been minimally prepared.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Sherwin-Williams Company (The)**]
    d. [**The Pittsburgh Paints Company**]

M. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched galvanized metal substrates to prepare it for subsequent water-based coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Rodda Paint Co.**]
    d. [**Sherwin-Williams Company (The)**]
    e. [**The Pittsburgh Paints Company**]

N. Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared aluminum substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**The Pittsburgh Paints Company**]

O. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid-wash primer formulated for use over cleaned ferrous metal substrates and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Sherwin-Williams Company (The)**]

P. Water-Based Bonding Primer: Water-based-emulsion primer formulated to promote adhesion of subsequent specified coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Valspar; a brand of The Sherwin-Williams Company**]

Q. Solvent-Based Bonding Primer: Solvent-based primer formulated to seal substrates and promote adhesion of specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. [**The Pittsburgh Paints Company**]

R. Wood-Knot Sealer: White shellac or other sealer recommended in writing by topcoat manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]

2.4 WATER-BASED FINISH COATINGS

A. Interior Latex Paint: Pigmented, water-based coating for use on interior primed/sealed plaster and gypsum board, and on primed wood and metals.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]

c. [**Coronado Paint; Benjamin Moore & Co.**]
d. [**Insl-X Products; Benjamin Moore & Co.**]
e. [**McCormick Paints**]
f. [**Rodda Paint Co.**]
g. [**Sherwin-Williams Company (The)**]
h. [**The Pittsburgh Paints Company**]
i. [**Valspar; a brand of The Sherwin-Williams Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**low sheen**][**eggshell**][**satin**][**semigloss**][**gloss**] .

B. Interior, Latex, Institutional Low-Odor/VOC Paint: White or colored latex coating with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**McCormick Paints**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**low sheen**][**eggshell**][**satin**][**semigloss**][**gloss**] .

C. Interior, Water-Based Light Industrial Coating: Pigmented, water-based emulsion coating for interior primed wood and metal surfaces (e.g., walls, doors, frames, trim, and sash), providing resistance to moderate abrasion and mild chemical exposure and corrosive conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**McCormick Paints**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**eggshell**][**semigloss**][**gloss**] .

D. Interior, High-Performance Architectural Latex: Water-based, pigmented, low-VOC, emulsion coating formulated to provide a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**low sheen**][**eggshell**][**satin**][**semigloss**] .

E. High-Performance Textured Latex Coating: Water-based, pigmented, self-priming coating that contains sand or other hard aggregate for selected texture and is formulated for use on concrete and masonry substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**nonflat**] .
3. Texture: [**Manufacturer's standard**][**Fine**][**Medium**][**Coarse**] .

F. Interior, Water-Based Alkyd Paint: Water-based, pigmented, low-VOC alkyd paint formulated for flash rust and water resistance and for use on interior, primed, wood, plaster, masonry, and metal surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**low sheen**][**semigloss**][**gloss**] .

G. Interior Latex, Antiviral/Antibacterial Coating: Water-based, pigmented, low-VOC paint with EPA-registered proprietary antimicrobial copper ion technology formulated to kill 99 percent of viruses and bacteria within 2 hours, for use on interior, primed, concrete, masonry, metal, wood, gypsum board, and plaster surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**The Pittsburgh Paints Company**]

2. Gloss Level: Manufacturer's standard [**eggshell**][**semigloss**] .

2.5 SOLVENT-BASED FINISH COATINGS

A. Interior Alkyd Paint: Pigmented, solvent-based alkyd coating for use on primed/sealed interior plaster, gypsum, wood, and metal substrates primarily in moderate traffic commercial environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**eggshell**][**semigloss**][**gloss**] .

B. Aluminum Paint: Aliphatic, solvent-based coating consisting of varnish or alkyd binder combined with aluminum pigment that is formulated for use as a stain-blocking coating and sealer, is able to be recoated with conventional alkyd and latex paints, and for use on wood, metal, bituminous-coated, and prepared masonry substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**Rodda Paint Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]

2.6 FLOOR SEALERS AND PAINTS

A. Concrete Stain: Penetrating semitransparent stain specifically manufactured for concrete horizontal and vertical surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]

B. Latex Floor Enamel: Water-based, pigmented coating formulated to hide stains, for alkali and incidental water resistance, and for use on concrete and primed-wood substrates subject to low to medium foot traffic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Sherwin-Williams Company (The)**]
    c. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**low gloss**][**gloss**] .
3. Slip-Resistant Aggregate: Manufacturer's standard additive.

C. Alkyd Floor Enamel: Solvent-based, pigmented coating; self-priming where applied to bare wood; formulated to hide stains, for durability, for microbial and abrasion resistance, and for use on wood-board substrates subject to low to medium foot traffic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**The Pittsburgh Paints Company**]

2. Gloss Level: Manufacturer's standard [**low gloss**][**gloss**] .
3. Slip-Resistant Aggregate: Manufacturer's standard additive.

D. Water-Based Concrete Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    c. [**Sherwin-Williams Company (The)**]
    d. [**The Pittsburgh Paints Company**]

E. Solvent-Based Concrete Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    c. [**Sherwin-Williams Company (The)**]

2.7 DRY FALL COATINGS

A. Dry Fall, Latex: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**McCormick Paints**]
d. [**Rodda Paint Co.**]
e. [**Sherwin-Williams Company (The)**]
f. [**The Pittsburgh Paints Company**]
g. [**Valspar; a brand of The Sherwin-Williams Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**eggshell**][**semigloss**] .

B. Dry Fall, Water-Based for Galvanized Steel: Pigmented, water-based coating for direct application to cleaned, interior galvanized-metal ceiling surfaces and adjacent primed metals.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**eggshell**][**semigloss**] .

C. Dry Fall, Alkyd: Pigmented, solvent-based, fast-setting, alkyd coating for use on interior ceiling substrates such as primed plaster, gypsum board, wood, and metals.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]

2. Gloss and Sheen Level: Manufacturer's standard [**flat**][**eggshell**][**semigloss**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Cementitious Composition Board: 12 percent.
3. Masonry (Clay and CMU): 12 percent.
4. Wood: 15 percent.
5. Gypsum Board: 12 percent. Verify that finishing compound is dry and sanded smooth.
6. Plaster: 12 percent. Verify that plaster is fully cured.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints to be painted exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer [**.**][**but not less than the following:**]

1. SSPC-SP 2.

2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of wood-knot sealer.
2. Sand surfaces that will be exposed to view and remove sanding dust.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Canvas and Cotton Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

L. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION OF INTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in the applicable interior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view in equipment rooms:

   a. Equipment, including panelboards [**and switch gear**] .
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Tanks that do not have factory-applied final finishes.
   h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed to view in occupied spaces:

   a. Equipment, including panelboards.
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   h. Other items as directed by the Owner.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing,

scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 INTERIOR PAINTING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. Latex System:

a. Prime Coat: [**Alkali-resistant, water-based primer**][**Matching topcoat**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Latex Aggregate System:

a. Prime Coat: High-performance textured latex coating.

1) Gloss and Sheen Level: Flat.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: High-performance textured latex coating.

1) Gloss and Sheen Level: [**Flat**][**Nonflat**] .

4. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

5. High-Performance Architectural Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

6. Antiviral/Antibacterial Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Water-Based Light Industrial Coating System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

8. Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

9. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

10. Concrete Stain System:

a. First Coat: Matching topcoat.
b. Topcoat: Concrete stain.

B. Horizontal (Traffic) Surfaces:

1. Latex Floor Enamel System:

a. Prime Coat: Matching topcoat
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel.

1) Gloss and Sheen Level: [**Low gloss**][**Gloss**] .

2. Alkyd Floor Enamel System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Alkyd floor enamel.

1) Gloss and Sheen Level: [**Low gloss**][**Gloss**] .

3. Concrete Stain System:

a. First Coat: Matching topcoat.
b. Topcoat: Concrete stain.

4. Solvent-Based Concrete Floor Sealer System:

a. First Coat: Matching topcoat.
b. Topcoat: Solvent-based concrete floor sealer.

5. Water-Based Concrete Floor Sealer System:

a. First Coat: Matching topcoat.
b. Topcoat: Water-based concrete floor sealer.

6. Latex Zone/Traffic-Marking Paint System:

a. As specified in Section 321723 "Pavement Markings."

7. Alkyd Zone/Traffic-Marking Paint System:

a. As specified in Section 321723 "Pavement Markings."

3.8 INTERIOR PAINTING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**][**Trim**][**Panels**] .

1. Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Water-Based Light Industrial Coating System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

5. Antiviral/Antibacterial Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

7. Water-Based Alkyd System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

3.9 INTERIOR PAINTING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Latex System:

a. Prime Coat: Alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: High-performance textured latex coating.

1) Gloss and Sheen Level: [**Flat**][**Nonflat**] .

3. Institutional Low-Odor/VOC Latex System:

   a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, high-performance architectural latex.

      1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, water-based light industrial coating.

      1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex, antiviral/antibacterial coating.

      1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior alkyd paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

   a. Prime Coat: Alkali-resistant, water-based primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, water-based alkyd paint.

      1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

B. CMU Substrates:

1. Latex System:

   a. Block Filler: Latex block filler.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex Aggregate System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: High-performance textured latex coating.

1) Gloss and Sheen Level: [**Flat**][**Nonflat**] .

3. Institutional Low-Odor/VOC Latex System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Block Filler: Latex block filler.
b. Prime Coat: Alkali-resistant, water-based primer.
c. Intermediate Coat: Matching topcoat.
d. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

a. Block Filler: Latex block filler.

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

3.10 INTERIOR PAINTING SCHEDULE, METAL SUBSTRATES

A. Steel and Iron Substrates:

1. Latex System, Alkyd Primer:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Shop-Applied, Quick-Drying Shop Primer System:

a. Intermediate Coat: Matching topcoat.
b. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Water-based, rust-inhibitive primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

a. Prime Coat: Water-based, rust-inhibitive primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

6. Water-Based Light Industrial Coating System over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**][**Gloss**] .

7. Water-Based Dry-Fall System:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Topcoat: [**Dry fall, latex**][**Dry fall, water-based for galvanized steel**] .

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**] .

8. Antiviral/Antibacterial Latex System:

a. Prime Coat: Quick-drying, alkyd metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

9. Alkyd System:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

10. Alkyd over Surface-Tolerant Primer System:

a. Prime Coat: Surface-tolerant metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**semigloss**][**gloss**] .

11. Alkyd over Rust-Inhibitive Primer System:

a. Prime Coat: Water-based, rust-inhibitive primer.
b. Intermediate Coat: Alkyd, interior, matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

12. Alkyd over Shop-Applied, Quick-Drying Shop Primer System:

a. Intermediate Coat: Alkyd, interior, matching topcoat.
b. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

13. Water-Based Alkyd System:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Quick-drying primer for shop application**][**Water-based, rust-inhibitive primer**][**Surface-tolerant metal primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

14. Quick-Drying Enamel System:

a. Prime Coat: Quick-drying, alkyd metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

15. Alkyd Dry-Fall System

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Topcoat: Dry fall, alkyd.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**] .

16. Alkyd Dry Fall over Quick-Drying Primer System:

a. Prime Coat: Quick-drying, alkyd metal primer.
b. Topcoat: Dry fall, alkyd.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**] .

17. Aluminum Paint System:

a. Prime Coat: [**Quick-drying, alkyd metal primer**][**Alkyd metal primer**][**Shop primer specified in Section where substrate is specified**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

B. Galvanized Metal Substrates:

1. Latex System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Water-based, galvanized-metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, high-performance architectural latex.

        1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Water-Based Light Industrial Coating System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, water-based light industrial coating.

        1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

5. Antiviral/Antibacterial Latex System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex, antiviral/antibacterial coating.

        1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Water-Based Dry-Fall System:

    a. Prime Coat: Matching topcoat.
    b. Topcoat: Dry fall, water-based for galvanized steel.

        1) Gloss and Sheen Level: Flat.

7. Alkyd System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior alkyd paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, water-based alkyd paint.

        1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

9. Alkyd Dry-Fall System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Topcoat: Dry fall, alkyd.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**] .

10. Aluminum Paint System:

    a. Prime Coat: Water-based, galvanized-metal primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Latex System:

    a. Prime Coat: Quick-drying aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Quick-drying aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

    a. Prime Coat: Quick-drying aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, high-performance architectural latex.

        1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Aluminum Paint System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

5. Water-Based Light Industrial Coating System:

    a. Prime Coat: Quick-drying aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, water-based light industrial coating.

        1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

    a. Prime Coat: Quick-drying aluminum primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex, antiviral/antibacterial coating.

        1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

a. Prime Coat: Primer, [**Vinyl wash primer**][**Quick-drying aluminum primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

a. Prime Coat: Quick-drying aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

D. Copper Substrates:

1. Latex System:

a. Prime Coat: Quick-drying aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Quick-drying aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

a. Prime Coat: Quick-drying aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Water-Based Light Industrial Coating System:

a. Prime Coat: Quick-drying aluminum primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

5. Aluminum Paint System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Aluminum paint.

6. Antiviral/Antibacterial Latex System:

   a. Prime Coat: Quick-drying aluminum primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex, antiviral/antibacterial coating.

      1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior alkyd paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

E. Stainless Steel Substrates:

1. Latex System:

   a. Prime Coat: Solvent-based bonding primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. High-Performance Architectural Latex System:

   a. Prime Coat: Solvent-based bonding primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, high-performance architectural latex.

      1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

3. Water-Based Light Industrial Coating System:

   a. Prime Coat: [**Solvent-based bonding primer**][**Quick-drying aluminum primer**] .
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, water-based light industrial coating.

      1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

4. Aluminum Paint System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Aluminum paint.

5. Antiviral/Antibacterial Latex System:

   a. Prime Coat: Quick-drying aluminum primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, latex antiviral/antibacterial coating.

      1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

   a. Prime Coat: Vinyl wash primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior alkyd paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

3.11 INTERIOR PAINTING SCHEDULE, WOOD SUBSTRATES

A. Glued-Laminated Wood Substrates:

1. Latex over Latex Primer System:

   a. Prime Coat: Interior, latex primer for wood.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System:

   a. Prime Coat: Interior alkyd primer sealer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

   a. Prime Coat: Interior, latex primer for wood.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

      1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

   a. Prime Coat: Interior, latex primer for wood.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, high-performance architectural latex.

      1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Antiviral/Antibacterial Latex System:

   a. Prime Coat: Interior alkyd primer sealer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior latex, antiviral/antibacterial coating.

      1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

7. Water-Based Alkyd System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

B. Exposed Wood Framed Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Antiviral/Antibacterial Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior alkyd paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

7. Water-Based Alkyd System:

    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, water-based alkyd paint.

        1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

C. Finish Carpentry Substrates: [**Wood trim**][**Doors**][**Windows**][**and**][**Wood board paneling**] .

1. Latex over Latex Primer System:

    a. Prime Coat: Interior, latex primer for wood.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System:

    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Interior, latex primer for wood.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

    a. Prime Coat: Interior, latex primer for wood.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, high-performance architectural latex.

        1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.

c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

D. Architectural Woodwork Substrates: [**Wood paneling**][**and**][**Casework**] .

1. Latex over Latex Primer System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

E. Wood Traffic Substrates: [**Floors**][**and**][**stairs**] .

1. Latex Porch and Floor Enamel System

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Latex floor enamel.

1) Gloss and Sheen Level: Low gloss.

d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Alkyd Floor Enamel System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.

c. Topcoat: Alkyd floor enamel.

1) Gloss and Sheen Level: Gloss.

d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

F. Wood Shingle and Shake Substrates:

1. Latex over Latex Primer System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Antiviral/Antibacterial Latex System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

4. Alkyd System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

5. Water-Based Alkyd System:

a. Prime Coat: Interior, latex primer for wood.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

3.12 INTERIOR PAINTING SCHEDULE, GYPSUM-BASED SUBSTRATES

A. Gypsum Board and Plaster Substrates:

1. Latex over Latex Sealer System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Latex over Alkyd Primer System (for Plaster Only):

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint:

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Water-Based Light Industrial Coating System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

6. Antiviral/Antibacterial Latex System:

a. Prime Coat: [**Interior latex primer sealer**][**Interior, institutional low-odor/VOC primer sealer**][**Interior alkyd primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

7. Alkyd over Latex Sealer System:

a. Prime Coat: [**Water-based alkyd primer sealer**][**Interior latex primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

8. Water-Based Alkyd System:

a. Prime Coat: [**Water-based alkyd primer sealer**][**Interior latex primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

3.13 INTERIOR PAINTING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Latex System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: [**Water-based bonding primer**][**Solvent-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Water-Based Light Industrial Coating System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

5. Antiviral/Antibacterial Latex System:

a. Prime Coat: [**Interior latex primer sealer**][**Interior, institutional low-odor/VOC primer sealer**][**Interior alkyd primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior Latex, Antiviral/Antibacterial Coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

7. Water-Based Alkyd System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

B. Plastic Trim Fabrication Substrates:

1. Latex System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Water-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. High-Performance Architectural Latex System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

4. Water-Based Light Industrial Coating System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

5. Antiviral/Antibacterial Latex System:

a. Prime Coat: [**Interior latex primer sealer**][**Interior, institutional low-odor/VOC primer sealer**][**Interior alkyd primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd System:

a. Prime Coat: Solvent-based bonding primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

7. Water-Based Alkyd System:

a. Prime Coat: [**Solvent-based bonding primer**][**Water-based bonding primer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based alkyd paint.

1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

C. Spray-Textured Ceiling Substrates:

1. Latex, Flat System: Spray applied:

a. Prime Coat: Matching topcoat.
b. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: Flat.

2. Latex System: Spray applied:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Latex over Alkyd Sealer System:

a. Prime Coat: Interior alkyd primer sealer
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. Alkyd, Flat System:

a. Prime Coat: Matching topcoat.
b. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: Flat.

5. Alkyd over Alkyd Sealer System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

D. Acoustic Panels and Tiles:

1. Latex, Flat System:

a. Prime Coat: Matching topcoat.
b. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: Flat.

2. Latex over Alkyd Sealer System:

a. Prime Coat: Interior alkyd primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

4. High-Performance Architectural Latex System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, high-performance architectural latex.

1) Gloss and Sheen Level: [**Low sheen**][**Eggshell**][**Satin**][**Semigloss**] .

5. Antiviral/Antibacterial Latex System:

a. Prime Coat: [**Interior latex primer sealer**][**Interior, institutional low-odor/VOC primer sealer**][**Interior alkyd primer sealer**] .
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior latex, antiviral/antibacterial coating.

1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

6. Alkyd, Flat System:

a. Prime Coat: Matching topcoat.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: Flat.

E. Canvas and Cotton Insulation-Covering Substrates: Including [**pipe and duct coverings**] .

1. Latex System:

    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, institutional low-odor/VOC paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

3. Antiviral/Antibacterial Latex System:

    a. Prime Coat: [**Interior latex primer sealer**][**Interior, institutional low-odor/VOC primer sealer**][**Interior alkyd primer sealer**] .
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex, antiviral/antibacterial coating.

        1) Gloss and Sheen Level: [**Eggshell**][**Semigloss**] .

4. Alkyd System:

    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior alkyd paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

5. Aluminum Paint System:

    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Aluminum paint.

F. Bituminous-Coated Substrates:

1. Latex System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior latex paint.

        1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Eggshell**][**Satin**][**Semigloss**][**Gloss**] .

2. Alkyd System:

    a. Prime Coat: Water-based, rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior alkyd paint.

1) Gloss and Sheen Level: [**Flat**][**Low sheen**][**Semigloss**][**Gloss**] .

3. Aluminum Paint System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Aluminum paint.

4. Water-Based Alkyd System:

   a. Prime Coat: Water-based, rust-inhibitive primer.
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Interior, water-based alkyd paint.

      1) Gloss and Sheen Level: [**Low sheen**][**Semigloss**][**Gloss**] .

END OF SECTION 09 91 23 00

Task	Specification	Specification Description
09 91 23 00	09 91 13 00	Exterior Painting
09 91 33 00	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 93 00 00 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers
2. Wood stains.
3. Transparent finishes.

B. Related Requirements:

1. Section 099123 "Interior Painting" for stains and transparent finishes on concrete floors.
2. Section 099600 "High-Performance Coatings" for transparent high-performance coatings on concrete floors and clay masonry.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
2. Include preparation requirements and application instructions.
3. Indicate VOC content.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

C. Samples for Verification: Sample for each type of finish system and in each color and gloss of finish required on representative samples of actual wood substrates.

1. Size: [8 inches (200 mm) square][8 inches (200 mm) long].
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration: For each product.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.

9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same product run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than **5 deg F (3 deg C)** above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations: Obtain each coating product from single source from single manufacturer.

2.2 STAINING AND TRANSPARENT FINISHING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Behr Paint Company (Behr Process LLC)**]
2. [**Benjamin Moore & Co.**]
3. [**Coronado Paint; Benjamin Moore & Co.**]
4. [**Diamond Vogel Paint Company**]
5. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]

6. [**Hempel (USA), Inc.**]
7. [**Lenmar Lacquers; Benjamin Moore & Co.**]
8. [**PPG Paints; PPG Industries, Inc.**]
9. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
10. [**Rodda Paint Co.**]
11. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
12. [**Sherwin-Williams Company (The)**]
13. [**United Gilsonite Laboratories (UGL)**]
14. [**Vista Paint Corporation**]

B. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

C. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Clear Wood Finishes, Varnishes: 350 g/L.
2. Clear Wood Finishes, Lacquers: 550 g/L.
3. Shellacs, Clear: 730 g/L.
4. Stains: 250 g/L.

D. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. VOC Content, LEED v4: For field applications[**that are inside the weatherproofing system**], paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Primers, Sealers, and Undercoaters: 100 g/L.
2. Clear Wood Finishes, Varnishes: 275 g/L.
3. Clear Wood Finishes, Lacquers: 275 g/L.
4. Shellacs, Clear: 730 g/L.
5. Stains: 100 g/L.

F. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

H. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Shellacs, Clear: 730 g/L.
    b. Stains: 250 g/L.
    c. Clear Wood Finishes (Varnishes, Sanding Sealers, and Lacquers): 275 g/L.

I. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

J. Stain Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**], as directed by the Owner.

2.3 PRIMERS

A. Primer, Alkyd Oil for Exterior Wood: Alkyd/oil-based primer for exterior wood with resistance to bleeding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Benjamin Moore & Co.**]
    b. [**Diamond Vogel Paint Company**]
    c. [**PPG Paints; PPG Industries, Inc.**]
    d. [**Rodda Paint Co.**]
    e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    f. [**Sherwin-Williams Company (The)**]

B. Primer, Latex for Exterior Wood: Pigmented, water-borne, emulsion-type primer for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Diamond Vogel Paint Company**]
    d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
    e. [**PPG Paints; PPG Industries, Inc.**]
    f. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    g. [**Rodda Paint Co.**]
    h. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    i. [**Sherwin-Williams Company (The)**]
    j. [**Vista Paint Corporation**]

C. Preservative for Exterior Wood: Solvent-based, penetrating anti-fungal treatment for exterior wood consisting mainly of zinc or copper napthenate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]

D. Alkyd Sanding Sealer, Interior, Solvent Based, Clear: Solvent-based, quick-drying, clear, sandable alkyd sealer used on new interior wood surfaces that are to be top-coated with an alkyd varnish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]

2.4 WOOD STAINS

A. Stain, Exterior, Solvent Based, Semitransparent: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Rodda Paint Co.**]
f. [**Sherwin-Williams Company (The)**]

B. Stain, Exterior, Solvent Based, Solid Hide: Solvent-based, oil or oil/alkyd, pigmented stain for new, or previously stained, wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond Vogel Paint Company**]
b. [**Sherwin-Williams Company (The)**]

C. Stain, Exterior, Water Based, Solid Hide: Water-based, solid-hide, emulsion-type, pigmented stain for primed or previously painted exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Sherwin-Williams Company (The)**]
h. [**Vista Paint Corporation**]

D. Stain, Exterior, Water Based, Semitransparent: Water-based, semitransparent, pigmented stain for new wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Coronado Paint; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]

E. Stain, Exterior, for Wood Decks: Solvent- or water- based, modified-oil or alkyd-type, semitransparent, penetrating stain for exterior dimensional wood decking.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Sherwin-Williams Company (The)**]

F. Stain, Interior, Semitransparent, for Interior Wood: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new interior wood surfaces that are to be finished with a clear varnish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**PPG Paints; PPG Industries, Inc.**]
c. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
d. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]

e. [**Sherwin-Williams Company (The)**]

G. Shellac: Alcohol-based, shellac type, clear or light amber-colored coating for use as a sealer on stains and knots or as a wash coat to even the porosity of some wood types.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
b. [**Sherwin-Williams Company (The)**]

H. Danish Oil: Solvent-based, oil-type, penetrating stain for application by brush or wiping on interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Sherwin-Williams Company (The)**]

2.5 TRANSPARENT FINISHES

A. Varnish, Marine Spar, Exterior, Gloss: Solvent-based, phenolic-modified clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

B. Varnish with UV Inhibitor, Exterior, Gloss: Solvent-based, alkyd-type, clear gloss varnish stabilized against UV deterioration for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

C. Varnish with UV Inhibitor, Exterior, Semigloss: Solvent-based, alkyd-type, clear semigloss varnish stabilized against UV deterioration for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**].

D. Varnish, Exterior, Aliphatic Polyurethane, Two Component: Solvent-based, two-component, aliphatic polyurethane clear coating used on exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hempel (USA), Inc.**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 80 units at 60 degrees when tested in accordance with ASTM D523**].

E. Varnish, Exterior, Water Based, Eggshell: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**PPG Paints; PPG Industries, Inc.**]

2. Gloss and Sheen Level: Gloss and Sheen Level: [**Manufacturer's standard eggshell finish**][**Gloss of 10 to 25 units at 60 degrees and sheen of 10 to 35 units at 85 degrees when tested in accordance with ASTM D523**].

F. Varnish, Exterior, Water Based, Satin: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**PPG Paints; PPG Industries, Inc.**]
   b. [**Sherwin-Williams Company (The)**]

2. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**].

G. Varnish, Exterior, Water Based, Semigloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**].

H. Varnish, Exterior, Water Based, Gloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

I. Varnish, Exterior, Water Based, High Gloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 85 units at 60 degrees when tested in accordance with ASTM D523**].

J. Varnish, Interior Polyurethane, Moisture Cured, Gloss: Solvent-based, moisture-curing polyurethane clear-coating with a gloss finish for interior wood surfaces,

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

K. Varnish, Interior, Polyurethane, Oil Modified, Gloss: Solvent-based, one-component, oil-modified polyurethane clear gloss varnish for new or previously varnished or stained interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

L. Varnish, Interior, Polyurethane, Oil Modified, Satin: Solvent-based, one-component, oil-modified polyurethane clear satin varnish for new or previously varnished or stained interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]

2. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**].

M. Varnish, Interior, Flat/Satin: Solvent-based, alkyd-type, clear flat/satin varnish for new or properly prepared, previously varnished interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Sherwin-Williams Company (The)**]

2. Gloss and Sheen Level: [**Manufacturer's standard flat finish**][**Maximum gloss of 5 units at 60 degrees and maximum sheen of 10 units at 85 degrees when tested in accordance with ASTM D523**].

N. Varnish, Interior, Gloss: Solvent-based, alkyd-type, clear gloss varnish for new or properly prepared, previously varnished interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**].

O. Varnish, Interior, Water Based, Clear, Satin: Water-based clear satin coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Lenmar Lacquers; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]

2. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**].

P. Varnish, Interior, Water Based, Clear, Semigloss: Water-based clear semigloss coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Moore & Co.**]
b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**].

Q. Varnish, Interior, Water Based, Clear, High Gloss: Water-based clear high-gloss coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Moore & Co.**]
b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Sherwin-Williams Company (The)**]

2. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 85 units at 60 degrees when tested in accordance with ASTM D523**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Maximum Moisture Content of Interior Wood Substrates: [**15**][**13**][**10**][**9**] percent, when measured with an electronic moisture meter.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with finish application only after unsatisfactory conditions have been corrected.

1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.

1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

C. Exterior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Prime edges, ends, faces, undersides, and backsides of wood.

a. For solid hide stained wood, stain edges and ends after priming.
b. For varnish-coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.

3. Countersink steel nails, if used, and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.

D. Interior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Apply wood filler paste to open-grain woods to produce smooth, glasslike finish.
3. Sand surfaces exposed to view and dust off.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions.

1. Use applicators and techniques suited for finish and substrate indicated.
2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Glued-Laminated Construction:

1. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

2. Varnish over Semitransparent Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

3. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

4. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

5. Clear, Two-Component Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
c. Second Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
d. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

6. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

B. Wood Substrates, Exposed Framing:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.

d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

7. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

8. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, [**gloss**][**high gloss**].

C. Wood Substrates, [**Wood Trim**][**Architectural woodwork**][**Doors**][**Windows**][**Wood Board Siding**][**and**][**Wood Fences**]:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent-based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

7. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

8. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Topcoat: Varnish, aliphatic polyurethane, two component gloss.

D. Wood Substrates, Wood-Based Panel Products:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, [**latex**][**alkyd**] for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

E. Wood Substrates, Traffic Surfaces, Including [**Lumber Decking**][**and**][**Stairs**]:

1. Deck Stain over Wood Preservative System :

   a. Preservative Coat: Preservative, for exterior wood.
   b. Intermediate Coat: Stain, for exterior wood decks, matching topcoat.
   c. Topcoat: Stain, for exterior wood decks.

2. Deck Stain System :

   a. Prime Coat: Stain, for exterior wood decks, matching topcoat.
   b. Topcoat: Stain, for exterior wood decks.

F. Wood Substrates, Wood Shingles and Shakes (Excluding Roofs):

1. Solid-Color, Water-Based Stain System :

   a. Prime Coat: Primer, alkyd for exterior wood.
   b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
   c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

   a. Prime Coat: Primer, alkyd for exterior wood.
   b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
   c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

   a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
   b. Topcoat: Stain, exterior, solvent based, semitransparent.

3.6 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Glued-Laminated Construction:

1. Solid-Color Latex Stain System :

   a. Prime Coat: Primer, alkyd for exterior wood.
   b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
   c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

   a. Prime Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
   b. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

   a. Prime Coat: Stain, semitransparent, matching topcoat.
   b. Topcoat: Stain, semitransparent, for interior wood.

4. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

5. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

6. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: [**Varnish matching topcoat**][**Alkyd, sanding sealer, clear**].
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

7. Alkyd Varnish System :

a. Prime Coat: Alkyd, sanding sealer, clear.
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

8. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

9. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

10. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

11. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

B. Wood Substrates, Exposed Framing:

1. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

2. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Alkyd, sanding sealer, clear.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

3. Alkyd Varnish System :

a. Prime Coat: Alkyd, sanding sealer, clear.
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

4. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

5. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

6. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

7. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

C. Wood Substrates, [**Wood Trim**][**Architectural Woodwork**][**Doors**][**Windows**][**and**][**Wood Board Paneling**]:

1. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

2. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.

b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

3. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

4. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

5. Alkyd Varnish System :

a. Prime Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

6. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

7. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

8. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

9. Moisture-Cured Clear Polyurethane System :

a. Prime Coat: Moisture-cured polyurethane matching topcoat.
b. Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, gloss.

10. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

11. Danish Oil System :

    a. Prime Coat: Danish oil matching topcoat.
    b. Topcoat: Danish oil.

D. Wood Substrates, [**Wood Paneling**][**and**][**Casework**]:

1. Semitransparent Stain System :

    a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
    b. Topcoat: Stain, exterior, solvent based, semitransparent.

2. Water-Based Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Water-based varnish matching topcoat.
    c. Second Intermediate Coat: Water-based varnish matching topcoat.
    d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

3. Water-Based Varnish System :

    a. Prime Coat: Water-based varnish matching topcoat.
    b. Intermediate Coat: Water-based varnish matching topcoat.
    c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

4. Alkyd Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
    c. Second Intermediate Coat: Varnish matching topcoat.
    d. Topcoat: Varnish, interior, [**flat**][**gloss**].

5. Alkyd Varnish System :

    a. Prime Coat: Alkyd, sanding sealer, clear [**Shellac, clear**].
    b. Intermediate Coat: Varnish matching topcoat.
    c. Topcoat: Varnish, interior, [**flat**][**gloss**].

6. Polyurethane Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Polyurethane varnish matching topcoat.
    c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
    d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

7. Polyurethane Varnish System :

    a. Prime Coat: Polyurethane varnish matching topcoat.
    b. Intermediate Coat: Polyurethane varnish matching topcoat.
    c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

8. Moisture-Cured Clear Polyurethane over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.

c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

9. Danish Oil System :

a. Prime Coat: Danish oil matching topcoat.
b. Topcoat: Danish oil.

E. Wood Substrates, Traffic Surfaces, Including [**Floors**][**and**][**Stairs**]:

1. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, gloss.

2. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, gloss.

3. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

4. Moisture-Cured Clear Polyurethane System :

a. Prime Coat: Moisture-cured polyurethane matching topcoat.
b. Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, gloss.

5. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

F. Wood Substrates, Wood Shingles and Shakes:

1. Solid-Color Latex Stain System :

a. Prime Coat: Primer, latex for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

   a. Prime Coat: Stain, semitransparent, matching topcoat.
   b. Topcoat: Stain, semitransparent, for interior wood.

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Task	Specification	Specification Description
09 93 13 00	09 93 00 00	Staining and Transparent Finishing
09 93 13 53	09 93 00 00	Staining and Transparent Finishing
09 93 23 00	09 93 00 00	Staining and Transparent Finishing
09 93 23 13	09 93 00 00	Staining and Transparent Finishing
09 93 23 53	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 96 00 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Block fillers.
2. Interior primers/sealers.
3. Metal primers.
4. Epoxy coatings.
5. Polyurethane coatings.

B. Related Requirements:

1. [**Section 051200 "Structural Steel Framing"**][**Section 051213 "Architecturally Exposed Structural Steel Framing"**] for shop priming structural steel substrates with primers specified in this Section.
2. Section 055213 "Pipe and Tube Railings" for shop priming and painting pipe and tube railings with coatings specified in this Section.
3. Section 099113 "Exterior Painting" for general field painting.
4. Section 099123 "Interior Painting" for general field painting.
5. Section 099300 "Staining and Transparent Finishing" for general field staining.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat. Submit [**actual paint drawdowns as specified below**][**paint manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on actual substrate material to be coated, **8 inches (200 mm)** square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in High-Performance Coating Schedules. Include color designations and production runs (batch numbers).

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Product Data for Green Seal GS-11 Certification: Green Seal GS-11 certification.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**from the same production run (batch number),**] that match coating system products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each coating system product from single source from single manufacturer.

2.2 HIGH-PERFORMANCE COATING PRODUCTS, GENERAL

A. High-Performance Coating Products: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work**

include but are not limited to products] listed in product types below and applicable exterior and interior high-performance coating schedule articles for the coating category indicated.

B. Material Compatibility:

1. Materials for use within each coating system must be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by topcoat manufacturer for use in system and on substrate indicated.

C. VOC Content: For field applications [**that are inside the weatherproofing system**] , verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
6. Pretreatment Wash Primers: 420 g/L.
7. Floor Coatings: 50 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify that not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with either of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Nonflat - High-Gloss Coatings: 150 g/L.
   d. Concrete/Masonry Sealers: 100 g/L.
   e. Floor Coatings: 100 g/L.
   f. Industrial Maintenance Coatings: 250 g/L.
   g. Low-Solids Coatings: 120 g/L.
   h. Mastic Texture Coatings: 100 g/L.
   i. Metallic Pigmented Coatings: 500 g/L.
   j. Pretreatment Wash Primers: 420 g/L.
   k. Primers, Sealers, and Undercoaters: 100 g/L.
   l. Reactive Penetrating Sealers: 350 g/L.
   m. Recycled Coatings: 250 g/L.
   n. Rust-Preventive Coatings: 250 g/L.

F. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's

"Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC emissions evaluation criteria.

H. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in color schedule on Drawings**] as directed by the Owner.

2.3 BLOCK FILLERS

A. Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

B. Epoxy Block Filler: Solvent-based, two-component, epoxy, high-solids coating; formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. [**The Pittsburgh Paints Company**]
d. [**Tnemec Company, Inc.**]

2.4 INTERIOR PRIMERS/SEALERS

A. Interior Latex Primer Sealer: Pigmented, water-based latex sealer; formulated to reduce porosity of substrate for finish coats; for use on new interior plaster, concrete, and gypsum board substrates. Not intended for use on wood or previously painted surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

B. Knot Sealer: White shellac or other sealer recommended in writing by topcoat manufacturer for sealing wood knots.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]

2.5 METAL PRIMERS

A. Zinc-Rich Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer; formulated for use on prepared ferrous metal substrates that will be exposed to severe industrial or marine environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]
c. [**Tnemec Company, Inc.**]

B. Epoxy Zinc-Rich Primer: Solvent-based, multi-component, epoxy-type anticorrosive primer; formulated for use on cleaned ferrous metal substrates that will be exposed to moderate industrial or marine environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]
c. [**Tnemec Company, Inc.**]

C. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

D. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anticorrosive primer; formulated for use on ferrous and galvanized metal substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]
c. [**Tnemec Company, Inc.**]

E. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid-wash primer formulated for use over cleaned ferrous metal substrates and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]

2.6 EPOXY COATINGS

A. Epoxy: Solvent-based, two-component epoxy coating; formulated for resistance to incidental splash and spillage of dilute (5 percent) sulfuric acid, (15 percent) hydrochloric acid, (20 percent) sodium hydroxide, gasoline, and heavy-duty cleaners and detergents; for use on wall and floor surfaces in moderate-to-heavy-traffic commercial and moderate industrial environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

B. High-Build Epoxy: Two-component epoxy, high-solids, self-priming coating for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**low gloss**][**gloss**] .

C. Epoxy-Modified Latex: Water-based, two-component, epoxy-modified latex paint for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
b. [**Sherwin-Williams Company (The)**]
c. [**The Pittsburgh Paints Company**]
d. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

D. Epoxy Deck Coating (Slip Resistant): Solvent-based, two-component epoxy, non-slip coating formulated for resistance to abrasion, solvents, fuel, and oils; for use on interior and exterior decks.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Neogard; Hempel Group**]
d. [**Sherwin-Williams Company (The)**]
e. [**The Pittsburgh Paints Company**]
f. [**Tnemec Company, Inc.**]

2.7 POLYURETHANE COATINGS

A. Pigmented Polyurethane: Solvent-based, two-component coating formulated for resistance to abrasion, weathering, and chemical and solvent exposure; for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. [**The Pittsburgh Paints Company**]
d. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

B. Varnish, Aliphatic Polyurethane: Clear, solvent-based, two-component coating formulated for use on interior or exterior wood substrates; manufacturer's standard gloss and sheen.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2.8 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: the Owner reserves the right to invoke the following procedure:

1. the Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. the Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor to remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

2. Cementitious Composition Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Portland Cement (Plaster Stucco): 12 percent. Verify that plaster is fully cured.
6. Gypsum Board: 12 percent. Verify that finishing compound is dry and sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of [**1500 to 4000 psi (10 350 to 27 580 kPa)**][**4000 to 10,000 psi (27 580 to 68 950 kPa)**] at **6 to 12 inches (150 to 300 mm)**.
2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.

E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of [**100 to 600 psi (690 to 4140 kPa)**][**600 to 1500 psi (4140 to 10 350 kPa)**][**1500 to 4000 psi (10 350 to 27 580 kPa)**] at **6 to 12 inches (150 to 300 mm)**.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other foreign matter. Clean using methods recommended in writing by coating manufacturer [**.**][**but not less than the following:**]

1. SSPC-SP 7/NACE No. 4.
2. SSPC-SP 11.
3. SSPC-SP 6/NACE No. 3.
4. SSPC-SP 10/NACE No. 2.
5. SSPC-SP 5/NACE No. 1.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.
2. Sand surfaces that will be exposed to view and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.

3.3 APPLICATION OF HIGH-PERFORMANCE COATINGS

A. Apply coating system products in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING

A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 PROTECTION

A. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

3.7 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Horizontal (Traffic) Surfaces:

1. Epoxy Non-Slip Deck Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Epoxy deck coating (slip resistant).

3.8 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**][**Trim**][**Panels**] .

1. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Portland Cement Plaster (Stucco) Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.9 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. CMU Substrates:

1. Epoxy System:

a. Block Filler: Epoxy block filler.

b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over High-Build Epoxy System:

a. Block Filler: Epoxy block filler.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.10 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, METAL SUBSTRATES

A. Steel Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy Deck Coating over Epoxy Primer and High-Build Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Epoxy deck coating (slip resistant).
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Epoxy Deck Coating over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Topcoat: Epoxy deck coating (slip resistant).
c. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

5. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, gloss.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

6. Pigmented Polyurethane over High-Build Epoxy System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: High-build epoxy, low gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

7. Pigmented Polyurethane over Self-Priming Epoxy System:

    a. Prime Coat: High-build epoxy.
    b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

8. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System:

    a. Prime Coat: Epoxy zinc-rich primer.
    b. Intermediate Coat: Epoxy, gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

9. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System:

    a. Prime Coat: Epoxy zinc-rich primer.
    b. Intermediate Coat: High-build epoxy, low gloss.
    c. First and Second Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

10. Pigmented Polyurethane over Zinc-Rich Inorganic Primer and High-Build Epoxy System:

    a. Prime Coat: Zinc-rich inorganic primer.
    b. Intermediate Coat: High-build epoxy, low gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Galvanized Metal Substrates:

1. Epoxy System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy Primer System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: Pigmented polyurethane, matching topcoat.

c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Vinyl Wash Primer and Epoxy Primer System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

D. Copper Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

E. Stainless Steel Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.11 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, WOOD SUBSTRATES

A. Glued-Laminated Wood Substrates:

1. Pigmented Polyurethane System:

a. Prime Coat: Pigmented polyurethane, matching topcoat.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

a. Stain Coat: As specified in Section 099300 "Staining and Transparent Finishing."
b. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
d. Topcoat: Varnish, aliphatic polyurethane.

B. Exposed Wood-Framed Substrates:

1. Pigmented Polyurethane System:

a. Prime Coat: Pigmented polyurethane, matching topcoat.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

C. Dressed Wood Substrates: [**Wood trim**][**Architectural woodwork**][**Doors**][**Windows**][**Wood board siding**][**Railings**][**and**][**Fences**] .

1. Pigmented Polyurethane System:

a. Prime Coat: Pigmented polyurethane, matching topcoat.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

3.12 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.13 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: Low gloss.

3. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Horizontal (Traffic) Surfaces.

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Pigmented Polyurethane System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

4. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

3.14 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**][**Trim**][**Panels**] .

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.15 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

B. CMU Substrates:

1. Epoxy System for Dry Environments:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy System for Wet Environments:

a. Block Filler: Epoxy block filler.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy, High-Build System:

a. Prime Coat: Epoxy block filler.
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

4. Epoxy-Modified Latex System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

5. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

3.16 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, METAL SUBSTRATES

A. Steel Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. High-Build Epoxy over Epoxy Zinc-Rich Primer System:

a. Prime Coat: Epoxy zinc-rich primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Epoxy over Self-Priming Epoxy System:

a. Prime Coat: High build epoxy.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

4. Epoxy, High-Build System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

5. Epoxy Deck Coating System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy.
c. Topcoat: Epoxy deck coating (slip resistant).

6. Epoxy-Modified Latex System:

a. Prime Coat, First Coat: Water-based, rust-inhibitive primer.
b. Prime Coat, Second Coat: Water-based, rust-inhibitive primer.
c. Intermediate Coat: Epoxy-modified latex, matching topcoat.
d. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

7. Pigmented Polyurethane over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

8. Pigmented Polyurethane over High-Build Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

9. Pigmented Polyurethane over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

10. Pigmented Polyurethane over Inorganic Zinc-Rich and Epoxy System:

a. Prime Coat: Zinc-rich inorganic primer.
b. Intermediate Coat: Epoxy.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

11. Pigmented Polyurethane over Epoxy Zinc-Rich and Epoxy System:

a. Prime Coat: Epoxy zinc-rich primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Galvanized Metal Substrates:

1. Epoxy over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

D. Copper Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

E. Stainless Steel Substrates:

1. Epoxy System:

a. Prime Coat: Primer, epoxy.
b. Intermediate Coat: Epoxy, matching topcoat.

c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.17 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, WOOD SUBSTRATES

A. Glued-Laminated Wood Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Pigmented polyurethane, matching topcoat.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

B. Exposed Wood-Framed Substrates:

1. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

C. Dressed Wood Substrates: [**Wood trim**][**Architectural woodwork**][**Doors**][**Windows**][**and**][**Wood board paneling**] .

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

D. Wood-Traffic Substrates: [**Floors**][**and**][**stairs**] .

1. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, .
d. Additive: Manufacturer's standard additive to increase skid resistance of coated surface.

3.18 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, GYPSUM-BASED SUBSTRATES

A. Gypsum Board and Plaster Substrates:

1. Epoxy System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Epoxy-Modified Latex System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.19 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.

b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

END OF SECTION 09 96 00 00

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SECTION 09 96 53 00 - ELASTOMERIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric coating systems.

B. Related Requirements:

1. Section 099113 "Exterior Painting."
2. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of elastomeric topcoat product.

C. Samples for Verification: For each type of elastomeric topcoat product indicated and in each color and gloss. Submit [**actual coating system drawdowns as specified below**][**coating manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on same type of substrate as that to receive application, **8 inches (200 mm)** square.
2. Apply coats on Samples in steps to show each separate coat, including primers and block fillers as applicable.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in the Elastomeric Coating Schedule to cross-reference coating systems specified in this Section. Include color designations.

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same production run,] that match products installed and that are

packaged with protective covering for storage and identified with labels describing contents.

1. Elastomeric Coating System Products: Furnish an additional [**5**] percent but not less than [**1 gal. (3.8 L)**] of each material, color, and texture applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between **50 and 90 deg F (10 and 32 deg C)** unless otherwise permitted by manufacturer's written instructions.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Water penetration through the coating.
b. Deterioration of coating beyond normal weathering.

2. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each coating system product from single source from single manufacturer.

2.2 ELASTOMERIC COATINGS, GENERAL

A. Elastomeric Coating Systems: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include but are not limited to products**] listed in the Elastomeric Coating Schedule Article for the substrate category

indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Coronado Paint; Benjamin Moore & Co.**]
    d. [**Insl-X Products; Benjamin Moore & Co.**]
    e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    f. [**Rodda Paint Co.**]
    g. [**Sherwin-Williams Company (The)**]
    h. [**Sto Corp.**]
    i. [**Textured Coatings of America, Inc**]
    j. [**The Pittsburgh Paints Company**]

B. Moisture-Vapor Transmission: based on testing in accordance with ASTM D1653.

C. Material Compatibility:

1. Materials for use within each coating system are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, products are recommended in writing by manufacturers of topcoat for use in elastomeric coating system and on substrate indicated.

D. VOC Content: For field applications, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

E. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**], as directed by the Owner.

1. [**10**][**20**][**30**] percent of surface area will be coated with deep tones.

F. Crack Fillers: Elastomeric coating manufacturer's recommended, factory-formulated crack fillers or sealants, including crack filler primers, compatible with substrate and other materials indicated.

G. Primer: Elastomeric coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.

H. Concrete Masonry Unit Block Filler: Elastomeric coating manufacturer's recommended, factory-formulated, high-performance latex block filler compatible with substrate and other materials indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of the Work.

B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.

C. Begin coating no sooner than [**28**] days after substrate is constructed and is visually dry on both sides.

D. Verify that substrate is within the range of alkalinity recommended by manufacturer.

E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Application of coating system indicates acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

D. Crack Repair: Fill cracks in accordance with manufacturer's written instructions before coating surfaces.

3.3 APPLICATION OF ELASTOMERIC COATING SYSTEMS

A. Apply elastomeric coatings in accordance with manufacturer's written instructions.

1. Use equipment and techniques best suited for substrate and type of material being applied.
2. Coat surfaces behind movable items the same as similar exposed surfaces.
3. Apply each coat separately in accordance with manufacturer's written instructions.

B. Primers: Apply at a rate to ensure complete coverage.

C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.

D. Elastomeric Finish Coat(s): [**Minimum two coats with a total dry film thickness of 16 to 18 mils (0.41 to 0.45 mm)**][**Minimum one coat with a total dry film thickness of 7 to 10 mils (0.18 to 0.25 mm)**][**Manufacturer's recommended number of coats and total dry film thickness for condition of substrate**].

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

F. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.

G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

H. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.

I. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: the Owner reserves the right to invoke the following testing procedures:

1. the Owner will engage the services of a qualified testing agency to sample materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance of materials with product requirements.
3. the Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

B. Field Testing and Inspection: the Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an

undamaged condition, as directed by the Owner.

D. At completion of construction activities, touch up and restore damaged or defaced coated surfaces.

3.6 ELASTOMERIC COATING SCHEDULE

A. Concrete Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

B. Concrete Masonry Unit Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Block Filler: As recommended in writing by topcoat manufacturer.
c. Intermediate Coat: As recommended in writing by topcoat manufacturer.
d. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

C. Stucco Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

END OF SECTION 09 96 53 00

Task	Specification	Specification Description
09 96 53 00	09 91 13 00	Exterior Painting
09 96 56 00	09 96 00 00	High-Performance Coatings
09 96 66 00	09 97 26 00	Cementitious Coatings
09 97 13 23	09 96 00 00	High-Performance Coatings
09 97 13 24	09 96 00 00	High-Performance Coatings

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SECTION 09 97 26 00 - CEMENTITIOUS COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and application of cementitious coating systems on the following substrates:

1. [**Exterior**][**Interior**] concrete.
2. [**Exterior**][**Interior**] concrete masonry units.
3. [**Exterior**][**Interior**] brick.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: In each color and gloss of topcoat.

1. Submit Samples on [rigid backing][actual substrate], not less than 8 inches (200 mm) square[with mortar joint in center].
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each cementitious coating, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are from same production run (batch mix) as materials applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quantity: Furnish an additional [**5**] percent of each color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of coating system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one [**actual substrate of each type**] to represent surfaces and conditions for application of coating, as directed by the Owner.

a. Wall Surfaces: Prepare Samples of at least [**100 sq. ft. (9.3 sq. m)**].

2. Apply mockups after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of colors selected by Architect at no added cost to the Owner, as directed by the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:

1. Product name or title of material.
2. Manufacturer's stock number and date of manufacture.
3. Contents by volume, for pigment and vehicle constituents.
4. Application instructions.
5. Color name and number.
6. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of **45 deg F (7 deg C)**. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.

1. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

1.7 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS COATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
2. [**Fox Industries, Inc.**]
3. [**Gemite Products Inc., a W.R. Meadows company**]
4. [**MAPEI Corporation**]
5. [**Master Builders Solutions**]
6. [**Sakrete; CRH Americas, Oldcastle APG**]
7. [**Silpro Corporation**]

B. Products: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include, but are not limited to products**] listed in the Cementitious Coating Schedule for the paint category indicated.

C. Source Limitations: Obtain cementitious coating materials from single source and from single manufacturer.

D. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.

1. Compressive Strength: Not less than [**3500 psi (24.1 MPa)**] at 28 days according to ASTM C109/C109M.
2. Tensile Strength: Not less than [**350 psi (2.41 MPa)**] at 28 days according to ASTM C109/C109M.

E. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.

F. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. VOC Content, LEED v4: For field applications[**that are inside the weatherproofing system**], paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

H. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from

Indoor Sources Using Environmental Chambers."

I. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Primers, Sealers, and Undercoaters: 100 g/L.

J. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Primers, Sealers, and Undercoats: 100 g/L.

K. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

L. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**], as directed by the Owner.

M. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility.

C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.

D. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

1. Cracks Larger Than **1/32 Inch (0.8 mm)**: Cut out static cracks, voids, or honeycombing larger than **1/32 inch (0.8 mm)** and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.

1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated and surface dry at time of application.
2. Brushes: Use Tampico or masonry brushes best suited for material being applied.
3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.

B. Apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:

1. First Coat: Apply polymer-modified cementitious coating material at the rate of **2 lb/sq. yd. (1 kg/sq. m)** to achieve a total cured thickness of **25 mils (0.6 mm)**.
2. Second Coat: Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd. (0.5 kg/sq. m)** to achieve a total cured thickness of **15 mils (0.4 mm)**.
3. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

C. On previously coated surfaces, apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:

1. Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd. (0.5 kg/sq. m)** to achieve a total cured thickness of **15 mils (0.4 mm)**.
2. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

D. Brush Application: Brush out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.

E. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

3.4 FIELD QUALITY CONTROL

A. Testing of Coating Materials: the Ownerthe Owner reserves the right to invoke the following procedure at any time and as often as the Ownerthe Owner deems necessary during the period when coating operations are being conducted:

1. the Owner will engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance with product requirements specified.
3. the Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 CEMENTITIOUS COATING SCHEDULE

A. Above-Grade Concrete and Masonry:

1. Polymer-Modified Cementitious Coating:

a. Prime Coat: As recommended in writing by topcoat manufacturer.

b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Polymer-modified cementitious coating.

END OF SECTION 09 97 26 00

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Task	Specification	Specification Description
09 97 26 13	09 96 00 00	High-Performance Coatings
09 97 26 13	09 97 26 00	Cementitious Coatings
09 97 35 00	09 91 23 00	Interior Painting
09 97 63 00	01 22 00 00	No Specification Required
09 97 63 00	09 96 00 00	High-Performance Coatings
09 97 63 00	23 05 00 00a	Coatings for HVAC

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Task	Specification	Specification Description
10 01 50 11	10 51 13 00	Metal Lockers

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SECTION 10 11 00 00 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Visual display board assemblies.
2. Floor-to-ceiling visual display assemblies.
3. Rail support system for visual display board assemblies.
4. Modular support system for visual display board assemblies.
5. Sliding visual display units.
6. Visual display conference units.
7. Glass markerboards.
8. Display rails.
9. Natural-slate chalkboards.

B. Related Requirements:

1. Section 097723 "Fabric-Wrapped Panels" for tackable, fabric-covered panels mounted on walls.
2. Section 101146 "Visual Display Fabrics" for visual display wall coverings intended for use with dry-erase markers.
3. Section 101200 "Display Cases" for [**individually framed and enclosed, wall-mounted bulletin boards**][**and for**][**tackboards within display cases**].

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Visual display board assemblies.
2. Floor-to-ceiling visual display assemblies.
3. Rail support system for visual display board assemblies.
4. Modular support system for visual display board assemblies.
5. Sliding visual display units.
6. Visual display conference units.
7. Glass markerboards.
8. Display rails.
9. Natural-slate chalkboards.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
2. Include electrical characteristics for motorized units.

C. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.
2. Show locations of panel joints.[**Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.**]
3. Show locations and layout of special-purpose graphics.
4. Include sections of typical trim members.
5. Include wiring diagrams for power and control wiring.

E. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:

1. Samples of facings for each visual display panel type, indicating color and texture.
2. Fabric swatches of fabric facings for tackboards.
3. Actual factory-finish color samples, applied to [**aluminum**][**wood**] substrate.
4. Include accessory Samples to verify color selected.

F. Samples for Verification: For each type of visual display unit indicated.

1. Visual Display Panel: Not less than **8-1/2 by 11 inches (215 by 280 mm)**, with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: **6-inch- (150-mm-)** long sections of each trim profile.
3. Display Rail: **6-inch- (150-mm-)** long section of each type.
4. [**Rail**][**Modular**] Support System: **6-inch- (150-mm-)** long sections.
5. Accessories: Full-size Sample of each type of accessory.

G. Product Schedule: For visual display units.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each visual display unit, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For visual display units[**and motorized units**] to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical [**wall area**][**visual display unit**][**floor-to-ceiling visual display assembly**] as shown on Drawings. Include accessories.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Surfaces lose original writing and erasing qualities.
b. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period:

a. [**50**] years from date of Substantial Completion.
b. Life of the building.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**50**][**450**] or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 VISUAL DISPLAY BOARD ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A-1 Visual Systems**]
2. [**Aarco Products, Inc.**]
3. [**ADP Lemco**]
4. [**ASI Visual Display Products**]
5. [**Aywon**]
6. [**Bangor Cork**]
7. [**CIG JAN Products, Ltd.**]
8. [**Claridge Products and Equipment, LLC.**]
9. [**Delta Products Ltd**]
10. [**Egan Visual**]
11. [**Everase, Inc.**]
12. [**EVERWhite Whiteboards**]
13. [**ghent; a GMi Company**]
14. [**K-Pro Specialty Products**]
15. [**Magna Visual Corp.**]
16. [**Marsh Industries, Inc.**]
17. [**MooreCo Inc**]
18. [**Nudo**]
19. [**Panel Processing, Inc.**]
20. [**Peter Pepper Products, Inc**]
21. [**Platinum Visual Solutions**]
22. [**PolyVision Corporation**]

B. Visual Display Board Assembly: [Field][factory] fabricated.

1. Assembly: [**Chalkboard**][**markerboard**][**and**][**tackboard**].
2. Corners: [**Square**][**Rounded**].
3. Width: [**As indicated on Drawings**].
4. Height: [**As indicated on Drawings**].
5. Mounting Method: [**Direct to wall**][**Rail support system**][**Modular support system**].

C. Chalkboard Panel: [**Porcelain-enamel**][**High-pressure chalkboard laminate**][**Melamine**][**Painted-finish**]-faced chalkboard panel on core indicated.

1. Color: [**Green**][**Blue**][**Brown**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

D. Markerboard Panel: [**Porcelain-enamel-faced**][**High-pressure markerboard laminate-faced**][**Melamine-faced**] markerboard panel on core indicated.

1. Color: [**White**][**Beige**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

E. Tackboard Panel: [**Natural-cork**][**Plastic-impregnated-cork**][**Vinyl-fabric-faced**][**Polyester-fabric-faced**] tackboard panel on core indicated.

1. Fabric Wrapped Edge: Wrap edge of tackboard panel with fabric facing.
2. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

F. Aluminum Frames and Trim: Fabricated from not less than **0.062-inch- (1.57-mm-)** thick, extruded aluminum; [**standard size and shape**][**slim size and standard shape**][**of size and shape indicated on Drawings**].

1. Field-Applied Trim: Manufacturer's standard, [**snap-on trim with no visible screws or exposed joints**][**slip-on trim**][**screw-on trim with Phillips flat-head screws**].
2. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked-enamel or powder-coat**] finish.

a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

G. Factory-Applied Wood Trim: [**Red oak**][**Walnut**][**Manufacturer's standard species**], not less than **1/2 inch (13 mm)** thick; [**standard size and shape**][**of size and shape indicated on Drawings**] with [**opaque**][**transparent**] finish.

H. Field-Applied Wood Trim: Comply with requirements specified in [**Section 062023 "Interior Finish Carpentry."**][**Section 064023 "Interior Architectural Woodwork."**]

I. Vinyl Trim: [**Dark brown**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

J. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, [**balanced around center of board, as acceptable to Architect**][**as indicated on approved Shop Drawings**], as directed by the Owner.

K. Combination Assemblies: Provide [**manufacturer's standard exposed trim**][**H-trim**][**hidden spline**] between abutting sections of visual display panels.

L. Chalktray: Manufacturer's standard; continuous.

1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

M. Display Rail: Manufacturer's standard, extruded-aluminum display rail with [**plastic-impregnated-cork**] insert, end stops, [**and continuous paper holder,**]designed to hold accessories.

1. Size: [**1 inch (25 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**] high by [**full length of visual display unit**][**length indicated on Drawings**].
2. Map Hooks: [**Two**] map hooks for every [**48 inches (1200 mm)**] of display rail or fraction thereof.
3. Map Hooks and Clips: [**Two**] map hooks with flexible metal clips for every [**48 inches (1200 mm)**] of display rail or fraction thereof.
4. Flag Holder: [**One**] for each room.
5. Tackboard Insert Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
6. Aluminum Color: Match finish of visual display assembly trim.

N. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.

O. Special-Purpose Graphics: Fuse or paint [semivisible writing guidelines][penmanship lines][music staff lines][grid, 1 inch (25 mm) square][rectangular graph coordinates][polar graph coordinates][horizontal lines, 2 inches (50 mm) o.c.][USA map][world map][soccer field][football field][basketball court] graphic onto surface of visual display unit[in locations indicated].

2.3 FLOOR-TO-CEILING VISUAL DISPLAY ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Claridge Products and Equipment, LLC.**]
2. [**Egan Visual**]
3. [**EVERWhite Whiteboards**]
4. [**K-Pro Specialty Products**]
5. [**Platinum Visual Solutions**]

B. Floor-to-Ceiling Markerboard Panel Assemblies: Consisting of markerboard panels with [**porcelain-enamel**][**high-pressure markerboard laminate**] facing on core indicated; fabricated for floor-to-ceiling assemblies.

1. Color: [**White**][**Beige**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

C. Floor-to-Ceiling Tackboard Panel Assemblies: Consisting of tackboard panels with [**natural-cork**][**plastic-impregnated-cork**][**vinyl-fabric**][**polyester-fabric**] facing on core indicated; fabricated for floor-to-ceiling assemblies.

1. Edge Treatments:

a. Panel-Joint Edges: [**Wrapped with fabric**][**Concealed by fabric-covered trim**].
b. Top-of-Wall Edges: [**Wrapped with fabric**][**Concealed by fabric-covered trim**].
c. Bottom-of-Wall Edges: [**Wrapped with fabric**][**Concealed by fabric-covered trim**].
d. Corners: [**Wrapped with fabric**][**Concealed by fabric-covered trim**].

2. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

D. Width: [**Full width of wall**][**As indicated on Drawings**].

E. Height: [**Full height of wall**][**Full height of wall above base**][**As indicated on Drawings**].

F. Joint Accessories: Manufacturer's standard, [**exposed color-matched trim**][**fabric-covered trim**][**concealed aluminum or steel spline**] at butt joints.

2.4 RAIL SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Egan Visual**]
2. [**Peter Pepper Products, Inc**]

B. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards[and capable of gripping and suspending paper directly from rail].

1. Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].
2. Color and Gloss: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display board assemblies by engaging support rail and top trim of board.

D. Visual Display Board Assemblies: Fabricated from not less than **3/8-inch- (9.5-mm-)** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.

2.5 MODULAR SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ADP Lemco**]
2. [**Claridge Products and Equipment, LLC.**]
3. [**MooreCo Inc**]
4. [**Platinum Visual Solutions**]

B. Standards: **72-inch- (1830-mm-)** long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Space slots at not less than [**4 inches (100 mm)**] o.c.

1. Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].
2. Color and Gloss: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Panel Clips: Extruded aluminum or steel with finish to match standards.

2.6 SLIDING VISUAL DISPLAY UNITS

A. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, aluminum-framed horizontal-sliding visual display panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aarco Products, Inc.**]
   b. [**ADP Lemco**]
   c. [**ASI Visual Display Products**]
   d. [**Aywon**]
   e. [**Claridge Products and Equipment, LLC.**]
   f. [**ghent; a GMi Company**]
   g. [**K-Pro Specialty Products**]
   h. [**MooreCo Inc**]
   i. [**Platinum Visual Solutions**]

2. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
3. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than [**one-third**][**one-half**] of overall length of unit.
4. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.

   a. Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display panel on both faces of each door.

5. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
6. Overall Width: [**As indicated on Drawings**].
7. Overall Height: [**As indicated on Drawings**].

B. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, and aluminum-framed vertical-sliding panels; [**motor operated;**]designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aarco Products, Inc.**]
   b. [**ADP Lemco**]
   c. [**ASI Visual Display Products**]
   d. [**Aywon**]
   e. [**Claridge Products and Equipment, LLC.**]
   f. [**K-Pro Specialty Products**]

g. [**MooreCo Inc**]
h. [**Platinum Visual Solutions**]

2. Type: Tubular frame on [**four sides**][**top and two sides, with sides extending to floor; with kick panel to conceal sliding panels**]. Design unit to support panels independently of wall.
3. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
4. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
5. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.
6. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.
7. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.

   a. Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, [**110**][**220**] V, 60 Hz.
   b. Control Station: Three-position, [**maintained**][**momentary**] contact, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide [**one**] control station(s) for each sliding panel unit.
   c. Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.

8. Overall Width: [**As indicated on Drawings**].
9. Overall Height: [**As indicated on Drawings**].

C. Panels and Accessories:

1. Sliding Chalkboard Panel: [**Porcelain-enamel**][**High-pressure chalkboard laminate**]-faced chalkboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than [**3/8 inch (9.5 mm)**] thick.

   a. Color: [**Green**][**Blue**][**Brown**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2. Sliding Markerboard Panel: [**Porcelain-enamel**][**High-pressure markerboard laminate**]-faced markerboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than [**3/8 inch (9.5 mm)**] thick.

   a. Color: [**White**][**Beige**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

3. Sliding Tackboard Panel: [**Natural-cork**][**Plastic-impregnated-cork**][**Vinyl-fabric-faced**][**Polyester-fabric-faced**] tackboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than [**3/8 inch (9.5 mm)**] thick.

   a. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by

the Owner.

4. Fixed Rear Chalkboard Panel: [**Porcelain-enamel**][**High-pressure chalkboard laminate**]-faced chalkboard panel on core indicated.

   a. Color: [**Green**][**Blue**][**Brown**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

5. Fixed Rear Markerboard Panel: [**Porcelain-enamel**][**High-pressure markerboard laminate**]-faced markerboard panel on core indicated.

   a. Color: [**White**][**Beige**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

6. Fixed Rear Tackboard Panel: [**Natural-cork**][**Plastic-impregnated-cork**][**Vinyl-fabric-faced**][**Polyester-fabric-faced**] tackboard panel on core indicated.

   a. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

7. Kick Panel: Manufacturer's standard [**fabric-covered cork**][**low-pressure laminate**].

   a. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

8. Accessories: [**Chalktray**][**locks**][**and**][**easel pad clamps**].
9. Display Rail: Manufacturer's standard, extruded-aluminum display rail with [**plastic-impregnated-cork**] insert, end stops, [**and continuous paper holder,**]designed to hold accessories.

   a. Size: [**1 inch (25 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**] high by full length of visual display unit.
   b. Map Hooks: [**Two**] map hooks for every [**48 inches (1200 mm)**] of display rail or fraction thereof.
   c. Flag Holder: [**One**] for each sliding visual display unit.
   d. Tackboard Insert Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

10. Aluminum Trim: [**Factory applied**][**Field applied**]; in [**manufacturer's standard**] size and profile; with [**clear anodic**] finish.

2.7 VISUAL DISPLAY CONFERENCE UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**A-1 Visual Systems**]
   2. [**Aarco Products, Inc.**]
   3. [**ASI Visual Display Products**]

4. [**CIG JAN Products, Ltd.**]
5. [**Claridge Products and Equipment, LLC.**]
6. [**Egan Visual**]
7. [**ghent; a GMi Company**]
8. [**K-Pro Specialty Products**]
9. [**MooreCo Inc**]
10. [**Peter Pepper Products, Inc**]
11. [**Platinum Visual Solutions**]

B. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than **3-inch (75-mm)** interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display units.

1. Wood Cabinets: Fabricated from solid wood with integral, solid-wood marker tray. Fabricate hinged door panels with solid-wood frame and wood-veneer exterior surface.

   a. Species and Finish: [**Red oak**][**Walnut**][**Mahogany**] with [**natural lacquered**][**oiled**][**stained**] finish.

2. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard wood panels finished with high-pressure decorative laminate; with integral marker tray.

   a. Color: [**Match Architect's sample**][**As indicated by referencing manufacturer's designations**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

3. Cabinet Corners: [**Square**][**Rounded**].
4. Hardware: Manufacturer's standard, full-height continuous hinges[wire door pulls,] and door bumpers.
5. Fixed Rear Panel: Manufacturer's standard [**porcelain-enamel**][**high-pressure markerboard laminate**][**glass**] markerboard panel.

   a. Color: [**White**][**Beige**][**Tan**][**Match Architect's sample**][**As indicated by referencing manufacturer's designations**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

6. Inside Surface of Doors:

   a. Same as fixed rear panel.
   b. Tackboard panel consisting of [**natural-cork**][**plastic-impregnated-cork**][**vinyl-fabric**][**polyester-fabric**] facing on manufacturer's standard core.
   c. Color: [**Match Architect's sample**][**As indicated by referencing manufacturer's designations**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

7. Projection Screen: Manufacturer's standard, pull-down, matte, white projection screen, not less than **8 inches (200 mm)** smaller in each direction than overall cabinet size, and mounted above rear visual display panel.
8. Fluorescent Light: Manufacturer's standard, not less than **24 inches (610 mm)** long, and mounted above rear visual display panel.
9. Width: [**48 inches (1219 mm)**][**As indicated on Drawings**].
10. Height: [**36 inches (914 mm)**][**48 inches (1219 mm)**][**72 inches (1829 mm)**][**As indicated on Drawings**].
11. Accessories: [**Cylinder lock**][**and**][**flip-chart pad clamp**].

2.8 GLASS MARKERBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A-1 Visual Systems**]
2. [**Aarco Products, Inc.**]
3. [**ADP Lemco**]
4. [**ASI Visual Display Products**]
5. [**CAP Architectural**]
6. [**Claridge Products and Equipment, LLC.**]
7. [**Clarus Glassboards, LLC.**]
8. [**Dillmeier Glass**]
9. [**Dreamwalls by Gardner Glass Products**]
10. [**Egan Visual**]
11. [**ghent; a GMi Company**]
12. [**Krystal Glass Writing Boards, Inc.**]
13. [**Magna Visual Corp.**]
14. [**Marsh Industries, Inc.**]
15. [**MooreCo Inc**]
16. [**Peter Pepper Products, Inc**]
17. [**Platinum Visual Solutions**]

B. Glass Markerboards: Fabricated of [6-mm tempered][6-mm tempered-laminated][low-iron][ultra-thin] glass[with steel backing for use with magnets].

1. Edge Treatment: Smooth polished edge with [**rounded**][**eased**] corners.
2. Frame: Aluminum trim in profile indicated.
3. Surface: [**Glossy**][**Matte**].
4. Color: [**White**][**Gray**][**Translucent**][**Clear**][**Black**][**Red**][**Blue**].

C. Mounting:

1. Round, stainless steel standoffs, holding glass approximately [**1 inch (25 mm)**] from wall surface; mounted [**through holes in**][**in notches in standoffs at top and bottom edges of**] markerboard.
2. Concealed, Z-shaped brackets.
3. Manufacturer's standard adhesive or adhesive-foam tape mounting.

D. Graphics: Provide screen-printed graphics as indicated.

E. Marker Tray: [**Glass**][**Aluminum**], attached with [**stainless steel clips**][**magnet**].

F. Size: [**18 by 24 inches (457 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**36 by 48 inches (914 by 1219 mm)**][**48 by 96 inches (1219 by 2438 mm)**].

2.9 DISPLAY RAILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aarco Products, Inc.**]

2. [**ADP Lemco**]
3. [**Aristocrat Industries, Inc.**]
4. [**Bangor Cork**]
5. [**Claridge Products and Equipment, LLC.**]
6. [**EVERWhite Whiteboards**]
7. [**ghent; a GMi Company**]
8. [**K-Pro Specialty Products**]
9. [**MooreCo Inc**]

B. Aluminum Display Rail: Manufacturer's standard, extruded-aluminum display rail with [**plastic-impregnated-cork**] tackable insert, [**and continuous paper holder,**]designed to hold accessories.

C. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.

1. Aluminum Finish: [**Clear anodic**] finish.

D. Wood Display Rail: Manufacturer's standard wood display rail with [**plastic-impregnated-cork**] insert.

1. Finish: [**Natural oak**].

E. Tackable Insert Color: [**Tan**][**Gray**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

F. Size: [**1 inch (25 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**] high by length indicated on Drawings.

G. End Stops: [**Aluminum**][**Not required**].

H. Accessories:

1. [**Metal**][**Plastic**] Map Hooks: Include [**two**] map hooks per [**room**][**20 feet (6 m)**][**of installed display rail**].
2. Roller Brackets: Include [**two**] roller brackets per [**room**][**20 feet (6 m)**][**of installed display rail**].
3. Flag Holders: Include [**one**] flag holder per [**room**][**20 feet (6 m)**][**of installed display rail**].

2.10 NATURAL-SLATE CHALKBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Natural Slate: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.

1. Thickness: Not less than **1/4 inch (6 mm)** or more than **3/8 inch (9.5 mm)** thick with maximum deviation of **1/16 inch (1.6 mm)** when an average thickness of at least **1/4 inch (6 mm)** is maintained.

C. Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.

1. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.
2. Provide writing surface free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and free of surface-applied stain, dye, or other

artificial coloring.

3. Length: Furnish panels approximately equal in length with permissible variation not more than **3 inches (75 mm)** in either direction of equal spacing. Allow **1/4-inch (6-mm)** clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:

   a. Up to **5 feet (1.5 m)**; one panel.
   b. More than **5 feet (1.5 m)** but less than **9 feet (2.7 m)**; two panels.
   c. More than **9 feet (2.7 m)** but less than **13.5 feet (4.1 m)**; three panels.
   d. More than **13.5 feet (4.1 m)** but less than **18 feet (5.5 m)**; four panels.
   e. More than **18 feet (5.5 m)** but less than **22.5 feet (6.9 m)**; five panels.
   f. More than **22.5 feet (6.9 m)** but less than **27 feet (8.2 m)**; six panels.

D. Aluminum: Fabricated from not less than **0.062-inch- (1.57-mm-)** thick, extruded aluminum; [**of size and shape indicated on Drawings**]; [**snap-on type with no visible screws or exposed joints**][**screw-on type with Phillips flat-head screws**].

E. Wood Trim: Comply with requirements specified in [**Section 062023 "Interior Finish Carpentry."**][**Section 064023 "Interior Architectural Woodwork."**]

2.11 CHALKBOARD PANELS

A. Porcelain-Enamel Chalkboard Panels: High-pressure factory-laminated chalkboard panels of balanced three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with matte finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.

   1. Face Sheet Thickness: [**0.021 inch (0.53 mm)**][**0.013 inch (0.33 mm)**] uncoated base metal thickness.
   2. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
   3. Hardboard Core: **1/4 inch (6 mm)** thick; with [**0.005-inch- (0.127-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.0129-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
   4. Particleboard Core: **3/8 inch (9.5 mm)** thick; with [**0.005-inch- (0.127-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.0129-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
   5. Fiberboard Core: [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] thick; with [**0.001-inch- (0.025-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.0129-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
   6. MDF Core: **7/16 inch (11 mm)** thick; with manufacturer's standard moisture-barrier backing.
   7. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

B. High-Pressure Chalkboard Laminate Panels: Factory-laminated chalkboard panels of balanced three-ply construction, consisting of backing, fiberboard core material, and high-pressure chalkboard laminate writing surface.

C. Melamine Chalkboard Panels: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard core permanently bonded with thermally fused, melamine-impregnated decorative paper writing surface complying.

D. Painted-Finish Chalkboard Panels: Fabricated from[**two plies of**] **1/4-inch- (6-mm-)** thick, treated, tempered hardboard core permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.

2.12 MARKERBOARD PANELS

A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with [**high**][**low**]-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.

1. Face Sheet Thickness: [**0.021 inch (0.53 mm)**][**0.013 inch (0.33 mm)**] uncoated base metal thickness.
2. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
3. Hardboard Core: **1/4 inch (6 mm)** thick; with [**0.005-inch- (0.127-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.013-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
4. Particleboard Core: [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] thick; with [**0.005-inch- (0.127-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.013-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
5. Fiberboard Core: [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] thick; with [**0.001-inch- (0.025-mm-) thick, aluminum foil**][**0.015-inch- (0.38-mm-) thick, aluminum sheet**][**0.013-inch- (0.33-mm-) thick, galvanized-steel sheet**] backing.
6. MDF Core: **7/16 inch (11 mm)** thick; with manufacturer's standard moisture-barrier backing.
7. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

B. High-Pressure Markerboard Laminate Panels: Factory-laminated markerboard panel of three-ply construction, consisting of backing, fiberboard core material, and high-pressure markerboard laminate writing surface.

C. Melamine Markerboard Panels: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard panels permanently bonded with thermally fused, melamine-impregnated decorative paper writing surface.

2.13 TACKBOARD PANELS

A. Tackboard Panels:

1. Facing:

a. [**1/16-inch- (1.6-mm-) thick,**][**1/8-inch- (3-mm-) thick,**][**1/4-inch- (6-mm-) thick,**][**natural cork**][**plastic-impregnated cork**].
b. [**Vinyl**][**Polyester**] fabric.
c. [**Vinyl**][**Polyester**] fabric factory laminated to [**1/16-inch- (1.6-mm-)**][**1/8-inch- (3-mm-)**][**1/4-inch- (6-mm-)**] thick, cork sheet.
d. Recycled rubber, **0.44 inch (11 mm)** thick; with [**tan**][**red**][**green**][**grey**][**blue**] color flecks.

2. Core:

a. Manufacturer's standard.
b. [**3/8-inch- (9.5-mm-)**][**7/16-inch- (11-mm-)**] thick fiberboard.
c. **1/4-inch- (6-mm-) thick [hardboard][particleboard].**

2.14 MATERIALS

A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.

B. High-Pressure Decorative Laminate: ISO 4586-3.

C. High-Pressure Markerboard Laminate: Complying with physical testing requirements of ISO 4586-3.

D. High-Pressure Chalkboard Laminate: Complying with physical testing requirements of ISO 4586-3.

E. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish[with surface-burning characteristics indicated].

F. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout[with surface-burning characteristics indicated].

G. Vinyl Fabric: Mildew resistant, washable, complying with ASTM F793/F793M, Type II, [**burlap weave**]; weighing not less than **13 oz./sq. yd. (440 g/sq. m)**; with surface-burning characteristics indicated.

H. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than **15 oz./sq. yd. (508 g/sq. m)**; with surface-burning characteristics indicated.

I. Composite Wood Products: Products shall be made without urea formaldehyde.

J. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

L. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

M. Composite Wood Products: Products shall be made without urea formaldehyde.

N. Hardboard: ANSI A135.4, tempered.

O. Particleboard: ANSI A208.1, Grade M-1.

P. MDF: ANSI A208.2, Grade 130.

Q. Fiberboard: ASTM C208 cellulosic fiber insulating board.

R. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.

S. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063.

T. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of

panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

1. Adhesives shall have a VOC content of [**50**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

U. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in [**Section 099123 "Interior Painting"**] and recommended in writing by visual display unit manufacturer for intended substrate.

2.15 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.16 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.

C. Examine walls and partitions for proper preparation and backing for visual display units.

D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

D. Prime wall surfaces indicated to receive [**visual display units**][**direct-applied, floor-to-ceiling visual display assemblies**] and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, [**balanced around center of board, as acceptable to Architect**][**as indicated on approved Shop Drawings**], as directed by the Owner.
2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated, as

directed by the Owner.

C. Factory-Fabricated Visual Display Board Assemblies:

1. Adhere to wall surfaces with [**egg-size**] adhesive gobs at **16 inches (400 mm)** o.c., horizontally and vertically.
2. Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than **16 inches (400 mm)** o.c. Secure tops and bottoms of boards to walls.

D. Natural-Slate Chalkboards: Align and level joints between adjoining panels, and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.

E. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.

1. Mounting Height [**for Grades K through 3**]: [**24 inches (610 mm)**] above finished floor to top of chalktray.
2. Mounting Height [**for Grades 4 through 6**]: [**28 inches (711 mm)**] above finished floor to top of chalktray.
3. Mounting Height [**for Grades 7 and Higher**]: [**36 inches (914 mm)**] above finished floor to top of chalktray.

F. Display Rails: Install rails at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than **16 inches (400 mm)** o.c.

1. Mounting Height: [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] above finished floor to top of rail.

G. Floor-to-Ceiling Markerboard Panels: Attach panels to wall surface with [**egg-size**] adhesive gobs at **16 inches (400 mm)** o.c., horizontally and vertically.

1. Join adjacent panels with concealed steel splines for smooth alignment.
2. Join adjacent panels with exposed, H-shaped aluminum trim painted to match wall panel.

H. Floor-to-Ceiling Tackboard Panels: Attach panels to wall surface with [**egg-size**] adhesive gobs at **16 inches (400 mm)** o.c., horizontally and vertically.

1. Install wrapped-edge panels with butt joints between adjacent wall panels.
2. Join adjacent panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.

I. Rail Support System: Install horizontal support rail at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall with fasteners at **12 inches (300 mm)** o.c.

1. Mounting Height: [**72 inches (1829 mm)**] above finished floor to top of rail.
2. Hang visual display units on rail support system.

J. Modular Support System: Install adjustable standards at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at **48 inches (1200 mm)** o.c., vertically aligned and plumb, and attached to wall with fasteners at **12 inches (300 mm)** o.c.

1. Mounting Height: [**12 inches (305 mm)**] above finished floor to bottom of standard.
2. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
3. Provide locking screw at top corner of visual display board at each standard.

4. Hang visual display units on modular support system.

K. Sliding Visual Display Units: Install units at mounting heights indicated. Attach to wall framing with fasteners at not more than **16 inches (400 mm)** o.c.

1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

L. Visual Display Conference Units: Install units at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with [**fasteners through back of cabinet**][**concealed brackets screwed to wall**][**concealed wood cleats screwed to wall**].

1. Mounting Height: [**72 inches (1829 mm)**] above finished floor to top of cabinet.

3.4 CLEANING AND PROTECTION

A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display units after installation and cleaning.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain motorized, sliding visual display units.

END OF SECTION 10 11 00 00

Task	Specification	Specification Description
10 11 13 00	10 11 00 00	Visual Display Units
10 11 13 13	10 11 00 00	Visual Display Units
10 11 13 33	10 11 00 00	Visual Display Units
10 11 16 00	10 11 00 00	Visual Display Units
10 11 16 13	10 11 00 00	Visual Display Units
10 11 16 33	10 11 00 00	Visual Display Units
10 11 23 00	10 11 00 00	Visual Display Units
10 11 23 13	10 11 00 00	Visual Display Units

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SECTION 10 12 00 00 - DISPLAY CASES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bulletin boards.
2. Display cases.

B. Related Requirements:

1. [**Section 062023 "Interior Finish Carpentry"**][**Section 064100 "Architectural Wood Casework"**][**Section 064101 "Architectural Wood Casework (NAAWS Standard)"**] for custom wood [**bulletin boards**][**and**][**display cases**].
2. Section 097723 "Fabric-Wrapped Panels" for tackable, fabric-covered wall panels.
3. Section 101100 "Visual Display Units" for tackboards.
4. Section 101300 "Directories" for boards with changeable messages or changeable letters and for bulletin boards within built-in directories.

1.2 DEFINITIONS

A. Bulletin Board: Glazed cabinet with tackboard panel, without shelves, typically of shallow depth for display of paper documents.

B. Display Case: Glazed cabinet with[**tackboard panel back surface and**] adjustable shelves.

C. Tackboard Panel: A material for holding push-pins or tacks, typically consisting of a facing such as fabric, vinyl, or cork; adhered to a substrate such as fiberboard, hardboard, or particleboard.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for [**display cases**][**and**][**bulletin boards**]. Include furnished specialties and accessories.
2. Include electrical characteristics for illuminated [**display cases**][**and**][**bulletin boards**].

B. Shop Drawings: For [**display cases**][**and**][**bulletin boards**].

1. Include plans, elevations, sections, and attachment details.
2. Show location of seams and joints in tackboard panels.
3. Include sections of typical trim members.

4. Include diagrams for wiring of illuminated [**display cases**][**and**][**bulletin boards**].

C. Samples: For each exposed product and for each color and texture specified; not less than **8-1/2 by 11 inches (215 by 280 mm)** for tackboard panels and **6 inches (150 mm)** long for trim with factory finish.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of tackboard panels[header panel] and factory-finished trim involving color finish selection.

E. Samples for Verification: For each type of exposed finish for the following:

1. Tackboard Panel: Not less than **8-1/2 by 11 inches (215 by 280 mm)**, with facing and substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: **6-inch- (150-mm-)** long sections of each trim profile[**including corner section**].

F. Sustainable Design Submittals:

1. Laboratory Test Reports: For adhesives, indicating compliance with VOC requirements in the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For [**fabrics**][**tackboard panels**], for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**display cases**][**and**][**bulletin boards**] to include in maintenance manuals.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install [**display cases**][**and**][**bulletin boards**] for indoor installations until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**display cases**][**and**][**bulletin boards**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**50**][**450**] or less.

B. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 BULLETIN BOARDS

A. Bulletin Boards:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A-1 Visual Systems**]
b. [**Aarco Products, Inc.**]
c. [**ADP Lemco**]
d. [**ASI Visual Display Products**]
e. [**Aywon**]
f. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
g. [**CIG JAN Products, Ltd.**]
h. [**Claridge Products and Equipment, LLC.**]
i. [**ghent; a GMi Company**]
j. [**Marsh Industries, Inc.**]
k. [**MooreCo Inc**]
l. [**Nelson-Harkins Industries**]
m. [**Peter Pepper Products, Inc**]
n. [**Platinum Visual Solutions**]
o. [**Poblocki Sign Company, LLC**]
p. [**Pyramid Presentation Products**]
q. [**Signature, Inc.**]
r. [**Swingframe Mfg.; a division of Access Display Group, Inc.**]
s. [**Tablet & Ticket Co. (The)**]
t. [**Visiontron Corp.**]
u. [**Vomar Products, Inc**]
v. [**Waddell; a GMi Company**]

2. General: Factory-fabricated unit consisting of manufacturer's standard wall-mounted cabinet with tackboard panel on back inside surface and operable glazed doors at front.

a. Frame and Cabinet Profile: [**Square**][**Rounded**] frame section with [**square**][**rounded**] cabinet corners.
b. Mounting: [**Surface mounted**][**Recessed**].
c. Size:

1) As indicated on Drawings.
2) [**48 inches (1200 mm)**] wide by [**36 inches (910 mm)**] high by [**4 inches (100 mm)**] deep.

3. Aluminum-Framed Cabinet: Extruded aluminum; with [**clear anodic**][**color anodic**][**manufacturer's standard baked-enamel or powder-coat**] finish.

    a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Wood-Framed Cabinet: [**Red oak**][**Maple**][**Walnut**][**Manufacturer's standard species**] with [**natural lacquered**][**oiled**][**stained**] finish.
5. Exterior Bulletin Boards: Aluminum-framed units of weather-resistant construction; with vents to dissipate trapped moisture, weather-resistant tackboard panel, and weather-stripped hinged doors.
6. Glazed Sliding Doors: [**Tempered glass**][**Clear acrylic sheet**]; unframed; with extruded-aluminum top and bottom track; supported on nylon or ball-bearing rollers; with plastic top guide and rubber bumpers. Equip each door with ground finger pull and adjustable cylinder lock with two keys.

    a. Thickness: Not less than [**5 mm**][**6 mm**] thick.
    b. Number of Doors: [**One**][**Two**][**Three**][**As indicated on Drawings**].

7. Glazed Hinged Doors: [**Tempered glass**][**Clear acrylic sheet**]; set in frame matching cabinet material and finish. Equip each door with full-height continuous hinge and cylinder lock with two keys.

    a. Thickness: Not less than [**5 mm**][**6 mm**] thick.
    b. Number of Doors: [**One**][**Two**][**Three**][**As indicated on Drawings**].

8. Header Panel: [**Nonilluminated; with opaque**][**Illuminated; with translucent**] acrylic sheet panel set within overall cabinet frame; with matching frame that separates header panel from bulletin board.

    a. Graphic Content and Style: Provide header panel copy that complies with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors of graphics, as directed by the Owner.
    b. Color: [**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

9. Illumination System: Concealed top-lighting system consisting of fluorescent-strip fixtures. Include lamps and internal wiring with single, concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.

    a. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.[**Provide exterior ballasts for exterior bulletin boards.**]

        1) Electrical Characteristics: Single-phase, [**120**][**277**] V.

10. Back Panel: Manufacturer's standard [natural-cork][plastic-impregnated-cork][vinyl-fabric-faced][polyester-fabric-faced] tackboard panel.

2.4 DISPLAY CASES

A. Display Cases:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A-1 Visual Systems**]
   b. [**Aarco Products, Inc.**]
   c. [**ADP Lemco**]
   d. [**ASI Visual Display Products**]
   e. [**Aywon**]
   f. [**CIG JAN Products, Ltd.**]
   g. [**Claridge Products and Equipment, LLC.**]
   h. [**ghent; a GMi Company**]
   i. [**Peter Pepper Products, Inc**]
   j. [**Platinum Visual Solutions**]
   k. [**Poblocki Sign Company, LLC**]
   l. [**Pyramid Presentation Products**]
   m. [**Tablet & Ticket Co. (The)**]
   n. [**Waddell; a GMi Company**]

2. Recessed Display Case: Factory-fabricated display case; with finished interior, operable glazed doors at front, and trim on face to cover edge of recessed opening.

   a. Display Case Cabinet: [**Extruded aluminum**][**Hardwood veneer plywood**].

      1) Veneer Species: [**Birch**][**Maple**][**Red oak**][**Walnut**][**Manufacturer's standard species**] with [**natural lacquered**][**oiled**][**stained**] finish.

   b. Face Frame:

      1) Aluminum.
      2) [**Wood, species to match interior of cabinet box**][**Birch**][**Maple**][**Red oak**][**Walnut**][**Manufacturer's standard hardwood species**] with [**natural lacquered**][**oiled**][**stained**] finish.

   c. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].

      1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Surface-Mounted Display Case: Factory-fabricated display case; with finished interior, and glazed doors at front.

   a. Hardwood-veneer-plywood bottom panel; glazed side panels; [**hardwood-veneer-plywood**][**glazed**] top panel; [**aluminum**][**hardwood**] face frame.

      1) Wood and Veneer Species: [**Birch**][**Maple**][**Red oak**][**Walnut**][**Manufacturer's standard species**] with [**natural lacquered**][**oiled**][**stained**] finish.

   b. Extruded-aluminum top, bottom, and side panels.
   c. Aluminum frame with glazed top[bottom,] and side panels.
   d. Hardwood frame:

      1) Wood Species: [Birch][Maple][Red Oak][Walnut][Manufacturer's standard hardwood

species] with [natural lacquered][oiled][stained] finish; glazed top[bottom,] and side panels.

e. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].

1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

f. Display Case Base: [**No base, for wall mounting**][**Legs, to match construction of frame**][**Full-height display case, with minimal base**][**Manufacturer's standard hardwood-plywood-veneer base, in species to match display case interior**].

4. Glazed Sliding Doors: Tempered glass; unframed; with extruded-aluminum top and bottom track; supported on nylon or ball-bearing rollers; with plastic top guide and rubber bumpers. Equip each door with ground finger pull and adjustable cylinder lock with two keys.

a. Thickness: Not less than [**5 mm**][**6 mm**] thick.
b. Number of Doors: [**Two**][**Three**][**As indicated on Drawings**].

5. Glazed Hinged Doors: Tempered glass; set in frame matching cabinet material and finish. Equip each door with full-height continuous hinge and cylinder lock with two keys.

a. Thickness: Not less than [**5 mm**][**6 mm**] thick.
b. Number of Doors: [**One**][**Two**][**Three**][**As indicated on Drawings**].

6. Shelves: 6-mm-thick tempered glass; supported on adjustable shelf standards and supports.

a. Shelf Depth: [**6 inches (150 mm)**][**8 inches (200 mm)**][**10 inches (250 mm)**][**12 inches (300 mm)**].
b. Number of Shelves: [**Three**][**As indicated on Drawings**].

7. Adjustable Shelf Standards and Supports: [**BHMA A156.9, B04102; with shelf brackets, B04112; recess mounted in rear surface**][**BHMA A156.9, B04071; with shelf rests, B04081; mounted on sides**]. Provide standards extending full height of display case.
8. Illumination System: Concealed top-lighting system consisting of fluorescent-strip fixtures. Include lamps and internal wiring with single concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.

a. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.

1) Electrical Characteristics: Single phase, [**120**][**277**] V.

9. Size: [**As indicated on Drawings**][**48 inches (1200 mm)**] wide, by [**60 inches (1500 mm)**] high, by [**8 inches (200 mm)**][**16 inches (400 mm)**][**24 inches (600 mm)**] deep.

2.5 TACKBOARD PANELS

A. Natural-Cork Tackboard Panel :

1. **1/16-inch- (1.6-mm-)** thick, natural-cork sheet factory laminated to [**3/8-inch- (9.5-mm-)**][**7/16-**

inch- (11-mm-)] thick, fiberboard backing.
2. 1/8-inch- (3-mm-) thick, natural-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
3. 1/4-inch- (6-mm-) thick, natural-cork sheet factory laminated to 1/4-inch- (6-mm-) thick, [**hardboard**][**particleboard**] backing.

B. Plastic-Impregnated-Cork Tackboard Panel :

1. 1/8-inch- (3-mm-) thick, plastic-impregnated-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
2. 1/4-inch- (6-mm-) thick, plastic-impregnated-cork sheet factory laminated to 1/4-inch- (6-mm-) thick, [**hardboard**][**particleboard**] backing.

C. Vinyl-Fabric-Faced Tackboard Panel :

1. Vinyl fabric factory laminated to [3/8-inch- (9.5-mm-)][7/16-inch- (11-mm-)][1/2-inch- (13-mm-)] thick, fiberboard backing.
2. 1/16-inch- (1.6-mm-) thick, vinyl-fabric-faced-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
3. 1/8-inch- (3-mm-) thick, vinyl-fabric-faced-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
4. 1/4-inch- (6-mm-) thick, vinyl-fabric-faced-cork sheet factory laminated to 1/4-inch- (6-mm-) thick, [**hardboard**][**particleboard**] backing.

D. Polyester-Fabric-Faced Tackboard Panel :

1. Polyester fabric factory laminated to [3/8-inch- (9.5-mm-)][1/2-inch- (13-mm-)] thick, fiberboard backing.
2. 1/16-inch- (1.6-mm-) thick, polyester-fabric-faced-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
3. 1/8-inch- (3-mm-) thick, polyester-fabric-faced-cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick, fiberboard backing.
4. 1/4-inch- (6-mm-) thick, polyester-fabric-faced-cork sheet factory laminated to 1/4-inch- (6-mm-) thick, [**hardboard**][**particleboard**] backing.

2.6 MATERIALS

A. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

B. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

C. Hardboard: ANSI A135.4, tempered.

D. Fiberboard: ASTM C208.

E. Particleboard: ANSI A208.1, Grade M-1.

F. Hardwood Plywood: HPVA HP-1.

G. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.

H. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto burlap backing; with washable vinyl finish and integral color throughout.

I. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than **15 oz./sq. yd. (508 g/sq. m)**; with flame-spread index of 25 or less when tested in accordance with ASTM E84.

J. Vinyl Fabric: ASTM F793/F793M, Type II, [**burlap weave**]; weighing not less than **13 oz./sq. yd. (440 g/sq. m)**; with flame-spread index of 25 or less when tested in accordance with ASTM E84.

K. Extruded-Aluminum Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063.

L. Aluminum Tubing: ASTM B429/B429M, Alloy 6063.

M. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.

N. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished), colorless sheet with visible light transmittance of 92 percent measured in accordance with ASTM D1003.

O. Opaque Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet).

P. Translucent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished). Provide white-colored sheet unless otherwise indicated, of density required to produce uniform brightness and minimum halation effects.

Q. High-Pressure Plastic Laminate: ISO 4586-3.

R. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless steel, or aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

S. Adhesives: Use adhesives that comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

T. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.7 FABRICATION

A. Fabricate [**bulletin boards**][**and**][**display cases**] to requirements indicated for dimensions, design, and thickness and finish of materials.

B. Use metals and shapes of thickness and reinforcing required to produce flat surfaces, and to impart strength for size, design, and application indicated.

C. Fabricate cabinets and door frames with reinforced corners, mitered to a hairline fit, with no exposed fasteners.

D. Fabricate shelf standards plumb and at heights to align shelf brackets for level shelves.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of illuminated units.

C. Examine walls and partitions for proper backing for [**bulletin boards**][**and**][**display cases**].

D. Examine walls and partitions for suitable framing depth if recessed units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for display cases as required by type and size of unit.

3.3 INSTALLATION

A. General: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at

heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

1. Mounting Height: [**72 inches (1830 mm)**] above finished floor to top of cabinet.

B. Bulletin Boards: Attach units to wall surfaces with concealed clips, hangers, or grounds.

C. Recessed Display Cases: Attach units to wall framing with fasteners at not more than **16 inches (400 mm)** o.c. Attach aluminum trim over edges of recessed display cases and conceal grounds and clips. Attach trim with fasteners at not more than **24 inches (600 mm)** o.c.

D. Surface-Mounted Display Cases: Attach units to wall surfaces with concealed clips, hangers, or grounds fastened at not more than **16 inches (400 mm)** o.c. Secure tops and bottoms of display cases to walls.

E. Floor-Mounted Display Cases: Attach display cases with [**bases**][**legs**] to floor with concealed anchors.

F. Comply with requirements specified elsewhere for connecting illuminated [**bulletin boards**][**and**][**display cases**].

G. Install display case shelving level and straight.

3.4 ADJUSTING AND CLEANING

A. Adjust doors to operate smoothly without warp or bind and so contact points meet accurately. Lubricate operating hardware as recommended in writing by manufacturer.

B. Touch up factory-applied finishes to restore damaged areas.

END OF SECTION 10 12 00 00

Task	Specification	Specification Description
10 12 00 00	01 22 00 00	No Specification Required

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SECTION 10 13 00 00 - DIRECTORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonilluminated and front-illuminated message-strip directories.
2. Rear-illuminated message-strip directories.
3. Changeable-letter directories.

B. Related Requirements:

1. Section 101423 "Panel Signage" for panel-sign-type directories.
2. Section 101429 "Modular Signage" for directories using modular signage systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for directories.
2. Include furnished specialties and accessories.
3. Include electrical characteristics for illuminated directories.

B. Shop Drawings: For directories.

1. Include plans, elevations, sections, and attachment details.
2. Include sections of typical trim members.
3. Indicate layout directory, including header and message strips.
4. Include diagrams for power wiring.

C. Samples: For each exposed product and for each color and texture specified.

1. Trim: **6 inches (150 mm)** long for profile and color of factory finish.
2. Message Strip: Length as indicated for finished product for profile and mounting configuration.
3. Typeface Sample for size and font.
4. Letterboard Panel: Not less than **8-1/2 by 11 inches (215 by 280 mm)**.
5. Changeable Letters: Six full-size letters indicating size and font.

D. Samples for Initial Selection: For each type of directory.

1. Message Strip: Typeface Sample for size and font.
2. Header Panel: Typeface Sample for size and font, and for color selection.
3. Trim: For profile and samples color of factory finish.

4. Letterboard: Fabric swatches for color.
5. Changeable Letters: For each size and font available.

E. Samples for Verification: For each type of directory.

1. Trim: **6-inch- (150-mm-)** long sections of each trim profile[**including corner section**], in color selected.
2. Message Strips: Full-size Samples of message strips in color selected with Sample of selected typeface and size.
3. Letterboards: Not less than **8-1/2 by 11 inches (215 by 280 mm)**, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
4. Letters: Full-size Samples of changeable letters of each size and font specified.

F. Message-Strip Schedule: For each message strip, indicating letter size, font, spacing, indents, text copy, and graphics.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each directory, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**], for surface-burning characteristics of letterboards.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For directories to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Message Strips: Full-size blank strips equal to [**10**] percent of number installed for each size indicated, but no fewer than [**20**] strips.
2. Paper Message-Strip Stock: Colored[perforated] paper stock for printing paper message-strip inserts using manufacturer-supplied software, equal to [2] times message-strip capacity of directory.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**50**][**450**] or less.

B. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 NONILLUMINATED AND FRONT-ILLUMINATED MESSAGE-STRIP DIRECTORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APCO Graphics, Inc**]
2. [**ASI Sign Systems, Inc**]
3. [**Nelson-Harkins Industries**]
4. [**Poblocki Sign Company, LLC**]
5. [**Signature, Inc.**]
6. [**Tablet & Ticket Co. (The)**]
7. [**Vomar Products, Inc**]

B. Profiled Frame: [**Molded-opaque-acrylic or molded-fiberglass**][**Extruded-aluminum**] profiled frame at top and bottom, with sheet metal rear cover, housing changeable message strips in configuration indicated.

1. Frame:

a. Top and Bottom Profile: [**Square**][**Radius**][**Bevel**].
b. Side Trim: [**Aluminum angle**][**Bronze angle**][**Brass angle**][**Molded-opaque-acrylic or molded-fiberglass integral to frame**].
c. Depth: Manufacturer's standard [**1-1/2- to 2-1/2-inch (38- to 64-mm)**] frame depth.
d. Profile Face Dimension: [**4 inches (100 mm)**][**6 inches (152 mm)**] high.
e. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].
f. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2. Cover: Removable, clear acrylic sheet held in place by perimeter frame. Provide suction cup tool for cover removal.
3. Number of Columns: [**Two**][**Three**][**Four**] columns of message strips.
4. Mounting: Surface.
5. Header: Copy applied to top section of profiled frame.
6. Divider Color: [**Same as message strips**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

C. Metal Frame: Directory with full perimeter metal frame and sheet metal rear cover, housing changeable message strips in configuration indicated.

1. Perimeter Frame:

a. Material: [**Extruded aluminum**][**Brass**][**Bronze**].
b. Profile: [**Square**][**Quarter round**][**Bevel**].
c. Corners: [**Square**][**Radius**].
d. Depth: Manufacturer's standard [**1-3/4- to 2-3/4-inch (44- to 70-mm)**] frame depth.

2. Cover: [**Non-sectional single-piece cover with full-length concealed hinge, full width of directory.**][**Cover for each section of message strips with full-length concealed hinge.**]Equip with cylinder lock(s).

a. Frame: Same material and finish as perimeter frame.
b. Hinge Location: [**Side**][**Top, with hold-open bracket**][**Top, with gas-cylinder hold-open**].

c. Glazing: [**Clear float glass**][**Clear tempered glass**][**Bronze-tinted tempered glass**][**Gray-tinted tempered glass**][**Clear acrylic sheet**].

3. Number of Columns: [**Two**][**Three**][**Four**] columns of message strips.
4. Mounting: [**Surface**][**Recessed, with reveal and flange to cover perimeter of opening**][**Recessed, with reveal; without perimeter frame for fully finished opening**][**Recessed with reveal, with frame to cover opening return**].
5. Header Panel: Full width of directory, by [**4 inches (102 mm)**][**6 inches (152 mm)**][**8 inches (203 mm)**] high.
6. Divider Strips: Provide divider strips between columns of message strips, and between header and message strips.

   a. Color: [**Same as message strips**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

7. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].

   a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

8. Brass Finish: [**Buffed**][**Medium satin**][**Fine matte**][**Statuary conversion coating**].
9. Bronze Finish: [**Buffed**][**Medium satin**][**Fine matte**][**Statuary conversion coating**].

D. Message Strips: Provide message strips compatible with directory system selected, with message copy indicated in message-strip schedule.

1. Type:

   a. Opaque flat plastic strips, which slide into retainer channels on sides of directory, with screen-printed or vinyl-film copy.
   b. Acrylic or high-pressure plastic-laminate strips with machine- or laser-engraved copy, which exposes contrasting core.
   c. Flexible magnetic tape with screen-printed or vinyl-film copy.
   d. Film-Insert Changeable Message Strips: Removable message strips fabricated from plastic film with [**vinyl**][**screen-printed**] lettering, held in interchangeable, interlocking plastic carriers.

2. Width: [**7 inches (175 mm)**][**11 inches (280 mm)**][**14 inches (350 mm)**][**18 inches (457 mm)**] long.
3. Height: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
4. Color:

   a. Message-Strip Background: [**Black**][**Gray**][**Brown**][**White**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Lettering: [**White**][**Black**][**Gray**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Lettering:

   a. Letter Height: [**3/16 inch (5 mm)**][**1/4 inch (6 mm)**][**3/8 inch (9.5 mm)**].

b. Font Style: [**Arial Medium**][**Clarendon Medium**][**Optima Bold**][**As selected by Architect**], as directed by the Owner.
c. Case: [**All capitals**][**Initial capitals**][**Capitals and lowercase**][**As indicated on message-strip schedule**].

6. Header Graphics: Provide copy that complies with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors of graphics, as directed by the Owner.
7. Graphics Panel: Screen-printed graphics or vinyl graphics laminated to opaque acrylic sheet; held in place by interchangeable, interlocking plastic carrier. Provide graphics that comply with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors, as directed by the Owner.
8. Directory Overall Width: [**24 inches (610 mm)**][**As indicated on Drawings**].
9. Directory Overall Height: [**36 inches (914 mm)**][**As indicated on Drawings**].

E. Exterior Directories: Metal-framed directories of weather-resistant construction; with vents to dissipate trapped moisture, weather-resistant components, and weather-stripped hinged doors.

F. Illumination System: Concealed top-lighting system consisting of [fluorescent][LED] fixtures. Include lamps and internal wiring with single, concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided. Provide angled message-strip section for more even illumination.

1. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.[**Provide exterior ballasts for exterior directories.**]
2. Electrical Characteristics: Single phase, [**120**][**277**] V.

2.3 REAR-ILLUMINATED MESSAGE-STRIP DIRECTORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APCO Graphics, Inc**]
2. [**ASI Sign Systems, Inc**]
3. [**Desk & Door Nameplate Co.**]
4. [**Nelson-Harkins Industries**]
5. [**Poblocki Sign Company, LLC**]
6. [**Signature, Inc.**]
7. [**Tablet & Ticket Co. (The)**]
8. [**Vomar Products, Inc**]

B. Rear-Illuminated Message-Strip Directory: Factory-fabricated unit consisting of changeable message strips held in place by retainer frame enclosed in manufacturer's standard [**4-to-6-inch- (100-to-150-mm-) deep**] perimeter frame; with glazed cover, aluminum-sheet rear cover panel, and concealed rear-illumination system.

1. Frame:

a. Material: [**Extruded aluminum**][**Brass**][**Bronze**][**Stainless steel**].
b. Profile: [**Square**][**Quarter round**][**Bevel**].
c. Corners: [**Square**][**Radius**].

2. Cover: Non-section, one-piece cover with concealed lock.

a. Cover Frame Material: Same material and finish as perimeter frame.
b. Cover Frame Profile: [**Square**][**Radius**][**Bevel**][**Floating glass, with frame concealed behind glass**][**Suspended glass, with frame partially concealed behind glass**].
c. Hinge Location: [**Side**][**Top, with hold-open bracket**][**Top, with gas-cylinder hold-open**].
d. Glazing: [**Gray-tinted float glass**][**Gray-tinted tempered glass**][**Bronze-tinted acrylic sheet**].

3. Header Panel: Same material and color as changeable message strips. Provide copy that complies with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors of graphics, as directed by the Owner.
4. Divider Color: Same as message strips.
5. Exterior Directories: Metal-framed directories of weather-resistant construction; with vents to dissipate trapped moisture, weather-resistant components, and weather-stripped hinged doors.
6. Film-Insert Message Strips: Removable, black, film-negative message strips in [**7-inch- (175-mm-)**][**14-inch- (350-mm-)**] long, interchangeable, interlocking plastic carriers.
7. Engraved Changeable Message Strips: Machine- or laser-engraved copy in [**7-inch- (175-mm-)**][**14-inch- (350-mm-)**] long, interchangeable, interlocking, black, acrylic strips with transparent core.

   a. Message-Strip Height: [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**].
   b. Letter Height: [**3/16 inch (5 mm)**][**1/4 inch (6 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
   c. Letter Style: [**Arial Medium**][**Clarendon Medium**][**Optima Bold**][**As selected by Architect**], as directed by the Owner.
   d. Letter Case: [**All capitals**][**Initial capitals**][**Capitals and lowercase**][**As indicated on message-strip schedule**].

8. Graphics Panel: Same material and color as changeable message strips. Provide graphics that comply with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors, as directed by the Owner.
9. Rear-Illumination System: Provide removable and accessible [fluorescent-strip][LED] fixture system with reflective interior surfaces for uniform illumination of message strips[and header panel] with minimum halation and without light leaks. Include lamps and internal wiring with single concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.

   a. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.[**Provide exterior ballasts for exterior directories.**]
   b. Electrical Characteristics: Single phase, [**120**][**277**] V.

10. Aluminum Finish: [**Clear anodic**][**Color anodic**][**Plated**].

    a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Gold**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
    b. Plating: [**Satin bronze**][**Mirror bronze**][**Bright chrome**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

11. Brass Finish: [**Buffed**][**Medium satin**][**Fine matte**][**Statuary conversion coating**].
12. Bronze Finish: [**Buffed**][**Medium satin**][**Fine matte**][**Statuary conversion coating**].

13. Stainless Steel Finish: [**ASTM A480/A480M No. 4**][**ASTM A480/A480M No. 8**].
14. Width: [**As indicated on Drawings**].
15. Height: [**As indicated on Drawings**].
16. Mounting: [**Surface**][**Recessed, with reveal and flange to cover perimeter of opening**][**Recessed, with reveal; without perimeter frame for fully finished opening**][**Recessed, with reveal; with frame to cover opening return**].

2.4 CHANGEABLE-LETTER DIRECTORIES

A. Enclosed-Face, Changeable-Letter Directory : Factory-fabricated unit consisting of manufacturer's standard, **2-inch- (50-mm-)** deep, perimeter frame with [**fixed**][**removable**] letterboard on back inside surface and with [**glazed doors**][**lift-off, glazed cover**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aarco Products, Inc.**]
   b. [**ASI Sign Systems, Inc**]
   c. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
   d. [**CIG JAN Products, Ltd.**]
   e. [**Claridge Products and Equipment, LLC.**]
   f. [**Desk & Door Nameplate Co.**]
   g. [**ghent; a GMi Company**]
   h. [**Marsh Industries, Inc.**]
   i. [**MooreCo Inc**]
   j. [**Nelson-Harkins Industries**]
   k. [**Peter Pepper Products, Inc**]
   l. [**Platinum Visual Solutions**]
   m. [**Pyramid Presentation Products**]
   n. [**Signature, Inc.**]
   o. [**Swingframe Mfg.; a division of Access Display Group, Inc.**]
   p. [**Tablet & Ticket Co. (The)**]
   q. [**United Visual Products, Inc.**]

2. Aluminum Perimeter Frame: Extruded aluminum[**with weather-resistant backing for exterior use**].

   a. Perimeter Frame Profile: [**Square**][**Half round**][**Quarter round**].
   b. Perimeter Frame Corners: [**Square**][**Radius**].
   c. Finish: [**Clear anodic**][**Color anodic**][**Manufacturer's standard baked enamel or powder coat**].

      1) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Wood Perimeter Frame: [**Red oak**][**Walnut**] with [**natural lacquered**][**oiled**][**stained**] finish.

   a. Perimeter Frame Profile: [**Square**][**Half round**][**Quarter round**].
   b. Perimeter Frame Corners: [**Square**][**Radius**].

4. Glazed Sliding Doors: Unframed, clear-tempered-glass doors supported on nylon or ball-bearing rollers in extruded-aluminum top and bottom track, with plastic top guide and rubber bumpers.

Equip each door with ground finger pull and adjustable cylinder lock with two keys.

a. Door Track: Same finish on exposed surfaces as perimeter frame.
b. Number of Doors: [**Two**][**Three**][**As indicated on Drawings**].

5. Glazed Hinged Doors: Clear [**acrylic sheet**][**tempered glass**] set in door frame equipped with full-height continuous hinge and cylinder lock with two keys.

a. Door Frame: Same material and finish as perimeter frame.
b. Number of Doors: [**One**][**Two**][**Three**][**As indicated on Drawings**].

6. Lift-off Cover: Clear [**acrylic sheet**][**tempered glass**] set in frame that snaps into place. Fabricate frame from same material and finish as perimeter frame.
7. Header Panel: [**Nonilluminated; with opaque**][**Illuminated; with translucent**] acrylic sheet panel set within overall perimeter frame; with matching frame that separates header panel from letterboard.

a. Graphic Content and Style: Provide header panel copy that complies with requirements indicated on [**Drawings**][**artwork supplied on electronic media by Architect**] for size, style, spacing, content, height, location, material, and colors, as directed by the Owner.
b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Letterboard: Manufacturer's standard [**felt**][**vinyl**][**rubber**]-covered panel material, with grooves spaced at **1/4 inch (6 mm)** o.c. to receive changeable letters.

a. Color: [**Black**][**Red**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

9. Letters: Molded plastic with tabs for engaging grooves in letterboard. Provide manufacturer's standard assortment of not less than [**300**] characters for each size, style, color, and case required; include letters, numbers, and characters. Package letters in compartmentalized carrying box.

a. Height: [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**] to top of capitals.
b. Style: [**Arial**][**Gothic**][**Roman**][**As selected by Architect**], as directed by the Owner.
c. Color: [**White**][**Black**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
d. Case: [**All capitals**][**Capitals and lowercase**].

10. Width: [**24 inches (610 mm)**][**As indicated on Drawings**].
11. Height: [**36 inches (914 mm)**][**As indicated on Drawings**].
12. Mounting: [**Recessed**][**Semirecessed**][**Surface**].
13. Exterior Directories: Aluminum-framed units of weather-resistant construction; with vents to dissipate trapped moisture, weather-resistant letterboard, and weather-stripped hinged doors.
14. Illumination System: Concealed top-lighting system consisting of [fluorescent][LED] fixtures. Include lamps and internal wiring with single, concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.

a. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.[**Provide exterior ballasts for exterior directories.**]

b. Electrical Characteristics: Single phase, [**120**][**277**] V.

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Sheet: **ASTM B209 (ASTM B209M)**.
2. Extruded Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063.

B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

C. Copper-Alloy Brass Sheet: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).

D. Copper-Alloy Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).

E. Clear Float Glass: ASTM C1036, Type I, Class 1, Quality q3.

F. Gray-Tinted Float Glass: ASTM C1036; Type I (transparent glass, flat); Class 2 (tinted, heat absorbing, and light reducing), Quality q3 (glazing select); gray-tinted monolithic glass with a maximum luminous transmittance of 14 percent.

G. Bronze-Tinted Float Glass: ASTM C1036; Type I (transparent glass, flat); Class 2 (tinted, heat absorbing, and light reducing), Quality q3 (glazing select); bronze-tinted monolithic glass with a maximum luminous transmittance of 44 percent.

H. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality q3, with exposed edges seamed before tempering.

I. Tinted Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 2 (tinted), tint as indicated, Quality q3, with exposed edges seamed before tempering.

J. Clear Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished), colorless sheet with visible light transmittance of 92 percent measured in accordance with ASTM D1003.

K. Bronze-Tinted Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished).

L. Translucent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished), white-colored sheet of density required to produce uniform brightness and minimum halation effects.

M. Opaque Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished), colors as indicated.

N. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless steel, or aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

2.6 FABRICATION

A. Fabricate directories to requirements indicated for dimensions, design, and thickness and finish of materials. Use metals and shapes of thickness and reinforcement to produce flat surfaces, free of oil canning, and to impart strength for size, design, and application indicated.

B. Fabricate directory cabinets and door frames with reinforced corners, mitered and welded to a hairline fit, with no exposed fasteners. Provide structural reinforcement to prevent racking and misalignment.

C. Fabricate exterior directories with vents to permit evaporation of moisture trapped inside.

D. Message-Strip Directories:

1. Provide blank message strips for each carrier in entire directory.
2. Provide message strips with wording and other designations for locations where wording is indicated. Include blank message strips as needed to fill out remainder of directory.

E. Provide hold-open arms for doors of top-hinged directories.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3. Directional Satin Finish: ASTM A480/A480M No. 4.
4. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8.

2.10 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

C. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

D. Statuary Conversion Coating over Satin Finish: M32-C55 (Mechanical Finish: directionally textured, medium satin; Chemical Finish: conversion coating, sulfide).

1. Color: Match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power system to verify actual locations of connections before installation of illuminated directories.

C. Examine walls and partitions for proper backing for directories.

D. Examine walls and partitions for suitable framing depth if recessed directories will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install directories with perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Mounting Height: Install directories at mounting heights indicated on Drawings, or if not indicated, at [**72 inches (1829 mm)**] above finished floor to top of directory.

C. Recessed Directories: Attach directories to wall framing with fasteners at not more than **16 inches (400 mm)** o.c. Attach aluminum trim over edges of recessed directories, and conceal grounds and clips.

D. Surface-Mounted Directories: Attach directories to wall framing with concealed clips, hangers, or grounds fastened at not more than **16 inches (400 mm)** o.c. Secure both top and bottom of directories to walls.

E. Comply with requirements specified elsewhere for connecting illuminated directories.

3.3 ADJUSTING AND CLEANING

A. Adjust directory doors to operate smoothly without warp or bind and so that contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 10 13 00 00

Task	Specification	Specification Description
10 13 11 00	10 11 00 00	Visual Display Units
10 13 11 00	10 13 00 00	Directories

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SECTION 10 14 16 00 - PLAQUES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal plaques.

B. Related Requirements:

1. Section 101423 "Panel Signage" and Section 101423.16 "Room-Identification Panel Signage" for plaques or signs similar to metal plaques, with or without frames, except that they are made of materials other than solid metal.
2. [**Section 142100 "Electric Traction Elevators"**][**Section 142400 "Hydraulic Elevators"**][**Section 143100 "Escalators"**][**Section 143200 "Moving Walks"**][**Section 144200 "Wheelchair Lifts"**] for code-required conveying equipment signage.
3. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
4. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
5. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For plaques.

1. Include fabrication and installation details and attachments to other work.
2. Show plaque mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements[including raised characters and Braille], and layout for each plaque at least [half size].

D. Samples for Initial Selection: For each type of plaque, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of plaque showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Plaques: [**Full-size Sample**][**Half-size Sample**].
2. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**] of each accessory type.
3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

F. Product Schedule: For plaques. Use same designations indicated on Drawings or specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For plaques to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of plaques that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.2 METAL PLAQUES

A. Cast Plaque : Cast-metal plaque with background texture, border, and characters having uniform faces,

sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.R.K. Ramos**]
    b. [**ACE Sign Systems, Inc.**]
    c. [**Erie Landmark Company; a division of Paul W. Zimmerman Foundaries, Inc.**]
    d. [**Gemini Signage; Gemini, Inc.**]
    e. [**Matthews International Corporation; Bronze Division**]
    f. [**Metallic Arts**]
    g. [**Signs & Decal Corp**]
    h. [**Southwell Company (The)**]

2. Plaque Material: Cast [**aluminum**][**brass**][**bronze**][**zinc**].
3. Plaque Thickness: [**0.153 inch (3.89 mm)**][**0.25 inch (6.35 mm)**][**0.50 inch (12.7 mm)**].
4. Finishes:

    a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**Mill finish raised surface with dark oxidized background**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
    b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
    c. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
    d. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**].

5. Background Texture: [**Smooth**][**Pebble**][**Leatherette**][**Matte**][**Stipple**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
6. Integrally Cast Border Style: [**As indicated on Drawings**][**Square cut without border**][**Square single line, polished**][**Square double line, polished**][**Plain bevel, brushed**][**Plain bevel, polished**][**Projected bevel**][**Raised flat band**][**Double-raised line border**].
7. Applied Frame Material, Style, and Finish: [**As indicated on Drawings**].
8. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**][**Adhesive**][**Two-face tape**].
9. Text and Typeface: [**Accessible raised characters and Braille**][**Times Roman**][**Typeface as indicated by manufacturer's designation**][**Typeface matching Architect's sample**][**Typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**].[**Finish raised characters to contrast with background color, and finish Braille to match background color.**], as directed by the Owner

B. Etched Plaque : Chemically etched or photochemically engraved metal sheet or plate with texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.R.K. Ramos**]

b. [**ACE Sign Systems, Inc.**]
c. [**Advance Corporation**]
d. [**Erie Landmark Company; a division of Paul W. Zimmerman Foundaries, Inc.**]
e. [**Gemini Signage; Gemini, Inc.**]
f. [**Metallic Arts**]
g. [**Mohawk Sign Systems**]
h. [**Nelson-Harkins Industries**]
i. [**Signs & Decal Corp**]
j. [**Southwell Company (The)**]
k. [**St. Paul Stamp Works, Inc.**]
l. [**Steel Art Company**]

2. Plaque Material: Sheet or plate [**aluminum**][**brass**][**bronze**][**copper**][**stainless steel**][**zinc**].
3. Plaque Thickness: [**0.064 inch (1.63 mm)**][**0.125 inch (3.18 mm)**][**0.153 inch (3.89 mm)**][**0.250 inch (6.35 mm)**].
4. Finishes:

   a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**Mill finish raised surface with dark oxidized background**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
   b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
   c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
   d. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
   e. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**].

5. Integral Edge Style: [**As indicated on Drawings**][**Square cut, polished**][**Plain bevel, brushed**].
6. Applied Frame Material, Style, and Finish: [**As indicated on Drawings**].
7. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**][**Adhesive**][**Two-face tape**].
8. Text and Typeface: [**Accessible raised characters and Braille**][**Times Roman**][**Typeface as indicated by manufacturer's designation**][**Typeface matching Architect's sample**][**Typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**].[**Finish raised characters to contrast with background color, and finish Braille to match background color.**], as directed by the Owner

2.3 MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by plaque manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

D. Brass Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy**

UNS No. C85200 (high-copper yellow brass)].

E. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**].

F. Bronze Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C86500 (No. 1 manganese bronze)**].

G. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**].

H. Copper Sheet: ASTM B152/B152M.

I. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

J. Zinc Castings: ASTM B240, alloy and temper recommended by plaque manufacturer for type of use and finish indicated.

K. Zinc Sheet: [**ASTM B69**], alloy and temper recommended by plaque manufacturer for type of use and finish indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [nonferrous-metal][stainless steel][hot-dip galvanized] devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

   a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   b. Fastener Heads: For nonstructural connections, use [flathead][oval countersunk] screws and bolts with tamper-resistant [Allen-head][spanner-head][one-way-head] slots unless otherwise indicated.

4. Plaque Mounting Fasteners:

   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of plaque, screwed into back of plaque, or screwed into tapped lugs cast integrally into back of plaque unless otherwise indicated.
   b. Through Fasteners: Exposed metal fasteners matching plaque finish, with type of head indicated, installed in predrilled holes.

B. Adhesive: As recommended by plaque manufacturer.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of

Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

A. General: Provide manufacturer's standard plaques according to requirements indicated.

1. Preassemble plaques in the shop to greatest extent possible. Disassemble plaques only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match plaque finish.
6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Surface-Engraved Graphics: Machine-engrave characters and other graphic devices into indicated plaque surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.

C. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted plaques to suit plaque construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [**to match plaque-background color**][**to match Architect's sample**] color unless otherwise indicated, as directed by the Owner.
2. Stainless Steel Brackets: Factory finish brackets [**to match plaque background**][**to match Architect's sample**][**with No. 4**] finish unless otherwise indicated, as directed by the Owner.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

2.9 LACQUER COATING FOR COPPER-ALLOY FINISHES

A. Lacquer Coating: Clear, organic, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of acrylic resin, methyl methacrylate copolymer, leveling agent, and corrosion inhibitor benzotriazole.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that plaque-support surfaces are within tolerances to accommodate plaques without gaps or irregularities between backs of plaques and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PLAQUES

A. General: Install plaques using mounting methods indicated and according to manufacturer's written instructions.

1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Plaques Used for Room Identification[**and Other Accessible Plaques**]: Install in locations on walls [**as indicated on Drawings**][**and**][**according to accessibility standard**].

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of plaque. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Through Fasteners: Drill holes in substrate using predrilled holes in plaque as template. Countersink holes in plaque if required. Place plaque in position and flush to surface. Install through fasteners and tighten.
3. Brackets: Remove loose debris from substrate surface and install bracket supports in position, so that plaque is correctly located and aligned.
4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of plaque and of suitable quantity to support weight of plaque after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as plaque is applied and to prevent visibility of cured adhesive at plaque edges. Place plaque in position, and push to engage adhesive. Temporarily support plaque in position until adhesive fully sets.
5. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of plaque and of suitable quantity to support weight of plaque without slippage. Keep strips away from edges to prevent visibility at plaque edges. Place plaque in position, and push to engage tape adhesive.
6. Shim-Plate Mounting: Provide **1/8-inch- (3-mm-)** thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach plaques to plate using [**method specified above**].

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed plaques and plaques that do not comply with specified requirements. Replace plaques with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as plaques are installed.

C. On completion of installation, clean exposed surfaces of plaques according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain plaques in a clean condition during construction and protect from damage until acceptance by the Owner.

END OF SECTION 10 14 16 00

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SECTION 10 14 19 00 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.

a. Cast dimensional characters.
b. Cutout dimensional characters.
c. Fabricated channel dimensional characters.
d. Illuminated, fabricated channel dimensional characters.
e. Molded-plastic dimensional characters.
f. Illuminated, molded-plastic dimensional characters.

1.2 DEFINITIONS

A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least [**half size**].
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Dimensional Characters: [**Full-size Sample**][**Half-size Sample**] of[**each type of**] dimensional character.
2. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**] of each accessory type.
3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

F. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.8 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of [**rooftop**][**dimensional character**] sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: [**As indicated on Drawings**].
2. Concentrated Horizontal Load: [**As indicated on Drawings**].
3. Other Design Load: [**As indicated on Drawings**]
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DIMENSIONAL CHARACTERS

A. Cast Characters : Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**ASI Sign Systems, Inc**]
d. [**Cosco**]
e. [**Gemini Signage; Gemini, Inc.**]
f. [**Matthews International Corporation; Bronze Division**]
g. [**Metal Arts**]
h. [**Metallic Arts**]
i. [**Southwell Company (The)**]

2. Character Material: Cast [**aluminum**][**brass**][**bronze**][**zinc**].
3. Character Height: [**As indicated on Drawings**].
4. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of character**].
5. Finishes:

a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
c. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
d. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**].

6. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Projecting studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**].
7. Typeface: [**Times Roman**].

B. Cutout Characters : Characters with uniform faces; square-cut, smooth[eased] edges; precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.R.K. Ramos**]
   b. [**ACE Sign Systems, Inc.**]
   c. [**APCO Graphics, Inc**]
   d. [**ASI Sign Systems, Inc**]
   e. [**Cosco**]
   f. [**Diskey Sign Company**]
   g. [**Gemini Signage; Gemini, Inc.**]
   h. [**inpro Corporation**]
   i. [**Matthews International Corporation; Bronze Division**]
   j. [**Metal Arts**]
   k. [**Metallic Arts**]
   l. [**Southwell Company (The)**]
   m. [**Steel Art Company**]

2. Character Material: Sheet or plate [**aluminum**][**brass**][**bronze**][**copper**][**stainless steel**][**zinc**][**acrylic**][**acrylic with laminated aluminum facing**][**acrylic with laminated brass facing**][**acrylic with laminated bronze facing**][**acrylic with laminated stainless steel facing**].
3. Character Height: [**As indicated on Drawings**].
4. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of character**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
5. Finishes:

   a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
   b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
   c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
   d. Integral Acrylic Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
   e. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
   f. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**].
   g. Painted Edges: Paint edges of acrylic characters with laminated metal facing as recommended in writing by manufacturer.

6. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Projecting studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**][**Concealed, painted aluminum back bar or bracket assembly**][**Concealed, stainless steel back bar or bracket**

assembly][**Adhesive**].

7. Typeface: [**Times Roman**].

C. Fabricated Channel Characters : [**Metal face and side returns**][**Open face with metal side returns**][**Translucent face with metal side returns**], formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.R.K. Ramos**]
   b. [**ACE Sign Systems, Inc.**]
   c. [**Allen Industries**]
   d. [**APCO Graphics, Inc**]
   e. [**ASI Sign Systems, Inc**]
   f. [**Charleston Manufacturing, LLC**]
   g. [**Cosco**]
   h. [**Gemini Signage; Gemini, Inc.**]
   i. [**Metallic Arts**]
   j. [**Signs & Decal Corp**]
   k. [**Steel Art Company**]

2. Illuminated Characters: [**Backlighted**][**Frontlighted**] character construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting, including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.

   a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**].
   b. Weeps: Provide weep holes to drain water at lowest part of exterior characters.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

3. Character Material: Sheet or plate [**aluminum**][**brass**][**bronze**][**copper**][**steel**][**stainless steel**][**zinc**].
4. Material Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size and design of character**][**0.100 inch (2.54 mm)**][**0.032 inch (0.81 mm)**][**Nominal 0.048 inch (1.21 mm) thick for face and 0.030 inch (0.76 mm) thick for returns**][**0.050 inch (1.27 mm) thick for face and 0.031 inch (0.79 mm) thick for returns**].
5. Translucent Face Sheet: Acrylic sheet with integral color [**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.

   a. Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard thickness for size of character**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].

6. Character Height: [**As indicated on Drawings**].
7. Character Depth: [**As indicated on Drawings**].
8. Finishes:

   a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
d. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
e. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**].

9. Mounting: [**As indicated on Drawings**][**Manufacturer's standard for size and design of character**][**Projecting studs**][**Concealed, painted aluminum back bar or bracket assembly**][**Concealed, stainless steel back bar or bracket assembly**].

a. Hold characters at [**2-inch (51-mm) distance**][**manufacturer's recommended distance**][**distance as selected by Architect**] from wall surface, as directed by the Owner.

10. Typeface: [**Times Roman**].

D. Molded-Plastic Characters : [Injection molded][thermoformed] characters having uniform faces and profiles, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACE Sign Systems, Inc.**]
b. [**ASI Sign Systems, Inc**]
c. [**Cosco**]
d. [**Gemini Signage; Gemini, Inc.**]
e. [**Metallic Arts**]
f. [**Signs & Decal Corp**]

2. Illuminated Characters: Characters with concealed [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting, including transformers, insulators, and other accessories; with provision for servicing and concealing connections to building electrical system. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**].
b. Weeps: Provide weep holes to drain water at lowest part of exterior characters.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

3. Color: Manufacturer's standard [**integral color**][**painted finish**] process, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
4. Typeface: [**Times Roman**].

2.3 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

D. Brass Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C85200 (high-copper yellow brass)**].

E. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**].

F. Bronze Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C86500 (No. 1 manganese bronze)**].

G. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**].

H. Copper Sheet: ASTM B152/B152M.

I. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

J. Zinc Castings: ASTM B240, alloy and temper recommended by sign manufacturer for type of use and finish indicated.

K. Zinc Sheet: [**ASTM B69**], alloy and temper recommended by sign manufacturer for type of use and finish indicated.

L. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

M. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [nonferrous-metal][stainless steel][hot-dip galvanized] devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    b. Fastener Heads: For nonstructural connections, use [**flathead**][**oval countersunk**] screws and bolts with tamper-resistant [**Allen-head**][**spanner-head**] [**one-way-head**] slots unless otherwise indicated.

4. Sign Mounting Fasteners:

   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
   b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
   c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing

work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [**to match sign-background color**][**to match Architect's sample**] color unless otherwise indicated, as directed by the Owner.
2. Stainless Steel Brackets: Factory finish brackets [**to match sign background**][**to match Architect's sample**][**with No. 4**] finish unless otherwise indicated, as directed by the Owner.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

2.9 LACQUER COATING FOR COPPER-ALLOY FINISHES

A. Lacquer Coating: Clear, organic, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of acrylic resin, methyl methacrylate copolymer, leveling agent, and corrosion inhibitor benzotriazole.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that electrical service is correctly sized and located to accommodate signs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers

pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by the Owner.

END OF SECTION 10 14 19 00

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Task	Specification	Specification Description
10 14 19 00	01 22 00 00	No Specification Required

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SECTION 10 14 23 00 - PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.
2. Field-applied, vinyl-character signs.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection-zone signage.
3. Section 101300 "Directories" for building directories.
4. Section 101423.16 "Room-Identification Panel Signage" for room-identification signs that are directly attached to the building.
5. Section 101426 "Post and Panel/Pylon Signage" for freestanding signs.
6. [**Section 142100 "Electric Traction Elevators"**][**Section 142400 "Hydraulic Elevators"**][**Section 143100 "Escalators"**][**Section 143200 "Moving Walks"**][**Section 144200 "Wheelchair Lifts"**] for code-required conveying equipment signage.
7. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
8. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
9. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
10. Section 265213 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

B. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Panel signs.
2. Field-applied, vinyl-character signs.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements[including raised characters and Braille], and layout for each sign at least [half size].
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Panel Signs: [**Full-size Sample**][**Not less than 12 inches (300 mm) square, including corner**].
2. Field-Applied, Vinyl-Character Signs: [**Full-size Sample of characters on glass**].
3. Variable Component Materials: [**Full-size Sample**][**8-inch (200-mm) Sample**] of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
4. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**] of each accessory type.
5. Full-size Samples, if approved, will be returned to Contractor for use in Project.

F. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Evaluation Reports: For [**post-installed anchors**][**and**][**power-actuated fasteners**], from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same product run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: [**12**] replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: [**One**] set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of [**anchorage devices**][**and**][**electrical service**] embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of [**rooftop**][**illuminated panel**] sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements are to withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: [**As indicated on Drawings**].
2. Concentrated Horizontal Load: [**As indicated on Drawings**].
3. Other Design Load: [**As indicated on Drawings**].
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

D. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PANEL SIGNS

A. Panel Sign : Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACE Sign Systems, Inc.**]
b. [**Advance Corporation**]
c. [**Allen Industries**]
d. [**Allen Markings**]
e. [**APCO Graphics, Inc**]
f. [**ASE, Inc**]
g. [**ASI Sign Systems, Inc**]
h. [**Best Sign Systems, Inc.**]
i. [**Bunting Graphics, Inc**]
j. [**Clarke Systems**]
k. [**Cosco**]
l. [**Diskey Sign Company**]
m. [**Foresight Supersign**]
n. [**Fossil Industries, Inc.**]
o. [**inpro Corporation**]
p. [**Mohawk Sign Systems**]
q. [**Nelson-Harkins Industries**]
r. [**Poblocki Sign Company, LLC**]
s. [**Seton Identification Products; a Brady Corporation company**]
t. [**Signs & Decal Corp**]
u. [**Vista System, LLC**]
v. [**Vomar Products, Inc**]

2. Illuminated Panel Sign: [**Backlighted**][**Edgelighted**] construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**].
b. Weeps: Provide weep holes to drain water at lowest part of exterior signs.[**Equip weeps**

with permanent baffles to block light leakage without inhibiting drainage.]

3. Solid-Sheet Sign: [Aluminum][Brass][Bronze][Copper][Steel][Stainless steel][Acrylic][Fiberglass][PVC] sheet [and returns][returns, and back] with finish specified in "Surface Finish and Applied Graphics" Subparagraph and as follows:

    a. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.060 inch (1.52 mm)**][**0.080 inch (2.03 mm)**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
    b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**baked enamel or powder coat**][**paint**][**photo image**].
    c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**].
    d. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
    e. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics [**flush with**][**slightly projecting from**] the sign panel.

4. Laminated Aluminum-Sheet Sign: Aluminum sheet laminated to both sides of [**acrylic**][**phenolic**] core sheet[**with painted edges**].

    a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
    b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**].
    c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**].

5. Laminated-Sheet Sign: [**Photopolymer**][**Sandblasted polymer**] face sheet with raised graphics laminated[**over subsurface graphics**] to [**acrylic**][**phenolic**] backing sheet to produce composite sheet.

    a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
    b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**].
    c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**].
    d. Subsurface Graphics: [**Reverse halftone or dot-screen image**][**Reverse etch image**][**Snap-in changeable insert beneath removable face sheet**][**Slide-in changeable insert**].

6. Composite Phenolic-Core Sign: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.

    a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.5 inch (12.7 mm)**][**1 inch (25.4 mm)**].

7. Laminated Polycarbonate-Sheet Sign: Polycarbonate face sheet laminated to each side of [**phenolic**] base sheet to produce composite sheet.

    a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
    b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**].
    c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**].
    d. Subsurface Graphics: [**Reverse halftone or dot-screen image**][**Reverse etch image**].

8. Engraved Plastic-Laminate Sign: Plastic-laminate face laminated to contrasting phenolic core to produce composite sheet.

    a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
    b. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose

contrasting phenolic core.

c. Plastic-Laminate Color and Pattern: [**As indicated by manufacturer's designation**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

d. Core Color: Manufacturer's standard [**dark color**].

9. Sign-Panel Perimeter: Finish edges smooth.

a. Edge Condition:

1) Vertical Edges: [**As indicated on Drawings**][**Square cut**][**Beveled**][**Bullnosed**].

2) Horizontal Edges: [**As indicated on Drawings**][**Square cut**][**Beveled**][**Bullnosed**].

b. Corner Condition in Elevation: [**As indicated on Drawings**][**Square**][**Rounded to radius indicated**].

10. Frame: [**Entire perimeter**][**Horizontal retainers**][**Vertical retainers**][**to hold changeable sign panel**].

a. Material: [**Aluminum**][**Brass**][**Bronze**][**Steel**][**Stainless steel**][**PVC**].

b. Frame Depth: [**As indicated on Drawings**].

c. Profile: [**Square**][**Beveled**][**Rounded**].

d. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].

e. Finish and Color: [**Mill**][**Painted, matte black color**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

11. Mounting: [As indicated on Drawings][Manufacturer's standard method for substrates indicated][Surface mounted to wall][Projecting from wall][Suspended][Aluminum bracket][Stainless steel bracket] with [concealed anchors][countersunk flathead through fasteners][adhesive][two-face tape][hook-and-loop tape][magnetic tape].

12. Surface Finish and Applied Graphics:

a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

d. Integral Sheet Color: [**Acrylic**][**Fiberglass**][**PVC**] sheet with color [**as indicated by manufacturer's designation**][**to match Architect's sample**][**as selected by Architect from full range of industry colors**], as directed by the Owner.

e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.

f. Painted Finish and Graphics: Manufacturer's standard, factory-applied [**exterior-grade sign paint**][**acrylic polyurethane**], in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.

g. Photo-Image Graphics: Manufacturer's standard [**black-and-white**][**multicolor**], [**600-dpi**] halftone or dot-screen image.

h. Overcoat: [**Manufacturer's standard baked-on clear coating**].

13. Text and Typeface: [**Accessible raised characters and Braille**][**Times Roman**][**typeface as indicated by manufacturer's designation**][**typeface matching Architect's sample**][**typeface**

as selected by Architect from manufacturer's full range][**and**][**variable content as scheduled**].[**Finish raised characters to contrast with background color, and finish Braille to match background color.**], as directed by the Owner

14. Flatness Tolerance: Sign is to remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus [**1/16 inch (1.5 mm)**] measured diagonally from corner to corner.

2.3 FIELD-APPLIED, VINYL-CHARACTER SIGNS

A. Field-Applied, Vinyl-Character Sign : Prespaced characters die cut from [**3- to 3.5-mil (0.076- to 0.089-mm)**] thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allen Markings**]
b. [**APCO Graphics, Inc**]
c. [**inpro Corporation**]
d. [**Mohawk Sign Systems**]
e. [**Seton Identification Products; a Brady Corporation company**]

2.4 PANEL-SIGN MATERIALS

A. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**].

D. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**].

E. Copper Sheet: ASTM B152/B152M.

F. Steel Materials:

1. Metallic-Coated Steel Sheet: ASTM A653/A653M, [**G90 (Z275)**] coating, either commercial or forming steel.
2. Steel Sheet: [Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, Type B, exposed][electrolytic zinc-coated, ASTM A879/A879M, Coating Designation 08Z (24G), with steel-sheet substrate according to ASTM A1008/A1008M, commercial steel, exposed].
3. Steel Members Fabricated from Plate or Bar Stock: ASTM A529/A529M or ASTM A572/A572M, **42,000-psi (290-MPa)** minimum yield strength.
4. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

G. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

H. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

I. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

J. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.

K. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.

L. Plastic-Laminate Sheet: ISO 4586-3, Grade HGS.

M. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

N. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [nonferrous-metal][stainless steel][hot-dip galvanized] devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

   a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   b. Fastener Heads: For nonstructural connections, use [**flathead**] [**oval countersunk**]<**Insert shape**> screws and bolts with tamper-resistant [**Allen-head**][**spanner-head**] [**one-way-head**] slots unless otherwise indicated.

4. Sign Mounting Fasteners:

   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
   b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
   c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

5. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to

an evaluation report acceptable to authorities having jurisdiction, based on [ICC-ES AC01][ICC-ES AC193][ICC-ES AC58][ICC-ES AC308] as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.
2. Type: [Torque-controlled, expansion anchor][torque-controlled, adhesive anchor][adhesive anchor].
3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

F. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

G. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.

C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image is to be free of rough edges.

D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

E. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

F. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:

1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. [**Subsequent changeable inserts are by the Ownerthe Owner**][**Furnish two blank inserts for each sign for the Ownerthe Owner's use**].
2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. [**Subsequent changeable inserts are by the Ownerthe Owner**][**Furnish two blank inserts for each sign for the Ownerthe Owner's use**].
3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. [**Subsequent changeable sign panels are by the Owner**].

G. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [**to match sign-background color**][**to match Architect's sample**] color unless otherwise indicated, as directed by the Owner.
2. Stainless Steel Brackets: Factory finish brackets [**to match sign background**][**to match Architect's sample**][**with No. 4**] finish unless otherwise indicated, as directed by the Owner.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 METALLIC-COATED STEEL FINISHES

A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

2.10 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.

1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film

thickness of **2 mils (0.05 mm)**.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

D. Verify that electrical service is correctly sized and located to accommodate signs.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Accessible Signage: Install in locations on walls [**as indicated on Drawings**][**and**][**according to the accessibility standard**].

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
7. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips [**0.250 inch (6.35 mm)**] away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
8. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.
9. Shim-Plate Mounting: Provide **1/8-inch- (3-mm-)** thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using method specified above.

D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.

E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of

glass to conceal back of sign and two-face tape.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by the Owner.

END OF SECTION 10 14 23 00

SECTION 10 14 23 00A - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

B. Related Requirements:

1. Section 101300 "Directories" for building directories.
2. Section 101416 "Plaques" for one-piece, solid metal signs, with or without frames, that are used for high-end room-identification.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements[including raised characters and Braille], and layout for each sign at least [half size].

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required

finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: [**Full-size Sample**].
2. Variable Component Materials: [**Full-size Sample**][**8-inch (200-mm) Sample**] of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
3. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**] of each accessory type.
4. Full-size Samples, if approved, will be returned to Contractor for use in Project.

F. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same product run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: [**12**] replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: [**One**] set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of [**anchorage devices**][**and**][**electrical service**] embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Deterioration of finishes beyond normal weathering.
   b. Deterioration of embedded graphic image.
   c. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign : [**Sign**][**Sign system**] with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACE Sign Systems, Inc.**]
   b. [**Advance Corporation**]
   c. [**Allen Industries**]
   d. [**APCO Graphics, Inc**]
   e. [**ASE, Inc**]
   f. [**ASI Sign Systems, Inc**]
   g. [**Best Sign Systems, Inc.**]
   h. [**Clarke Systems**]
   i. [**Cosco**]
   j. [**Diskey Sign Company**]
   k. [**Foresight Supersign**]
   l. [**inpro Corporation**]
   m. [**Mohawk Sign Systems**]
   n. [**Nelson-Harkins Industries**]
   o. [**Poblocki Sign Company, LLC**]
   p. [**Seton Identification Products; a Brady Corporation company**]
   q. [**Signature Signs, Inc.**]
   r. [**Signs & Decal Corp**]
   s. [**Vista System, LLC**]
   t. [**Vomar Products, Inc**]

2. Laminated-Sheet Sign: [**Photopolymer**][**Sandblasted polymer**] face sheet with raised graphics laminated[**over subsurface graphics**] to [**acrylic**][**phenolic**] backing sheet to produce composite sheet.

   a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].

b. Surface-Applied Graphics: Applied [**vinyl film**][**paint**][**photo image**].
c. Subsurface Graphics: [**Reverse halftone or dot-screen image**][**Reverse etch image**][**Snap-in changeable insert beneath removable face sheet**][**Slide-in changeable insert**].
d. Color(s): [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Sign-Panel Perimeter: Finish edges smooth.

a. Edge Condition[**at Vertical Edges**][**at Horizontal Edges**]: [**As indicated on Drawings**][**Square cut**][**Beveled**][**Bullnosed**].
b. Corner Condition in Elevation: [**As indicated on Drawings**][**Square**][**Rounded to radius indicated**].

4. Frame: [**Entire perimeter**][**Horizontal retainers**][**Vertical retainers**][**to hold changeable sign panel**].

a. Material: [**Aluminum**].
b. Frame Depth: [**As indicated on Drawings**][**Convex-curved frame to receive removable face sheet and changeable subsurface graphics**].
c. Profile: [**Square**][**Beveled**][**Rounded**].
d. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].
e. Finish and Color: [**Mill**][**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Painted, matte black color**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Mounting: [Manufacturer's standard method for substrates indicated][Surface mounted to wall] with [concealed anchors][countersunk flathead through fasteners][adhesive][two-face tape][hook-and-loop tape][magnetic tape].
6. Text and Typeface: [**Accessible raised characters and Braille**][**Times Roman**][**typeface as indicated by manufacturer's designation**][**typeface matching Architect's sample**][**typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**].[**Finish raised characters to contrast with background color, and finish Braille to match background color.**], as directed by the Owner

2.3 SIGN MATERIALS

A. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

D. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings[**and suitable for exterior applications**].

E. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [nonferrous-metal][stainless-steel][hot-dip galvanized] devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

   a. Fabricated from same basic metal and finish of fastened sign unless otherwise indicated.
   b. Fastener Heads: Use [flathead][oval countersunk] screws and bolts with tamper-resistant [Allen-head][spanner-head][one-way-head] slots unless otherwise indicated.

4. Sign Mounting Fasteners:

   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
   b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

D. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

E. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

D. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:

1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. [**Subsequent changeable inserts are by the Ownerthe Owner**][**Furnish two blank inserts for each sign for the Ownerthe Owner's use**].
2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. [**Subsequent changeable inserts are by the Ownerthe Owner**][**Furnish two blank inserts for each sign for the Ownerthe Owner's use**].
3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. [**Subsequent changeable sign panels are by the Owner**].

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessibility: Install signs in locations on walls [**as indicated on Drawings**][**and**][**according to the accessibility standard**].

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
3. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
4. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
5. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips [**0.250 inch (6.35 mm)**] away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
6. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified

requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by the Owner.

END OF SECTION 10 14 23 00A

SECTION 10 14 23 00B - POST AND PANEL_PYLON SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonilluminated post-and-panel signs.
2. Internally illuminated post-and-panel signs.
3. Nonilluminated pylon signs.
4. Internally illuminated pylon signs.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
2. Section 033000 "Cast-in-Place Concrete" for concrete foundations, concrete fill in postholes, and setting anchor bolts in concrete foundations for signs.
3. Section 101416 "Plaques" for one-piece, solid-metal signs, with or without frames.
4. Section 101423 "Panel Signage" and Section 101423.16 "Room-Identification Panel Signage" for wall-mounted sign panels.

1.2 DEFINITIONS

A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates and tolerance information for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signage.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least [**half size**].
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly, showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Post-and-Panel Signs: [**Full-size Sample**][**Not less than 12 inches (300 mm) square, including corner and post**].
2. Pylon Signs: [**Full-size Sample**][**Not less than 12 inches (300 mm) square, including corner**].
3. Variable Component Materials: [**Full-size Sample**][**8-inch (200-mm) Sample**] of each base material, character or graphic element, in each exposed color and finish not included in other Samples.
4. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**] of each accessory type.
5. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For post-and-panel and pylon signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Evaluation Reports: For [**post-installed anchors**][**and**][**power-actuated fasteners**], from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same product run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: [**12**] replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: [**One**] set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of [**anchorage devices**][**and**][**electrical service**] embedded in permanent construction by other installers by field measurements before fabrication, and indicate

measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of [**post-and-panel**][**pylon**] sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: [**As indicated on Drawings**].
2. Concentrated Horizontal Load: [**As indicated on Drawings**].
3. Other Design Load: [**As indicated on Drawings**].
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

D. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 POST-AND-PANEL SIGNS

A. Post-and-Panel Sign : Sign of [**single-panel**][**hollow-box**] configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACE Sign Systems, Inc.**]
b. [**Allen Industries**]
c. [**APCO Graphics, Inc**]
d. [**ASI Sign Systems, Inc**]
e. [**Bunting Graphics, Inc**]
f. [**Charleston Manufacturing, LLC**]
g. [**Clarke Systems**]
h. [**Diskey Sign Company**]
i. [**Foresight Supersign**]
j. [**Fossil Industries, Inc.**]
k. [**Nelson-Harkins Industries**]
l. [**Poblocki Sign Company, LLC**]
m. [**Signs & Decal Corp**]
n. [**Vista System, LLC**]
o. [**Vomar Products, Inc**]

2. Illuminated Sign: [**Backlighted**][**Edgelighted**] construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.

   a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**].
   b. Weeps: Provide weep holes to drain water at lowest part of exterior signs.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

3. Solid-Sheet Sign Panels[and Returns][Returns, and Back]: [Aluminum][Brass][Bronze][Copper][Stainless-steel][Acrylic][Fiberglass][Polycarbonate] sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph and as follows:

   a. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.060 inch (1.52 mm)**][**0.080 inch (2.03 mm)**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
   b. Surface-Applied Graphics: Applied [**vinyl film**][**baked enamel or powder coat**][**paint**][**photo image**].
   c. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
   d. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics [**flush with**][**slightly projecting from**] the sign panel.

4. Laminated, Aluminum-Sheet Sign Panels: Aluminum sheet laminated to both sides of [**acrylic**][**phenolic**] core sheet[**with painted edges**].

   a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
   b. Surface-Applied Graphics: Applied [**vinyl film**][**paint**][**photo image**].

5. Composite, Phenolic-Core Sign Panels: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.

   a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].

6. Single-Panel Sign Frame: [**Entire perimeter**][**Horizontal retainers**][**Vertical retainers**].

   a. Material: [**Aluminum**][**Brass**][**Bronze**][**Steel**][**Stainless steel**].
   b. Frame Depth: [**As indicated on Drawings**].
   c. Profile: [**Square**][**Beveled**][**Rounded**].
   d. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].
   e. Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

7. Hollow-Box Sign Frame: Entire perimeter framed with formed-aluminum sheet or extruded-aluminum, hollow-box-type frame with vertical edges attached to supports with aluminum fittings. Close top and bottom edges of panels with manufacturer's standard welded seams or extrusions.

   a. Hollow-Box Depth: [**2 inches (50 mm)**][**6 inches (150 mm)**][**Same depth as posts**].
   b. Profile: [**Square**][**Beveled**][**Rounded**].
   c. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].
   d. Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Sign-Frame Mounting: [**Between posts**][**Over posts**][**As indicated on Drawings**].
9. Multiple-Message Bars and Inserts: Fixed message bars capable of receiving changeable messages in the form of slide-in, [**aluminum**][**acrylic-sheet**] changeable inserts.[**Provide initial messages as indicated on Drawings.**]
10. Posts: [**Aluminum**][**Steel**].

    a. Shape: [**Round**][**Square**][**Rectangular**][**Semicircular**].
    b. Size: [**2-inch (50-mm) diameter**][**3-inch (75-mm) diameter**][**4-inch (100-mm) diameter**][**2 by 2 inches (50 by 50 mm)**][**3 by 3 inches (75 by 75 mm)**][**4 by 4 inches (100 by 100 mm)**][**2 by 4 inches (50 by 100 mm)**][**1-3/4 by 3 inches (44 by 75 mm)**].
    c. Installation Method: [**Direct burial**][**Baseplate**][**Sleeve**][**Reverse sleeve**].
    d. Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match sign-panel frame**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

11. Sign-Panel-Face Finish and Applied Graphics:

    a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**Mill finish raised surface with dark oxidized background**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
    b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
    c. Integral Stainless-Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
    d. Integral [**Acrylic**][**Fiberglass**][**Polycarbonate**] Sheet Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
    e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**match Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
    f. Painted Finish and Graphics: Manufacturer's standard, factory-applied [**exterior-grade sign paint**][**acrylic polyurethane**], in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from**

manufacturer's full range], as directed by the Owner.

g. Photo-Image Graphics: Manufacturer's standard [**black-and-white**][**multicolor**], [**600-dpi**] halftone or dot-screen image.

h. Overcoat: [**Manufacturer's standard baked-on clear coating**].

12. Text and Typeface: [**Times Roman**][**typeface as indicated by manufacturer's designation**][**typeface matching Architect's sample**][**typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**], as directed by the Owner.

2.3 PYLON SIGNS

A. Pylon Sign : Sign with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACE Sign Systems, Inc.**]
b. [**Allen Industries**]
c. [**APCO Graphics, Inc**]
d. [**ASI Sign Systems, Inc**]
e. [**Bunting Graphics, Inc**]
f. [**Charleston Manufacturing, LLC**]
g. [**Diskey Sign Company**]
h. [**Foresight Supersign**]
i. [**Nelson-Harkins Industries**]
j. [**Poblocki Sign Company, LLC**]
k. [**Signs & Decal Corp**]
l. [**Vista System, LLC**]
m. [**Vomar Products, Inc**]

2. Illuminated Sign: [**Backlighted**][**Edgelighted**] construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**].
b. Weeps: Provide weep holes to drain water at lowest part of exterior signs.

3. Solid-Sheet Sign Panels[and Returns][Returns, and Back]: [Aluminum][Brass][Bronze][Copper][Stainless-steel][Acrylic][Fiberglass][Polycarbonate] sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph and as follows:

a. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.060 inch (1.52 mm)**][**0.080 inch (2.03 mm)**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
b. Surface-Applied Graphics: Applied [**vinyl film**][**baked enamel or powder coat**][**paint**][**photo image**].
c. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
d. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics [**flush with**][**slightly projecting from**] the sign panel.

4. Laminated, Aluminum-Sheet Sign Panels: Aluminum sheet laminated to both sides of [**acrylic**][**phenolic**] core sheet[**with painted edges**].

   a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].
   b. Surface-Applied Graphics: Applied [**vinyl film**][**paint**][**photo image**].

5. Composite, Phenolic-Core Sign Panels: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.

   a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**].

6. Single-Panel Sign Frame: [**Entire perimeter**][**Horizontal retainers**][**Vertical retainers**].

   a. Material: [**Aluminum**][**Brass**][**Bronze**][**Steel**][**Stainless steel**].
   b. Frame Depth: [**As indicated on Drawings**].
   c. Profile: [**Square**][**Beveled**][**Rounded**].
   d. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].
   e. Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

7. Hollow-Box Sign Frame: Entire perimeter framed with formed-aluminum sheet or extruded-aluminum, hollow-box-type frame with vertical edges attached to supports with aluminum fittings. Close top and bottom edges of panels with manufacturer's standard welded seams or extrusions.

   a. Hollow-Box Depth: [**2 inches (50 mm)**][**6 inches (150 mm)**][**Same depth as external pylon frame**].
   b. Profile: [**Square**][**Beveled**][**Rounded**].
   c. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**].
   d. Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Sign-Frame Mounting: [**Between pylon supports**][**Over pylon supports**][**As indicated on Drawings**].
9. Multiple-Message Bars and Inserts: Fixed message bars capable of receiving changeable messages in the form of slide-in, [**aluminum**][**acrylic-sheet**] changeable inserts.[**Provide initial messages as indicated on Drawings.**]
10. Pylon Structure: [**Internal**][**External**] frame.

    a. Pylon Shape: [**Rectangular**][**Square**][**Triangular**][**Circular**].
    b. External-Frame Finish and Color: [**Mill**][**Black baked enamel or powder coat**][**Match sign-panel face**][**Match sign-panel frame**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

11. Sign-Panel-Face Finish and Applied Graphics:

    a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**Mill finish raised surface with dark oxidized background**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
    b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

c. Integral Stainless-Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.
d. Integral [**Acrylic**][**Fiberglass**][**Polycarbonate**] Sheet Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**match Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
f. Painted Finish and Graphics: Manufacturer's standard, factory-applied [**exterior-grade sign paint**][**acrylic polyurethane**], in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
g. Photo-Image Graphics: Manufacturer's standard [**black-and-white**][**multicolor**], [**600-dpi**] halftone or dot-screen image.
h. Overcoat: [**Manufacturer's standard baked-on clear coating**].

12. Text and Typeface: [**Times Roman**][**typeface as indicated by manufacturer's designation**][**typeface matching Architect's sample**][**typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**].

D. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**].

E. Copper Sheet: ASTM B152/B152M.

F. Steel Materials:

1. Metallic-Coated Steel Sheet: ASTM A653/A653M, [**G90 (Z275)**] coating, either commercial or forming steel.
2. Steel Sheet: [Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, Type B, exposed][electrolytic zinc-coated, ASTM A879/A879M, Coating Designation 08Z (24G), with steel sheet substrate according to ASTM A1008/A1008M, commercial steel, exposed].
3. Hot-Rolled, Structural-Steel Shapes: ASTM A36/A36M or ASTM A529/A529M.
4. Steel Members Fabricated from Plate or Bar Stock: ASTM A529/A529M or ASTM A572/A572M, **42,000-psi (290-MPa)** minimum yield strength.
5. Steel Tubing or Pipe: ASTM A500/A500M, Grade B.
6. Bolts for Steel Framing: ASTM A307 or ASTM F3125/F3125M, **Grade A325 (Grade A325M)** as necessary for design loads and connection details.
7. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

G. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

H. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

I. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

J. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.

K. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

L. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [nonferrous-metal][stainless-steel][hot-dip galvanized] devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

   a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   b. Fastener Heads: For nonstructural connections, use [**flathead**][**oval countersunk**] screws and bolts with tamper-resistant, [**Allen-head**][**spanner-head**] [**one-way-head**] slots unless otherwise indicated.

4. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on [ICC-ES AC01][ICC-ES AC193][ICC-ES AC58][ICC-ES AC308] as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.
2. Type: [Torque-controlled, expansion anchor][torque-controlled, adhesive anchor][adhesive anchor].
3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless-steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Anchoring Materials:

1. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
2. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

   a. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in locations concealed from view after final assembly.
2. Mill joints to tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
4. Conceal fasteners and anchors unless indicated to be exposed; locate exposed fasteners where they will be inconspicuous.
5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.

B. Sign Message Panels: Construct sign-panel surfaces to be smooth and to remain flat under installed conditions within a tolerance of plus or minus **1/16 inch (1.5 mm)** measured diagonally from corner to corner.

1. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
2. Increase panel thickness or reinforce with concealed stiffeners or backing materials as needed to produce surfaces without distortion, buckles, warp, or other surface deformations.
3. Continuously weld joints and seams unless other methods are indicated; grind, fill, and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.

C. Post Fabrication: Fabricate posts designed for structural performance indicated and of lengths required for installation method indicated for each sign.

1. Aluminum Posts: Manufacturer's standard **0.125-inch- (3.18-mm-)** thick, extruded-aluminum tubing unless otherwise indicated, with brackets or slots to engage sign panels. Include post caps, fillers, spacers, junction boxes, access panels, reinforcement where required for loading conditions, and related accessories required for complete installation.
2. Steel Posts: Fabricate from minimum [**0.120-inch- (3.05-mm-)**] thick, steel tubing unless otherwise indicated. Include post caps, fillers, spacers, junction boxes, access panels, reinforcement where required for loading conditions, and related accessories required for complete installation.

a. Hot-dip galvanize post assemblies after fabrication according to ASTM A123/A123M.

3. Direct Burial: Fabricate posts **36 inches (910 mm)** longer than height of sign to permit direct burial or embedment in concrete foundations or concrete-filled postholes.
4. Baseplates: Fabricate posts with baseplates welded to bottom of posts. Drill holes in baseplate for anchor-bolt connection.

   a. Provide [**preset**][**drilled-in-place**] anchor bolts of size required for connecting posts to concrete foundations.

5. Sleeves: Fabricate posts [**12 inches (300 mm)**] longer than height of sign to permit embedment in sleeves cast in concrete foundations or concrete-filled postholes. Provide sleeves by manufacturer, sized to receive outside diameter of posts. Size sleeves for direct embedment in concrete foundations or concrete-filled postholes and to prevent sign movement, but not less than [**24 inches (610 mm)**][**36 inches (910 mm)**] for embedment.
6. Reverse Sleeves: Provide inserts by sign manufacturer, sized for close fit inside posts. Size inserts for direct embedment in concrete foundations and to attach sign posts securely and prevent sign movement, but of a height not less than one-third of post height plus **36 inches (910 mm)** for embedment.

   a. Provide through bolts to fasten posts to inserts.

D. Pylon Fabrication: Fabricate pylon signs with integral base consisting of channels, angles, plates, or other fittings. Design and fabricate pylon and anchorage for structural performance indicated. Detail anchorage so that water can drain out of assembly without obstruction. Drill holes in members for anchor-bolt connection. Provide anchor bolts of size required for connecting base to concrete foundations.

1. Internal Frames: Manufacturer's standard internal steel framing system and anchorage, modified as required for Project requirements. Provide welded construction. Cut, drill, and tap units to receive hardware, bolts, and similar items.

   a. Hot-dip galvanize steel framing system after fabrication according to ASTM A123/A123M.

2. External Frames: Manufacturer's standard external [**aluminum**][**steel**] framing system and anchorage for direct attachment of sign message panels, modified as required for Project requirements. Provide welded construction using mitered joints. Cut, drill, and tap units to receive hardware, bolts, and similar items.

   a. Hot-dip galvanize steel framing system after fabrication according to ASTM A123/A123M.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 METALLIC-COATED STEEL FINISHES

A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

2.10 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.

1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

2.11 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs.

C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

D. Verify that electrical service is correctly sized and located to accommodate signs.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLING POSTS

A. Vertical Tolerance: Set posts plumb within a tolerance of [**1/16 inch in 3 feet (2 mm in 1 m)**].

B. Direct-Burial Method:

1. Excavation: Excavate posthole to dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional [**12 inches (300 mm)**], backfilling with satisfactory soil or well-graded aggregate, and compacting to original subgrade elevation.
2. Setting in Earth: Set post in position, support to prevent movement, and backfill with satisfactory soil or well-graded aggregate as recommended in writing by manufacturer. Place and compact backfill in **6-inch (150-mm)** lifts, compacting each lift.
3. Setting in Cast-in-Place Concrete: Set post in position, support to prevent movement, and place concrete [in posthole][for concrete foundation] as indicated on Drawings.
4. Setting in Preformed Hole in Concrete Foundation: Form or core drill holes in concrete foundation not less than 3/4 inch (20 mm) larger than outside dimension of post for installing posts in concrete. Set post in position, shim to prevent movement, and fill annular space between post and hole with [nonshrink, nonmetallic grout][anchoring cement], mixed and placed to comply with manufacturer's written instructions.

a. Cover anchorage joint in concrete foundations with flange of same metal and finish as

post, [**welded to post after placing anchoring material**][**attached to post with set screws**].

b. Leave anchorage joint exposed with [**1/8-inch (3-mm) anchoring material sloped away from post**][**anchoring material flush with adjacent surface**].

C. Baseplate Method:

1. Preset Anchor Bolts: Set post baseplate in position over anchor bolts projecting from concrete foundation, shim and support post to prevent movement, place washers and nuts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.
2. Drilled-in-Place Anchor Bolts: Set post baseplate in position over concrete foundation, locate and drill anchor holes, shim and support post to prevent movement, place washers and anchor bolts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

D. Sleeve Method: Set post in position in sleeve and support post to prevent movement, fill annular space between post and sleeve with [nonshrink, nonmetallic grout][anchoring cement], mixed and placed to comply with manufacturer's written instructions.

1. Cover anchorage joint with flange of same metal and finish as post, [**welded to post after placing anchoring material**][**attached to post with set screws**].
2. Leave anchorage joint exposed with [**1/8-inch (3-mm) anchoring material sloped away from post**][**anchoring material flush with adjacent surface**].

E. Reverse-Sleeve Method: Set post in position over the projecting insert and support post to prevent movement, drill posts and inserts for through bolts, and install and tighten through bolts.

3.4 INSTALLING PYLONS

A. Vertical Tolerance: Install pylons plumb within a tolerance of [**1/16 inch in 3 feet (2 mm in 1 m)**].

B. Attachment with Preset Anchor Bolts: Set pylon base in position over anchor bolts projecting from concrete foundation, shim and support pylon to prevent movement, place washers and nuts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

C. Attachment with Drilled-in-Place Anchor Bolts: Set pylon base in position over concrete foundation, locate and drill anchor holes, shim and support pylon to prevent movement, place washers and anchor bolts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

3.5 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by the Owner.

END OF SECTION 10 14 23 00B

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SECTION 10 14 23 00C - MODULAR SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular signs.

B. Related Requirements:

1. Section 101300 "Directories" for building directories enclosed in cases or illuminated.
2. Section 101423 "Panel Signage" for one-piece signs.
3. Section 101423.16 "Room-Identification Signage" for panel-type room-identification signs.
4. Section 101426 "Post and Panel/Pylon Signage" for freestanding signs.

1.2 ACTION SUBMITTALS

A. Product Data: Modular signs.

B. Product Data Submittals:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

D. Shop Drawings: For modular signs.

1. Include plans, elevations, sections, and mounting details.
2. Show message list, typestyles, graphic elements[including raised characters and Braille], and layout for each sign at least [half size].

E. Samples for Initial Selection: For each type of modular sign, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

F. Samples for Verification: For each type of modular sign showing each component and with the required finishes, in manufacturer's standard size unless otherwise indicated and as follows:

1. Modular Signs: [**Full-size Sample**][**Not less than 12 inches (300 mm) square, including corner**]; including one of each type insert indicated.

G. Product Schedule: For modular signs. Use same designations indicated on Drawings or specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same product run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Inserts: Full-size blank inserts equal to [**10**] percent of number installed for each size indicated, but no fewer than [**20**].
2. Tools: One set of specialty tools for replacing inserts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.2 MODULAR SIGNS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**2/90 Sign Systems**]
2. [**APCO Graphics, Inc**]
3. [**Appenx, Inc.**]
4. [**ASI Sign Systems, Inc**]
5. [**Best Sign Systems, Inc.**]
6. [**Clarke Systems**]
7. [**inpro Corporation**]
8. [**Vista System, LLC**]

B. Sign System: Sign with removable inserts for graphics and copy attached to a receiver frame system using clips, splines, or comparable method. Provide system with modular increments of height and width, permitting assembly of units with multiple inserts of varying size.

1. Sign Size: [**As indicated**].
2. Provide tamper-resistant feature requiring special tool to change inserts.
3. Backer Panel: Shaped, decorative backing panel mounted behind modular signage system [**as indicated**][**as selected from manufacturer's full range**].
4. Double-Faced Signs: Provide signs with two faces back-to-back for signs suspended from ceiling or mounted perpendicular to wall, and as indicated.

C. Inserts:

1. Module Height: System of inserts fabricated in multiples of [**manufacturer's standard dimension**][**9/16 inch (15 mm)**][**1 inch (25 mm)**][**1.25 inches (32 mm)**].
2. Type: [**Extruded aluminum for applied graphics**][**Rigid plastic for applied graphics**][**Extruded aluminum with slots for secondary inserts**].

   a. Secondary Inserts: [**Transparent plastic lens to cover paper inserts**][**ADA compliant with raised text and Braille**][**Opaque plastic with surface graphics**].

3. Finish: [**Anodized**][**Painted**][**Plastic laminate**].
4. Color and Pattern: [**One**][**Two**] color(s), [**indicated by manufacturer's designation**][**selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Graphics and Copy:

1. Surface Applied: [**Die-cut vinyl film**][**Silk-screen**][**Direct print**][**Paint**][**Photo image**].
2. Raised, ADA Compliant: [**Manufacturer's standard**][**Applied**][**Photopolymer**][**Subsurface**] raised characters and Braille .
3. Etched and Filled: Sign face etched or routed to receive enamel-paint infill.
4. Engraved: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
5. Text and Typeface: [**Times Roman**][**Arial**][**Typeface as indicated by manufacturer's designation**][**Typeface matching Architect's sample**][**Typeface as selected by Architect from manufacturer's full range**].[**Finish raised characters to contrast with background color, and finish Braille to match background color.**], as directed by the Owner

E. End Caps and Trim:

1. Side Trim: Continuous [**extruded-aluminum**] trim attached to message-strip receiver frame.
2. End Caps: [**Individual snap-on caps for each message strip**][**Snap-on caps covering ends of multiple message strips**].
3. Profile: [**Narrow**][**Square**][**Bevel**][**Radius corner**][**Quarter round**][**Stepped**][**Contoured**].
4. Top and Bottom Trim: [**Message strips with integral trim profile to provide finished appearance**][**Extruded-aluminum trim section, attached to message-strip receiver frame**]. Provide [**narrow face**][**square**][**bevel**][**contoured**] profile.

F. Mounting: Mount modular signs to wall surfaces using [manufacturer's standard method][adhesive][two-faced tape][magnetic tape][hook-and-loop tape][screws].

1. Suspended Mounting: Provide hanger and bracket designed to support signs from [**suspended ceiling grid**][**building structure**]. Factory finish to match [**sign-background color**][**Architect's sample color**] unless otherwise indicated, as directed by the Owner.
2. Perpendicular Wall Mount: Provide bracket designed to support signs perpendicular to wall surface, and to suit mounting conditions. Attach with screws or other method capable of supporting weight of sign. Factory finish to match [**sign-background color**][**Architect's sample color**] unless otherwise indicated, as directed by the Owner.

G. Accessories: Provide [**sliding insert to indicate room occupancy**][**user-changeable paper insert feature**][**note gripper**][**pen holder**] where indicated.

2.3 MATERIALS

A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Plastic-Laminate Sheet: ISO 4586-3, Grade HGS.

C. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form copy indicated on Drawings.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined. Use concealed fasteners and anchors unless indicated to be exposed.

B. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**] g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

D. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

E. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

2.5 FABRICATION

A. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.

B. Subsurface-Applied Graphics: Apply graphics to back of clear face-sheet material to produce precisely formed image. Image to be free of rough edges.

C. Subsurface-Engraved Graphics: Reverse engrave back of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

D. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting finishes on raised features unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install signs using mounting methods indicated and in accordance with manufacturer's written instructions.

B. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.

C. Accessible Signage: Install in locations on walls [**as indicated on Drawings**][**and**][**in accordance with the accessibility standards**].

D. Clean substrate of [**adhesives**][**and**][**tapes**] to remove materials that would adversely affect bond. Use materials and quantities sufficient to support weight of sign after cure without slippage. Keep [**adhesives**][**and**][**tapes**] away from edges to prevent visibility at sign edges.

3.3 ADJUSTING AND CLEANING

A. Touch up factory-applied finishes to restore damaged or soiled areas.

B. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 10 14 23 00C

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SECTION 10 14 23 00D - PAINTED SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field-lettered signs painted directly on substrates in good condition.
2. Wall-identification signs for fire and smoke assemblies.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
2. Section 099423 " Gilding" for gilding surfaces and gilding applied to painted signs.
3. Section 101423 "Panel Signage" for field-applied, vinyl-character signs.
4. Section 321723 "Pavement Markings" for signage painted on pavements.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

B. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

C. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

E. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

F. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

G. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For painted signs.

1. Show sign locations and mounting heights.
2. Show message list, typestyles, graphic elements, and layout for each sign at least [**half size**].

D. Product Schedule: For painted signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Color Matching Certificate: For computer color matching of colors.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and sign location on building.

1. Quantity: Furnish the Owner with an additional [**3**][**5**][**7**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.7 QUALITY ASSURANCE

A. Color Matching: Custom computer-match paint colors to colors indicated [**in sign schedule at the end of Part 3**][**on Drawings**].[**For colors indicated by a standardized coding system, obtain a color chip for each color indicated from the color-coding-system company; computer-match paint colors to the color chips.**]

B. Mockups: Prepare mockups of painted signs for each type of sign material and substrate indicated and each color and finish required to demonstrate aesthetic effects and to set quality standards for materials and execution. Duplicate appearance of approved Sample submittals.

1. Locate mockups [**on existing surfaces where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**], as directed by the Owner.
2. Sign Mockups: [**Two**] sign texts that represent surfaces and conditions for signage application under same conditions as the completed Work.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with painting signs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to have painted signs are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.

PART 2 - PRODUCTS

2.1 SIGN PAINT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Matthews Paint; A Subsidiary of PPG**]
2. [**Ronan Paints; Coventry Coatings Company**]

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.3 PAINTED SIGNS

A. Painted Sign : Sign painted directly on indicated substrate, including primers, sealers, undercoats, and transition coats as required.

1. Paint Type: [**Alkyd**][**Epoxy**][**Latex**][**Polyurethane**].

a. Gloss: [**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**].

2. Substrate: [**As indicated on Drawings**][**As scheduled**][**Painted surface**][**Concrete**][**Stone**][**Glazed block**][**Glass**][**Wood**].
3. Text and Typeface: [**Arial**][**Times Roman**][**As indicated on Drawings**][**As scheduled**][**Match Architect's sample**][**Match design reference sample**], as directed by the Owner.

a. Size: [**As indicated on Drawings**][**As scheduled**][**2 in. (51 mm) based on height of uppercase "I" letter**].
b. Color: [**As indicated on Drawings**][**As scheduled**][**Black**].

4. Background: [**Characters outlined**][**Overall rectangular background**].

a. Thickness or Extent: [**As indicated on Drawings**][**As scheduled**].
b. Color: [**As indicated on Drawings**][**As scheduled**][**Light gray**].

B. Wall-Identification Sign : Sign applied directly on indicated substrate to identify fire and smoke assemblies, including preparatory treatment as required.

1. Sign Material: Stenciled-on [alkyd][latex][VOC-compliant spray-applied] paint or preprinted, self-

adhesive decals .

2. Font: Minimum [**3 inches (76 mm)**] high characters in a contrasting color, with minimum [**0.375-inch (9.5-mm)**] wide strokes.
3. Text: [**"FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS."**][**"1-HOUR FIRE BARRIER - PROTECT ALL OPENINGS."**][**"2-HOUR FIRE BARRIER - PROTECT ALL OPENINGS."**][**"SMOKE BARRIER - PROTECT ALL OPENINGS."**]

2.4 PAINT MATERIALS

A. Sign Paints and Coatings: Inks, dyes, and paints that are recommended in writing by manufacturer for optimum adherence to substrate and are UV and water resistant for colors and exposure indicated.

1. Compatibility: Provide paint materials that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

B. VOC Content. LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Clear Wood Finishes, Varnishes: 350 g/L.
9. Clear Wood Finishes, Lacquers: 550 g/L.
10. Floor Coatings: 100 g/L.
11. Shellacs, Clear: 730 g/L.
12. Shellacs, Pigmented: 550 g/L.
13. Stains: 250 g/L.

C. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. VOC Content, LEED v4: For field applications[**that are inside the weatherproofing system**], paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Clear Wood Finishes, Varnishes: 275 g/L.
9. Clear Wood Finishes, Lacquers: 275 g/L.

10. Floor Coatings: 50 g/L.
11. Shellacs, Clear: 730 g/L.
12. Shellacs, Pigmented: 550 g/L.
13. Stains: 100 g/L.

E. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Nonflat - High-Gloss Coatings: 150 g/L.
    d. Concrete/Masonry Sealers: 100 g/L.
    e. Dry-Fog Coatings: 150 g/L.
    f. Floor Coatings: 100 g/L.
    g. Industrial Maintenance Coatings: 250 g/L.
    h. Low-Solids Coatings: 120 g/L.
    i. Mastic Texture Coatings: 100 g/L.
    j. Metallic Pigmented Coatings: 500 g/L.
    k. Pretreatment Wash Primers: 420 g/L.
    l. Primers, Sealers, and Undercoaters: 100 g/L.
    m. Reactive Penetrating Sealers: 350 g/L.
    n. Recycled Coatings: 250 g/L.
    o. Rust-Preventive Coatings: 250 g/L.

G. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoats: 100 g/L.
    d. Floor Coatings: 100 g/L.
    e. Shellacs, Clear: 730 g/L.
    f. Shellacs, Pigmented: 550 g/L.
    g. Stains: 250 g/L.
    h. Clear Wood Finishes (Varnishes, Sanding Sealers, and Lacquers): 275 g/L.

H. VOC Content: For field applications inside the building, wall paints shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Interior Flat Latex Wall Paint: 50 g/L.

2. Interior Nonflat Latex Wall Paint: 150 g/L.

I. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance. Comply with paint manufacturer's written instructions for inspection.

B. If existing surfaces cannot be prepared to an acceptable condition for proper painting, notify Architect in writing, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surface is dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Appearance Standard: Completed sign work shall have a sharp and uniformly delineated appearance as viewed by Architect from building interior at [**5 feet (1.5 m)**][**10 feet (3 m)**] away from painted surface and from building exterior at [**20 feet (6 m)**][**50 feet (15 m)**] away from painted surface, as directed by the Owner.

B. Comply with manufacturers' written instructions for surface preparation and paint-application for each substrate condition.

C. Apply a transition coat over incompatible existing coatings and substrate materials.

D. Apply primers, sealers, undercoats, and transition coats so that they do not extend beyond the limits of the painted signage. Remove excess without damaging the substrate.

E. Install signs level, plumb, true to line, with uniform delineation and borders, and at locations and heights indicated.

1. Prespaced characters with template, cutout stencil, or ruler and straightedge.

F. Accessible Signage: Install in locations on walls [**as indicated on Drawings**][**and**][**according to accessibility standard**].

G. Signs Painted on Glass: Provide opaque[black] paint matching painted sign material and finish onto opposite side of glass to conceal back of sign.

3.3 MARKING FIRE AND SMOKE ASSEMBLIES

A. Wall-Identification Signs: Permanently identify both sides of each fire and smoke assembly indicated on Drawings. Place signs in accessible, concealed floor, floor-ceiling, or attic space at maximum [**15 feet (4.57 m)**] from end of wall and at maximum intervals of [**30 feet (9.14 m)**], measured horizontally along the assembly. Locate signs for greatest visibility in the space.

3.4 ADJUSTING AND CLEANING

A. Remove and reapply damaged or deformed signs and signs that do not comply with specified requirements. Reapply signs with damaged or deteriorated finishes that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. After completing sign application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition, as directed by the Owner.

D. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 10 14 23 00D

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Task	Specification	Specification Description
10 14 23 11	10 14 23 00b	Post And Panel_Pylon Signage
10 21 13 00	01 22 00 00	No Specification Required

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SECTION 10 21 13 13 - METAL TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal toilet compartments.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach [**ceiling-hung compartments**][**floor-and-ceiling-anchored compartments**][**and**][**post-to-ceiling screens**] to overhead structural system.
2. Section 061000 "Rough Carpentry" for [**blocking**][**overhead support of floor-and-ceiling-anchored compartments**][**and**][**overhead support of post-to-ceiling screens**].
3. Section 092216 "Non-Structural Metal Framing" for blocking.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for [**overhead supports,**]blocking, reinforcing, and other supports concealed within wall[**and ceiling**] to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Metal toilet compartments.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
4. Show locations of centerlines of toilet fixtures.
5. Show locations of floor drains.
6. Show[**ceiling grid, ceiling-mounted items, and**] overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished product for each type of toilet compartment, hardware, and accessory.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: [**One**] door bumper(s) with associated fasteners.
4. Door Pull: [**One**] door pull(s) with associated fasteners.
5. Fasteners: [**10**] fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**][**75**][**200**] or less.
2. Smoke-Developed Index: 450 or less.

I. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

J. Regulatory Requirements: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for toilet compartments designated as accessible.

2.3 METAL TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Metal Corp**]
2. [**American Sanitary Partition Corporation**]
3. [**ASI Accurate Partitions**]
4. [**ASI Global Partitions**]
5. [**Bradley Corporation**]
6. [**Flush Metal Partitions**]
7. [**General Partitions Mfg. Corp**]
8. [**Hadrian Inc.; Zurn Industries, LLC**]
9. [**Metpar Corp**]

B. Toilet-Enclosure Style: [Overhead braced][Floor anchored][Ceiling hung][Floor-and-ceiling anchored][privacy type].

C. Entrance-Screen Style: [**Overhead braced**][**Floor anchored**][**Ceiling hung**][**Floor-and-ceiling anchored**].

D. Urinal-Screen Style: [**Wall hung, flat panel**][**Wall hung with integral flanges**][**Wall hung, wedge shaped**][**Floor anchored**][**Overhead braced**][**Post to ceiling**].

E. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth.[**Provide with no-sightline system consisting of a full-height continuous stop on latch side of door and full-height continuous filler strip on hinge side of door (unless continuous hinge is used).**] Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of **1 inch (25 mm)** for doors and panels and **1-1/4 inches (32 mm)** for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand specified structural performance requirements.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

F. Entrance Screen Construction: Matching panel construction.

G. Urinal-Screen Construction:

1. Flat-Panel Urinal Screen: Matching panel construction.
2. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum **1-1/4 inches (32 mm)** thick.
3. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum **6 inches (152 mm)** wide at wall and minimum **1 inch (25 mm)**

wide at protruding end.

H. Facing Sheets and Closures: [Electrolytically coated steel][hot-dip galvanized-steel] sheet with nominal base-metal (uncoated) thicknesses as follows:

1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than **0.036 inch (0.91 mm)**.
2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than **0.048 inch (1.21 mm)**.
3. Panels: [**Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm)**][**0.036 inch (0.91 mm)**].
4. Doors: Manufacturer's standard thickness, but not less than **0.030 inch (0.76 mm)**.
5. Entrance Screens: Thickness matching panels.
6. Flat-Panel Urinal Screens: Thickness matching panels.
7. Integral-Flange, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than **0.030 inch (0.76 mm)**.
8. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than **0.036 inch (0.91 mm)**.

I. Pilaster Shoes: Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

J. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

K. Urinal-Screen Post: Manufacturer's standard post design of [material matching the thickness and construction of pilasters][1-3/4-inch- (44-mm-) square, aluminum tube with satin finish]; with shoe[and sleeve (cap)] matching that on the pilaster.

L. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets; [**chrome-plated zamac**][**stainless steel**].
2. Full-Height (Continuous) Type: Manufacturer's standard design; [**stainless steel**][**aluminum**].

M. Steel Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Apply [**one color**][**two colors**] in each room.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.

1. Hinges:

a. Manufacturer's gravity-actuated, cam-action, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.

1) Material, Gravity-Type Hinge: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

b. Manufacturer's continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.

1) Material, Continuous, Cam-Type Hinge: Stainless steel.

c. Manufacturer's continuous, spring-loaded type, allowing emergency access by lifting door.

1) Material, Continuous, Spring-Loaded Hinge: [**Stainless steel**][**Aluminum**][**Manufacturer's standard**].

d. Manufacturer's standard hinge.

2. Latch and Keeper: Manufacturer's [**recessed**][**recessed, with occupancy indicator**][**surface-mounted**] latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

3. Coat Hook: Manufacturer's combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors.

a. Material: Manufacturer's standard.

5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

B. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.

1. Hinges: Manufacturer's minimum **0.062-inch- (1.59-mm-)** thick, stainless steel [**gravity-actuated, cam-action, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees**][**continuous, cam type that swings to a closed or partially open position**][**continuous, spring-loaded type**], allowing emergency access by lifting door. Mount with through bolts.
2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible. Mount with through bolts.
3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at outswinging doors. Mount with through bolts.
5. Door Pull: Manufacturer's heavy-duty, cast stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible. Mount with through bolts.

C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

C. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.

1. Electrolytically Zinc Coated: ASTM A879/A879M, **01Z (03G)**.
2. Hot-Dip Galvanized: ASTM A653/A653M, either hot-dip galvanized or galvannealed.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

E. Stainless Steel Castings: ASTM A743/A743M.

F. Zamac: ASTM B86, commercial zinc-alloy die castings, chrome plated.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories, and solid blocking within panel where required for attachment of toilet accessories.

B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Ceiling-Hung Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

E. Floor-and-Ceiling-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

F. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment at[**tops and**] bottoms of posts. Provide shoes[**and sleeves (caps)**] at posts to conceal anchorage.

G. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide, inswinging doors for standard toilet enclosures and **36-inch- (914-mm-)** wide, outswinging doors with a minimum **32-**

inch- (813-mm-) wide, clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position indicated with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels or Screens: 1/2 inch (13 mm).
b. Panels or Screens and Walls: 1 inch (25 mm).

2. Stirrup Brackets: Secure panels or screens to walls and to pilasters with no fewer than [**two brackets attached**][**three brackets attached at midpoint and**] near top and bottom of panel.

a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and

tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 13 13

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Task	Specification	Specification Description
10 21 13 13	01 22 00 00	No Specification Required

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SECTION 10 21 13 14 - STAINLESS STEEL TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless steel toilet compartments.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach [**ceiling-hung compartments**][**floor-and-ceiling-anchored compartments**][**and**][**post-to-ceiling screens**] to overhead structural system.
2. Section 061000 "Rough Carpentry" for [**blocking**][**overhead support of floor-and-ceiling-anchored compartments**][**and**][**overhead support of post-to-ceiling screens**].
3. Section 092216 "Non-Structural Metal Framing" for blocking.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for [**overhead supports,**]blocking, reinforcing, and other supports concealed within wall[**and ceiling**] to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Stainless steel toilet compartments.

   a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
4. Show locations of centerlines of toilet fixtures.
5. Show locations of floor drains.
6. Show[**ceiling grid, ceiling-mounted items, and**] overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available finishes for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: [**One**] door bumper(s) with associated fasteners.
4. Door Pull: [**One**] door pull(s) with associated fasteners.
5. Fasteners: [**10**] fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain stainless steel toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**][**75**][**200**] or less.
2. Smoke-Developed Index: 450 or less.

I. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

J. Regulatory Requirements: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for toilet compartments designated as accessible.

2.3 STAINLESS STEEL TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Metal Corp**]
2. [**American Sanitary Partition Corporation**]
3. [**ASI Accurate Partitions**]
4. [**ASI Global Partitions**]
5. [**Bradley Corporation**]
6. [**Flush Metal Partitions**]
7. [**General Partitions Mfg. Corp**]
8. [**Hadrian Inc.; Zurn Industries, LLC**]
9. [**Metpar Corp**]

B. Toilet-Enclosure Style: [Overhead braced][Floor anchored][Ceiling hung][Floor-and-ceiling anchored][privacy type].

C. Entrance-Screen Style: [**Overhead braced**][**Floor anchored**][**Ceiling hung**][**Floor-and-ceiling anchored**].

D. Urinal-Screen Style: [**Wall hung flat panel**][**Wall hung with integral flanges**][**Wall hung, wedge shaped**][**Floor anchored**][**Overhead braced**][**Post to ceiling**].

E. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth.[**Provide with no-sightline system consisting of a full-height continuous stop on latch side of door and full-height continuous filler strip on hinge side of door (unless continuous hinge is used).**] Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of **1 inch (25 mm)** for doors and panels and **1-1/4 inches (32 mm)** for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand specified structural performance requirements.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

F. Entrance-Screen Construction: Matching panel construction.

G. Urinal-Screen Construction:

1. Flat-Panel Urinal Screen: Matching panel construction.
2. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum **1-1/4 inches (32 mm)** thick.
3. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum **6 inches (152 mm)** wide at wall and minimum **1 inch (25 mm)**

wide at protruding end.

H. Facing Sheets and Closures: Stainless steel sheet of nominal thicknesses as follows:

1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than **0.038 inch (0.95 mm)**.
2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than **0.050 inch (1.27 mm)**.
3. Panels: [**Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm)**][**0.038 inch (0.95 mm)**].
4. Doors: Manufacturer's standard thickness, but not less than **0.031 inch (0.79 mm)**.
5. Entrance Screens: Thickness matching panels.
6. Flat-Panel Urinal Screens: Thickness matching panels.
7. Integral-Flange, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than **0.031 inch (0.79 mm)**.
8. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than **0.038 inch (0.95 mm)**.

I. Pilaster Shoes: Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

J. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

K. Urinal-Screen Post: Manufacturer's standard post design of [material matching the thickness and construction of pilasters][1-3/4-inch- (44-mm-) square, aluminum tube with satin finish]; with shoe[and sleeve (cap)] matching that on the pilaster.

L. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets; [**chrome-plated zamac**][**stainless steel**].
2. Full-Height (Continuous) Type: Manufacturer's standard design; [**stainless steel**][**aluminum**].

M. Stainless Steel Finish: [**Directional Satin Finish: ASTM A480/A480M, No. 4**][**Manufacturer's standard textured finish**] on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.

1. Hinges:

a. Manufacturer's gravity-actuated, cam-action, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.

1) Material, Gravity-Type Hinge: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

b. Manufacturer's continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.

1) Material, Continuous, Cam-Type Hinge: Stainless steel.

c. Manufacturer's continuous, spring-loaded type, allowing emergency access by lifting door.

1) Material, Continuous, Spring-Loaded Hinge: [**Stainless steel**][**Aluminum**][**Manufacturer's standard**].

d. Manufacturer's standard hinge.

2. Latch and Keeper: Manufacturer's [**recessed**][**recessed, with occupancy indicator**][**surface-mounted**] latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

3. Coat Hook: Manufacturer's combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors.

a. Material: Manufacturer's standard.

5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

B. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.

1. Hinges: Manufacturer's minimum **0.062-inch- (1.59-mm-)** thick, stainless steel [**gravity-actuated, cam-action, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees**][**continuous, cam type that swings to a closed or partially open position**][**continuous, spring-loaded type**], allowing emergency access by lifting door. Mount with through bolts.
2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible. Mount with through bolts.
3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at outswinging doors. Mount with through bolts.
5. Door Pull: Manufacturer's heavy-duty, cast stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible. Mount with through bolts.

C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt

applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel anchors compatible with related materials.

2.5 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories and solid blocking within panel where required for attachment of toilet accessories.

B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Ceiling-Hung Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

E. Floor-and-Ceiling-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

F. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment nuts at[**tops and**] bottoms of posts. Provide shoes[**and sleeves (caps)**] at posts to conceal anchorage.

G. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide inswinging doors for standard toilet enclosures and **36-inch- (914-mm-)** wide outswinging doors with a minimum **32-inch- (813-mm-)** wide clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels or Screens: **1/2 inch (13 mm)**.
b. Panels or Screens and Walls: **1 inch (25 mm)**.

2. Stirrup Brackets: Secure panels or screens to walls and to pilasters with no fewer than [**two brackets attached**][**three brackets attached at midpoint and**] near top and bottom of panel.

a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than **2 inches (51 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb,

rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 13 14

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Task	Specification	Specification Description
10 21 13 14	01 22 00 00	No Specification Required
10 21 13 14	10 21 13 13	Metal Toilet Compartments

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SECTION 10 21 13 16 - PLASTIC-LAMINATE-CLAD TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad toilet compartments.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach [**ceiling-hung compartments**][**floor-and-ceiling-anchored compartments**][**and**][**post-to-ceiling screens**] to overhead structural system.
2. Section 061000 "Rough Carpentry" for [**blocking**][**overhead support of floor-and-ceiling-anchored compartments**][**and**][**overhead support of post-to-ceiling screens**].
3. Section 092216 "Non-Structural Metal Framing" for blocking.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for [**overhead supports,**]blocking, reinforcing, and other supports concealed within wall[**and ceiling**] to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-clad toilet compartments.

   a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show[**ceiling grid, ceiling-mounted items, and**] overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
12. Product Data: For adhesives, indicating VOC content.
13. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
14. Product Data: For particleboard, indicating that product contains no urea formaldehyde.
15. Laboratory Test Reports: For particleboard, indicating compliance with requirements for low-emitting materials.
16. Laboratory Test Reports: For particleboard, indicating compliance with requirements for low-emitting materials.
17. Product Data: For particleboard, indicating compliance with requirements for formaldehyde emissions.
18. Product Data: For particleboard, indicating that product contains no urea formaldehyde.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: [**One**] door bumper(s) with associated fasteners.
4. Door Pull: [**One**] door pull(s) with associated fasteners.
5. Fasteners: [**10**] fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain plastic-laminate-clad toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**][**75**][**200**] or less.
2. Smoke-Developed Index: 450 or less.

G. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

H. Regulatory Requirements: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for toilet compartments designated as accessible.

2.3 PLASTIC-LAMINATE-CLAD TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Metal Corp**]
2. [**American Sanitary Partition Corporation**]
3. [**ASI Accurate Partitions**]
4. [**ASI Global Partitions**]
5. [**Bobrick Washroom Equipment, Inc**]
6. [**Decolam**]
7. [**Flush Metal Partitions**]
8. [**General Partitions Mfg. Corp**]
9. [**Metpar Corp**]
10. [**Weis/Robart Partitions, Inc.**]

B. Toilet-Enclosure Style: [Overhead braced][Floor anchored][Ceiling hung][Floor-and-ceiling anchored][privacy type].

C. Entrance-Screen Style: [**Overhead braced**][**Floor anchored**][**Ceiling hung**][**Floor-and-ceiling anchored**].

D. Urinal-Screen Style: [**Wall hung**][**Floor anchored**][**Overhead braced**][**Post to ceiling**].

E. Door, Panel, and Pilaster Construction: One-piece, plastic-laminate facing sheets pressure laminated to core material without splices or joints in facings or cores; with [**manufacturer's standard edge trim**][**laminate**] applied to edges before faces to seal edges and prevent laminate from being pried loose. Seal exposed core material at cutouts to protect core from moisture.[**Provide with no-sightline system consisting of a full-height continuous stop on latch side of door and full-height continuous filler strip on hinge side of door (unless continuous hinge is used).**]

1. Core Material:

   a. Door and Panel: [**Particleboard**].
   b. Pilaster: [**Manufacturer's standard**][**particleboard**].

2. Thickness:

   a. Doors and Panels: Finished to not less than **1 inch (25 mm)** thick.
   b. Pilasters: Finished to not less than **1-1/4 inches (32 mm)** thick[**and with internal, nominal 0.134-inch- (3.42-mm-) thick, steel sheet reinforcement**].

F. Entrance-Screen Construction: Matching panel construction.

G. Urinal-Screen Construction: Matching panel construction.

H. Pilaster Shoes: Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

I. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

J. Urinal-Screen Post: Manufacturer's standard post design of [material matching the thickness and construction of pilasters][1-3/4-inch- (44-mm-) square, aluminum tube with satin finish]; with shoe[and sleeve (cap)] matching that on the pilaster.

K. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, [**chrome-plated zamac**][**stainless steel**].
2. Full-Height (Continuous) Type: Manufacturer's standard design; [**stainless steel**][**aluminum**].

L. Plastic-Laminate Finish: [**One color**][**Two colors**] in each room.

1. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.[**Mount with through bolts.**]

1. Hinges:

a. Manufacturer's gravity-actuated, cam-action, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.

1) Material, Gravity-Type Hinge: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

b. Manufacturer's continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.

1) Material, Continuous, Cam-Type Hinge: Stainless steel.

c. Manufacturer's continuous, spring-loaded type, allowing emergency access by lifting door.

1) Material, Continuous, Spring-Loaded-Type Hinge: Stainless steel.

d. Manufacturer's standard hinge.

2. Latch and Keeper: Manufacturer's [**recessed**][**recessed, with occupancy indicator**][**surface-mounted**] latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

3. Coat Hook: Manufacturer's combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors.

a. Material: Manufacturer's standard.

5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel anchors compatible with related materials.

2.5 MATERIALS

A. Particleboard: ANSI A208.1, Grade M-2.

1. Particleboard shall be made without urea formaldehyde.
2. Particleboard shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Particleboard shall be made without urea formaldehyde.
4. Particleboard shall have formaldehyde emission rates not greater than 0.09 ppm when tested according to ASTM D 6007 or ASTM E 1333.
5. Particleboard shall be made without urea formaldehyde.

B. Plastic Laminate: ISO 4586-3, general-purpose HGS grade.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Adhesives: Do not use adhesives that contain urea formaldehyde.

G. Adhesives: Do not use adhesives that contain urea formaldehyde.

H. Aluminum Castings: ASTM B26/B26M.

I. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

J. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

K. Stainless Steel Castings: ASTM A743/A743M.

L. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Ceiling-Hung Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

E. Floor-and-Ceiling-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

F. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment nuts at[**tops and**] bottoms of posts. Provide shoes[**and sleeves (caps)**] at posts to conceal anchorage.

G. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide inswinging doors for standard toilet enclosures and **36-inch- (914-mm-)** wide outswinging doors with a minimum **32-inch- (813-mm-)** wide clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels or Screens: **1/2 inch (13 mm)**.

b. Panels or Screens and Walls: **1 inch (25 mm)**.

2. Stirrup Brackets: Secure panels or screens to walls and to pilasters with no fewer than [**two brackets attached**][**three brackets attached at midpoint and**] near top and bottom of panel or screen.

   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.

   a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than **2 inches (51 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 13 16

Task	Specification	Specification Description
10 21 13 16	01 22 00 00	No Specification Required
10 21 13 16	10 21 13 13	Metal Toilet Compartments

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SECTION 10 21 13 19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-plastic toilet compartments.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach [**ceiling-hung compartments**][**floor-and-ceiling-anchored compartments**][**and**][**post-to-ceiling screens**] to overhead structural system.
2. Section 061000 "Rough Carpentry" for [**blocking**][**overhead support of floor-and-ceiling-anchored compartments**][**and**][**overhead support of post-to-ceiling screens**].
3. Section 092216 "Non-Structural Metal Framing" for blocking.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for [**overhead supports,**]blocking, reinforcing, and other supports concealed within wall[**and ceiling**] to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Solid-plastic toilet compartments:

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show[**ceiling grid, ceiling-mounted items, and**] overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.

1. Size: [**Manufacturer's standard size**].

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: [**One**] bumper(s) with associated fasteners.
4. Door Pull: [**One**] door pull(s) with associated fasteners.
5. Fasteners: [**10**] fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other

construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain plastic toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

G. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

H. Regulatory Requirements: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for toilet compartments designated as accessible.

2.3 SOLID-PLASTIC TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Metal Corp**]
2. [**American Sanitary Partition Corporation**]
3. [**ASI Accurate Partitions**]

4. [**ASI Global Partitions**]
5. [**General Partitions Mfg. Corp**]
6. [**Hadrian Inc.; Zurn Industries, LLC**]
7. [**Knickerbocker Partition Corporation**]
8. [**Metpar Corp**]
9. [**Partition Systems International of South Carolina (PSISC); Columbia Systems International of South Carolina LLC**]
10. [**Scranton Products**]
11. [**Weis/Robart Partitions, Inc.**]

B. Toilet-Enclosure Style: [Overhead braced][Floor anchored][Ceiling hung][Floor-and-ceiling anchored][privacy type].

C. Entrance-Screen Style: [**Overhead braced**][**Floor anchored**][**Ceiling hung**][**Floor-and-ceiling anchored**].

D. Urinal-Screen Style: [**Wall hung**][**Floor anchored**][**Overhead braced**][**Post to ceiling**].

E. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) material, not less than **1 inch (25 mm)** thick, seamless, with eased edges, and with homogenous color throughout thickness of material.[**Provide with no-sightline system consisting of door and pilaster lapped edges on strike side of door and door and pilaster lapped edges on hinge side of door (unless continuous hinge is used).**]

1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
2. Heat-Sink Strip: Manufacturer's continuous, [extruded-aluminum][stainless steel] strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
3. Color: [**One color**][**Two colors**] in each room [**as indicated by manufacturer's designations**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Entrance-Screen Construction: Matching panel construction.

G. Urinal-Screen Construction: Matching panel construction.

H. Pilaster Shoes: Manufacturer's standard design; [solid plastic][stainless steel].

1. Plastic Color: [**Matching pilaster**][**Contrasting with pilaster, as indicated by manufacturer's designations**][**Contrasting with pilaster, as selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Pilaster Sleeves (Caps): Manufacturer's standard design; [solid plastic][stainless steel].

1. Plastic Color: [**Matching pilaster**][**Contrasting with pilaster, as indicated by manufacturer's designations**][**Contrasting with pilaster, as selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Urinal-Screen Post: Manufacturer's standard post design of [material matching the thickness and construction of pilasters][1-3/4-inch- (44-mm-) square aluminum tube with satin finish]; with shoe[and sleeve (cap)] matching that on the pilaster.

K. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, [**aluminum**][**stainless steel**].
2. Full-Height (Continuous) Type: Manufacturer's standard design; [**solid plastic or extruded**

aluminum][**solid plastic**][**extruded aluminum**][**stainless steel**].

a. Plastic Color: [**Matching panel**][**Contrasting with panel, as indicated by manufacturer's designations**][**Contrasting with panel, as selected by Architect from manufacturer's full range**], as directed by the Owner.

L. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from solid plastic.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.[**Mount with through bolts.**]

1. Hinges:

a. Manufacturer's paired, wraparound, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.

1) Material, Paired Hinge: Aluminum.

b. Manufacturer's [**continuous, cam type that swings to a closed or partially open position**][**continuous, spring-loaded type**], allowing emergency access by lifting door.

1) Material, Continuous Hinge: [**Aluminum**][**Stainless steel**][**Manufacturer's standard**].

c. Manufacturer's integral hinge for solid-plastic doors, allowing emergency access by lifting door.

1) Material, Integral Hinge: Nylon gravity cam unit with stainless steel pins/screws.

d. Manufacturer's standard hinge.

2. Latch and Keeper: Manufacturer's surface-mounted latch unit, designed for emergency access, and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.

a. Material: [**Aluminum**][**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

3. Coat Hook: Manufacturer's combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

a. Material: [**Chrome-plated zamac**][**Stainless steel**][**Manufacturer's standard**].

B. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.

1. Hinges: Manufacturer's minimum **0.062-inch- (1.59-mm-)** thick, stainless steel [**paired, wraparound, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees**][**continuous, cam type that swings to a closed or partially open position**][**continuous, spring-loaded type**], allowing emergency access by lifting door. Mount with through bolts.
2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit, designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible. Mount with through bolts.
3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at outswinging doors. Mount with through bolts.
5. Door Pull: Manufacturer's heavy-duty, cast stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible. Mount with through bolts.

C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters

and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Ceiling-Hung Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

E. Floor-and-Ceiling-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

F. Urinal-Screen Posts: Manufacturer's standard corrosion-resistant anchoring assemblies at posts and walls, with leveling adjustment nuts at[**tops and**] bottoms of posts. Provide shoes[**and sleeves (caps)**] at posts to conceal anchorage.

G. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide, inswinging doors for standard toilet enclosures and **36-inch- (914-mm-)** wide, outswinging doors with a minimum **32-inch- (813-mm-)** wide, clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels or Screens: **1/2 inch (13 mm)**.
b. Panels or Screens and Walls: **1 inch (25 mm)**.

2. Stirrup Brackets: Secure panels or screens to walls and to pilasters with no fewer than [**two brackets attached**][**three brackets attached at midpoint and**] near top and bottom of panel or screen.

a. Locate wall brackets, so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.

b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels and adjust, so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than **2 inches (51 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust, so tops of doors are level with tops of pilasters when doors are in closed position.

D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust, so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust, so doors are level and aligned with panels, when doors are in closed position.

F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 13 19

Task	Specification	Specification Description
10 21 13 19	01 22 00 00	No Specification Required
10 21 13 19	10 21 13 13	Metal Toilet Compartments

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SECTION 10 21 13 43 - PHENOLIC-CORE PEDESTAL-MOUNTED PRIVACY TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Phenolic-core pedestal-mounted privacy toilet compartments.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for blocking.
2. Section 092216 "Non-Structural Metal Framing" for blocking.
3. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

A. Coordinate requirements for blocking, reinforcing, and other supports concealed within wall to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data.

1. Phenolic-core pedestal-mounted privacy toilet compartments.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing

location and selected colors for toilet compartment material.

F. Delegated Design Submittals: For grab bars mounted on toilet compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

G. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
12. Low-Emitting Materials: Provide testing reports in accordance with the General Emissions Evaluation.
13. Product Data: For product, indicating that product contains no urea formaldehyde.
14. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.
15. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.
16. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.
17. Product Data: For product, indicating that product contains no urea formaldehyde.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For toilet compartments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: [**One**] door bumper(s) with associated fasteners.

4. Door Pull: [**One**] door pull(s) with associated fasteners.
5. Fasteners: [**10**] fasteners of each size and type.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain phenolic-core pedestal-mounted privacy toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Product shall be made without urea formaldehyde.

G. Product shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Product shall be made without urea formaldehyde.

I. Product shall have formaldehyde emission rates not greater than 0.09 ppm when tested according to ASTM D 6007 or ASTM E 1333.

J. Product shall be made without urea formaldehyde.

K. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**][**75**][**200**] or less.
2. Smoke-Developed Index: 450 or less.

L. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

M. Regulatory Requirements: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for toilet compartments designated as accessible.

2.3 PHENOLIC-CORE PEDESTAL-MOUNTED PRIVACY TOILET COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASI Accurate Partitions**]
2. [**ASI Global Partitions**]
3. [**Bobrick Washroom Equipment, Inc**]
4. [**Bradley Corporation**]
5. [**Decolam**]
6. [**EAD Design**]

B. Toilet-Enclosure Style: Overhead-braced, floor-anchored pedestal supports. Privacy-type doors, panels, and pilasters.

C. Entrance-Screen Style: Overhead-braced, floor-anchored pedestal supports.

D. Urinal-Screen Style: Wall-hung, floor-anchored pedestal supports.

E. Door, Panel and Pilaster Construction: Solid phenolic-core material with melamine facing on both sides fused to substrate during manufacture (not separately laminated), and with eased and polished edges. Provide minimum **1/2-inch- (13-mm-)** thick doors, panels, and pilasters. Provide with [**manufacturer's standard**] no-sightline system at door and pilaster edges.

F. Entrance-Screen Construction: Matching panel construction.

G. Urinal-Screen Construction: Matching panel construction.

H. Pedestal: Manufacturer's standard design.

1. Pedestal Material: [**Manufacturer's standard**].

I. Brackets (Fittings): Manufacturer's standard design full-height (continuous) type.

1. Bracket Material: [**Manufacturer's standard**].

J. Phenolic Finish: [**One color**][**Two colors**] in each room.

1. Dark-Core Phenolic: Manufacturer's standard dark color core and edge.

a. Facing Sheet Color: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Through-Color Phenolic: Manufacturer's standard solid through-color.

a. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.

1. Hinges: [**Manufacturer's standard**], allowing emergency access by lifting door.
2. Latch and Keeper: [**Manufacturer's standard**] surface-mounted latch unit with occupancy indicator, designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.
3. Coat Hook: [**Manufacturer's standard**] combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.
4. Door Bumper: [**Manufacturer's standard**] rubber-tipped bumper at outswinging doors.
5. Door Pull: [**Manufacturer's standard**] pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum headrail[**with antigrip profile and**] in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

2.6 FABRICATION

A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pedestals and walls to suit floor and wall conditions.

C. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide inswinging doors for standard toilet enclosures and **36-inch- (914-mm-)** wide outswinging doors with a minimum **32-inch- (813-mm-)** wide clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Panels or Screens and Walls: **1 inch (25 mm)**.

2. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Secure pedestals to floor and level, plumb, and tighten. Set pedestals with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 13 43

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Task	Specification	Specification Description
10 21 13 43	01 22 00 00	No Specification Required
10 21 13 43	10 21 13 13	Metal Toilet Compartments

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SECTION 10 21 16 17 - PHENOLIC-CORE SHOWER AND DRESSING COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Phenolic-core shower and dressing compartments.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach floor-and-ceiling-anchored compartments to the overhead structural system.
2. Section 061000 "Rough Carpentry" for [**blocking**][**and**][**overhead support of floor-and-ceiling-anchored compartments**].
3. Section 092216 "Non-Structural Metal Framing" for blocking.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on compartments.
5. Section 105113 "Metal Lockers" for dressing compartment benches.
6. Section 224200 "Commercial Plumbing Fixtures" for shower heads, valves, and receptors.

1.2 COORDINATION

A. Coordinate requirements for [**overhead supports,**]blocking, reinforcing, and other supports concealed within wall[**and ceiling**] to ensure that compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show locations of cutouts for compartment-mounted accessories.
3. Show locations of centerlines of drains.
4. Show[**ceiling grid, ceiling-mounted items, and**] overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available finishes for each type of compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished product for each type of compartment, hardware, and accessory.

1. Size: [**Manufacturers' standard size**].

E. Delegated Design Submittals: For [**grab bars**][**shower seats**][**and**][**accessible benches**] mounted on compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

F. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For phenolic panel, by a qualified testing agency.

B. Delegated design engineer qualifications.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For shower and dressing compartments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: [**One**] door hinge(s) with associated fasteners.
2. Latch and Keeper: [**One**] latch(es) and keeper(s) with associated fasteners.
3. Clothing Hook: [**One**] clothing hook(s) with associated fasteners.
4. Door Bumper: [**One**] door bumper(s) with associated fasteners.
5. Door Pull: [**One**] door pull(s) with associated fasteners.
6. Fasteners: [**10**] fasteners of each size and type.
7. Curtain Rod: [**One**] curtain rod(s) with associated fasteners.
8. Curtain Hooks: [**Five**] curtain hooks.
9. Soap Holder: [**One**] soap holder(s) with associated fasteners.

1.7 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of fixtures, drains, walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain shower and dressing compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**][**75**][**200**] or less.
2. Smoke-Developed Index: 450 or less.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to provide structural design calculations for grab bars, shower seats, or seats of accessible benches mounted on shower or dressing compartment panels.

C. Structural Performance: Where grab bars, shower seats, or accessible benches are mounted on shower or dressing compartment panels, design panels to comply with the following requirements:

1. Panels are able to withstand a concentrated load on grab bar, shower seat, or seat of accessible bench of at least **250 lbf (1112 N)** applied at any direction and at any point, without deformation of panel.

D. Regulatory Requirements: Comply with applicable provisions in [**the DOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for shower and dressing compartments designated as accessible.

E. Regional Materials: Verify products are manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Regional Materials: Verify products are manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

2.3 PHENOLIC-CORE SHOWER AND DRESSING COMPARTMENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**All American Metal Corp**]

2. [**ASI Accurate Partitions**]
3. [**ASI Global Partitions**]
4. [**EAD Design**]
5. [**Flush Metal Partitions**]
6. [**General Partitions Mfg. Corp**]
7. [**Knickerbocker Partition Corporation**]
8. [**Metpar Corp**]

B. Configuration: [**Shower compartment(s)**][**Shower and dressing compartment(s)**],[**with manufacturer's precast terrazzo shower receptor,**] as indicated on Drawings.

1. Precast Terrazzo Shower Receptor: Manufacturer's standard, prefabricated, terrazzo receptor complete with integral brass drain and removable stainless steel strainer. Designed to receive panels and create a waterstop when panels are in place.

   a. Curb: Not less than 2 inches (51 mm) and not more than 9 inches (229 mm) deep when measured from the top of the curb to the top of the drain; with curb threshold not less than 1 inch (25 mm) below the sides and back of the receptor[and with a ramped entrance surface for accessible compartments].
   b. Finish: Manufacturer's standard finish on exposed surfaces, [**matching color of compartment panels**][**as indicated by manufacturer's designations**][**as selected by Architect from manufacturer's full range**] and with slip-resistant floor surface texture, as directed by the Owner.

C. Compartment Style: [Overhead braced][Floor and ceiling anchored][privacy type].

D. Panel Construction: Solid phenolic-core panel material with melamine facing on both sides fused together during panel manufacture (not separately laminated) and with eased and polished edges. Provide minimum **1/2-inch- (13-mm-)** thick panels.

E. Pilaster Construction: Match panels; **3/4-inch- (19-mm-)** minimum thickness.

F. Door Construction: Match panels; **3/4-inch (19-mm)** minimum thickness.[**Equip door and pilasters with lapped edge no-sightline system.**]

G. Pilaster Shoes: Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

H. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than **0.031-inch (0.79-mm)** nominal thickness and **3 inches (76 mm)** high, finished to match hardware.

I. Brackets (Fittings):

1. Shower Compartment Brackets:

   a. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2. Dressing Compartment Brackets:

   a. Match shower compartment brackets.
   b. Stirrup Type: Ear or U-brackets; stainless steel.
   c. Match toilet-compartment brackets specified in Section 102113.17 "Phenolic-Core Toilet Compartments."

J. Phenolic Compartment Finish: [**One color**][**Two colors**] in each room.

1. Dark-Core Phenolic: Manufacturer's standard dark color core and edge.

   a. Facing Sheet Color: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Through-Color Phenolic: Manufacturer's standard solid through-color.

   a. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 HARDWARE AND ACCESSORIES

A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.[**Mount with through bolts.**]

1. Hinges: [**Manufacturer's stainless steel, surface-mounted, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees**][**Manufacturer's stainless steel continuous, cam type that swings to a closed or partially open position**][**Manufacturer's stainless steel continuous, spring-loaded type**][**Manufacturer's standard**], allowing emergency access by lifting door.
2. Latch and Keeper: Manufacturer's standard, stainless steel, surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility[**at each compartment, accessible or not**][**at compartments designated as accessible**].
3. Clothing Hooks: Manufacturer's standard stainless steel clothing hooks in each dressing compartment[include one combination hook and rubber-tipped bumper at inswinging doors, sized to prevent door from hitting wall panel or compartment-mounted accessories].
4. Door Bumper: Manufacturer's standard stainless steel, rubber-tipped bumper at outswinging doors.
5. Door Pull: Manufacturer's standard stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with antigrip profile; in manufacturer's standard finish.

C. Headrail with Hooks: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with curtain hooks running in concealed track; with antigrip profile; in manufacturer's standard finish.

D. Curtain Rod with Hooks: Manufacturer's standard, **1-inch- (25-mm-)** diameter, [**stainless steel**] curtain rod with matching hooks.

E. Curtain: Flame-resistant, [**polyester-reinforced vinyl fabric**][**manufacturer's standard fabric**] that is stain resistant, self-sanitizing, antistatic, antimicrobial, and launderable to a temperature of not less than [**90 deg F (32 deg C)**].

1. Flame Resistance: Passes NFPA 701 tests when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Labeling: Identify fabrics with appropriate markings of applicable testing and inspecting agency.
3. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than **6 inches (152 mm)** o.c.; machined into top hem.
4. Width: Minimum [**6 inches (152 mm)**][**12 inches (305 mm)**] wider than opening.
5. Length: Where curtain extends to a floor surface, size so that bottom hem clears finished floor by not more than **1 inch (25 mm)** and not less than **1/2 inch (13 mm)** above floor surface. Where curtains extend to a shower-receptor curb, size so that bottom hem hangs above curb line and

clears curb line by not more than **1/2 inch (13 mm)**.

6. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Soap Holder:

1. Manufacturer's standard.
2. [**Surface-mounted**][**Recessed**], seamless [**stainless steel**] soap dish.

G. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. Use countersunk, flush-type bolt heads or otherwise make fasteners inconspicuous if exposed on opposite side of panel from hardware or accessory item. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

2.6 FABRICATION

A. Fabricate shower and dressing compartment components to sizes indicated.

B. Overhead-Braced Compartments: Manufacturer's standard, corrosion-resistant supports, leveling method, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling method.

C. Floor-and-Ceiling-Anchored Compartments: Manufacturer's standard, corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

D. Door Sizes and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide, inswinging doors for standard shower and dressing compartments, and **36-inch- (914-mm-)** wide, outswinging doors with a minimum **32-inch- (813-mm-)** wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the

Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PHENOLIC-CORE SHOWER AND DRESSING COMPARTMENTS

A. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.

1. Clearances for Dressing Compartments: Maximum **1/2 inch (13 mm)** between pilasters and panels; **1 inch (25 mm)** between panels and walls.
2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than [**two brackets attached**][**three brackets attached at midpoint and**] near top and bottom of panel.

   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.

   a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Compartments: Secure pilasters to floor, and level, plumb, and tighten. Set pilasters with anchors penetrating not less than **1-3/4 inches (44 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous headrail to each pilaster with no fewer than two fasteners.[**Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.**]

C. Floor-and-Ceiling-Anchored Compartments: Secure pilasters to supporting construction, and level, plumb, and tighten.[**Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.**]

D. Curtains: Install curtains to specified length, and verify that they hang vertically without stress points or diagonal folds.

E. Shower Receptors: Install manufacturer's prefabricated shower receptors with drain gasket compression fit to OD of waste pipe.

3.3 ADJUSTING AND CLEANING

A. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.

B. Hardware Adjustment: Clean, adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

C. Clean exposed surfaces of compartments after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering and for cleaning. Replace damaged or defective items.

END OF SECTION 10 21 16 17

Task	Specification	Specification Description
10 21 16 17	10 21 13 13	Metal Toilet Compartments

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SECTION 10 21 23 00 - CUBICLE CURTAINS AND TRACK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cubicle-curtain support systems.
2. Cubicle curtains.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for supplementary wood framing and blocking for mounting items requiring anchorage.
2. Section 092216 "Non-Structural Metal Framing" for supplementary metal framing and blocking for mounting items requiring anchorage.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Cubicle-curtain support systems.
2. Cubicle curtains.

B. Product Data Submittals: For each product.

1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.

C. Shop Drawings: For curtains and tracks.

1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
2. Include details of blocking for track support.

D. Samples: For each exposed product and for each color and texture specified, **10 inches (254 mm)** in size.

E. Samples for Initial Selection: For each type of curtain material indicated.

F. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:

1. Curtain Fabric: Not less than **10 inches (254 mm)** square and showing complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
2. Mesh Top: Not less than **10 inches (254 mm)** square.
3. Curtain Track: Not less than **10 inches (254 mm)** long.
4. Curtain Carrier: Full-size unit.

G. Product Schedule: For curtains and tracks.[**Use same designations indicated on Drawings**].

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Curtain Carriers and Track End Caps: Full-size units equal to [**3**]<**Insert number**> percent of amount installed for each size indicated, but no fewer than [**10**]<**Insert number**> units.
2. Curtains: Full-size units equal to [**10**]<**Insert number**> percent of amount installed for each size indicated, but no fewer than [**two**]<**Insert number**> units.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical cubicle as shown on Drawings[**as part of patient-room mockup**].
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Cubicle Curtains: Provide curtain fabrics with the following characteristics:

1. Laundering: Launderable to a water temperature of not less than [**160 deg F (71 deg C)**]<**Insert temperature**>.
2. Flame Resistance: Provide fabrics identical to those that have passed NFPA 701 when tested by a qualified testing agency acceptable to authorities having jurisdiction.

   a. Identify fabrics with appropriate markings of a qualified testing agency.

2.2 CUBICLE-CURTAIN SUPPORT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alderman Acres Manufacturing, Inc.**]
2. [**AR Nelson**]
3. [**Automatic Devices Company**]
4. [**Barjan Manufacturing Ltd.**]

5. [**Construction Specialties, Inc.**]
6. [**Covoc Corporation**]
7. [**Cubicle Curtain Factory, Inc**]
8. [**Erwin and Associates, Inc**]
9. [**Healthcare Curtains**]
10. [**Imperial Fastener Company, Inc.**]
11. [**inpro Corporation**]
12. [**Pryor Products, Inc.**]
13. [**Standard Textile Co., Inc.**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alderman Acres Manufacturing, Inc.**]
2. [**AR Nelson**]
3. [**Automatic Devices Company**]
4. [**Barjan Manufacturing Ltd.**]
5. [**Construction Specialties, Inc.**]
6. [**Covoc Corporation**]
7. [**Cubicle Curtain Factory, Inc**]
8. [**Erwin and Associates, Inc**]
9. [**Healthcare Curtains**]
10. [**Imperial Fastener Company, Inc.**]
11. [**inpro Corporation**]
12. [**Pryor Products, Inc.**]
13. [**Standard Textile Co., Inc.**]
14. <**Insert manufacturer's name**>

C. Extruded-Aluminum Curtain Track: Not less than [**1-1/4 inches wide by 3/4 inch high (32 mm wide by 19 mm high)**][**5/8 inch wide by 1/2 inch high (16 mm wide by 13 mm high)**].

1. Track Minimum Wall Thickness: [**0.050 inch (1.27 mm)**][**0.058 inch (1.47 mm)**][**0.062 inch (1.57 mm)**][**Manufacturer's standard**]<**Insert dimension**>.
2. Curved Track: Factory-fabricated, [**12-inch- (305-mm-)**]<**Insert radius**> radius bends.
3. Finish: [**Clear anodized**][**Satin anodized**][**Baked enamel, acrylic, or epoxy**]<**Insert finish**>.

D. PVC Curtain Track: Not less than **1-1/4 inches wide by 15/16 inch high (32 mm wide by 24 mm high)**.

1. Curved Track: Factory-fabricated, **12-inch- (305-mm-)** radius bends.

E. Curtain-Track Mounting: [**Surface**][**Suspended**][**As indicated on Drawings**].

F. Curtain-Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.

1. Suspended-Track Support: Not less than [**5/8-inch- (16-mm-) square**][**7/8-inch- (22.2-mm-) OD**] tube.
2. End Stop: [**Nonremovable**][**Removable with carrier hook**].
3. Switch Unit: Shuttle and coupling device for rerouting and securing cubicle curtain, with pull chain for switching track.

G. Curtain Roller Carriers: Two nylon rollers and nylon axle with [**chrome-plated steel**][**nylon**][**aluminum**] hook.

H. Curtain Glide Carriers: One-piece nylon glide with [**chrome-plated steel**][**nylon**] hook.

I. Breakaway Curtain Carriers: [**One-piece nylon**][**Velcro**] breakaway curtain carriers designed to allow curtains to detach from tracks with a pulling force of no more than **5 lbf (22.2 N)**.

J. Exposed Fasteners: Stainless steel.

K. Concealed Fasteners: [**Hot-dip galvanized**][**Stainless steel**].

2.3 CUBICLE CURTAINS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alderman Acres Manufacturing, Inc.**]
2. [**AR Nelson**]
3. [**Automatic Devices Company**]
4. [**Barjan Manufacturing Ltd.**]
5. [**Covoc Corporation**]
6. [**Cubicle Curtain Factory, Inc**]
7. [**Erwin and Associates, Inc**]
8. [**Healthcare Curtains**]
9. [**Imperial Fastener Company, Inc.**]
10. [**inpro Corporation**]
11. [**Pryor Products, Inc.**]
12. [**Salsbury Industries**]
13. [**Sereneview & Catalina Curtain Co.**]
14. [**Standard Textile Co., Inc.**]
15. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alderman Acres Manufacturing, Inc.**]
2. [**AR Nelson**]
3. [**Automatic Devices Company**]
4. [**Barjan Manufacturing Ltd.**]
5. [**Covoc Corporation**]
6. [**Cubicle Curtain Factory, Inc**]
7. [**Erwin and Associates, Inc**]
8. [**Healthcare Curtains**]
9. [**Imperial Fastener Company, Inc.**]
10. [**inpro Corporation**]
11. [**Pryor Products, Inc.**]
12. [**Salsbury Industries**]
13. [**Sereneview & Catalina Curtain Co.**]
14. [**Standard Textile Co., Inc.**]
15. <**Insert manufacturer's name**>

C. Fabric: Curtain manufacturer's standard, 100 percent polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.

1. Pattern: <**Insert manufacturer's style name**>.

2. Width: <**Insert dimension**>.
3. Color: [**As selected by Architect from manufacturer's full range**]<**Insert requirements**>.

D. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than **6 inches (152 mm)** o.c.; machined into top hem.

E. Mesh Top: Not less than [**20-inch- (508-mm-)**][**22-inch- (559-mm-)**]<**Insert dimension**> high mesh top.

1. Mesh: No. [**50**][**40**][**42**] nylon mesh.

F. Beaded-Chain Curtain Drop: [**6 inches (152 mm)**][**9 inches (229 mm)**][**12 inches (305 mm)**][**15 inches (381 mm)**][**18 inches (457 mm)**] long; nickel-plated steel with aluminum hook.

G. PVC-Strip Curtain Drop: [**16 inches (406 mm)**][**18 inches (457 mm)**] long with chrome-plated steel hook.

H. Snap Attachments: Provide manufacturer's standard nickel-plated brass snap attachments for modular panels.

I. Curtain Tieback: Nickel-plated brass chain; one at each curtain termination.

2.4 CURTAIN FABRICATION

A. Continuous Curtain Panels:

1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than **12 inches (305 mm)** of added fullness.
2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of [**12 inches (305 mm)**][**15 inches (381 mm)**][**As indicated on Drawings**]<**Insert requirements**>.
3. Top Hem: Not less than **1 inch (25.4 mm)** and not more than **1-1/2 inches (38 mm)** wide, triple thickness, reinforced with integral web, and double lockstitched.
4. Mesh Top: Top hem of mesh not less than **1 inch (25.4 mm)** and not more than **1-1/2 inches (38 mm)** wide, triple thickness, reinforced with integral web, and double lockstitched. Double lockstitch bottom of mesh directly to **1/2-inch (13-mm)** triple thickness, top hem of curtain fabric.
5. Bottom Hem: Not less than **1 inch (25.4 mm)** and not more than **1-1/2 inches (38 mm)** wide, [**double thickness and single**][**double thickness and double**][**triple thickness, reinforced, and double**] lockstitched.
6. Side Hems: Not less than **1/2 inch (13 mm)** and not more than **1-1/4 inches (32 mm)** wide, with [**double**][**triple**] turned edges, and single lockstitched.
7. Vertical Seams: Not less than **1/2 inch (13 mm)** wide, double turned and double stitched.

B. Modular Curtain Panels:

1. Fabric Panels: [**48 inches (1219 mm)**][**66 inches (1676 mm)**]<**Insert dimension**> wide. Fabricate panels in quantity required to provide assembled curtains equal to track lengths plus 10 percent added fullness, but not less than **12 inches (305 mm)** added fullness.

   a. Top Hem: Not less than **1 inch (25.4 mm)** and not more than **1-1/2 inches (38 mm)** wide, triple thickness, reinforced with integral web, double lockstitched, and with snap attachments to attach panels to mesh top.
   b. Side Hems: Not less than **1/2 inch (13 mm)** and not more than **1-1/4 inches (32 mm)** wide, with double turned edges, single lockstitched, and [**designed for panels hung with overlapping side hems for privacy**][**with snap attachments to attach one panel to another**].

2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of [**12 inches (305 mm)**][**15 inches (381 mm)**][**As indicated on Drawings**]<**Insert requirements**>.
3. Mesh Top: Top hem of mesh not less than **1 inch (25.4 mm)** and not more than **1-1/2 inches (38 mm)** wide, triple thickness, reinforced with integral web, and double lockstitched.

    a. Type: [**Continuous for each track length, matching overall width of assembled curtains**][**Modular, matching width of modular fabric panels with snap attachments at side hems of mesh-top panels**].

4. Vertical Seams: Not less than **1/2 inch (13 mm)** wide, double turned and double stitched.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install tracks level and plumb, according to manufacturer's written instructions.

B. For tracks of up to **20 feet (6.0 m)** in length, provide track fabricated from single, continuous length.

    1. Curtain-Track Mounting: [**Surface**][**Suspended**][**As indicated on Drawings**].

C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:

    1. Mechanically fasten directly to bottom of concrete deck with post-installed anchors.
    2. Mechanically fasten directly to finished ceiling with toggle bolts.
    3. Mechanically fasten to furring through suspended ceiling with screw and tube spacer.
    4. Mechanically fasten to suspended ceiling grid with screws.
    5. Attach track to suspended ceiling grid with manufacturer's proprietary clip.

D. Suspended-Track Mounting: Install track with manufacturer's standard tubular aluminum suspended supports at intervals and with fasteners recommended by manufacturer. Fasten supports to structure. Provide supports at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.

E. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.

    1. Provide one locking switch unit for each pair of beds.
    2. Provide one hinged loading unit for each [**bed**][**pair of beds with locking switch unit**].

F. Curtain Carriers: Provide curtain carriers adequate for **6-inch (152-mm)** spacing along full length of

curtain plus an additional carrier.

G. Cubicle Curtains: Hang curtains on each curtain track.[**Secure with curtain tieback.**]

END OF SECTION 10 21 23 00

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Task	Specification	Specification Description
10 21 23 13	10 21 23 00	Cubicle Curtains and Track
10 21 23 16	10 21 23 00	Cubicle Curtains and Track

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SECTION 10 22 00 00 - FOLDING PANEL PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Operable acoustical panel partitions.
2. Operable fire-rated panel partitions.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
2. Section 092900 "Gypsum Board" for fire-rated assemblies and sound barrier construction above the ceiling at track.
3. Section 102226.13 "Accordion Folding Partitions" for accordion-type folding partitions having a pantograph mechanism and outer flexible covering, or narrow, vertically hinged segments.
4. Section 102239.13 "Folding Glass-Panel Partitions" for operable panel partitions made of glass panels.
5. Electrical and communications Sections for electrical service and connections for motor operators, controls, and limit switches and for system disconnect switches.

1.2 DEFINITIONS

A. NIC: Noise Isolation Class.

B. NRC: Noise Reduction Coefficient.

C. STC: Sound Transmission Class.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Operable acoustical panel partitions.
2. Operable fire-rated panel partitions.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.

4. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
7. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
8. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For operable panel partitions.

1. Include plans, elevations, sections, attachment details[and numbered panel installation sequence].
2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
3. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:

1. Textile Facing Material: Full width by not less than **36-inch- (914-mm-)** long section of [**fabric**][**carpet**] from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
2. Panel Facing Material: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
3. Panel Edge Material: Not less than **3 inches (75 mm)** long.
4. Chair Rail: Manufacturer's standard-size unit, **6 inches (150 mm)** long.
5. Glass: Units **12 inches (300 mm)** square.
6. Hardware: One of each exposed door-operating device.

F. Delegated Design Submittals: For operable panel partitions.

1. Include design calculations for seismic restraints that brace tracks to structure above.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Partition track, track supports and bracing, switches, turning space, and storage layout.
2. Suspended ceiling components.
3. Structural members to which suspension systems will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.
   b. HVAC ductwork, outlets, and inlets.
   c. Speakers.

d. Sprinklers.
e. Smoke detectors.
f. Access panels.

6. Plenum [**fire**][**smoke**][**and**][**acoustical**] barriers.

B. Setting Drawings: For embedded items and cutouts required in other work[including support-beam, mounting-hole template].

C. Qualification Data: For [**Installer**][**testing agency**].

D. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:

1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, in accordance with ASCE/SEI 7.
2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of operable panel partition.

1. Include approval letter signed by manufacturer acknowledging the Owner-furnished panel facing material complies with requirements.

F. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.

G. Field quality-control reports.

H. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
b. Seals, hardware, track, track switches, carriers, and other operating components.
c. Electric operator and controls.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of operable panel partitions.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing of tracks to structure above.

B. Seismic Performance: Operable panel partitions are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."

C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties in accordance with test methods indicated:

1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance in accordance with ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance in accordance with ASTM C423, and rated for not less than the NRC indicated.
3. Noise-Isolation Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC in accordance with ASTM E336, determined by ASTM E413, and rated for [**10 dB less than STC value indicated**].

D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: [**25**] or less.
   b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with [NFPA 265 Method B Protocol][NFPA 286].

E. Fire Resistance: Provide fire-rated operable panel partition assemblies[**including pass doors**] complying with NFPA 80, based on testing in accordance with UL 10B for fire-rated door assemblies.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Pass doors in fire-rated operable panel partition assemblies are to meet positive-pressure requirements.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 OPERABLE ACOUSTICAL PANEL PARTITIONS

A. Operable Acoustical Panel Partitions : Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Equipment Corporation**]
   b. [**KWIK-WALL Company**]
   c. [**Moderco Inc**]
   d. [**Modernfold, Inc**]

B. Panel Operation: [**Manually operated, individual**][**Manually operated, paired**][**Manually operated, continuously hinged**][**Electrically operated, continuously hinged**] panels.

C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate

panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

1. Panel Width: [**Standard widths**][**Equal widths**][**As indicated**].

E. STC: Not less than [**38**][**41**][**45**][**47**][**50**][**52**][**54**][**56**].

F. NRC: Not less than [**0.50**][**0.60**][**0.65**][**0.90**].

G. Panel Weight: [**8 lb/sq. ft. (40 kg/sq. m)**][**10 lb/sq. ft. (50 kg/sq. m)**][**12 lb/sq. ft. (59 kg/sq. m)**] maximum.

H. Panel Thickness: [**Maximum**][**Minimum**][**Nominal**] dimension of [**3 inches (75 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**].

I. Panel Materials:

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.
2. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
5. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
6. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
7. Adhesives: Do not use adhesives that contain urea formaldehyde.
8. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
10. Adhesives: Do not use adhesives that contain urea formaldehyde.
11. Adhesives: Do not use adhesives that contain urea formaldehyde.
12. Composite Wood Products: Products shall be made without urea formaldehyde.
13. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
14. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

15. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

16. Composite Wood Products: Products shall be made without urea formaldehyde.
17. Steel Frame: Steel sheet, [**manufacturer's standard**][**0.0508-inch (1.3-mm)**][**0.0641-inch (1.6-mm)**][**0.0747-inch (1.9-mm)**] nominal minimum thickness for uncoated steel.
18. Steel Face/Liner Sheets: Tension-leveled steel sheet, [**manufacturer's standard**][**0.0299-inch (0.75-mm)**][**0.0359-inch (0.9-mm)**][**0.0478-inch (1.2-mm)**][**0.0598-inch (1.5-mm)**][**0.0747-inch (1.9-mm)**] minimum nominal thickness for uncoated steel.
19. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; **ASTM B221 (ASTM B221M)** for extrusions; manufacturer's standard strengths and thicknesses for type of use.

    a. Frame Reinforcement: Manufacturer's standard steel or aluminum.

20. Gypsum Board: ASTM C1396/C1396M.
21. Cement Board: ASTM C1288.
22. Particleboard: ANSI A208.1.
23. Medium-Density Fiberboard: ANSI A208.2.
24. Plywood: DOC PS 1.

J. Panel Closure: Manufacturer's standard unless otherwise indicated.

1. Initial Closure: [**Resilient, bulb-shaped acoustical seal**][**Fixed jamb**][**As indicated**].
2. Final Closure: [**Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal**][**Hinged jamb closure**][**Hinged communicating panel**][**Fixed jamb**][**Angle jamb**][**Resilient, bulb-shaped acoustical seal**].

K. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

1. Hinges: [**Manufacturer's standard**][**Concealed (invisible)**].

L. Finish Facing: [**the Owner furnished**][**Vinyl-coated fabric wall covering**][**Carpet wall covering**][**Fabric wall covering**][**High-pressure decorative laminate**][**Wood veneer**][**Paint**].

2.3 OPERABLE FIRE-RATED PANEL PARTITIONS

A. Operable Fire-Rated Panel Partitions : Fire-rated, acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Equipment Corporation**]
    b. [**Modernfold, Inc**]

B. Panel Operation: Manually operated, [**individual**][**paired**] panels.

C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Dimensions: Fabricate operable fire-rated panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

1. Panel Width: [**Standard widths**][**Equal widths**][**As indicated**].

E. Fire Rating: [**1**] hour(s).

F. STC: Not less than [**38**][**41**][**45**][**47**][**50**][**52**][**54**].

G. NRC: Not less than [**0.50**][**0.60**][**0.65**][**0.90**].

H. Panel Weight: [**8.5 lb/sq. ft. (41.5 kg/sq. m)**][**10 lb/sq. ft. (50 kg/sq. m)**][**12 lb/sq. ft. (59 kg/sq. m)**] maximum.

I. Panel Thickness: [**Maximum**][**Minimum**][**Nominal**] dimension of [**3 inches (75 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**].

J. Panel Materials:

1. Steel Frame: Steel sheet, [**manufacturer's standard**][**0.0508-inch (1.3-mm)**][**0.0641-inch (1.6-mm)**][**0.0747-inch (1.9-mm)**] nominal minimum thickness for uncoated steel.
2. Steel Face/Liner Sheets: Tension-leveled steel sheet, [**manufacturer's standard**][**0.0299-inch (0.75-mm)**][**0.0359-inch (0.9-mm)**][**0.0478-inch (1.2-mm)**][**0.0598-inch (1.5-mm)**][**0.0747-inch (1.9-mm)**] minimum nominal thickness for uncoated steel.

K. Panel Closure: Manufacturer's standard fire-rated closure unless otherwise indicated.

1. Initial Closure: [**Resilient, bulb-shaped acoustical seal**][**Fixed jamb**][**As indicated**].
2. Final Closure: Fire-rated, [**constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal**][**hinged jamb closure**][**hinged communicating panel**][**fixed jamb**][**angle jamb**][**resilient, bulb-shaped acoustical seal**].

L. Hardware: Manufacturer's standard as required to operate fire-rated operable panel partition and accessories; with decorative, protective finish.

1. Hinges: [**Manufacturer's standard**].

M. Finish Facing: [**the Owner furnished**][**Vinyl-coated fabric wall covering**][**Carpet wall covering**][**Fabric wall covering**][**High-pressure decorative laminate**][**Wood veneer**][**Paint**].

2.4 SEALS

A. Description: Seals that produce operable panel partitions complying with performance requirements and the following:

1. Manufacturer's standard seals unless otherwise indicated.
2. Seals made from materials and in profiles that minimize sound leakage.

3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.

B. Vertical Seals: Deep-nesting, interlocking[**steel**] astragals mounted on each edge of panel, with continuous, resilient acoustical seal.

C. Horizontal Top Seals: [Continuous-contact, resilient seal exerting uniform constant pressure on track][resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended].

D. Horizontal Bottom Seals:

1. Manufacturer's standard continuous-contact seal exerting uniform constant pressure on floor.
2. Resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.

a. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**] between retracted seal and floor finish.
b. Mechanically Operated for Fire-Rated Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**4 inches (102 mm)**] between retracted seal and floor finish.
c. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] between retracted seal and floor finish.

2.5 PANEL FINISH FACINGS

A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.

1. Apply[**one-piece, seamless**] facings free of air bubbles, wrinkles, blisters, and other defects, [**with edges tightly butted, and**][**with invisible seams complying with Shop Drawings for location, and**] with no gaps or overlaps. Horizontal [**butted edges**][**seams**] are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
2. Where facings with [**directional or repeating patterns or directional weave**][**directional, repeating, or matching grain**] are indicated, mark facing top and attach facing in same direction.
3. Match facing pattern **72 inches (1830 mm)** above finished floor.

B. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with WA-101, [**Type I-Light Duty**][**Type II-Medium Duty**][**Type III-Heavy Duty**]; Class A.

1. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.
2. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Carpet Wall Covering: Manufacturer's standard[**nonwoven, needle-punched carpet with fibers fused to backing**], from same dye lot, treated to resist stains.

1. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Fabric Wall Covering: [**Manufacturer's standard fabric**][**100 percent polyolefin woven fabric**], from same dye lot, treated to resist stains.

1. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. High-Pressure Decorative Laminate: ISO 4586-3, Horizontal grade.

1. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Wood Veneer: Laminated to [**noncombustible**][**fire-retardant-treated wood**] core with moisture-resistant adhesive.

1. Species and Cut: [**Maple, plain sliced**][**Poplar, plain sliced**][**White oak, rift cut**][**White ash, plain sliced**][**As indicated**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Matching of Adjacent Veneer Leaves: [**Book**][**Slip**][**Random**] match.
3. Veneer Matching within Panel Face: [**Running**][**Balance**][**Center-balance**] match.
4. Panel-Matching Method: [**No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels**].
5. Vertical Panel-Matching Method: [**Continuous match; veneer leaves of upper panels are continuations of veneer leaves of lower panels**][**Vertical book match; veneer leaves are individually book matched from lower panels to upper panels**][**Vertical slip match; veneer leaves are individually slip matched from lower panels to upper panels**][**Panel vertical book match; panels are book matched from lower panels to upper panels**][**Panel vertical slip match; panels are slip matched from lower panels to upper panels**].
6. Wood-Veneer Finish:

   a. [**As specified in Section 099300 "Staining and Transparent Finishing."**]
   b. [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as follows:, as directed by the Owner

      1) Type: [**Transparent finish**][**Transparent finish over stain**] over wood variety indicated.

G. Paint: Manufacturer's standard [**factory-**][**field-**]painted finish.

1. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Cap-Trimmed Edges: Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:

1. Steel, Painted: Finished with manufacturer's [**standard neutral color**][**color matching Architect's sample**][**color as selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Aluminum: Finished with manufacturer's standard [**mill**][**clear anodic**][**color anodic**] finish.

I. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.6 SUSPENSION SYSTEMS

A. Tracks: Steel or aluminum [**mounted directly to overhead structural support,**][**with adjustable steel hanger rods for overhead support,**] designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than **0.10 inch (2.54 mm)** between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
2. Head Closure Trim: As required for acoustical performance; [**with factory-applied, decorative, protective finish**][**primed for field finish**].

B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

1. Multidirectional Carriers: Capable of negotiating intersections without track switches.

C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.

1. Curve-and-Diverter Switches: Allow radius turns to divert panels to an auxiliary track.
2. L Intersections: Allow panels to change 90 degrees in direction of travel.
3. T Intersections: Allow panels to pass through or change 90 degrees to another direction of travel.
4. X Intersections: Allow panels to pass through or change travel direction full circle in 90-degree increments, and allow one partition to cross track of another.
5. Multidirectional Switches: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.
6. Center carrier stop.

D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

E. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.7 ELECTRIC OPERATORS

A. Factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. Comply with NFPA 70.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

D. Motor Electrical Characteristics:

1. Horsepower: [**Manufacturer's standard**].
2. Volts: [**115**][**208**][**230**][**460**].

3. Phase: [**Single phase**][**Polyphase**].
4. Hertz: 60.

E. Control Stations: Two single-key-operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Open," "Close," and "[**Off**][**Stop**]." Furnish two keys per station.

F. Obstruction-Detection Devices: Equip each motorized operable panel partition with indicated automatic safety sensor that causes operator to immediately [**shut off motor**][**stop and reverse direction**].

1. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.
2. Sensor Mat: Electrically operated, contact-weight-sensitive safety mat in storage pocket area.
3. Infrared Sensor System: Designed to detect an obstruction in partition's path and sound an audible alarm, without obstruction contacting partition.

G. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.

H. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

I. Electric Interlock: Equip each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:

1. On storage pocket door, to prevent operation if door is not in fully open position.
2. On partitions at location of convergence by another partition, to prevent operation if merging partitions are in place.

2.8 ACCESSORIES

A. Pass Doors: Swinging door built into and matching panel [**materials,**][**construction,**][**acoustical qualities,**][**fire rating,**] finish and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.

1. Accessibility Standard: Fabricate doors to comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].
2. Single Pass Door: [**36 by 80 inches (914 by 2032 mm)**][**36 by 84 inches (914 by 2134 mm)**].
3. Double Pass Door: [**72 by 80 inches (1829 by 2032 mm)**][**72 by 84 inches (1829 by 2134 mm)**].
4. Pass-Door Hardware: Equip pass door with the following:

a. Door Seals: [**Mechanically operated floor seal on panels containing pass doors**][**Sweep floor seals**].
b. [**Panic**][**Fire exit**] hardware.
c. Concealed door closer.
d. Door Viewer: Installed with view in direction of swing.
e. Exit Sign: Recessed, self-illuminated.
f. Latchset: Passage set.
g. Lock, Key Operated: Key-operated lock with cylinder[keyed to master key system,] operable from both sides of door. Include two keys per lock.
h. Lock, Deadlock: Deadlock to receive cylinder, operable from both sides of door. See [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for lock cylinder and keying requirements.

B. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware[**and acoustical seals at soffit, floor, and jambs**]. Hinges in finish to match other exposed hardware.

1. Manufacturer's standard method to secure storage pocket door in closed position.
2. Rim Lock, Key Operated: Key-operated lock cylinder[keyed to master key system,] to secure storage pocket door in closed position. Include two keys per lock.
3. Rim Lock, Deadlock: Deadlock to receive cylinder, to secure storage pocket door in closed position. See [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for lock cylinder and keying requirements.

C. Windows: [**Manufacturer's standard**][**As indicated**].

1. Glass: Safety glass [**matching Architect's sample**][**as selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Safety Glass Standard for Partition Panels: Glass products complying with testing requirements in 16 CFR 1201, Category II, or in ANSI Z97.1, Class A.
3. Safety Glass Standard for Pass Doors: Glass products complying with testing requirements in 16 CFR 1201, Category II.

D. Work Surfaces: Quantities, placement, and size indicated.

1. Surface: [**Porcelain steel marker/projection surface**][**Self-healing, tackable, vinyl-coated fabric wall covering, complying with WA-101, Type II-Medium Duty; Class A; laminated to natural cork tackboard**].
2. Surface Color: [**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Size: [**Full width and height of panel**][**Full width of panel by 48 inches (1219 mm)**][**48 by 48 inches (1219 by 1219 mm)**][**As indicated on Drawings**].
4. Trim: [**Aluminum slip-on or snap-on trim with no visible screws or exposed joints and with corners mitered to a neat, hairline joint**].

E. Chalk Tray and Eraser Pocket: Aluminum with [**mill**][**clear anodic**][**color anodic**] finish.

F. Chair Rails: . [**Recessed**][**Surface mounted**] in locations indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF OPERABLE PANEL PARTITIONS

A. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.

B. Install panels in numbered sequence indicated on Shop Drawings.

C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

E. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals.[**Perform test and make adjustments before NIC testing.**]

3.3 FIELD QUALITY CONTROL

A. NIC Testing: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing Extent: Testing agency is to randomly select [**one**] operable panel partition installation(s) for testing.
2. Testing Methodology: Perform testing of installed operable panel partition for noise isolation in accordance with ASTM E336, determined by ASTM E413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

B. An operable panel partition installation will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust [**pass doors**][**and**][**storage pocket doors**] to operate smoothly and easily, without binding or warping.

C. Verify that safety devices are properly functioning.

3.5 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service is to include [**three**][**six**][**nine**][**12**] months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 10 22 00 00

SECTION 10 22 00 00A - ALL-GLASS PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed all-glass partitions.
2. Manual-folding all-glass partition systems.
3. Manual-sliding all-glass partition systems.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for overhead-steel support for all-glass partitions.
2. Section 084126.23 "Interior All-Glass Entrances" for interior, manual-swinging and manual-sliding all-glass doors used as pass doors in all-glass partitions.
3. Section 102239.13 "Folding-Glass-Panel Partitions" for manual-folding and manual-sliding, framed, glass panel partition systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics and furnished accessories.

B. Shop Drawings:

1. Plans, elevations, sections,[**numbered panel installation sequence,**] and attachment details.
2. Dimensions, configuration of glass panels.[**Include stacking layout, operating clearances, and direction of travel.**]
3. Location and installation requirements for hardware and overhead support.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of fitting, accessory fitting, glass, and hardware.

D. Samples for Verification: Actual sample of finished products for each type of fitting, accessory fitting, glass; showing exposed edge finish, and hardware.

1. Size: [**Manufacturers' standard size**].

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party-Certified Life-Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For heat-soak testing of fully tempered glass.

B. Field Quality-Control Reports: For egress door inspections for pivoting swing panels used as a means of egress.

C. Qualification Statements: For Installer[**and egress door inspector**].

D. Delegated Design Submittals: For seismic restraint of all-glass partitions, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Delegated design engineer qualifications.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all-glass partitions.

1. Furnish a complete set of specialized tools and maintenance instructions as required for the Owner's continued adjustment and maintenance of [**manual-folding**][**manual-sliding**] all-glass partitions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer[**and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Egress Door Inspector Qualifications:

1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with all-glass partitions by field measurements; coordinate prior to fabrication.

1.9 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of all-glass partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of all-glass partitions[**and doors within all-glass partitions**], including fittings,

hardware, and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraint of all-glass partition systems.

B. Seismic Performance: All-glass partitions to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

C. Deflection Limits, Interior Glazed Areas: Differential deflection of two adjacent unsupported glass panel edges is not to exceed thickness of panels when a force of **50 plf (0.73 kN)** is applied horizontally to one panel at any point up to **42 inches (1067 mm)** above finished floor.

D. Accessibility Standards: Comply with applicable provisions in [the DOJ's "2010 ADA Standards for Accessible Design"][and][ICC A117.1] for [pivoting swing][sliding] glass panels designated as accessible.

2.3 FIXED ALL-GLASS PARTITIONS

A. Fixed All-Glass Partition : Interior partitions composed of single-glazed frameless glass panels and fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Avanti Systems USA**]
b. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]

B. Glass Panels:

1. Width: [**Manufacturer's standard panel width to form an assembled system of dimensions indicated on Drawings and verified by field measurements**][**Equal width panels to form an assembled system of dimensions indicated on Drawings and verified by field measurements; widths not to exceed manufacturer's maximum**][**As indicated on Drawings**].
2. Height: [**Manufacturer's standard**][**As indicated on Drawings**].
3. Glass Type:

a. Monolithic Glass: [**Fully tempered float glass; clear**][**Fully tempered float glass; low iron**][**Fully tempered patterned glass**].

1) Glass Thickness: [**10**][**12**][**16**][**19**] mm.

b. Laminated Glass: [**Annealed float glass; clear**][**Annealed float glass; low iron**][**Patterned glass**].

1) Glass Ply Thickness: [**5**][**6**][**8**] mm each.
2) Interlayer Material: [**Polyvinyl butyral**][**Ionoplast**][**Manufacturer's standard**].
3) Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch**

(2.3 mm)].
4) Interlayer Type: [**Clear**][**Colored**][**Patterned**][**Graphic**].

4. Manufacturer's standard factory-glazing system, single-glazed.

C. Fitting Configuration: [**Recessed glazing channel at top and continuous rail fitting at bottom**][**Recessed glazing channel at top and bottom**][**Continuous rail fitting at top and bottom**].

D. Rail Fittings:

1. Top Rail Height: [**4 inches (102 mm)**][**As indicated**].
2. Bottom Rail Height: [**4 inches (102 mm)**][**As indicated**].
3. Profile: [**Tapered**][**Tapered flat**][**Square**][**Curved**][**As indicated**].
4. End Caps: Manufacturer's standard precision-fit end caps finished to match rail.[**Miter endcaps at corner panels.**]

E. Accessory Fittings:

1. U-channel.

F. Fitting Material: [**Clear-anodized aluminum**][**Color-anodized aluminum**][**Powder-coated aluminum**][**Bronze-clad aluminum**][**Brass-clad aluminum**][**Stainless steel-clad aluminum**].

G. Anchors and Fastenings: Concealed.

2.4 MANUAL-FOLDING ALL-GLASS PARTITION SYSTEMS

A. Manual-Folding All-Glass Partition System : Interior partition systems composed of single-glazed frameless glass panels, fittings, and hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hufcor, Inc**]
b. [**Modernfold, Inc**]
c. [**Nana Wall Systems, Inc.**]

2. Operation: Manually operated, top-hung,[**center pivot,**][**continuously hinged**][**paired**][**continuously hinged and paired**] folding glass panels[**with end single-action pivoting swing panel**][**with end double-action pivoting swing panel**][**with lead single-action folding pivoting swing panel**].
3. Partition/Track Configuration: As indicated on Drawings.
4. Stacking Configuration: [**Center stacking**][**Perpendicular inward stacking**][**Perpendicular outward stacking**][**As indicated on Drawings**].

B. Glass Panels:

1. Width: [**Manufacturer's standard panel width to form an assembled system of dimensions indicated on Drawings and verified by field measurements**][**Equal width panels to form an assembled system of dimensions indicated on Drawings and verified by field measurements; widths not to exceed manufacturer's maximum**][**As indicated on Drawings**].[**Width to not be less than 32 inches (813 mm) clear.**]
2. Height: [**Manufacturer's standard**][**As indicated on Drawings**].[**Height to not be less than**

80 inches (2032 mm).]

3. Weight: [7 lb/sq. ft. (34 kg/sq. m)] maximum.
4. Glass Type:

   a. Monolithic Glass: [**Fully tempered float glass; clear**][**Fully tempered float glass; low iron**].

      1) Glass Thickness: [**10**][**12**] mm .

   b. Laminated Glass: [**Annealed float glass; clear**][**Annealed float glass; low iron**][**Fully tempered float glass; clear**][**Fully tempered float glass; low iron**].

      1) Glass Ply Thickness: [**5**][**6**] mm each.
      2) Interlayer Material: [**Polyvinyl butyral**][**Ionoplast**][**Manufacturer's standard**].
      3) Interlayer Thickness: [0.030 inch (0.76 mm)][0.060 inch (1.52 mm)][0.090 inch (2.3 mm)].
      4) Interlayer Type: [**Clear**][**Colored**][**Patterned**][**Graphic**].

5. Manufacturer's standard factory-glazing system; single glazed.

C. Rail Fittings: Continuous interlocking rail fittings at top and bottom of glass panels.

1. Top Rail Height: [4 inches (102 mm)][**As indicated on Drawings**].
2. Bottom Rail Height: [4 inches (102 mm)][10 inches (255 mm)][**As indicated on Drawings**].
3. Top and Bottom Rail Depth: [1-7/16 inches (36 mm)][**As indicated on Drawings**].
4. Profile: [**Square**][**Tapered at 60 degrees minimum from the horizontal**][**As indicated on Drawings**].
5. End Caps: Manufacturer's standard precision-fit end caps finished to match rail.[**Miter endcaps at corner panels.**]
6. Fitting Material: [**Clear-anodized aluminum**][**Color-anodized aluminum**][**Powder-coated aluminum**][**Bronze-clad aluminum**][**Brass-clad aluminum**][**Stainless steel-clad aluminum**].

D. Hardware:

1. Provide manufacturer's standard hardware designed to smoothly operate, tightly close, and securely lock manual-folding all-glass partition system in place. Size hardware to accommodate panel weights and dimensions. For exposed parts, match metal and finish of fittings.
2. Glass Panel Hardware:

   a. Hinges: [**Manufacturer's standard**][**Concealed (invisible)**] hinges attached to top and bottom rail.
   b. Floor Bolt: Manufacturer's standard floor bolt and floor-mounted receiver at each panel.
   c. Partition System Lock: [**Thumb-turn**][**Key-actuated**] floor bolt and floor strike at lead panel.

3. Pivoting Swing Panel Hardware:

   a. Panic hardware.
   b. Lock: [**Thumb-turn**][**Key-actuated**] floor bolt and floor strike.
   c. Closer: [**Overhead**][**Floor**].
   d. Door Pulls Back-to-Back: [**Tubular pull**][**Ladder pull**][**Locking ladder pull**][**Finger pull rosette**][**Push/pull knob**].

4. Suspension System: Provide panel suspension system designed for size, weight, and performance requirements of manual-folding all-glass partition systems indicated.

a. Overhead Track: Extruded aluminum [**mounted directly to overhead structural support**][**with adjustable steel hanger rods for overhead support**]. Size track to support partition operation and stacking without damage to suspension system, glass panels, or adjacent construction. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated.

1) Aluminum Finish: [**Clear anodized**][**Color anodized**][**Powder coated**][**Manufacturer's standard factory-applied finish**].

b. Carriers: Manufacturer's standard multi-wheeled carriers with sealed ball bearings.
c. Floor Track: Manufacturer's standard recessed floor guide track. Finish to match overhead track.
d. Center carrier stop.

E. Accessories:

1. Glass Edge Protection: Manufacturer's standard [**transparent gasket**][**thin aluminum astragal trim**] to protect vertical edge of glass.
2. Head Closure Trim: [**Finish to match fittings**][**Primed for field finish**].
3. [**Single**][**Double**] top and bottom brush seals.

F. Anchors and Fastenings: Concealed.

2.5 MANUAL-SLIDING ALL-GLASS PARTITION SYSTEMS

A. Manual-Sliding All-Glass Partition System : Interior partition systems composed of single-glazed frameless glass panels, fittings, and hardware.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Avanti Systems USA**]
b. [**dormakaba USA Inc.**]
c. [**Hufcor, Inc**]
d. [**KWIK-WALL Company**]
e. [**Moderco Inc**]
f. [**Modernfold, Inc**]
g. [**Nana Wall Systems, Inc.**]

2. Operation: Manually operated, top-hung,[**center pivot,**] individual sliding glass panels on single track[**with end single-action pivoting swing panel**][**with end double-action pivoting swing panel**][**with single-action pivoting swing panel in location(s) indicated on Drawings**][**with double-action pivoting swing panel in location(s) indicated on Drawings**].
3. Partition/Track Configuration: As indicated on Drawings.
4. Stacking Configuration: [**Center stacking**][**Offset parallel stacking**][**Offset perpendicular stacking**][**As indicated on Drawings**].

B. Glass Panels:

1. Width: [**Manufacturer's standard panel width to form an assembled system of dimensions indicated on Drawings and verified by field measurements**][**Equal width panels to form an assembled system of dimensions indicated on Drawings and verified by field**

measurements; widths not to exceed manufacturer's maximum][**As indicated on Drawings**].[**Width to not be less than 32 inches (813 mm) clear.**]

2. Height: [**Manufacturer's standard**][**As indicated on Drawings**].[**Height to not be less than 80 inches (2032 mm).**]
3. Weight: [**7 lb/sq. ft. (34 kg/sq. m)**] maximum.
4. Glass Type:

   a. Monolithic Glass: [**Fully tempered float glass; clear**][**Fully tempered float glass; low iron**].

      1) Glass Thickness: [**10**][**12**] mm .

   b. Laminated Glass: [**Annealed float glass; clear**][**Annealed float glass; low iron**][**Fully tempered float glass; clear**][**Fully tempered float glass; low iron**].

      1) Glass Ply Thickness: [**5**][**6**] mm each.
      2) Interlayer Material: [**Polyvinyl butyral**][**Ionoplast**][**Manufacturer's standard**].
      3) Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.3 mm)**].
      4) Interlayer Type: [**Clear**][**Colored**][**Patterned**][**Graphic**].

5. Manufacturer's standard factory-glazing system; single glazed.

C. Rail Fittings: Continuous interlocking rail fittings at top and bottom of glass panels.

1. Top Rail Height: [**4 inches (102 mm)**][**As indicated on Drawings**].
2. Bottom Rail Height: [**4 inches (102 mm)**][**10 inches (255 mm)**][**As indicated on Drawings**].
3. Top and Bottom Rail Depth: [**1-7/16 inches (36 mm)**][**As indicated on Drawings**].
4. Profile: [**Square**][**Tapered at 60 degrees minimum from the horizontal**][**As indicated on Drawings**].
5. End Caps: Manufacturer's standard precision-fit end caps finished to match rail.[**Miter endcaps at corner panels.**]
6. Fitting Material: [**Clear-anodized aluminum**][**Color-anodized aluminum**][**Powder-coated aluminum**][**Bronze-clad aluminum**][**Brass-clad aluminum**][**Stainless steel-clad aluminum**].

D. Hardware:

1. Provide manufacturer's standard hardware designed to smoothly operate, tightly close, and securely lock manual-sliding all-glass partition system in place. Size hardware to accommodate panel weights and dimensions. For exposed parts, match metal and finish of fittings.
2. Glass Panel Hardware:

   a. Floor Bolt: Manufacturer's standard floor bolt and floor-mounted receiver at each panel.
   b. Partition System Lock: [**Thumb-turn**][**Key-actuated**] floor bolt and floor strike at lead panel.

3. Pivoting Swing Panel Hardware:

   a. Panic hardware.
   b. Lock: [**Thumb-turn**][**Key-actuated**] floor bolt and floor strike.
   c. Closer: [**Overhead**][**Floor**].
   d. Door Pulls Back-to-Back: [**Tubular pull**][**Ladder pull**][**Locking ladder pull**][**Finger pull rosette**][**Push/pull knob**].

4. Suspension System: Provide panel suspension system designed for size, weight, and

performance requirements of manual-sliding all-glass partition systems indicated.

a. Overhead Track: Extruded aluminum [**mounted directly to overhead structural support**][**with adjustable steel hanger rods for overhead support**]. Size track to support partition operation and stacking without damage to suspension system, glass panels, or adjacent construction. Limit track deflection to no more than [**0.10 inch (2.54 mm)**] between supports when fully loaded. Provide a continuous system of track sections and accessories to accommodate partition configuration and layout indicated. Provide intersections, switches, and accessories required for stacking configuration indicated.

1) Aluminum Finish: [**Clear anodized**][**Color anodized**][**Powder coated**][**Manufacturer's standard factory-applied finish**].

b. Carriers: Manufacturer's standard multi-wheeled counter-rotating carriers with sealed ball bearings.
c. Floor Track: Manufacturer's standard recessed floor guide track. Finish to match overhead track.
d. Center carrier stop.

E. Accessories:

1. Glass Edge Protection: Manufacturer's standard [**transparent gasket**][**thin aluminum astragal trim**] to protect vertical edge of glass.
2. Head Closure Trim: [**Finish to match fittings**][**Primed for field finish**].
3. [**Single**][**Double**] top and bottom brush seals.

F. Anchors and Fastenings: Concealed.

2.6 GLASS

A. Glass: As specified in Section 088000 "Glazing."

B. Glass as Follows:

1. Safety Glass:

a. Glass Panels: Safety glass complying with testing requirements in 16 CFR 1201, Category II, or ANSI Z97.1.
b. Pivoting Swing Panels: Safety glass complying with testing requirements in 16 CFR 1201, Category II.
c. Safety-Glass Labeling: Permanently mark each pane of safety glass with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][manufacturer]. Label must indicate manufacturer or Installer's name, type of glass, thickness, and safety glazing standard with which glass complies.

2. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I (transparent flat glass), Class 1 (clear and low iron), Quality-Q3.[**Fully tempered glass to be heat-soak tested in accordance with BS EN 14179-1.**]
3. Fully Tempered Patterned Glass: ASTM C1048, Kind FT (fully tempered), Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.[**Fully tempered glass to be heat-soak tested in accordance with BS EN 14179-1.**]
4. Laminated Glass: ASTM C1172 [**Type I**][**Type 2**] with two plies of glass bonded together by an interlayer.

a. Annealed Float Glass: ASTM C1036, Type I (transparent flat glass), Class 1 (clear and low iron), Quality-Q3.
b. Patterned Glass: ASTM C1036, Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.
c. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I (transparent flat glass), Class 1 (clear and low iron), Quality-Q3.

5. Exposed Edges: Machine ground and flat polished.
6. Butt Edges: Flat ground.
7. Corner Edges: Lap-joint corners with exposed edges polished.

C. Distraction Markings: All-glass doors and adjacent all-glass panels to have [**factory-**][**field-**]applied markings located [**between 30 and 36 inches (762 and 914 mm)**] above finished floor and located [**between 60 and 66 inches (1524 and 1675 mm)**] above finished floor.

1. Marking Design: [**As indicated on Drawings**].
2. Marking Dimensions: [**As indicated on Drawings**].
3. Marking Method: [**Chemical etching**][**Sandblasting**][**Adhesive strips**][**Decals**][**Gilding**].

2.7 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, with strength and durability characteristics of not less than Alloy 6063-T5 for extruded bars, rods, profiles, and tubes. ASTM B209/B209M for sheet and plat.

1. Clear-Anodized Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
2. Color-Anodized Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

3. Powder-Coated Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Bronze Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**Statuary M31-C5**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

5. Brass Cladding: ASTM B36/B36M, alloy [**as standard with manufacturer**].

a. Finish: [**Polished M21-O6x**][**Satin M31-M34-O6x**][**As selected by Architect from full range of industry finishes**], as directed by the Owner.

6. Stainless Steel Cladding: ASTM A240/A240M or ASTM A666, Type 304.

a. Finish: [**Directional Satin Finish: ASTM A480/480M, No. 4**][**Mirror Finish: ASTM A480/480M, No. 8**].

B. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M or ASTM A666, austenitic stainless steel, Type 304.

1. Finish: [**ASTM A480/480M No. 4 directional satin finish**][**ASTM A480/480M No. 6 dull satin finish**][**ASTM A480/480M No. 7 reflective, directional finish**].

C. Stainless Steel Tubing: ASTM A240/A240M or ASTM A666, austenitic stainless steel, Type 304.

1. Finish: [**180-Grit Polished Finish: Uniform, directionally textured finish**][**280-Grit Polished Finish: Fine finish**][**Polished and Buffed Finish: 320-grit finish followed by buffing**].

a. Polished and Buffed Finish: Buff to [**high luster finish**][**mirrorlike finish**][**match Architect's sample**], as directed by the Owner.

D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.

1. Finish: [**ASTM A480/480M No. 4 directional satin finish**][**ASTM A480/480M No. 6 dull satin finish**][**ASTM A480/480M No. 7 reflective, directional finish**].

2.8 FABRICATION

A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or glass panel.

B. Complete fabrication, assembly, finishing, fitting and hardware application, and other work in the factory to greatest extent possible.

C. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight hairline joints and uniform appearance, and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Factory-Glazed Fabrication: Glaze all-glass partitions in the factory. Comply with manufacturer's written instructions and with requirements in Section 088000 "Glazing."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of floor, and operational clearances.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install all-glass partitions and associated components in accordance with Drawings, approved Shop Drawings, and manufacturer's written instructions.

B. Install panels in numbered sequence indicated on approved Shop Drawings.

C. Set units level, plumb, and true to line, with uniform joints.

D. Maintain uniform clearances between adjacent components.

E. Lubricate hardware and other moving parts in accordance with manufacturer's written instructions.

F. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: [**the Owner will engage**][**Engage**] a qualified inspector to perform inspections.

B. Inspections:

1. Egress Door Inspections: Inspect each pivoting swing panel equipped with panic hardware or located in an exit enclosure, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Pivoting swing panels will be considered defective if they do not pass inspections.

C. Prepare inspection reports.

3.4 ADJUSTING

A. Adjust operable all-glass partitions and hardware to function smoothly.

3.5 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service to include [**three**][**six**][**nine**][**12**] months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain operable all-glass partitions.

END OF SECTION 10 22 00 00A

SECTION 10 22 13 00 - WIRE MESH PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard-duty wire mesh partitions.
2. Heavy-duty wire mesh partitions.
3. Wire mesh ceilings.
4. Wire mesh stairway partitions.
5. Wire mesh equipment barriers.

1.2 DEFINITIONS

A. Intermediate Crimp: Wires pass over one and under the next adjacent wire in both directions, with wires crimped before weaving and with extra crimps between the intersections.

B. Lock Crimp: Deep crimps at points of the intersection that lock wires securely in place.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Wire mesh [**partitions**][**ceilings**][**stairway partitions**][**and**][**equipment barriers**].

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Indicate clearances required for operation of [**service windows**][**doors**][**and**][**gates**].

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for units with factory-applied color finishes.

D. Samples for Verification: Panel constructed of specified frame members and wire mesh. Show method of finishing members at intersections.

1. Size: **12 by 12 inches (300 by 300 mm)**.

E. Delegated Design Submittals: For wire mesh partitions indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Welding certificates.

B. Qualification Statements: For Installer.

C. Delegated design engineer qualifications.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wire mesh partition hardware.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installers: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].
2. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

a. AWS D1.1/D1.1M.
b. AWS D1.3/D1.3M.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire mesh items [**with cardboard protectors on perimeters of panels and doors and with posts wrapped**][**palleted**][**crated**] to provide protection during transit and Project-site storage. Use vented plastic.

B. Inventory wire mesh partition door hardware on receipt, and provide secure lockup for wire mesh partition door hardware delivered to Project site.

1. Tag each item or package separately with identification, and include basic installation instructions with each item or package.

C. Deliver keys to the Owner by registered mail or overnight package service[.][addressed as follows:]

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with wire mesh units by field

measurements before fabrication.

PART 2 - PRODUCTS

2.1 WIRE MESH PARTITIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acorn Wire & Iron Works**]
2. [**American Wire Corporation**]
3. [**California Wire Products Corporation**]
4. [**Central Wire & Iron Works, LLC**]
5. [**Folding Guard, Incorporated**]
6. [**G-S Company (The)**]
7. [**Indiana Wire Products, Inc**]
8. [**Jesco Industries, Inc.**]
9. [**Kenco Wire & Iron Products Inc.**]
10. [**King Wire Partitions, Inc**]
11. [**Miller Wire Works, Inc**]
12. [**Newark Wire Works Inc**]
13. [**R. J. Donaldson, Inc.**]
14. [**SpaceGuard Products**]
15. [**Standard Wire & Steel Works**]
16. [**WireCrafters, LLC**]

2.2 SOURCE LIMITATIONS

A. For wire mesh products, obtain each color, grade, finish, type, and variety from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wire mesh units.

B. Structural Performance: Wire mesh units to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)** at any location on a panel.
2. Total load of [**200 lbf (0.89 kN)**] applied uniformly over each panel.
3. Concentrated load and total load need not be assumed to act concurrently.

C. Seismic Performance: Wire mesh units to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

D. Regulatory Requirements: Comply with applicable provisions in [**the United States Access Board's ADA-ABA Accessibility Guidelines**][**and**][**ICC A117.1**] for doors and gates designated as accessible.

2.4 STANDARD-DUTY WIRE MESH PARTITIONS

A. Mesh: **0.135-inch- (3.5-mm-)** diameter, intermediate-crimp steel wire woven into **1-1/2-inch (38-mm)** diamond mesh.

B. Vertical Panel Framing: **1-1/4-by-5/8-by-0.080-inch (32-by-16-by-2.0-mm)** cold-rolled, C-shaped steel channels with holes for **1/4-inch- (6-mm-)** diameter bolts not more than **12 inches (300 mm)** o.c.

C. Horizontal Panel Framing: **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channels.

D. Horizontal Panel Stiffeners: Two cold-rolled steel channels, **3/4 by 3/8 by 1/8 inch (19 by 9.5 by 3.2 mm)**, bolted or riveted toe to toe through mesh; or one **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channel with wire mesh woven through channel.

E. Top Capping Bars: **2-1/4-by-1-inch (57-by-25-mm)** cold-rolled steel channels.

F. Posts for 90-Degree Corners: **1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3.2-mm)** steel angles or square tubes with holes for **1/4-inch- (6-mm-)** diameter bolts aligning with bolt holes in vertical framing; with floor anchor clips.

G. Posts for Other-Than-90-Degree Corners: Steel pipe or tubing with holes for **1/4-inch- (6-mm-)** diameter bolts aligning with bolt holes in vertical framing; with floor anchor clips.

1. Partitions up to **12 Ft. (3.7 m)** High: **1-1/4-inch (32-mm)** OD by **1/8 inch (3.2 mm)**.
2. Partitions up to **20 Ft. (6.1 m)** High: **2-1/2-inch (65-mm)** OD by **1/8 inch (3.2 mm)**.

H. Adjustable Corner Posts: Two **1-1/4-by-5/8-by-0.080-inch (32-by-16-by-2.0-mm)** cold-rolled, C-shaped steel channels connected by steel hinges at **36 inches (900 mm)** o.c., with holes for **1/4-inch- (6-mm-)** diameter bolts aligning with bolt holes in vertical framing.

I. Line Posts: **3-inch-by-4.1-lb (76-mm-by-1.9-kg)** or **3-1/2-by-1-1/4-by-0.127-inch (89-by-32-by-3.2-mm)** steel channels; with **1/4-inch (6.4-mm)** steel base plates.

J. Three-Way Intersection Posts: **1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3.2-mm)** steel tubes or channels, with holes for **1/4-inch- (6-mm-)** diameter bolts aligned for bolting to adjacent panels.

K. Four-Way Intersection Posts: **1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3.2-mm)** steel tubes, with holes for **1/4-inch- (6-mm-)** diameter bolts aligned for bolting to adjacent panels.

L. Floor Shoes: Metal, not less than **2 inches (50 mm)** high; sized to suit vertical framing, drilled for attachment to floor, and with setscrews for leveling adjustment.

M. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels or **1-1/4-by-5/8-by-0.080-inch (32-by-16-by-2.0-mm)** cold-rolled, C-shaped steel channels, banded with **1-1/4-by-1/8-inch (32-by-3.2-mm)** flat steel bar cover plates on [**three**][**four**] sides, and with **1/8-inch- (3.2-mm-)** thick angle strike bar and cover on strike jamb.

1. Hinges: Full-surface type, **3-by-3-inch (76-by-76-mm)** steel, three per door; bolted, riveted, or welded to door and jamb framing.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside.

4. Inactive Leaf Hardware: Cane bolt at bottom and chain bolt at top.

N. Swinging Dutch Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels or **1-1/4-by-5/8-by-0.080-inch (32-by-16-by-2.0-mm)** cold-rolled, C-shaped steel channels, banded with **1-1/4-by-1/8-inch (32-by-3.2-mm)** flat steel bar cover plates on [**three**][**four**] sides, and with **1/8-inch- (3.2-mm-)** thick angle strike bar and cover on strike jamb.

1. Hinges: Full-surface type, **3-by-3-inch (76-by-76-mm)** steel, two per section of door (top and bottom); bolted, riveted, or welded to door and jamb framing.
2. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside; mounted in lower section of door.
3. Bolt: Mounted in, securing upper section of door.
4. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet, [**12 inches (300 mm)**][**18 inches (450 mm)**] deep by full width of door less **4 inches (102 mm)**; with corners rounded and edges finished smooth; mounted on top of lower section of door and braced with manufacturer's standard brackets.

O. Sliding Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** steel channels, banded with **1-1/2-by-1/8-inch (38-by-3.2-mm)** flat steel bar cover plates on four sides.

1. Hardware: Two, four-wheel roller-bearing carriers; box track; and bottom guide channel for each door.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside.

P. Vertically Sliding Service Windows: Fabricated from same mesh and framing as panels and equipped with [**spring catch**][**slide bolts**] on each jamb to lock window in open position and a padlock lug to lock window in closed position. Include opening frame in partition fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels.

1. Size: [**24 inches wide by 18 inches high (600 mm wide by 450 mm high)**][**24 inches wide by 21-1/2 inches high (600 mm wide by 546 mm high)**][**As indicated**].
2. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.

   a. Size: [**23 inches wide by 12 inches deep (590 mm wide by 300 mm deep)**][**As indicated**].

Q. Swinging Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch on strike jamb that locks window in closed position. Include opening frame in partition fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels.

1. Size: [**24 inches wide by 18 inches high (600 mm wide by 450 mm high)**][**24 inches wide by 15 inches high (600 mm wide by 380 mm high)**][**As indicated**].
2. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.

   a. Size: [**24 inches wide by 12 inches deep (600 mm wide by 300 mm deep)**][**24 inches wide by 15-3/4 inches deep (600 mm wide by 400 mm deep)**][**As indicated**].

R. Accessories:

1. Sheet Metal Base: [**0.060-inch- (1.5-mm-)**][**0.035-inch- (0.9-mm-)**] thick, steel sheet.
2. Adjustable Filler Panels: **0.060-inch- (1.5-mm-)** thick, steel sheet; capable of filling openings from **2 to 12 inches (50 to 300 mm)**.
3. Wall Clips: Manufacturer's standard, steel sheet[allowing up to 1 inch (25 mm) of adjustment].

S. Finish: [**Hot-dip galvanized**][**Hot-dip galvanized and shop primed for field painting**][**Shop primed for field painting**][**Enamel finish**][**Powder-coated finish**] unless otherwise indicated.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 HEAVY-DUTY WIRE MESH PARTITIONS

A. Mesh:

1. **0.192-inch- (4.9-mm-)** diameter, intermediate-crimp steel wire woven into **2-inch (50-mm)** diamond mesh.
2. **0.192-inch- (4.9-mm-)** diameter steel wire, resistance welded into **1-1/2-by-2-1/2-inch (38-mm-by-65-mm)** rectangular mesh.

B. Vertical and Horizontal Panel Framing: **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** cold-rolled steel channels; with holes for **3/8-inch- (9.5-mm-)** diameter bolts not more than **12 inches (300 mm)** o.c.

C. Horizontal Panel Stiffeners: Two cold-rolled steel channels, **1 by 1/2 by 1/8 inch (25 by 13 by 3.2 mm)**, bolted or riveted toe to toe through mesh.

D. Top Capping Bars: **3-by-1-inch (76-by-25-mm)** steel channels.

E. Posts for 90-Degree Corners: **1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm)** steel angles or tubes[**or 2-by-2-by-0.075-inch (50-by-50-by-1.9-mm) cold-rolled steel angles or tubes**], with holes for **3/8-inch- (9.5-mm-)** diameter bolts aligning with bolt holes in vertical framing; with **1/4-inch (6.4-mm)** steel base plates.

F. Posts for Other-Than-90-Degree Corners: **2-inch- (50-mm)** OD by **1/8-inch (3.2-mm)** steel pipe or round tube, with holes for **3/8-inch- (9.5-mm-)** diameter bolts aligning with bolt holes in vertical framing; with **1/4-inch (6.4-mm)** steel base plates.

G. Adjustable Corner Posts: Two **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** cold-rolled, steel channels or **2-by-2-by-0.075-inch (50-by-50-by-1.9-mm)** steel tubes connected by steel hinges at **36 inches (900 mm)** o.c. attached to posts; with **1/4-inch- (6-mm-)** diameter bolt holes aligning with bolt holes in vertical framing; with **1/4-inch (6.4-mm)** steel base plates.

H. Line Posts: **3-inch-by-4.1-lb (76-mm-by-1.9-kg)** or **3-1/2-by-1-1/4-by-1/8-inch (89-by-32-by-3.2-mm)** steel channels; with **1/4-inch (6.4-mm)** steel base plates.

I. [**Three-**][**and**][**Four-**]Way Intersection Posts: **2-by-2-by-0.075-inch (50-by-50-by-1.9-mm)** steel tubes, with holes for **3/8-inch- (9.5-mm-)** diameter bolts aligned for bolting to adjacent panels; with **1/4-inch (6.4-mm)** steel base plates.

J. Floor Shoes: Metal, not less than **2 inches (50 mm)** high; sized to suit vertical framing, drilled for

attachment to floor, and with setscrews for leveling adjustment.

K. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** steel channels, banded with **1-1/2-by-1/8-inch (38-by-3.2-mm)** flat steel bar cover plates on four sides, and with **1/8-inch- (3.2-mm-)** thick angle strike bar and cover on strike jamb.

1. Hinges: Full-surface type, **3-1/2-by-3-1/2-inch (89-by-89-mm)** steel, three per door; bolted, riveted, or welded to door and jamb framing.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside; mounted in lower section of door.
4. Inactive Leaf Hardware: Cane bolt at bottom and chain bolt at top.

L. Swinging Dutch Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** steel channels, banded with **1-1/2-by-1/8-inch (38-by-3.2-mm)** flat steel bar cover plates on [**three**][**four**] sides, and with **1/8-inch- (3.2-mm-)** thick angle strike bar and cover on strike jamb.

1. Hinges: Full-surface type, **3-1/2-by-3-1/2-inch (89-by-89-mm)** steel, two per section of door (top and bottom); bolted, riveted, or welded to door and jamb framing.
2. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside; mounted in lower section of door.
3. Bolt: Mounted in, securing upper section of door.
4. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet, [**12 inches (300 mm)**][**18 inches (450 mm)**] deep by full width of door less **4 inches (102 mm)**; with corners rounded and edges finished smooth; mounted on top of lower section of door and braced with manufacturer's standard brackets.

M. Sliding Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** steel channels, banded with **1-1/2-by-1/8-inch (38-by-3.2-mm)** flat steel bar cover plates on four sides.

1. Hardware: Two, four-wheel roller-bearing carriers; box track; and bottom guide channel for each door.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside; mounted in lower section of door.

N. Vertically Sliding Service Windows: Fabricated from same mesh and framing as panels and equipped with [**spring catch**][**slide bolts**] on each jamb to lock window in open and closed positions. Include opening frame in partition fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels.

1. Size: [**24 inches wide by 18 inches high (600 mm wide by 450 mm high)**][**24 inches wide by 21-1/2 inches high (600 mm wide by 546 mm high)**][**As indicated**].
2. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.

   a. Size: [**24 inches wide by 12 inches deep (600 mm wide by 300 mm deep)**][**As**

indicated].

O. Swinging Service Windows: Fabricated from same mesh and framing as panels and equipped with spring catch on strike jamb that locks window in closed position. Include opening frame in partition fabricated from **1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3.2-mm)** steel channels.

1. Size: [**24 inches wide by 18 inches high (600 mm wide by 450 mm high)**][**24 inches wide by 15 inches high (600 mm wide by 380 mm high)**][**As indicated**].
2. Shelf: Fabricated from **0.097-inch- (2.5-mm-)** thick, steel sheet; with corners rounded and edges finished smooth; braced with manufacturer's standard brackets.

   a. Size: [**24 inches wide by 12 inches deep (600 mm wide by 300 mm deep)**][**24 inches wide by 15-3/4 inches deep (600 mm wide by 400 mm deep)**][**As indicated**].

P. Accessories:

1. Sheet Metal Base: **0.060-inch- (1.5-mm-)** thick, steel sheet.
2. Adjustable Filler Panels: **0.060-inch- (1.5-mm-)** thick, steel sheet; capable of filling openings from **2 to 12 inches (50 to 300 mm)**.
3. Wall Clips: Manufacturer's standard, cold-rolled steel sheet[allowing up to 1 inch (25 mm) of adjustment].

Q. Finish: [**Hot-dip galvanized**][**Hot-dip galvanized and shop primed for field painting**][**Shop primed for field painting**][**Enamel finish**][**Powder-coated finish**] unless otherwise indicated.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 WIRE MESH CEILINGS

A. Mesh, Framing, and Stiffeners: Fabricated from same mesh and framing as wire mesh partition panels.

B. Perimeter Partition Supports: [**1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm)**][**1-1/2-by-1-1/2-by-0.075-inch (38-by-38-by-1.9-mm)**] steel angle, with holes for **1/4-inch- (6-mm-)** diameter bolts aligned for bolting to top of wire mesh partitions and to sides of wire mesh ceiling panels.

C. Wall Supports: [**1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm)**][**1-1/2-by-1-1/2-by-0.075-inch (38-by-38-by-1.9-mm)**] steel angle punched for attachment to wall and wire mesh ceiling panels.

D. Intermediate Supports: Steel I-beams or rectangular tubes, as recommended by manufacturer.

E. Intermediate Support Posts: [**2-by-2-by-1/8-inch (50-by-50-by-3.2-mm)**][**2-by-2-by-0.075-inch (50-by-50-by-1.9-mm)**] steel tubes.

F. Finishes: Match adjacent wire mesh partitions.

2.7 WIRE MESH STAIRWAY PARTITIONS

A. Standard-Duty Stairway Partitions:

1. Diamond Mesh: **0.135-inch- (3.5-mm-)** diameter, intermediate-crimp steel wire woven into **1-1/2-inch (38-mm)** diamond pattern and securely clinched to frames.

2. Square Mesh: **0.135-inch- (3.5-mm-)** diameter, [**intermediate**][**lock**]-crimp steel wire woven into **1-1/2-inch (38-mm)** square pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
3. Rectangular Mesh: **0.135-inch- (3.5-mm-)** diameter, [**intermediate**][**lock**]-crimp steel wire woven into **2-by-1-inch (50-by-25-mm)** rectangular pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
4. Vertical Panel Framing: **1-1/4-by-5/8-by-0.097-inch (32-by-16-by-2.5-mm)** cold-rolled, C-shaped steel channels; with **1/4-inch- (6-mm-)** diameter bolt holes spaced not more than **18 inches (450 mm)** o.c. along center of framing.
5. Horizontal Panel Framing: **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channels.
6. Horizontal Panel Stiffeners: **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channels with wire woven through, or two **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channels bolted or riveted toe to toe through mesh.

B. Heavy-Duty Stairway Partitions:

1. Diamond Mesh: **0.192-inch- (4.9-mm-)** diameter, intermediate-crimp steel wire woven into **2-inch (50-mm)** diamond pattern and securely clinched to frames.
2. Square Mesh: **0.192-inch- (4.9-mm-)** diameter, [**intermediate**][**lock**]-crimp steel wire woven into **2-inch (50-mm)** square pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
3. Rectangular Mesh: **0.192-inch- (4.9-mm-)** diameter, [**intermediate**][**lock**]-crimp steel wire woven into **2-by-1-inch (50-by-25-mm)** rectangular pattern, inserted through frame holes and welded into frame. Vertical wires are plumb, and horizontal wires are perpendicular to vertical wires.
4. Vertical and Horizontal Panel Framing: **1-1/2-by-3/4-by-0.097-inch (38-by-19-by-2.5-mm)** cold-rolled, C-shaped steel channels; with **3/8-inch- (9.5-mm-)** diameter bolt holes spaced not more than **18 inches (450 mm)** o.c. along center of framing.
5. Horizontal Panel Stiffeners: **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** cold-rolled steel channels with wire woven through, or two **1-by-1/2-by-1/8-inch (25-by-13-by-3.2-mm)** cold-rolled steel channels bolted or riveted toe to toe through mesh.

C. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from **1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm)** steel channels, banded with **1-1/2-by-1/8-inch (38-by-3.2-mm)** flat steel bar cover plates on [**three**][**four**] sides, and with **1/8-inch- (3.2-mm-)** thick angle strike bar and cover on strike jamb.

1. Hinges: Full-surface spring type, **3-1/2-by-3-1/2-inch (89-by-89-mm)** steel, one and a half pairs per door; bolted, riveted, or welded to door and jamb framing.
2. Exit Device: As specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]
3. Tamper Shield: Fabricated from **0.097-inch- (2.5-mm-)** thick, cold-rolled steel sheet; **15 inches (380 mm)** high by width of door.

D. Door Jamb Framing: **2-by-2-by-1/8-inch (50-by-50-by-3.2-mm)** steel pipe or tubing.

E. Floor Shoes: Steel, cast iron, or cast aluminum, not less than **2 inches (50 mm)** high; sized to suit vertical framing, drilled for attachment to floor, and with setscrews for leveling adjustment.

F. Wall Clips: Manufacturer's standard, cold-rolled steel sheet[allowing up to 1 inch (25 mm) of adjustment].

G. Finish for Uncoated Ferrous Steel: [**Hot-dip galvanized**][**Hot-dip galvanized and shop primed for field painting**][**Shop primed for field painting**][**Enamel finish**][**Powder-coated finish**] unless otherwise indicated.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.8 WIRE MESH EQUIPMENT BARRIERS

A. Mesh: **0.135-inch- (3.5-mm-)** diameter, intermediate-crimp steel wire woven into [**1-1/2-inch (38-mm) diamond**][**1-by-2-inch (25-by-50-mm) rectangular**] mesh.

B. Panels: **1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3.2-mm)** steel angle framing on four sides, with wire mesh welded to framing.

1. Horizontal Panel Stiffeners: **1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3.2-mm)** steel angles or **3/4-by-1/4-inch (19-by-6.4-mm)** hot-rolled steel flat bars.
2. Height: [**48 inches (1220 mm)**][**60 inches (1524 mm)**].

C. Line and Corner Posts: **2-by-2-by-0.068-inch (50-by-50-by-1.7-mm)** steel tubing with steel base plates welded to bottoms, drilled for attachment to floor, and with steel caps welded to tops.

1. Height: Panel height plus [**12-inch- (300-mm-)**] high, sweep space.

D. Swinging Gates: Fabricated from same mesh as panels, with gate framing fabricated from **1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-4.7-mm)** steel angles on four sides, and with wire mesh welded to framing.

1. Hinges: Full-surface[**spring**] type, **3-1/2-by-3-1/2-inch (89-by-89-mm)** steel, one pair per door; bolted, riveted, or welded to door and jamb framing.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside.

E. Sliding Gates: Fabricated from same mesh as panels, with framing fabricated from **1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-4.7-mm)** steel angles on four sides, and with wire mesh welded to framing.

1. Hardware: Two, four-wheel roller-bearing carriers; box track; and bottom guide channel for each door.
2. Padlock Lug: Mortised into door framing and enclosed with steel cover.
3. Cylinder Lock: Mortise type with [**manufacturer's standard cylinder**][**cylinder specified in Section 087100 "Door Hardware"**][**cylinder specified in Section 087111 "Door Hardware (Descriptive Specification)"**]; operated by key outside and [**recessed turn knob**][**knob**][**lever**] inside.

F. Finish for Uncoated Ferrous Steel: [**Hot-dip galvanized**][**Hot-dip galvanized and shop primed for field painting**][**Shop primed for field painting**][**Enamel finish**][**Powder-coated finish**] unless otherwise indicated.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Steel Wire: ASTM A510/A510M.

C. Steel Plates, Channels, Angles, and Bars: ASTM A36/A36M.

D. Steel Sheet: Cold-rolled steel sheet, ASTM A1008/A1008M, Commercial Steel (CS), Type B.

E. Steel Pipe: ASTM A53/A53M, Schedule 40, unless another weight is indicated or required by structural loads.

F. Steel Tubing: ASTM A500/A500M, cold-formed structural-steel tubing or ASTM A513/A513M, Type 5, mandrel-drawn mechanical tubing.

G. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating designation.

H. Panel-to-Panel Fasteners: Manufacturer's standard steel bolts, nuts, and washers.

I. Post-Installed Anchors: Capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components are zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506)**, and nuts, **ASTM F594 (ASTM F836M)**.

J. Power-Driven Fasteners: ICC-ES AC70.

K. Seismic Bracing: Angles with legs not less than **1-1/4 inches (32 mm)** wide, formed from **0.040-inch- (1.0-mm-)** thick, metallic-coated steel sheet; with bolted connections and **1/4-inch- (6-mm-)** diameter bolts.

L. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting"**][**and**][**Section 099123 "Interior Painting."**]

M. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer, complying with MPI#79.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

N. Zinc-Rich Primer: Compatible with topcoat, complying with SSPC-Paint 20 or SSPC-Paint 29.

O. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2.10 FABRICATION

A. General: Fabricate wire mesh items from components of sizes not less than those indicated. Use larger-sized components as recommended by wire mesh item manufacturer. Furnish bolts, hardware, and accessories required for complete installation with manufacturer's standard finishes.

1. Fabricate wire mesh items to be readily disassembled.
2. Welding: Weld corner joints of framing and [**grind smooth, leaving no evidence of joint**][**finish sand**][**remove spatter**][**leave as applied**].

B. [**Standard-**][**and**][**Heavy-**]Duty Wire Mesh Partitions: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.

1. Mesh: [**Securely clinch**][**Weld**] mesh to framing.
2. Framing: Fabricate framing with mortise-and-tenon corner construction.

a. Provide horizontal stiffeners as indicated or, if not indicated, as required by panel height and as recommended by wire mesh partition manufacturer. Weld horizontal stiffeners to vertical framing.
b. Fabricate [**three-**][**and**][**four-**]way intersections using [**intersection posts**][**manufacturer's standard connecting clips and fasteners**].
c. Fabricate partition and door framing with slotted holes for connecting adjacent panels.

3. Fabricate wire mesh partitions with **3 to 4 inches (75 to 100 mm)** of clear space between finished floor and bottom horizontal framing.
4. Fabricate wire mesh partitions with bottom horizontal framing flush with finished floor.
5. Doors: Align bottom of door with bottom of adjacent panels.

a. For doors that do not extend full height of partition, provide transom over door, fabricated from same mesh and framing as partition panels.

6. Hardware Preparation: Mortise, reinforce, drill, and tap doors and framing as required to install hardware.

C. Wire Mesh Ceilings: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.

1. Mesh: [**Securely clinch**][**Weld**] mesh to framing.
2. Framing: Fabricate framing with [**mortise-and-tenon**][**welded**] corner construction.

a. Provide stiffeners as indicated or, if not indicated, as required by panel span and as recommended by wire mesh ceiling manufacturer. Weld stiffeners to framing.

D. Wire Mesh Stairway Partitions: Provide door jamb framing on each side of doors. Attach tamper shields centered behind exit devices.

2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean items of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**]

D. Shop Priming: Apply shop primer to uncoated surfaces of wire mesh units unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard enamel finish, suitable for use indicated, with a minimum dry film thickness of [**2 mils (0.05 mm)**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on powder-coat finish, suitable for use indicated, with a minimum dry film thickness of [**2 mils (0.05 mm)**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine floors for suitable conditions where wire mesh items will be installed.

C. Examine walls to which wire mesh items will be attached for properly located blocking, grounds, and other solid backing for attachment of support fasteners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRE MESH PARTITIONS

A. Anchor wire mesh partitions to floor with **3/8-inch- (9.5-mm-)** diameter, postinstalled expansion anchors at **12 inches (300 mm)** o.c. through anchor clips located at each post and corner. Shim anchor clips as required to achieve level and plumb installation.

1. Anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.

B. Anchor wire mesh partitions to floor with **3/8-inch- (9.5-mm-)** diameter, postinstalled expansion anchors at **12 inches (305 mm)** o.c. through floor shoes located at each post and corner. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.

1. Anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.

C. Anchor wire mesh partitions to walls at **12 inches (305 mm)** o.c. through back corner panel framing and as follows:

1. For concrete and solid masonry anchorage, use expansion anchors.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed gypsum board assemblies, use lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

D. Secure top capping bars to top framing channels with **1/4-inch- (6-mm-)** diameter, "U" bolts spaced not more than **28 inches (700 mm)** o.c.

E. Provide line posts at locations indicated or, if not indicated, as follows:

1. On each side of sliding-door openings.
2. For partitions that are **7 to 9 ft. (2.1 to 2.7 m)** high, spaced at **15 to 20 ft. (4.6 to 6.1 m)** o.c.
3. For partitions that are **10 to 12 ft. (3.0 to 3.7 m)** high, located between every other panel.
4. For partitions that are more than **12 ft. (3.7 m)** high, located between each panel.

F. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.

G. Where standard-width wire mesh partition panels do not fill entire length of run, provide adjustable filler panels to fill openings.

H. Install doors complete with door hardware.

I. Install service windows complete with window hardware.

J. Weld or bolt sheet metal bases to [**wire mesh partitions**][**and**][**doors**][**where indicated**].

K. Bolt accessories to wire mesh partition framing.

3.3 INSTALLATION OF WIRE MESH CEILINGS

A. Anchor wall support angle to walls at **12 inches (300 mm)** o.c. and as follows:

1. For concrete and solid masonry anchorage, use expansion anchors.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed gypsum board assemblies, use lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

B. Attach wire mesh ceiling panels to wall support angles with bolts at **12 inches (305 mm)** o.c.

C. Attach wire mesh ceiling panels to wire mesh partitions with slotted angles bolted to sides of ceiling panels and to top of partitions at **12 inches (305 mm)** o.c.

D. Attach wire mesh ceiling panels to intermediate supports as recommended by manufacturer.

E. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.

3.4 INSTALLATION OF WIRE MESH STAIRWAY PARTITIONS

A. Anchor wire mesh stairway partitions to floor with **3/8-inch- (9.5-mm-)** diameter, postinstalled expansion anchors at **12 inches (305 mm)** o.c. through floor shoes located at each post. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.

1. Anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.

B. Anchor angle clips supporting wire mesh stairway partitions at stairs and intermediate landings with **3/8-inch- (9.5-mm-)** diameter, postinstalled expansion anchors at **12 inches (305 mm)** o.c. Weld stairway partition framing to angle clips.

1. Anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.

C. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability; extend and fasten members to supporting structure.

D. Install doors complete with door hardware.

3.5 INSTALLATION OF WIRE MESH EQUIPMENT BARRIERS

A. Anchor wire mesh equipment barriers to floor with **3/8-inch- (9.5-mm-)** diameter, expansion anchors through post bases. Shim post bases as required to achieve level and plumb installation.

B. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.

C. Install gates complete with gate hardware.

3.6 REPAIR

A. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.7 ADJUSTING

A. Adjust [**doors**][**gates**][**service windows**] to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Verify that latches and locks engage accurately and securely without forcing or binding.

3.8 PROTECTION

A. Remove and replace defective work, including doors and framing that are warped, bowed, or otherwise unacceptable.

END OF SECTION 10 22 13 00

Task	Specification	Specification Description
10 22 13 00	10 22 00 00	Folding Panel Partitions
10 22 13 00	10 22 00 00a	All-Glass Partitions

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SECTION 10 22 19 00 - DEMOUNTABLE PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site-assembled demountable partitions.
2. Unitized-panel demountable partitions.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Site-assembled demountable partitions.
2. Unitized-panel demountable partitions.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
8. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
9. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
10. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
12. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
13. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For demountable partitions.

1. Include plans, elevations, sections, and attachment details at floors, columns, permanent partitions, and ceilings; and method of erection and disassembly.

2. Include diagrams for power-, signal-, and control-wiring raceways; and details of access to raceways.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of hardware and accessories involving color or finish selection.

E. Samples for Verification: For each type of the following products:

1. Face-Panel Finish: Manufacturer's standard-size unit, but not less than [**6 inches (150 mm) square**].
2. Linear Trim: [**12-inch- (300-mm-)**] long Samples.
3. Door Finish: Manufacturer's standard-size unit, but not less than [**3 inches (75 mm) square**].
4. Glazing: Manufacturer's standard-size unit, but not less than [**3 inches (75 mm) square**].
5. Hardware and Accessories: [**Whole units**].

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from the installers of the items involved:

1. Suspended-ceiling components and dimensioned ceiling-grid layout.
2. Locations of fixed door and window mullions.
3. Overhead bracing, seismic restraints, and related structural members.
4. Ductwork above ceiling.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of demountable partition.

D. Product Test Reports: For each type of demountable-partition assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For demountable partitions to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[from the same production run,] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups for demountable partitions including accessories.

a. Size: [**48 inches (1200 mm) by full height**][**48 inches (1200 mm) by 48 inches (1200 mm) by full height corner**].
b. [**Each type of exposed construction**][**corner**][**door and frame**][**glass and frame**][**and**][**accessory panel**].

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 FIELD CONDITIONS

A. Finished Spaces: Do not deliver or install demountable partitions until finishes in spaces to receive them are complete, including suspended ceilings, floors, carpeting, and painting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] or less.
2. Smoke-Developed Index: [**450**] or less.

B. Structural Performance: Provide demountable partitions capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Load-Bearing Capacity: Not less than [**300 lb (136 kg) concentrated**][**2.3 lb/linear inch (0.041 kg/linear mm) distributed**] proof load when tested according to BIFMA X 5.6.
2. Transverse-Load Capacity: Lateral deflection of not more than [**1/120**][**1/240**] of the overall span when tested under a uniformly distributed load of **5 lb/sq. ft. (24.4 kg/sq. m)** according to ASTM E72.

C. Acoustical Performance: Where acoustical rating is indicated, provide demountable-partition assembly tested by a qualified testing agency for sound transmission loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

2.2 SITE-ASSEMBLED DEMOUNTABLE PARTITIONS

A. Site-Assembled Demountable Partitions : Site-assembled, [**progressive,**][**nonprogressive,**] demountable-partition assembly and components that are the standard products of manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Avanti Systems USA**]
b. [**DIRTT Environmental Solutions**]
c. [**dormakaba USA Inc.**]
d. [**Gravity Lock Systems, Inc**]
e. [**Hugh Robinson, Inc.**]
f. [**IMT Modular Partitions Ltd.**]
g. [**Inscape Corporation**]
h. [**Lindner Group**]
i. [**MAARS Living Walls; Maars US Inc.**]
j. [**McCain Walls; SwiftWall Solutions**]
k. [**Neslo Manufacturing; a division of Musano, Inc.**]
l. [**Nordwall USA LLC**]
m. [**OldCastle BuildingEnvelope (OBE)**]
n. [**ProPart Modular**]
o. [**Special-Lite**]
p. [**Steelcase Inc.**]
q. [**U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
r. [**ULTRAWALL LLC**]

B. Acoustical Rating: STC [**35**].

C. Face Panels: Manufacturer's standard [gypsum board][particleboard][steel-sheet-faced gypsum board][stainless steel-sheet-faced gypsum board] substrate.

1. Thickness: [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**Manufacturer's standard**][**As indicated on Drawings**].
2. Panel Widths: Modular, [**24 inches (610 mm)**][**30 inches (762 mm)**][**as indicated on Drawings**][**as selected by Architect from manufacturer's standard widths**], except for required filler panels, as directed by the Owner.
3. Finish: [**As indicated on Drawings**][**Unfinished**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**No. 4 satin polish on stainless steel**].

a. Color: [**As indicated on Drawings**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Facing: [**Vinyl wall covering**][**Fabric**][**Carpet wall covering**][**Plastic laminate**][**Wood veneer**][**the Owner-furnished material**].

a. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Wood-Veneer Species and Finish: [**Species as indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White ash**][**Red oak**][**Birch**] with [**transparent**

finish.][**transparent finish over stain.**][**wood finish as specified in Section 099300 "Staining and Transparent Finishing."**], as directed by the Owner.

D. Accessory Panels: Manufacturer's standard [**fabric-covered tackboard**][**porcelain-enamel markerboard**][**porcelain-enamel chalkboard**].

E. Framing: [Metallic-coated steel][aluminum] studs and top and bottom tracks, [2-1/2 inches (64 mm) deep][4 inches (102 mm) deep][manufacturer's standard depth][depth as indicated on Drawings].

F. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in [**floor level**][**floor and ceiling levels**].

1. Trim Material: [Vinyl][steel][stainless steel][aluminum].
2. Panel Joints: [**Butt joints without trim**][**Closure trim**].
3. Outside Corner Trim: [**Square**][**Radiused**].
4. Base Profile: [**Recessed**][**Projected**][**Flush**].
5. Ceiling Trim Profile: [**Recessed**][**Projected**].
6. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
7. Exposed-Metal Trim Finish: [**Match metal face panels**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**No. 4 satin polish on stainless steel**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
8. Trim Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Doors:

1. [**As specified in Section 081113 "Hollow Metal Doors and Frames."**][**As specified in Section 081416 "Flush Wood Doors."**][**As specified in Section 081433 "Stile and Rail Wood Doors."**]<**Insert requirement**>.
2. Manufacturer's standard **1-3/4-inch- (45-mm-)** thick, [**steel**][**solid-core wood**][**framed glass**][**frameless glass**] door construction.

   a. Door Operation: [**Pivoting**][**Sliding**][**Swinging**].
   b. Door Finish: [**Match face panels of partition**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Plastic laminate**][**Wood veneer**].

      1) Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
      2) Wood-Veneer Species and Finish: [**Species as indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White ash**][**Red oak**][**Birch**] with [**transparent finish.**][**transparent finish over stain.**][**wood finish as specified in Section 099300 "Staining and Transparent Finishing."**], as directed by the Owner.

H. Door Frames: Manufacturer's standard [steel][aluminum] frames for 1-3/4-inch (45-mm) doors[reversible][factory mortised to receive hardware].

1. Frame Finish: [**Match metal face panels**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
2. Frame Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Door Hardware: [**As selected by Architect from manufacturer's full range.**][**As specified in Section**

087100 "Door Hardware."][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]<**Insert requirement**>, as directed by the Owner.

J. Glazing Frames: Manufacturer's standard [**steel**][**aluminum**] frames for[**frameless (top and bottom-supported)**] glazing thickness indicated.

1. Frame Finish: [**Match door frames**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
2. Frame Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Glazing:

1. [**Fully tempered clear float glass**][**Insulating, fully tempered clear float glass**][**Laminated clear float glass**][**As indicated on Drawings**] as specified in Section 088000 "Glazing."
2. Manufacturer's standard [**fully tempered clear float glass**][**insulating, fully tempered clear float glass**][**laminated clear float glass**][**glass as indicated on Drawings**].

L. Frameless Glazing: Manufacturer's standard [**fully tempered clear float glass**][**laminated clear float glass**][**glass as indicated on Drawings**] for butt-glazing with top and bottom support.

M. Seals: [**Manufacturer's standard**].

N. Electrical Devices: Integral, concealed raceways to serve electrical power and communication devices indicated on Drawings.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 UNITIZED-PANEL DEMOUNTABLE PARTITIONS

A. Unitized-Panel Demountable Partitions : Unitized, [**progressive,**][**nonprogressive,**] demountable-partition assembly and components that are the standard products of manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**E2 Walls, Inc.**]
b. [**Fellowes, Inc.**]
c. [**Haworth, Inc**]
d. [**Hugh Robinson, Inc.**]
e. [**Inscape Corporation**]
f. [**KI**]
g. [**Lindner Group**]
h. [**MAARS Living Walls; Maars US Inc.**]
i. [**Nello Wall Systems, Inc.**]
j. [**Panel Systems Manufacturing, Inc**]
k. [**Steelcase Inc.**]
l. [**Superior Steel Door & Trim Company, Inc.**]
m. [**Transwall Office Systems, Inc.**]
n. [**Trendway Corporation**]

B. Acoustical Rating: STC [**35**].

C. Unitized Panels: Manufacturer's standard [**gypsum board**][**particleboard**][**steel-sheet-faced gypsum board**][**stainless steel-sheet-faced gypsum board**].

1. Thickness: [**Manufacturer's standard**][**1-3/4 inches (45 mm)**][**2-1/4 inches (57 mm)**].
2. Panel Widths: Modular, [**24 inches (610 mm)**][**30 inches (762 mm)**][**as indicated on Drawings**][**as selected by Architect from manufacturer's standard widths**], except for required filler panels, as directed by the Owner.
3. Finish: [**Unfinished**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**No. 4 satin polish on stainless steel**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Facing: [**Vinyl wall covering**][**Fabric**][**Carpet wall covering**][**Plastic laminate**][**Wood veneer**][**the Owner-furnished material**].

   a. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Wood-Veneer Species and Finish: [**Species as indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White ash**][**Red oak**][**Birch**] with [**transparent finish.**][**transparent finish over stain.**][**wood finish as specified in Section 099300 "Staining and Transparent Finishing."**], as directed by the Owner.

D. Accessory Panels: Manufacturer's standard [**fabric-covered tackboard**][**porcelain-enamel markerboard**][**porcelain-enamel chalkboard**].

E. Framing: [**Manufacturer's standard**][**Steel**][**Aluminum**].

1. Exposed Finish: [**Match unitized panels**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
2. Color of Exposed Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in [**floor level**][**floor and ceiling levels**].

1. Trim Material: [Vinyl][steel][stainless steel][aluminum].
2. Panel Joints: [**Butt joints without trim**][**Closure trim**].
3. Base Profile: [**Recessed**][**Projected**][**Flush**].
4. Ceiling Trim Profile: [**Recessed**][**Projected**].
5. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
6. Exposed-Metal Trim Finish: [**Match unitized panels**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**No. 4 satin polish on stainless steel**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
7. Trim Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Doors: Manufacturer's standard **1-3/4-inch- (45-mm-)** thick, [**steel**][**solid-core wood**][**framed glass**][**frameless glass**] door construction.

1. Door Operation: [**Pivoting**][**Sliding**][**Swinging**].

2. Door Finish: [**Match face panels of partition**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Plastic laminate**][**Wood veneer**].

    a. Color, Texture, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
    b. Wood-Veneer Species and Finish: [**Species as indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White ash**][**Red oak**][**Birch**] with [**transparent finish.**][**transparent finish over stain.**][**wood finish as specified in Section 099300 "Staining and Transparent Finishing."**], as directed by the Owner.

H. Door Frames: Manufacturer's standard [steel][aluminum] frames for 1-3/4-inch (45-mm) doors[reversible][factory mortised to receive hardware].

1. Frame Finish: [**Match metal face panels**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
2. Frame Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Door Hardware: [**As selected by Architect from manufacturer's full range.**][**As specified in Section 087100 "Door Hardware."**][**As specified in Section 087111 "Door Hardware (Descriptive Specification)."**]<**Insert requirement**>, as directed by the Owner.

J. Glazing Frames: Manufacturer's standard [**steel**][**aluminum**] frames for[**frameless (top and bottom-supported)**] glazing thickness indicated.

1. Frame Finish: [**Match door frames**][**Factory primed for field painting**][**Factory-applied, baked-enamel or powder-coat finish**][**Clear-anodized aluminum**][**Color-anodized aluminum**].
2. Frame Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Glazing:

1. [**Fully tempered clear float glass**][**Insulating, fully tempered clear float glass**][**Laminated clear float glass**][**As indicated on Drawings**] as specified in Section 088000 "Glazing."
2. Manufacturer's standard [**fully tempered clear float glass**][**insulating, fully tempered clear float glass**][**laminated clear float glass**][**glass as indicated on Drawings**].

L. Frameless Glazing: Manufacturer's standard [**fully tempered clear float glass**][**laminated clear float glass**][**glass as indicated on Drawings**] for butt-glazing with top and bottom support.

M. Seals: [**Manufacturer's standard**].

N. Electrical Devices: Integral, concealed raceways[**and wiring**] to serve electrical power and communication devices indicated on Drawings.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 WOOD MATERIALS

A. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

D. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

E. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

F. Composite Wood Products: Products shall be made without urea formaldehyde.

G. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

I. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

J. Composite Wood Products: Products shall be made without urea formaldehyde.

K. Particleboard: Panels complying with ANSI A208.1, Grade M-2.

1. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested according to ASTM E84 or UL 723.

L. Wood Veneer: Genuine wood veneer; clear, vertical grain, straight, and kiln dried; of wood species indicated, laminated to panel substrate with moisture-resistant adhesive.

2.5 OTHER MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**] percent.

B. Gypsum Board: ASTM C1396/C1396M.

C. Vinyl Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with W-101 for [Type II][Type III]; Class A.

1. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.

D. Fabric: [**Manufacturer's standard fabric**][**100 percent polyolefin woven fabric**] wall covering, from same dye lot, treated to resist stains.

E. Carpet Wall Covering: Manufacturer's standard[**nonwoven, needle-punched carpet with fibers fused to backing**], from same dye lot, treated to resist stains, and meeting performance requirements for surface-burning characteristics.

F. Plastic Laminate: High-pressure decorative laminate according to ISO 4586-3[Grade VGL (vertical, general purpose)][Grade VGF (vertical, flame retardant)].

G. Adhesives: Do not use adhesives that contain urea formaldehyde.

H. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Adhesives: Do not use adhesives that contain urea formaldehyde.

K. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.6 FABRICATION

A. General: Fabricate demountable walls for installation with concealed fastening devices and pressure-fit members that will not damage ceiling or floor coverings. Fabricate systems for installation with continuous seals at floor, ceiling, and other locations where partitions abut fixed construction.

B. Panels for Site-Assembled Demountable Partitions: Face panels fabricated and finished in modular widths indicated.

1. Transom Panels: Fabricated in material and finish to match wall panels unless otherwise indicated.

C. Panels for Unitized-Panel Demountable Partitions: Factory-assembled, flush, unitized-panel construction; with faces smooth and free of buckles, oil-canning, and seams; and insulated with solidly packed, inorganic, mineral filler.

1. Factory glaze panels to the greatest extent possible.

D. Finish Facings: Factory apply finish-facing materials with appropriate backings, using mildew-resistant nonstaining adhesive as recommended by finish-material manufacturer's written instructions.

1. Apply facing to panel [**in one piece, seamless**][**with tightly butted invisible seams where indicated on Drawings**], and with no gaps or overlaps; free of air bubbles, wrinkles, blisters, or other defects.
2. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
3. Where facings with [**directional or repeating patterns or directional weave**][**directional, repeating, or matching grain**] are indicated, mark facing top and attach facing in same direction.
4. Match facing pattern **72 inches (1830 mm)** above finished floor.

E. Wiring: Conceal conductors and cables in raceways. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**nonspecular as fabricated**] mechanical finish.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**nonspecular as fabricated**] mechanical finish.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 STEEL FINISH

A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry-film thickness.

2.10 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes [**vertical for vertical surfaces**][**and**][**parallel to long dimension for framing**].
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine components before installation. Reject components that are wet, moisture damaged, mold damaged, broken, cracked, chipped, deformed, or unmatched.

C. Examine roughing-in for electrical power to verify actual locations of power connections before partition installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install demountable partitions after other finishing operations have been completed.

1. Install partitions rigid, level, plumb, and aligned. Install seals at connections with floors, ceilings, fixed walls, and abutting surfaces to prevent light and sound transmission.
2. Except for filler panels scribed to fixed walls or columns, do not modify manufacturer's standard components.

B. Suspended-Ceiling System: [**Do not alter suspended-ceiling system**][**Make alterations to suspended-ceiling system required by partition installation or to gain access to electrical or communication systems without affecting the structural integrity of suspended-ceiling system. Make alterations so they are not noticeable after panel installation**].

C. Doors and Frames: Install door-and-frame[**and glazing-and-glazing-frame**] assemblies securely anchored to partitions and with doors aligned and fitted. Install and adjust door hardware for proper operation.

D. Electrical Devices: Connect integral, concealed wiring to serve electrical power and communication devices indicated on Drawings.

1. Connect electrical service at junction-box locations according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Connect data communication service at junction-box locations according to Section 271513 "Communications Copper Horizontal Cabling."

3.3 ERECTION TOLERANCES

A. Install each demountable partition so surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by the faces of adjacent partitions.

3.4 ADJUSTING

A. Inspect installation, correct misalignments, and tighten loose connections.

B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer. Verify that latches and locks engage accurately and securely without forcing or binding.

C. Remove and replace defaced or damaged components[**that cannot be satisfactorily repaired**].

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, assemble, disassemble, and maintain demountable partitions.

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Task	Specification	Specification Description
10 22 19 00	10 22 00 00	Folding Panel Partitions
10 22 19 00	10 22 00 00a	All-Glass Partitions
10 22 19 13	10 22 19 00	Demountable Partitions
10 22 19 13	10 22 00 00	Folding Panel Partitions
10 22 19 13	10 22 00 00a	All-Glass Partitions
10 22 19 43	10 22 19 00	Demountable Partitions
10 22 19 43	10 22 00 00	Folding Panel Partitions
10 22 19 43	10 22 00 00a	All-Glass Partitions
10 22 19 53	10 22 19 00	Demountable Partitions
10 22 19 53	10 22 00 00	Folding Panel Partitions
10 22 19 53	10 22 00 00a	All-Glass Partitions
10 22 23 00	10 22 00 00	Folding Panel Partitions
10 22 23 00	10 22 00 00a	All-Glass Partitions
10 22 23 23	10 22 19 00	Demountable Partitions
10 22 23 23	10 22 00 00	Folding Panel Partitions
10 22 23 23	10 22 00 00a	All-Glass Partitions

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SECTION 10 22 33 00 - ACCORDION FOLDING PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated, accordion folding partitions.
2. Manually operated, fire-rated accordion folding partitions.
3. Electrically operated, accordion folding partitions.
4. Electrically operated, fire-rated accordion folding partitions.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
2. Section 083513 "Folding Doors" for small-size, non-acoustically rated, fire-rated, and non-fire-rated accordion folding doors.

1.2 DEFINITIONS

A. NIC: Noise Isolation Class.

B. NRC: Noise Reduction Coefficient.

C. STC: Sound Transmission Class.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

8. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
9. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For accordion folding partitions.

1. Include plans, elevations, sections, and attachment details.
2. Indicate storage and operating clearances.
3. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
4. Indicate facing-material seam locations if any.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of exposed material, facing material, and finish indicated.

1. Include similar Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed material, facing material, and finish indicated, prepared on Samples of size indicated below:

1. Textile Facing Material: Full width by not less than **36-inch- (914-mm-)** long section of [**fabric**][**carpet**] from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
2. Facing Material Other Than Textile: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
3. Edge Material: Not less than full width by **3 inches (75 mm)** long.
4. Hardware: Manufacturer's standard exposed door-operating device.

F. Delegated-Design Submittal: For seismic bracing of accordion folding partitions.

1. Include design calculations for seismic restraints that brace tracks to structure above.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Partition track, track supports[**and seismic bracing**], switches, turning space, and storage layout.
2. Suspended ceiling components.
3. Structural members to which suspension systems will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

   a. Lighting fixtures.
   b. HVAC ductwork, outlets, and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Smoke detectors.
   f. Access panels.

6. Plenum [**fire**][**smoke**][**and**][**acoustical**] barriers.

B. Setting Drawings: For embedded items and cutouts required in other work[including support-beam, mounting-hole template].

C. Qualification Data: For [**manufacturer or vendor**][**Installer**][**and**][**testing agency**].

D. Product Certificates: For each type of accordion folding partition, from manufacturer.

E. Material Certificates: For each textile dye lot, signed by manufacturers.

F. Product Test Reports: For each accordion folding partition, for tests performed by a qualified testing agency.

G. Field quality-control reports.

H. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For accordion folding partitions to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Facing materials and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
b. Seals, hardware, track, carriers, and other operating components.
c. Electric operator and controls.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of accordion folding partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of accordion folding partitions.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
3. Warranty Period for Pantographic Frames, Trolleys, and Tracks: [**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing of tracks to structure above, according to the seismic performance requirements.

B. Seismic Performance: Accordion folding partitions shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

C. Acoustical Performance: Provide accordion folding partitions tested by a qualified testing agency for the following acoustical properties, according to test methods indicated:

1. Sound-Transmission Requirements: Accordion folding partition assembly tested in a laboratory for sound-transmission loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.
2. Noise-Reduction Requirements: Accordion folding partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C423, and rated for not less than the NRC indicated.
3. Noise-Isolation Requirements: Installed accordion folding partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E336, determined by ASTM E413, and rated for [**10 dB less than STC value indicated**].

D. Fire-Test-Response Characteristics: Provide partitions with finishes complying with one of the following, as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**] or less.
b. Smoke-Developed Index: [**450**] or less.

2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to [NFPA 265 Method B Protocol][NFPA 286].

E. Fire Resistance: Provide fire-rated accordion folding partitions complying with NFPA 80, based on testing according to UL 10B for fire-rated door assemblies.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

2.2 ACCORDION FOLDING PARTITION

A. Accordion Folding Partition: Accordion folding frame with [pantograph][hinged] sections designed for horizontal extension and retraction, covered with decorative facing material, reinforced for hardware attachment, supported by overhead suspension system, and equipped with manufacturer's standard air-release method to prevent billowing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cornell; a CornellCookson company**]
b. [**KWIK-WALL Company**]
c. [**Moderco Inc**]
d. [**Modernfold, Inc**]
e. [**Won-Door Corporation**]
f. [**Woodfold Manufacturing, Inc.**]

B. Partition Type: [**Single fixed-jamb partition**][**Single sliding-jamb partition**][**Bi-parting partition with fixed jambs**][**Bi-parting partition with sliding jambs**][**Double-end-post partition in one accordion section**][**Double-end-post partition in two accordion sections**][**As indicated on Drawings**] with the following hardware:

1. Lead Post Latching Hardware:

a. [**Latch on one side**][**Latch on one side with coin-slot release on opposite side**][**Latch on both sides**] secured to [**recessed jamb striker**][**surface jamb striker**][**meeting post striker**].
b. Key-operated lock cylinder[keyed to master key system,] operable from [latch side][both sides] of post.
c. Deadlock to receive cylinder, operable from [**latch side**][**both sides**] of post. See Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for lock cylinder and keying requirements.

2. Meeting Post: [**Attached**][**Floating**], with meeting/closing arrangement as indicated on Drawings.
3. Intermediate Post: For intersecting partition on [**one side**][**both sides**] of partition.
4. Storage-End Hardware: [**Anchor post, secured to opening jamb**][**Sliding jamb within storage pocket**][**Same as lead post, secured to recessed jamb striker**][**Same as lead post, secured to surface jamb striker**][**Same as lead post, secured to fixed jamb on pocket door**].
5. Pendant Pull: Near top of lead post in addition to standard pull handle/latch [**for units more than 10 feet (3 m) high or 20 feet (6 m) wide, or both**].
6. Foot Bolt: On [**lead**][**attached meeting**][**and**][**intermediate**] post(s) where indicated; secured to post without interference with seals.

C. STC: [**30**][**35**][**40**][**45**].

D. NRC: Not less than [**0.50**][**0.70**][**0.85**].

E. Dimensions: Fabricate partitions to form an assembled system of dimensions indicated on Drawings and verified by field measurements.

1. Stack Width (Stored): Maximum [**8-1/2-inch (216-mm)**][**12-1/2-inch (318-mm)**] thickness from

one side of the partition to the other.
2. Width When Extended: Maximum [**5-inch (127-mm)**][**7-inch (178-mm)**] thickness from one side of the partition to the other.
3. Total Stack Depth (Stored): Maximum [**38 inches (965 mm)**].

F. Electric Controls: [**Remote-control station**][**Two remote-control stations**][**Obstruction-detection device**][**and**][**emergency release mechanism**].

G. Facing Material: [**Carpet wall covering**][**Fabric**][**Vinyl-coated fabric**][**Vinyl film**][**Plastic laminate**][**Wood veneer**][**Paint**][**the Owner-furnished material**].

1. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 FIRE-RATED ACCORDION FOLDING PARTITION

A. Fire-Rated Accordion Folding Partition: Accordion folding frame with pantograph sections designed for horizontal extension and retraction, covered with decorative facing material, reinforced for hardware attachment, supported by overhead suspension system, and equipped with manufacturer's standard air-release method to prevent billowing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Won-Door Corporation**]

B. Partition Type: [**Single sliding-jamb partition**][**Bi-parting partition with sliding jambs**][**As indicated on Drawings**] with the following hardware:

1. Lead Post Latching Hardware:

a. [**Latch on one side**][**Latch on one side with coin-slot release on opposite side**][**Latch on both sides**] secured to [**recessed jamb striker**].
b. Key-operated lock cylinder[keyed to master key system,] operable from [latch side][both sides] of post.
c. Deadlock to receive cylinder, operable from [**latch side**][**both sides**] of post. See Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for lock cylinder and keying requirements.

2. Storage-End Hardware: [**Sliding jamb within storage pocket**].
3. Pendant Pull: Near top of lead post in addition to standard pull handle/latch [**for units more than 10 feet (3 m) high or 20 feet (6 m) wide, or both**].
4. Foot Bolt: On lead post; secured to post to avoid interference with seals.

C. Fire Rating: [**3/4 hour**][**1 hour**][**1-1/2 hours**][**3 hours**].

D. STC: [**30**][**40**][**44**].

E. Dimensions: Fabricate partitions to form an assembled system of dimensions indicated on Drawings and verified by field measurements.

1. Stack Width (Stored): Maximum [**11-1/2-inch (292-mm)**] thickness from one side of the partition to the other.
2. Width When Extended: Maximum [**13-3/4-inch (349-mm)**] thickness from one side of the partition to the other.
3. Total Stack Depth (Stored): Maximum [**38 inches (965 mm)**].

F. Electric Controls: [**Remote-control station**][**Two remote-control stations**][**Obstruction-detection device**][**and**][**emergency release mechanism**].

G. Facing Material: [**Vinyl film**][**Paint**].

1. Color/Pattern: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 COMPONENTS

A. Posts and Seals: Provide types of posts and seals that produce accordion folding partitions complying with performance requirements.

1. Posts: Steel or aluminum; formed with deep-nesting and interlocking interfaces and fabricated to ensure rigidity of accordion folding partition.
2. Perimeter Seals: Manufacturer's standard vinyl, neoprene, or woven silica vertical seals, horizontal top and bottom seals, and closures for lead posts and jambs.[**Seals and closures at fire-rated partitions shall be identical to products tested for fire rating indicated and shall form an effective smoke and draft seal.**]

B. Hardware: Manufacturer's standard manually operated pulls, latches, locks, and bolts as required to operate accordion folding partitions; with decorative, protective finish.

C. Trim: Manufacturer's standard with decorative, protective finish.

D. Tiebacks: As required to maintain accordion folding partitions in stacked position; with manufacturer's standard finish.

2.5 SUSPENSION SYSTEMS

A. Tracks: Steel or aluminum, [**mounted directly to overhead structural support,**][**with adjustable steel hanger rods for overhead support,**] designed for operation, size, and weight of accordion folding partition indicated. Size track to support partition operation and storage without damage to suspension system, accordion folding partitions, or adjacent construction. Limit track deflection to no more than **0.10 inch (2.54 mm)** between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

1. Track: [**Surface mounted**][**Recessed**].

a. Head Closure Trim: Integral with track for protecting overhead surfaces; [**with factory-applied, decorative, protective finish**][**primed for field finish**].
b. Head Closure Trim and Track Channel Pocket: For protecting overhead surfaces and enclosing overhead track opening; [**with factory-applied, decorative, protective finish**][**primed for field finish**].

B. Carriers: Trolley system as required for size and weight of partition and for easy, quiet operation; with [**four-wheel**][**six-wheel**][**12-wheel**][**manufacturer's standard**] ball-bearing carriers at lead post and [**two-wheel**][**manufacturer's standard**] ball-bearing carriers at intermediate partition supports.

1. Wheels: [**Nylon**][**Steel**][**Manufacturer's standard**].

C. Track Switches and Accessories: Manufacturer's standard switches as required for type of operation, storage, track configuration, and layout indicated.

D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

E. Steel Finish: Factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.6 ELECTRIC OPERATORS

A. Factory-assembled electric operation system of size and capacity recommended and provided by accordion folding partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, remote-control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. Comply with NFPA 70.

C. Motor Electrical Characteristics:

1. Horsepower: [**1/4**][**1/3**][**3/4**][**Manufacturer's standard**].
2. Volts: [**115**][**208**].
3. Phase: [**Single phase**][**Polyphase**].
4. Hertz: 60.

D. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

E. Remote-Control Station: For partitions indicated, provide manufacturer's standard key-operated, constant-pressure, three-position control station labeled "Open," "Close," and "[**Off**][**Stop**]." Provide two keys per station.

F. Obstruction-Detection Device: For partitions indicated, provide automatic safety sensor indicated that causes operator to immediately [**shut off motor**][**stop and reverse direction**].

1. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.

G. Limit Switches: Provide each partition with adjustable switches, interlocked with motor controls and set to automatically stop accordion folding partition at fully extended and fully stacked positions.

H. Electric Interlock: Provide each partition with safety interlocks to prevent operation of accordion folding partition under the following conditions:

1. On partition, to prevent operation when partition is extended and locked.
2. On storage pocket door, to prevent partition operation if door is not in fully open position.
3. On partitions, at location of convergence by another partition, to prevent operation if merging partitions are in place.

I. Emergency Release Mechanism: For partitions indicated, provide quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

2.7 WOOD MATERIALS, GENERAL

A. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

D. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

E. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Adhesives: Do not use adhesives that contain urea formaldehyde.
2. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives: Do not use adhesives that contain urea formaldehyde.
5. Adhesives: Do not use adhesives that contain urea formaldehyde.

F. Composite Wood Products: Products shall be made without urea formaldehyde.

G. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

I. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

J. Composite Wood Products: Products shall be made without urea formaldehyde.

2.8 FACING MATERIALS

A. Provide facing materials with appropriate backing that comply with indicated fire-test-response characteristics, and that are factory attached to accordion folding partitions with concealed fasteners.

1. Factory-apply facing material free of air bubbles, wrinkles, blisters, and other defects; [**in one piece, seamless;**][**with vertical invisible seams complying with Shop Drawings for location;**] and with no gaps or overlaps. Tightly secure and conceal raw and selvage edges of facing material for finished appearance. Horizontal butted edges or seams are not permitted.
2. Where facing material with [**directional or repeating patterns or directional weave**][**directional, repeating, or matching grain**] are indicated, mark facing-material top and attach facing material in same direction.
3. Match facing pattern **72 inches (1830 mm)** above finished floor unless otherwise indicated.

B. Carpet Wall Covering: Manufacturer's standard[**nonwoven, needle-punched carpet with fibers fused to backing**], from same dye lot, treated to resist stains.

C. Fabric: [**Manufacturer's standard fabric**][**100 percent polyolefin woven fabric**], from same dye lot, treated to resist stains.

D. Vinyl-Coated Fabric: Manufacturer's standard mildew-resistant, washable, vinyl-coated fabric wall covering; complying with WA-101, [Type II-Medium Duty][Type III-Heavy Duty]; Class A.

1. Antimicrobial Treatment: Additives capable of inhibiting growth of bacteria, fungi, and yeasts.

E. Vinyl Film: Manufacturer's standard vinyl film laminated to partition substrate.

F. Plastic Laminate: High-pressure decorative laminate; NEMA LD 3, Grade HGS.

G. Wood Veneer: Laminated to [**noncombustible**][**fire-retardant-treated wood**] core with moisture-resistant adhesive.

1. Wood Species and Finish: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Cherry**][**Maple**][**Poplar**][**Red oak**] with [**transparent finish**][**transparent finish over stain**][**wood finish as specified in Section 099300 "Staining and Transparent Finishing."**], as directed by the Owner.

H. Paint: Manufacturer's standard baked enamel.

2.9 STORAGE POCKET DOORS

A. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition[of same materials, finish, construction, thickness, and acoustical qualities as partition]; complete with operating hardware[and acoustical seals at soffit, floor, and jambs]. Hinges in finish to match other exposed hardware.

1. Manufacturer's standard method to secure storage pocket door in closed position.
2. Rim Lock, Key Operated: Key-operated lock cylinder[keyed to master key system,] to secure storage pocket door in closed position. Include two keys per lock.
3. Rim Lock, Deadlock: Deadlock to receive cylinder, to secure storage pocket door in closed position. See [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for lock cylinder and keying requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of accordion folding partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with accordion folding partition manufacturer's written installation instructions. Install accordion folding partitions level and plumb, with tight joints and uniform appearance, and free of deformation and surface and finish irregularities.

B. Install accordion folding partitions[seismic bracing,] and accessories after other finishing operations, including painting, have been completed in area of partition installation.

C. Broken, cracked, chipped, deformed, or unmatched sections are unacceptable.

D. Broken, cracked, deformed, or unmatched seals or seals with gaps at butted ends are unacceptable.

E. Light-Leakage Test: Illuminate one side of partition installation, and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals.[**Perform test and make adjustments before NIC testing.**]

3.3 FIELD QUALITY CONTROL

A. NIC Testing: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing Extent: Testing agency shall randomly select [**one**] accordion folding partition installation(s) for testing.
2. Testing Methodology: Perform testing of installed accordion folding partition for noise isolation according to ASTM E336, determined by ASTM E413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

B. Accordion folding partitions will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust accordion folding partitions to operate smoothly, without warping or binding. Lubricate hardware and other moving parts as recommended by manufacturer.

B. Adjust storage pocket doors to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Electrically Operated Partitions: Adjust electric interlocks to properly control partition operation.

D. Verify that safety devices are properly functioning.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain accordion folding partitions.

END OF SECTION 10 22 33 00

Task	Specification	Specification Description
10 22 33 00	10 22 00 00	Folding Panel Partitions
10 22 33 00	10 22 00 00a	All-Glass Partitions
10 22 43 00	10 22 00 00	Folding Panel Partitions
10 22 43 00	10 22 00 00a	All-Glass Partitions

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SECTION 10 26 00 00 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall guards.
2. Impact-resistant handrails.
3. Corner guards.
4. End-wall guards.
5. Abuse-resistant wall coverings.
6. Door-edge protection.
7. Door-frame protection.
8. Door-hardware protection.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for [**steel angle corner guards**][**pipe guards**][**and**][**wheel guards**] .
2. Section 057300 "Decorative Metal Railings" for metal handrails without plastic bumpers.
3. Section 064023 "Interior Architectural Woodwork for solid-wood handrails, bumper rails, chair rails, or corner moldings without plastic bumpers.
4. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for metal and plastic protective trim units used for armor, kick, mop, and push plates.
5. Section 117300 "Patient Care Equipment" for patient bed locators.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
2. Include fire ratings of units recessed in fire-rated walls and listings for door protection items attached to fire-rated doors.

B. Shop Drawings: For each type of wall and door protection, indicating locations and extent.

1. Include plans, elevations, sections, and attachment details. [**Show handrail design and support spacing required to withstand structural loads.**]

C. Samples for Initial Selection: For each type of impact-resistant wall protection unit indicated, in each color and texture specified.

1. Include Samples of accent strips and accessories to verify color selection.

D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Wall Guards: **12 inches (300 mm)** long. Include examples of joinery, corners, [**end caps,**][**top caps,**] and field splices.
2. Impact-Resistant Handrails: **12 inches (300 mm)** long. Include examples of joinery, corners, and field splices.
3. Guards: For [**corner**][**and**][**end wall**] . **12 inches (300 mm)** long. Include example top caps.
4. Abuse-Resistant Wall Coverings: **6 by 6 inches (150 by 150 mm)** square.
5. Door Edging: **12 inches (300 mm)** long.
6. Door-Frame Protector: **12 inches (300 mm)** long.
7. Door-Knob and Door-Lever Protector: Full-size unit of each type.

E. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
4. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.
5. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each type of exposed plastic material, by a qualified testing agency.

B. Product Test Reports: For each type of handrail.

C. Sample Warranties: For specified special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of wall and door protection product.

1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Guard Covers: Full-size plastic covers of maximum length equal to [**2**] percent of each type, color, and texture of cover installed, but no fewer than [**two, 96-inch- (2400-mm-)**] long units.
2. Handrail Covers: Full-size plastic covers of maximum length equal to [**2**] percent of each type, color, and texture of cover installed, but no fewer than [**two, 96-inch- (2400-mm-)**] long units.
3. Corner-Guard Covers: Full-size plastic covers of maximum length equal to [**2**] percent of each type, color, and texture of cover installed, but no fewer than [**two, 48-inch- (1200-mm-)**] long units.
4. Mounting and Accessory Components: Amounts proportional to quantities of extra materials. Package mounting and accessory components with each extra material.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than **70 deg F (21 deg C)** during the period plastic materials are stored.
2. Keep plastic materials out of direct sunlight.
3. Store plastic wall and door protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of **70 deg F (21 deg C)**.

a. Store corner-guard covers in a vertical position.
b. Store [**wall-guard**][**and**][**handrail**] covers in a horizontal position.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall and door protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain wall and door protection products [**of each type**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in [**the United States Access Board's ADA-ABA Accessibility Guidelines**][**and**][**ICC A117.1**] .

C. Structural Performance: Handrails, including attachment to building construction, must withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of [**50 lbf/ft. (0.73 kN/m)**] applied in any direction.
2. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

2.3 WALL GUARDS

A. Crash Rail :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Babcock-Davis**]
   b. [**Construction Specialties, Inc.**]
   c. [**inpro Corporation**]
   d. [**Koroseal Interior Products, LLC**]
   e. [**Nystrom, Inc.**]
   f. [**Pawling Corporation**]
   g. [**The R.C. Musson Rubber Co.**]
   h. [**Wallprotex**]

2. Type: Heavy-duty assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.
3. Cover: Extruded, rigid plastic, minimum **0.100-inch (2.5-mm)** wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

   a. Profile: [**Flat**][**Convex**] .

      1) Dimensions: Nominal [**6 inches high by 1 inch deep (150 mm high by 25 mm deep)**][**8 inches high by 1 inch deep (200 mm high by 25 mm deep)**] .
      2) Surface: [**Uniform**][**Uniform with coextruded accent inlay strip in contrasting color**][**Grooved**] .

         a) Accent Inlay Strip: Nominal [**2 inches (50 mm)**] high by length of rail.

   b. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

4. Retainer:

   a. Continuous Retainer: Minimum **0.080-inch- (2.0-mm-)** thick, one-piece, extruded aluminum.
   b. Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.

5. Bumper: Continuous, resilient bumper cushion(s).
6. End Caps and Corners: Prefabricated, injection-molded plastic; [**matching color**][**contrasting with color**] cover; field adjustable for close alignment with snap-on cover.
7. Accessories: Concealed splices and mounting hardware.
8. Mounting: [**Surface mounted directly to wall**][**Reveal mounted on bumper cushion(s)**][**Extended mounting on injection-molded plastic mounting brackets**] .

B. Bumper Rails:

1. Plastic Bumper Rail :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Babcock-Davis**]
2) [**Boston Group USA**]
3) [**Construction Specialties, Inc.**]
4) [**inpro Corporation**]
5) [**Koroseal Interior Products, LLC**]
6) [**Nystrom, Inc.**]
7) [**Pawling Corporation**]
8) [**Wallprotex**]

b. Type: Standard-duty assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.

c. Cover: Extruded, rigid plastic, minimum **0.078-inch (2.0-mm)** wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: [**Half-round profile, nominal 1 inch high by 1 inch deep (25 mm high by 25 mm deep)**][**Rounded bullnose profile, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep)**][**Angled profile with rounded bullnose front edge, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep)**][**Flat profile, nominal 4 inches high by 1 inch deep (100 mm high by 25 mm deep)**] .
2) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

d. Retainer:

1) Continuous Retainer: Minimum **0.080-inch- (2.0-mm-)** thick, one-piece, extruded aluminum.
2) Retainer Clips: Manufacturer's standard impact-absorbing clips.

e. Bumper: Continuous, resilient bumper cushion(s).

f. End Caps and Corners: Prefabricated, injection-molded plastic; [**matching color**][**contrasting with color**] cover; field adjustable for close alignment with snap-on cover.

g. Accessories: Concealed splices and mounting hardware.

h. Mounting: [**Surface mounted directly to wall**][**Reveal mounted on bumper cushions**][**Extended mounting on injection-molded plastic mounting brackets**] .

2. Wood Bumper Rail :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Construction Specialties, Inc.**]
2) [**Koroseal Interior Products, LLC**]
3) [**Pawling Corporation**]
4) [**WallGuard.com**]

b. Type: Standard-duty assembly consisting of continuous sculpted, solid-wood rail, with continuous bumper insert installed in continuous recessed retainer.

c. Wood Rail: [**3-1/2 inches high by 7/8 inch deep (89 mm high by 22 mm deep)**][**5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep)**][**Size and profile indicated on Drawings**] .

1) Wood Species: [**Red oak**][**Maple**][**Ash**][**Beech**] .
2) Finish: [**Clear**][**Stained**] .
3) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

d. Bumper: Extruded plastic, minimum **0.078-inch (2.0-mm)** wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: [**Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep)**][**Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep)**] .
2) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
3) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

e. Retainer: Minimum **0.0625-inch- (1.6-mm-)** thick, one-piece, extruded aluminum.

1) Finish: [**Mill**][**Brass colored**] .

f. Accessories: Concealed splices and mounting hardware.
g. Mounting: Surface mounted directly to wall.

3. Transparent-Plastic Chair Rail : Consisting of clear polycarbonate plastic sheet.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Commercial Corner Guards**]
2) [**inpro Corporation**]
3) [**WallGuard.com**]
4) [**Wallprotex**]

b. Height: [**3 inches (75 mm) nominal**][**4 inches (100 mm) nominal**][**As indicated on Drawings**] .
c. Mounting: Surface mounted using flat-head countersunk screws through factory-drilled mounting holes.

2.4 IMPACT-RESISTANT HANDRAILS

A. Plastic, Impact-Resistant Handrails :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Babcock-Davis**]
b. [**Construction Specialties, Inc.**]
c. [**inpro Corporation**]
d. [**Koroseal Interior Products, LLC**]
e. [**Nystrom, Inc.**]
f. [**Pawling Corporation**]
g. [**The R.C. Musson Rubber Co.**]
h. [**WallGuard.com**]
i. [**Wallprotex**]

2. Type: Manufacturer's standard assembly consisting of snap-on plastic cover installed over continuous retainer.
3. Cover: Minimum [**0.078-inch- (2.0-mm-)**][**0.100-inch- (2.5-mm-)**] thick, extruded, rigid plastic; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

   a. Single Handrail: Cylindrical tube profile cover with continuous retainer; with mounting brackets supporting bottom of rail.
   b. Bumper Rail: Cover with [**flat**][**sculpted with contoured thumb recess on**] front side; with **1-1/2-inch- (38-mm-)** diameter, gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.

      1) Bumper-Rail Dimensions: Nominal [**5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep)**][**5-1/2 inches high by 2 inches deep (140 mm high by 50 mm deep)**] .
      2) Bumper Surface: [**Smooth**][**Smooth with coextruded accent inlay strip in contrasting color**][**Smooth with coextruded accent inlay strips in contrasting color**][**Grooved**] .
      3) Accent Inlay Strip(s): [**One strip**][**Two strips**] , nominal [**2 inches (50 mm)**] high by length of rail.

   c. Double Handrail with Bumper-Rail Profile: Two tubes mounted above and below nominal, flat-faced bumper rail; each tube with **1-1/2-inch- (38-mm-)** diameter, gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.

      1) Bumper-Rail Dimensions: Nominal [**4 inches high by 1-1/2 inches deep (100 mm high by 38 mm deep)**] .
      2) Bumper Surface: [**Smooth**][**Smooth with coextruded accent inlay strip in contrasting color**][**Smooth with coextruded accent inlay strips in contrasting color**][**Grooved**] .
      3) Accent Inlay Strip(s): [**One strip**][**Two strips**] , nominal [**2 inches (50 mm)**] high by length of rail.

   d. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

4. Retainer: Minimum **0.080-inch- (2.0-mm-)** thick, one-piece, extruded aluminum.
5. Mounting Bracket: Extended mounting on [**injection-molded plastic**][**anodized-aluminum**] mounting brackets.
6. End Caps and Corners: Prefabricated, injection-molded plastic; [**matching color**][**contrasting with color**] cover; field adjustable for close alignment with snap-on cover.
7. Accessories: Concealed splices, cushions, and mounting hardware.

B. Combination Wood-Plastic Bumper Handrail :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Construction Specialties, Inc.**]
   b. [**inpro Corporation**]
   c. [**Pawling Corporation**]
   d. [**WallGuard.com**]

2. Type: Manufacturer's standard assembly consisting of solid-wood handrail mounted above plastic bumper rail, both mounted on continuous retainer; with reveal between handrail and bumper serving as thumb recess on front side; with **1-1/2-inch- (38-mm-)** diameter, gripping surface and finger recess on back side.
3. Wood Handrail: **1-1/2 inches (38 mm)** in diameter; with matching end caps and corners.

   a. Wood Species: [**Red oak**][**Maple**][**Ash**][**Beech**] .
   b. Finish: [**Clear**][**Stained**] .
   c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

4. Bumper: Extruded, rigid plastic, minimum [**0.078-inch- (2.0-mm-)**][**0.100-inch- (2.5-mm-)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

   a. Profile: [**Flat**][**Convex**] profile, nominal [**4 inches high by 1 inch deep (100 mm high by 25 mm deep)**] .
   b. Accent Inlay Strip: Nominal [**2 inches (50 mm)**] high by length of rail.
   c. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
   d. End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

5. Retainer: Minimum **0.0625-inch- (1.6-mm-)** thick, one-piece, extruded aluminum.
6. Reveal: Extruded, rigid plastic over aluminum retainer.

   a. Color: [**Brass**][**Chrome**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

7. Accessories: Concealed splices, cushion(s), and mounting hardware.

C. Wood Handrail with Bumper :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**inpro Corporation**]
   b. [**Pawling Corporation**]
   c. [**WallGuard.com**]

2. Type: Manufacturer's standard assembly consisting of continuous sculpted, solid-wood handrail, with bumper insert installed in continuous retainer recessed into the face of the wood.

3. Wood Handrail: [**As indicated on Drawings**] with **1-1/2-inch- (38-mm-)** diameter, gripping surface.

   a. End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
   b. Wood Species: [**Red oak**][**Maple**][**Ash**][**Beech**][**Bamboo**] .
   c. Finish: [**Clear**][**Stained**] .
   d. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

4. Bumper: Extruded plastic, minimum **0.078-inch (2.0-mm)** wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings**] .

   a. Profile: [**Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep)**][**Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep)**] .
   b. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
   c. End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

5. Retainer: Minimum **0.0625-inch- (1.6-mm-)** thick, one-piece, extruded aluminum.

   a. Finish: [**Mill**][**Brass colored**] .

6. Accessories: Concealed splices and mounting hardware.

2.5 CORNER GUARDS

A. Surface-Mounted Corner Guards:

1. Surface-Mounted, Plastic-Cover Corner Guards :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**Babcock-Davis**]
      2) [**Commercial Corner Guards**]
      3) [**Construction Specialties, Inc.**]
      4) [**inpro Corporation**]
      5) [**JL Industries; Activar Construction Products Group, Inc.**]
      6) [**Koroseal Interior Products, LLC**]
      7) [**Nystrom, Inc.**]
      8) [**The R.C. Musson Rubber Co.**]
      9) [**WallGuard.com**]
      10) [**Wallprotex**]

   b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition
   c. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: Nominal [**2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius**] .
2) Height: [**4 ft. (1.2 m)**][**8 ft. (2.4 m)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

d. Retainer:

1) Continuous Retainer: [**Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum**][**One-piece, extruded plastic**] .
2) Retainer Clips: Manufacturer's standard impact-absorbing clips.

e. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2. Surface-Mounted, Plastic Corner Guards :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Babcock-Davis**]
2) [**Boston Group USA**]
3) [**Construction Specialties, Inc.**]
4) [**inpro Corporation**]
5) [**JL Industries; Activar Construction Products Group, Inc.**]
6) [**Koroseal Interior Products, LLC**]
7) [**Nystrom, Inc.**]
8) [**Pawling Corporation**]
9) [**The R.C. Musson Rubber Co.**]
10) [**WallGuard.com**]
11) [**Wallprotex**]

b. Type: Fabricated as one piece from [plastic][acrylic-modified vinyl sheet][clear polycarbonate sheet][opaque polycarbonate sheet] ; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
c. Wing Size: Nominal [**3/4 by 3/4 inch (20 by 20 mm)**][**1-1/8 by 1-1/8 inches (30 by 30 mm)**][**2-1/2 by 2-1/2 inches (65 by 65 mm)**] .
d. Mounting: [**Countersunk screws through factory-drilled mounting holes**][**Adhesive**] .
e. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

3. Surface-Mounted, Metal Corner Guards :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Babcock-Davis**]
2) [**Boston Group USA**]

3) [**Burns Manufacturing Incorporated**]
4) [**Construction Specialties, Inc.**]
5) [**inpro Corporation**]
6) [**JL Industries; Activar Construction Products Group, Inc.**]
7) [**Koroseal Interior Products, LLC**]
8) [**Nystrom, Inc.**]
9) [**Pawling Corporation**]
10) [**WallGuard.com**]
11) [**Wallprotex**]

b. Type: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition
c. Material:

1) Stainless steel sheet, [**Type 304**][**Type 430**] .

a) Thickness: Minimum [**0.0500 inch (1.3 mm)**][**0.0625 inch (1.6 mm)**][**0.0781 inch (2.0 mm)**] .
b) Finish: [**Directional satin, No. 4**][**Bright annealed**] .

2) Extruded aluminum, minimum **0.0625 inch (1.6 mm)** thick, with clear anodic finish.
3) Brass sheet, minimum **0.0500 inch (1.3 mm)** thick, with [**buffed, smooth specular**][**fine satin**] finish.

d. Wing Size: Nominal [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**2-1/2 by 2-1/2 inches (65 by 65 mm)**][**3-1/2 by 3-1/2 inches (90 by 90 mm)**] .
e. Corner Radius: [**1/8 inch (3 mm)**][**3/4 inch (19 mm)**] .
f. Mounting: [**Flat-head, countersunk screws through factory-drilled mounting holes**][**Oval head, countersunk screws through factory-drilled mounting holes**][**Adhesive**] .

B. Flush-Mounted Corner Guards:

1. Flush-Mounted, Plastic-Cover Corner Guards :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Commercial Corner Guards**]
2) [**Construction Specialties, Inc.**]
3) [**inpro Corporation**]
4) [**Nystrom, Inc.**]
5) [**Pawling Corporation**]
6) [**WallGuard.com**]

b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface, installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
c. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: Nominal [**2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius**] .

2) Height: [**4 ft. (1.2 m)**][**8 ft. (2.4 m)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

d. Retainer:

1) Continuous Retainer: Minimum **0.060-inch- (1.5-mm-)** thick, one-piece, extruded aluminum.
2) Retainer Clips: Manufacturer's standard impact-absorbing clips.

e. Aluminum Cove Base: Nominal [**4 inches (100 mm)**][**6 inches (150 mm)**] high.

2. Fire-Rated, Flush-Mounted, Plastic-Cover Corner Guards :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Construction Specialties, Inc.**]
2) [**inpro Corporation**]
3) [**Nystrom, Inc.**]
4) [**Pawling Corporation**]
5) [**WallGuard.com**]

b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface, installed over continuous retainer and intumescent fire barrier; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
c. Fire Rating: [**1 hour**][**2 hours**][**Same rating as wall in which corner guard is installed**] ; UL listed and labeled in accordance with ASTM E1966 or UL 2079.

1) L-Rating at Smoke Barriers: Not exceeding **5.0 cfm/ft. (0.00775 cu. m/s x m)** of joint at **0.30 inch wg (74.7 Pa)** at both ambient and elevated temperatures in accordance with UL 2079.

d. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Leg: Nominal [**2 inches (50 mm)**][**3 inches (75 mm)**] .
2) Corner Radius: [**1/4 inch (6 mm)**][**1-1/4 inches (32 mm)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

e. Retainer: Minimum **0.070-inch- (1.8-mm-)** thick, one-piece, extruded aluminum.
f. Aluminum Cove Base: Nominal [**4 inches (100 mm)**][**6 inches (150 mm)**] high.

2.6 END-WALL GUARDS

A. Surface-Mounted End-Wall Guards:

1. Surface-Mounted, Plastic-Cover, End-Wall Guard :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**inpro Corporation**]
2) [**Pawling Corporation**]
3) [**WallGuard.com**]

b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover installed over [**continuous retainer**][**continuous retainer at each corner, with end of wall covered by semirigid, abuse-resistant wall covering**] ; including mounting hardware.

c. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: Nominal [**2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius**] .
2) Height: [**4 ft. (1.2 m)**][**8 ft. (2.4 m)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Match corner guards**] , as directed by the Owner.

d. Retainer: Minimum **0.060-inch- (1.5-mm-)** thick, one-piece, extruded aluminum.

e. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2. Surface-Mounted, Metal, End-Wall Guards :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**American Floor Products Company, Inc**]
2) [**WallGuard.com**]

b. Type: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.

c. Material:

1) Stainless steel sheet, [**Type 304**][**Type 430**] .

a) Thickness: Minimum [**0.0500 inch (1.3 mm)**][**0.0625 inch (1.6 mm)**][**0.0781 inch (2.0 mm)**] .
b) Finish: [**Directional satin, No. 4**][**Bright annealed**] .

2) Extruded aluminum, minimum **0.0625 inch (1.6 mm)** thick, with clear anodic finish.
3) Brass sheet, minimum **0.0500 inch (1.3 mm)** thick, with [**buffed, smooth specular**][**fine satin**] finish.

d. Wing Size: Nominal [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**2-1/2 by 2-1/2 inches (65 by 65 mm)**][**3-1/2 by 3-1/2 inches (90 by 90 mm)**] .

e. Corner Radius: [**1/8 inch (3 mm)**][**3/4 inch (19 mm)**] .

f. Mounting: [**Flat-head, countersunk screws through factory-drilled mounting**

holes][**Oval head, countersunk screws through factory-drilled mounting holes**][**Adhesive**] .

B. Flush-Mounted End-Wall Guards:

1. Flush-Mounted, Plastic-Cover, End-Wall Guard :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Construction Specialties, Inc.**]
2) [**inpro Corporation**]
3) [**Nystrom, Inc.**]
4) [**Pawling Corporation**]
5) [**WallGuard.com**]

b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over [**continuous retainer**][**continuous retainer at each corner, with end of wall covered by semirigid, abuse-resistant wall covering**] ; including mounting hardware.

c. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Profile: Nominal [**2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius**][**3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius**] .
2) Height: [**4 ft. (1.2 m)**][**8 ft. (2.4 m)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Match corner guards**] , as directed by the Owner.

d. Retainer: Minimum **0.060-inch- (1.5-mm-)** thick, one-piece, extruded aluminum.

e. Aluminum Cove Base: Nominal [**4 inches (100 mm)**][**6 inches (150 mm)**] high.

2. Fire-Rated, Flush-Mounted, Plastic-Cover, End-Wall Guard :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**inpro Corporation**]
2) [**Nystrom, Inc.**]
3) [**Pawling Corporation**]
4) [**WallGuard.com**]

b. Type: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer and intumescent fire barrier; including mounting hardware; full wall height.

c. Fire Rating: [**1 hour**][**2 hours**][**Same rating as wall in which end guard is installed**] ; UL listed and labeled in accordance with UL 2079.

d. Cover: Extruded, rigid plastic, minimum [**0.078-inch (2.0-mm)**][**0.100-inch (2.5-mm)**] wall

thickness; [**as follows:**][**in dimensions and profiles indicated on Drawings.**]

1) Leg: Nominal [**2 inches (50 mm)**][**3 inches (75 mm)**] .
2) Corner Radius: [**1/4 inch (6 mm)**][**1-1/4 inches (32 mm)**] .
3) Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Match corner guards**] , as directed by the Owner.

e. Retainer: Minimum **0.070-inch- (1.8-mm-)** thick, one-piece, extruded aluminum.
f. Aluminum Cove Base: Nominal [**4 inches (100 mm)**][**6 inches (150 mm)**] high.

2.7 ABUSE-RESISTANT WALL COVERINGS

A. Abuse-Resistant Sheet Wall Covering : Fabricated from semirigid, plastic sheet wall-covering material.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Construction Specialties, Inc.**]
b. [**inpro Corporation**]
c. [**Koroseal Interior Products, LLC**]
d. [**Nystrom, Inc.**]
e. [**Pawling Corporation**]
f. [**WallGuard.com**]
g. [**Wallprotex**]

2. Size: [**48 by 96 inches (1219 by 2438 mm) for sheet**][**48 by 120 inches (1219 by 3048 mm) for roll**][**As indicated**] .
3. Sheet Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.7 mm)**][**0.040 inch (1.0 mm)**][**0.060 inch (1.5 mm)**][**0.080 inch (2.0 mm)**][**0.093 inch (2.4 mm)**][**0.125 inch (3.0 mm)**] .
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
5. Height: [**Full wall**][**Wainscot**][**As indicated**] .
6. Trim and Joint Moldings: Extruded, rigid plastic that matches wall-covering color.
7. Mounting: Adhesive.

B. Rub Strip :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Commercial Corner Guards**]
b. [**Construction Specialties, Inc.**]
c. [**inpro Corporation**]
d. [**Koroseal Interior Products, LLC**]
e. [**Pawling Corporation**]
f. [**WallGuard.com**]
g. [**Wallprotex**]

2. Type: Continuous strip, consisting of minimum [**0.040-inch- (1.0-mm-)**][**0.060-inch- (1.5-mm-)**] thick, semirigid, plastic sheet wall-covering material.

3. Height: [**8 inches (200 mm) nominal**] .
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
5. Mounting: Surface mounting with adhesive.

2.8 DOOR-EDGE PROTECTION

A. Door Edging :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Construction Specialties, Inc.**]
   b. [**inpro Corporation**]
   c. [**Koroseal Interior Products, LLC**]
   d. [**Pawling Corporation**]
   e. [**WallGuard.com**]

2. Type: Fabricated from extruded, rigid plastic, minimum [**0.040-inch (1.0-mm)**][**0.060-inch (1.5-mm)**] wall thickness; formed to fit over door edge without mortising.
3. Shape: [**L**][**U**] .
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
5. Mounting: [**Adhesive**][**Countersunk screws through factory-drilled mounting holes**] .

2.9 DOOR-FRAME PROTECTION

A. Door-Frame Protector Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Construction Specialties, Inc.**]
   b. [**inpro Corporation**]
   c. [**Koroseal Interior Products, LLC**]
   d. [**Pawling Corporation**]
   e. [**WallGuard.com**]

2. Type: Two-piece assembly consisting of snap-on plastic cover installed over continuous retainer; formed to fit half of door frame on opposite side of door swing.
3. Cover: Extruded, rigid plastic, minimum **0.080-inch (2.0-mm)** wall thickness; in dimensions and profiles indicated.

   a. Height: [**36 inches (914 mm)**][**48 inches (1219 mm)**] .
   b. Corner Radius: [**1/4 inch (6 mm)**][**1-1/4 inches (32 mm)**] .
   c. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

4. Retainer: Minimum **0.080-inch- (2.0-mm-)** thick, one-piece, extruded aluminum.

B. Door-Frame Protector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Construction Specialties, Inc.**]
   b. [**inpro Corporation**]
   c. [**Koroseal Interior Products, LLC**]
   d. [**Pawling Corporation**]
   e. [**WallGuard.com**]

2. Type: One piece fabricated from extruded, rigid plastic, minimum [**0.040-inch (1.0-mm)**][**0.050-inch (1.3-mm)**][**0.060-inch (1.5-mm)**] wall thickness; formed to fit entire door-frame profile.
3. Height: [**36 inches (914 mm)**][**48 inches (1219 mm)**] .
4. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
5. Mounting: [**Adhesive**][**Countersunk screws through factory-drilled mounting holes**] .

2.10 DOOR-HARDWARE PROTECTION

A. Door-Knob and Door-Lever Protector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Construction Specialties, Inc.**]
   b. [**Pawling Corporation**]
   c. [**WallGuard.com**]

2. Type: [**Angled**][**Cupped**] protector fabricated from injection-molded plastic, minimum **0.060-inch (1.5-mm)** wall thickness.
3. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.
4. Mounting: Countersunk screws through factory-drilled mounting holes.

2.11 MATERIALS

A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required; thickness as indicated.

B. Polycarbonate Plastic Sheet: ASTM D6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of **15 ft.-lbf/in. (800 J/m)** of notch when tested in accordance with ASTM D256, Test Method A.

C. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.

1. Certified Wood: Verify wood products are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in

accordance with FSC STD-01-001 and FSC STD-40-004.
2. Certified Wood: Verify wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
3. Certified Wood: Verify wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

D. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

E. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

F. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

G. Adhesive: As recommended in writing by protection product manufacturer.

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.12 FABRICATION OF WALL AND DOOR PROTECTION

A. Fabricate wall and door protection in accordance with requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

B. Curved Panels: Preform curved, semirigid, abuse-resistant sheet wall covering in factory for radius and sheet thickness as follows:

1. Sheet Thickness of 0.040 Inch (1.0 mm): **24-inch (610-mm)** radius.
2. Sheet Thickness of 0.060 Inch (1.5 mm): **36-inch (914-mm)** radius.

C. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

D. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

E. Wood Handrails: Miter corners and ends of wood handrails for returns.

2.13 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances [fire rating,] and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION OF WALL AND DOOR PROTECTION

A. Install wall and door protection in accordance with manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings. [**If not indicated on Drawings, install at heights indicated below:**]

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

1. Provide anchoring devices and suitable locations to withstand imposed loads.
2. Where splices occur in horizontal runs of more than **20 ft. (6.1 m)**, splice aluminum retainers and

plastic covers at different locations along the run, but no closer than **12 inches (305 mm)** apart.

3. Adjust [**end**][**and**][**top**] caps as required to ensure tight seams.

D. Abuse-Resistant Wall Coverings: Install top and edge moldings, corners, and divider bars as required for a complete installation.

E. Door-Frame Protectors: Install on both door jambs.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 00 00

Task	Specification	Specification Description
10 26 13 00	05 50 00 00	Metal Fabrications
10 26 13 00	10 26 00 00	Wall and Door Protection
10 26 16 00	10 26 00 00	Wall and Door Protection
10 26 16 13	10 26 00 00	Wall and Door Protection
10 26 16 16	10 26 00 00	Wall and Door Protection
10 26 23 00	10 26 00 00	Wall and Door Protection
10 26 23 13	10 26 00 00	Wall and Door Protection
10 26 41 00	10 26 00 00	Wall and Door Protection

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SECTION 10 28 00 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Toilet-compartment occupancy-indicator system.
3. Public-use shower room accessories.
4. Private-use bathroom accessories.
5. Healthcare accessories.
6. Childcare accessories.
7. Underlavatory guards.
8. Custodial accessories.
9. Hand-sanitizer dispensers.

B. Related Requirements:

1. Section 088300 "Mirrors" for frameless mirrors.
2. Section 093013 "Ceramic Tiling" for ceramic toilet and bath accessories.
3. Section 102813.63 "Detention Toilet Accessories" for accessories designed for installation in detention facilities.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

D. Delegated Design Submittals: For [**grab bars**][**and**][**shower seats**][**and**][**fixed-height adult changing stations**][**adjustable-height adult changing stations**] including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: [**10**][**15**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Toilet-Compartment Occupancy-Indicator Systems: Manufacturer agrees to repair or replace toilet-compartment occupancy-indicator systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist **250 lbf (1112 N)** minimum concentrated load applied in any direction and at any point.
2. Folding Shower Seats: Installed units are able to resist [**250 lbf (1112 N)**][**360 lbf (1601 N)**] minimum concentrated load applied in any direction and at any point.
3. Private-Use Folding Shower Seats: Installed units are able to resist [**250 lbf (1112 N)**][**360 lbf (1601 N)**] minimum concentrated load applied in any direction and at any point.
4. Fixed-Height Adult Changing Stations: Installed units able to support [**400 lb (181 kg)**][**500 lb (227 kg)**] minimum static load, in open position.
5. Adjustable-Height Adult Changing Stations: Installed units able to support [**400 lb (181 kg)**][**500 lb (227 kg)**] minimum static load, in open position.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain [**public-use washroom accessories**][**each type of public-use washroom accessory**] from single source from single manufacturer.

B. Toilet Tissue (Roll) Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   g. [**Seachrome Corporation**]
   h. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Roll-in-reserve dispenser with hinged front secured with tumbler lockset**][**Single-roll dispenser**][**Double-roll dispenser**][**Double-roll dispenser with shelf**] .
3. Mounting: [**Recessed**][**Partition mounted, serving two adjacent toilet compartments**][**Surface mounted**] .
4. Operation: [**Noncontrol delivery with standard spindle**][**Noncontrol delivery with theft-resistant spindle**][**Spindleless with tension-spring controlled delivery**][**Spindleless with tension-spring controlled delivery and self-locking device extending through core that prevents core removal until roll is empty**][**Eccentric-shaped, molded-plastic spindle revolves one-half revolution per dispensing operation for controlled delivery; core cannot be removed until roll is empty**] .
5. Capacity: Designed for [**4-1/2- or 5-inch- (114- or 127-mm-)**][**5-inch- (127-mm-)**] diameter tissue rolls.
6. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Chrome-plated zinc alloy (zamac) or steel**][**Satin-finish aluminum bracket with plastic spindle**].

C. Combination Toilet Tissue Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
e. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Combination unit with double-roll toilet tissue dispenser and the following:

   a. Removable Sanitary-Napkin Waste Receptacle: Self-closing, disposal-opening cover.
   b. Seat-Cover Dispenser: Minimum capacity of [**500**][**1000**] single or half-fold seat covers.

3. Mounting: [**Recessed**][**Surface mounted**][**Partition mounted, dual access with two tissue rolls per compartment**][**Partition mounted, dual access with two tissue rolls per compartment and with one side that mounts flush with partition of accessible compartment**] .
4. Toilet Tissue Dispenser Capacity: [**4-1/2- or 5-inch- (114- or 127-mm-)**] diameter tissue rolls.
5. Toilet Tissue Dispenser Operation: [**Noncontrol delivery with theft-resistant spindles**].
6. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**] .
7. Lockset: Tumbler type.

D. Toilet Tissue (Jumbo-Roll) Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**One-roll unit**][**Two-roll unit with sliding panel to expose other roll**] .
3. Mounting: Surface mounted.
4. Capacity: [**9- or 10-inch- (228- or 254-mm-)**] diameter rolls.
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray, with translucent front cover**] .
6. Lockset: Tumbler type.
7. Refill Indicator: Pierced slots at front.

E. Paper Towel (Folded) Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]

c. [**Bobrick Washroom Equipment, Inc**]
d. [**Bradley Corporation**]
e. [**Brey-Krause Manufacturing Co.**]
f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
g. [**Seachrome Corporation**]
h. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Recessed**][**Semirecessed**][**Deck mounted, recessed**][**Surface mounted**] .
3. Minimum Capacity: [**400 C-fold or 525 multifold towels**][**600 C-fold or 800 multifold towels**][**400 single-fold towels**].
4. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray**].
5. Lockset: Tumbler type.
6. Refill Indicator: Pierced slots at sides or front.

F. Paper Towel (Roll) Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
e. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Lever-actuated**][**Pull-towel-actuated**] mechanism that permits controlled delivery of paper rolls in preset lengths.
3. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**] .
4. Minimum Capacity: [**8-inch- (203-mm-) wide, 800-foot- (244-m-) long roll**] .
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray, with translucent front cover**] .
6. Lockset: Tumbler type.

G. Automatic Paper Towel (Roll) Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]

2. Description: Automatic motion-sensing mechanism with user-adjustable delay and paper towel length; [**electrically operated, with adapter for 110 to 240 V ac power supply**][**battery powered**] .
3. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**] .
4. Minimum Capacity: [**8-inch- (203-mm-) wide, 800-foot- (244-m-) long roll**] .

5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray**] .
6. Lockset: Tumbler type.

H. Waste Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Open top, recessed**][**Self-closing disposal-opening cover, recessed**][**Semirecessed**][**Surface mounted**][**Wall mounted for corner installation**][**Freestanding**][**Undercounter**] .
3. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**] .
4. Liner: [**Reusable vinyl liner**] .
5. Lockset: Tumbler type for waste receptacle.

I. Countertop-Mounted Circular Waste Chute :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]

2. OD: [**6 inches (152 mm)**][**7 inches (178 mm)**][**9 inches (229 mm)**] .
3. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**] .

J. Combination Towel (Folded) Dispenser/Waste Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   e. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
3. Mounting: [**Surface mounted**][**Surface mounted with stainless steel collar**][**Recessed**][**Recessed with projecting receptacle**][**Semirecessed**][**Under vanity**].

   a. Mounting Depth: Designed for nominal [**4-inch (100-mm)**][**6-inch (150-mm)**] wall depth.

4. Minimum Towel-Dispenser Capacity: [**600 C-fold or 800 multifold paper towels**] .
5. Minimum Waste-Receptacle Capacity: [**4 gal. (15 L)**][**12 gal. (45.4 L)**] .
6. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**] .
7. Liner: [**Reusable, vinyl waste-receptacle liner**] .
8. Lockset: Tumbler type for towel-dispenser compartment [**and waste receptacle**] .

K. Combination Towel (Roll) Dispenser/Waste Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   e. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Combination unit for dispensing preset length of roll paper towels, with removable waste receptacle.
3. Towel Mechanism: [**Lever**][**Pull towel**][**Automatic, electric sensor; with adapter for 110 to 240 V ac power supply**][**Automatic, battery-operated sensor**] .
4. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**] .
5. Minimum Towel-Dispenser Capacity: [**8-inch- (203-mm-) wide, 800-foot- (244-m-) long roll**] .
6. Minimum Waste Receptacle Capacity: [**8 gal. (30 L)**][**12 gal. (45.4 L)**][**15 gal. (56.8 L)**].
7. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**] .
8. Liner: [**Reusable, vinyl waste-receptacle liner**] .
9. Lockset: Tumbler type for towel dispenser compartment [**and waste receptacle**] .

L. Multipurpose Soap/Towel Dispenser Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]

2. Description: Combination unit for dispensing soap in [**liquid or lotion**][**lather**] form and folded towels.
3. Mounting: [**Recessed, designed for nominal 4-inch (100-mm) wall depth**][**Surface mounted with stainless steel collar and mirror**] .
4. Minimum Soap-Dispenser Capacity: [**80 oz. (2.36 L)**].

5. Minimum Towel-Dispenser Capacity: [**600 C-fold or 800 multifold towels**][**1000 single-fold towels**] .
6. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**] for unit body and soap valve.
7. Lockset: Tumbler type.

M. Warm-Air Hand Dryer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Dryer, Inc**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Excel Dryer Inc.**]
   f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   g. [**Saniflow Corporation; Mediclinics S.A.**]
   h. [**Sloan Valve Company**]
   i. [**Tubular Specialties Manufacturing, Inc.**]
   j. [**World Dryer Corporation (Zurn Industries, LLC)**]

2. Description: Standard-speed, warm-air hand dryer.
3. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**] .

   a. Protrusion Limit: Installed unit protrudes maximum **4 inches (102 mm)** from wall surface.

4. Operation: [**Touch-button**][**Infrared-sensor**] activated with timed power cutoff switch.

   a. Automatic Shutoff: At [**40**][**80**][**120**] seconds.

5. Maximum Sound Level: [**63**][**67**][**87**] dB.
6. Cover Material and Finish: [**Steel, with white enamel finish**][**Cast iron, with enamel finish in color selected by Architect**][**Chrome-plated steel**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Molded plastic, gray**][**Molded plastic, white**] as directed by the Owner.
7. Electrical Requirements: [**115 V, 13 A, 1500 W**][**115 V, 15 A, 1725 W**][**115 V, 20 A, 2300 W**][**208 to 240 V, 9 to 10 A, 1900 to 2300 W**] .

N. High-Speed Air Hand Dryer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Dryer, Inc**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Dyson Inc.**]
   f. [**Excel Dryer Inc.**]
   g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]

h. [**Mitsubishi Electric US, Inc.**]
i. [**Saniflow Corporation; Mediclinics S.A.**]
j. [**Sloan Valve Company**]
k. [**Stern Engineering Ltd.**]
l. [**World Dryer Corporation (Zurn Industries, LLC)**]

2. Description: High-speed, [**warm**][**unheated**] -air hand dryer for rapid hand drying.
3. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**] .

   a. Protrusion Limit: Installed unit protrudes maximum **4 inches (102 mm)** from wall surface.

4. Operation: Infrared-sensor activated with timed power cutoff switch.

   a. Average Dry Time: [**12**] seconds.
   b. Automatic Shutoff: At [**60**] seconds.

5. Maximum Sound Level: [**69**][**75**] dB.
6. Cover Material and Finish: [**Steel, with white enamel finish**][**Cast iron, with enamel finish in color selected by Architect**][**Chrome-plated steel**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Molded plastic, gray**][**Molded plastic, white**] as directed by the Owner.
7. Electrical Requirements: [**115 V, 13 A, 1500 W**][**115 V, 15 A, 1725 W**][**115 V, 20 A, 2300 W**][**208 to 240 V, 9 to 10 A, 1900 to 2300 W**] .

O. Multiple-Airflow Hand Dryer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Dyson Inc.**]
   d. [**Mitsubishi Electric US, Inc.**]
   e. [**Saniflow Corporation; Mediclinics S.A.**]
   f. [**World Dryer Corporation (Zurn Industries, LLC)**]

2. Description: Multiple-airflow hand dryer, using two or more airstreams for rapid hand drying [**with heating unit on-off control**] .
3. Mounting: [**Surface mounted**] .
4. Operation: Electronic-sensor activated with timed power cutoff switch.

   a. Average Dry Time: [**12**] seconds.
   b. Automatic Shutoff: At [**60**] seconds.

5. Maximum Sound Level: [**56**][**75**] dB.
6. Water Collection: Removable reservoir.
7. Filter: HEPA, replaceable.
8. Cover Material and Finish: [**Steel, with white enamel finish**][**Cast iron, with enamel finish in color selected by Architect**][**Chrome-plated steel**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Molded plastic, gray**][**Molded plastic, white**] as directed by the Owner.
9. Electrical Requirements: [**115 V, 13 A, 1500 W**][**115 V, 15 A, 1725 W**][**115 V, 20 A, 2300 W**][**208 to 240 V, 9 to 10 A, 1900 to 2300 W**] .

P. Soap Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   g. [**Seachrome Corporation**]
   h. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Designed for manual operation and dispensing soap in [**liquid or lotion**][**lather**] form.
3. Mounting: [**Deck mounted on vanity**][**Deck mounted on lavatory**][**Horizontally oriented, recessed**][**Horizontally oriented, surface mounted**][**Vertically oriented, surface mounted**].
4. Lockset: Tumbler type.
5. Refill Indicator: Window type.

Q. Automatic Soap Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advanced Modern Technologies Corporation - AMTC**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bradley Corporation**]
   d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   e. [**GOJO Industries**]
   f. [**Sloan Valve Company**]
   g. [**Stern Engineering Ltd.**]

2. Description: Automatic dispenser with infrared sensor to detect presence of hands; [**electrically operated, with adapter for 110 to 240 V ac power supply**][**battery powered**] ; designed for dispensing soap in [**liquid or lotion**][**lather**] form.
3. Mounting: [**Deck mounted on vanity**][**Deck mounted on lavatory**][**Surface mounted**] .
4. Refill Indicator: LED indicator.
5. Low-Battery Indicator: LED indicator.

R. Grab Bars :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]

b. [**ASI-American Specialties, Inc.**]
c. [**Bobrick Washroom Equipment, Inc**]
d. [**Bradley Corporation**]
e. [**Brey-Krause Manufacturing Co.**]
f. [**Construction Solutions**]
g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
h. [**Oatey Co.**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**Seachrome Corporation**]
k. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: Flanges with [**concealed**][**exposed**] fasteners.
3. Material: Stainless steel, **0.05 inch (1.3 mm)** thick.

   a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) [**on ends and slip-resistant texture in grip area**] .

4. OD: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] .
5. Configuration and Length: [**As indicated on Drawings**][**Straight, 36 inches (914 mm) long**].

S. Sanitary-Napkin and Tampon Vendor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   e. [**Tubular Specialties Manufacturing, Inc.**]

Mounting: [**Fully recessed, designed for 4-inch (100-mm) wall depth**][**Semirecessed**][**Surface mounted**] .
2. Operation: [**No coin (free)**][**Single coin (25 cents)**][**Two coins (50 cents)**].
3. Exposed Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].
4. Lockset: Tumbler type with separate lock and key for coin box.

T. Sanitary-Napkin Disposal Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Recessed**][**Partition mounted, dual access**][**Surface mounted**] .
3. Door or Cover: Self-closing, disposal-opening cover [**and hinged face panel with tumbler lockset**] .
4. Receptacle: Removable.
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray**].

U. Seat-Cover Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Surface mounted**][**Recessed**][**Partition mounted, dual access**] .
3. Minimum Capacity: [**250**][**500**] seat covers.
4. Exposed Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**ABS plastic, gray**].
5. Lockset: Tumbler type.

V. Shelf :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Fixed rectangular unit**][**Hinged unit with spring-loaded shelf that automatically returns to vertical position**].
3. Nominal Size: [**15 inches (381 mm) long by 5-1/2 inches (140 mm) wide**].
4. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Chrome-plated cast-zinc alloy (zamac) with stippled finish on tray and bright chrome finish on edges**].

W. Mirror Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Seachrome Corporation**]
g. [**Seawin Hospitality; Seawin Global**]
h. [**Tubular Specialties Manufacturing, Inc.**]

2. Frame: [**Stainless steel angle, 0.05 inch (1.3 mm) thick**][**Stainless steel channel**][**Stainless steel, fixed tilt**][**Stainless steel, adjustable tilt**] .

   a. Corners: [**Manufacturer's standard**][**Mitered and mechanically interlocked**][**Welded and ground smooth**] .

3. Size: [**As indicated on Drawings**].
4. Shelf:

   a. Type: [**Integral, welded**][**Concealed mounting**][**Exposed mounting**] .
   b. Depth: [**5 inches (127 mm)**].

5. Hangers: [**Manufacturer's standard rigid, tamper and theft resistant**].

X. Hook :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Double-prong unit**][**Single-prong unit**][**Combination hat and coat hook**][**Combination door bumper and coat hook**].
3. Mounting: [**Concealed**][**Exposed**] .
4. Material and Finish: [**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

Y. Fixed-Height Adult Changing Station :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Pressalit Inc.**]

b. [**Sova (Formerly Foundations)**]

2. Description: Horizontal unit that opens by folding down from stored position and with [**adjustable strap**][**safety rail**][**adjustable strap or safety rail**] .

   a. Safety Rail: Extending minimum 2/3 the length of the changing surface and centered along open side. Capable of being raised and lowered; in raised position, top of rail to lock in place at **5 inches (127 mm)** minimum above top of changing surface.

3. Mounting: [**Surface mounted, with unit projecting not more than 4 inches (102 mm) from wall when closed**][**Semirecessed, with unit projecting not more than 1 inch (25 mm) from wall when closed**] .
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), with PVC mattress**][**HDPE in manufacturer's standard color, with PVC mattress**][**Manufacturer's standard**].
6. Liner Dispenser: Provide [**built-in**][**separate, locking**] dispenser for disposable sanitary liners.

Z. Adjustable-Height Adult Changing Station :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Koala Kare Products; Bobrick Washroom Equipment, Inc.**]
   b. [**Pressalit Inc.**]
   c. [**Smirthwaite USA LLC; Prism Medical Group**]
   d. [**Sova (Formerly Foundations)**]

2. Description: Electrically powered, height-adjustable, horizontal unit with safety rail. Height adjustable from **17 inches (432 mm)** minimum to **38 inches (965 mm)** maximum above floor to top of changing surface.

   a. Safety Rail: Extending minimum 2/3 the length of the changing surface and centered along open side. Capable of being raised and lowered; in raised position, top of rail to lock in place at **5 inches (127 mm)** minimum above top of changing surface.

3. Mounting: Surface mounted, foldable by pneumatic shock-absorbing mechanism.
4. Electrical Characteristics: Manufacturer's standard actuator and control system, with integrated 24 V dc transformer, powered by single 120 V electrical receptacle.
5. Operation: [**Integrated electronic push button control(s)**][**Wired hand control**][**Manufacturer's standard control(s)**] with emergency stop [**and battery back-up**] .
6. Material and Finish: [**HDPE in manufacturer's standard color**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), with PVC mattress**][**HDPE in manufacturer's standard color, with PVC mattress**][**Manufacturer's standard**].

2.3 TOILET-COMPARTMENT OCCUPANCY-INDICATOR SYSTEM

A. Toilet-Compartment Occupancy-Indicator System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Tooshlights; Modus Systems, LLC (Sloan Valve Company)**]

2. Description: Battery-powered latch and electrically powered indicator-light system. Latches communicate wirelessly with separate, overhead indicator lights.
3. Latch: Slide operation.

   a. Compatibility: Provide latch compatible with compartment doors indicated for Project.
   b. Power Source: Two AA batteries.

      1) Low-Battery Warning: Indicator light pulses when associated batteries of corresponding latch require replacement.

   c. Patch Kit: Stainless steel in manufacturer's standard finish, adhesively applied to interior and exterior of compartment door to cover existing hardware locations.
   d. Latch Material and Finish: Matte chrome-plated, die-cast zinc alloy (zamac); installed with stainless steel fasteners.

4. Indicator Light: Full-color, low-voltage, LED indicator that displays red when compartment door is latched, green when standard compartment door is unlatched, and blue when accessible compartment door is unlatched.

   a. Traffic-Management-System Operation: Indicator lights also controlled by traffic management system for remote [**override of indicator light color**][**and**][**data collection from indicator lights**] .
   b. Mounting: [**Ceiling, surface**][**Ceiling, semirecessed**][**Ceiling, pendant**][**Wall**] mounted.
   c. Body Material and Finish: Satin white finish ABS plastic; installed with stainless steel fasteners.
   d. Lens Material and Finish: [**Clear**][**Frosted**] acrylic.
   e. Electrical Requirements: Provide indicator lights with dc adapters and that allow up to 30 lights to be powered by single 115 V, 20 A, electrical receptacle.

2.4 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Source Limitations: Obtain [**public-use shower room accessories**][**each type of public-use shower room accessory**] from single source from single manufacturer.

B. Shower Curtain Rod :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]

c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**1-inch- (25.4-mm-)**][**1-1/4-inch- (32-mm-)**] OD, straight rod.
3. Configuration: [**As indicated on Drawings**].
4. Mounting Flanges: [**Exposed**][**Concealed**] fasteners; in [**manufacturer's standard material and finish**][**material and finish matching rod**]
5. Rod Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Polished chrome-plated brass**].

C. Shower Curtain :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Size: Minimum [**6 inches (152 mm)**][**12 inches (305 mm)**] wider than opening by **72 inches (1829 mm)** high.
3. Material: [**Vinyl, minimum 0.006 inch (0.15 mm) thick, opaque, matte**][**Duck, minimum 8 oz. (227 g), white, 100 percent cotton**][**Nylon-reinforced vinyl, minimum 9 oz. (255 g) or 0.008-inch- (0.2-mm-) thick vinyl, with integral antibacterial and flame-retardant agents**].
4. Color: [**White**][**As selected from manufacturer's full range**].
5. Grommets: Corrosion resistant at minimum **6 inches (152 mm)** o.c. through top hem.
6. Shower Curtain Hooks: [**Chrome-plated or stainless steel, spring wire curtain hooks with snap fasteners**], sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

D. Folding Shower Seat :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Seachrome Corporation**]
g. [**Tubular Specialties Manufacturing, Inc.**]

2. Configuration: [**L-shaped seat, designed for wheelchair access**][**Rectangular seat**][**Triangular, corner-type seat**][**Stainless steel seat designed to fold into recessed-**

mounted, stainless steel wall box].

3. Seat: [**Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect**][**White vinyl padded seat**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin); 0.05-inch- (1.3-mm-) minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth**] as directed by the Owner.
4. Mounting Mechanism: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].

E. Soap Dish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Recessed**][**Surface**] mounted, with the following features:

   a. Washcloth bar.

3. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].

F. Robe Hook :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Double**][**Single**] -prong unit.
3. Material and Finish: [**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

2.5 PRIVATE-USE BATHROOM ACCESSORIES

A. Source Limitations: Obtain [**private-use bathroom accessories**][**each type of private-use bathroom accessory**] from single source from single manufacturer.

B. Private-Use Toilet Tissue Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Basco, Inc**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
   g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   h. [**Ginger; Brasstech, Inc.; Masco Corporation**]
   i. [**Seachrome Corporation**]
   j. [**Taymor Industries Ltd.**]
   k. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Single**][**Double**] -roll dispenser with the following features:

   a. Hood.

3. Mounting: [**Recessed**][**Surface mounted**] .
4. Capacity: Designed for **4-1/2- or 5-inch- (114- or 127-mm-)** diameter tissue rolls.
5. Material and Finish: [**Solid brass, polished**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

C. Private-Use Shower Curtain Rod :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Basco, Inc**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   g. [**Ginger; Brasstech, Inc.; Masco Corporation**]
   h. [**Seachrome Corporation**]
   i. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**1-inch- (25.4-mm-)**][**1-1/4-inch- (32-mm-)**] OD, [**straight**][**curved**] rod.
3. Configuration: [**As indicated on Drawings**].
4. Mounting Flanges: [**Exposed**][**Concealed**] fasteners; in [**manufacturer's standard material and finish**][**material and finish matching rod**].
5. Rod Material and Finish: [**Solid brass, polished**][**Polished chrome-plated brass**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7**

finish (polished)].

6. Features: Integral chrome-plated brass glide hooks.

D. Private-Use Folding Shower Seat :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bobrick Washroom Equipment, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   f. [**Seachrome Corporation**]
   g. [**Tubular Specialties Manufacturing, Inc.**]

2. Configuration: [**L-shaped seat, designed for wheelchair access**][**Rectangular seat**][**Triangular, corner-type seat**][**Stainless steel seat designed to fold into recessed-mounted, stainless steel wall box**].
3. Seat: [**Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect**][**White vinyl padded seat**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin); 0.05-inch- (1.3-mm-) minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth**] as directed by the Owner.
4. Mounting Mechanism: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].

E. Private-Use Soap Dish :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Basco, Inc**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
   g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   h. [**Ginger; Brasstech, Inc.; Masco Corporation**]
   i. [**Seachrome Corporation**]
   j. [**Taymor Industries Ltd.**]
   k. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Recessed**][**Surface mounted**] .
3. Material and Finish: [**Solid brass, polished**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

F. Private-Use Medicine Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ASI-American Specialties, Inc.**]
    b. [**Basco, Inc**]
    c. [**Bobrick Washroom Equipment, Inc**]
    d. [**Bradley Corporation**]
    e. [**Brey-Krause Manufacturing Co.**]
    f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
    g. [**Ketcham Medicine Cabinets & Accessories; Fred Silver & Company, Inc.**]
    h. [**Seachrome Corporation**]
    i. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Recessed, for nominal 4-inch (100-mm) wall depth**][**Surface mounted**] .
3. Size: [**18 by 24 inches (457 by 610 mm)**].
4. Door: [**Framed mirror door concealing storage cabinet equipped with continuous hinge and spring-buffered, rod-type stop and magnetic door catch**].
5. Shelves: [**Three, adjustable**].
6. Material and Finish:

    a. Cabinet: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Steel with corrosion-resistant finish**] .

G. Private-Use Facial Tissue Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aluids; Krome USA Inc.**]
    b. [**ASI-American Specialties, Inc.**]
    c. [**Basco, Inc**]
    d. [**Bobrick Washroom Equipment, Inc**]
    e. [**Bradley Corporation**]
    f. [**Brey-Krause Manufacturing Co.**]
    g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
    h. [**Seachrome Corporation**]
    i. [**Taymor Industries Ltd.**]
    j. [**Tubular Specialties Manufacturing, Inc.**]

2. Mounting: [**Recessed**][**Surface mounted**].
3. Depth: [**2-5/8 inches (67 mm)**][**4 inches (102 mm)**].
4. Material and Finish:

    a. Dispenser Face: [**Polished chrome-plated brass**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated steel**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].
    b. Cabinet: [**Steel with corrosion-resistant finish**].

H. Private-Use Robe Hook :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Basco, Inc**]
   d. [**Bobrick Washroom Equipment, Inc**]
   e. [**Bradley Corporation**]
   f. [**Brey-Krause Manufacturing Co.**]
   g. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
   h. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   i. [**Ginger; Brasstech, Inc.; Masco Corporation**]
   j. [**Seachrome Corporation**]
   k. [**Taymor Industries Ltd.**]
   l. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Double**][**Single**] -prong unit.
3. Material and Finish: [**Solid brass, polished**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

I. Private-Use Toothbrush and Tumbler Holder :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Basco, Inc**]
   c. [**Bradley Corporation**]
   d. [**Brey-Krause Manufacturing Co.**]
   e. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
   f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   g. [**Taymor Industries Ltd.**]
   h. [**Tubular Specialties Manufacturing, Inc.**]

2. Material and Finish: [**Solid brass, polished**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

J. Private-Use Towel Bar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aluids; Krome USA Inc.**]
   b. [**ASI-American Specialties, Inc.**]

c. [**Basco, Inc**]
d. [**Bobrick Washroom Equipment, Inc**]
e. [**Bradley Corporation**]
f. [**Brey-Krause Manufacturing Co.**]
g. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
h. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
i. [**Ginger; Brasstech, Inc.; Masco Corporation**]
j. [**Seachrome Corporation**]
k. [**Taymor Industries Ltd.**]
l. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**3/4-inch- (19-mm-) square tube with rectangular end brackets**][**3/4-inch- (19-mm-) round tube with circular end brackets**].
3. Mounting: Flanges with [**concealed**][**exposed**] fasteners.
4. Length: [**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**].
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**][**Polished aluminum**].

K. Private-Use Towel Pin :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aluids; Krome USA Inc.**]
b. [**ASI-American Specialties, Inc.**]
c. [**Basco, Inc**]
d. [**Bobrick Washroom Equipment, Inc**]
e. [**Bradley Corporation**]
f. [**Brey-Krause Manufacturing Co.**]
g. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
h. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
i. [**Ginger; Brasstech, Inc.; Masco Corporation**]
j. [**Seachrome Corporation**]
k. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Projecting minimum of [**3 inches (76 mm)**][**5 inches (127 mm)**] from wall surface.
3. Material and Finish: [**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

L. Private-Use Towel Ring :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aluids; Krome USA Inc.**]
b. [**ASI-American Specialties, Inc.**]
c. [**Basco, Inc**]
d. [**Bradley Corporation**]

e. [**Brey-Krause Manufacturing Co.**]
f. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
h. [**Ginger; Brasstech, Inc.; Masco Corporation**]
i. [**Seachrome Corporation**]
j. [**Taymor Industries Ltd.**]
k. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Pin projecting approximately [**2-1/2 inches (64 mm)**] from wall with [**square**][**circular**][**oval**][**trapezoidal**] ring.
3. Material and Finish:

a. Pin: [**Solid brass, polished**][**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated brass**][**Polished chrome-plated zinc alloy (zamac)**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].
b. Ring: [**Matching pin**][**Clear plastic**].

M. Private-Use Towel Shelf :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Basco, Inc**]
c. [**Bobrick Washroom Equipment, Inc**]
d. [**Bradley Corporation**]
e. [**Brey-Krause Manufacturing Co.**]
f. [**Franklin Brass; Liberty Hardware Manufacturing Corporation; Masco Corporation**]
g. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
h. [**Ginger; Brasstech, Inc.; Masco Corporation**]
i. [**Seachrome Corporation**]
j. [**Taymor Industries Ltd.**]
k. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Surface-mounted, guest-towel shelf with [**four**] stainless steel tubes, [**3/8 inch (10 mm) in diameter**][**5/16 inch (8 mm) square**], mounted in support arms.

a. Towel Bar: [**1/4-inch- (6-mm-) diameter**][**5/16-inch- (8-mm-) square**] stainless steel towel bar below shelf.

3. Length: [**18 inches (457 mm)**][**24 inches (610 mm)**].
4. Material and Finish: [**Polished brass-plated stainless steel**][**Polished chrome-plated stainless steel**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

N. Private-Use Towel Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aluids; Krome USA Inc.**]
b. [**Basco, Inc**]
c. [**Taymor Industries Ltd.**]
d. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Surface-mounted, guest-towel unit with approximately 1/4-inch- (6-mm-) diameter wire rings welded to upright wire bracket**].
3. Capacity: [**Two**][**Three**][**Four**] sets of bath towels, hand towels, and washcloths.
4. Nominal Height: [**11 inches (279 mm)**][**17 inches (432 mm)**][**21 inches (533 mm)**].
5. Material and Finish: [**Polished brass-plated zinc alloy (zamac)**][**Polished chrome-plated zinc alloy (zamac)**].

O. Private-Use Retractable Clothesline :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Basco, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: Surface-mounted [**rectangular**][**circular**] housing with minimum **72-inch- (1829-mm-)** long, retractable, spring-actuated, synthetic clothesline and remote retention bracket.
3. Material and Finish [**Chrome-plated brass**][**Stainless steel, ASTM A480/A480M No. 7 finish (polished)**].

2.6 HEALTHCARE ACCESSORIES

A. Source Limitations: Obtain [**healthcare accessories**][**each type of healthcare accessory**] from single source from single manufacturer.

B. Specimen Pass-Through Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Carr Corporation**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Two-sided type, with self-closing, interlocking doors on both sides, that**

prevent both from being open at same time, and removable stainless steel tray][**Turntable type, with minimum 12-inch- (305-mm-) diameter removable cylinder that revolves on stainless steel, self-lubricating, ball-bearing plates; with over-rotation prevention mechanism**].

3. Nominal Wall Opening: [**12 by 11-1/4 inches (305 by 286 mm)**][**13-1/4 by 14 inches (337 by 356 mm)**], width by height.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Lockset: Tumbler type.

C. Bedpan and Urinal Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]

2. Description: [**For storing one conventional-size bedpan and one urinal bottle; with door that produces 1/2-inch (13-mm) opening at top and bottom of cabinet to allow air circulation**].
3. Mounting: Recessed.
4. Nominal Wall Opening: [**13-1/2 by 26-1/2 by 5 inches (343 by 673 by 127 mm)**], width by height by depth.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

D. Bedpan Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: For storing [**one conventional-size bedpan**][**two conventional-size bedpans**] .
3. Mounting: Surface mounted.
4. Size: [**12 by 11 inches (305 by 279 mm)**][**12 by 27 inches (305 by 686 mm)**], width by height.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

E. Bedpan and Urinal Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   d. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: For storing one conventional-size bedpan and one urinal bottle.
3. Mounting: Surface mounted.
4. Size: [**12 by 27 inches (305 by 686 mm)**], width by height.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.7 CHILDCARE ACCESSORIES

A. Source Limitations: Obtain [**childcare accessories**][**each type of childcare accessory**] from single source from single manufacturer.

B. Diaper-Changing Station :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Diaper Deck & Co.**]
   d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
   e. [**Koala Kare Products; Bobrick Washroom Equipment, Inc.**]
   f. [**Safe-Strap Company, LLC**]
   g. [**Sova (Formerly Foundations)**]
   h. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Horizontal**][**Vertical**] unit that opens by folding down from stored position and with child-protection strap.

   a. Structural Performance: Engineered to support minimum of [**250 lb (113 kg)**] static load when opened.

3. Mounting: [**Surface mounted, with unit projecting not more than 4 inches (102 mm) from wall when closed**][**Semirecessed, with unit projecting not more than 1 inch (25 mm) from wall when closed**] .
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: [**HDPE in manufacturer's standard color**][**HDPE with plastic-laminate insert in color selected by Architect**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners**][**Stainless steel, ASTM A480/A480M No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color**] as directed by the Owner.
6. Liner Dispenser: Provide [**built-in**][**separate, locking**] dispenser for disposable sanitary liners.

C. Diaper-Changing Station Liner Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Koala Kare Products; Bobrick Washroom Equipment, Inc.**]
   b. [**Sova (Formerly Foundations)**]

2. Mounting: Recessed.
3. Minimum Capacity: [**100**] liners.
4. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].
5. Lockset: Tumbler type.

D. Diaper-Pack Vendor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Koala Kare Products; Bobrick Washroom Equipment, Inc.**]
   b. [**Sova (Formerly Foundations)**]

2. Mounting: [**Surface mounted**][**Recessed**] .
3. Minimum Capacity: [**24**] diaper packs.
4. Coin Operation: Coin slot preset for [**one U.S. dollar, adjustable up in 25-cent increments**].
5. Material and Finish: [**Stainless steel, ASTM A480/A480M No. 4 finish (satin)**].

E. Child-Protection Seat :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Diaper Deck & Co.**]
   d. [**Koala Kare Products; Bobrick Washroom Equipment, Inc.**]
   e. [**Safe-Strap Company, LLC**]
   f. [**Sova (Formerly Foundations)**]

2. Description: Unit that opens by folding down from stored position and with child-protection strap.

   a. Structural Performance: Engineered to support minimum of [**80 lb (36 kg)**][**150 lb (68 kg)**] static load when opened.

3. Mounting: Surface mounted, with unit projecting not more than [**4-1/2 inches (114 mm)**][**6 inches (152 mm)**] from wall when closed.
4. Material and Finish: [**HDPE in manufacturer's standard color**].

2.8 UNDERLAVATORY GUARDS

A. Underlavatory Guard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Buckaroos, Inc.**]

b. [**Plumberex Specialty Products, Inc.**]
c. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
d. [**Truebro; IPS Corporation**]

2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

2.9 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain [**custodial accessories**][**each type of custodial accessory**] from single source from single manufacturer.

B. Custodial Utility Shelf :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: With exposed edges turned down not less than **1/2 inch (13 mm)** and supported by two triangular brackets welded to shelf underside.
3. Size: [**16 inches (406 mm) long by 6 inches (152 mm) deep**].
4. Material and Finish: Not less than nominal **0.05-inch- (1.3-mm-)** thick stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Custodial Mop and Broom Holder :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASI-American Specialties, Inc.**]
b. [**Bobrick Washroom Equipment, Inc**]
c. [**Bradley Corporation**]
d. [**Brey-Krause Manufacturing Co.**]
e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
f. [**Tubular Specialties Manufacturing, Inc.**]

2. Description: [**Unit with shelf, hooks, holders, and rod suspended beneath shelf**].
3. Length: [**36 inches (914 mm)**].
4. Hooks: [**Four**].
5. Mop/Broom Holders: [**Three**], spring-loaded, rubber hat, cam type.

6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

   a. Shelf: Not less than nominal **0.05-inch- (1.3-mm-)** thick stainless steel.
   b. Rod: Approximately **1/4-inch- (6-mm-)** diameter stainless steel.

2.10 HAND-SANITIZER DISPENSERS

A. Source Limitations: Obtain [**hand-sanitizer dispensers**][**each type of hand-sanitizer dispenser**] from single source from single manufacturer.

B. Hand-Sanitizer Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**GOJO Industries**]
   b. [**Rubbermaid Commercial Products**]
   c. [**Tork; Essity Professional Hygiene North America LLC**]

2. Description: Manually operated dispenser [**with drip tray,**] designed for dispensing alcohol-based hand rub in [**gel**][**foam**] form. Designed to not release contents unless manually activated and to not dispense more hand rub than the amount required for hand hygiene consistent with label instructions.
3. Mounting: Wall mounted.

   a. Protrusion Limit: Installed unit protrudes maximum **4 inches (102 mm)** from wall surface.

4. Capacity: [**24 oz. (700 mL)**][**34 oz. (1000 mL)**][**41 oz. (1200 mL)**][**68 oz. (2000 mL)**] maximum.
5. Materials: [**ABS plastic, white**][**ABS plastic, black**][**ABS plastic, dark gray**].
6. Lockset: Tumbler type.
7. Refill Indicator: [**Window type**][**Translucent top**][**Translucent bottom**] .

C. Automatic Hand-Sanitizer Dispenser :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**GOJO Industries**]
   b. [**Rubbermaid Commercial Products**]
   c. [**SWIE Industries LLC**]
   d. [**Tork; Essity Professional Hygiene North America LLC**]

2. Description: Automatic, battery-powered dispenser with [**drip tray, and**] infrared sensor designed to detect presence of hands and dispense alcohol-based hand rub in [**gel**][**foam**] form. Designed to not release contents unless activated and to not dispense more hand rub than the amount required for hand hygiene consistent with label instructions. Designed for activation to only occur when an object is placed within **4 inches (102 mm)** of sensing device and so that an object placed and left within the activation zone will not cause more than one activation.
3. Mounting: [**Wall mounted**][**Floor stand**] .

a. Protrusion Limit: Installed unit protrudes maximum **4 inches (102 mm)** from wall surface.

4. Capacity: [**34 oz. (1000 mL)**][**41 oz. (1200 mL)**] maximum.
5. Materials: [**ABS plastic, white**][**ABS plastic, black**][**ABS plastic, dark gray**].
6. Refill Indicator: [**LED indicator**][**Window type**][**Translucent top**][**Translucent bottom**] .
7. Low-Battery Indicator: LED indicator.

2.11 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, **0.031-inch- (0.8-mm-)** minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.

C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), **0.036-inch- (0.9-mm-)** minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A653/A653M, with **G60 (Z180)** hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer in writing or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.12 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of [**six**] keys, as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION OF TOILET, BATH, AND LAUNDRY ACCESSORIES

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer in writing. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

C. Folding Shower Seats: Install to comply with specified structural-performance requirements.

D. Private-Use Folding Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

3.3 CLEANING

A. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 10 28 00 00

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Task	Specification	Specification Description
10 28 13 00	01 22 00 00	No Specification Required
10 28 13 00	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 13 13	01 22 00 00	No Specification Required
10 28 13 13	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 13 13	10 28 13 63	Detention Toilet Accessories

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SECTION 10 28 13 63 - DETENTION TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Safety hooks.
2. Shelves.
3. Combination shelves with safety hooks.
4. Miscellaneous toilet accessories.
5. Stainless-steel mirrors.
6. Grab bars.
7. Shower seats.

B. Related Requirements:

1. Section 102800 "Toilet, Bath, and Laundry Accessories" for nondetention toilet accessories.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention toilet accessories. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in adjoining construction. Deliver such items to Project site in time for installation.

C. Coordinate size and location of recesses in wall construction to receive recessed detention toilet accessories.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

2. Product Data: For sealants, indicating VOC content.
3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Samples for Verification: For each type of detention toilet accessory indicated.

1. Approved full-size Samples will be returned and may be used in the Work.

D. Product Schedule: For detention toilet accessories. Indicate types, quantities, sizes, and installation locations by room of each accessory required.[**Use same designations indicated on Drawings.**]

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Location of each built-in anchor supporting detention toilet accessories, including anchors to be installed as work of other Sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Locations, dimensions, and profiles of wall and floor reinforcements.
2. Locations and installation details of built-in anchors.
3. Elevations of each detention toilet accessory showing dimensions of accessory, preparations for receiving anchors, and locations of anchorage.
4. Details of attachment of each detention toilet accessory to built-in anchors.

B. Examination reports documenting inspection of substrates, areas, and conditions.

C. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

D. Field quality-control certification signed by Contractor[**and Detention Specialist**].

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For detention toilet accessories to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Security Fasteners: Furnish not less than 1 box for each 50 boxes or fraction thereof, of each type and size of security fastener installed.
2. Tools: Provide [**two**] sets of tools for installing and removing security fasteners.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace detention toilet accessories that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including deflection exceeding **1/4 inch (6.3 mm)**.

b. Faulty operation of hardware.
c. Deterioration of metals, metal finishes, and other materials.

2. Warranty Period: [**Two**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DETENTION SAFETY HOOKS

A. Individual, Curved, Detention Safety Hook: **0.188-inch (4.77-m)** nominal-thickness, stainless-steel curved hook held by [**0.141-inch- (3.58-mm-)**][**0.109-inch- (2.77-mm-)**] thick, stainless-steel bracket punched with not less than two holes for fastening with security fastener. Provide friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit indicated in Part 3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]
b. [**ASI-American Specialties, Inc.**]
c. [**Bradley Corporation**]
d. [**Maximum Security Products Corp**]
e. [**PSI LLC**]
f. [**Willo Products Company, Inc.**]

B. Individual, Straight, Detention Safety Hook: [**3/8-inch- (9.5-mm-)**][**1/4-inch- (6.3-mm-)**] diameter, stainless-steel straight hook held by [**0.109-inch- (2.77-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel mounting plate approximately **4 inches (102 mm)** square. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds [**8 lbf (35.6 N)**][**15 lbf (66.7 N)**][**20 lbf (89.0 N)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**ASI-American Specialties, Inc.**]
c. [**Bobrick Washroom Equipment, Inc**]
d. [**Bradley Corporation**]
e. [**Brey-Krause Manufacturing Co.**]
f. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
g. [**Maximum Security Products Corp**]
h. [**Norix Group, Inc.**]
i. [**PSI LLC**]
j. [**Southern Folger Detention Equipment Company**]
k. [**Willoughby Industries, Inc.**]

2. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

C. Multiple, Curved, Safety Hook Strip: Minimum **5-1/2-inch- (140-mm-)** high backplate by length

indicated, formed from [**0.125-inch- (3.18-mm-)**][**0.109-inch- (2.77-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel sheet. Provide **0.188-inch- (4.77-mm-)** thick, stainless-steel hooks attached to backplate; with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit indicated in Part 3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**PSI LLC**]

2. Configuration: [**16 inches (406 mm) long with two hooks**][**18 inches (457 mm) long with four hooks**][**21 inches (533 mm) long with four hooks**][**24 inches (610 mm) long with three hooks**][**32 inches (813 mm) long with four hooks**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

D. Multiple, Straight, Safety Hook Strip: Minimum **5-1/2-inch- (140-mm-)** high backplate by length indicated, formed from [**0.141-inch- (3.58-mm-)**][**0.109-inch- (2.77-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel sheet. Provide [**3/8-inch- (9.5-mm-)**][**1/4-inch- (6.3-mm-)**] diameter, stainless-steel straight hooks attached to backplate. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds [**8 lbf (35.6 N)**][**15 lbf (66.7 N)**][**20 lbf (89.0 N)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Bobrick Washroom Equipment, Inc**]
   d. [**Bradley Corporation**]
   e. [**Brey-Krause Manufacturing Co.**]
   f. [**Norix Group, Inc.**]
   g. [**PSI LLC**]
   h. [**Willoughby Industries, Inc.**]

2. Configuration: [**16 inches (406 mm) long with two hooks**][**18 inches (457 mm) long with four hooks**][**24 inches (610 mm) long with three hooks**][**32 inches (813 mm) long with four hooks**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

E. Materials:

1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

F. Stainless-Steel Finish:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    c. Directional Satin Finish: No. 4.

2.2 DETENTION SHELVES

A. Surface-Mounted, Steel Detention Shelf: Minimum **6 inches high by 8 inches (152 mm high by 203 mm)** deep by [**16 inches (406 mm)**][**24 inches (610 mm)**][**32 inches (813 mm)**] long; formed from [**0.138-inch (3.50-mm)**][**0.108-inch (2.74-mm)**] nominal-thickness, metallic-coated steel sheet; with welded side gussets and minimum **1-inch (25.4-mm)** flanged front edge; with back punched for fastening to wall with security fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Jail Products L.L.C.**]
    b. [**Maximum Security Products Corp**]
    c. [**Southern Folger Detention Equipment Company**]
    d. [**Willo Products Company, Inc.**]

B. Surface-Mounted, Stainless-Steel Detention Shelf: Minimum **5-1/2 inches high by 8 inches (140 mm high by 203 mm)** deep by [**18 inches (457 mm)**][**24 inches (610 mm)**] long; formed from **0.078-inch- (1.98-mm-)** thick, stainless-steel sheet; with welded side gussets and hemmed front edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**American Jail Products L.L.C.**]
    c. [**Bradley Corporation**]
    d. [**Brey-Krause Manufacturing Co.**]

2. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

C. Recessed, Stainless-Steel Detention Shelf: Minimum inside dimensions of [**16 inches (406 mm)**] wide by **5 inches high by 4 inches (127 mm high by 102 mm)** deep; formed from **0.062-inch- (1.57-mm-)** thick, stainless-steel sheet; with **1-inch- (25.4-mm-)** wide flanged front edge. Secure to wall with rear-mounting steel strap and adjustment bolts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**ASI-American Specialties, Inc.**]

c. [**Bradley Corporation**]
d. [**Norix Group, Inc.**]
e. [**PSI LLC**]
f. [**Willoughby Industries, Inc.**]

D. Materials:

1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) coating designation.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

E. Finishes:

1. Metallic-Coated Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
b. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the coating to be applied over it.
c. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Stainless-Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.
2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3) Directional Satin Finish: No. 4.

2.3 COMBINATION DETENTION SHELVES WITH SAFETY HOOKS

A. Steel Detention Shelf with Multiple, Curved Safety Hooks: Minimum **6 inches high by 8 inches (152 mm high by 203 mm)** deep by length indicated, formed from [**0.138-inch (3.50-mm)**][**0.108-inch (2.74-mm)**] nominal-thickness, metallic-coated steel sheet, with welded side gussets and hemmed or flanged front edge. Provide **0.138-inch (3.50-mm)** nominal-thickness, zinc-plated-steel curved hooks held by **0.1265-inch- (3.21-mm-)** thick steel brackets welded to backplate, with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit indicated in Part 3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**Maximum Security Products Corp**]
   c. [**PSI LLC**]
   d. [**Willo Products Company, Inc.**]

2. Configuration: [**16 inches (406 mm) long with two hooks**][**24 inches (610 mm) long with three hooks**][**32 inches (813 mm) long with four hooks**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

B. Stainless-Steel Detention Shelf with Multiple, Curved Safety Hooks: Minimum **5-1/2 inches high by 8 inches (140 mm high by 203 mm)** deep by length indicated; formed from **0.078-inch- (1.98-mm-)** thick, stainless-steel sheet; with welded side gussets and hemmed or flanged front edge. Provide **0.141-inch (3.58-mm)** stainless-steel curved hooks held by **0.141-inch- (3.58-mm-)** thick, stainless-steel brackets welded to backplate, with each hook having a friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit indicated in Part 3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASI-American Specialties, Inc.**]
   b. [**Bradley Corporation**]
   c. [**Sweeper Metal Fabricators Corp**]

2. Configuration: [**16 inches (406 mm) long with two hooks**][**18 inches (457 mm) long with four hooks**][**24 inches (610 mm) long with three hooks**][**32 inches (813 mm) long with four hooks**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

C. Stainless-Steel Detention Shelf with Multiple, Straight Safety Hooks: Minimum **5-1/2 inches high by 8 inches (140 mm high by 203 mm)** deep by length indicated; formed from **0.078-inch- (1.98-mm-)** thick, stainless-steel sheet; with welded side gussets and hemmed or flanged front edge. Provide [**3/8-inch- (9.5-mm-)**][**1/4-inch- (6.3-mm-)**] diameter, stainless-steel straight hooks held by [**0.109-inch- (2.77-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel mounting plate. Provide pivoting assembly that maintains pressure on hook and snaps down when load exceeds [**8 lbf (35.6 N)**][**15 lbf (66.7 N)**][**20 lbf (89.0 N)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**ASI-American Specialties, Inc.**]
   c. [**Norix Group, Inc.**]
   d. [**PSI LLC**]
   e. [**Willoughby Industries, Inc.**]

2. Configuration: [**16 inches (406 mm) long with two hooks**][**18 inches (457 mm) long with four hooks**][**24 inches (610 mm) long with three hooks**][**32 inches (813 mm) long with four hooks**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

D. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) coating designation.
3. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
4. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

E. Finishes:

1. Steel Finish:

a. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with [**SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning"**][**or**][**SSPC-SP 8, "Pickling"**].[**After cleaning, apply a conversion coating suited to the organic coating to be applied over it.**]
b. Galvanizing: After fabrication, galvanize window components by chemical cleaning complying with SSPC-SP 1, "Solvent Cleaning," and pickling treatment complying with SSPC-SP 8, "Pickling," followed by hot-dip galvanizing complying with ASTM A123/A123M.
c. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.
d. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Metallic-Coated Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
b. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the coating to be applied over it.
c. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless-Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.

2.4 MISCELLANEOUS DETENTION TOILET ACCESSORIES

A. Recessed, Detention Toilet Tissue Holder: Minimum **5-inch diameter by 4-1/2 inches (127-mm diameter by 114 mm)** deep; formed from **0.062-inch- (1.57-mm-)** thick, stainless-steel sheet. Secure to wall with rear-mounting steel strap and adjustment bolts.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Acorn Engineering Company; a Division of Morris Group International**]
      b. [**ASI-American Specialties, Inc.**]
      c. [**Bradley Corporation**]
      d. [**Brey-Krause Manufacturing Co.**]
      e. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
      f. [**Norix Group, Inc.**]
      g. [**PSI LLC**]
      h. [**Willoughby Industries, Inc.**]

   2. Face: [**1-inch (25.4-mm) lip around entire face**][**7-inch- (178-mm-) square face flange**].

B. Recessed, Detention Soap Dish: Minimum inside dimensions of **5-3/4 inches wide by 4-1/2 inches high by 2-1/2 inches (146 mm wide by 114 mm high by 64 mm)** deep with **3/4-inch (19-mm)** lip around entire face; formed from [**0.062-inch- (1.57-mm-)**][**0.050-inch- (1.27-mm-)**] thick, stainless-steel sheet. Secure to wall with rear-mounting steel strap and adjustment bolts.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Acorn Engineering Company; a Division of Morris Group International**]
      b. [**ASI-American Specialties, Inc.**]
      c. [**Bradley Corporation**]
      d. [**Norix Group, Inc.**]
      e. [**Willoughby Industries, Inc.**]

C. Materials:

   1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
   2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

D. Stainless-Steel Finish:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
c. Directional Satin Finish: No. 4.

2.5 DETENTION MIRRORS

A. Small, Framed Detention Mirror: Formed from **0.038-inch- (0.95-mm-)** thick, stainless-steel sheet with fiberboard backing; enclosed in a frame formed from **0.064-inch (1.63-mm)** nominal-thickness, zinc-plated steel sheet; with round corners. Fabricate frame with welded and ground corners or from one piece of metal.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Maximum Security Products Corp**]
b. [**PSI LLC**]
c. [**Sweeper Metal Fabricators Corp**]

2. Size: [**Approximately 9-1/2 by 11 inches (241 by 279 mm)**].
3. Mounting: [**Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate**][**Chase mounting with welded anchor nuts on backplate**].

B. Small, Integrally Framed Detention Mirror: Mirror and integral frame formed from a single sheet of [**0.038-inch- (0.95-mm-)**][**0.062-inch- (1.57-mm-)**] thick, stainless steel; with round corners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASI-American Specialties, Inc.**]
b. [**Norix Group, Inc.**]
c. [**PSI LLC**]
d. [**Willo Products Company, Inc.**]
e. [**Willoughby Industries, Inc.**]

2. Size: [**Approximately 9-1/2 by 11 inches (241 by 279 mm)**].
3. Mounting: [**Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate**][**Chase mounting with welded anchor nuts on backplate**].

C. Large, Framed Detention Mirror with Square Corners: Formed from [**0.038-inch- (0.95-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel sheet with fiberboard backing; enclosed in a metal frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASI-American Specialties, Inc.**]
b. [**Bradley Corporation**]
c. [**Brey-Krause Manufacturing Co.**]
d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
e. [**Willoughby Industries, Inc.**]

2. Size: [**Minimum 12 by 16 inches (305 by 406 mm)**].
3. Frame: Formed from [**0.064-inch (1.63-mm) nominal-thickness, chrome-plated steel**][**0.062-inch- (1.57-mm-) thick, stainless-steel**][**0.078-inch- (1.98-mm-) thick, stainless-steel**] sheet. Fabricate frame with welded and ground corners or from one piece of metal.
4. Mounting: [**Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate**][**Chase mounting with welded anchor nuts on backplate**].

D. Large, Framed Detention Mirror with Round Corners: Formed from a single sheet of [**0.038-inch- (0.95-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless steel; enclosed in a metal frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Maximum Security Products Corp**]
c. [**PSI LLC**]
d. [**Sweeper Metal Fabricators Corp**]

2. Size: [**Minimum 12 by 16 inches (305 by 406 mm)**].
3. Frame: Formed from [**0.064-inch (1.63-mm) nominal-thickness, chrome-plated steel**][**0.078-inch- (1.98-mm-) thick, stainless-steel**] sheet. Fabricate frame with welded and ground corners or from one piece of metal.
4. Mounting: [**Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate**][**Chase mounting with welded anchor nuts on backplate**].

E. Large, Integrally Framed Detention Mirror with Round Corners: Mirror and integral frame formed from [**0.038-inch- (0.95-mm-)**][**0.062-inch- (1.57-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel sheet; with round corners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**ASI-American Specialties, Inc.**]
c. [**Bobrick Washroom Equipment, Inc**]
d. [**Bradley Corporation**]
e. [**Norix Group, Inc.**]
f. [**PSI LLC**]
g. [**Southern Folger Detention Equipment Company**]
h. [**Willo Products Company, Inc.**]

i. [**Willoughby Industries, Inc.**]

2. Size: [**Minimum 12 by 16 inches (305 by 406 mm)**].
3. Mounting: [**Front mounting with security fasteners to 0.168-inch (4.27-mm) nominal-thickness, metallic-coated steel mounting plate**][**Chase mounting with welded anchor nuts on backplate**].

F. Materials:

1. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) coating designation.
2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

G. Finishes:

1. Metallic-Coated Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
b. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the coating to be applied over it.
c. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Stainless-Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2) Mirrorlike Reflective, Nondirectional Polish: No. 8.

3. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

2.6 DETENTION GRAB BARS

A. Grab Bars: **1-1/2 inches (38.1 mm)** in diameter; formed from **0.038-inch- (0.95-mm-)** thick, stainless-steel tubing, with **3-inch- (76.2-mm-)** diameter flanges formed from **0.125-inch- (3.18-mm-)** thick, stainless steel. Closure plates formed from **0.125-inch- (3.18-mm-)** thick, stainless steel. All-welded construction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASI-American Specialties, Inc.**]
    b. [**Bradley Corporation**]
    c. [**Brey-Krause Manufacturing Co.**]
    d. [**Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.**]
    e. [**Norix Group, Inc.**]
    f. [**PSI LLC**]
    g. [**Willoughby Industries, Inc.**]

2. Length: [**As indicated on Drawings**][**36 inches (914 mm) long**].
3. Mounting: [**Front mounting with security fasteners**][**Chase mounting with welded anchor nuts on backplate**].

B. Materials:

1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
2. Stainless-Steel Tubing: ASTM A1016/A1016M, austenitic stainless steel, Type 304, seamless.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Stainless-Steel Finish:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    c. Directional Satin Finish: No. 4.

2.7 DETENTION SHOWER SEATS

A. Shower Seats: Double-pan retractable, recessed shower seat with recessed handle. Approximately **16- by 16-inch (406- by 406-mm)** overall size formed from [**0.062-inch- (1.57-mm-)**][**0.078-inch- (1.98-mm-)**] thick, stainless-steel sheet. Seat pivots on solid **0.375-inch- (9.5-mm-)** diameter stainless-steel rod and self-latches when closed. Minimum **750-lb (340-kg)** loading capacity.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASI-American Specialties, Inc.**]
    b. [**Norix Group, Inc.**]

B. Materials:

1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content

not less than [**25**] percent.

C. Stainless-Steel Finish:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

2.8 FABRICATION

A. Coordinate dimensions and attachment methods of detention toilet accessories with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Form edges and corners to be free of sharp edges and rough areas. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12.7-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (0.8 mm)** and support with concealed stiffeners.

D. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention toilet accessories rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

G. Cut, reinforce, drill, and tap detention toilet accessories to receive hardware, security fasteners, and similar items.

H. Form exposed work true to line and level with accurate angles and surfaces. Grind off and ease edges unless otherwise indicated.

I. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security fasteners. Locate joints where least conspicuous.

2.9 SECURITY FASTENERS

A. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
   b. [**Bryce Fastener Mfg., Inc.**]
   c. [**Safety Socket LLC**]
   d. [**Tamper-Pruf Screws**]

2. Drive-System Type: [**Pinned Torx-Plus**][**Pinned Torx**].
3. Fastener Strength: **120,000 psi (827 MPa)**.
4. Socket Button Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

5. Socket Flat Countersunk Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

6. Socket Head Cap Fasteners:

   a. Heat-treated alloy steel, ASTM A574.
   b. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

7. Protective Coatings for Heat-Treated Alloy Steel:

   a. Zinc and clear trivalent chromium where indicated.
   b. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.10 SECURITY SEALANTS

A. Polyurethane Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Master Builders Solutions**]
   b. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Epoxy Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with no movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**Master Builders Solutions**]
   c. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.11 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining,

without failure, a load equal to [**four**] times the load imposed, as determined by testing according to ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below:

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.

C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

D. Proprietary Built-in Masonry Anchors: Fabricated from [0.134-inch (3.42-mm) nominal-thickness steel sheet][1/4-inch (6-mm) nominal-thickness steel plate][1/2-inch (12.7-mm) nominal-thickness steel plate] into [6-inch- (152-mm-)][8-inch- (203-mm-)] deep blocks matching size of concrete masonry units[with weld nuts attached on inside to receive field-bolted attachments].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**M/BED Block Systems, LLC.**]

2. Finish: [**Factory primed for field painting for anchors with field-welded attachments**][**Polyester powder coat for anchors with bolted attachments**][**Epoxy paint for anchors with bolted attachments**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention toilet accessories.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention toilet accessory connections before detention toilet accessory installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention toilet accessories.

D. Inspect built-in and cast-in anchor installations before installing detention toilet accessories to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention toilet accessories.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention toilet accessories to in-place construction. Include threaded fasteners for [**concrete**][**and**][**masonry**] inserts, security fasteners, and other connectors.

B. Provide temporary bracing or anchors in formwork for items that are to be built into [concrete][masonry] or similar construction.

C. Apply [**polyurethane**][**epoxy**] security sealant around perimeter in a continuous ribbon on back of detention toilet accessories before installation.

D. Security Fasteners: Install detention toilet accessories using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials.[**Provide stainless-steel security fasteners in stainless-steel materials.**]

E. Grab Bars: Install to withstand a downward load of not less than **250 lbf (1112 N)** per ASTM F446.

3.3 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Remove and replace detention work where inspections indicate that work does not comply with specified requirements.

C. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

D. Prepare field quality-control certification[**endorsed by Detention Specialist**] that states installed products and their installation comply with requirements in the Contract Documents.

3.4 ADJUSTING AND CLEANING

A. Remove temporary labels and protective coatings.

B. Adjust curved safety hooks to release with application of [**8-lbf (35.6-N)**][**15 lbf (66.7 N)**][**20 lbf (89.0 N)**] load.

1. Verify tightness of accessible connections by calibrated torque driver.

C. Touchup Painting:

1. Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
2. Cleaning and touchup painting of bolted connections and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

END OF SECTION 10 28 13 63

Task	Specification	Specification Description
10 28 13 63	01 22 00 00	No Specification Required
10 28 13 63	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 16 00	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 16 13	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 16 13	10 28 13 63	Detention Toilet Accessories

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SECTION 10 28 19 00 - TUB AND SHOWER ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framed shower doors and enclosures.
2. Frameless shower doors and enclosures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for shower doors and enclosures.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For tub and shower doors and enclosures.

1. Include plans, elevations, sections, and attachment details.

D. Samples for Initial Selection: For each type of exposed finish.

E. Samples for Verification: For tub and shower doors and enclosures.

1. Each type of mounting and operating hardware; full size.
2. Glass and glazing; **12 inches (305 mm)** square.
3. Trim; **12-inch (305-mm)** lengths.

F. Product Schedule: For tub and shower doors and enclosures.[**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tub and shower doors and enclosures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of tub and shower doors and enclosure as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

A. Verify dimensions by field measurements before fabrication and indicate on Shop Drawings.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tub and shower doors and enclosures that fail in materials or workmanship within specified warranty period, without monetary limitation.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: [**Two**][**Three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FRAMED ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alumax Bath Enclosures**]
2. [**American Shower Door Corporation**]
3. [**Anzzi; a brand of SWCorp**]
4. [**Artistcraft Shower Doors**]
5. [**Basco, Inc**]
6. [**Century Bathworks**]
7. [**Fleurco Products Inc.**]
8. [**Hartung Glass Industries**]
9. [**HMI**]
10. [**Seawin Hospitality; Seawin Global**]
11. [**Southeastern Aluminum Products, LLC**]
12. [**VIGO Industries LLC**]

B. Glass panels with full perimeter frames of extruded aluminum with screw-fastened corners. Minimum **3/8-inch (10-mm)** penetration of glass into frame. Framing members of thickness required to support imposed loads.

C. Frames, Hardware, and Trim: Manufacturer's standard units as indicated and as required for a complete installation.

1. Materials: Aluminum; ASTM B221 (ASTM B221M).
2. Finish: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**].
3. Color: [**Silver**][**Gold**][**Black**].

D. Bypassing Doors: Sliding units suspended from top track by fully adjustable ball-bearing rollers. Self-draining sill tracks with nylon panel guides. Molded jamb bumpers with concealed fasteners.

1. Door Pulls: Full-door-width, single-sided towel bars.

E. Swinging Doors: [**Full-height piano hinge**][**Top-and-bottom pivot hinges**]. Manufacturer's standard pulls and latch.

F. Glazing:

1. [**Clear**][**Clear obscured**][**Tinted**][**Patterned**] fully tempered. Comply with requirements in Section 088000 "Glazing."
2. Safety glazing materials complying with 16 CFR 1201, Category II, with permanently etched identification acceptable to authorities having jurisdiction.

a. Glass Nominal Thickness: [**6**][**10**] mm.
b. Clear Glass: ASTM C1048, Type I, Quality-Q3, Class I (clear), Kind FT.

1) Obscured Panels: [**Acid etched**][**Sandblasted**].

c. Tinted Glass: ASTM C1048, Type I, Quality-Q3, Class II, Kind FT.

1) Color: [**Bronze**][**Green**].

d. Patterned Glass: ASTM C1048, Kind FT (fully tempered), Type II, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned, one side).

1) Pattern: [**Manufacturer's standard**][**Pattern P3 (random)**].

e. Protective, Self-Cleaning, Glass Coating: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

G. Fasteners: Manufacturer's standard stainless steel or other noncorrosive fasteners.

H. Sealant: Mildew-resistant, single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, for Use NT.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.2 FRAMELESS ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alumax Bath Enclosures**]
2. [**American Shower Door Corporation**]
3. [**Anzzi; a brand of SWCorp**]
4. [**Artistcraft Shower Doors**]
5. [**Basco, Inc**]
6. [**Century Bathworks**]
7. [**Fleurco Products Inc.**]
8. [**Hartung Glass Industries**]
9. [**HMI**]
10. [**PRL Glass Systems Inc.**]
11. [**Seawin Hospitality; Seawin Global**]
12. [**SouFlo**]
13. [**Southeastern Aluminum Products, LLC**]
14. [**VIGO Industries LLC**]

B. Frameless glass panels with mounting and operating hardware of types and sizes required to support imposed loads.

C. Hardware and Trim: Manufacturer's standard units as indicated and as required for complete installation.

1. Materials:

a. Aluminum:

1) Finish: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**].
2) Color: [**Silver**][**Gold**][**Black**].

b. Brass:

1) Finish: [**Chrome**][**Satin chrome**][**Brass**][**Satin brass**][**Oil-rubbed brass**][**Bronze**][**Brushed bronze**][**Oil-rubbed bronze**].

c. Stainless Steel Sheet and Plate:

1) Finish: [**ASTM A480/A480M No. 4 directional satin finish**][**ASTM A480/A480M No. 6 dull satin finish**][**ASTM A480/A480M No. 7 reflective, directional finish**].

d. Stainless Steel Tubing:

1) Finish: [**180-Grit Polished Finish: Uniform, directionally textured finish**][**280-Grit Polished Finish: Fine finish**][**Polished and Buffed Finish: 320-grit finish followed by buffing**].

a) Polished and Buffed Finish: Buff to [**a high luster finish**][**a mirrorlike finish**][**match Architect's sample**], as directed by the Owner.

D. Bypass Doors: Sliding units suspended from extruded-aluminum header track by fully adjustable, sealed, heavy-duty ball-bearing rollers. Self-draining sill tracks with nylon panel guides. Molded jamb bumpers with concealed fasteners.

1. Door Pulls: [**Full-door-width, single-sided towel bars**][**Single-sided vertical blade handles**][**Single-sided knobs**].
2. Safety Clip System: Manufacturer's standard safety device designed to prevent doors from falling off sliding track.

E. Sliding Door and Fixed In-Line Panel: Sliding unit with exposed, adjustable, heavy-duty rollers operating above full-span header bar. Door bottom guide, antilift fittings, stoppers, and mounts for fixed panel and header bar.

1. Door Pulls: Back-to-back, [**D-pull**][**mitered pull**][**ladder pull**][**C-pull**][**knob**].
2. Sill Strip: Manufacturer's standard sill strip designed to direct dripping water back into the enclosure.

F. Swinging Doors: Hinged for [**90 degrees outwards swing, self-closing**][**90 degrees inwards and outwards swing, self-centering when doors are within 15 degrees of closed position**][**full rotation swing, self-centering when doors are within 15 degrees of closed position**]. Soft bulb seal or wipes; affixed to door to direct water back into enclosure and provide a tight water seal.

1. Hinges: [**Full-height piano**][**Side-hinged, 90-degree patch**][**Side-hinged, 135-degree patch**][**Side-hinged, 180-degree patch**][**Top-and-bottom pivots**].
2. Door Pulls: [**Single-sided**][**Back-to-back**], [**towel bar**][**D-pull**][**mitered pull**][**ladder pull**][**C-pull**][**knob**].

a. Towel Bar Length: [**18 inches (460 mm)**][**24 inches (610 mm)**][**30 inches (760 mm)**].

G. Fixed Panels: [**Side**][**Top-and-bottom**] mounts; match hinges in material and finish.

H. Ventilating Transom: Rotating clamps centered on transom.

I. Glazing:

1. [**Clear**][**Clear obscured**][**Tinted**][**Patterned**] fully tempered. Comply with requirements in Section 088000 "Glazing."
2. Safety glazing materials complying with 16 CFR 1201, Category II, with permanently etched identification acceptable to authorities having jurisdiction.

a. Glass Nominal Thickness: [**As determined by manufacturer based on panel size**][**8 mm**][**10 mm**][**12 mm**].
b. Clear Glass: ASTM C1048, Type I, Quality-Q3, Class I (clear), Kind FT.

1) Obscured Panels: [**Acid etched**][**Sandblasted**].

c. Tinted Glass: ASTM C1048, Type I, Quality-Q3, Class II, Kind FT.

1) Color: [**Bronze**][**Green**].

d. Patterned Glass: ASTM C1048, Kind FT (fully tempered), Type II, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned, one side).

1) Pattern: [**Manufacturer's standard**][**Pattern P3 (random)**].

e. Protective, Self-Cleaning, Glass Coating: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

J. Fasteners: Manufacturer's standard stainless steel or other noncorrosive fasteners.

K. Sealant: Mildew-resistant, single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, for Use NT.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

L. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

a. Sheet and Plate: **ASTM B209 (ASTM B209M)**.
b. Extrusions: **ASTM B221 (ASTM B221M)**.

2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 302 or 304.
3. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 302 or 304.
4. Copper-Alloy Sheet and Shapes: ASTM B36/B36M.
5. Copper-Alloy Extrusions: ASTM B455, alloy UNS No. C38500 (architectural brass).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare and install per manufacturer's written instructions unless more stringent requirements are contained in NGA's "GANA Glazing Manual."

B. Clean substrates, removing projections, filling voids, and sealing joints.

C. Set units level, plumb, and true to line, without warp or rack of frames and panels, and anchor securely in place.

D. Fasten components securely in place, with provisions for thermal movement. Install with concealed fasteners unless otherwise indicated.

E. Install components to drain and return water to tub or shower.

F. Install doors to produce smooth operation and tight fit at contact points.

G. Repair, refinish, or replace components damaged during installation.

3.2 ADJUSTING AND CLEANING

A. Adjust operating parts and hardware for smooth, quiet operation and watertight closure. Lubricate hardware and moving parts.

B. Remove nonpermanent labels, and clean surfaces immediately after installation.

END OF SECTION 10 28 19 00

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Task	Specification	Specification Description
10 28 19 00	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 19 16	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 19 16	10 28 19 00	Tub and Shower Enclosures
10 28 19 19	10 28 00 00	Toilet, Bath, and Laundry Accessories
10 28 19 19	10 28 19 00	Tub and Shower Enclosures

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SECTION 10 44 13 00 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinet.
2. Security fire-protection cabinet.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.
2. Section 211000 "Water-Based Fire-Suppression Systems" for fire-hose connections.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
2. Show location of knockouts for hose valves.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of exposed finish required.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples **6 by 6 inches (150 by 150 mm)** square.

E. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. [**Use same designations indicated on Drawings.**]

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of [**fire extinguishers**][**fire hoses, hose valves, and hose racks**] indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 FIRE-PROTECTION CABINETS

A. Fire-Protection Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Babcock-Davis**]
   b. [**Croker; a Division of Morris Group International**]
   c. [**Guardian Fire Equipment, Inc**]
   d. [**JL Industries; Activar Construction Products Group, Inc.**]
   e. [**Larsen's Manufacturing Company**]
   f. [**Modern Metal Products**]
   g. [**MOON American, Inc.**]
   h. [**Nystrom, Inc.**]
   i. [**Potter Roemer LLC; a Division of Morris Group International**]
   j. [**Strike First Corporation of America**]

2. Fire-Protection Cabinet Type: Suitable for fire [**extinguisher**][**extinguisher and hose valve**][**hose, rack, valve, and extinguisher**][**hose, rack, and valve**][**-hose valve**] .

3. Cabinet Construction: [**Nonrated**][**One-hour fire rated**][**Two-hour fire rated**] .

   a. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from **0.043-inch- (1.09-mm-)** thick cold-rolled steel sheet lined with minimum **5/8-inch- (16-mm-)** thick fire-barrier material. Provide factory-drilled mounting holes.

4. Cabinet Material: [**Cold-rolled steel sheet**][**Aluminum sheet**][**Stainless steel sheet**] .

   a. Shelf: Same metal and finish as cabinet.

5. Recessed Cabinet:

   a. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box, to act as [**plaster stop**][**drywall bead**] .
   b. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
   c. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

6. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

   a. Square-Edge Trim: **1-1/4- to 1-1/2-inch (32- to 38-mm)** backbend depth.
   b. Rolled-Edge Trim: [**2-1/2-inch (64-mm)**][**4-inch (102-mm)**][**4-1/2-inch (114-mm)**] backbend depth.

7. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.
8. Cabinet Trim Material: [**Steel sheet**][**Aluminum sheet**][**Extruded-aluminum shapes**][**Stainless steel sheet**][**Copper-alloy brass sheet**][**Copper-alloy bronze sheet**][**Same material and finish as door**] .
9. Door Material: [**Steel sheet**][**Aluminum sheet**][**Extruded-aluminum shapes**][**Stainless steel sheet**][**Copper-alloy brass sheet**][**Copper-alloy bronze sheet**] .
10. Door Style: [**Fully glazed, frameless, backless, acrylic panel**][**Fully glazed panel with frame**][**Full acrylic bubble, frameless**][**Full acrylic bubble with frame**][**Full acrylic bubble with frameless, rotating turntable**][**Horizontal duo panel with frame**][**Vertical duo panel with frame**][**Center glass panel with frame**][**Solid opaque panel with frame**][**Flush opaque panel, frameless, with no exposed hinges**] .
11. Door Glazing: [**Clear float glass**][**Tempered float glass (clear)**][**Tempered float glass (bronze tint)**][**Break glass**][**Tempered break glass**][**Wire glass**][**Acrylic sheet**][**Break acrylic bubble**][**Molded acrylic bubble**] .

    a. Acrylic Sheet Color:

       1) [**Clear**][**Bronze**] transparent acrylic sheet.
       2) Clear transparent acrylic sheet painted [**white**][**red**][**black**] on unexposed side.

    b. Acrylic Bubble Color: [**Clear**][**Bronze**][**Red**] , transparent.

12. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

    a. Provide [**projecting lever handle with cam-action latch**][**projecting door pull and friction latch**][**recessed door pull and friction latch**][**manufacturer's standard**] .
    b. Provide [**continuous hinge, of same material and finish as trim,**][**concealed**

hinge,][**pivot hinge,**][**manufacturer's standard hinge,**] permitting door to open 180 degrees.

13. Accessories:

    a. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
    b. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
    c. Break-Glass Door Handle: Manufacturer's standard, integral to glass with the words "PULL TO BREAK GLASS" applied to handle.
    d. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
    e. Door Lock: [**Cam lock that allows door to be opened during emergency by pulling sharply on door handle**][**Cylinder lock, keyed alike to other cabinets**] .
    f. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate, as directed by the Owner.

        1) Identify fire extinguisher in fire-protection cabinet with the words " [**FIRE EXTINGUISHER**]."

            a) Location: Applied to [**cabinet door**][**cabinet glazing**][**location indicated on Drawings**] .
            b) Application Process: [**Silk-screened**][**Engraved**][**Etched**][**Decals**][**Pressure-sensitive vinyl letters**] .
            c) Lettering Color: [**Red**][**Black**][**White**] .
            d) Orientation: [**Vertical**][**Horizontal**][**As indicated on Drawings**] .

    g. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by [**batteries**][**low voltage, complete with transformer**] .

14. Materials:

    a. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.

        1) Finish: [**Factory primed for field painting**][**Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603**] .
        2) Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        3) Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

    b. Aluminum: **ASTM B221 (ASTM B221M)** for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.

        1) Finish: [**Clear anodic**][**Color anodic**][**Baked enamel or powder coat**] .
        2) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**] as directed by the Owner.

    c. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.

        1) Finish: [**ASTM A480/A480M No. 4 directional satin finish,**][**ASTM A480/A480M**

No. 8 mirrorlike reflective, nondirectional polish].

d. Copper Alloy, Brass: ASTM B36/B36M alloy [**as standard with manufacturer**].

1) Finish: [**Polished**][**Satin**][**As selected by Architect from full range of industry finishes**] as directed by the Owner.

e. Copper Alloy, Bronze: ASTM B36/B36M alloy [**as standard with manufacturer**].

1) Finish: [**Mirror polish**][**Satin polish**][**Satin oxidized oil rub**][**Clear baked enamel**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**] as directed by the Owner.

f. Clear Float Glass: ASTM C1036, Type I, Class 1, Quality q3, [**3**][**6**] mm thick.
g. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, [**Class 1 (clear)**][**Class 2 (tinted, heat absorbing, and light reducing), bronze tint**] .
h. Break Glass: Clear annealed float glass, ASTM C1036, Type I, Class 1, Quality q3, 1.5 mm thick, single strength.
i. Tempered Break Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.
j. Wire Glass: ASTM C1036, Type II, Class 1, Form 1, Quality q8, Mesh m1 (diamond), 6 mm thick.
k. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), [**1.5**][**3**][**6**] mm thick, with [**Finish 1 (smooth or polished)**][**Finish 2 (patterned, textured)**] .

2.4 SECURITY FIRE-PROTECTION CABINETS

A. Security Fire-Protection Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Babcock-Davis**]
b. [**Croker; a Division of Morris Group International**]
c. [**Guardian Fire Equipment, Inc**]
d. [**JL Industries; Activar Construction Products Group, Inc.**]
e. [**Larsen's Manufacturing Company**]
f. [**Nystrom, Inc.**]
g. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Security Fire-Protection Cabinet Type: Suitable for fire [**extinguisher**][**extinguisher and hose valve**][**hose, rack, valve, and extinguisher**][**hose, rack, and valve**][**hose valve**] .
3. Cabinet Construction: [**Nonrated**][**One-hour fire rated**][**Two-hour fire rated**] .

a. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls lined with minimum **5/8-inch- (16-mm-)** thick fire-barrier material.

4. Cabinet Material: [**0.068-inch- (1.72-mm-) thick steel sheet**][**0.097-inch- (2.45-mm-) thick steel sheet**][**0.078-inch- (1.98-mm-) thick stainless steel sheet**] .

a. Shelf: Same metal and finish as cabinet.

5. Recessed Cabinet:

    a. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

6. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

    a. Square-Edge Trim: **1-1/4- to 1-1/2-inch (32- to 38-mm)** backbend depth.
    b. Rolled-Edge Trim: **2-1/2-inch (64-mm)** backbend depth.

7. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.
8. Cabinet Trim Material: [**Steel sheet**][**Stainless steel sheet**][**Same material and finish as door**] .
9. Door Material: [**0.097-inch- (2.45-mm-) thick steel**][**0.078-inch- (1.98-mm-) thick stainless steel**][**0.109-inch- (2.78-mm-) thick stainless steel**] sheet.
10. Door Style: Solid opaque panel with frame.
11. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated, and as follows:

    a. Recessed door pull.
    b. Continuous Hinge: Same material and finish as trim, permitting door to open 180 degrees.
    c. Mechanical Deadlock:

        1) Lockbolt retracted and extended by five-tumbler [**paracentric**][**mogul**] cylinder; keyed one side.

            a) Lockbolt: **1-1/2 inches high by 3/4 inch (38 mm high by 19 mm)** thick; **5/8-inch (16-mm)** throw.

        2) As specified in Section 119814 "Detention Door Hardware."

    d. Mechanical Snaplatch:

        1) Automatic snaplatch when closed; latchbolt retracted by five-tumbler [**paracentric**][**mogul**] cylinder; keyed one side.

            a) Lockbolt: **1 inch high by 7/16 inch (25 mm high by 11 mm)** thick; **5/16-inch (8-mm)** throw.

        2) As specified in Section 119814 "Detention Door Hardware."

12. Accessories:

    a. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to security fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
    b. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate, as directed by the Owner.

        1) Identify fire extinguisher in security fire-protection cabinet with the words " [**FIRE EXTINGUISHER**]."

            a) Location: Applied to [**cabinet door**][**location indicated on Drawings**] .
            b) Application Process: [**Silk-screened**][**Engraved**][**Etched**][**Decals**][**Pressure-**

sensitive vinyl letters] .
c) Lettering Color: [**Red**][**Black**][**White**] .
d) Orientation: [**Vertical**][**Horizontal**][**As indicated on Drawings**] .

c. Keys: Three per door lock.

13. Materials:

a. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.

1) Finish: [**Factory primed for field painting**][**Baked enamel or powder coat**] .
2) Color: [**Match Architect's sample**][**As selected by Architect from full range of industry colors**] as directed by the Owner.

b. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.

1) Finish: [**ASTM A480/A480M No. 4 directional satin finish**][**ASTM A480/A480M No. 8 mirrorlike reflective, nondirectional polish**].

2.5 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.
4. Prepare doors and frames to receive locks.
5. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum **1/2 inch (13 mm)** thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM AMP 500for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for hose [**valves**][**racks**] and cabinets to verify actual locations of piping connections before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where [**recessed**][**and**][**semirecessed**] cabinets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for [**recessed**][**and**][**semirecessed**] fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION OF FIRE-PROTECTION CABINETS

A. General: Install fire-protection cabinets in locations and at mounting heights indicated [**or, if not indicated, at height indicated below:**][**or, if not indicated, at heights acceptable to authorities having jurisdiction.**]

1. Fire-Protection Cabinet Mounting Height: [**42 inches (1067 mm)**][**As indicated on Drawings**] above finished floor to top of fire extinguisher.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
4. Fire-Rated Cabinets:

   a. Install cabinet with not more than **1/16-inch (1.6-mm)** tolerance between pipe OD and knockout OD. Center pipe within knockout.
   b. Seal through penetrations with firestopping sealant as specified in Section 078413 "Penetration Firestopping."

C. Identification:

1. Apply [**decals**][**vinyl lettering**] at locations indicated.
2. Apply [**decals**][**vinyl lettering**] on field-painted fire-protection cabinets after painting is complete.

3.4 ADJUSTING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices

operate properly.

3.5 CLEANING

A. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

B. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

C. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13 00

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SECTION 10 44 16 00 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, [**hand-carried**][**wheeled**] fire extinguishers[**and mounting brackets for fire extinguishers**].

B. the Owner-Furnished Material: [**Hand-carried**][**Wheeled**] fire extinguishers.

C. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."
2. Section 233813 "Commercial-Kitchen Hoods" for fire-extinguishing systems provided as part of commercial-kitchen exhaust hoods.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher[**and mounting brackets**].

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: [**Six**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each [**fire-protection cabinet**][**and**][**mounting bracket**] indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerex Corporation**]
b. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
c. [**Babcock-Davis**]
d. [**Badger Fire Protection; a Carrier company**]
e. [**Buckeye Fire Equipment Company**]
f. [**Croker; a Division of Morris Group International**]
g. [**Guardian Fire Equipment, Inc**]
h. [**JL Industries; Activar Construction Products Group, Inc.**]
i. [**Kidde; Carrier Global Corporation**]
j. [**Larsen's Manufacturing Company**]
k. [**MOON American, Inc.**]
l. [**Nystrom, Inc.**]
m. [**Potter Roemer LLC; a Division of Morris Group International**]
n. [**Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America**]

o. [**Strike First Corporation of America**]

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: [**Manufacturer's standard**][**Nickel-plated, polished-brass body**].
4. Handles and Levers: [**Manufacturer's standard**][**Stainless steel**].
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B[and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging].

B. Stored-Pressure Water Type : UL-rated 2-A, **2.5-gal. (9.5-L)** nominal capacity, with water in stainless steel container; with pressure-indicating gage.

C. Stored-Pressure Antifreeze Water Type : UL-rated 2-A, **2.5-gal. (9.5-L)** nominal capacity, with water and approved antifreeze solution mixed for temperatures as low as **minus 40 deg F (minus 40 deg C)** in stainless steel container; with pressure-indicating gage.

D. Stored-Pressure Water-Mist Type : UL-rated 2-A:C, **2.5-gal. (9.5-L)** nominal capacity, with water in enameled-steel container; with pressure-indicating gage.

E. Pressurized, AFFF-Foam Type : UL-rated [**2-A:10-B, 1.6-gal. (6-L)**][**3-A:20-B, 2.5-gal. (9.5-L)**] nominal capacity, with AFFF foam in stainless steel container; with pressure-indicating gage.

F. Pressurized, FFFP-Foam Type : UL-rated 3-A:20-B, **2.5-gal. (9.5-L)** nominal capacity, with FFFP foam in stainless steel container; with pressure-indicating gage.

G. Wet-Chemical Type : UL-rated 2-A:1-B:C:K, [**1.6-gal. (6-L)**][**2.5-gal. (9.5-L)**] nominal capacity, with potassium [**acetate**][**citrate**][**carbonate**]-based chemical in stainless steel container; with pressure-indicating gage.

H. Regular Dry-Chemical Type in Steel Container : UL-rated [**2-B:C, 1-lb (0.4-kg)**][**10-B:C, 2.5-lb (1.1-kg)**][**10-B:C, 5-lb (2.3-kg)**][**40-B:C, 5.5-lb (2.5-kg)**][**40-B:C, 6-lb (2.7-kg)**][**60-B:C, 10-lb (4.5-kg)**][**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in enameled-steel container.

I. Regular Dry-Chemical Type in Aluminum Container : UL-rated [**2-B:C, 1-lb (0.4-kg)**][**10-B:C, 2.5-lb (1.1-kg)**][**10-B:C, 5-lb (2.3-kg)**][**40-B:C, 5.5-lb (2.5-kg)**][**60-B:C, 10-lb (4.5-kg)**][**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in enameled-aluminum container.

J. Regular Dry-Chemical Type in Brass Container : UL-rated [**40-B:C, 6-lb (2.7-kg)**][**60-B:C, 10-lb (4.5-kg)**][**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in chrome-plated-brass container.

K. Multipurpose Dry-Chemical Type in Steel Container : UL-rated [**1-A:10-B:C, 2.5-lb (1.1-kg)**][**2-A:10-B:C, 5-lb (2.3-kg)**][**3-A:40-B:C, 5-lb (2.3-kg)**][**3-A:40-B:C, 6-lb (2.7-kg)**][**4-A:60-B:C, 10-lb (4.5-kg)**][**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

L. Multipurpose Dry-Chemical Type in Aluminum Container : UL-rated [**1-A:10-B:C, 2.5-lb (1.1-kg)**][**2-A:10-B:C, 5-lb (2.3-kg)**][**3-A:40-B:C, 5-lb (2.3-kg)**][**3-A:40-B:C, 6-lb (2.7-kg)**][**4-A:60-B:C, 10-lb (4.5-kg)**][**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

M. Multipurpose Dry-Chemical Type in Brass Container : UL-rated [**2-A:10-B:C, 5-lb (2.3-kg)**][**3-A:40-B:C, 6-lb (2.7-kg)**][**4-A:60-B:C, 10-lb (4.5-kg)**][**4-A:80-B:C, 10-lb (4.5-kg)**][**10-A:120-B:C, 20-lb (9.1-kg)**] nominal capacity, with monoammonium phosphate-based dry chemical in chrome-plated-brass container.

N. Purple-K Dry-Chemical Type in Aluminum Container : UL-rated [**10-B:C, 2.5-lb (1.1-kg)**][**30-B:C, 5-lb (2.3-kg)**][**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in enameled-aluminum container.

O. Purple-K Dry-Chemical Type in Brass Container : UL-rated [**80-B:C, 10-lb (4.5-kg)**][**120-B:C, 20-lb (9.1-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in chrome-plated-brass container.

P. Carbon Dioxide Type : UL-rated [**5-B:C, 5-lb (2.3-kg)**][**10-B:C, 10-lb (4.5-kg)**][**10-B:C, 15-lb (6.8-kg)**][**10-B:C, 20-lb (9.1-kg)**] nominal capacity, with carbon dioxide in [**manufacturer's standard enameled-metal**][**enameled-steel**][**enameled-aluminum**] container.

Q. Dry-Powder Type : [**FM approved,**]UL-rated Class D, **30-lb (13.6-kg)** nominal capacity, with [**sodium chloride**][**copper**]-based powder in enameled-steel container; with pressure-indicating gage.

R. Halon Type : [**5-B:C, 2.5-lb (1.1-kg)**][**10-B:C, 5-lb (2.3-kg)**] nominal capacity, in enameled-steel container; with pressure-indicating gage.

1. UL-rated.

S. Clean-Agent Type in Aluminum Container : UL-rated [**1-B:C, 1.4-lb (0.6-kg)**][**2-B:C, 2.5-lb (1.1-kg)**][**5-B:C, 5-lb (2.3-kg)**] nominal capacity, with HCFC Blend B agent and inert material in enameled-aluminum container; with pressure-indicating gage.

T. Clean-Agent Type in Brass Container : UL-rated [**1-A:10-B:C, 11-lb (5-kg)**][**2-A:10-B:C, 15.5-lb (7-kg)**] nominal capacity, with HCFC Blend B agent and inert material in chrome-plated-brass container; with pressure-indicating gage.

U. Clean-Agent Type in Steel Container : UL-rated [**5-B:C, 4.75-lb (2.2-kg)**][**1-A:10-B:C, 10-lb (4.5-kg)**][**2-A:10-B:C, 14-lb (6.4-kg)**] nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard[**galvanized**] steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or [**red**][**black**] baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerex Corporation**]
b. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
c. [**Babcock-Davis**]
d. [**Badger Fire Protection; a Carrier company**]
e. [**Buckeye Fire Equipment Company**]
f. [**Croker; a Division of Morris Group International**]
g. [**Guardian Fire Equipment, Inc**]
h. [**JL Industries; Activar Construction Products Group, Inc.**]
i. [**Kidde; Carrier Global Corporation**]
j. [**Larsen's Manufacturing Company**]

k. [**Nystrom, Inc.**]
l. [**Potter Roemer LLC; a Division of Morris Group International**]
m. [**Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America**]
n. [**Strike First Corporation of America**]

2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect, as directed by the Owner.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: [**Vertical**][**Horizontal**].

2.4 WHEELED FIRE EXTINGUISHERS

A. Wheeled Fire Extinguishers: Type, size, and capacity for locations indicated, complete with carriage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerex Corporation**]
b. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
c. [**Badger Fire Protection; a Carrier company**]
d. [**Buckeye Fire Equipment Company**]
e. [**Croker; a Division of Morris Group International**]
f. [**Guardian Fire Equipment, Inc**]
g. [**JL Industries; Activar Construction Products Group, Inc.**]
h. [**Potter Roemer LLC; a Division of Morris Group International**]
i. [**Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America**]

B. Source Limitations: Obtain wheeled fire extinguishers and fire extinguishers from single source from single manufacturer.

1. Carriage: Fabricated from enameled-steel pipe, complete with hanger assembly, long-range nozzle, hose, and [**semipneumatic solid-rubber tires**][**wide-rim wheels**].

a. Hose: [**15 feet (4.6 m)**][**50 feet (15.2 m)**][**100 feet (30.5 m)**].

C. Pressurized, FFFP-Foam Type: UL-rated 20-A:160-B, **33-gal. (125-L)** nominal capacity, with FFFP foam in stainless steel container.

D. Regular Dry-Chemical Type: UL-rated [**160-B:C, 50-lb (23-kg)**][**240-B:C, 150-lb (68-kg)**][**160-B:C, 250-lb (113-kg)**] nominal capacity, with sodium bicarbonate-based dry chemical in [**regulated**][**stored**][**direct**]-pressure, enameled-steel container.

E. Multipurpose Dry-Chemical Type: UL-rated [**20-A:160-B:C, 30-lb (13.6-kg)**][**30-A:160-B:C, 50-lb (23-kg)**][**40-A:240-B:C, 125-lb (57-kg)**][**40-A:160-B:C, 250-lb (113-kg)**] nominal capacity, with

monoammonium phosphate-based dry chemical in [**regulated**][**stored**][**direct**]-pressure, enameled-[**steel**][**aluminum**][**steel or -aluminum**] container.

F. Purple-K Dry-Chemical Type: UL-rated [**160-B:C, 50-lb (23-kg)**][**320-B:C, 125-lb (57-kg)**][**160-B:C, 250-lb (113-kg)**] nominal capacity, with potassium bicarbonate-based dry chemical in [**regulated**][**stored**][**direct**]-pressure, enameled-steel container.

G. Carbon Dioxide Type: UL-rated [**20-B:C, 50-lb (23-kg)**][**20-B:C, 100-lb (45-kg)**] nominal capacity, with carbon dioxide in [**manufacturer's standard enameled-metal**][**enameled-steel**][**enameled-aluminum**] container.

H. Dry-Powder Type: [**FM approved,**]UL-rated Class D, [**sodium chloride-based powder, 150-lb (68-kg)**][**copper-based powder, 250-lb (113-kg)**] nominal capacity, in regulated-pressure, enameled-steel container; with pressure-indicating gage.

I. Clean-Agent Type: UL-rated [**4-A:40-B:C, 65-lb (29-kg)**][**10-A:80-B:C, 150-lb (68-kg)**] nominal capacity, with HCFC Blend B agent and inert material in stored-pressure, enameled-steel container; with pressure-indicating gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers[**and mounting brackets**] in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

1. Mounting Height: Top of fire extinguisher to be at [**42 inches (1067 mm)**] above finished floor.

END OF SECTION 10 44 16 00

Task	Specification	Specification Description
10 44 16 13	01 22 00 00	No Specification Required
10 44 16 13	10 44 13 00	Fire Protection Cabinets
10 44 16 13	10 44 16 00	Fire Extinguishers

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SECTION 10 51 13 00 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Knocked-down corridor lockers.
2. Welded corridor lockers.
3. Knocked-down athletic lockers.
4. Welded athletic lockers.
5. Knocked-down, open-front athletic lockers.
6. Welded, open-front athletic lockers.
7. Locker benches.

B. Related Requirements:

1. Section 105113.13 "Coin-Operated Metal Lockers" for coin-operated lockers used in public facilities for temporary storage of personal belongings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker[**and bench**].

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
11. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
12. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

13. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
14. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For metal lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show locker trim and accessories.
3. Include locker identification system and numbering sequence.

D. Samples: For each color specified, in manufacturer's standard size.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

F. Samples for Verification: For the following products, in manufacturer's standard size:

1. Lockers and equipment.
2. Locker benches.

G. Product Schedule: For lockers.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. The following metal locker hardware items equal to [**10**] percent of amount installed for each type and finish installed, but no fewer than [**five**] units:

a. Locks.
b. Blank identification plates.
c. Hooks.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver [master and control keys][combination control charts] to the Owner by registered mail or

overnight package service[.][addressed as follows:]

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate sizes and locations of [**concrete**][**concrete masonry**][**wood**] bases for metal lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for Knocked-Down Metal Lockers: [**Two**] years from date of Substantial Completion.
4. Warranty Period for Welded Metal Lockers: [**Lifetime**][**10 years**] from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal lockers[locker benches,] and accessories from single source from single locker manufacturer.

1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers[**and locker benches**] indicated to be accessible, comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**]

2.3 KNOCKED-DOWN CORRIDOR LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**GSS Lockers**]
4. [**Hadrian Inc.; Zurn Industries, LLC**]
5. [**List Industries Inc.**]
6. [**LockersMFG**]
7. [**Lyon LLC**]
8. [**Olympus Lockers & Storage Products, Inc.**]
9. [**Penco Products, Inc.**]
10. [**Republic Storage Systems, LLC**]
11. [**Top Tier Storage Products**]
12. [**WEC Manufacturing LLC**]

B. Doors: One piece; fabricated from [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Doors less than **12 inches (305 mm)** wide may be fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.
2. Doors for box lockers less than **15 inches (381 mm)** wide may be fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.
3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than **15 inches (381 mm)** wide; welded to inner face of doors.
4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet; welded to inner face of doors.
5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
6. Door Style: [**Unperforated panel.**][**Vented panel as follows:**]

   a. Louvered Vents: No fewer than [**six louver openings at top and bottom for single-tier**][**three louver openings at top and bottom for double-tier**][**two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier**] lockers.
   b. Security Vents: Manufacturer's standard, stamped horizontal or vertical.
   c. Perforated Vents: [**Manufacturer's standard shape and configuration**].
   d. Concealed Vents: Slotted perforations in top and bottom horizontal door return flanges.

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Intermediate Dividers: **0.024-inch (0.61-mm)** nominal thickness, with single bend at sides.
2. Backs and Sides: **0.024-inch (0.61-mm)** nominal thickness, with full-height, double-flanged connections.
3. Shelves: **0.024-inch (0.61-mm)** nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main

frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
2. Frame Vents: Fabricate face frames with vents.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[self-closing].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum **2 inches (51 mm)** high. Provide no fewer than three hinges for each door more than **42 inches (1067 mm)** high.
2. Continuous Hinges: Manufacturer's standard, steel, full height.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.

1. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.105-inch (2.66-mm)** nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.

   a. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.105-inch (2.66-mm)** nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
   b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**][**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

   a. Latch Hook: Equip each door with one latch hook, fabricated from **0.105-inch (2.66-mm)** nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

H. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

I. Door Handle and Latch for 16-Person Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

J. Locks: [**Combination padlocks**][**Built-in combination locks**][**Cylinder locks**][**Built-in, card-operated locks**][**Digital keypad locks**][**Built-in, coin-operated locks**].

K. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

L. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

M. Coat Rods: [**1-inch- (25-mm-) diameter steel tube or rod, chrome finished**][**1-inch- (25-mm-) diameter steel tube or rod, nickel plated**][**3/4-inch- (19-mm-) diameter steel tube or rod, chrome finished**][**3/4-inch- (19-mm-) diameter steel tube or rod, nickel plated**][**Manufacturer's standard**].

N. Legs: [**6 inches (152 mm)**] high; formed by extending vertical frame members, or fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from **0.036-inch (0.91-mm)** nominal-thickness steel sheet.

O. Continuous Zee Base: Fabricated from [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**][**manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

1. Height: [**4 inches (102 mm)**].

P. Continuous Sloping Tops: Fabricated from [**0.036-inch (0.91-mm)**][**0.048-inch (1.21-mm)**][**manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm)**] nominal-thickness steel sheet.

1. Closures: [**Vertical**][**Hipped**]-end type.
2. Sloping-top corner fillers, mitered.

Q. Individual Sloping Tops: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet.

R. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Filler Panels: Fabricated from [**0.036-inch (0.91-mm)**][**0.048-inch (1.21-mm)**][**manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm)**] nominal-thickness steel sheet.

T. Boxed End Panels: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

U. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

V. Center Dividers: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet.

W. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.

X. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 WELDED CORRIDOR LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**DEBOURGH ALL-AMERICAN LOCKERS**]
4. [**GSS Lockers**]
5. [**List Industries Inc.**]
6. [**LockersMFG**]
7. [**Lyon LLC**]
8. [**Olympus Lockers & Storage Products, Inc.**]
9. [**Penco Products, Inc.**]
10. [**Republic Storage Systems, LLC**]
11. [**Top Tier Storage Products**]
12. [**WEC Manufacturing LLC**]

B. Doors: One piece; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than **15 inches (381 mm)** wide; welded to inner face of doors.
2. Door Style: [**Unperforated panel.**][**Vented panel as follows:**]

   a. Louvered Vents: No fewer than [**six louver openings at top and bottom for single-tier**][**three louver openings at top and bottom for double-tier**][**two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier**] lockers.
   b. Security Vents: Manufacturer's standard, stamped horizontal or vertical.
   c. Perforated Vents: [**Manufacturer's standard shape and configuration**].

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Sides: **0.060-inch (1.52-mm)** nominal thickness.
2. Backs: **0.048-inch (1.21-mm)** nominal thickness.
3. Shelves: **0.060-inch (1.52-mm)** nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[self-closing].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum **2 inches (51 mm)** high. Provide no fewer than three hinges for each door more than **42 inches (1067 mm)** high.
2. Continuous Hinges: Manufacturer's standard, steel, full height.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.

1. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.105-inch (2.66-mm)** nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and prelocking.

   a. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
   b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**][**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

   a. Latch Hook: Equip each door with one latch hook, fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

H. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

I. Door Handle and Latch for 16-Person Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

J. Locks: [**Combination padlocks**][**Built-in combination locks**][**Cylinder locks**][**Built-in, card-operated locks**][**Digital keypad locks**][**Built-in, coin-operated locks**].

K. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

L. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

M. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**][**1-inch- (25-mm-) diameter steel,**

nickel plated][**3/4-inch- (19-mm-) diameter steel, chrome finished**][**3/4-inch- (19-mm-) diameter steel, nickel plated**][**Manufacturer's standard**].

N. Legs: [**6 inches (152 mm)**] high; formed by extending vertical frame members, or fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from **0.036-inch (0.91-mm)** nominal-thickness steel sheet.

O. Continuous Zee Base: Fabricated from, [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**][**manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

1. Height: [**4 inches (102 mm)**].

P. Continuous Sloping Tops: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**][**Hipped**]-end type.

Q. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

R. Filler Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Boxed End Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

T. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

U. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.

V. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 KNOCKED-DOWN ATHLETIC LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**GSS Lockers**]
4. [**Hadrian Inc.; Zurn Industries, LLC**]

5. [**List Industries Inc.**]
6. [**LockersMFG**]
7. [**Lyon LLC**]
8. [**Olympus Lockers & Storage Products, Inc.**]
9. [**Penco Products, Inc.**]
10. [**Republic Storage Systems, LLC**]
11. [**Top Tier Storage Products**]
12. [**WEC Manufacturing LLC**]

B. Perforated Doors: One piece; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet with manufacturer's standard diamond perforations; formed into channel shape with double bend at [**vertical edges and with right-angle single bend at horizontal edges**][**and**][**latch point (bottom) and right-angle single bend at remaining edges for box lockers**].

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than **15 inches (381 mm)** wide; welded to inner face of doors.

C. Expanded-Metal Doors: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angle frame; with **0.090-inch (2.28-mm)** nominal-thickness, steel sheet lock panel backed by **0.060-inch (1.52-mm)** nominal-thickness, steel sheet retainer welded to door frame.

D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: **0.060-inch (1.52-mm)** nominal thickness, with single bend at edges.
2. Backs: **0.048-inch (1.21-mm)** nominal thickness.
3. Shelves: **0.060-inch (1.52-mm)** nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from [**0.048-inch (1.21-mm)**][**0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet with manufacturer's standard diamond perforations.

G. Expanded-Metal Sides: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angles or **0.060-inch (1.52-mm)** nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet or **0.097-inch (2.45-mm)** nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames for Double-Tier Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
2. Cross Frames for Triple-Tier Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180

degrees[self-closing].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum **2 inches (51 mm)** high. Provide no fewer than three hinges for each door more than **42 inches (1067 mm)** high.
2. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

K. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic latching and prelocking.

   a. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
   b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**][**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

   a. Latch Hook: Equip each door with one latch hook, fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

L. Projecting Turn-Handle and Latch: Steel handle welded to manufacturer's standard, three-point, cremone-type latching mechanism consisting of steel rods or bars that engage locker frame at top and bottom of door, and center latch that engages strike jamb; with steel padlock loop.

M. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

N. Locks: [**Combination padlocks**][**Built-in combination locks**][**Cylinder locks**][**Built-in, card-operated locks**][**Digital keypad locks**][**Built-in, coin-operated locks**].

O. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

P. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

Q. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**][**1-inch- (25-mm-) diameter steel, nickel plated**][**3/4-inch- (19-mm-) diameter steel, chrome finished**][**3/4-inch- (19-mm-) diameter steel, nickel plated**][**Manufacturer's standard**].

R. Legs: [**6 inches (152 mm)**] high; formed by extending vertical frame members, or fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to bottom of locker.

1. Closed Front and End Bases: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Continuous Zee Base: **4 inches (102 mm)** high; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet.

T. Continuous Sloping Tops: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**][**Hipped**]-end type.

U. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

V. Filler Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

W. Boxed End Panels: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

X. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

Y. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), **3/4-inch (19-mm)** steel mesh, with at least 70 percent open area.

Z. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 WELDED ATHLETIC LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**DEBOURGH ALL-AMERICAN LOCKERS**]
4. [**GSS Lockers**]
5. [**List Industries Inc.**]
6. [**LockersMFG**]
7. [**Lyon LLC**]
8. [**Olympus Lockers & Storage Products, Inc.**]
9. [**Penco Products, Inc.**]
10. [**Republic Storage Systems, LLC**]
11. [**Top Tier Storage Products**]
12. [**WEC Manufacturing LLC**]

B. Perforated Doors: One piece; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet with

manufacturer's standard diamond perforations; formed into channel shape with double bend at [**vertical edges and with right-angle single bend at horizontal edges**][**and**][**latch point (bottom) and right-angle single bend at remaining edges for box lockers**].

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than **15 inches (381 mm)** wide; welded to inner face of doors.

C. Expanded-Metal Doors: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angle frame; with **0.090-inch (2.28-mm)** nominal-thickness, steel sheet lock panel backed by **0.060-inch (1.52-mm)** nominal-thickness, steel sheet retainer welded to door frame.

D. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: **0.060-inch (1.52-mm)** nominal thickness, with single bend at edges.
2. Backs: **0.048-inch (1.21-mm)** nominal thickness.
3. Shelves: **0.060-inch (1.52-mm)** nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from [**0.048-inch (1.21-mm)**][**0.060-inch (1.52-mm)**] nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet with manufacturer's standard diamond perforations.

G. Expanded-Metal Sides: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angles or **0.060-inch (1.52-mm)** nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet or **0.097-inch (2.45-mm)** nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames for Double-Tier Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
2. Cross Frames for Triple-Tier Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**] nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees[self-closing].

1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum **2 inches (51 mm)** high. Provide no fewer than three hinges for each door more than **42 inches (1067 mm)** high.
2. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

K. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic latching and prelocking.

    a. Latch Hooks: Equip doors **48 inches (1219 mm)** and higher with three latch hooks and doors less than **48 inches (1219 mm)** high with two latch hooks; fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
    b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

2. Single-Point Latching: Nonmoving latch hook [**designed to engage bolt of built-in combination or cylinder lock**][**with steel padlock loop that projects through recessed cup and is finished to match metal locker body**].

    a. Latch Hook: Equip each door with one latch hook, fabricated from **0.120-inch (3.04-mm)** nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.

L. Projecting Turn-Handle and Latch: Steel handle welded to manufacturer's standard, three-point, cremone-type latching mechanism consisting of steel rods or bars that engage locker frame at top and bottom of door, and center latch that engages strike jamb; with steel padlock loop.

M. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

N. Locks: [**Combination padlocks**][**Built-in combination locks**][**Cylinder locks**][**Built-in, card-operated locks**][**Digital keypad locks**][**Built-in, coin-operated locks**].

O. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

P. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

Q. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**][**1-inch- (25-mm-) diameter steel, nickel plated**][**3/4-inch- (19-mm-) diameter steel, chrome finished**][**3/4-inch- (19-mm-) diameter steel, nickel plated**][**Manufacturer's standard**].

R. Legs: [**6 inches (152 mm)**] high; formed by extending vertical frame members, or fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to bottom of locker.

    1. Closed Front and End Bases: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Continuous Zee Base: **4 inches (102 mm)** high; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet.

T. Continuous Sloping Tops: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

    1. Closures: [**Vertical**][**Hipped**]-end type.

U. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

V. Filler Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

W. Boxed End Panels: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

X. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

Y. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), **3/4-inch (19-mm)** steel mesh, with at least 70 percent open area.

Z. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**Two colors, with door one color and frame and body another color; as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.7 KNOCKED-DOWN, OPEN-FRONT ATHLETIC LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**Hadrian Inc.; Zurn Industries, LLC**]
4. [**List Industries Inc.**]
5. [**LockersMFG**]
6. [**Lyon LLC**]
7. [**Olympus Lockers & Storage Products, Inc.**]
8. [**Penco Products, Inc.**]
9. [**Republic Storage Systems, LLC**]
10. [**Top Tier Storage Products**]
11. [**WEC Manufacturing LLC**]

B. Locker Arrangement: Open front, with [**seat/shelf**][**seat/footlocker**][**upper shelf**][**upper shelf with security box**][**and**][**full-width security compartment**][**configuration as indicated on Drawings**].

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: **0.060-inch (1.52-mm)** nominal thickness, with single bend at edges.
2. Backs: **0.048-inch (1.21-mm)** nominal thickness.
3. Shelves: **0.060-inch (1.52-mm)** nominal thickness, with double bend at front and single bend at sides and back.

D. Unperforated Sides: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

E. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations. Perforations not to occur [above upper shelf][at security compartment][at seat/footlocker].

F. Expanded-Metal Sides: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angles or **0.060-inch (1.52-mm)** nominal-thickness steel channel frames.

G. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet or **0.105-inch (2.66-mm)** nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames.

H. Reinforced Bottoms: Structural channels, formed from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to front and rear of side-panel frames.

I. Seats/Shelves: Full width of metal locker; channel formed; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; with stiffeners for reinforcement.

J. Seats/Footlockers: Enclosure full width of bottom of metal locker; fabricated from cold-rolled steel sheet.

1. Seat/Lid: **0.075-inch (1.90-mm)** nominal-thickness steel sheet; channel formed and reinforced with stiffeners; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when seat/lid is closed; with padlock hasp.
2. Front Panel: **0.075-inch (1.90-mm)** nominal-thickness steel sheet; channel formed at top edge; with minilouvers for ventilation; recessed for padlock loop.
3. Sides: [**Integral part of unperforated**][**Unperforated bottom portions of perforated**][**0.060-inch (1.52-mm) nominal-thickness steel sheet inside expanded-metal**] sides.

K. Security Boxes: Nonperforated, consisting of partition extending from upper shelf to top of metal locker, fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet; with channel-formed, **0.060-inch (1.52-mm)** nominal-thickness, steel sheet door frame, and door fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet with right-angle single bend at edges; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Single-Point Latching: Stainless steel strike plate with integral pull; with steel, nonmoving latch hook [**designed to engage bolt of lock**][**with steel padlock loop that projects through door and is finished to match metal locker body**].
2. Locks: [**Combination padlocks**][**Built-in combination locks**].

L. Security Compartments: Nonperforated, running full width of metal locker, with door fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet.

1. Locks: [**Combination padlocks**][**Built-in combination locks**].

M. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

N. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

O. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**][**1-inch- (25-mm-) diameter steel, nickel plated**][**3/4-inch- (19-mm-) diameter steel, chrome finished**][**3/4-inch- (19-mm-) diameter steel, nickel plated**][**Manufacturer's standard**].

P. Continuous Sloping Tops: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet, with a

pitch of approximately 20 degrees.

1. Closures: [**Vertical**][**Hipped**]-end type.

Q. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

R. Filler Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Boxed End Panels: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

T. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

U. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), **3/4-inch (19-mm)** steel mesh, with at least 70 percent open area.

V. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.8 WELDED, OPEN-FRONT ATHLETIC LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**DEBOURGH ALL-AMERICAN LOCKERS**]
4. [**List Industries Inc.**]
5. [**LockersMFG**]
6. [**Lyon LLC**]
7. [**Olympus Lockers & Storage Products, Inc.**]
8. [**Penco Products, Inc.**]
9. [**Republic Storage Systems, LLC**]
10. [**Top Tier Storage Products**]
11. [**WEC Manufacturing LLC**]

B. Locker Arrangement: Open front, with [**seat/shelf**][**seat/footlocker**][**upper shelf**][**upper shelf with security box**][**and**][**full-width security compartment**][**configuration as indicated on Drawings**].

C. Material: [**Cold-rolled**][**Metallic-coated**] steel sheet.

D. Body: Assembled by [welding][riveting or bolting] body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops and Bottoms: **0.060-inch (1.52-mm)** nominal thickness, with single bend at edges.
2. Backs: **0.048-inch (1.21-mm)** nominal thickness.
3. Shelves: **0.060-inch (1.52-mm)** nominal thickness, with double bend at front and single bend at sides and back.

E. Unperforated Sides: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

F. Perforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations. Perforations not to occur [above upper shelf][at security compartment][at seat/footlocker].

G. Expanded-Metal Sides: Fabricated from **0.090-inch (2.28-mm)** nominal-thickness expanded metal; welded to **0.105-inch (2.66-mm)** nominal-thickness steel angles or **0.060-inch (1.52-mm)** nominal-thickness steel channel frames.

H. Frames: Channel formed; fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet or **0.105-inch (2.66-mm)** nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames.

I. Reinforced Bottoms: Structural channels, formed from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; welded to front and rear of side-panel frames.

J. Seats/Shelves: Full width of metal locker; channel formed; fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet; with stiffeners for reinforcement.

K. Seats/Footlockers: Enclosure full width of bottom of metal locker; fabricated from cold-rolled steel sheet.

1. Seat/Lid: **0.075-inch (1.90-mm)** nominal-thickness steel sheet; channel formed and reinforced with stiffeners; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when seat/lid is closed; with padlock hasp.
2. Front Panel: **0.075-inch (1.90-mm)** nominal-thickness steel sheet; channel formed at top edge; with minilouvers for ventilation; recessed for padlock loop.
3. Sides: [**Integral part of unperforated**][**Unperforated bottom portions of perforated**][**0.060-inch (1.52-mm) nominal-thickness steel sheet inside expanded-metal**] sides.

L. Security Boxes: Nonperforated, consisting of partition extending from upper shelf to top of metal locker, fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet; with channel-formed, **0.060-inch (1.52-mm)** nominal-thickness, steel sheet door frame, and door fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet with right-angle single bend at edges; with manufacturer's standard, steel continuous hinge that is completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Single-Point Latching: Stainless steel strike plate with integral pull; with steel, nonmoving latch hook [**designed to engage bolt of lock**][**with steel padlock loop that projects through door and is finished to match metal locker body**].
2. Locks: [**Combination padlocks**][**Built-in combination locks**].

M. Security Compartments: Nonperforated, running full width of metal locker, with door fabricated from **0.075-inch (1.90-mm)** nominal-thickness steel sheet.

1. Locks: [**Combination padlocks**][**Built-in combination locks**].

N. Identification Plates: Manufacturer's standard, etched, embossed, or stamped [**aluminum**][**plastic**] plates, with numbers and letters at least **3/8 inch (9 mm)** high.

O. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

P. Coat Rods: [**1-inch- (25-mm-) diameter steel, chrome finished**][**1-inch- (25-mm-) diameter steel, nickel plated**][**3/4-inch- (19-mm-) diameter steel, chrome finished**][**3/4-inch- (19-mm-) diameter steel, nickel plated**][**Manufacturer's standard**].

Q. Continuous Sloping Tops: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: [**Vertical**][**Hipped**]-end type.

R. Recess Trim: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

S. Filler Panels: Fabricated from **0.048-inch (1.21-mm)** nominal-thickness steel sheet.

T. Boxed End Panels: Fabricated from **0.060-inch (1.52-mm)** nominal-thickness steel sheet.

U. Finished End Panels: Fabricated from **0.024-inch (0.61-mm)** nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

V. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with **A60 (ZF180)** zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F1267, Type II (flattened), Class I (uncoated), **3/4-inch (19-mm)** steel mesh, with at least 70 percent open area.

W. Finish: Baked enamel or powder coat.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 LOCKS

A. Combination Padlock: [**Key-controlled, three-number dialing combination locks; capable of five combination changes**][**Provided by the Owner**].

B. Built-in Combination Lock: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.

1. Bolt Operation: [Manually locking deadbolt][automatically locking spring bolt].

C. Cylinder Lock: Built-in, flush, cam lock with five-pin tumbler keyway, keyed separately and master keyed. Furnish two change keys for each lock and [**two**] master keys.

1. Key Type: [Flat][Grooved][with minimum 2- by 2.68-inch (51- by 68.3-mm) key head for accessible lockers].
2. Bolt Operation: [Manually locking deadbolt][automatically locking spring bolt].

D. Built-in, Card-Operated Lock: Self-contained units mounted on interior of door with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one

change card key for each lock and one master card key.

1. Bolt Operation: [Manually locking deadbolt][automatically locking spring bolt].

E. Digital Keypad Lock: Battery-powered electronic keypad with reprogrammable manager and the Owner codes that override access. Three consecutive incorrect code entries will disable lock for three minutes.

1. Designed for permanently assigned access via entry of user's four-digit code.
2. Designed for shared or temporary access by multiple users, with user-defined code to lock and unlock. Provide LED indicator to show when lock is in use.

F. Built-in, Coin-Operated Lock: Self-contained units mounted on interior of door with replaceable lock cylinders keyed separately and master keyed. Mount instruction decals on both door faces. Furnish one change key for each lock and one master key.

1. Bolt Operation: [Manually locking deadbolt][automatically locking spring bolt].
2. Lock Type: Fee [**return/deposit**][**collect/pay**].
3. Fee Type: [**Token**][**Coin, one quarter**][**Coin, two quarters**].
4. Coin Box: Manufacturer's standard housing or stainless steel cash box with stainless steel flanged cover set into base of lock channel frame. Furnish with removable cylinder and key, and master code changer key.

2.10 LOCKER BENCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Art Metal Products**]
2. [**ASI Storage Solutions**]
3. [**Hadrian Inc.; Zurn Industries, LLC**]
4. [**List Industries Inc.**]
5. [**Lyon LLC**]
6. [**Penco Products, Inc.**]
7. [**Top Tier Storage Products**]

B. Provide bench units with overall assembly height of [**17-1/2 inches (445 mm)**].

C. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.

1. Size: Minimum **9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick)**[**except provide 20- to 24-inch- (508- to 610-mm-) wide tops where accessible benches are indicated**].
2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
3. Plastic laminate over particleboard core, with two steel tubes running full length of top and positioned to receive pedestal fasteners.

   a. Color: [**Match metal lockers**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Extruded aluminum with clear anodic finish.

D. Fixed-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:

1. Tubular Steel:

   a. **1-1/2-inch- (38-mm-)** diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.
   b. **1-1/4-inch- (32-mm-)** diameter steel tubing, with **0.1265-inch- (3.2-mm-)** thick steel flanges welded at top and base; with [**baked-enamel**][**zinc-plated**] finish; anchored with exposed fasteners.
   c. Color: [**Match metal lockers**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Movable-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top, complete with fasteners, and as follows:

1. Aluminum: **1/8-inch-thick by 3-inch-wide (3-mm-thick by 76-mm-wide)** channel or **1/4-inch-thick by 3-inch-wide (6-mm-thick by 76-mm-wide)** bar stock, shaped into [**trapezoidal**][**inverted-T**] form; with nonskid pads at bottom.

   a. Finish: [**Clear**][**Black**][**Gold**] anodic finish.

2. Stainless Steel: **1/8-inch-thick by 3-inch-wide (3-mm-thick by 76-mm-wide)** channel or **1/4-inch-thick by 3-inch-wide (6-mm-thick by 76-mm-wide)** bar stock, shaped into trapezoidal form; with nonskid pads at bottom.

   a. Finish: [**Manufacturer's standard**][**No. 4B**].

F. Materials:

1. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 304.
2. Plastic Laminate: ISO 4586-3, Grade HGP.
3. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
4. Steel Tube: ASTM A500/A500M, cold rolled.
5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
8. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

9. Composite Wood Products: Products shall be made without urea formaldehyde.
10. Particleboard: ANSI A208.1, Grade M-2.

2.11 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Equipment: Provide each locker with an identification plate and the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
3. Triple-Tier Units: One double-prong ceiling hook.
4. Coat Rods: [**As indicated on Drawings**][**For each compartment of each locker**][**In lieu of ceiling hook for metal lockers 24 inches (610 mm) high or more**][**In lieu of ceiling hook for metal lockers 18 inches (457 mm) deep or more**].
5. Open-Front Athletic Lockers: Two single-prong wall hooks bolted to locker back and coat rod.

D. Knocked-Down Construction: Fabricate metal lockers by [**assembling at Project site**][**preassembling at plant prior to shipping**], using manufacturer's nuts, bolts, screws, or rivets.

E. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

F. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than **15 inches (381 mm)** above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than **48 inches (1219 mm)** above the floor.

G. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

H. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

1. Sloping-top corner fillers, mitered.

I. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.

J. Recess Trim: Fabricated with minimum **2-1/2-inch (64-mm)** face width and in lengths as long as practical; finished to match lockers.

K. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

L. Boxed End Panels: Fabricated with **1-inch- (25-mm-)** wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match

lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

M. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

N. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.12 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.

1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls[and elsewhere as indicated,] for corrosion resistance.
2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than **36 inches (910 mm)** o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top [**and bottom of lockers**][**of lockers and to floor**].
3. Anchor back-to-back metal lockers to floor.

B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.

C. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

D. Equipment:

1. Attach hooks with at least two fasteners.
2. Attach door locks on doors using security-type fasteners.
3. Identification Plates: Identify metal lockers with identification indicated on Drawings.

    a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
    b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.

E. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

F. Fixed Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than **72 inches (1830 mm)** apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

G. Movable Benches: Place benches in locations indicated on Drawings.

3.3 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.[**Verify that integral locking devices operate properly.**]

3.4 PROTECTION

A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13 00

Task	Specification	Specification Description
10 51 13 00	01 22 00 00	No Specification Required
10 51 53 00	01 22 00 00	No Specification Required

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SECTION 10 55 00 00 - USPS-DELIVERY POSTAL SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mail receptacles.
2. Cluster box units.
3. Parcel lockers.
4. Front-loading collection boxes.
5. Rear-loading collection boxes.
6. Accessories.

B. Related Requirements:

1. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for lock cylinders for postal specialties that are keyed to building keying system and for letter slots in doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of postal specialty.

B. Shop Drawings: For postal specialties.

1. Include plans, elevations, sections, and attachment details.
2. Include identification sequence for compartments.
3. Include layout of identification text.
4. Include setting drawings, templates, and installation instructions for anchor bolts and other anchorages installed as part of the Work of other Sections.

C. Samples for Verification: For each type of exposed finish, prepared on **6-by-6-inch** **(150-by-150-mm)** square Samples.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of postal specialty required to comply with USPS regulations, signed by product manufacturer. Include written approval by Postmaster General.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For postal specialties and finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Furnish lock keys according to USPS requirements; with temporary identification for their respective locks, bagged, and securely taped inside the collection compartment for shipping.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of postal specialties that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MAIL RECEPTACLES

A. Front-Loading Mail Receptacles : Consisting of multiple compartments with fixed, solid compartment backs, enclosed within a recessed wall box. Provide access to compartments for distributing incoming mail from front of unit by unlocking master lock and swinging side-hinged master door to provide accessibility to entire group of compartments. Provide access to each compartment for removing mail by swinging compartment door. Comply with USPS-STD-4C.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**2B Global Inc.**]
b. [**American Eagle Mailbox Mfg. Corp.**]
c. [**Florence Corporation; Gibraltar Industries Company**]
d. [**Jayco Industries**]
e. [**Jensen Mailboxes Manufacturing Company**]
f. [**National Mailboxes; a division of NMHP, Inc.**]
g. [**Postal Products Unlimited, Inc.**]
h. [**W. A. Charnstrom Company**]

2. Front-Loading Master Door: Fabricated from extruded aluminum and braced and framed to hold compartment doors; prepared to receive master-door lock.

a. Master-Door Lock: Door prepared to receive lock provided by local postmaster.

3. Compartments: [**Number and size as follows:**][**As indicated on Drawings, of the following sizes:**][**As indicated on Drawings.**]

   a. Type I: A group of mail receptacles in single-column configuration with single master door, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, one outgoing mail collection compartment prepared for master-door lock, and one parcel-locker compartment **15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**.
   b. Type II: A group of mail receptacles in double-column configuration with double master door, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, one outgoing mail collection compartment prepared for master-door lock, and [**one**][**two**] parcel-locker compartment(s): [**15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**and**][**18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**].
   c. Type III: A group of mail receptacles in double-column configuration with single master door, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, one outgoing mail collection compartment prepared for master-door lock, and [**one**][**two**] parcel-locker compartment(s): [**15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**and**][**18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**].
   d. Type VI (No Parcel-Locker Compartment): A group of mail receptacles in single-column configuration with single master door, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, and one outgoing mail collection compartment prepared for master-door lock.
   e. Type VIII (No Parcel-Locker Compartment): A group of mail receptacles in double-column configuration with double master door, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, and one outgoing mail collection compartment prepared for master-door lock.

4. Compartment Doors: Fabricated from extruded aluminum. Equip each with lock and tenant identification as required by USPS-STD-4C.[**Provide mail slot in the compartment with master-door lock.**]

   a. Compartment-Door Locks: Comply with USPS-L-1172C for locks and keys, or equivalent as approved by the USPS; with three keys for each compartment door. Key each compartment differently.
   b. Parcel-Locker-Compartment-Door Locks: Two-key security system in which control key provides access to parcel-locker-compartment key, which opens compartment and is retained once opened.

5. Frames: Fabricated from extruded aluminum or aluminum sheet; ganged and nested units, with cardholder and blank cards for tenant's identification within each compartment.
6. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
7. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

   a. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Rear-Loading Mail Receptacles : Consisting of multiple compartments enclosed within a recessed wall

box. Provide access to compartments for distributing incoming mail from rear of unit with accessibility to entire group of compartments. Provide access to each compartment for removing mail by swinging compartment door. Comply with USPS-STD-4C.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**2B Global Inc.**]
    b. [**American Eagle Mailbox Mfg. Corp.**]
    c. [**Florence Corporation; Gibraltar Industries Company**]
    d. [**Jayco Industries**]
    e. [**Jensen Mailboxes Manufacturing Company**]
    f. [**National Mailboxes; a division of NMHP, Inc.**]
    g. [**Postal Products Unlimited, Inc.**]
    h. [**W. A. Charnstrom Company**]

2. Compartments: [**Number and size as follows:**][**As indicated on Drawings, of the following sizes:**][**As indicated on Drawings.**]

    a. Type IV: A group of mail receptacles in single-column configuration with a rear-access cover, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, one outgoing mail collection compartment, and one parcel-locker compartment **15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**.
    b. Type V: A group of mail receptacles in double-column configuration with a rear-access cover, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, one outgoing mail collection compartment, and [**one**][**two**] parcel-locker compartment(s) [**15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**and**][**18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**].
    c. Type VII (No Parcel-Locker Compartment): A group of mail receptacles in single-column configuration with a rear-access cover, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, and one outgoing mail collection compartment.
    d. Type IX (No Parcel-Locker Compartment): A group of mail receptacles in double-column configuration with a rear-access cover, [**three**] mail compartments not less than **3 inches high by 12 inches wide by 15 inches deep (76 mm high by 305 mm wide by 381 mm deep)**, and one outgoing mail collection compartment.

3. Rear-Loading Cover: [**Not required**][**Lift-off rear cover fabricated from extruded aluminum or aluminum sheet, finished to match front of unit**].
4. Rear-Loading Door: Side hinged, fabricated from extruded aluminum or aluminum sheet, finished to match front of unit; with full-length, stainless-steel piano hinge on one side and [**positive-latching**][**locking**] mechanism on the other.

    a. Rear-Door Lock: Door prepared to receive lock provided by local postmaster.

5. Compartment Doors: Fabricated from extruded aluminum. Equip each with lock and tenant identification as required by USPS-STD-4C.[**One compartment with outgoing mail slot.**]

    a. Compartment-Door Locks: Comply with USPS-L-1172C for locks and keys, or equivalent as approved by the USPS; with three keys for each compartment door. Key each

compartment differently.

b. Parcel-Locker-Compartment-Door Locks: Two-key security system in which control key provides access to parcel-locker-compartment key, which opens compartment and is retained once opened.

6. Frames: Fabricated from extruded aluminum or aluminum sheet; ganged and nested units, with cardholder and blank cards for tenant's identification behind each compartment.
7. Snap-on Trim: Fabricated from same material and finish as compartment doors.
8. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
9. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

a. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.2 CLUSTER BOX UNITS (CBUs)

A. Cluster Box Units (CBUs): Consisting of multiple compartments enclosed within a freestanding, pedestal-mounted enclosure. Provide access to compartments for distributing incoming mail from front of unit by unlocking master lock and swinging pair of side-hinged master doors to provide accessibility to entire group of compartments. Provide access to each compartment for removing mail by swinging compartment door. Comply with USPS-B-1118G.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Eagle Mailbox Mfg. Corp.**]
b. [**Florence Corporation; Gibraltar Industries Company**]
c. [**Jensen Mailboxes Manufacturing Company**]
d. [**National Mailboxes; a division of NMHP, Inc.**]
e. [**Postal Products Unlimited, Inc.**]

B. Compartment Enclosure: Fabricated from aluminum sheet with aluminum mounting pedestal and weather-protection hood, with the following number and size of compartments:

1. Type I: Eight compartments **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, one outgoing mail compartment **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, one parcel-locker compartment **12 inches wide by 10 inches high by 15 inches deep (305 mm wide by 254 mm high by 381 mm deep)**, and another parcel-locker compartment **12 inches wide by 13-1/2 inches high by 15 inches deep (305 mm wide by 343 mm high by 381 mm deep)**.
2. Type II: 12 compartments **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, one outgoing mail compartment **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, and one parcel-locker compartment **12 inches wide by 10 inches high by 15 inches deep (305 mm wide by 254 mm high by 381 mm deep)**.
3. Type III: 16 compartments **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, one outgoing mail compartment **12 inches wide by 3 inches high by 15 inches deep (305 mm wide by 76 mm high by 381 mm deep)**, one parcel-locker compartment **12 inches wide by 10 inches high by 15 inches deep (305 mm wide by 254 mm high by 381 mm deep)**, and another parcel-locker compartment **12 inches wide by 13-1/2 inches high by 15 inches deep (305 mm wide by 343 mm high by 381 mm deep)**.

4. Type IV: 13 compartments **12 inches wide by 4-3/4 inches high by 15 inches deep (305 mm wide by 121 mm high by 381 mm deep)**, one outgoing mail compartment **12 inches wide by 4-3/4 inches high by 15 inches deep (305 mm wide by 121 mm high by 381 mm deep)**, and one parcel-locker compartment **12 inches wide by 10 inches high by 15 inches deep (305 mm wide by 254 mm high by 381 mm deep)**.

C. Compartment Doors and Frames: Fabricated from one-piece extruded aluminum or aluminum sheet. Equip each compartment door with lock, tenant identification, and concealed, full-length, flush hinge on one side. Provide outgoing mail slot with weather protection flap.

1. Tenant Identification: Number [**engraved into face**][**applied into recess**] of compartment door.
2. Compartment-Door Locks: Comply with USPS-L-1172C for locks and keys, or equivalent as approved by the USPS; with three keys for each compartment door. Key each compartment differently.
3. Parcel-Locker-Compartment-Door Locks: Two-key security system in which control key provides access to parcel-locker-compartment key, which opens compartment and is retained once opened.

D. Pedestal: Aluminum, with same finish as compartment enclosure and attached with theft-resistant fasteners.

E. Exposed Aluminum Finish: Finish surfaces exposed to view with powder-coated finish in [**postal gray (light gray)**][**color as selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

2.3 PARCEL LOCKERS

A. Front-Loading Parcel Lockers, Recessed : Consisting of single or multiple compartments enclosed within a larger enclosure of type indicated below. Provide access to compartments for distributing incoming parcels from front of unit. Provide access to each compartment for removing parcels by swinging compartment door. Comply with USPS-STD-4C.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Florence Corporation; Gibraltar Industries Company**]
   c. [**Jayco Industries**]
   d. [**Jensen Mailboxes Manufacturing Company**]
   e. [**National Mailboxes; a division of NMHP, Inc.**]
   f. [**Postal Products Unlimited, Inc.**]
   g. [**W. A. Charnstrom Company**]

2. Enclosure Type: Recessed.
3. Compartments: [**Number and size as follows:**][**As indicated on Drawings, of the following sizes:**][**As indicated on Drawings.**]

   a. Type X, Parcel Only, Single: Single parcel receptacle [**15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**] without a master door.
   b. Type X, Parcel Only, Group: A group of parcel receptacles in single-column configuration

without a master door; [**one**][**two**] compartment(s) **18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**[**and**][**one compartment 15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**].

c. Type XI, Parcel Only, Group: A group of parcel receptacles in single-column configuration with single master door prepared for master-door lock; [**one**][**two**][**compartment(s) 15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**and**][**one**][**two**][**compartment(s) 18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**].

4. Front-Loading Master Door: Fabricated to hold compartment doors; prepared to receive master-door lock provided by local postmaster.
5. Compartment Doors and Frames: Fabricated from [**same material and finish as adjacent mail receptacles**][**extruded aluminum**][**aluminum sheet**][**metallic-coated steel sheet**][**aluminum or metallic-coated steel sheet**]. Equip each compartment door with lock; identification; and concealed, full-length, spring-loaded, flush hinge on right side.

   a. Compartment Identification: Black, sequential numbers [**engraved into**][**stamped onto**] recess in face of compartment door.
   b. Compartment-Door Locks: Dual-lock security system in which master lock provides access to customer lock (USPS-L-1172C) and parcel-locker key opens compartment and is retained once opened.

6. Aluminum Finish: Finish surfaces exposed to view as follows:

   a. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Rear-Loading Parcel Lockers, Recessed : Consisting of single or multiple compartments enclosed within a recessed wall box. Provide access to compartments for distributing incoming parcels from rear of unit with accessibility to entire group of compartments. Provide access to each compartment for removing parcels by swinging compartment door. Comply with USPS-STD-4C.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Florence Corporation; Gibraltar Industries Company**]
   c. [**Jayco Industries**]
   d. [**Jensen Mailboxes Manufacturing Company**]
   e. [**Postal Products Unlimited, Inc.**]
   f. [**W. A. Charnstrom Company**]

2. Compartments: [**Number and size as follows:**][**As indicated on Drawings, of the following sizes:**][**As indicated on Drawings.**]

   a. Type XII, Parcel Only: A group of parcel receptacles in single-column configuration with a rear-access cover; [**one**][**two**][**compartment(s) 15 inches high by 12 inches wide by 15 inches deep (381 mm high by 305 mm wide by 381 mm deep)**][**and**][**one**][**two**][**compartment(s) 18 inches high by 12 inches wide by 15 inches deep (457 mm high by 305 mm wide by 381 mm deep)**].

3. Rear-Loading Cover: [**Not required**][**Lift-off rear cover fabricated from extruded aluminum or**

aluminum sheet, finished to match front of unit].

4. Rear-Loading Door: Side hinged, fabricated from extruded aluminum or aluminum sheet, finished to match front of unit; with full-length, stainless-steel piano hinge on one side and [**positive-latching**][**locking**] mechanism on the other.

   a. Rear-Door Lock: Door prepared to receive lock provided by local postmaster.

5. Compartment Doors and Frames: Fabricated from [**same material and finish as adjacent mail receptacles**][**extruded aluminum**][**aluminum sheet**][**metallic-coated steel sheet**][**aluminum or metallic-coated steel sheet**]. Equip each compartment door with lock; identification; and concealed, full-length, spring-loaded, flush hinge on one side.

   a. Compartment Identification: Black, sequential numbers [**engraved into**][**stamped onto**] recess in face of compartment door.
   b. Compartment-Door Locks: Dual-lock security system in which master lock provides access to customer lock (USPS-L-1172C) and parcel-locker key opens compartment and is retained once opened.

6. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

   a. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Outdoor Parcel Lockers, Pedestal Mounted : Consisting of multiple compartments enclosed within a freestanding, pedestal-mounted enclosure. Provide access to compartments for distributing incoming parcels from front of unit by unlocking master lock and swinging pair of side-hinged master doors to provide accessibility to entire group of compartments. Provide access to each compartment for removing parcels by swinging compartment door.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Bommer Industries, Inc**]
   c. [**Florence Corporation; Gibraltar Industries Company**]
   d. [**Jayco Industries**]
   e. [**Jensen Mailboxes Manufacturing Company**]
   f. [**National Mailboxes; a division of NMHP, Inc.**]
   g. [**Postal Products Unlimited, Inc.**]
   h. [**Security Manufacturing Corporation**]
   i. [**W. A. Charnstrom Company**]

2. Compartment Enclosure: Fabricated from aluminum sheet with aluminum mounting pedestal and weather-protection hood, with the following number and size of compartments:

   a. Type I: One box with two compartments, one on top of the other, each compartment with inside dimensions of **12 inches wide by 14 inches high by 15 inches deep (305 mm wide by 356 mm high by 381 mm deep)**.
   b. Type II: One box with four compartments, side by side, two on top and two on bottom, each compartment with inside dimensions of **12 inches wide by 14 inches high by 15 inches deep (305 mm wide by 356 mm high by 381 mm deep)**.

3. Compartment Doors and Frames: Fabricated from one-piece extruded aluminum or aluminum sheet. Equip each compartment door with lock, tenant identification; and concealed, full-length, flush hinge on one side. Provide outgoing mail slot with weather protection flap.

   a. Locker Identification: Number [**engraved into face**][**applied into recess**] of compartment door.
   b. Door Locks: Two-key security system in which control key provides access to parcel-locker key, which opens compartment and is retained once opened.

4. Pedestal: Aluminum, with same finish as compartment enclosure and attached with theft-resistant fasteners.
5. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

   a. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 COLLECTION BOXES

A. Front-Loading Collection Boxes : Consisting of single compartment with fire-resistant cushion bottom, enclosed within wall box, with [**mail slot**][**hopper door**] to receive mail. Provide door for collecting mail from front of unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Bommer Industries, Inc**]
   c. [**Florence Corporation; Gibraltar Industries Company**]
   d. [**Jayco Industries**]
   e. [**Jensen Mailboxes Manufacturing Company**]
   f. [**National Mailboxes; a division of NMHP, Inc.**]
   g. [**Postal Products Unlimited, Inc.**]
   h. [**Security Manufacturing Corporation**]
   i. [**W. A. Charnstrom Company**]

2. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**].
3. Height:

   a. Sized to match height of [**four**][**five**][**six**][**seven**] mail receptacles.
   b. [**As indicated on Drawings**].

4. Compartment Doors and Frames: Fabricated from **1/4-inch- (6-mm-)** thick aluminum, with opening not less than **12 by 20 inches (305 by 508 mm)** and not more than **18 by 30 inches (457 by 762 mm)**. Equip door with lock and concealed, full-length, flush hinge on one side.

   a. Door Lock: Door prepared to receive lock provided by local postmaster.
   b. Identification: Engrave face of compartment door with **1-inch- (25-mm-)** high letters as follows: "U.S. MAIL LETTER BOX" on two lines at top or bottom of unit.
   c. Door Style: [**Set door within face frame**][**Extend door full width and height of unit, with no exposed frame**].

5. Mail Slot: Fabricated from **1/4-inch- (6-mm-)** thick aluminum, with **11-inch-wide by 1-1/4-inch-**

(279-mm-wide by 32-mm-) high opening, protected by inside hood and hinge flap, and with inside baffle to prevent removal of mail from box.

6. Hopper Door: Fabricated from 1/4-inch- (6-mm-) thick aluminum, with opening that allows a bundle measuring 6-1/2 inches wide by 11-1/2 inches long by 4 inches high (165 mm wide by 292 mm long by 102 mm high) to be deposited, and with inside baffle to prevent removal of mail from box. Equip door with door pull and concealed, full-length bottom hinge.

    a. Identification: Engrave face of hopper door with 1-inch- (25-mm-) high letters as follows: "LETTERS AND LETTER MAIL TIED IN BUNDLES."
    b. Door Style: [**Set door within face frame**][**Extend door full width and height of unit, with no exposed frame**].

7. Exposed Materials: Fabricated from extruded or sheet aluminum.

    a. Anodic Finish: [**Clear**][**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
    b. Baked-Enamel or Powder-Coated Finish: [**Silver**][**Black**][**Medium bronze**][**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
9. Schedule-Card Holder: Recessed or surface-mounted holder for pickup schedule card in center of bottom front portion of unit. Fabricate of same material and finish as front of unit.
10. Mailbag Hooks: Two aluminum or stainless-steel hooks at exterior front edge of bottom of surface-mounted units, spaced 15 to 17-1/2 inches (381 to 445 mm) apart, for supporting mailbags.
11. Mailbag Rack: Internal rack system for supporting mailbags within unit.

B. Rear-Loading Collection Boxes : Consisting of single compartment with fire-resistant cushion bottom, enclosed within a recessed wall box, with [**mail slot**][**hopper door**] to receive mail. Provide access to compartment for collecting mail from rear of unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Eagle Mailbox Mfg. Corp.**]
    b. [**Bommer Industries, Inc**]
    c. [**Florence Corporation; Gibraltar Industries Company**]
    d. [**Jayco Industries**]
    e. [**Jensen Mailboxes Manufacturing Company**]
    f. [**National Mailboxes; a division of NMHP, Inc.**]
    g. [**Postal Products Unlimited, Inc.**]
    h. [**Security Manufacturing Corporation**]
    i. [**W. A. Charnstrom Company**]

2. Height:

    a. Sized to match height of [**four**][**five**][**six**][**seven**] mail receptacles.
    b. [**As indicated on Drawings**].

3. Compartment Frame and Front Panel: Fabricated from 1/4-inch- (6-mm-) thick aluminum.

a. Identification: Engrave face of front panel with **1-inch- (25-mm-)** high letters as follows: "U.S. MAIL LETTER BOX" on two lines at top or bottom of unit.

4. Mail Slot: Fabricated from **1/4-inch- (6-mm-)** thick metal plate, with **11-inch-wide by 1-1/4-inch- (279-mm-wide by 32-mm-)** high opening, protected by inside hood and hinge flap, and with inside baffle to prevent removal of mail from box.
5. Hopper Door: Fabricated from **1/4-inch- (6-mm-)** thick metal plate, with opening that allows a bundle measuring **6-1/2 inches wide by 11-1/2 inches long by 4 inches high (165 mm wide by 292 mm long by 102 mm high)** to be deposited, and with inside baffle to prevent removal of mail from box. Equip door with door pull and concealed, full-length bottom hinge.

   a. Identification: Engrave face of hopper door with **1-inch- (25-mm-)** high letters as follows: "LETTERS AND LETTER MAIL TIED IN BUNDLES."
   b. Door Style: [**Set door within face frame**][**Extend door full width and height of unit, with no exposed frame**].

6. Rear-Loading Enclosure: Lift-off rear cover fabricated from same material and finish as front of unit.
7. Rear-Loading Door: Side hinged, with opening not less than **12 by 20 inches (305 by 508 mm)** and not more than **18 by 30 inches (457 by 762 mm)**, fabricated from same material and finish as front of unit; with full-length, stainless-steel piano hinge on one side and positive-latching mechanism on the other. Fabricate rear-loading door to remain open while mail is collected.

   a. Rear-Door Lock: Door prepared to receive lock provided by local postmaster.

8. Exposed Materials: Fabricated from extruded or sheet aluminum.

   a. Anodic Finish: [**Clear**][**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Baked-Enamel or Powder-Coated Finish: [**Black**][**Gold**][**Dark bronze**][**Medium bronze**][**Silver**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

9. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
10. Schedule-Card Holder: Recessed or surface-mounted holder for pickup schedule card in center of bottom front portion of unit. Fabricate of same material and finish as front of unit.
11. Mailbag Hooks: Two aluminum or stainless-steel hooks at exterior front edge of bottom of surface-mounted units, spaced **15 to 17-1/2 inches (381 to 445 mm)** apart, for supporting mailbags.
12. Mailbag Rack: Internal rack system for supporting mailbags within unit.

2.5 ACCESSORIES

A. Directory for Mail Receptacles : Surface-mounted, front-opening unit, with clear glass or plastic window.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Bommer Industries, Inc**]
   c. [**Florence Corporation; Gibraltar Industries Company**]
   d. [**Jayco Industries**]

e. [**Jensen Mailboxes Manufacturing Company**]
f. [**National Mailboxes; a division of NMHP, Inc.**]
g. [**Postal Products Unlimited, Inc.**]
h. [**Security Manufacturing Corporation**]
i. [**W. A. Charnstrom Company**]

2. Framed, Top-Mount Unit for Mail Receptacles: Fabricate directory as framed, horizontal unit with modular sections having a [24-name capacity (3 modules)][32-name capacity (4 modules)][40-name capacity (5 modules)]; of same material[size,] and finish as adjacent mail receptacles; mounted above mail receptacles[as indicated on Drawings].
3. Framed, Side-Mount Unit for Mail Receptacles: Fabricate directory as framed, horizontal unit with [**50-name capacity, 28 inches (711 mm)**][**60-name capacity, 33-3/8 inches (848 mm)**][**70-name capacity, 38-3/4 inches (984 mm)**] high; of same material and finish as adjacent mail receptacles; mounted alongside of mail receptacles[**as indicated on Drawings**].
4. Name Strips: **1/4-inch- (6-mm-)** high label tape.

B. Key Keeper : Consisting of single compartment with door; interior compartment size not less than [**4-3/4 inches wide by 2-1/4 inches high by 1-1/2 inches deep (121 mm wide by 57 mm high by 38 mm deep)**], USPS approved.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Eagle Mailbox Mfg. Corp.**]
b. [**Bommer Industries, Inc**]
c. [**Florence Corporation; Gibraltar Industries Company**]
d. [**Jayco Industries**]
e. [**Jensen Mailboxes Manufacturing Company**]
f. [**Knox Company**]
g. [**Postal Products Unlimited, Inc.**]
h. [**Security Manufacturing Corporation**]

2. Mounting: [**Recessed**][**Surface mounted**].
3. Style: Compartment door [**set within face frame**][**extending full width and height of unit, with no exposed frame**].
4. Type of Operation: [**Loose key in box**][**Retractor reel with minimum 20-inch- (508-mm-) long chain**][**Push-button, 24-V switch in box**].
5. Door Lock: Door prepared to receive lock furnished by local postmaster.
6. Exposed Materials: Fabricated from extruded or sheet aluminum.

a. Anodic Finish: [**Clear**][**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Baked-Enamel or Powder-Coated Finish: [**Black**][**Gold**][**Dark bronze**][**Medium bronze**][**Silver**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Key Cabinet : Wall-mounted,[**metallic-coated**] steel cabinet with pivoting, key-holding panels and side-hinged door equipped with five-pin tumbler, cylinder-door lock and concealed, full-length flush hinge. Finish cabinet, panels, and door with baked-enamel or powder-coated finish. Key-control system consisting of key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Eagle Mailbox Mfg. Corp.**]
b. [**Bommer Industries, Inc**]
c. [**Florence Corporation; Gibraltar Industries Company**]
d. [**Jayco Industries**]
e. [**Jensen Mailboxes Manufacturing Company**]
f. [**National Mailboxes; a division of NMHP, Inc.**]
g. [**Postal Products Unlimited, Inc.**]
h. [**Security Manufacturing Corporation**]
i. [**W. A. Charnstrom Company**]

2. Capacity: Keys for [**150 percent of the number of**] mail-receptacle locks.
3. Cross-Index System: Consisting of index cards for recording key information. Include three receipt forms for each key-holding hook.
4. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 FABRICATION

A. Form postal specialties to required shapes and sizes, with true lines and angles, square, rigid, and without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges and corners free of sharp edges and burrs and safe to touch. Fabricate doors of postal specialties to preclude binding, warping, or misalignment.

B. Preassemble postal specialties in shop to greatest extent possible to minimize field assembly.

C. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.

D. Drill or punch holes required for fasteners and remove burrs. Use security fasteners where fasteners are exposed. If used, seal external rivets before finishing.

E. Weld in concealed locations to greatest extent possible without distorting or discoloring exposed surfaces. Remove weld spatter and welding oxides from exposed surfaces.

F. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support loads.

G. Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturers of dissimilar metals.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions[with Installer present,] for compliance with requirements for roughing-in openings, clearances, and other conditions affecting performance of the Work.

B. Examine walls and other adjacent construction for suitable conditions before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install postal specialties level and plumb, according to manufacturer's written instructions.

1. Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturer.
2. Where aluminum contacts grout, concrete, masonry, or wood, protect against corrosion by painting contact surfaces with bituminous coating.
3. Final acceptance of postal specialties served by the USPS depends on compliance with USPS requirements.

B. Mail Receptacles: Install mail receptacles with center of tenant-door lock cylinders and bottom of compartments at the maximum and minimum heights above finished floor established by the USPS and manufacturer's written instructions.

1. Install removable-core and keyed-in door lock cylinders as required for each type of cylinder lock.

C. Pedestal-Mounted Postal Specialties: Anchor units with **1/2-inch- (13-mm-)** diameter, stainless-steel anchor bolts with hooked ends.

D. Collection Boxes: Install collection boxes with [**centerline of mail slots**][**handle of hopper doors**] not more than **48 inches (1219 mm)** above finished floor.

3.3 FIELD QUALITY CONTROL

A. Arrange for USPS personnel to examine and test postal specialties served by the USPS after they have been installed according to USPS regulations.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as postal specialties are installed

unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust doors, hardware, and moving parts to function smoothly, and lubricate as recommended by manufacturer. Verify that integral locking devices operate properly.

C. Touch up marred finishes or replace postal specialties that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by postal-specialty manufacturer.

D. Replace postal specialties that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

E. On completion of postal-specialty installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION 10 55 00 00

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SECTION 10 55 00 00A - PRIVATE-DELIVERY POSTAL SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal mail receptacles.
2. Vertical mail receptacles.
3. Mail collection boxes.
4. Data distribution boxes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of postal specialty.

B. Shop Drawings: For postal specialties.

1. Include plans, elevations, sections, and attachment details.
2. Include identification sequence for compartments.
3. Include layout of identification text.
4. Include setting drawings, templates, and installation instructions for anchor bolts and other anchorages installed as part of the Work of other Sections.

C. Samples for Verification: For each type of exposed finish, prepared on **6-by-6-inch- (150-by-150-mm-)** square Samples.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For postal specialties and finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Furnish lock keys with temporary identification for their respective locks, bagged, and securely taped

inside the collection compartment for shipping.

B. Deliver lock keys to the Owner by registered mail or overnight package service with a record of each corresponding lock and key number.

C. Deliver combination-lock combinations to the Owner by registered mail or overnight package service with a record of each corresponding lock and combination.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of postal specialties that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of hardware[**including electrical components**].
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HORIZONTAL MAIL RECEPTACLES

A. Front-Loading, Horizontal Mail Receptacles : Consisting of multiple compartments with fixed, solid compartment backs, enclosed within recessed wall box. Provide access to compartments for distributing incoming mail from front of unit by unlocking master lock and swinging side-hinged master door to provide accessibility to entire group of compartments. Provide access to each compartment for removing mail by swinging compartment door.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**2B Global Inc.**]
b. [**American Eagle Mailbox Mfg. Corp.**]
c. [**Bommer Industries, Inc**]
d. [**Florence Corporation; Gibraltar Industries Company**]
e. [**Jayco Industries**]
f. [**Jensen Mailboxes Manufacturing Company**]
g. [**National Mailboxes; a division of NMHP, Inc.**]
h. [**Postal Products Unlimited, Inc.**]
i. [**Salsbury Industries**]
j. [**Security Manufacturing Corporation**]
k. [**W. A. Charnstrom Company**]

2. Front-Loading Master Door: Braced and framed to hold compartment doors; with master-door lock and concealed, full-length, stainless-steel piano hinge on one side. Fabricate master door to remain open while mail is deposited.

a. Master-Door Lock:

1) Manufacturer's standard five-pin tumbler, cylinder lock; with [**two**][**three**] keys.
2) Cylinder lock keyed to building keying system; with [**two**][**three**]<**Insert number**> keys. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

3. Compartments with Aluminum Doors: Manufacturer's standard compartments with extruded aluminum doors. Equip each with lock, tenant identification, and concealed, full-length, flush hinge on one side. Provide one compartment prepared for master-door lock[**and with outgoing mail slot**].

a. Tenant Identification:

1) **2-inch-wide by 5/8-inch- (51-mm-wide by 16-mm-)** high, clear-plastic cardholder set in recessed slot in face of compartment door. Provide cardboard strip and self-adhesive numbers.
2) Laminated, black plastic tabs, engraved with identification and adhesively applied to face of compartment door.
3) Identification engraved into face of compartment door.

4. Compartments with Ornamental Metal Doors: Manufacturer's standard compartments with ornamental doors fabricated from solid, die-cast [**brass**][**zinc**]. Equip each with[**glass window,**] lock, nameplate, and two hinges.

a. Compartments: [**Number and size as follows:**][**As indicated on Drawings, of the following sizes:**][**As indicated on Drawings.**]

5. Compartment-Door Locks:

a. Five-pin tumbler, cylinder [**cam**][**spring-latch-type**] locks capable of at least 1000 key changes; with [**two**][**three**] keys for each compartment door. Key each compartment differently.
b. Removable core locks, furnished by the Owner and installed as the Work of this Section.
c. Spring-latch-type lock designed to accommodate cylinders keyed to building keying system; with [**two**][**three**]<**Insert number**> keys for each compartment door. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]
d. Three-digit, single-dial, combination locks with spring latch and automatic throw off. Set each compartment with different combination.

6. Frames: Ganged and nested units, with cardholder and blank cards for tenant's identification behind each compartment.
7. Snap-on Trim: Fabricated from the same material and finish as compartment doors.
8. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
9. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

a. Anodic Finish: [**Clear**].
b. Baked-Enamel or Powder-Coated Finish: [**Black**][**Dark bronze**][**Gold**][**Medium bronze**][**Silver**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

10. Brass Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Brushed satin, lacquered**].
11. Zinc Finish: Manufacturer's standard powder-coated finish, [**tan**].

B. Rear-Loading, Horizontal Mail Receptacles : Consisting of multiple compartments enclosed within recessed wall box. Provide access to compartments for distributing incoming mail from rear of unit with accessibility to entire group of compartments. Provide access to each compartment for removing mail by swinging compartment door.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**2B Global Inc.**]
   b. [**American Eagle Mailbox Mfg. Corp.**]
   c. [**Bommer Industries, Inc**]
   d. [**Florence Corporation; Gibraltar Industries Company**]
   e. [**Jayco Industries**]
   f. [**Jensen Mailboxes Manufacturing Company**]
   g. [**National Mailboxes; a division of NMHP, Inc.**]
   h. [**Postal Products Unlimited, Inc.**]
   i. [**Salsbury Industries**]
   j. [**Security Manufacturing Corporation**]
   k. [**W. A. Charnstrom Company**]

2. Rear-Loading Cover: [**Not required**][**Lift-off rear cover fabricated from extruded aluminum or aluminum sheet, finished to match front of unit**].
3. Rear-Loading Door: Side hinged, fabricated from extruded aluminum or aluminum sheet[finished to match front of unit]; with full-length, stainless-steel piano hinge on one side and [positive-latching][locking] mechanism on the other. Fabricate rear-loading door to open not less than 90 degrees and to remain open while mail is deposited.

   a. Rear-Door Lock:

      1) Manufacturer's standard five-pin tumbler, cylinder lock; with [**two**][**three**] keys.
      2) Cylinder lock keyed to building keying system; with [**two**][**three**]<**Insert number**> keys. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

4. Compartments with Aluminum Doors: Manufacturer's standard compartments with doors fabricated from extruded aluminum. Equip each with lock, tenant identification, and concealed, full-length, flush hinge on one side. Provide one compartment prepared for master-door lock[**and with outgoing mail slot**].
5. Compartments with Ornamental Metal Doors: Manufacturer's standard compartments with ornamental doors fabricated from [**brass**][**zinc**]. Equip each with[**glass window,**] lock, nameplate, and two hinges.
6. Compartment-Door Locks:

   a. Five-pin tumbler, cylinder [**cam**][**spring-latch-type**] locks capable of at least 1000 key changes; with [**two**][**three**] keys for each compartment door. Key each compartment differently.
   b. Removable core locks, furnished by the Owner and installed as the Work of this Section.
   c. Spring-latch-type lock designed to accommodate cylinders keyed to building keying system; with [**two**][**three**]<**Insert number**> keys for each compartment door. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]
   d. Three-digit, single-dial, combination locks with spring latch and automatic throw off. Set each compartment with different combination.

7. Frames: Ganged and nested units, with cardholder and blank cards for tenant's identification behind each compartment.
8. Snap-on Trim: Fabricated from the same material and finish as compartment doors.
9. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
10. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

    a. Anodic Finish: [**Clear**].
    b. Baked-Enamel or Powder-Coated Finish: [**Black**][**Dark bronze**][**Gold**][**Medium bronze**][**Silver**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

11. Brass Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Brushed satin, lacquered**].
12. Zinc Finish: Manufacturer's standard powder-coated finish, [**tan**].

2.2 VERTICAL MAIL RECEPTACLES

A. Vertical Mail Receptacles : Consisting of vertical compartments enclosed within wall box; with inside dimensions of each compartment not less than **15 inches high by 5 inches wide by 6 inches deep (381 mm high by 127 mm wide by 152 mm deep)**. Provide access to compartments for distributing incoming mail from front of unit by unlocking master lock and tilting inner compartments forward as a group. Provide access to each compartment for removing mail by swinging compartment door.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Eagle Mailbox Mfg. Corp.**]
    b. [**Bommer Industries, Inc**]
    c. [**Florence Corporation; Gibraltar Industries Company**]
    d. [**National Mailboxes; a division of NMHP, Inc.**]
    e. [**Postal Products Unlimited, Inc.**]
    f. [**Salsbury Industries**]
    g. [**Security Manufacturing Corporation**]
    h. [**W. A. Charnstrom Company**]

2. Mounting: [**Recessed**][**Semirecessed with mounting frame**][**Surface mounted with mounting frame**][**As indicated on Drawings**].
3. Compartments: Provide [**three**][**as indicated on Drawings**].
4. Compartment Doors and Frames: Fabricated from striated, extruded aluminum. Equip each compartment door with lock, slot in face of door to receive tenant identification, and concealed, full-length, flush hinge on one side.[**Provide one double-wide compartment with outgoing mail slot.**]

    a. Tenant Identification: [**Cardboard name and number tab**][**Laminated, black plastic tabs, engraved with identification**].
    b. Compartment-Door Locks:

        1) Five-pin tumbler, cylinder [**cam**][**spring-latch-type**] locks capable of at least 1000 key changes; with [**two**][**three**] keys for each compartment door. Key each compartment differently.
        2) Removable core locks, furnished by the Owner and installed as the Work of this Section.

3) Spring-latch-type lock designed to accommodate cylinders keyed to building keying system; with [**two**][**three**]<**Insert number**> keys for each compartment door. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

5. Frames: Ganged and nested units, with cardholder and blank cards for tenant's identification within each compartment.
6. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
7. Exposed Aluminum Finish: Finish surfaces exposed to view as follows:

   a. Anodic Finish: [**Clear**][**Gold**][**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Baked-Enamel or Powder-Coated Finish: [**Aluminum**][**Black**][**Brass**][**Dark bronze**][**Gold**][**Green**][**Ivory**][**Medium bronze**][**Silver**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 MAIL COLLECTION BOXES

A. Mail Collection Boxes : Consisting of single compartment of same depth as horizontal mail receptacles, enclosed within wall box, with slot in top of front to receive mail. Provide door for collecting mail from front of unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Eagle Mailbox Mfg. Corp.**]
   b. [**Bommer Industries, Inc**]
   c. [**Florence Corporation; Gibraltar Industries Company**]
   d. [**Jayco Industries**]
   e. [**Jensen Mailboxes Manufacturing Company**]
   f. [**National Mailboxes; a division of NMHP, Inc.**]
   g. [**Postal Products Unlimited, Inc.**]
   h. [**Salsbury Industries**]
   i. [**Security Manufacturing Corporation**]
   j. [**W. A. Charnstrom Company**]

2. Height: Sized to match height of [**four**][**five**][**six**][**seven**] horizontal mail receptacles.
3. Mounting: [**Recessed**][**Semirecessed**][**Surface mounted**].
4. Compartment Doors and Frames: Fabricated from extruded aluminum or aluminum sheet that is [**full height of unit including**][**in portion of unit below**] mail slot, and equipped with lock and concealed, continuous side hinge.

   a. Door Lock: Cylinder lock keyed to building keying system; with [**two**][**three**]<**Insert number**> keys. Provide cylinders specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]
   b. Identification: Engrave face of compartment door with **1-inch- (25-mm-)** high letters as follows: "[**LETTERS**][**OUTGOING MAIL**][**OFFICE**]."

5. Aluminum Finish: Finish surfaces exposed to view as follows:

a. Anodic Finish: [**Clear**].
b. Baked-Enamel or Powder-Coated Finish: [**Black**][**Dark bronze**][**Gold**][**Medium bronze**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 DATA DISTRIBUTION BOXES

A. Data Distribution Boxes : Consisting of multiple compartments contained within enclosure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**National Mailboxes; a division of NMHP, Inc.**]
b. [**Salsbury Industries**]

2. Enclosure Configuration: [**Freestanding**][**Recessed in wall**][**Recessed in wall and installed between rack ladders**].
3. Compartment Access: Provide access to compartments as follows:

a. For Distributing Incoming Mail from Front of Unit: Mail slot in each compartment door.
b. For Distributing Incoming Mail from Rear of Unit: Open backs[**with aluminum cover finished to match front of unit**].
c. For Removing Mail: Unlocking and swinging compartment door.

4. Compartment Doors: Equip with lock and concealed, continuous hinge.

a. Door Locks:

1) Five-pin tumbler, cylinder [**cam**][**spring-latch-type**] locks capable of at least 1000 key changes; with [**two**][**three**] keys for each compartment door. Key each compartment differently.
2) Three-digit, single-dial, combination locks with spring latch and automatic throw off. Set each compartment with different combination.

5. Concealed Components and Mounting Frames: Aluminum or steel sheet with manufacturer's standard finish.
6. Exposed Materials: Fabricated from steel sheet or aluminum with powder-coat finish.
7. Rack Ladders: Aluminum or steel with manufacturer's standard finish.
8. Powder-Coated Finish: [**Silver**][**Silver with black trim**][**Silver with slate trim**][**Sandalwood with sand trim**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 ACCESSORIES

A. Directory for Mail Receptacles : Surface-mounted, front-opening unit, with clear glass or plastic window.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bommer Industries, Inc**]

b. [**Florence Corporation; Gibraltar Industries Company**]
c. [**Jensen Mailboxes Manufacturing Company**]
d. [**National Mailboxes; a division of NMHP, Inc.**]
e. [**Salsbury Industries**]
f. [**Security Manufacturing Corporation**]

2. Framed, Top-Mount Unit for Horizontal Mail Receptacles: Fabricate directory as framed, horizontal unit with modular sections having a [24-name capacity (3 modules)][32-name capacity (4 modules)][40-name capacity (5 modules)]; of same material[size,] and finish as adjacent mail receptacles; mounted above mail receptacles[as indicated on Drawings].
3. Framed, Side-Mount Unit for Horizontal Mail Receptacles: Fabricate directory as framed, horizontal unit with [**50-name capacity, 28 inches (711 mm)**][**60-name capacity, 33-3/8 inches (848 mm)**][**70-name capacity, 38-3/4 inches (984 mm)**] high; of same material and finish as adjacent mail receptacles; mounted at side of mail receptacles[**as indicated on Drawings**].
4. Framed, Side-Mount Unit for Vertical Mail Receptacles: Fabricate directory as framed, vertical unit with modular sections having a [**40-name capacity (1 module)**][**80-name capacity (2 modules)**][**120-name capacity (3 modules)**][**160-name capacity (4 modules)**][**200-name capacity (5 modules)**]; of same size, material, and finish as adjacent vertical mail compartment doors unless otherwise indicated.
5. Insert Units for Vertical Mail Receptacles: Fabricate directory as modular inserts having a [**40-name capacity (1 module)**][**80-name capacity (2 modules)**][**120-name capacity (3 modules)**][**160-name capacity (4 modules)**][**200-name capacity (5 modules)**]; of same size, material, and finish as adjacent vertical mail compartment doors unless otherwise indicated.
6. Provide name strips made of **1/4-inch- (6-mm-)** high, label tape.

B. Key Cabinet : Wall-mounted,[**metallic-coated**] steel cabinet with pivoting, key-holding panels and side-hinged door equipped with five-pin tumbler, cylinder door lock and concealed, full-length flush hinge. Finish cabinet, panels, and door with baked-enamel or powder-coated finish. Provide key control system consisting of key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Florence Corporation; Gibraltar Industries Company**]
b. [**Jayco Industries**]
c. [**National Mailboxes; a division of NMHP, Inc.**]
d. [**Postal Products Unlimited, Inc.**]
e. [**Salsbury Industries**]
f. [**Security Manufacturing Corporation**]

2. Cross-Index System: Consisting of index cards for recording key information. Include three receipt forms for each key-holding hook.
3. Baked-Enamel or Powder-Coated Finish: [**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Letter Drops (Through Wall) : Consisting of **11-inch-wide by 3-1/2-inch- (279-mm-wide by 89-mm-)** high, top-hinged, spring-loaded flap that pivots inward, held in place by **1-inch- (25-mm-)** wide face frame. Fabricated from **1/4-inch- (6-mm-)** thick aluminum or steel, with exposed surfaces finished to match adjacent mail receptacles.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bommer Industries, Inc**]
b. [**Florence Corporation; Gibraltar Industries Company**]
c. [**National Mailboxes; a division of NMHP, Inc.**]
d. [**Postal Products Unlimited, Inc.**]
e. [**Salsbury Industries**]
f. [**Security Manufacturing Corporation**]

2. Sleeve: Provide[**metallic-coated**] steel wall sleeve for full depth of wall.
3. Finished Frame: Provide finished face frame on back side of wall opening.
4. Identification: Engrave face of swinging flap with **1-inch- (25-mm-)** high letters as follows: "[**LETTERS**][**OUTGOING MAIL**]."
5. Exposed Material and Finish: [**Exposed surfaces fabricated from same material and finish as adjacent mail receptacles**].

D. Package Depository (Through Wall) : Consisting of **1/4-inch- (6-mm-)** thick, aluminum or steel faceplate and through-the-wall hopper door[**with hinged baffle**] allowing receipt of packages; fabricated from **1/4-inch- (6-mm-)** thick aluminum or steel.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Florence Corporation; Gibraltar Industries Company**]
b. [**Jayco Industries**]
c. [**National Mailboxes; a division of NMHP, Inc.**]
d. [**Postal Products Unlimited, Inc.**]
e. [**Salsbury Industries**]
f. [**Security Manufacturing Corporation**]

2. Hopper Door: Equipped with door pull and concealed, full-length bottom hinge; with opening size [**not less than 15 inches wide by 6-1/2 inches high (381 mm wide by 165 mm high)**][**as indicated on Drawings**].
3. Sleeve: Provide[**metallic-coated**] steel wall sleeve for full depth of wall.
4. Slowdown: Provide steel slowdown ramp on back side of wall opening.
5. Identification: Engrave face of hopper door with **1-inch- (25-mm-)** high letters as follows: "[**LETTERS**]."
6. Finish: Exposed surfaces finished same as mail receptacles.
7. Aluminum Finish: Finish surfaces exposed to view as follows:

a. Anodic Finish: [**Clear**][**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Baked-Enamel or Powder-Coated Finish: [**Dark bronze**][**Gold**][**Color as indicated by manufacturer's designations**][**Color as selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Steel Finish: Finish surfaces exposed to view with baked-enamel or powder-coated finish; [**color as indicated by manufacturer's designations**][**color as selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 FABRICATION

A. Form postal specialties to required shapes and sizes, with true lines and angles, square, rigid, and without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges and corners free of sharp edges and burrs and safe to touch. Fabricate doors of postal specialties to preclude binding, warping, or misalignment.

B. Preassemble postal specialties in shop to greatest extent possible to minimize field assembly.

C. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.

D. Drill or punch holes required for fasteners and remove burrs. Use security fasteners where fasteners are exposed. If used, seal external rivets before finishing.

E. Weld in concealed locations to greatest extent possible without distorting or discoloring exposed surfaces. Remove weld spatter and welding oxides from exposed surfaces.

F. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support loads.

G. Fabricate rack ladders to support indicated number of units to form a column of units.

H. Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturers of dissimilar metals.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions[with Installer present,] for compliance with requirements for roughing-in openings, clearances, and other conditions affecting performance of the Work.

B. Examine walls and other adjacent construction for suitable conditions where units will be installed.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install postal specialties level and plumb, according to manufacturer's written instructions and roughing-in drawings.

1. Where dissimilar metals are in permanent contact with each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturer for this purpose.
2. Where aluminum contacts grout, concrete, masonry, or wood, protect against corrosion by painting contact surfaces with bituminous coating.

B. Horizontal Mail Receptacles: Install horizontal mail receptacles with center of tenant-door lock cylinders not more than **48 inches (1219 mm)** and bottom of receptacles not less than **15 inches (381 mm)** above finished floor.

1. Install removable-core and keyed-in door lock cylinders as required for each type of cylinder lock.
2. Install and align two rack ladders for the first column of mail receptacles and one rack ladder for each additional adjacent column of mail receptacles.

C. Vertical Mail Receptacles: Install vertical mail receptacles with center of master lock cylinder not more than **48 inches (1219 mm)** and bottom of receptacles not less than **15 inches (381 mm)** above finished floor.

D. Pedestal-Mounted Postal Specialties: Anchor units with **1/2-inch- (13-mm-)** diameter, [**galvanized**][**stainless**]-steel anchor bolts with hooked ends.

E. Mail Collection Boxes: Install collection boxes with [**centerline of mail slots**][**handle of hopper doors**] not more than **48 inches (1219 mm)** above finished floor.

F. Freestanding Data Distribution Boxes: Locate freestanding data distribution boxes at locations indicated[**or, if not indicated, as directed by the Owner**].

G. Rack-Ladder Data Distribution Boxes: Install and align two rack ladders for the first column of data distribution boxes and one rack ladder for each additional adjacent column of data distribution boxes.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as postal specialties are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust doors, hardware, and moving parts to function smoothly, and lubricate as recommended by manufacturer. Verify that integral locking devices operate properly.

C. Touch up marred finishes or replace postal specialties that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by postal-specialty manufacturer.

D. Replace postal specialties that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

E. On completion of postal-specialty installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION 10 55 00 00A

Task	Specification	Specification Description
10 55 23 00	10 55 00 00	USPS-Delivery Postal Specialties
10 55 23 00	10 55 00 00a	Private-Delivery Postal Specialties
10 55 23 23	10 55 00 00	USPS-Delivery Postal Specialties
10 55 23 23	10 55 00 00a	Private-Delivery Postal Specialties
10 55 23 26	10 55 00 00	USPS-Delivery Postal Specialties
10 55 23 26	10 55 00 00a	Private-Delivery Postal Specialties
10 55 26 00	10 55 00 00	USPS-Delivery Postal Specialties
10 55 26 00	10 55 00 00a	Private-Delivery Postal Specialties

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SECTION 10 56 13 00 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Case-type metal storage shelving.
2. Four-post metal storage shelving.
3. Wire-type, four-post metal storage shelving.
4. Post-and-beam metal storage shelving.

B. Related Requirements:

1. Section 114000 "Foodservice Equipment" for metal shelving in kitchen, pantry, and refrigerated spaces.
2. Section 115123 "Library Stack Systems" for library shelving systems including cantilever-bracket shelving supported by wall-mounted standards.
3. Section 123553.13 "Metal Laboratory Casework" for metal shelving in laboratories.
4. Section 123570 "Healthcare Casework" for metal shelving in central sterile supply rooms, clean utility rooms, and similar spaces for the storage of medical instruments and supplies.

1.2 COORDINATION

A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.

B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

C. Shop Drawings: For metal storage shelving.

1. Include plans, elevations, sections, and attachment details.
2. Include installation details of connectors, lateral bracing, and special bracing.

D. Samples: For each type of metal storage shelving and for each color specified, in the following sizes:

1. Vertical Supports: **12 inches (305 mm)** tall.
2. Shelves: Full size, but not more than **24 inches wide by 12 inches deep (610 mm wide by 305 mm deep)**.
3. Connectors: Full size.
4. Shelf-Label Holders: Full size.

E. Samples for Initial Selection: For each type of metal storage shelving with factory-applied color finishes.

1. Include Samples of accessories involving color selection.

F. Samples for Verification: For the following component, of size indicated below:

1. Vertical Supports: **12 inches (305 mm)** tall.
2. Shelves: Full size, but not more than **24 inches wide by 12 inches deep (610 mm wide by 305 mm deep)**.
3. Connectors: Full size.
4. Shelf-Label Holders: Full size.

G. Product Schedule: For metal storage shelving.[**Use same designations indicated on Drawings.**]

H. Delegated Design Submittals: For seismic restraint of metal storage shelving.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.

C. Product Certificates: For each type of metal storage shelving.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shelves: Full-size units equal to [**5**] percent of amount installed for each type indicated, but no fewer than [**5**] shelves.
2. Shelf-to-Post Connectors: Full-size units equal to [**5**] percent of amount installed for each type indicated, but no fewer than [**10**] connectors.

3. Shelf-Label Holders: Full-size units equal to [**5**] percent of amount installed for each type indicated, but no fewer than [**10**] holders.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Metal storage shelving to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Seismic Component Importance Factor: [**1.5**][**1.0**].

C. Sustainable Design Performance:

D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

E. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

F. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

2.2 CASE-TYPE METAL STORAGE SHELVING

A. Case-Type Metal Storage Shelving: Complying with MH 28.1; freestanding units and field assembled from factory-formed components. Shelves span between two independent supporting sheet metal end panels that allow shelf-height adjustment over full height of shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Borroughs Corporation**]
    b. [**EQUIPTO**]
    c. [**Karp Associates, Inc**]
    d. [**Lyon LLC**]
    e. [**Montel Inc.**]
    f. [**Republic Storage Systems, LLC**]
    g. [**Tennsco**]
    h. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]

B. Load-Carrying Capacity per Shelf: [**200 lb (91 kg)**][**As indicated on Drawings**], uniformly distributed.

C. End Panels with Concealed Perforations: Fabricated from cold-rolled steel sheet, perforations at front and back edges at [**manufacturer's standard spacing**][**1 inch (25 mm) o.c.**] for receiving adjustable shelf clips.

1. Steel Sheet Thickness, Nominal: [**0.036 inch (0.91 mm)**][**As required for load-carrying capacity per shelf and number of shelves**].
2. Adjustable Shelf Clips: Cold-rolled steel, nominal thickness [**0.036-inch- (0.91-mm-)**][**as required for load-carrying capacity per shelf**]; with projections designed to engage at least two perforations in end panels.

D. End Panels with Horizontal Slots: Fabricated from cold-rolled steel sheet; slots spaced at [**manufacturer's standard spacing**][**1 inch (25 mm) o.c.**][**1-1/2 inches (38 mm) o.c.**] for supporting shelves.

1. Steel Sheet Thickness, Nominal: [**0.036 inch (0.91 mm)**][**As required for load-carrying capacity per shelf and number of shelves**].

E. Back Panel: One piece, fabricated from cold-rolled steel sheet.

F. Shelves: Fabricated from cold-rolled steel sheet. Fabricate shelves with vertical front that is flanged and returned.

1. Shelf-Divider Slots: [**2 inches (51 mm) o.c.**].
2. Steel Sheet Thickness, Nominal: [**0.048 inch (1.21 mm)**][**As required for load-carrying capacity per shelf and number of shelves**].

G. Shelf Quantity: [**Three**][**Four**][**Five**][**Six**] shelves per shelving unit in addition to top and bottom shelf.

H. Base: Closed front, with base strips fabricated from same material and with same finish as end panels.

I. Overall Unit Width: [**30 inches (762 mm)**][**36 inches (914 mm)**][**42 inches (1067 mm)**][**48 inches (1219 mm)**].

J. Overall Unit Depth: [**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**].

K. Overall Unit Height: [**72 inches (1829 mm)**][**84 inches (2134 mm)**][**96 inches (2438 mm)**].

L. Accessories:

1. Finished End Panels: Fabricated as [**solid**][**perforated**] full-height panels from same material and with same finish as end panels, with trim along edges abutting end panels and top shelf.
2. Shelf Dividers: Fabricated from same material and with same finish as shelves; [**full-height**][**angle**][**tapered**][**sliding**] type.
3. Bins: [**Fabricated from same material and with same finish as shelves**][**Plastic**]; [**size as indicated on Drawings**].
4. Shelf-Label Holders: [**Clear**][**Colored**] plastic, designed to clip onto front edge of shelf.

M. Steel Finish: [Baked enamel][powder coat].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 FOUR-POST METAL STORAGE SHELVING

A. Four-Post Metal Storage Shelving : Complying with MH 28.1 and field assembled from factory-formed components. Shelves span between supporting corner posts that allow shelf-height adjustment over full height of shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aurora Storage Products, Inc.**]
   b. [**Borroughs Corporation**]
   c. [**Durham Manufacturing Company (The)**]
   d. [**Edsal Manufacturing Company, Inc.**]
   e. [**EQUIPTO**]
   f. [**Excalibur Wood Products**]
   g. [**Hodge**]
   h. [**Interlake Mecalux**]
   i. [**Jeter; a TAB Company**]
   j. [**Karp Associates, Inc**]
   k. [**List Industries Inc.**]
   l. [**Lyon LLC**]
   m. [**Montel Inc.**]
   n. [**Penco Products, Inc.**]
   o. [**Republic Storage Systems, LLC**]
   p. [**Rousseau Metal Inc**]
   q. [**Safco Products Company**]
   r. [**Schaefer Systems International, Inc**]
   s. [**Spacefile International Corp.**]
   t. [**Spacesaver Corporation**]
   u. [**Tennsco**]
   v. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
   w. [**Western Pacific Storage Systems**]

2. Load-Carrying Capacity per Shelf: [**350 lb (159 kg)**][**700 lb (318 kg)**][**1500 lb (680 kg)**][**As indicated on Drawings**].
3. Posts: Fabricated from hot-rolled steel; in [**angle**][**offset-angle**][**beaded**][**T**][**tubular T**][**V**][**box**][**manufacturer's standard**] shape; with perforations at **1-1/2 inches (38 mm)** o.c. to receive shelf-to-post connectors.

a. Unit Configuration: Configure shelving units as [**individual, freestanding**][**starter- and add-on unit**] assemblies.

1) Add-On Shelf Posts: Fabricated from hot-rolled steel, [**T**][**manufacturer's standard**] shape; perforated to match main posts.

b. Post Base: [**Bolt leveler**][**Adjustable steel floor plate, drilled for floor anchors**].

4. Bracing: Manufacturer's standard, [single][double] diagonal cross bracing.

a. Location: At unit [**back**][**and**][**ends**] as required for stability, load-carrying capacity of shelves, and number of shelves indicated.

5. Back Panel: [**One piece**][**Two half panels**] fabricated from cold-rolled steel sheet.

a. Steel Sheet Thickness, Nominal: [**0.024 inch (0.61 mm)**][**As required for load-carrying capacity per shelf**].

6. End Panels: Fabricated from cold-rolled steel sheet.

a. Steel Sheet Thickness, Nominal: [**0.024 inch (0.61 mm)**][**As required for load-carrying capacity per shelf**].

7. Solid-Type Shelves:

a. Steel Sheet: Nominal thickness [**0.030 inch (0.76 mm)**][**0.036 inch (0.91 mm)**][**0.048 inch (1.21 mm)**][**as required for load-carrying capacity per shelf**].
b. Metallic-Coated Steel Sheet: Nominal thickness [**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**][**as required for load-carrying capacity per shelf**].
c. Slots or Holes for Shelf Dividers: [**2 inches (51 mm)**][**3 inches (76 mm)**] o.c.
d. Fabricate fronts and backs of shelves with box-formed edges, with corners lapped and welded.
e. Fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel [bars][angles][channels].

8. Framed-Type Wire Shelves: [**Steel**][**Metallic-coated-steel**] wire; with shelf frame fabricated from same material and with same finish as posts.
9. Truss-Type Wire Shelves: [**Steel**][**Metallic-coated-steel**][**Stainless steel**][**Manufacturer's standard, chrome-plated**] wire-over-wire construction, with downturned wire truss edges.
10. Shelf Quantity: [**Three**][**Four**][**Five**][**Six**] shelves per shelving unit in addition to top and bottom shelf.
11. Shelf-to-Post Connectors: [**Mechanical fasteners (nuts and bolts)**][**Compression clips**][**Support clips**][**Containment clips**][**Horizontal supports with rivet connectors to post**][**Manufacturer's standard connectors**].
12. Base: [**Open, with exposed post legs**][**Closed, with base strips fabricated from same material and with same finish as shelving**].
13. Overall Unit Width: [**30 inches (762 mm)**][**36 inches (914 mm)**][**42 inches (1067 mm)**][**48 inches (1219 mm)**], inclusive of two end posts.
14. Overall Unit Depth: [**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**].
15. Overall Unit Height: [**72 inches (1829 mm)**][**84 inches (2134 mm)**][**96 inches (2438 mm)**].
16. Accessories:

a. Finished End Panels: Fabricated as [**solid**][**perforated**] full-height panels from manufacturer's standard thickness cold-rolled steel sheet and with same finish as posts, with trim for a finished appearance along edges abutting posts and top shelf.

b. Shelf Dividers: Fabricated from same material and with same finish as shelves; [**full-height**][**angle**][**tapered**][**sliding**] type.
c. Bins: Fabricated from same material and with same finish as shelves; [**size as indicated on Drawings**].
d. Shelf-Label Holders: [**Clear**][**Colored**] plastic, designed to clip onto front edge of shelf.

17. Steel Finish: [Baked enamel][powder coat].

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Wire-Type, Four-Post Metal Storage Shelving : Complying with MH 28.1; field assembled from factory-formed components. Shelves span between supporting corner posts that allow shelf-height adjustment over full height of shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMCO Corporation**]
b. [**Aurora Storage Products, Inc.**]
c. [**Gillis Associated Industries**]
d. [**InterMetro Industries Corporation; an Ali Group Company**]
e. [**Lyon LLC**]
f. [**Nexel Industries; Global Industrial Storage Solutions**]
g. [**Safco Products Company**]
h. [**Spacesaver Corporation**]
i. [**Tennsco**]

2. Load-Carrying Capacity per Shelf: [**200 lb (91 kg)**][**600 lb (272 kg)**][**1200 lb (544 kg)**][**As indicated on Drawings**], uniformly distributed.
3. Posts: Fabricated from **1-inch- (25-mm-)** OD, [**square**][**round**] tubing of indicated material; with grooves or notches at **1 inch (25 mm)** o.c. to receive shelf-to-post connectors. Label posts with numbers at not less than **2 inches (51 mm)** o.c. for determining shelf height.

a. Post Material: [**Steel**][**Stainless steel**].
b. Post Base: [**Bolt leveler**][**Adjustable steel floor plate, drilled for floor anchors**].
c. Post Cap: Nylon or plastic.
d. Unit Configuration: Configure shelving units as [**individual, freestanding**][**starter- and add-on unit**] assemblies.

4. Framed-Type Wire Shelves: [**Steel**][**Metallic-coated-steel**][**Stainless steel**] wire-over-wire construction, with shelf frame fabricated from same material and with same finish as posts; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
5. Truss-Type Wire Shelves: [**Steel**][**Metallic-coated-steel**][**Stainless steel**][**Manufacturer's standard, chrome-plated**] wire-over-wire construction, with downturned wire truss edges; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
6. Waterfall-Type Wire Shelves: [**Steel**][**Metallic-coated-steel**][**Stainless steel**] wire-over-wire waterfall construction; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
7. Shelf Quantity: [**Three**][**Four**][**Five**][**Six**] shelves per shelving unit in addition to top and bottom shelf.
8. Shelf-to-Post Connectors: Manufacturer's standard one-piece collet (wedge), designed to engage

post collar attached to shelves.

9. Bracing: Manufacturer's standard diagonal cross bracing, as required for stability, load-carrying capacity of shelves, and number of shelves.
10. Overall Unit Width: [**24 inches (610 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**], inclusive of two end posts.
11. Overall Unit Depth: [**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**].
12. Overall Unit Height: [**60 inches (1524 mm)**][**72 inches (1829 mm)**][**84 inches (2134 mm)**].
13. Accessories:

    a. Shelf Dividers: Fabricated from same material and with same finish as shelves; [**full-height**][**angle**][**tapered**][**sliding**] type.
    b. Shelf Inlay: Manufacturer's standard [**clear plastic**][**static-dissipative plastic**][**hardboard**] mat.
    c. Storage Basket: Edge-of-shelf-mounted wire basket, ; fabricated from same material and with same finish as shelves.
    d. Back Ledges: [**1 inch (25 mm)**][**4 inches (102 mm)**] high, fabricated from same material and with same finish as shelves.
    e. Side Ledges: [**1 inch (25 mm)**][**4 inches (102 mm)**] high, fabricated from same material and with same finish as shelves.
    f. Garment Hanger Tube: Width of [**21 inches (533 mm)**][**shelves**]; with mounting brackets.
    g. Shelf-Label Holders: [**Clear plastic**][**Colored plastic**][**Cold-rolled steel sheet**], designed to clip onto front edge of shelf.

14. Steel Finish: [**Baked enamel or powder coat**][**Manufacturer's standard chrome plated**].

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

15. Stainless Steel Finish: [**No. 4 directional-satin finish**][**Manufacturer's standard nondirectional-polish finish**].

2.4 POST-AND-BEAM METAL STORAGE SHELVING

A. Post-and-Beam Metal Shelving: Complying with MH 28.2; field-assembled from factory-formed components. Shelves are supported by beams that span between supporting corner posts that allow beam-height adjustment over full height of shelving unit. Provide fixed top and bottom beams, adjustable intermediate beams, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Borroughs Corporation**]
    b. [**Edsal Manufacturing Company, Inc.**]
    c. [**EQUIPTO**]
    d. [**Interlake Mecalux**]
    e. [**Lyon LLC**]
    f. [**Penco Products, Inc.**]
    g. [**Republic Storage Systems, LLC**]
    h. [**Rousseau Metal Inc**]
    i. [**Schaefer Systems International, Inc**]
    j. [**Tennsco**]

k. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
l. [**Western Pacific Storage Systems**]

B. Load-Carrying Capacity per Shelf: [**400 lb (181 kg)**][**1000 lb (454 kg)**][**2000 lb (907 kg)**][**As indicated on Drawings**], uniformly distributed.

C. Posts: Fabricated from cold-rolled steel; in [**manufacturer's standard**][**manufacturer's standard angle or open-box**][**1-1/2-by-1-1/2-inch (38-by-38-mm) angle**][**open-box**] shape; with perforations at **1-1/2 inches (38 mm)** o.c. to receive beam-to-post connectors.

1. Unit Configuration: Configure shelving units as [**individual, freestanding**][**starter- and add-on unit**] assemblies.
2. Steel Thickness, Nominal: [**0.075 inch (1.90 mm)**][**As required for load-carrying capacity per shelf and number of shelves**].

   a. Add-On Shelf Posts: Fabricated from hot-rolled steel, T-shape; perforated to match main posts and of same thickness.

3. Post Base: Cold-rolled steel floor plate, drilled for floor anchors.

D. Beams: Fabricated from cold-rolled steel; in [**channel**][**flanged**][**channel or flanged**][**manufacturer's standard**] shape. Provide beam at each side of each shelf, with center supports as required for load-carrying capacity of shelf.

1. Steel Thickness, Nominal: [**0.075 inch (1.90 mm)**][**As required for load-carrying capacity per shelf**].
2. Beam-to-Post Connectors: Projecting [**rivet**][**tab**][**manufacturer's standard**] at each end that engage posts.

   a. Top and Bottom Shelf Beams: Provide with [**single**][**double**] beam-to-post connectors.
   b. Intermediate Shelf Beams: Provide with [**single**][**double**] beam-to-post connectors.

3. Beam Quantity: [**As required for number of shelves indicated**] per shelving unit.

E. Particleboard Shelves: 5/8 inch (16 mm) thick; [factory][field] cut.

F. Flat Metal Shelves: Fabricate [**fronts and backs**][**fronts, backs, and sides**] of shelves with box-formed edges, with corners lapped and welded from the following material:

1. Steel Sheet: Nominal thickness [**0.030 inch (0.76 mm)**][**0.036 inch (0.91 mm)**][**0.048 inch (1.21 mm)**][**as required for load-carrying capacity per shelf**].
2. Metallic-Coated Steel Sheet: Nominal Thickness [**0.034 inch (0.86 mm)**][**0.040 inch (1.02 mm)**][**0.052 inch (1.32 mm)**][**as required for load-carrying capacity per shelf**].

G. Ribbed-Metal-Decking Shelves: Fabricated from [**0.036-inch- (0.91-mm-)**] nominal thickness steel sheet.

H. Wire Shelves: Welded steel wire; with [**2-by-4-inch (51-by-102-mm)**][**Manufacturer's standard**] openings.

I. Shelf Quantity: [**Three**][**Four**][**Five**][**Six**] shelves per shelving unit in addition to top and bottom shelf.

J. Overall Unit Width: [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**69 inches (1753 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**], inclusive of two end posts.

K. Overall Unit Depth: [**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].

L. Overall Unit Height: [**60 inches (1524 mm)**][**72 inches (1829 mm)**][**84 inches (2134 mm)**][**96 inches (2438 mm)**].

M. Accessories:

1. Tie Plates: Cold-rolled steel, finished to match posts; designed for joining posts of adjacent shelving units.
2. Supports: [**Back-to-wall**][**and**][**back-to-back**] type that bolt to posts; as required for shelving unit stability.
3. Record Boxes: Knocked-down, corrugated fiberboard with white finish and contrasting contents legend; with prepunched handles and matching separate lid.

   a. Letter/Legal-Size Boxes: **12-1/2 inches wide by 16 inches deep by 10-1/2 inches high (318 mm wide by 406 mm deep by 267 mm high)** for letter-size material stored left to right and legal-size material stored front to back.
   b. Letter-Size Boxes: **12-1/2 inches wide by 24 inches deep by 10-1/2 inches high (318 mm wide by 610 mm deep by 267 mm high)** for letter-size material stored left to right.

4. Record Box Support Rails: **1-1/2-by-1-1/2-inch (38-by-38-mm)** metal angle, with length to match depth of shelving unit; fabricated from same material and with same finish as beams.

N. Steel Finish: [Baked enamel][powder coat].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 ANCHORS

A. Floor Anchors: Galvanized-steel, [post-installed expansion anchors][power-actuated fasteners][threaded concrete screws]. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.

B. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide [**one**] per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.6 FABRICATION

A. Fabricate metal storage shelving components to provide field-assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.

1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
2. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
3. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.

B. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible

without causing grain separation or otherwise impairing the Work.[**Form backs of shelving units of up to 48 inches (1219 mm) wide from one piece.**]

C. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a hem on the concealed side; ease edges of metal plate to radius of approximately **1/32 inch (0.8 mm)**. Shear and punch metals cleanly and accurately. Remove burrs.

D. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so surface is smooth after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Examine [**walls**][**and**][**ceilings**] to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum and clean finished floor over which metal storage shelving is to be installed.

3.3 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.

1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
3. Adjust post-base bolt leveler to achieve level and plumb installation.
4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
5. Install seismic restraints.
6. Connect [**side-to-side**][**and**][**back-to-back**] shelving units together.
7. Install shelves in each shelving unit at [**spacing indicated on Drawings**][**equal spacing**].

    a. Case-Type Metal Storage Shelving: Install adjustable shelf clips at front and back of each shelf.
    b. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.

c. Post-and-Beam Metal Storage Shelving: Install beams with beam-to-post connectors fully engaged in post perforations.

B. Accessories:

1. Install finished end panels and trim at exposed ends of shelving units.
2. Shelf Dividers: Install [**at locations indicated on Drawings**].
3. Bins: Install [**at locations indicated on Drawings**].
4. Shelf-Label Holders: Install [**one**] on each shelf.

   a. Install [**centered**][**vertically aligned**][**at locations indicated on Drawings**] within each shelving unit.

5. Record Box Support Rails: Provide two for each record storage box.
6. Shelf Inlays: Install [**one per shelf**][**at locations indicated on Drawings**].
7. Storage Baskets: Install [**at locations indicated on Drawings**].
8. Back Ledges: Install [**one per shelf**][**at locations indicated on Drawings**].
9. Side Ledges: Install [**on each side of each shelf**][**at locations indicated on Drawings**].
10. Garment Hanger Tubes: Install [**at locations indicated on Drawings**].

3.4 ERECTION TOLERANCES

A. Erect [**case-type**][**and**][**four-post**] metal storage shelving to a maximum tolerance from vertical of **1/2 inch (13 mm)** in up to **10 ft. (3 m)** of height, not exceeding **1 inch (25 mm)** for heights taller than **10 ft. (3 m)**.

B. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of **1/4 inch (6 mm)** in **84 inches (2134 mm)** of height.

3.5 ADJUSTING

A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.

B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.

C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.

D. Replace metal storage shelving components that have been damaged beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 56 13 00

Task	Specification	Specification Description
10 56 13 16	10 56 13 00	Metal Storage Shelving
10 71 13 13	01 22 00 00	No Specification Required
10 71 16 13	01 22 00 00	No Specification Required
10 71 16 16	01 22 00 00	No Specification Required

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SECTION 10 73 13 00 - AWNINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed awnings.
2. Manually operated retractable awnings.
3. Motorized retractable awnings.

B. Related Requirements:

1. Section 108316 "Banners" for ornamental fabrics for interior or exterior use.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for awnings.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, mounting heights, and attachment details.
2. Detail fabrication and assembly of awnings[including seam layout, spacing, and orientation of awning fabric].
3. Include diagrams for power, signal, and control wiring.
4. Show locations for blocking, reinforcement, and supplementary structural support.
5. Graphics: Show text message, font, character sizes, and other graphic forms; character, word, and line spacing; margin widths; position of copy; and other information related to graphic design.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of graphics[**on fabric**] and accessories involving color or finish selection.

E. Samples for Verification: For the following:

1. Awning Fabric: **12-inch- (300-mm-)** square section of fabric from dye lot to be used for the Work, with specified treatments applied. Mark face of fabric.
2. Graphics: Not less than **12-inch- (300-mm-)** square section showing graphics application method.
3. Seam, Edge, and Corner Condition: Not less than **12-inch- (300-mm-)** long section showing seam, edge, and corner treatment.
4. Valance: Full-size unit, not less than **12 inches (300 mm)** long.

5. Frame Finish: Not less than **6-inch (150-mm)** lengths.

F. Product Schedule: For awnings. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For awnings to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including framework.
b. Deterioration of fabric including seam failure.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Faulty operation of operator.

2. Awning Warranty Period: [**Five**] years from date of Substantial Completion.
3. Fabric Warranty Period: [**Three**][**Five**][**Eight**][**12**] years from date of Substantial Completion.
4. Thread Warranty Period: [**Five**][**Eight**] years from date of Substantial Completion.
5. Graphics Warranty Period: Outdoor durability not less than [**five**][**three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

B. Fire-Test-Response Characteristics: Provide awning fabrics with the fire-test-response characteristics indicated, as determined by testing identical products according to test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes [**NFPA 701**][**California Code of Regulations, Title 19**].
2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency for Flame-Spread Index of [**25**] or less.
3. Permanently attach label to each awning fabric indicating whether fabric is inherently and permanently flame resistant or is treated with flame-retardant chemicals, and whether it requires retreatment after designated time period or cleaning.

2.2 FABRIC

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Fabric:

1. Fiber Content: [**Vinyl-laminated or -coated polyester mesh**][**Vinyl-laminated or -coated polyester**][**Acrylic-coated polyester**][**Resin-coated polyester**][**Vinyl-coated polyester/cotton blend**][**Acrylic-coated polyester/cotton blend**][**Resin-coated polyester/cotton blend**][**Solution-dyed acrylic**][**Solution-dyed modacrylic**][**Expanded PTFE**].
2. .
3. Mildew Resistance: Showing no growth when tested according to ASTM G21.
4. Shrinkage: Not greater than [**0.1**][**0.5**][**1**] percent according to ASTM D1204.
5. Stretch Factor: Not less than [**0.4**][**1**][**4**] percent according to ASTM D4851.
6. Applied Treatment: [**Stain resistant**][**Mildew resistant**][**Polymer, flame resistant**][**Water repellent**][**Lamination**].
7. Pattern and Color: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in an awning schedule**], as directed by the Owner.

C. Seam Thread: [**100 percent expanded PTFE**][**100 percent bonded polyester**], UV-light, mildew, and rot resistant.

D. Decorative Trims: [**Borders**][**Braid and bindings**][**Cords**][**Fringe**][**Patterned edge; scalloped**][**Patterned edge; V-shaped**][**Streamers**][**Tassels**][**Welting**].

1. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**Matching or coordinating with awning fabric color**][**As selected by Architect from manufacturer's full range**][**As indicated in an awning schedule**], as directed by the Owner.

E. Fringe: [**As indicated by manufacturer's designation for style and color**][**As indicated in awning schedule**].

2.3 AWNING FRAME AND ACCESSORY MATERIALS

A. Steel:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Steel Tubing: ASTM A500/A500M.
3. Galvanized Steel Tubing: ASTM A787/A787M.
4. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40).

B. Aluminum: Alloy and temper recommended by awning manufacturer for type of use and finish indicated and with not less than the strength and durability properties of alloy and temper required by structural loads.

1. Aluminum Plate and Sheet: **ASTM B209 (ASTM B209M)**.
2. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.
3. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, standard weight (Schedule 40).
4. Drawn Seamless Tubing: **ASTM B210 (ASTM B210M)**.

C. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant or noncorrodible units; weather-resistant, [**tamperproof, vandal- and theft-resistant,**]compatible, nonstaining materials. Provide as required for awning assembly, mounting, and secure attachment. Number as needed to comply with performance requirements and to maintain uniform appearance; evenly spaced. Where exposed to view, provide finish and color as selected by Architect from manufacturer's full range, as directed by the Owner.

1. Wood Screws: ASME B18.6.1.
2. Lag Bolts: **ASME B18.2.1 (ASME B18.2.3.8M)**.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M,**Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH, (ASTM A563M, Class 10S)** heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers, zinc coated.
4. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E488 conducted by a qualified independent testing and inspecting agency.

   a. Material: Stainless steel with bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4)**.

5. Adhesive-Bonded Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E1512 conducted by a qualified independent testing and inspecting agency.

   a. Material: Stainless steel with bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4)**.

6. Grommets: [**Zinc-coated brass, No. 2**][**Stainless steel, No. 2**].
7. Lacing: [**100 percent polyester, braided No. 4**].

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.4 AWNING FABRIC FABRICATION

A. Fabrication: Reinforce wear points and hardware attachment points with [**nonwoven**][**mesh**][**polypropylene mesh**] webbing. Seam fabrics [**in locations indicated on the Drawings and**] as follows:

1. Fabric Edges and Seams:

a. Fold and stitch selvedge and cut fabric edges.
b. Hot cut and sealed.
c. Radio-frequency welded.
d. Adhesively bonded.
e. Manufacturer's standard hemming and seaming methods.

2. Fabric Attachment:

a. [**Manufacturer's standard**][**Hem pockets**][**Screws**][**Staples**].
b. Grommets.

1) Grommet Spacing: [**6 inches (150 mm) o.c.**].

B. Fabric Insets: [**Heat-sealed**][**Sewn-in**] process.

C. Graphic Application: [**Hand painting**][**Silk-screen printing**][**Heat color transfer**][**Vinyl film with pressure-sensitive adhesive backing**][**PVDF film with pressure-sensitive adhesive backing**][**PVF film with pressure-sensitive adhesive backing**][**Radio-frequency, heat-sealed vinyl film**][**Eradication**][**Cut-out lettering**].

1. Graphic Image: [**As indicated on Drawings**][**As indicated in awning schedule**].
2. Text Message: [**As indicated on Drawings**][**As indicated in an awning schedule**].

a. Text Font: [**Arial**].
b. Character Size: Minimum [**1-inch- (25.4-mm-)**][**1-foot- (0.3048-m-)**] high characters.

3. Vinyl Film: [**Calendered-vinyl film, not less than 3 mils (0.076 mm) thick, with pressure-sensitive adhesive backing**][**Cast-vinyl film, not less than 2 mils (0.051 mm) thick, with pressure-sensitive adhesive backing**][**Cast-vinyl reflective film, not less than 2 mils (0.051 mm) thick, with pressure-sensitive adhesive backing**].

2.5 FIXED AWNINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Steel Finish: [**Galvanized mill finish; apply galvanizing repair paint to welds.**][**Manufacturer's standard primed and top-coated decorative**][**Baked-enamel or powder-coat**] finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Aluminum Finish: [**Mill**][**Manufacturer's standard primed and top-coated decorative**][**Baked-enamel**

or powder-coat] finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 MANUALLY OPERATED RETRACTABLE AWNINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

B. Type: Retractable awning, fabricated form aluminum, with hinged arms attached to [**steel**] torsion bar with tensioning system designed to keep fabric taut in any position.

C. Fabric Roll Protection: [**Cassette design to fully enclose**][**Semi-cassette design to partially enclose**][**Sheet metal hood to protect**] fabric roll when awning is retracted.

D. Manual Operator: Provide gear and crank operator.

1. Manual Operator Assist Mechanism: Manufacturer's standard spring assist for operating heavy awnings.
2. Crank Handle: [**One**][**Two**], detachable.
3. Awning Coupler System: Designed for simultaneously operating multiple awnings with a single crank. Provide system [**for each group of awnings**][**where indicated on Drawings**][**where indicated in an awning schedule**].
4. Operating Function: [**Stop and hold awning at any position in ascending or descending travel**][**Stop and hold awning at fully open or fully closed positions only**].

E. Mounting Brackets: Configured for mounting to surface indicated, with adjustable pitch.

F. Finish: [**Manufacturer's standard primed and top-coated decorative**][**Baked-enamel or powder-coat**] finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.7 MOTORIZED RETRACTABLE AWNINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eclipse Shading Systems**]
2. [**Markilux USA**]
3. [**Somfy Systems Inc.**]

B. Type: Retractable awning, fabricated form aluminum, with hinged arms attached to [**steel**] torsion bar, with tensioning system designed to keep fabric taut in any position.

C. Fabric Roll Protection: [**Cassette design to fully enclose**][**Semi-cassette design to partially**

enclose][**Sheet metal hood to protect**] fabric roll when awning is retracted.

D. Motorized Operator: Provide factory-assembled, motorized, retractable-awning operator designed for retracting awnings of type, size, weight, construction, use, and operation frequency indicated.

E. Mounting Brackets: Configured for mounting to surface indicated, with adjustable pitch.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6[**with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc**].

H. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection and internal limit switches; sized by awning manufacturer to start and operate size and weight of awning considering service factor or considering Project's service conditions without exceeding nameplate ratings.

1. Service Factor: According to NEMA MG 1 unless otherwise indicated.
2. Motor Characteristics: Single phase, [**24**][**110**][**220**] V, 60 Hz.
3. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
4. Motor Mounting: Within manufacturer's standard roller enclosure.

I. Remote Controls: Electric controls with NEMA ICS 6, [**Type 1**][**Type 4**] enclosure for [**surface**][**recessed or flush**] mounting. Provide the following devices for remote-control activation of awnings:

1. Keyed Control Stations: [**Maintained**][**Momentary**]-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
2. Control Stations: [**Maintained**][**Momentary**]-contact, three-position, [**toggle**][**rocker**]-style, wall-switch-operated control station with open, close, and center-off functions.

   a. Function: [**Individual**][**Group**][**Combined individual and group**].
   b. Color: [**Ivory**][**White**][**As indicated in an awning schedule**].

3. Sun Sensor Controls: Programmable system activated by LEDs detecting daylight intensity and responding by automatically adjusting awnings.
4. Radio Controls: Digital system consisting of code-compatible universal coaxial receiver, [**one per awning**][**where indicated on Drawings**].

   a. Single Channel Radio Transmitters: Portable single-channel transmitters for operating a single motor with a single button to open and retract awning; provide [**two**] units.
   b. Multi-Channel Radio Transmitters: Portable multi-channel transmitters for operating [**two**][**four**][**up to 12**] awnings individually, each with a single button to open and close awnings; provide [**two**] units.

5. Timer Controls: Clock timer, [**24-hour**][**seven-day**] programmable for regular events.
6. Microprocessor Controls: Electronic programmable means for setting, changing, and adjusting control features. Provide unit isolated from voltage spikes and surges.

J. Operating Features: Include the following:

1. Capable of accepting input from building automation control system.
2. Override switch.
3. Backup gear and crank operator for manual operation during power failures with detachable

handle, [**6 feet (1.8 m) long**][**manufacturer's standard length**][**length required to make operation convenient from ground level**][**length as indicated on Drawings**].

4. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop awning at fully raised and fully lowered positions.
5. Preset Position Function: [**Stop and hold awning at any position**][**Stop and hold awning at three predetermined positions including open, closed, and one user-programmed position**].

K. Finish: [**Manufacturer's standard primed and top-coated decorative**][**Baked-enamel or powder-coat**] finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, [**operational clearances, accurate locations of connections to building electrical system,**][**lighting,**] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install awnings[**and motor controls**] at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Install awnings after other finishing operations, including joint sealing and painting, have been completed.

C. Slip fit frame connections accurately together to form hairline joints, and tighten to secure.

D. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

1. Field Welding: Comply with the following requirements:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation

accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

G. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and in a manner that prevents exterior moisture from passing through completed exterior wall and roof assemblies.

3.3 ADJUSTING

A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by retractable-awning manufacturer.

3.4 CLEANING AND PROTECTION

A. Touch up factory-applied finishes to restore damaged or soiled areas.

B. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A780.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain retractable awnings.

END OF SECTION 10 73 13 00

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Task	Specification	Specification Description
10 73 13 13	10 73 13 00	Awnings
10 73 13 23	10 73 13 00	Awnings
10 73 26 13	01 22 00 00	No Specification Required

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SECTION 10 75 16 00 - GROUND-SET FLAGPOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum flagpole.
2. Copper-alloy (bronze) flagpole.
3. Stainless steel flagpole.
4. Steel flagpole.
5. Fiberglass flagpole.

B. Products Installed, but Not Furnished, under This Section:

1. Flag(s); furnished by the Owner.

C. Related Requirements:

1. Section 033000 "Cast-In-Place Concrete" for concrete footings for flagpole.
2. Section 264113 "Lightning Protection for Structures" for connecting metal flagpole to lightning protection system.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpole.

B. Shop Drawings: Include plans, elevations, and attachment details. Show general arrangement, fittings, accessories, grounding, anchoring, and support details.

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

E. Delegated Design Submittals: For flagpoles, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flagpoles.

1.4 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in

[**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpole with heavy paper and enclose in a hard fiber tube or other protective container.

B. Unload, store, and erect flagpole in a manner to prevent bending and surface damage.

1.6 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of flagpole and accessories in accordance with manufacturers' written installation instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain flagpole as complete unit, including fittings and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Flagpole assemblies to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

B. Structural Performance: Flagpole assemblies, including anchorages and supports, to withstand design loads within limits and under conditions indicated.

1. Wind Loads: Determine in accordance with NAAMM FP 1001. Basic wind speed for Project location as indicated on Drawings.
2. Base flagpole design on [**polyester**][**nylon or cotton**] flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.3 GROUND-SET FLAGPOLES

A. Aluminum Flagpole: Fabricated from extruded tubing complying with ASTM B221 (ASTM B221M), Alloy 6063, minimum wall thickness of **3/16 inch (4.8 mm)**, without visible seam.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Lingo Flagpoles**]
b. [**Concord American Flagpole**]
c. [**Eder Flag Manufacturing Company, Inc**]
d. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]

e. [**Liberty Flagpoles**]
f. [**Morgan-Francis Flagpoles and Accessories**]
g. [**Pole-Tech Co., Inc.**]

2. Shape: [**Cone**][**Entasis**] tapered.
3. Exposed Height: [**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**35 ft. (11 m)**][**40 ft. (12 m)**][**45 ft. (13.5 m)**][**50 ft. (15 m)**][**60 ft. (18 m)**][**70 ft. (21 m)**][**80 ft. (24 m)**] .
4. Construct flagpole in one piece if possible. If more than one piece is necessary, comply with the following:

   a. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
   b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

5. Natural Satin Finish: [**AA-M32, fine, directional, medium satin polish**][**AA-M20, buff finish**] ; seal aluminum surfaces with clear, hard-coat wax.
6. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] .
7. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] .

   a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

8. Gold Anodic Finish: AAMA 611, AA-M32C22A43, Class I, 0.018 mm; gold color.
9. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

10. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

11. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, **0.060-inch (1.52-mm)** wall thickness with **3/16-inch (4.8-mm)** steel bottom plate and support plate; **3/4-inch (19-mm-)** diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

    a. Flashing Collar: Same material and finish as flagpole.

12. Foundation Sleeve: [Fiberglass][PVC pipe] foundation sleeve, made to fit flagpole, for casting into concrete foundation.

    a. Flashing Collar: Same material and finish as flagpole.

13. Cast-Metal Shoe Base: Made from aluminum [**with same finish and color as flagpoles**] for

anchor-bolt mounting; furnish with anchor bolts.

a. Furnish ground spike.

14. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.

a. Finish: Same as flagpole.
b. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
c. Furnish ground spike.

15. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Furnish tilting flagpole with steel counterweight box and weights, or furnish with internal counterweight. Furnish base with anchor bolts.

a. Finish: Same as flagpole.
b. Furnish ground spike.

B. Copper-Alloy (Bronze) Flagpole: Fabricated from seamless pipe or tube complying with ASTM B43 or ASTM B135/B135M, Alloy UNS C23000 (red brass, 85 percent copper).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Lingo Flagpoles**]
b. [**Eder Flag Manufacturing Company, Inc**]
c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
d. [**Pole-Tech Co., Inc.**]

2. Shape: [**Cone**][**Entasis**] tapered.
3. Exposed Height: [**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**35 ft. (11 m)**][**40 ft. (12 m)**][**45 ft. (13.5 m)**][**50 ft. (15 m)**][**60 ft. (18 m)**][**70 ft. (21 m)**][**80 ft. (24 m)**] .
4. Construct flagpole in one piece if possible. If more than one piece is necessary, comply with the following:

a. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

5. Hand-Rubbed Finish, Lacquered: Directionally textured, fine satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.
6. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.

a. Color: Match Architect's sample, as directed by the Owner.
b. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

7. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, **0.060-inch (1.52-mm)** wall thickness with **3/16-inch (4.8-mm)** steel bottom plate and support plate; **3/4-inch (19-mm)** diameter, steel ground spike; and steel centering wedges welded together. Galvanize

foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

a. Flashing Collar: Same material and finish as flagpole.

8. Cast-Metal Shoe Base: Made from steel [**with finish matching flagpole**] for anchor-bolt mounting; furnish with anchor bolts.

a. Furnish ground spike.

C. Stainless Steel Flagpole: Fabricated from pipe, tube, or plate complying with ASTM A312/A312M, ASTM A269/A269M, or ASTM A666/A666M [**Type 304**][**Type 316L**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Acme Lingo Flagpoles**]
b. [**Eder Flag Manufacturing Company, Inc**]
c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
d. [**Pole-Tech Co., Inc.**]

2. Shape: [**Cone**][**Entasis**] tapered.
3. Exposed Height: [**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**35 ft. (11 m)**][**40 ft. (12 m)**][**45 ft. (13.5 m)**][**50 ft. (15 m)**][**60 ft. (18 m)**][**70 ft. (21 m)**][**80 ft. (24 m)**] .
4. Construct flagpole in one piece if possible. If more than one piece is necessary, comply with the following:

a. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

5. Stainless Steel Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
c. Brushed Finish: ASTM A480/A480M No. 4.
d. Mirror Polish Finish: ASTM A480/A480M No. 8.

6. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, **0.060-inch (1.52-mm)** wall thickness with **3/16-inch (4.8-mm)** steel bottom plate and support plate; **3/4-inch (19-mm)** diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

a. Flashing Collar: Same material and finish as flagpole.

7. Cast-Metal Shoe Base: Made from steel [**with finish matching flagpole**] for anchor-bolt mounting; furnish with anchor bolts.

a. Furnish ground spike.

D. Steel Flagpole: Fabricated from standard-weight, seamless steel pipe complying with ASTM A53/A53M, Type S, Grade B, or steel tube complying with ASTM A513/A513M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Acme Lingo Flagpoles**]
    b. [**Eder Flag Manufacturing Company, Inc**]
    c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
    d. [**Pole-Tech Co., Inc.**]

2. Shape: [**Cone tapered**][**Stepped sectional**] .
3. Exposed Height: [**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**35 ft. (11 m)**][**40 ft. (12 m)**][**45 ft. (13.5 m)**][**50 ft. (15 m)**][**60 ft. (18 m)**][**70 ft. (21 m)**][**80 ft. (24 m)**] .
4. Construct flagpole in one piece if possible. If more than one piece is necessary, comply with the following:

    a. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
    b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
    c. Provide self-aligning, snug-fitting joints.

5. Flagpole Interior Finish: Apply one coat of bituminous paint on interior of flagpole.
6. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A123/A123M.

    a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

7. Baked-Enamel or Powder-Coat Finish: Remove mill scale and rust, if present, from uncoated steel, complying with [**NACE No. 1/SSPC-SP, "White Metal Blast Cleaning"**] . After cleaning, apply a conversion coating suited to the organic coating to be applied over it. After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

8. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, **0.060-inch (1.52-mm)** wall thickness with **3/16-inch (4.8-mm)** steel bottom plate and support plate; **3/4-inch (19-mm)** diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

    a. Flashing Collar: Same material and finish as flagpole.
    b. Furnish steel ground protectors extending **12 inches (300 mm)** aboveground and **6 inches (150 mm)** belowground for steel flagpoles where flashing collars are not provided.

9. Cast-Metal Shoe Base: Made from steel [**with finish matching flagpole**] for anchor-bolt mounting; furnish with anchor bolts.

    a. Furnish ground spike.

E. Fiberglass Flagpole: flagpole fabricated from polyester resin reinforced with woven glass-fiber roving with 75 percent of glass fibers parallel to length of flagpole.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flagmore**]
b. [**Liberty Flagpoles**]
c. [**PLP Composite Technologies, Inc**]
d. [**Pole-Tech Co., Inc.**]

2. Shape: [**Cone**][**Entasis**] tapered.
3. Exposed Height: [**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**35 ft. (11 m)**][**40 ft. (12 m)**][**45 ft. (13.5 m)**][**50 ft. (15 m)**][**60 ft. (18 m)**][**70 ft. (21 m)**][**80 ft. (24 m)**] .
4. Construct flagpole in one piece if possible. If more than one piece is necessary, comply with the following:

   a. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
   b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

5. Fiberglass Finish: Manufacturer's standard UV-light stable, hard, high-gloss gel coat or high-gloss, high-build polyurethane or polyester coating.

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] , as directed by the Owner.

6. Sleeve for Fiberglass Flagpole: [Fiberglass][PVC pipe] foundation sleeve, made to fit flagpole, for casting into concrete foundation.

   a. Flashing Collar: Same material and finish as flagpole.

7. Cast-Metal Shoe Base: Made from aluminum [**with finish matching flagpole**] for anchor-bolt mounting; furnish with anchor bolts.

   a. Furnish ground spike.

8. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.

   a. Finish: Same as flagpole.
   b. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
   c. Furnish ground spike.

2.4 FITTINGS

A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.

   1. **0.063-inch (1.6-mm) spun aluminum [finished to match flagpole][with gold anodic finish] .**
   2. **20-oz. (0.70-mm)** copper with 23-karat, gold-leaf finish.
   3. Spun stainless steel, finished to match flagpole.
   4. Spun copper alloy, finished to match flagpole.

B. Finial Eagle: Sized [**as indicated**][**as standard with manufacturer for flagpole size indicated**] .

   1. Cast aluminum [finished to match flagpole][with gold anodic finish] .

2. **20-oz. (0.70-mm)** copper with 23-karat, gold-leaf finish.

C. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

1. Halyard Flag Snaps: [**Chromium-plated bronze**][**Stainless steel**][**Bronze**][**Nylon**] swivel snap hooks [**with neoprene or vinyl covers**] . Furnish two per halyard.
2. Plastic Halyard Flag Clasps for Internal Halyard, Winch System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clasps attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

D. Internal Halyard, Cam Cleat System: [**5/16-inch (8-mm) diameter, braided polypropylene**] halyard; cam cleat; and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

1. Halyard Flag Snaps: [**Chromium-plated bronze**][**Stainless steel**][**Bronze**][**Nylon**] swivel snap hooks [**with neoprene or vinyl covers**] . Furnish two per halyard.
2. Plastic Halyard Flag Clasps for Internal Halyard, Cam Cleat System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clasps attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

E. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous [**5/16-inch (8-mm) diameter, braided polypropylene halyard**] and **9 inches (228-mm)** cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.

1. Halyards and Cleats: [**One**][**Two**] at each flagpole.
2. Cleat Covers: Cast metal, finished to match flagpole, secured with cylinder locks.
3. Halyard Covers: **2 inches (50-mm)** channel, **60 inches (1500 mm)** long, finished to match flagpole.
4. Halyard Flag Snaps: [**Chromium-plated bronze**][**Stainless steel**][**Bronze**][**Nylon**] swivel snap hooks [**with neoprene or vinyl covers**] . Furnish two per halyard.
5. Plastic Halyard Flag Clasps for External Halyard, Ball-Bearing System: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clasps attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

2.5 MISCELLANEOUS MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.

C. Sand: ASTM C33/C33M, fine aggregate.

D. Elastomeric Joint Sealant: [**Multicomponent nonsag urethane**][**Single-component nonsag urethane**][**Single-component neutral-curing silicone**] joint sealant complying with requirements in Section 079200 "Joint Sealants."

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.

B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.

C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concrete placement.

D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.

E. Sleeves: Locate and secure sleeves in forms by bracing to concrete reinforcement and forms.

F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to concrete reinforcement steel.

G. Place concrete as specified in Section 033000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.

H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.2 INSTALLATION OF GROUND-SET FLAGPOLES

A. General: Install flagpoles where indicated on Drawings and in accordance with approved Shop Drawings and manufacturer's written instructions.

B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a **2-inch (50-mm)** layer of elastomeric joint sealant and cover with flashing collar.

C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION 10 75 16 00

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SECTION 10 75 23 00 - WALL-MOUNTED FLAGPOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall-mounted flagpoles made from [**aluminum**][**copper alloy (bronze)**][**stainless steel**][**and**][**fiberglass**].

B. the Owner-Furnished Material: Flags.

C. Related Requirements:

1. Section 264113 "Lightning Protection for Structures" for connecting wall-mounted metal flagpoles to lightning protection system.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.

B. Shop Drawings: For flagpoles.

1. Include plans, elevations, and details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
2. Include details of wall-mounted connections and mountings.

C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

D. Delegated-Design Submittal: For flagpoles.

1. Include loads, point reactions, and locations for attachment of flagpoles to building's structure.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of anchorages for flagpoles. Furnish setting drawings, templates, and directions for installing anchorages that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design flagpole assemblies.

B. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

C. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.

1. Base flagpole design on [**polyester**][**nylon or cotton**] flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.3 ALUMINUM FLAGPOLES

A. Aluminum Flagpoles: [**Cone**][**Entasis**]-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B241/B241M, Alloy 6063, with a minimum wall thickness of **3/16 inch (4.8 mm)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acme Lingo Flagpoles**]
b. [**American Flagpole**]
c. [**Baartol Company**]
d. [**Concord American Flagpole**]
e. [**Eder Flag Manufacturing Company, Inc**]
f. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
g. [**Morgan-Francis Flagpoles and Accessories**]
h. [**Pole-Tech Co., Inc.**]
i. [**US Flag & Flagpole Supply, LLC**]

B. Exposed Length: [**8 feet (2.5 m)**][**10 feet (3 m)**][**12 feet (3.7 m)**][**15 feet (4.6 m)**][**20 feet (6 m)**][**25 feet (7.5 m)**][**30 feet (9 m)**].

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Vertical Wall Mount: Cast-aluminum mounting bracket complete with[**escutcheon,**] mounting plate and

through-wall anchorage.

1. Finish: [**Same as flagpole**][**Gold anodic**][**Bronze powder coated**][**Black powder coated**].

E. Outrigger Wall Mount: Aluminum mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: [**Same as flagpole**][**Gold anodic**][**Bronze powder coated**][**Black powder coated**].

2.4 COPPER-ALLOY (BRONZE) FLAGPOLES

A. Copper-Alloy (Bronze) Flagpoles: [**Cone**][**Entasis**]-tapered flagpoles fabricated from seamless pipe or tube complying with ASTM B43 or **ASTM B135 (ASTM B135M)**, Alloy UNS C23000 (red brass, 85 percent copper).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acme Lingo Flagpoles**]
b. [**Baartol Company**]
c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
d. [**Pole-Tech Co., Inc.**]

B. Exposed Length: [**20 feet (6 m)**][**25 feet (7.5 m)**][**30 feet (9 m)**][**35 feet (11 m)**][**40 feet (12 m)**].

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Vertical Wall Mount: Cast-copper-alloy (bronze) mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: Same as flagpole.

E. Outrigger Wall Mount: Copper-alloy (bronze) mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: Same as flagpole.

2.5 STAINLESS-STEEL FLAGPOLES

A. Stainless-Steel Flagpoles: [**Cone**][**Entasis**]-tapered flagpoles fabricated from pipe, tube, or plate complying with ASTM A312/A312M, ASTM A269, or ASTM A666, [**Type 304**][**Type 316L**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acme Lingo Flagpoles**]
b. [**Baartol Company**]
c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
d. [**Pole-Tech Co., Inc.**]

B. Exposed Length: [**20 feet (6 m)**][**25 feet (7.5 m)**][**30 feet (9 m)**][**35 feet (11 m)**][**40 feet (12 m)**].

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Vertical Wall Mount: Cast-aluminum mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: [**Clear anodic**][**Gold anodic**][**Bronze powder-coated**][**Black powder-coated**][**Silver powder-coated**].

E. Outrigger Wall Mount: Aluminum mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: [**Clear anodic**][**Gold anodic**][**Bronze powder-coated**][**Black powder-coated**][**Silver powder-coated**].

2.6 FIBERGLASS FLAGPOLES

A. Fiberglass Flagpoles: [**Cone**][**Entasis**]-tapered flagpoles fabricated from polyester resin reinforced with woven glass-fiber roving with 75 percent of glass fibers parallel to length of flagpole.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlantic Fiberglass Products, Inc.**]
b. [**Eder Flag Manufacturing Company, Inc**]
c. [**Ewing Flagpole Co., Inc.; Ewing Group Company**]
d. [**PLP Composite Technologies, Inc**]
e. [**Pole-Tech Co., Inc.**]

B. Exposed Length: [**20 feet (6 m)**][**25 feet (7.5 m)**][**30 feet (9 m)**][**35 feet (11 m)**][**40 feet (12 m)**].

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Vertical Wall Mount: Cast-aluminum mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: [**Matching flagpole**][**Gold anodic**][**Bronze powder-coated**][**Black powder-coated**].

E. Outrigger Wall Mount: Aluminum mounting bracket complete with[**escutcheon,**] mounting plate and through-wall anchorage.

1. Finish: [**Matching flagpole**][**Gold anodic**][**Bronze powder-coated**][**Black powder-coated**].

2.7 FITTINGS

A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.

1. **0.063-inch (1.6-mm) spun aluminum[finished to match flagpole][with gold anodic finish].**
2. **20-oz. (0.70-mm)** copper with 23-karat gold-leaf finish.
3. Spun stainless steel, finished to match flagpole.
4. Spun copper alloy, finished to match flagpole.

B. Finial Eagle: Sized [**as indicated**][**as standard with manufacturer for flagpole size indicated**].

1. Cast aluminum[finished to match flagpole][with gold anodic finish].
2. **20-oz. (0.70-mm)** copper with 23-karat gold-leaf finish.

C. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

1. Halyard Flag Snaps for Internal Halyard, Winch System: [**Chromium-plated bronze**][**Stainless steel**][**Bronze**][**Nylon**] swivel snap hooks[**with neoprene or vinyl covers**]. Furnish two per halyard.
2. Plastic Halyard Flag Clips for Internal Halyard, Winch System: Made from injection-molded, UV-stabilized acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acme Lingo Flagpoles**]

D. Internal Halyard, Cam Cleat System: [**5/16-inch- (8-mm-) diameter, braided polypropylene**] halyard; cam cleat; and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

1. Halyard Flag Snaps for Internal Halyard, Cam Cleat System: [**Chromium-plated bronze**][**Stainless-steel**][**Bronze**][**Nylon**] swivel snap hooks[**with neoprene or vinyl covers**]. Furnish two per halyard.
2. Plastic Halyard Flag Clips for Internal Halyard, Cam Cleat System: Made from injection-molded, UV-stabilized acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acme Lingo Flagpoles**]

E. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous [**5/16-inch- (8-mm-) diameter, braided polypropylene halyard**] and **9-inch (228-mm)** cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.

1. Halyards and Cleats: [**One**][**Two**] at each flagpole.
2. Halyard Flag Snaps for External Halyard, Ball-Bearing System: [**Chromium-plated bronze**][**Stainless-steel**][**Bronze**][**Nylon**] swivel snap hooks[**with neoprene or vinyl covers**]. Furnish two per halyard.
3. Plastic Halyard Flag Clips for External Halyard, Ball-Bearing System: Made from injection-molded, UV-stabilized acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Acme Lingo Flagpoles**]

2.8 ALUMINUM FINISHES

A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41**][**AA-M12C22A31**].

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44**][**AA-M12C22A32/A34**].

1. Color:

   a. [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
   b. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Gold Anodic Finish: AAMA 611, AA-M32C22A43; gold color.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's**

sample][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.9 COPPER-ALLOY FINISHES

A. Hand-Rubbed Finish, Lacquered: Directionally textured, fine satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

B. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.

1. Color: Match Architect's sample, as directed by the Owner.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.

2.11 FIBERGLASS FINISHES

A. Fiberglass: UV-light stable, hard, high-gloss gel coat or high-gloss, high-build polyurethane or polyester coating.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FLAGPOLE INSTALLATION

A. General: Install flagpoles where shown and according to[**Shop Drawings and**] manufacturer's written instructions.

B. Mounting Brackets and Bases: Anchor brackets and bases securely to structural support with fasteners

as indicated on Shop Drawings.

END OF SECTION 10 75 23 00

Task	Specification	Specification Description
10 75 23 00	10 75 16 00	Ground-Set Flagpoles
10 86 00 00	10 28 13 63	Detention Toilet Accessories
10 86 00 00	12 55 00 00	Detention Furniture

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SECTION 11 11 36 00 - VEHICLE CHARGING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Offboard electric vehicle charging system equipment.
2. Fleet electric vehicle charging system equipment with bidirectional capability.
3. Onboard electric vehicle supply equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases.
5. Section 260553 "Identification for Electrical Systems" specifies identification products.
6. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and fault current withstand ratings referenced by this Section.
7. [**Section 262726 "Wiring Devices"**][**Section 262726.31 "General-Grade Single Straight-Blade Receptacles"**] specifies 6-50R receptacles.
8. Section 262816 "Enclosed Switches and Circuit Breakers" specifies[**fused**] safety switches.

1.2 DEFINITIONS

A. CCS: Combined charging system; a means for using the same connector port for both AC Level 2 charging and DC Level 3 fast charging.

B. EV: Electric vehicle.

C. EVCE: Electric vehicle charging system equipment. This term refers to DC Level 3 charging equipment located offboard the vehicle.

D. EVSE: Electric vehicle supply equipment. This term refers to AC Level 2 charging equipment that depends on the built-in charger located onboard the vehicle.

E. Fastened in Place: Does not require tools to be removed and replaced.

F. Fixed in Place: Requires tools to be removed and replaced.

G. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

H. OCPP: Open Charge Point Protocol; an application protocol for communication between EVs and a central management system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Routing and attachment of permanent wiring.

a. Include plans, elevations, sections, details, and attachments to other work.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

a. Provide Drawings indicating location and number of EV charging units, and distance from building.
b. Provide Drawings indicating "reasonable accessibility" to EV charging units.
c. Provide Drawings indicating location and number of EV charging units, charging levels and connectors, distance from building, signage details, and ability of EV charging units to participate in a demand-response or time-of-use pricing program.
d. Provide Drawings indicating locations for AC Level 2 or greater EV charging equipment installed at each required parking space. Indicate distance from building, signage details, charging levels, types of vehicle connectors provided, and ability of EV charging units to participate in a demand-response or time-of-use pricing program.
e. Provide Drawings indicating locations for 208 to 240 V dedicated branch circuit in minimum Metric Designator 27 (Trade Size 1) conduit terminated in electrical box or enclosure installed and ready for connection to AC Level 2 or greater EV charging equipment at each required parking space.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction test reports.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Software and firmware service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] testing standards.

1.8 PRECONSTRUCTION TESTING

A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

B. Preconstruction Test Reports: Collect, assemble, and submit test reports prepared by qualified testing agency.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that assembled and installed vehicle charging equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that vehicle charging equipment performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 OFFBOARD ELECTRIC VEHICLE CHARGING SYSTEM EQUIPMENT

A. Description: EVCE located offboard the vehicle that is designed for providing DC Level 3 fast charging of vehicle batteries.

B. UL FFTG - DC Level 3 EV Charging System Equipment (EVCE) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blink Charging**]
b. [**ChargePoint, Inc.; subsidiary of ChargePoint Holdings, Inc.**]
c. [**Efacec Electric Mobility; company of Efacec Power Solutions, SGPS, S.A.**]
d. [**FLO (FLO Services USA Inc. in USA, and Services FLO Inc. in Canada)/AddÉnergie**

Technologies Inc]
e. [**Loop Global, Inc.**]
f. [**Wallbox USA; subsidiary of Wall Box Chargers S.L.U.**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. EVCE: UL CCN FFTG; including UL 2202.
   b. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features: Complies with Article 625 of NFPA 70.
5. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Equipment has earned ENERGY STAR product label.
   c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Location Rating: [**Indoor**][**Indoor/outdoor**].
   b. Input Feeder Rating: 480Y/277 V(ac), three phase, 60 Hz, [**30 A**][**70 A**][**80 A**][**100 A**][**200 A**][**250 A**][**500 A**].
   c. Output Quantity: [**1**][**2**].
   d. Output Wiring: Flexible cord.

      1) Output Cable Nominal Length: [**14 ft (4.3 m)**][**25 ft (7.6 m)**].
      2) Cable management system.
      3) Output Attachment Plug: [**CCS Combo 1 (SAE J1772)**][**CCS Combo 2 (IEC 62196-3)**][**and**][**CHAdeMO (Japan)**].

   e. Mounting: [**Concrete base mount**][**As indicated on Drawings**].
   f. Metering: [**Revenue**][**Nonrevenue**] grade meter.
   g. Networking:

      1) Protocol: [**OCPP**].
      2) WAN Communications: Cellular [**GSM**][**LTE**].
      3) LAN Communications: [**802.11 b/g/n WiFi**][**Ethernet**][**Modbus**][**Zigbee**].
      4) Capable of remote configuration and reporting.

   h. Authorization or Payment System:

      1) [**RFID reader**][**NFC reader**][**Bluetooth reader**][**Keypad**][**Proximity card reader**][**in**

accordance with Section 281500 "Integrated Access Control Hardware Devices."][**in accordance with Section 281511 "Integrated Credential Readers and Entry Management."**]

2) PCI compliant.
3) Capable of remote control and authorization.

7. Accessories:

a. Multifunctional Display: Provide electronic signage integral with charger pedestal that is capable of displaying operating instructions, video advertising, and other messages while charger is in operation.

2.3 FLEET ELECTRIC VEHICLE CHARGING SYSTEM EQUIPMENT WITH BIDIRECTIONAL CAPABILITY

A. Description: EVCE located offboard the vehicle that is designed to use connected vehicle batteries through an inverter for electric utility peak shaving, or for supplying power to premise or load during utility power outage, and to DC Level 3 fast charge those vehicle batteries during off-peak times or when utility power becomes available.

B. UL FFTN - Fleet DC Level 3 EV Charger with Utility Interactive Inverter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fermata, LLC d/b/a Fermata Energy**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Bidirectional EVCE: UL CCN FFTN; including UL Subject 9741.
b. Grid Interactive Equipment: UL CCN QIKH; including UL 1741.
c. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features:

a. Complies with Article 625 of NFPA 70.

5. Sustainable Design Features:

a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
b. Equipment has earned ENERGY STAR product label.
c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Location Rating: [**Indoor**][**Indoor/outdoor**].
b. Input Feeder Rating: 480Y/277 V(ac), three phase, 60 Hz, [**40 A**][**dual 40 A**].
c. Output Quantity: [**1**][**2**].
d. Output Wiring: Flexible cord.

1) Output Cable Nominal Length: [**13 ft (4 m)**].
2) Output Attachment Plug: [**CHAdeMO (Japan)**].

e. Mounting: [**Pedestal mount**][**Wall mount**][**As indicated on Drawings**].
f. Networking:

1) Protocol: Proprietary.
2) WAN Communications: Cellular.

g. Authorization or Payment System:

1) Keypad.

2.4 ONBOARD ELECTRIC VEHICLE SUPPLY EQUIPMENT

A. Description: EVSE with input rated up to 600 V(ac) for AC Level 2 charging of vehicle batteries using the EV's onboard charger.

B. UL FFWA - AC Level 2 EV Supply Equipment (EVSE) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blink Charging**]
b. [**Bosch Automotive Service Solutions**]
c. [**ChargePoint, Inc.; subsidiary of ChargePoint Holdings, Inc.**]
d. [**ClipperCreek, Inc**]
e. [**Enel X North America, Inc.; Enel Group**]
f. [**EVBox Group; subsidiary of EVBox B.V.**]
g. [**EvoCharge**]
h. [**FLO (FLO Services USA Inc. in USA, and Services FLO Inc. in Canada)/AddÉnergie Technologies Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**Loop Global, Inc.**]
k. [**Lynkwell**]
l. [**SemaConnect, Inc.; subsidiary of Blink Charging Co.**]
m. [**Siemens Industry, Inc.; Energy and Automation Division**]
n. [**Wallbox USA; subsidiary of Wall Box Chargers S.L.U.**]
o. [**Xeal**]

2. Source Limitations: Obtain products from single manufacturer.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. EV Supply Equipment: UL CCN FFWA; including UL 2594.
    b. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.

4. Standard Features:

    a. Complies with Article 625 of NFPA 70.

5. Sustainable Design Features:

    a. Equipment has earned ENERGY STAR product label.
    b. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
    c. Corporate Sustainability Report: Provide[**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Location Rating: [**Indoor**][**Indoor/outdoor**].
    b. Input Feeder Rating:

        1) 208 to 240 V(ac), single phase, 60 Hz, [**40 A**][**50 A**][**60 A**][**80 A**][**dual 80 A**][**100 A**].
        2) 208 to 240 V(ac), three phase, 60 Hz, [**40 A**][**60 A**][**100 A**].

    c. Input Feeder Type: [**Hard wired**][**6-50R receptacle**].
    d. Output Quantity: [**1**][**2**].
    e. Output Wiring: Flexible cord.

        1) Output Cable Nominal Length (Usable Length May Be Less): [**18 ft (5.5 m)**][**20 ft (6 m)**][**23 ft (7 m)**][**25 ft (7.6 m)**].
        2) Cable management system.
        3) Output Attachment Plug: [**Type 1 (SAE J1772)**][**Type 2 (IEC 62196-2)**][**and**][**CHAdeMO (Japan)**].

    f. Mounting: [**Concrete base mount**][**Pedestal mount**][**Pole mount**][**Wall mount**][**As indicated on Drawings**].
    g. Metering: [**Revenue**][**Nonrevenue**] grade meter.
    h. Networking:

        1) Protocol: [**OCPP**].
        2) WAN Communications: Cellular [**GSM**][**LTE**].
        3) LAN Communications: [**802.11 b/g/n WiFi**][**Ethernet**][**Modbus**][**Zigbee**].

4) Capable of remote configuration and reporting.

i. Authorization or Payment System:

1) [**RFID reader**][**NFC reader**][**Bluetooth reader**][**Keypad**][**Proximity card reader**][**in accordance with Section 281500 "Integrated Access Control Hardware Devices."**][**in accordance with Section 281511 "Integrated Credential Readers and Entry Management."**]
2) PCI compliant.
3) Capable of remote control and authorization.

7. Accessories:

a. Multifunctional Display: Provide electronic signage integral with charger pedestal that is capable of displaying operating instructions, video advertising, and other messages while charger is in operation.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to the Owner spare parts, for repairing vehicle charging equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to vehicle charging equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and bollards or posts for suitable conditions where vehicle charging equipment will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF VEHICLE CHARGING EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
6. Electric Vehicle Power Transfer System: Article 625 of NFPA 70 and NECA NEIS 413.
7. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Special Installation Techniques:

1. Hard-Wired Connection: Provide[**fusible**] safety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.
2. 250 V Plug-In Connection:

    a. Provide 6-50R single receptacle not less than **18 inch (450 mm)** and not more than **4 ft (1.2 m)** above finished floor.
    b. Remove plug and provide[**fusible**] safety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.

3. Fastened in Place: Comply with manufacturer's published instructions for installing mounting hardware. Provide manufacturer's recommended seismic controls when required for compliance with the Project's requirements.
4. Fixed in Place: Comply with manufacturer's published instructions for installation and torquing of hardware fasteners. Provide manufacturer's recommended seismic controls when required for compliance with the Project's requirements.
5. Base Mounting: When indicated on Drawings or in manufacturer's published instructions, provide concrete bases for installing vehicle charging equipment.
6. Identification: Provide labels for vehicle charging equipment and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each enclosure with engraved metal or laminated-plastic nameplate.

D. Cybersecurity:

1. Software:

    a. Coordinate security requirements with [**IT department**][**CIO**].
    b. Ensure that latest stable software release is installed and properly operating.
    c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

    a. Coordinate location and access requirements with [**IT department**][**CIO**].
    b. Enable highest level of wireless encryption that is compatible with the Owner's information and communications technology network.
    c. Disable dual network connections.

E. Interfaces with Other Work:

1. Coordinate installation of new vehicle charging equipment with existing conditions.
2. Work must be rated to handle available fault current on input feeder.
3. Provide appropriate warning labels for arc-flash hazard on input feeder.

3.3 FIELD QUALITY CONTROL OF VEHICLE CHARGING EQUIPMENT

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical power testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified electrical power testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**], as directed by the Owner.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. For each unit of vehicle charging equipment, perform the following tests and inspections:

a. Unit self-test.
b. Operation test with load bank.
c. Operation test with EV.
d. Network communications test.

F. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**]

system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 PROTECTION

A. After installation, protect vehicle charging equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

3.6 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**] years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**] years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**] days to allow the Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 11 11 36 00

Task	Specification	Specification Description
11 11 36 13	11 11 36 00	Vehicle Charging Equipment

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SECTION 11 12 00 00 - PARKING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Automatic barrier gates.
2. Vehicle detectors.
3. Traffic controllers.
4. Entry terminals.
5. Exit terminals.
6. Pay stations.
7. Fee computers.
8. Miscellaneous parking control equipment.
9. Parking facility management software.
10. Access control units.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for pipe bollards to protect parking control equipment.
2. Section 133423.16 "Fabricated Control Booths" for cashiers'/parking attendants' booths.
3. Section 281300 "Access Control Software and Database Management" for integrating parking control equipment with building access control.
4. Section 281500 "Access Control Hardware Devices" for parking control equipment access devices.
5. Section 283100 "Intrusion Detection" for integrating parking control equipment with the building intrusion detection system.
6. Section 283121 "Area and Perimeter Intrusion Detection" for integrating parking control equipment with the site security control system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Verify that equipment operation is consistent with system description.
3. Review sequence of operation for each type of parking control equipment.
4. Review coordination of interlocked equipment specified in this Section and elsewhere.
5. Review required testing, inspecting, and certifying procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for parking control equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished

specialties.

B. Shop Drawings: For parking control equipment.

1. Include plans, elevations, sections and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Vehicle Detectors: Layout and method of placement of vehicle loop detector system.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** square in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish **6 inches (150 mm)** square in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On [**USB media**][**and**][**approved online or cloud solution**].
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gate Arms: [**Two**] breakaway gate arms for each gate installed, complete with accessory components.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Parking Control System: For the following types of parking management:

1. Transient Parking: Hourly rated parking, with fee paid while [**entering**][**exiting**].
2. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
3. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
4. Flat-Rate or Hourly Parking: Fee paid at central pay station after parking.
5. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
6. Limited Date and Time Parking: Limited-duration parking, with predetermined fee access control card.
7. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.
8. Valet Parking: Assisted parking, with fee paid while entering or exiting.
9. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SOURCE LIMITATIONS

A. Obtain [**parking control equipment**] from single source from single manufacturer.

2.3 AUTOMATIC BARRIER GATES

A. Automatic Barrier Gates: Provide parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than **35 inches (889 mm)** above pavement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Automatic Systems**]
d. [**CAME Americas Automation LLC**]
e. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
f. [**Delta Scientific Corporation**]
g. [**DoorKing, Inc**]
h. [**Engineered Parking Systems, Inc**]
i. [**Falcon Eye Global Security, LLC**]
j. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
k. [**Magnetic AutoControl USA**]
l. [**Parking Systems, Inc.**]

2. Standards: Barrier gate operators that are listed and labeled according to UL 325 by a qualified testing agency.

B. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections. [**Noncommunicating**][**Communicating**] type.

1. Noncommunicating Type:

   a. Capable of logic for one- and two-way lanes.
   b. Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.

2. Communicating Type:

   a. Real-time communication of lane counts, status messages, and execute commands.
   b. Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
   c. Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.
   d. Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling [**ticket dispensers**][**card readers**][**barcode imagers**][**license plate recognition**][**automatic vehicle identification**].

3. Physical Characteristics:

   a. On-off power supply switch.
   b. Automatic-manual switch.
   c. Differential counter.
   d. Communication port.
   e. Internal [**resettable**][**non-resettable**] counters.
   f. Thermal-overload protection with manual reset.
   g. Plug-in connectors for [**two**][**three**] vehicle loop detectors.
   h. Thermostatically controlled heater with on/off/auto switch.
   i. Thermostatically controlled fan with on/off/auto switch.
   j. Switch to test motor and limit switches.
   k. Emergency manual disconnect.
   l. Battery backup.
   m. [**Single**][**Two**][**Four**], 115-V ac grounded power receptacle.

4. Operational Characteristics:

   a. Able to store successive inputs and sequentially processing each one.
   b. Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a zero- to 60-second, variable-time reset device.
   c. Directional arming logic.
   d. Broken gate-arm monitoring.
   e. Programmable[**automatic**] timer.
   f. Diagnostic mode for on-site testing[with LEDs for inputs and outputs].
   g. Automatic and continuous testing of inputs and outputs.
   h. Reversible arm capability for right- or left-handed operation.

C. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

    a. Finish cabinet exterior with No. 4 finish.

D. Straight Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**][**Fiberglass, PVC, or polycarbonate**][**Aluminum**].

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

E. Folding Gate Arm: Two pieces of **1-by-4-inch nominal- (19-by-89-mm actual-)** size pine or redwood joined together with metal side brackets.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

F. Straight Gate Arm with Counterbalance: **1-by-6-inch nominal- (19-by-140-mm actual-)** size pine or redwood with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**16 feet (4.9 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

G. Wishbone-Style Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**] formed into wishbone configuration, with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**14 feet (4.3 m)**][**As indicated on Drawings**].
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

H. Operator: UL labeled and listed, [**Class I**][**Class II**][**Class III**][**Class IV**]. [**1/3**][**1/2**] hp; -V, 60-Hz, single-

phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through the speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.

1. Opening Time: [**Three**][**Six**] seconds.
2. Inherently adjustable, torque limiting clutch for safety.

I. Characteristics:

1. Audible alarm that activates as part of a safety device system.
2. Additional obstruction detector; noncontact [**infrared**][**photoelectric**][**radio-frequency barrier**].
3. Gate-arm warning safety signs on both sides of unit to limit traffic to vehicular traffic.
4. Low-voltage [**yellow**][**red**] warning lights that illuminate when gate is in down position.
5. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
6. LED integrated into gate-arm for increased visibility.
7. Manually operated crank for emergency operation.
8. Gate-arm tip support[**with electromagnetic lock**].
9. Gate-arm skirt bottom[**and top**].

2.4 VEHICLE DETECTORS

A. Vehicle Detectors: Provide detection devices that sense presence or transit of vehicles and emit signals activating gate-arm operators.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Delta Scientific Corporation**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Magnetic AutoControl USA**]
   f. [**Parking Systems, Inc.**]

B. Vehicle Loop Detector System: Self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light. Include automatic closing timer with adjustable time delay before closing[timer cut-off switch,] designed to hold gate arm open until traffic clears. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location indicated on Drawings, as recommended in writing by detection system manufacturer for [pave-over][saw-cut] installation.

1. Field-Assembled Loop: Wire, in size indicated for field assembly.
2. Factory-Formed Loop: Wire, preformed in size indicated.
3. Operation:

   a. Recognize vehicles within **6 inches (152 mm)** of each other on standard-sized loop.
   b. Recognize vehicle direction by detecting vehicle moving from one loop to another.
   c. Generate reverse count if vehicle backs up after generating directional count in forward direction.
   d. Continuous diagnostic monitoring [**and memory**]for intermittently operating and failed loops.

e. Crosstalk test between adjacent loops.

C. Active Infrared Vehicle Detector: [Retroreflective][Emitter/receiver]-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing[timer cut-off switch,] and vehicle presence detector designed to hold gate arm open until traffic clears.

2.5 TRAFFIC CONTROLLERS

A. Traffic Controllers: Provide directional enforcement system that allows passage of vehicle in only one direction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ameristar Perimeter Security; ASSA ABLOY**]
   b. [**Delta Scientific Corporation**]
   c. [**DoorKing, Inc**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Falcon Eye Global Security, LLC**]

B. Penetrating Type: System consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual, with each tooth controlled by torsion spring**][**Electromechanical**][**Hydraulic**].
3. Latch Down: Allow disarming for two-way traffic flow. Furnish [**one**] tool(s) for latch-down operation.
4. Illuminated Warning Signs: [Single][Double]-faced warning signs consisting of LED lamps [with photo cell control]and keyed on/off override switches, contained in welded steel bodies with baked-enamel or powder-coat finish and fiberglass sign faces[with flood lamp].

   a. Post Mounting: Provide [**in-ground**][**surface-mounted**] base sleeves and posts.
   b. Sign Copy: [**"Wrong Way, Stop, Severe Tire Damage."**][**"Warning, Do Not Back Up, Tire Damage."**]

5. Speed Bumps: [**Composite plastic**][**Compression molded rubber compound**] for speed reduction to **5 mph (8 km/h)** or less.

C. Nonpenetrating Type: System consisting of steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual**][**Electromechanical**][**Hydraulic**].

2.6 ENTRY TERMINALS

A. Entry Terminals: Provide entry terminals with mechanisms, components, and controllers housed in cabinet enclosures.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amano Cincinnati, Inc**]
    b. [**ASPS Access Security & Parking Systems Inc.**]
    c. [**CAME Americas Automation LLC**]
    d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
    e. [**Engineered Parking Systems, Inc**]
    f. [**Falcon Eye Global Security, LLC**]
    g. [**Parking Systems, Inc.**]
    h. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Time Indicator: 24-hour cycle with [**A.M. and P.M.**][**military-time**] clock mechanism.
4. Voice annunciation.
5. Tickets: [**Standard paper**][**Magnetic stripe**][**Barcode**].
6. Removable ticket tray with capacity of [**5000**] fan-folded tickets.
7. Battery backup for clock and RAM memory.
8. Communication port.
9. Thermostatically controlled heater with on/off/auto switch.
10. Thermostatically controlled fan with on/off/auto switch.
11. Ticket printing and dispensing mechanism.
12. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
13. Access card reader.
14. Multiple ticket option for valet parking.
15. Intercom.
16. Pinhole camera.
17. Barcode imager scanner.
18. Proximity access reader.
19. Automatic vehicle identification reader.
20. License plate recognition.

C. Operational Characteristics:

1. Operation: [**Standalone**][**Online communication to remote computer**].
2. Activation by [**button with "Push for Ticket" message**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].

    a. On activation by button, unit automatically records entry time[license plate,] and date on ticket,[sounds buzzer,] dispenses ticket, and raises barrier gate.
    b. On activation by means other than button, credentials are recorded and signal is automatically sent to raise barrier gate.

3. Credit card pay on entry.
4. Automatic ticket validation.
5. Programmable ticket numbering.
6. Programmable facility code.
7. Programmable display.

8. Programmable timer for closing barrier gate.
9. Built-in-service diagnostics.
10. Low-ticket alarm.
11. Out-of-ticket alarm.
12. Ticket jam detection.
13. Test ticket printing.
14. Back-out ticket function.
15. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth, approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall); consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

E. Ticket-Dispensing Mechanisms: Removable assembly, with [self-sharpening ticket cutter][ticket burster] and plug-in controller.

2.7 EXIT TERMINALS

A. Exit Terminals: Provide exit terminals with controllers and components housed in cabinet enclosures.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**CAME Americas Automation LLC**]
   d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   e. [**Engineered Parking Systems, Inc**]
   f. [**Parking Systems, Inc.**]
   g. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.

3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Communication port.
6. Thermostatically controlled heater with on/off/auto switch.
7. Thermostatically controlled fan with on/off/auto switch.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Access card reader.
10. Ticket reader.
11. Receipt printer.
12. Intercom.
13. Pinhole camera.
14. Barcode imager scanner.
15. Proximity access reader.
16. Automatic vehicle identification reader.
17. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].
3. Activation results in the following:

    a. Valid Prepaid Exit: Signal is automatically sent to raise barrier gate.
    b. Pay at Exit: Parking fee is calculated and displayed for payment.
    c. Invalid Exit: Activation is rejected and "Pay Cashier First" or "Return to Cashier" message is displayed.

4. Programmable lost ticket function.
5. Display fee.
6. Accept payment by [**credit card**][**debit card**][**smart card**][**prepaid value card**][**scanned media**][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Print receipts on demand.
9. Programmable facility code.
10. Programmable grace period.
11. Programmable display.
12. Programmable timer for closing barrier gate.
13. Reports for events and exception events.
14. Programmable merchant validations.
15. Built-in service diagnostics.
16. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than 0.097-inch- (2.5-mm-) thick[galvanized-] steel sheet.

    a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

2.8 PAY STATIONS

A. Pay Stations: Provide self-contained, cashiering [**central**][**entry**][**exit**] pay stations designed for self-service operation; with mechanisms, components,[**controllers,**] and fee computers housed in a combined enclosure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Parking Systems, Inc.**]
   f. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Thermostatically controlled heater with on/off/auto switch.
6. Thermostatically controlled fan with on/off/auto switch.
7. Ticket printing and dispensing mechanism.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Bill acceptor.
10. Access card reader.
11. Ticket reader.
12. Printer.
13. Intercom.
14. Pinhole camera.
15. Barcode imager scanner.
16. Proximity access reader.
17. Automatic vehicle identification reader.
18. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**].

3. Activation results in the following:

    a. Valid Prepayment: Signal is automatically sent to raise barrier gate.
    b. Payment Prompt: Parking fee is calculated and displayed for payment.

4. Compute multiple parking fees based on recorded entry times.
5. Compute multiple taxes by percentage and fixed amount.
6. Programmable lost ticket function.
7. Display fee.
8. Accept payment by cash and [**credit card**][**debit card**][**scanned media**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
9. Accept discounted coupons.
10. Compute change.
11. Print receipts on demand.
12. Print validation on ticket.
13. Print audit trail.
14. Programmable for up to [**six**] fee structures.
15. Test mode to verify accuracy of fee structure program.
16. Programmable time.
17. Programmable facility code.
18. Programmable grace period.
19. Programmable display.
20. Programmable timer for closing barrier gate.
21. Programmable merchant validations.
22. Built-in service diagnostics.
23. Print cash audit, revenue, operational, and statistical reports on demand.
24. Duress alarm output for emergencies.
25. Cancel transaction function.

D. Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately 36 inches wide by 18 inches deep by 60 inches tall (914 mm wide by 457 mm deep by 1524 mm tall). Provide single, gasketed access door with flush-mounted locks. Furnish [two] keys for each lock[all locks keyed alike]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

    1. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**] baked-enamel or powder-coat finish.

2.9 FEE COMPUTERS

A. Fee Computers: Provide modular[**PC-based**] system. Register permanent record of each transaction in computer's memory.

    1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        a. [**Amano Cincinnati, Inc**]
        b. [**ASPS Access Security & Parking Systems Inc.**]
        c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
        d. [**Engineered Parking Systems, Inc**]
        e. [**Falcon Eye Global Security, LLC**]
        f. [**Parking Systems, Inc.**]

g. [**Zeag; HUB Parking Technology; FAAC Group**]

B. Physical Characteristics:

1. Touchscreen display.
2. Battery backup for clock and RAM memory.
3. Communication port.
4. [**Cash drawer**][**Two cash drawers**].
5. Standard ticket reader.
6. Magnetic stripe ticket reader.
7. Barcode ticket reader.
8. Credit card reader[**with smart card reader**].
9. Access card reader.
10. Proximity access reader.
11. Automatic Vehicle Identification reader.
12. License plate recognition.
13. [**Keyed**][**Keyless-membrane**] keypad.
14. Detachable printer.

C. Operational Characteristics:

1. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
2. Compute multiple taxes by percentage and fixed amount.
3. Programmable lost ticket function.
4. Display fee on remote fee display device.
5. Credit card in/out.
6. Accept payment by cash and [**credit card**][**debit card**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Control independent cash drawer.
9. Compute change.
10. Print receipts.
11. Print validation on ticket.
12. Print audit trail.
13. Reload value cards.
14. Interface to automatic barrier gate.
15. Programmable with up to [**six**] fee structures.
16. Programmable time.
17. Programmable keys.
18. Programmable for special events validations.
19. Programmable for automatic activation for limited date and time validations.
20. Programmable merchant validations.
21. Programmable valet parking.
22. Programmable hotel guest parking.
23. Three levels of security including cashier, supervisor, and master.
24. Recall last transaction.
25. Test mode to verify accuracy of fee structure program.
26. Built-in service diagnostics.
27. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
28. Duress alarm output for emergencies.

D. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.

E. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of **1-inch- (25-mm-)** tall, digital displays or LCDs contained in welded steel bodies with baked-enamel or powder-coat

finish.

1. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
2. Mounting: [**Front of cashier's booth**][**42-inch- (1067-mm-) high pedestal**].

2.10 MISCELLANEOUS PARKING CONTROL EQUIPMENT

A. "Lot Full" Signs : Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be [**4 (102)**] **inches (mm)** tall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASPS Access Security & Parking Systems Inc.**]
   b. [**CAME Americas Automation LLC**]
   c. [**Engineered Parking Systems, Inc**]

2. Type: [**Flashing**][**Nonflashing**].
3. Operation: [**Manual by push button**][**Automatic by barrier gate controller**].
4. Illumination: [**Traffic signal lamps and colored**][**LED bulb and clear**] acrylic sign face.
5. Mounting: [**Top of barrier gate cabinet**][**42-inch- (1067-mm-) high pedestal**].

2.11 PARKING FACILITY MANAGEMENT SOFTWARE

A. Parking Facility Management Software: Manufacturer's standard software that is compatible with security-access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**WPS Parking Systems; Dynniq Group**]

B. Operation:

1. Collect data for revenue and activity reporting.
2. Collect data for access and space control.
3. Notification services.
4. On-line prepaid parking.
5. Event management.
6. Validation solutions.
7. License plate recognition systems.
8. Pay-by-phone.
9. Loyalty programs.
10. Track tickets.
11. Programmable parking control equipment.

2.12 ACCESS CONTROL UNITS

A. Access Control Units: Provide access control unit that activates barrier gates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
d. [**DoorKing, Inc**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Nortek Security & Control, LLC**]
h. [**Parking Systems, Inc.**]

B. Unit Housing: Fabricate from [**welded cold-rolled steel or aluminum sheet**][**plastic**] with weatherproof front access panel equipped with flush-mounted lock and [**two**] keys. Provide face-lighted unit fully visible at night.

1. Steel Finish: Manufacturer's standard baked-enamel or powder-coat finish system.

C. Card Reader Controlled Unit: Functions only when authorized card is presented.

1. System: [**Magnetically coded, single-code system activated by coded card**][**Programmable, multiple-code capability permitting validation or voiding of individual cards**].

a. Permit four different access time periods.

2. Reader Type: [Swipe][Proximity].

a. Swipe reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
b. Insertion reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
c. Proximity reader for proximity cards.

3. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].
4. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**][**Digital display or LCD**][**Programmable by PDA (personal digital assistant) by infrared interface**].
5. Mounting: [**With pedestal**][**Wall**][**In enclosed cabinet**][**As indicated on Drawings**].

D. Digital Keypad Controlled Unit: Functions only when authorized code is entered on [**keyed**][**keyless-membrane**] keypad.

1. System: [**Multiple-code capability**][**Programmable, multiple-code capability**].

a. Multiple-code capability of no fewer than [**five**][**100**][**500**] possible individual codes.
b. Programmable, multiple-code capability permitting validation or voiding of no fewer than [100][2500][10,000] possible individual codes, consisting of [one to six] digits[and permitting four different access time periods].

2. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].

3. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**].
4. Mounting: [**With pedestal**][**Wall**][**As indicated on Drawings**].

E. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver[one per barrier gate][where indicated on Drawings], remote antenna with coaxial cable and mounting brackets, and [one permanently mounted][four portable] transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validation or voiding of no fewer than [1000][10,000] codes per channel configured for the following functions:

1. Transmitters: [**Single-button**][**Triple-button**] operated.

a. Single-button operated with [**open**][**open and close**] functions.
b. Triple-button operated with open, close, and stop functions.

1) Provide transmitters featuring [**two**][**three**][**four**] independent channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

2.13 ANCHORAGES

A. Anchor Bolts: [**Galvanized**][**Stainless steel**].

1. Hot-dip galvanized according to ASTM A153/A153M and ASTM F2329/F2329M.
2. Stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including equipment bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before parking control equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

3.3 INSTALLATION, GENERAL

A. Install parking control equipment as required for complete and integrated installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF AUTOMATIC BARRIER GATES

A. Anchor cabinets to concrete bases with anchor bolts or expansion anchors, and mount barrier gate arms.

1. Install barrier gates according to UL 325.

3.5 INSTALLATION OF VEHICLE DETECTORS

A. [**Cut grooves in pavement and bury**][**Bury**] and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.

3.6 INSTALLATION OF TRAFFIC CONTROLLERS

A. Anchor controllers to [**recessed concrete bases**][**driveway surfaces**] with anchor bolts or expansion anchors.

3.7 INSTALLATION OF ENTRY TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.8 INSTALLATION OF EXIT TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.9 INSTALLATION OF PAY STATIONS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.10 INSTALLATION OF FEE COMPUTERS

A. Install computers at locations indicated, including connecting to peripheral equipment[**and remote computers**].

3.11 INSTALLATION OF CARD READER PEDESTALS

A. [**Pad**][**In-ground**] mount with mounting bolts.

3.12 INSTALLATION OF ELECTRICAL

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Parking control equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.14 ADJUSTING

A. Adjust parking control equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Confirm that locks engage accurately and securely without forcing or binding.

C. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

3.15 PROTECTION

A. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Substantial Completion.

3.16 MAINTENANCE SERVICE

A. Maintenance Service Description: Beginning at Substantial Completion, maintenance service shall

include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of parking control equipment Installer**][**manufacturer's authorized service representative**]. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper parking control equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.17 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**] years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**] years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**] days to allow the Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.18 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain parking control equipment.

END OF SECTION 11 12 00 00

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Task	Specification	Specification Description
11 12 16 00	11 12 00 00	Parking Control Equipment
11 12 16 00	13 34 23 16	Fabricated Control Booths
11 12 23 00	11 12 00 00	Parking Control Equipment
11 12 23 00	13 34 23 16	Fabricated Control Booths
11 12 26 00	11 12 00 00	Parking Control Equipment
11 12 26 13	11 12 00 00	Parking Control Equipment
11 12 26 13	13 34 23 16	Fabricated Control Booths
11 12 33 00	11 12 00 00	Parking Control Equipment
11 12 33 13	11 12 00 00	Parking Control Equipment
11 12 36 00	11 12 00 00	Parking Control Equipment

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SECTION 11 13 13 00 - LOADING DOCK BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes loading dock bumpers.

B. Related Requirements:

1. Section 111319 "Stationary Loading Dock Equipment" for loading dock bumpers that are integral with dock levelers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of loading dock bumper.

B. Shop Drawings: For dock bumpers. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 LOADING DOCK BUMPERS

A. Dock Bumpers: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Floor Products Company, Inc**]
b. [**Beacon Industries, Inc**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Durable Corporation**]
e. [**Hugger Dock Equipment Company; Columbus Foam Products, Inc.**]
f. [**Kelley; Entrematic; ASSA ABLOY**]
g. [**Pioneer Dock Equipment**]
h. [**Rite-Hite Holding Corporation**]
i. [**Rotary Products Inc**]
j. [**Serco; Entrematic; ASSA ABLOY**]
k. [**Super Seal Mfg. Ltd**]
l. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Laminated-Tread Loading Dock Bumper : Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel

end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

1. Thickness: [**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
2. Horizontal Style: [**6 inches (152 mm)**][**10 inches (250 mm)**][**12 inches (305 mm)**] high by [**length indicated on Drawings**].
3. Vertical Style: **8 inches (203 mm)** wide by [**20 inches (508 mm) high**][**24 inches (610 mm) high**][**36 inches (914 mm) high**][**height indicated on Drawings**].

C. Molded-Rubber Loading Dock Bumpers : Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240; of size and configuration indicated. Fabricate units with not less than two predrilled anchor holes.

1. Configuration: [**T shape**][**Inverted-L shape**][**Square**][**Rectangular**][**As indicated on Drawings**].
2. Thickness: [**2 inches (50 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].

D. Extruded-Rubber Loading Dock Bumpers : Fabricated from ASTM D2000, extruded synthetic rubber with Shore A durometer hardness of 75, plus or minus 5, when tested according to ASTM D2240; of size and configuration indicated. Furnish units with predrilled anchor holes and concealed, flat, steel mounting bar.

1. Configuration: [**Flat or ribbed, with 2-inch (50-mm) nominal thickness and 9-inch (229-mm) height**][**4-1/2-inch- (114-mm-) wide base and 4-inch (102-mm) depth with half-oval shape that compresses and returns to original shape**][**As indicated on Drawings**].

E. Steel-Face, Laminated-Tread Loading Dock Bumpers : Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires and with **3/8-inch (9.5-mm)** steel faceplate of same size as rubber surface. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles. Weld faceplate to two steel support brackets, which shall extend back to and engage **3/4-inch- (19-mm-)** diameter support rods in elongated holes, allowing steel face to float on impact.

1. Thickness: [**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
2. Horizontal Style: [**6 inches (152 mm)**][**10 inches (250 mm)**][**12 inches (305 mm)**] high by [**length indicated on Drawings**].
3. Vertical Style: **8 inches (203 mm)** wide by [**20 inches (508 mm) high**][**24 inches (610 mm) high**][**36 inches (914 mm) high**][**height indicated on Drawings**].

F. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.

G. Materials: ASTM A36/A36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A123/A123M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Loading Dock Bumpers: Attach loading dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.

1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

3.3 ADJUSTING

A. After completing installation of exposed, factory-finished dock bumpers, inspect exposed finishes and repair damaged finishes.

END OF SECTION 11 13 13 00

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SECTION 11 13 16 00 - LOADING DOCK SEALS AND SHELTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foam-pad loading dock seals.
2. Inflatable loading dock seals.
3. Frame-type loading dock shelters.
4. Inflatable loading dock shelters.
5. Transparent-strip door curtains.

1.2 COORDINATION

A. Coordinate sizes and configurations of dock seals with finish grade slopes, walls, dock configuration, doors, dock bumpers, and other adjacent construction.

B. Coordinate sizes, configurations, and mounting of transparent-strip door curtains with walls, doors, dock levelers, and other adjacent construction.

C. Electrical System Roughing-in: Coordinate layout and installation of motor/blower and activation switch with connections to power supplies[**and interlock to other dock equipment**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include electrical characteristics of inflatable blower motor.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of anchors and field connection.
3. Include diagrams for power, signal, and control wiring of inflatable blower motor.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For each type of fabric indicated.

E. Samples for Verification: For each type of fabric indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inflatable units to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of dock openings and contiguous construction by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FOAM-PAD LOADING DOCK SEALS

A. Foam-Pad Dock Seals: Dock seals consisting of fabric-covered foam pads designed to compress **4 to 5 inches (102 to 127 mm)** under pressure of truck body to form an airtight seal at jambs and head of loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Fairborn U.S.A., Inc.**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Rite-Hite Holding Corporation**]
l. [**Rotary Products Inc**]
m. [**Serco; Entrematic; ASSA ABLOY**]
n. [**Super Seal Mfg. Ltd**]
o. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Stationary Head Pad: [8 inches (203 mm)][12 inches (305 mm)][18 inches (457 mm)][24 inches (610 mm)] high and same depth as jamb pads[beveled]; sized for opening width.

C. Adjustable Head Pad: [**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**] high and same depth as jamb pads; sized for opening width; with manufacturer's standard hardware and tension spring or counterweight mechanism for adjusting pad height.

D. Jamb Pads: [**Square**][**Beveled; tapered to reduce opening width**][**V-shaped**].

1. Nominal Size: [**8 inches (203 mm) wide**][**12 inches (305 mm) wide**][**As indicated on**

Drawings] and sized for opening height.

E. Construction: Consisting of single- or double-ply, coated, fabric-covered, urethane-foam core with supporting frame. Fabricate jamb and head pads of same depth and sized for opening width.

1. Wood Support Frame: Factory-painted[pressure-treated] wood; with steel mounting hardware.
2. Steel Support Frame: Steel channel frame of manufacturer's standard weight, shape, and finish; with steel mounting hardware.

   a. Steel Finish: Hot-dip galvanize components to comply with the following:

      1) ASTM A123/A123M for iron and steel support framing.
      2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

3. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades, and make sealing edge of dock seal parallel to back edge of truck. Taper for [**declined approach**][**inclined approach**][**approach as indicated on Drawings**].
4. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on jamb pads.
5. Pleated Protectors: On face of jamb pads of overlapping layers of coated fabric attached to base fabric; [**4-inch (102-mm)**][**8-inch (203-mm)**][**16-inch (406-mm)**] wear exposure.
6. Reinforcing: Manufacturer's standard reinforcing over cover fabric on [**upper corners**][**inside face of jamb pads**][**inside and full face of jamb pads and upper corners**] of dock seal.

F. Materials:

1. Vinyl-Coated Nylon Cover Fabric: Minimum total weight of [**22 oz./sq. yd. (746 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

   a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

      1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

2. Neoprene-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**][**45 oz./sq. yd. (1526 g/sq. m)**].

   a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

      1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

3. Hypalon-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

   a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

      1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

4. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**300 by 300 (1334 by 1334)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**6000**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**1200 by 1200 (5338 by 5338)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

1) High-Visibility Layer: Manufacturer's standard yellow or orange layer.

5. Pleated Protectors: Same fabric as cover.
6. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.
7. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA U1; Use Category UC3.

a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

2.3 INFLATABLE LOADING DOCK SEALS

A. Inflatable Dock Seals: Inflatable dock seals consisting of one-piece jamb[sill,] and header seals designed to inflate by motor/blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kelley; Entrematic; ASSA ABLOY**]
b. [**Pentalift Equipment Corporation**]
c. [**Serco; Entrematic; ASSA ABLOY**]
d. [**Super Seal Mfg. Ltd**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Head Members: [**One**][**Two**].

C. Jamb Members: [**One**][**Two**].

D. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Inflate seals by use of 1/2-hp motor/blower mounted above header seal in galvanized-steel hood with separate manual on/off activation switch with indicator light. [**Provide electrical interlock.**]Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.

E. Materials:

1. Neoprene-Coated Nylon Fabric: Minimum total weight of **14 oz./sq. yd. (475 g/sq. m)**.

a. Color: [**Black**][**Gray**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Fabric: Manufacturer's proprietary fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**110 by 85 (489 by 378)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**490**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**500 by 440 (2224 by 1957)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Gray**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Steel Finish: Hot-dip galvanize components to comply with the following:

1. ASTM A123/A123M for iron and steel support framing.
2. ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

2.4 FRAME-TYPE LOADING DOCK SHELTERS

A. Frame-Type Dock Shelters: Dock shelters designed to form a seal with sides and top of truck body while leaving entire width and height of truck's rear opening unobstructed; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**Fairborn U.S.A., Inc.**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Rite-Hite Holding Corporation**]
l. [**Rotary Products Inc**]
m. [**Serco; Entrematic; ASSA ABLOY**]
n. [**Super Seal Mfg. Ltd**]
o. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Rigid-Frame Type: Fabricated from [**fabric-covered**][**fiberglass**] side and top panels attached to fixed supporting framework. Provide head and side curtains with built-in flexible stays, wind straps between head curtain and side frame, pleated protectors, reinforcing, and guide strips. Slope head frame from

center for drainage. Provide replaceable, fabric-covered, tapered, foam-bottom pads and protective steel bumpers of size and type required for application shown.

C. Flexible-Frame Type: Fabricated from fabric-covered side and top panels attached to retractable supporting framework with independent spring-tension extension arms. Provide head and side curtains with built-in flexible stays, pleated protectors, reinforcing, and guide strips. Provide replaceable, fabric-covered, tapered, foam-bottom pads of size and type required for application shown.

D. Head-Pad Height: [**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**].

E. Construction: Fabricate framework, pads, bumpers, fabric for curtains and panels, and other components to sizes and shapes indicated or required to fit door-opening sizes shown, and allow for not less than **18 inches (457 mm)** of truck-body penetration when truck is docked.

1. Wood Framework: Factory painted; mechanically fastened together using nails and lag bolts or metal connectors to form a rigid assembly.
2. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.

   a. Steel Finish: Hot-dip galvanize components to comply with the following:

      1) ASTM A123/A123M for iron and steel support framing.
      2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

3. Top and Side Panels:

   a. White, translucent fiberglass, **0.045 inch (1.1 mm)** thick, weighing **6 oz./sq. ft. (1831 g/sq. m)**.
   b. White, translucent vinyl, weighing **14 oz./sq. ft. (4272 g/sq. m)**.

4. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades, and make sealing edge of dock shelter parallel to back edge of truck. Taper for [**declined**][**inclined**] approach.
5. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on side curtains.
6. Pleated Protectors: On head curtain of overlapping layers of coated fabric attached to base fabric.
7. Reinforcing: Manufacturer's standard reinforcing over cover fabric on side curtains [**and top cover**]of dock shelter.

F. Fabric:

1. Vinyl-Coated Nylon Cover Fabric: Minimum total weight of [**22 oz./sq. yd. (746 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

   a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Polyurethane-Coated Nylon Cover Fabric: Minimum total weight of **25 oz./sq. yd. (848 g/sq. m)**.

   a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Neoprene-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40**

oz./sq. yd. (1356 g/sq. m)][45 oz./sq. yd. (1526 g/sq. m)].

a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Hypalon-Coated Nylon Cover Fabric: Minimum total weight of [**16 oz./sq. yd. (543 g/sq. m)**][**40 oz./sq. yd. (1356 g/sq. m)**].

a. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:

a. Tearing strength of not less than [**300 by 300 (1334 by 1334)**] **lbf (N)** when tested according to ASTM D2261.
b. Abrasion resistance of not less than [**6000**] cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than [**1200 by 1200 (5338 by 5338)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
d. Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
e. Color: [**Black**][**Green**][**Blue**][**Brown**][**Tan**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. Pleated Protectors: Same fabric as cover.

G. Accessories:

1. Buffer flaps.
2. Bottom filler curtain.
3. Bottom seal pads.

2.5 INFLATABLE LOADING DOCK SHELTERS

A. Inflatable Dock Shelters: Inflatable dock shelters designed to inflate by blower and compress against truck bodies to form airtight seals at loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**air Locke Dock Seal**]
b. [**Kelley; Entrematic; ASSA ABLOY**]
c. [**Nordock Inc.**]
d. [**Pentalift Equipment Corporation**]
e. [**Rite-Hite Holding Corporation**]
f. [**Serco; Entrematic; ASSA ABLOY**]
g. [**Super Seal Mfg. Ltd**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Rigid Canopy: Consisting of rigid canopy, fabric-covered header curtain, and one-piece inflatable header and jamb seals. Fabricate canopy from white, translucent plastic attached to rigid support framework.

C. Rigid Canopy and Sides: Consisting of rigid canopy and sides, fabric-covered header curtain, and one-piece, inflatable header and jamb seals. Fabricate canopy and sides from white, translucent plastic attached to rigid support framework.

D. Construction: Fabricate header seal full width over jamb seals. Mount seals on pressure-treated wood frame with hot-dip galvanized-steel mounting hardware. Provide header curtain with built-in flexible stays and two guide strips. Slope canopy frame from center for drainage. Provide two protective steel bumpers of size and type required for application shown. Inflate seals by use of a 1/2-hp motor/blower, mounted under canopy frame with separate manual on/off activation switch with indicator light.[**Provide electrical interlock.**] Provide bottom of header and jamb seals with grommets to allow for release of moisture and excess air.

1. Shape and Size: Fabricate framework, fabric for curtains, and other components to sizes and shapes indicated or required to fit door-opening sizes shown, and allow for not less than **12 inches (305 mm)** of truck-body penetration when truck is docked.
2. Wood Framework: Fasten members together mechanically, using nails and lag bolts or metal connectors to form a rigid assembly.
3. Steel Framework: Zinc-plated steel tubing of size and thickness standard with manufacturer, with joints welded.

   a. Steel Finish: Hot-dip galvanize components to comply with the following:

      1) ASTM A123/A123M for iron and steel support framing.
      2) ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

4. Guide Strips: **4-inch- (102-mm-)** wide, coated, nylon guide strips on header curtain.

E. Materials:

1. Fabric:

   a. [**Polyurethane**][**Vinyl**]; minimum total weight of **14 oz./sq. yd. (475 g/sq. m)**.

      1) Color: [**Black**][**Green**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

   b. Manufacturer's proprietary fabric complying with the following minimum requirements:

      1) Tearing strength of not less than [**110 by 85 (489 by 378)**] **lbf (N)** when tested according to ASTM D2261.
      2) Abrasion resistance of not less than [**490**] cycles when tested according to FED-STD-191A-5306.
      3) Tensile strength of not less than [**500 by 440 (2224 by 1957)**] **lbf (N)** when tested according to FED-STD-191A-5100.1.
      4) Cold resistance to **minus 40 deg F (minus 40 deg C)** when tested according to FED-STD-191A-5874.
      5) Color: [**Black**][**Green**][**Blue**][**Brown**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 TRANSPARENT-STRIP DOOR CURTAINS

A. Transparent-Strip Door Curtains: Door curtains consisting of overlapping strips suspended from top of opening to form a sealed door curtain. Provide strips of length required to suit opening height and with sufficient unit number to close opening width with overlap indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Floor Products Company, Inc**]
b. [**Chalfant Sewing Fabricators, Inc**]
c. [**Chase Doors; a Senneca Company**]
d. [**Rotary Products Inc**]
e. [**Super Seal Mfg. Ltd**]
f. [**Verilon Vinyl**]
g. [**Vestil Manufacturing Company**]

2. Source Limitations: Obtain from single source from single manufacturer.

B. Strip Material: Curved, clear, transparent, extruded PVC. Fabricate strips for manufacturer's standard method of attachment to overhead mounting system indicated.

1. Standard Grade: Designed to withstand temperature range of **0 to plus 150 deg F (minus 18 to plus 66 deg C)**.
2. Low-Temperature Grade: USDA accepted; designed to withstand temperature range of **minus 30 to plus 150 deg F (minus 34 to plus 66 deg C)**.
3. Strip Dimensions: [**6 inches (152 mm) and 0.060 inch (1.5 mm)**][**8 inches (203 mm) and 0.080 inch (2 mm)**][**12 inches (305 mm) and 0.120 inch (3 mm)**][**16 inches (406 mm) and 0.160 inch (4 mm)**] width and thickness, respectively.
4. Overlap: [**None**][**One-third**][**One-half**][**Two-thirds**][**Three-quarters**][**Full**].

C. Header Mounting: Consisting of an angle bolted or welded to opening lintel; equip angle with permanently attached mounting pins and a steel-angle or -plate retaining strip attached to angle with wing nuts.

D. Steel-Plate Wall Surface Mounting: Consisting of a steel plate bolted to side of lintel; equip plate with permanently attached, threaded, mounting pins and steel-angle or -plate retaining strip attached to plate with wing nuts.

E. Steel-Pipe Wall Surface Mounting: Consisting of steel pipe attached to side of lintel by manufacturer's standard, winged-U-type suspension brackets.

F. Wall Surface Mounting: Consisting of a rigid, vinyl, wall-mounting unit bolted to side of lintel above opening; equip unit with a similarly formed, rigid, vinyl retainer attached to unit with wing nuts.

G. Wall Offset Mounting: Consisting of an angle bolted to face of wall projecting out on each side of door opening to allow hanging strips to clear overhead door hood. Equip angle with permanently attached mounting pins and a steel angle or plate retaining strip attached to angle with wing nuts. Return hanging strips to face of wall at jambs to fully enclose space interior to overhead door.

H. Steel Finish: Hot-dip galvanize components to comply with the following:

1. ASTM A123/A123M for iron and steel support mounting.
2. ASTM A153/A153M or ASTM F2329 for iron and steel hardware and anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for inflatable units to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Coordinate electrical connections with Division 26 Sections.

3.3 INSTALLATION OF FOAM PAD LOADING DOCK SEALS

A. Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.

3.4 INSTALLATION OF LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.5 INSTALLATION OF INFLATABLE LOADING DOCK SEALS

A. Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.

3.6 INSTALLATION OF FRAME-TYPE LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.7 INSTALLATION OF INFLATABLE LOADING DOCK SHELTERS

A. Attach dock shelters securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure an effective seal of dock-shelter curtains with sides and top of truck body when trucks are positioned against dock bumpers.

3.8 INSTALLATION OF TRANSPARENT-STRIP DOOR CURTAINS

A. Attach door-curtain mounting system to lintel with screw anchors or toggle bolts. Mount curtain strips to overlap.

3.9 ADJUSTING

A. After completing installation, inspect exposed factory finishes and repair damaged finishes.

END OF SECTION 11 13 16 00

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Task	Specification	Specification Description
11 13 16 13	11 13 16 00	Loading Dock Seals and Shelters
11 13 16 23	11 13 16 00	Loading Dock Seals and Shelters

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SECTION 11 13 19 00 - STATIONARY LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Recessed loading dock levelers.
2. Edge-of-dock loading dock levelers.
3. Top-of-dock loading dock levelers.
4. Vertical-storing loading dock levelers.
5. Truck levelers.
6. Stationary loading dock lifts (scissor lifts).
7. Truck restraints.
8. Light communication systems.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for [**curb angles at edges of recessed pits**][**and**][**loading dock platform edge channels**].
2. Section 083323 "Overhead Coiling Doors" for coiling overhead doors electrically interlocked to dock levelers.
3. Section 083613 "Sectional Doors" for sectional overhead doors electrically interlocked to dock levelers.
4. Section 111313 "Loading Dock Bumpers" for loading dock bumpers that are not integral with loading dock levelers.
5. Section 111316 "Loading Dock Seals and Shelters" for loading dock seals and shelters.
6. Section 111323 "Portable Dock Equipment" for portable loading dock lifts.

1.2 DEFINITIONS

A. Operating Range: Maximum amount of travel above and below the loading dock level.

B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

1.3 COORDINATION

A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation

B. Coordinate installation of cast-in-place items. Furnish setting drawings and templates.

C. Electrical System Roughing-in: Coordinate layout and installation of loading dock equipment with connections to power supplies[**and interlocked equipment**].

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of loading dock equipment.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for stationary loading dock equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For stationary loading dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.
3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Product Test Reports: For each dock leveler, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Indicate compliance of dock levelers with requirements in MH 30.1 for determining rated capacity based on comprehensive testing within last two years of current products.
2. Submittal Form: According to MH 30.1.

D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For stationary loading dock equipment to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**one**][**two**] hours' normal travel time from Installer's place of business to Project site.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with stationary loading dock equipment, including [**recessed pit dimensions**][**slopes of driveways**][**and**][**heights of loading docks**], by field measurements before fabrication.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
b. Faulty operation of operators, control system, or hardware.
c. Deck plate failures including cracked plate or permanent deformation in excess of **1/4 inch (6 mm)** between deck supports.
d. Hydraulic system failures including failure of hydraulic seals and cylinders.

2. Warranty Period for Structural Assembly: [**10**] years from date of Substantial Completion.
3. Warranty Period for Hydraulic System: [**Four**][**Five**] years from date of Substantial Completion.
4. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 RECESSED LOADING DOCK LEVELERS

A. Recessed Loading Dock Levelers: Recessed, hinged-lip-type dock levelers designed for permanent installation in concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**DLM; Systems, LLC**]

e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Poweramp; System, LLC**]
l. [**Rite-Hite Holding Corporation**]
m. [**Rotary Products Inc**]
n. [**Serco; Entrematic; ASSA ABLOY**]
o. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**][**30,000 (13 608)**][**45,000 (20 412)**] **lb (kg)** without permanent deflection or distortion.

E. Platform: Not less than [**3/16- (5-)**][**1/4- (6-)**][**3/8- (9.5-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Platform Width: [**72 inches (1829 mm)**][**78 inches (1981 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**]
2. Platform Length: [**72 inches (1829 mm)**][**96 inches (2438 mm)**][**120 inches (3048 mm)**][**As indicated on Drawings**].
3. Frame: [**Manufacturer's standard**][**Clean-pit type, designed to support leveler at sides of pit, with no supports at front of pit floor**].
4. Toe Guards: Equip open sides of dock leveler over range indicated with steel toe guards.

   a. Toe-Guard Range: Entire upper [**operating**][**working**] range.

F. Hinged Lip: Not less than [**1/2- (13-)**][**5/8- (16-)**][**3/4- (19-)**][**1- (25-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.
2. Safety Barrier Lip: Designed to protect material-handling equipment from an accidental fall from loading platform edge of the dock leveler when the leveler is not in use.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

   a. Above Adjoining Platform: [**12 inches (305 mm)**][**18 inches (457 mm)**][**As indicated on Drawings**].
   b. Below Adjoining Platform: [**12 inches (305 mm)**][**14 inches (356 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall

compensate automatically for canted truck beds of up to **4 inches (102 mm)** over width of ramp.

4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

    a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than) [**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.
6. Interlock: Leveler does not operate while [**overhead door is in closed position**][**leveler night lock is engaged**][**truck restraint is not engaged**][**inflatable dock seal is not inflated**][**and**][**inflatable dock shelter is not inflated**].

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.

I. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

    a. Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.
    b. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

3. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independent of raising and lowering of ramp.

J. Electric Operating System: Electric control from a remote-control station; motorized operation. Electric activation for raising of ramp and automatic extending of lip. Equip leveler with a packaged unit including a unitized electric motor and shaft assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

K. Air-Bag Operating System: Electric control from a remote-control station; pneumatic operation. High-volume, low-pressure lifting of ramp. Equip leveler with a packaged unit including a PVC-coated, reinforced polyester lifting bag and two-stage, single-speed electric fan of proper size, type, and operation for capacity of leveler indicated. Include dock-leveler supports controlled by release chain for lowering ramp below platform level without extending lip.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**] box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.

L. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

M. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

N. Integral Laminated-Tread Dock Bumpers: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

O. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

P. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

1. Toe Guards: Baked-on factory finish.

Q. Accessories:

1. Curb Angles: **3-by-3-by-1/4-inch (76-by-76-by-6-mm)** galvanized-steel curb angles for edge of recessed leveler pit, with **1/2-inch- (13-mm-)** diameter by **6-inch- (152-mm-)** long concrete anchors welded to angle at **6 inches (152 mm)** o.c.
2. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming[**spray zinc metallized**] steel form system for poured-in-place construction of concrete pit.
3. Night Locks: Manufacturer's standard means to prevent extending lip and lowering ramp when overhead doors are locked.
4. Side and rear weatherseals.
5. Foam insulation under dock-leveler platform.
6. [**Abrasive skid-resistant**][**Smooth**] surface.

2.2 EDGE-OF-DOCK LOADING DOCK LEVELERS

A. Edge-of-Dock Loading Levelers: Surface-mounted, hinged-lip-type, edge-of-dock levelers designed for permanent installation on face of loading dock platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Bluff Manufacturing, Inc**]
d. [**Chalfant Sewing Fabricators, Inc**]
e. [**DLM; Systems, LLC**]
f. [**Kelley; Entrematic; ASSA ABLOY**]
g. [**McGuire; Systems, LLC**]
h. [**Nordock Inc.**]
i. [**NOVA Technology International, L.L.C.**]
j. [**Pentalift Equipment Corporation**]
k. [**Pioneer Dock Equipment**]
l. [**Poweramp; System, LLC**]
m. [**Rite-Hite Holding Corporation**]
n. [**Rotary Products Inc**]
o. [**Serco; Entrematic; ASSA ABLOY**]
p. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**][**30,000 (13 608)**] **lb (kg)** without permanent deflection or distortion.

E. Platform Ramp Width: [**66 inches (1676 mm)**][**72 inches (1829 mm)**][**78 inches (1981 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**3/8- (9.5-)**][**7/16- (11-)**][**1/2- (13-)**] **inch- (mm-)** thick, nonskid steel tread plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

a. Above Adjoining Platform: [**5 inches (127 mm)**][**6 inches (152 mm)**][**As indicated on Drawings**].
b. Below Adjoining Platform: [**5 inches (127 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to **3 inches (76 mm)** over width of ramp.
4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than [**15 inches (381 mm)**][**17 inches (432 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.

1. Lever Handle: Self-storing lever handle for raising unloaded ramp with minimal lifting force by pulling lever back to extend lip and pushing lever forward to lower ramp and lip.
2. Removable Lifting Handle: For raising unloaded ramp by lifting action.

I. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 4**][**Type 12**] box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

J. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- and formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in

stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.

2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

K. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

L. Integral Laminated-Tread Dock Bumper: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

M. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

N. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

O. Accessories:

1. Self-forming pan.
2. Cast-in-place design.
3. Run-off guards.
4. Ramp approach plate.
5. [**Interlock to truck restraint**][**Key switch**].

2.3 TOP-OF-DOCK LOADING DOCK LEVELERS

A. Top-of-Dock Loading Dock Levelers: Surface-mounted, hinged-lip-type, top-of-dock levelers designed for permanent installation on top edge of loading dock platform without concrete pit; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**DLM; Systems, LLC**]
c. [**Pioneer Dock Equipment**]
d. [**Rotary Products Inc**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**20,000 (9072)**][**25,000 (11 340)**] **lb (kg)** without permanent deflection or distortion.

E. Platform Width: [**72 inches (1829 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**3/8- (9.5-)**][**7/16- (11-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with a minimum working range of [**10 (254)**] **inches (mm)** above and [**4 (102)**] **inches (mm)** below adjoining platform level.
2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

   a. Length of Lip Extension: Not less than **12 inches (305 mm)** from face of dock bumpers and not less than [**15 inches (381 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

4. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs. Leveler shall be capable of retracting to stored position while truck is at loading dock.

H. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with a torsion-spring counterbalancing mechanism controlled by a hold-down device.

1. Removable Lifting Hook: For raising unloaded ramp by lifting action and pushing forward to lower ramp and lip.

I. Hydraulic Operating System: Electric control from a remote-control station, fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp and lip raise to vertical position and extend to truck bed by depressing and holding button.

J. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- and formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

K. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

L. Integral Laminated-Tread Dock Bumpers: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

M. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

N. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

2.4 VERTICAL-STORING LOADING DOCK LEVELERS

A. Vertical-Storing Loading Dock Levelers: Recessed, hinged-lip-type, vertical-storing dock levelers designed for permanent installation in shallow concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Giant Equipment Corporation**]
   b. [**Kelley; Entrematic; ASSA ABLOY**]
   c. [**McGuire; Systems, LLC**]
   d. [**Pentalift Equipment Corporation**]
   e. [**Poweramp; System, LLC**]
   f. [**Rite-Hite Holding Corporation**]
   g. [**Serco; Entrematic; ASSA ABLOY**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.1[except for structural testing to establish rated capacity].

D. Rated Capacity: Capable of supporting total gross load of [**40,000 (18 144)**][**45,000 (20 412)**][**50,000 (22 680)**] **lb (kg)** without permanent deflection or distortion.

E. Platform: Not less than [**3/16- (5-)**][**1/4- (6-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Platform Width: [**72 inches (1829 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**].

2. Platform Length: [**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**][**As indicated on Drawings**].

F. Hinged Lip: Not less than [**1/2- (13-)**][**5/8- (16-)**] **inch- (mm-)** thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube[**and grease fittings**], with gussets on lip and ramp for support.

G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

a. Above Adjoining Platform: [**6 inches (152 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**][**As indicated on Drawings**].
b. Below Adjoining Platform: [**6 inches (152 mm)**][**As indicated on Drawings**].

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to **4 inches (102 mm)** over width of ramp.
4. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.

a. Length of Lip Extension: Not less than **12 inches (305 mm) from face of dock bumpers and not less than)**[**16 inches (406 mm)**][**18 inches (457 mm)**][**20 inches (508 mm)**][**dimension indicated on Drawings**] measured from ramp edge.

H. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than **3 inches (76 mm)**. Provide mechanical lock that prevents leveler from lowering without hydraulic pressure.

1. Remote-Control Station: [**Weatherproof single**][**Single**]-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp lowers at a controlled rate.
2. Remote-Control Station with Emergency Stop: [**Weatherproof multibutton**][**Multibutton**] control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, [**Type 12**] box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

a. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

3. Independent Lip Operation: Electric-powered hydraulic raising and lowering of lip, controlled independent of raising and lowering of ramp.

I. Construction: Fabricate dock-leveler frame, platform supports,[**run-off guards,**] and lip supports from

structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

J. Integral Molded-Rubber Dock Bumpers: Fabricated from [**4- (102-)**][**6- (152-)**] **inch- (mm-)** thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.

K. Integral Laminated-Tread Dock Bumpers: Fabricated from [**4-1/2- (114-)**][**6- (152-)**] **inch- (mm-)** thick, multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two **3/4-inch- (19-mm-)** diameter, steel supporting rods that are welded at one end to **1/4-inch- (6-mm-)** thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than **1 inch (25 mm)** of tread plies extending beyond the face of closure angles.

L. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

M. Dock-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**][**Spray zinc metallized**].

N. Accessories:

1. Interlock: Leveler does not operate while [**overhead door is in closed position**][**and**][**truck restraint is not engaged**].
2. Curb Angles: **3-by-3-by-1/4-inch (76-by-76-by-6-mm)** galvanized-steel curb angles for edge of recessed leveler pit, with **1/2-inch- (13-mm-)** diameter by **6-inch- (152-mm-)** long concrete anchors welded to angle at **6 inches (152 mm)** o.c.

2.5 TRUCK LEVELERS

A. Truck Levelers: Two-cylinder, hydraulic ramp designed to raise and lower end of truck at loading dock. Equip leveler with a packaged unit including a unitized electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity indicated. Provide manufacturer's standard means for limiting loaded ramp's free fall.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Lifts, Inc**]
b. [**Autoquip Corporation**]
c. [**Beacon Industries, Inc**]
d. [**Kelley; Entrematic; ASSA ABLOY**]
e. [**Pentalift Equipment Corporation**]
f. [**Poweramp; System, LLC**]
g. [**Rite-Hite Holding Corporation**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Rated Capacity: Capable of supporting total gross load of [**50,000 (22 680)**][**55,000 (24 948)**][**60,000 (27 216)**][**65,000 (29 484)**] **lb (kg)** without permanent deflection or distortion.

D. Travel Speed: Leveler raises and lowers at **3 fpm (0.015 m/s)**, measured at traveling end.

E. Surface-Mounted Units: Designed for mounting on surface of concrete driveway.

F. Shallow-Pit-Mounted Units: Designed for mounting in sloping shallow pit; capable of **18 inches (457 mm)** of vertical travel above and below level of driveway.

G. Full-Pit-Mounted Units: Designed for installation in a fully recessed pit, with top of platform in stored position flush with driveway.

1. Provide removable plate for access to pit for service.

H. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Self-contained, electric-powered hydraulic raising and hydraulic lowering of lift.

1. Remote-Control Station: Weatherproof, multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate truck leveler from structural- and formed-steel shapes; fabricate platform from nonskid steel plate. Construct platform with notch at loading dock end to provide clearance for truck restraint.

1. Cylinders: Equip truck leveler with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

K. Truck-Leveler Finish: [**Manufacturer's standard prime-paint or baked-on factory finish**][**Hot-dip galvanized**].

2.6 STATIONARY LOADING DOCK LIFTS

A. Stationary Loading Dock Lifts: Stationary, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Lifts, Inc**]
    b. [**Autoquip Corporation**]
    c. [**Beacon Industries, Inc**]
    d. [**Blue Giant Equipment Corporation**]
    e. [**Kelley; Entrematic; ASSA ABLOY**]
    f. [**Pentalift Equipment Corporation**]
    g. [**Presto Lifts Inc.**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: MH 29.1.

D. Rated Capacity: Lifting capacity of not less than [**8000 lb (3629)**][**load indicated on Drawings**] with axle loads of [**6500 lb (2948 kg) at ends and 5000 lb (2268 kg) at sides**][**magnitudes indicated on Drawings**].

E. Platform: [**Nonskid, safety-tread**][**Smooth-surface**] heavy[**hot-dip galvanized-**] steel deck plate.

1. Platform Size: [**72 inches (1829 mm) long by 72 inches (1829 mm) wide**][**96 inches (2438 mm) long by 72 inches (1829 mm) wide**][**120 inches (3048 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
2. Platform Guarding: [**Bevel toe guards**][**Toe sensor**][**Indicator bar**][**Skirts**][**Enclosure**] to comply with requirements in MH 29.1.
3. [**Removable**][**Fixed**] Guard Rails: Provide [**steel**][**hot-dip galvanized-steel**][**aluminum**] guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than **39 inches (991 mm)** high with midrail and **4-inch- (102-mm-)** high, kick plate at bottom.[**Mount rail sockets flush with platform surface.**]

F. Bridge: [**Nonskid, safety-tread steel**][**Nonskid, safety-tread, hot-dip galvanized-steel**][**High-tensile aluminum**] plate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
2. Size: [**18 inches (457 mm) long by 60 inches (1524 mm) wide**][**18 inches (457 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
3. Locations: [**Ends**][**Sides**][**As indicated on Drawings**].

G. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel and Travel Speed: As indicated on Drawings.
2. Vertical Travel: Maximum of [**60 (1524)**] **inches (mm)** from a lowered height of [**12 (305)**] **inches (mm)** for a total raised height of [**72 (1829)**]**inches (mm)**.
3. Travel Speed: Nominal raising speed of [**8 (0.04)**][**10 (0.05)**][**12 (0.06)**]**fpm (m/s)**.
4. Hinged Throw-over Bridge Operation: [**Manual**][**Spring assist**][**Manual-assist bridge winch**][**Automatic powered**].

H. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.

    a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
    b. Equip reservoir, valve manifold, and pressure line with oil-line filters.

2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement-plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

    a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.

3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

    a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

1. Scissors Mechanism: Fabricate leg members from heavy,[**hot-dip galvanized-**] steel-formed tube or plate members to provide maximum strength and rigidity.
2. Scissors Configuration: [**Single leg**][**Multiple width**][**Multiple length**].
3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
5. Mounting: [**Surface**][**Pit**].

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.

K. Dock Lift Finish: Manufacturer's standard baked-on factory finish unless otherwise indicated.

2.7 TRUCK RESTRAINTS

A. Truck Restraints: Manufacturer's standard device designed to engage truck's rear-impact guard and hold truck at loading dock. Restraint shall consist of an iron or steel restraining arm that raises until contacting rear-impact guard. Arm shall move vertically, automatically adjusting to varying height of truck due to loading and unloading operations.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Beacon Industries, Inc**]
b. [**Blue Giant Equipment Corporation**]
c. [**Chalfant Sewing Fabricators, Inc**]
d. [**DLM; Systems, LLC**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**McGuire; Systems, LLC**]
g. [**Nordock Inc.**]
h. [**NOVA Technology International, L.L.C.**]
i. [**Pentalift Equipment Corporation**]
j. [**Pioneer Dock Equipment**]
k. [**Poweramp; System, LLC**]
l. [**Rite-Hite Holding Corporation**]
m. [**Rotary Products Inc**]
n. [**Serco; Entrematic; ASSA ABLOY**]
o. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: Comply with MH 30.3.

D. Rated Capacity: Capable of supporting total gross load of [**30,000 (13 608)**][**32,000 (14 515)**] **lb (kg)** without permanent deflection or distortion.

E. Operating Range: Capable of restraining rear-impact guards within a range from:

1. Vertical Range: Minimum of [**7 inches (178 mm)**][**8 inches (203 mm)**][**9 inches (229 mm)**][**11 inches (279 mm)**][**dimension indicated on Drawings**] to maximum of [**28 inches (711 mm)**][**30 inches (762 mm)**][**34 inches (864 mm)**][**dimension indicated on Drawings**] above driveway.
2. Horizontal Range: Zero to [**10 inches (254 mm)**][**12 inches (305 mm)**][**15 inches (381 mm)**][**dimension indicated on Drawings**] in front of dock bumpers.

F. Power Operating System: Manufacturer's standard electromechanical or hydraulic unit.

1. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in NEMA ICS 6, [**Type 12**] box. Restraint is engaged by depressing and holding button; restraint is released by releasing button.
2. Interlock: Leveler does not operate while truck restraint is not engaged.

G. Mechanical Operating System: Restraint operates by use of a lifting rod or hook to raise engagement device.

H. Rear-Impact-Guard Sensor: Detects presence of rear-impact guard[**and automatically returns to stored position if rear-impact guard is not engaged**].

I. Caution Signs: Exterior, surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows. Provide one sign at each truck-restraint location.

1. Sign Copy in Forward and Reverse Text: [**Manufacturer's standard text permitting truck movement with green light**].
2. Interior Sign Copy: [**Manufacturer's standard text permitting truck movement with green light**].

J. Light Communication System: Red and green illuminated signal-light sets, with lens approximately **4 inches (102 mm)** in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel located at interior of dock that [**includes illuminated lights**

indicating][**indicates**] status of exterior signal lights. Provide signal-light set and control panel at each location indicated for light communication system. Enclose exterior signal-light sets in steel or plastic housing with sunshade.

1. Manual Operation: System is activated by push button or switch located on [**interior**][**truck-restraint**] control panel.
2. Automatic Operation:

   a. System is activated automatically by [**limit switch**][**photoelectric sensor**][**magnetic switch**] mounted on overhead door track. Provide on-off switch located on [**light communication system**][**truck-restraint**] control panel.
   b. System is activated automatically when device engages rear-impact guard. Provide on-off switch located on truck-restraint control panel.

3. Mounting: [**Wall**][**Driveway**][**Pit**][**Pedestal**].

   a. Pedestal: **4 by 4 inches (102 by 102 mm) post with base plate and face plate for mounting light communication system,)60 inches (1524 mm) high.)**

      1) Finish: [**Manufacturer's standard baked-on factory finish in yellow or orange**][**Hot-dip galvanized**].

K. Alarm: [**Audible**][**and**][**visual**] system indicating that rear-impact guard is not engaged, with manual reset.

L. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

M. Truck-Restraint Finish: [**Manufacturer's standard electrodeposited zinc coating**][**Hot-dip galvanized**].

N. Accessories: [**Interlock to dock leveler**][**Key switch**].

2.8 LIGHT COMMUNICATION SYSTEMS

A. Light Communication Systems: Communication system consisting of signal-light sets, caution signs, alarms, and controls for each location indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Beacon Industries, Inc**]
   b. [**Kelley; Entrematic; ASSA ABLOY**]
   c. [**Nordock Inc.**]
   d. [**Rite-Hite Holding Corporation**]
   e. [**Serco; Entrematic; ASSA ABLOY**]

f. [**Vestil Manufacturing Company**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Caution Signs: Surface mounted; designed to inform both dock attendant and truck driver; with sign copy as follows:

1. Exterior Sign Copy in Forward and Reverse Text: [**Manufacturer's standard text permitting truck movement with green light**].
2. Interior Sign Copy: [**Manufacturer's standard text permitting truck movement with green light**].
3. Mounting: [**Wall**][**Pedestal**]

D. Signal-Light Sets: Red and green illuminated signal-light sets, with lens approximately **4 inches (102 mm)** in diameter, designed to indicate status to both dock attendant and truck driver. Equip system with steel control panel that [**includes illuminated lights indicating**][**indicates**] status of exterior signal lights; locate control panel at interior of dock. Provide signal-light set and control panel at each location indicated for light communication system. Enclose signal lights in steel or plastic housing, with exterior signal-light sets equipped with sunshade.

1. Manual Operation: Lights are activated by push button or switch located on [**interior signal-light enclosure**][**control panel**].
2. Automatic Operation: Lights are activated automatically by [**limit switch**][**photoelectric sensor**][**magnetic switch**] mounted on overhead door track. Provide on-off switch located on control panel.
3. Mounting: [**Wall**][**Pedestal**]

E. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55 (380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.9 FINISH REQUIREMENTS

A. Finish loading dock equipment after assembly and testing.

B. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A123/A123M for iron and steel loading dock equipment.
2. ASTM A153/A153M or ASTM F2329/F2329M for iron and steel hardware for loading dock equipment.

C. Spray Zinc Metallizing: ASTM B833.

D. Electrodeposited Zinc Coatings: ASTM B633.

E. Steel Prime Paint Finish: Clean, pretreat, and apply manufacturer's standard primer.

F. Baked-on Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

1. Color: [**Manufacturer's standard**][**Match Architect's sample**], as directed by the Owner.
2. Toe Guards: Paint to comply with ANSI Z535.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.

C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.

B. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.

C. Place self-forming pan system for [**recessed dock**][**edge-of-dock**] levelers in proper relation to loading platform before pouring concrete.

D. Clean recessed pits of debris.

3.3 INSTALLATION, GENERAL

A. Install loading dock equipment as required for a complete installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF RECESSED LOADING DOCK LEVELERS

A. Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.

3.5 INSTALLATION OF EDGE-OF-DOCK LOADING DOCK LEVELERS

A. Attach dock levelers to loading dock platform in a manner that complies with requirements indicated for arrangement and position relative to top of platform.

1. Weld anchor holes in contact with continuous embedded loading dock edge channel. Weld or bolt bumper blocks to face of loading dock.

3.6 INSTALLATION OF TOP-OF-DOCK LOADING DOCK LEVELERS

A. Attach dock levelers to loading dock platform in a manner that complies with requirements indicated for arrangement and position relative to top of platform.

1. Weld anchor holes in contact with continuous embedded loading dock edge channel. Weld or bolt bumper blocks to face of loading dock.

3.7 INSTALLATION OF TRUCK LEVELERS

A. Attach truck levelers securely to driveway construction with expansion anchors and bolts.

3.8 INSTALLATION OF STATIONARY LOADING DOCK LIFTS

A. Attach dock lifts securely to [**loading platform**][**floor of recessed pit**][**surface of driveway**].

3.9 INSTALLATION OF TRUCK RESTRAINTS

A. Attach truck restraints in a manner that complies with requirements for arrangement and height required for device to engage vehicle rear-impact guard.[**Interconnect control panel and signals with dock leveler.**]

1. Wall-Mounted Units: [**Weld**][**Anchor**]

a. Weld truck restraints to steel [**curb angle**][**edge channel**][**mounting plate**] embedded in loading dock edge.
b. Anchor truck restraints to face of loading dock with expansion anchors and bolts.

2. Driveway-Mounted Units: Anchor truck restraints to driveway with expansion anchors and bolts.
3. Pit-Mounted Units: Anchor truck restraints to concrete pit with expansion anchors and bolts.

3.10 ADJUSTING

A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. Test dock levelers for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

3.11 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include [**12**] months' full maintenance by skilled employees of loading dock equipment Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and

adjusting as required for proper loading dock equipment operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 11 13 19 00

Task	Specification	Specification Description
11 13 19 13	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 23	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 26	11 13 19 00	Stationary Loading Dock Equipment
11 13 19 33	11 13 19 00	Stationary Loading Dock Equipment

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SECTION 11 13 23 00 - PORTABLE DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable loading dock lifts (scissors lifts).

B. Related Requirements:

1. Section 111319 "Stationary Loading Dock Equipment" for stationary dock lifts (scissor lifts).

1.2 DEFINITIONS

A. Operating Range: Maximum amount of travel above and below the loading dock level.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of portable dock equipment.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For portable dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For portable dock equipment, to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PORTABLE LOADING DOCK LIFTS (SCISSOR LIFTS)

A. Dock Lifts: Portable, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Lifts, Inc**]
b. [**Autoquip Corporation**]
c. [**Beacon Industries, Inc**]
d. [**Blue Giant Equipment Corporation**]
e. [**Kelley; Entrematic; ASSA ABLOY**]
f. [**Pentalift Equipment Corporation**]
g. [**Presto Lifts Inc.**]

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard: MH 29.1.

D. Rated Capacity: Lifting capacity of not less than [**8000 lb (3629 kg)**][**load indicated on Drawings**] and with axle loads of [**6500 lb (2948 kg) at ends and 5000 lb (2268 kg) at sides**][**magnitudes indicated on Drawings**].

E. Platform: [**Nonskid, safety-tread**][**Smooth-surface**] heavy[**hot-dip galvanized-**] steel deck plate.

1. Platform Size: [**72 inches (1829 mm) wide by 72 inches (1829 mm) long**][**72 inches (1829 mm) wideby 96 inches (2438 mm) long**][**72 inches (1829 mm) wideby 120 inches (3048 mm) long**][**As indicated on Drawings**].
2. Platform Guarding: [**Bevel toe guards**][**Toe sensor**][**Indicator bar**][**Skirts**][**Enclosure**] to comply with requirements in MH 29.1.
3. [**Removable**][**Fixed**] Guard Rails: Provide [**steel**][**hot-dip galvanized-steel**][**aluminum**] guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than **39 inches (991 mm)** high with midrail and **4-inch- (102-mm-)** high, kick plate at bottom.[**Mount rail sockets flush with platform surface.**]

F. Bridge: [**Nonskid, safety-tread steel**][**Nonskid, safety-tread hot-dip galvanized-steel**][**High-tensile**

aluminum] plate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
2. Size: [**18 inches (457 mm) long by 60 inches (1524 mm) wide**][**18 inches (457 mm) long by 72 inches (1829 mm) wide**][**As indicated on Drawings**].
3. Locations: [**Ends**][**Sides**][**As indicated on Drawings**].

G. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel and Travel Speed: As indicated on Drawings.
2. Vertical Travel: Maximum of [**60 (1524)**] **inches (mm)** from a lowered height of [**12 (305)**] **inches (mm)** for a total raised height of [**72 (1829)**]**inches (mm)**.
3. Travel Speed: Nominal raising speed of [**8 (0.04)**][**10 (0.05)**][**12 (0.06)**]**fpm (m/s)**.
4. Hinged Throw-over Bridge Operation: [**Manual**][**Spring assist**][**Manual-assist bridge winch**][**Automatic powered**].

H. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.

   a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
   b. Equip reservoir, valve manifold, and pressure line with oil-line filters.

2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

   a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.

3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [**Type 12**] box.

   a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

I. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

1. Scissors Mechanism: Fabricate leg members from heavy,[**hot-dip galvanized**] steel-formed tube or plate members to provide maximum strength and rigidity.
2. Scissors Configuration: [**Single leg**][**Multiple width**][**Multiple length**].
3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.

J. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade **55** **(380)**.
3. Steel Tubing: ASTM A500/A500M, cold formed.

2.2 FINISH REQUIREMENTS

A. Baked-on Factory Finish: Provide unless otherwise indicated. Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.

1. Toe Guards: Paint to comply with ANSI Z535.1.

B. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A123/A123M for iron and steel portable dock equipment.
2. ASTM A153/A153M or ASTM F2329/F2329M for iron and steel hardware for portable dock equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for portable dock equipment to verify actual locations of connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install portable dock equipment as required for a complete installation.

3.3 ADJUSTING

A. Adjust portable dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. Test lifts for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished portable dock equipment, inspect exposed finishes and repair damaged finishes.

3.4 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months'

full maintenance by [**skilled employees of portable dock equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper portable dock equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain portable dock equipment.

END OF SECTION 11 13 23 00

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Task	Specification	Specification Description
11 13 23 23	11 13 23 00	Portable Dock Equipment
11 21 63 00	11 40 00 00	Foodservice Equipment

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SECTION 11 30 13 00 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Kitchen exhaust ventilation.
3. Refrigeration appliances.
4. Cleaning appliances.
5. Trash compactors.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for kitchen sinks, dishwasher air-gap fittings, waste (garbage) disposers, and instant hot-water dispensers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Samples: For each exposed product and for each color and texture specified, in [**manufacturer's standard**] size.

C. Product Schedule: For appliances.[**Use same designations indicated on Drawings.**]

D. Sustainable Design Submittals:

1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
2. ENERGY STAR: Product data for indicated products, showing compliance with requirements for ENERGY STAR product labeling.
3. Product Data: For water-efficient clothes washer, indicating compliance with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of appliance.

C. Field quality-control reports.

D. Sample Warranties: For manufacturers' special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Gas-Fuel Conversion: Provide gas-fueled appliances with manufacturer's [**high-altitude**][**and**][**propane**] conversion kit installed by a qualified service agency according to manufacturer's written instructions for Project location and type of fuel.

1.7 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period[**except as qualified below:**]

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

B. Electric Cooktop and Range: [**Full warranty, including parts and labor,**][**Limited warranty, including parts and labor for first year and parts thereafter,**] for on-site service on surface-burner elements.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

C. Microwave Oven: [**Full warranty, including parts and labor,**][**Limited warranty, including parts and labor for first year and parts thereafter,**] for on-site service [**on the magnetron tube**]

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

D. Refrigerator/Freezer, Freezer, and Icemaker, Sealed System: [**Full warranty, including parts and labor,**][**Limited warranty, including parts and labor for first year and parts thereafter,**] for on-site service on the product.

1. Warranty Period for [**Sealed Refrigeration System**]: [**Two**][**Five**] years from date of Substantial Completion.
2. Warranty Period [**for Other Components**]: [**Two**] years from date of Substantial Completion.

E. Dishwasher: [**Full warranty, including parts and labor,**][**Limited warranty, including parts and labor for first year and parts thereafter,**] for on-site service on the product.

1. Warranty Period for [**Deterioration of Tub and Metal Door Liner**]: [**Three**][**Five**][**10**] years from date of Substantial Completion.
2. Warranty Period [**for Other Components**]: [**Two**] years from date of Substantial Completion.

F. Clothes Washer: [**Full warranty, including parts and labor,**][**Limited warranty, including parts and labor for first year and parts thereafter,**] for on-site service on the product.

1. Warranty Period: [**Two**][**Three**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**residential appliances from single source**][**and**][**each type of residential appliance from single manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Gas-Fueled Appliances: Certified by a qualified testing agency for each type of gas-fueled appliance according to ANSI Z21 Series standards.

C. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in [**the DOJ's 2010 ADA Standards for Accessible Design**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.3 COOKING APPLIANCES

A. Electric Cooktop :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch US; BSH Home Appliances Corporation**]
   b. [**Dacor, Inc.**]
   c. [**Fisher & Paykel Appliances Ltd**]
   d. [**Frigidaire**]
   e. [**Gaggenau; BSH Home Appliances Corporation**]
   f. [**GE Appliances; Haier Group**]
   g. [**Jennair; Whirlpool Corporation**]
   h. [**Kenmore; Transformco SR Brands LLC**]
   i. [**KitchenAid; Whirlpool Corporation**]
   j. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   k. [**Maytag; Whirlpool Corporation**]
   l. [**Miele**]
   m. [**Thermador; BSH Home Appliances Corporation**]
   n. [**Viking Range, LLC; Middleby Corporation**]
   o. [**Whirlpool Corporation**]
   p. [**Wolf; Sub-Zero Group, Inc.**]

2. Width: [**12 inches (305 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**].
3. Electric Burner Elements: [**Two**][**Four**][**Six**].

   a. Coil Type: [**Manufacturer's standard**][**Two 1200 W and two 2200 W**][**One 1200 W, one**

2200-W dual element, and two 2200 W].

b. Radiant Type: [**Two 1500 W and two 2000 W**][**One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element**].

c. Induction Type: [**Manufacturer's standard**][**Two 1200 W and two 1800 W**][**One 1200 W, one 1800 W, one 2700 W, and one 3300 W**].

4. Controls: Digital panel controls, located [**on front**][**on left side**][**on right side**][**remotely, where indicated**].
5. Downdraft Ventilation: [**Manufacturer's standard**][**550 cfm (260 L/s)**] built-in downdraft ventilation, with [**remote**]blower and exterior weatherproof wall cap.
6. Other Features: [**Grill**][**deep fryer**][**wok burner**][**and**][**wok ring**].
7. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
8. Top Material: [**Manufacturer's standard**][**Ceramic glass**][**Porcelain-enameled steel**][**Stainless steel**].

a. Color/Finish: [**White**][**Black**].

B. Gas Cooktop :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch US; BSH Home Appliances Corporation**]
b. [**Dacor, Inc.**]
c. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
d. [**Fisher & Paykel Appliances Ltd**]
e. [**Frigidaire**]
f. [**Gaggenau; BSH Home Appliances Corporation**]
g. [**GE Appliances; Haier Group**]
h. [**Jennair; Whirlpool Corporation**]
i. [**Kenmore; Transformco SR Brands LLC**]
j. [**KitchenAid; Whirlpool Corporation**]
k. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
l. [**Maytag; Whirlpool Corporation**]
m. [**Miele**]
n. [**Thermador; BSH Home Appliances Corporation**]
o. [**Viking Range, LLC; Middleby Corporation**]
p. [**Whirlpool Corporation**]
q. [**Wolf; Sub-Zero Group, Inc.**]

2. Width: [**12 inches (305 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**].
3. Gas Burners: [**Two**][**Four**][**Six**].

a. Power Ratings: [**Manufacturer's standard**][**One 5000 Btu/h (1500 W), two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W)**].

b. Grates: [**Individual**][**Continuous**].

4. Controls: [**Digital panel**][**Manual-dial**] controls, located on [**front**][**left side**][**right side**].
5. Downdraft Ventilation: [**Manufacturer's standard**][**550 cfm (260 L/s)**] built-in downdraft ventilation, with [**remote**]blower and exterior weatherproof wall cap.
6. Other Features: [**Sealed burners**][**auto-reigniting burners**][**grill**][**deep fryer**][**wok burner**][**and**][**wok ring**].
7. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].

8. Top Material: [**Manufacturer's standard**][**Ceramic glass**][**Porcelain-enameled steel**][**Stainless steel**].

   a. Color/Finish: [**White**][**Black**].

C. Electric Range : [**Freestanding**][**Slide-in**][**Drop-in**] range with [**one**][**two**] oven(s) and complying with AHAM ER-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amana; Whirlpool Corporation**]
   b. [**Bosch US; BSH Home Appliances Corporation**]
   c. [**Dacor, Inc.**]
   d. [**Fisher & Paykel Appliances Ltd**]
   e. [**Frigidaire**]
   f. [**GE Appliances; Haier Group**]
   g. [**Jennair; Whirlpool Corporation**]
   h. [**Kenmore; Transformco SR Brands LLC**]
   i. [**KitchenAid; Whirlpool Corporation**]
   j. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   k. [**Maytag; Whirlpool Corporation**]
   l. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
   m. [**Viking Range, LLC; Middleby Corporation**]
   n. [**Whirlpool Corporation**]

2. Width: [**30 inches (762 mm)**][**36 inches (914 mm)**].
3. Electric Burner Elements: [**Four**][**Six**].

   a. Coil Type: [**Manufacturer's standard**][**Two 1200 W and two 2200 W**][**One 1200 W, one 2200-W dual element, and two 2200 W**].
   b. Radiant Type: [**Two 1500 W and two 2000 W**][**One 1200-W element, dual 1500-W/1500-W bridge element, and one 1200-W/2500-W expandable element**].
   c. Induction Type: [**Manufacturer's standard**][**Two 1200 W and two 1800 W**][**One 1200 W, one 1800 W, one 2700 W, and one 3300 W**].
   d. Controls: Digital panel controls, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].

4. Oven Features:

   a. Capacity: [3.3 cu. ft. (0.09 cu. m)].
   b. Operation: [**Baking**][**convection**][**and**][**pyrolytic self-cleaning or catalytic continuous cleaning**].
   c. Broiler: Located in [**top of oven**][**separate roll-out drawer on bottom**].
   d. Oven Door(s): Counterbalanced, removable, with [**observation window**][**and**][**full-width**] handle.
   e. Electric Power Rating:

      1) Oven(s): [Manufacturer's standard][2400 W].
      2) Broiler: [**Manufacturer's standard**][**3500 W**].

   f. Controls: Digital panel controls and timer display, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].

5. Anti-Tip Device: Manufacturer's standard.
6. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
7. Material: [**Porcelain-enameled**][**Stainless**] steel with [**manufacturer's standard**][**ceramic-glass**] cooktop.

    a. Color/Finish: [**White**][**Black**].

D. Gas Range : [**Freestanding**][**Slide-in**] range with [**one**][**two**] oven(s).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amana; Whirlpool Corporation**]
    b. [**Bosch US; BSH Home Appliances Corporation**]
    c. [**Dacor, Inc.**]
    d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
    e. [**Fisher & Paykel Appliances Ltd**]
    f. [**Frigidaire**]
    g. [**GE Appliances; Haier Group**]
    h. [**Jennair; Whirlpool Corporation**]
    i. [**Kenmore; Transformco SR Brands LLC**]
    j. [**KitchenAid; Whirlpool Corporation**]
    k. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
    l. [**Maytag; Whirlpool Corporation**]
    m. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
    n. [**Thermador; BSH Home Appliances Corporation**]
    o. [**Viking Range, LLC; Middleby Corporation**]
    p. [**Whirlpool Corporation**]
    q. [**Wolf; Sub-Zero Group, Inc.**]

2. Width: [**30 inches (762 mm)**][**36 inches (914 mm)**].
3. Gas Burners: [**Four**][**Six**].

    a. Power Ratings: [**Manufacturer's standard**][**One 5000 Btu/h (1500 W), two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W)**].
    b. Controls: [**Digital panel**][**Manual-dial**] controls, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].
    c. Grates: [**Individual**][**Continuous**].
    d. Other Feature(s): [**Sealed burners**][**auto-reigniting burners**][**and**][**grill**].

4. Oven Features:

    a. Capacity: [3.3 cu. ft. (0.09 cu. m)].
    b. Operation: [**Baking**][**convection**][**and**][**pyrolytic self-cleaning or catalytic continuous cleaning**].
    c. Broiler: Located in [**top of oven**][**separate roll-out drawer on bottom**].
    d. Oven Door(s): Counterbalanced, removable, with [**observation window**][**and**][**full-width**] handle.
    e. Gas Power Ratings:

        1) Oven(s): [Manufacturer's standard][9100 Btu/h (2700 W)].
        2) Broiler: [**Manufacturer's standard**][**14,500 Btu/h (4200 W)**].

f. Controls: [**Digital panel**][**Manual-dial**] controls and timer display, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].

5. Anti-Tip Device: Manufacturer's standard.
6. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 15 A**][**As indicated on Drawings**].
7. Material: [**Porcelain-enameled**][**Stainless**] steel with [**manufacturer's standard**][**ceramic-glass**] cooktop.

a. Color/Finish: [**White**][**Black**].

E. Dual Fuel Range : [**Freestanding**][**Slide-in**] range with gas burners and [**one**][**two**] electric oven(s).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amana; Whirlpool Corporation**]
b. [**Bosch US; BSH Home Appliances Corporation**]
c. [**Dacor, Inc.**]
d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
e. [**Fisher & Paykel Appliances Ltd**]
f. [**Frigidaire**]
g. [**GE Appliances; Haier Group**]
h. [**Jennair; Whirlpool Corporation**]
i. [**Kenmore; Transformco SR Brands LLC**]
j. [**KitchenAid; Whirlpool Corporation**]
k. [**Thermador; BSH Home Appliances Corporation**]
l. [**Viking Range, LLC; Middleby Corporation**]
m. [**Wolf; Sub-Zero Group, Inc.**]

2. Width: [**30 inches (762 mm)**][**36 inches (914 mm)**].
3. Gas Burners: [**Four**][**Six**].

a. Power Ratings: [**Manufacturer's standard**][**One 5000 Btu/h (1500 W), two 9100 Btu/h (2700 W), and one 12,000 Btu/h (3500 W)**].
b. Controls: [**Digital panel**][**Manual-dial**] controls, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].
c. Grates: [**Individual**][**Continuous**].

4. Oven Features:

a. Capacity: [3.3 cu. ft. (0.09 cu. m)].
b. Operation: [**Baking**][**convection**][**and**][**pyrolytic self-cleaning or catalytic continuous cleaning**].
c. Broiler: Located in [**top of oven**][**separate roll-out drawer on bottom**].
d. Oven Door(s): Counterbalanced, removable, with [**observation window**][**and**][**full-width**] handle.
e. Electric Power Rating:

1) Oven(s): [Manufacturer's standard][2400 W].
2) Broiler: [**Manufacturer's standard**][**3500 W**].

f. Controls: [**Digital panel**][**Manual-dial**] controls and timer display, located on [**front**][**left side**][**right side**][**splash panel at rear of rangetop**].

5. Anti-Tip Device: Manufacturer's standard.
6. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
7. Material: [**Porcelain-enameled**][**Stainless**] steel with [**manufacturer's standard**][**ceramic-glass**] cooktop.

    a. Color/Finish: [**White**][**Black**].

F. Electric Wall Oven : [**One**][**Two**]-oven unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bosch US; BSH Home Appliances Corporation**]
    b. [**Dacor, Inc.**]
    c. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
    d. [**Fisher & Paykel Appliances Ltd**]
    e. [**Frigidaire**]
    f. [**Gaggenau; BSH Home Appliances Corporation**]
    g. [**GE Appliances; Haier Group**]
    h. [**Jennair; Whirlpool Corporation**]
    i. [**Kenmore; Transformco SR Brands LLC**]
    j. [**KitchenAid; Whirlpool Corporation**]
    k. [**Maytag; Whirlpool Corporation**]
    l. [**Miele**]
    m. [**Thermador; BSH Home Appliances Corporation**]
    n. [**Viking Range, LLC; Middleby Corporation**]
    o. [**Whirlpool Corporation**]
    p. [**Wolf; Sub-Zero Group, Inc.**]

2. Mounting: Built-in [**wall**][**undercounter**].
3. Capacity: [3.3 cu. ft. (0.09 cu. m)].
4. Operation: [**Baking**][**convection**][**and**][**pyrolytic self-cleaning or catalytic continuous cleaning**].
5. Broiler: Located in [**top of oven**][**separate roll-out drawer on bottom**].
6. Oven Door(s): Counterbalanced, removable, with [**observation window**][**and**][**full-width**] handle.
7. Electric Power Rating:

    a. Oven(s): [Manufacturer's standard][2400 W].
    b. Broiler: [**Manufacturer's standard**][**3500 W**].

8. Electric Power Supply: [**240 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
9. Controls: [**Digital panel**][**Manual-dial**] controls and timer display.
10. Material: [**Porcelain-enameled steel**][**Stainless steel**][**Manufacturer's standard**].

    a. Color/Finish: [**White**][**Black**].

G. Gas Wall Oven : [**One**][**Two**]-oven unit.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frigidaire**]
b. [**GE Appliances; Haier Group**]
c. [**Kenmore; Transformco SR Brands LLC**]
d. [**Maytag; Whirlpool Corporation**]

2. Mounting: Built-in [**wall**][**undercounter**].
3. Capacity: [3.3 cu. ft. (0.09 cu. m)].
4. Operation: [**Baking**][**convection**][**and**][**pyrolytic self-cleaning or catalytic continuous cleaning**].
5. Broiler: Located in [**top of oven**][**separate roll-out drawer on bottom**].
6. Oven Door(s): Counterbalanced, removable, with [**observation window**][**and**][**full-width**] handle.
7. Gas Power Ratings:

   a. Oven(s): [Manufacturer's standard][9100 Btu/h (2700 W)].
   b. Broiler: [**Manufacturer's standard**][**14,500 Btu/h (4200 W)**].

8. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
9. Controls: [**Digital panel**][**Manual-dial**] controls and timer display
10. Material: [**Porcelain-enameled steel**][**Stainless steel**][**Manufacturer's standard**].

    a. Color/Finish: [**White**][**Black**].

H. Microwave Oven :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amana; Whirlpool Corporation**]
   b. [**Bosch US; BSH Home Appliances Corporation**]
   c. [**Dacor, Inc.**]
   d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
   e. [**Fisher & Paykel Appliances Ltd**]
   f. [**Frigidaire**]
   g. [**Gaggenau; BSH Home Appliances Corporation**]
   h. [**GE Appliances; Haier Group**]
   i. [**Jennair; Whirlpool Corporation**]
   j. [**Kenmore; Transformco SR Brands LLC**]
   k. [**KitchenAid; Whirlpool Corporation**]
   l. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   m. [**Maytag; Whirlpool Corporation**]
   n. [**Miele**]
   o. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
   p. [**Sharp Electronics Corp.**]
   q. [**Thermador; BSH Home Appliances Corporation**]
   r. [**Viking Range, LLC; Middleby Corporation**]
   s. [**Whirlpool Corporation**]
   t. [**Wolf; Sub-Zero Group, Inc.**]

2. Mounting: [**Undercabinet**][**Wall cabinet**].
3. Type: [**Conventional**][**Convection**].
4. Dimensions:

   a. Width: [**24 inches (610 mm)**][**30 inches (762 mm)**][**As indicated on Drawings**].
   b. Depth: [**19-1/2 inches (495 mm)**][**As indicated on Drawings**].

c. Height: [**14 inches (356 mm)**][**18 inches (457 mm)**][**As indicated on Drawings**].

5. Capacity: [**1.5 cu. ft. (0.04 cu. m)**][**2.0 cu. ft. (0.06 cu. m)**].
6. Oven Door: Door with observation window [**and pull handle**][**and pushbutton latch release**].
7. Exhaust Fan: [**Variable**][**Two**][**Four**]-speed fan, [**vented to outside**][**nonvented, recirculating type with charcoal filter**] and with [**manufacturer's standard**][**300 cfm (140 L/s)**] capacity.
8. Microwave Power Rating: [**Manufacturer's standard**][**1000 W**].

   a. Convection Element Power Rating: [**Manufacturer's standard**][**1450 W**].

9. Electric Power Supply: [**120 V, 60 Hz, 1 phase, 15 A**][**As indicated on Drawings**].
10. Controls: Digital panel controls and timer display.
11. Other Features: [**Turntable**][**temperature probe**][**and**][**lock-out feature**].
12. Material: [**Porcelain-enameled steel**][**Stainless steel**][**Manufacturer's standard**].

    a. Color/Finish: [**White**][**Black**].

2.4 KITCHEN EXHAUST VENTILATION

A. Overhead Exhaust Hood :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amana; Whirlpool Corporation**]
   b. [**Bosch US; BSH Home Appliances Corporation**]
   c. [**Dacor, Inc.**]
   d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
   e. [**Fisher & Paykel Appliances Ltd**]
   f. [**Frigidaire**]
   g. [**Gaggenau; BSH Home Appliances Corporation**]
   h. [**GE Appliances; Haier Group**]
   i. [**Jennair; Whirlpool Corporation**]
   j. [**Kenmore; Transformco SR Brands LLC**]
   k. [**KitchenAid; Whirlpool Corporation**]
   l. [**Maytag; Whirlpool Corporation**]
   m. [**Miele**]
   n. [**Thermador; BSH Home Appliances Corporation**]
   o. [**Viking Range, LLC; Middleby Corporation**]
   p. [**Whirlpool Corporation**]
   q. [**Wolf; Sub-Zero Group, Inc.**]

2. Type: [**Wall-mounted,**][**Suspended-island-canopy,**] exhaust-hood system.
3. Dimensions:

   a. Width: [**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**][**As indicated on Drawings**].
   b. Depth: [**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**][**As indicated on Drawings**].

4. Exhaust Fan: [**Variable**][**Two**][**Three**]-speed fan [**built into hood**][**remotely located, with separate housing**] and with [**manufacturer's standard**][**500 cfm (236 L/s)**][**900 cfm (425 L/s)**]

capacity.

a. Venting: [**Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening**][**Vented to outside through wall with weatherproof wall cap, backdraft damper, and rodent-proof screening**][**Nonvented, recirculating type with charcoal filter**][**As indicated on Drawings**].
b. Fan Control: [**Hood**][**Wall**]-mounted[**touch-pad to control**] fan switch, with separate hood-light control switch.

5. Duct Type: [**Manufacturer's standard**][**7-inch- (175-mm-) diameter round**][**3-1/4 by 10 inches (82 by 250 mm) rectangular**][**As indicated on Drawings**].
6. Finish: [**Baked enamel**][**Stainless steel**].

a. Color: [**White**].

7. Features:

a. Permanent, washable [**aluminum-mesh**][**stainless steel-mesh**][**baffle-type**] filter(s).
b. Built-in [**halogen**][**incandescent**][**fluorescent**] lighting.
c. Warming lamp socket(s).

B. Downdraft Exhaust :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amana; Whirlpool Corporation**]
b. [**Bosch US; BSH Home Appliances Corporation**]
c. [**Dacor, Inc.**]
d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
e. [**Frigidaire**]
f. [**Gaggenau; BSH Home Appliances Corporation**]
g. [**GE Appliances; Haier Group**]
h. [**Jennair; Whirlpool Corporation**]
i. [**KitchenAid; Whirlpool Corporation**]
j. [**Maytag; Whirlpool Corporation**]
k. [**Miele**]
l. [**Thermador; BSH Home Appliances Corporation**]
m. [**Viking Range, LLC; Middleby Corporation**]
n. [**Whirlpool Corporation**]
o. [**Wolf; Sub-Zero Group, Inc.**]

2. Type: [**Retractable-downdraft**] exhaust system.
3. Width: [**30 inches (762 mm)**][**36 inches (914 mm)**][**As indicated on Drawings**].
4. Exhaust Fan: [**Variable**][**Two**][**Three**]-speed fan [**built into cabinet below countertop**][**remotely located, with separate housing**] and with [**manufacturer's standard**][**500 cfm (236 L/s)**][**900 cfm (425 L/s)**] capacity.

a. Venting: [**Vented to outside through roof with weatherproof roof cap, backdraft damper, and rodent-proof screening**][**Vented to outside through wall with weatherproof wall cap, backdraft damper, and rodent-proof screening**][**Nonvented, recirculating type with charcoal filter**][**As indicated on Drawings**].
b. Fan Control: [**Countertop**]-mounted[**touch-pad to control**] fan switch.

5. Duct Type: [**Manufacturer's standard**][**7-inch- (175-mm-) diameter round**][**3-1/4 by 10 inches (82 by 250 mm) rectangular**].
6. Finish: [**Baked enamel**][**Stainless steel**].

    a. Color: [**White**].

7. Features:

    a. Permanent, washable [**aluminum-mesh**][**stainless steel-mesh**][**baffle-type**] filter(s).

2.5 REFRIGERATION APPLIANCES

A. Refrigerator/Freezer : [**One-door refrigerator with freezer compartment inside**][**Two-door, side-by-side refrigerator/freezer**][**Two-door refrigerator/freezer with freezer on top**][**Two-door refrigerator/freezer with freezer on bottom**] and complying with AHAM HRF-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amana; Whirlpool Corporation**]
    b. [**Bosch US; BSH Home Appliances Corporation**]
    c. [**Dacor, Inc.**]
    d. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
    e. [**Fisher & Paykel Appliances Ltd**]
    f. [**Frigidaire**]
    g. [**Gaggenau; BSH Home Appliances Corporation**]
    h. [**GE Appliances; Haier Group**]
    i. [**Jennair; Whirlpool Corporation**]
    j. [**Kenmore; Transformco SR Brands LLC**]
    k. [**KitchenAid; Whirlpool Corporation**]
    l. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
    m. [**Maytag; Whirlpool Corporation**]
    n. [**Miele**]
    o. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
    p. [**Thermador; BSH Home Appliances Corporation**]
    q. [**Viking Range, LLC; Middleby Corporation**]
    r. [**Whirlpool Corporation**]
    s. [**Wolf; Sub-Zero Group, Inc.**]

2. Type: [**Freestanding**][**Built in**][**Undercounter**].
3. Dimensions:

    a. Width: [**16 inches (406 mm)**][**24 inches (610 mm)**][**27 inches (686 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**42 inches (1067 mm)**][**48 inches (1219 mm)**][**As indicated on Drawings**].
    b. Depth: [**24 inches (610 mm)**][**27 inches (686 mm)**][**33-1/4 inches (845 mm)**][**As indicated on Drawings**].
    c. Height: [**34-1/2 inches (876 mm)**][**70 inches (1778 mm)**][**73 inches (1854 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**].

4. Storage Capacity:

a. Refrigeration Compartment Volume: [**15.6 cu. ft. (0.44 cu. m)**].
b. Freezer Volume: [**5.13 cu. ft. (0.15 cu. m)**].
c. Shelf Area: [**Three**] adjustable [**wire**][**glass**] shelves, [**26 sq. ft. (2.42 sq. m)**].

5. General Features:

a. Door Configuration: [**Framed**][**Overlay**].
b. Dispenser in door for [**ice**][**and**][**cold water**][**with dispenser lock**].
c. Built-in water-filtration system.
d. Dual refrigeration systems.
e. Separate[**touch-pad**] temperature controls for each compartment.

6. Refrigerator Features:

a. Interior light in refrigeration compartment.
b. Compartment Storage: [**Wine racks**][**vegetable crisper**][**and**][**meat compartment**].
c. Door Storage: [**Glazed door without storage**][**Modular compartments**][**1 gal. (3.8 L) milk-container storage**].
d. Temperature-controlled meat/deli bin.

7. Freezer Features: [**One**][**Two**] freezer compartment(s) [**with door(s)**][**configured as pull-out drawer(s)**].

a. [**Automatic**][**Manual**] defrost.
b. Interior light in freezer compartment.
c. Automatic icemaker and storage bin.

8. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
9. Front Panel(s): [**Manufacturer's standard**][**Wood panel(s) to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert(s) specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert(s) specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert(s) specified in Section 123530 "Residential Casework" to match kitchen cabinets**][**Reversible panel(s) with choice of colors**].

a. Panel Color: [**White**][**Black**].

10. Appliance Color/Finish: [**White**][**Black**][**Stainless steel**].

B. Freezer : [**One**][**Two**] freezer compartment(s) [**with door(s)**][**configured as pull-out drawer(s)**] and complying with AHAM HRF-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Frigidaire**]
b. [**GE Appliances; Haier Group**]
c. [**Kenmore; Transformco SR Brands LLC**]
d. [**Maytag; Whirlpool Corporation**]
e. [**Miele**]
f. [**Thermador; BSH Home Appliances Corporation**]
g. [**Viking Range, LLC; Middleby Corporation**]
h. [**Whirlpool Corporation**]

i. [**Wolf; Sub-Zero Group, Inc.**]

2. Type: [**Freestanding**][**Built in**][**Undercounter**].
3. Dimensions:

   a. Width: [**27 inches (686 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**As indicated on Drawings**].
   b. Depth: [**24 inches (610 mm)**][**27 inches (686 mm)**][**As indicated on Drawings**].
   c. Height: [**34-1/2 inches (876 mm)**][**70 inches (1778 mm)**][**73 inches (1854 mm)**][**84 inches (2134 mm)**][**As indicated on Drawings**].

4. Storage Capacity:

   a. Volume: [**5.13 cu. ft. (0.15 cu. m)**][**15.0 cu. ft. (0.42 cu. m)**].
   b. Shelf Area: [**Three**] adjustable [**wire**][**glass**] shelves, [**26 sq. ft. (2.42 sq. m)**].

5. Features:

   a. Door Configuration: [**Framed**][**Overlay**].
   b. [**Automatic**][**Manual**] defrost.
   c. Interior light in compartment.
   d. Automatic icemaker and storage bin.
   e. Temperature[**touch-pad**] controls for[**each**] compartment.
   f. Defrost drain.
   g. Lock with key.

6. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
7. Front Panel(s): [**Manufacturer's standard**][**Wood panel(s) to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert(s) specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert(s) specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert(s) specified in Section 123530 "Residential Casework" to match kitchen cabinets**].

   a. Panel Color: [**White**][**Black**].

8. Appliance Color/Finish: [**White**][**Black**][**Stainless steel**].

C. Icemaker :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GE Appliances; Haier Group**]
   b. [**Jennair; Whirlpool Corporation**]
   c. [**KitchenAid; Whirlpool Corporation**]
   d. [**Maytag; Whirlpool Corporation**]
   e. [**Viking Range, LLC; Middleby Corporation**]
   f. [**Whirlpool Corporation**]

2. Type: [**Undercounter**].
3. Dimensions:

a. Width: [**14-3/4 inches (375 mm)**][**15-1/4 inches (387 mm)**][**As indicated on Drawings**].
b. Depth: [**24 inches (610 mm)**][**25-1/4 inches (641 mm)**][**As indicated on Drawings**].
c. Height: [**33-5/8 inches (386 mm)**][**34-1/2 inches (876 mm)**][**As indicated on Drawings**].

4. Ice Capacity:

a. Production: [**30 lb (13.6 kg)**][**50 lb (22.7 kg)**] per day.
b. Storage: [**25 lb (11.3 kg)**][**35 lb (15.9 kg)**].

5. Features:

a. Door Configuration: [**Framed**][**Overlay**].
b. [**Automatic defrost**].
c. Automatic shutoff.
d. Defrost drain[**with pump**].

6. Front Panel: [**Manufacturer's standard**][**Wood panel to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert specified in Section 123530 "Residential Casework" to match kitchen cabinets**].

a. Panel Color: [**White**][**Black**].

7. Appliance Color/Finish: [**White**][**Black**][**Stainless steel**].

2.6 CLEANING APPLIANCES

A. Dishwasher : Complying with AHAM DW-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amana; Whirlpool Corporation**]
b. [**ASKO Appliances**]
c. [**Bosch US; BSH Home Appliances Corporation**]
d. [**Dacor, Inc.**]
e. [**DCS Appliances; Fisher and Paykel Appliances Ltd**]
f. [**Fisher & Paykel Appliances Ltd**]
g. [**Frigidaire**]
h. [**Gaggenau; BSH Home Appliances Corporation**]
i. [**GE Appliances; Haier Group**]
j. [**Jennair; Whirlpool Corporation**]
k. [**Kenmore; Transformco SR Brands LLC**]
l. [**KitchenAid; Whirlpool Corporation**]
m. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
n. [**Maytag; Whirlpool Corporation**]
o. [**Miele**]
p. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
q. [**Thermador; BSH Home Appliances Corporation**]
r. [**Viking Range, LLC; Middleby Corporation**]
s. [**Whirlpool Corporation**]

2. Type: [**Built-in undercounter**][**Built-in under sink**][**Portable**].
3. Dimensions:

    a. Width: [**18 inches (457 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].
    b. Depth: [**23 inches (584 mm)**][**25-3/4 inches (654 mm)**][**As indicated on Drawings**].
    c. Height: [**34-1/2 inches (876 mm)**][**As indicated on Drawings**].

4. Capacity:

    a. International Place Settings of China: [**Eight**][**12**][**14**].
    b. Water Consumption for Full Load: [**3.2 gal. (12 L)**] per cycle.

5. Sound Level: Maximum [**42**][**48**] dB.
6. Tub and Door Liner: [**Manufacturer's standard**][**Porcelain-enameled steel**][**Stainless steel**][**Porcelain-enameled steel tub and molded-plastic door liner**] with sealed detergent and automatic rinsing-aid dispensers.
7. Rack System: [**Nylon**][**PVC**]-coated sliding dish racks, with [**removable cutlery basket**][**top cutlery tray**].
8. Controls: [**Touch-pad**][**Rotary-dial**] controls with [**four**] wash cycles and hot-air and heat-off drying cycle options.
9. Features:

    a. Waste food disposer.
    b. Self-cleaning food-filter system.
    c. Hot-water booster heater for [**140 deg F (60 deg C)**][**160 deg F (71 deg C)**] wash water with incoming water at **100 deg F (38 deg C)**.
    d. Lock-out feature.
    e. Half-load option.
    f. Delay-wash option.
    g. Digital display panel.
    h. Water softener.
    i. Soil-sensing water use control system.

10. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
11. Front Panel: [**Manufacturer's standard**][**Wood panel to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert specified in Section 123530 "Residential Casework" to match kitchen cabinets**][**Reversible panel with choice of colors**].

    a. Panel Color: [**White**][**Black**].

12. Appliance Color/Finish: [**White**][**Black**][**Stainless steel**].

B. Clothes Washer : Complying with AHAM HLW-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amana; Whirlpool Corporation**]
    b. [**ASKO Appliances**]

c. [**Bosch US; BSH Home Appliances Corporation**]
d. [**Fisher & Paykel Appliances Ltd**]
e. [**Frigidaire**]
f. [**GE Appliances; Haier Group**]
g. [**Kenmore; Transformco SR Brands LLC**]
h. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
i. [**Maytag; Whirlpool Corporation**]
j. [**Miele**]
k. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
l. [**Whirlpool Corporation**]

2. Type: [**Freestanding**][**Stacking**][**Undercounter**], [**top**][**front**]-loading unit.
3. Dimensions:

   a. Width: [**23-1/2 inches (597 mm)**][**27 inches (686 mm)**][**30 inches (762 mm)**][**As indicated on Drawings**].
   b. Depth: [**24 inches (610 mm)**][**29 inches (737 mm)**][**31 inches (787 mm)**][**As indicated on Drawings**].
   c. Height: [**34-1/2 inches (876 mm)**][**38 inches (965 mm)**][**45 inches (1143 mm)**][**As indicated on Drawings**].

4. Drum: [**Manufacturer's standard**][**Perforated porcelain-enameled steel**][**Perforated stainless steel**].

   a. Capacity: [**2.7 cu. ft. (0.08 cu. m)**][**3.2 cu. ft. (0.09 cu. m)**][**3.8 cu. ft. (0.11 cu. m)**].

5. Controls: [**Touch-pad**][**Rotary-dial**] controls for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.

   a. Wash Cycles: [**Four**][**Six**][**10**] wash cycles, including regular, delicate, and permanent press.
   b. Wash Temperatures: [**Three**] settings.
   c. Speed Combinations: [**Two**][**Four**][**Five**].

6. Electrical Power: [**120 V, 60 Hz, 1 phase, 15 A**][**As indicated on Drawings**].
7. Motor: Manufacturer's standard with built-in overload protector.
8. Features:

   a. Agitator: [**Center spindle**][**Impeller (without spindle)**].
   b. Self-cleaning lint filter.
   c. Unbalanced-load compensator.
   d. Inlet Hoses: Minimum length **60 inches (1525 mm)**.
   e. Drain Hoses: Minimum length **48 inches (1220 mm)**.
   f. Self-leveling legs.
   g. Automatic dispenser for [**bleach**][**fabric softener**][**and**][**detergent**].
   h. Spin-cycle safety switch.
   i. End-of-cycle signal.
   j. Extra-rinse option.
   k. Delay-wash option.
   l. Electronic temperature control.
   m. Water levels automatically set.
   n. Pedestal: [**8-inch- (203-mm-) high**][**15-inch- (381-mm-) high**][**Manufacturer's standard height**] laundry pedestal with storage drawer, matching appliance finish.

9. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.

10. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
11. Appliance Finish: [**Enamel**][**Stainless steel**].

    a. Color: [**White**][**Almond**].

12. Front-Panel Finish: [**Manufacturer's standard**][**Wood panel to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert specified in Section 123530 "Residential Casework" to match kitchen cabinets**].

    a. Panel Color: [**White**][**Black**].

C. Clothes Dryer : Complying with AHAM HLD-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amana; Whirlpool Corporation**]
    b. [**ASKO Appliances**]
    c. [**Bosch US; BSH Home Appliances Corporation**]
    d. [**Fisher & Paykel Appliances Ltd**]
    e. [**Frigidaire**]
    f. [**GE Appliances; Haier Group**]
    g. [**Kenmore; Transformco SR Brands LLC**]
    h. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
    i. [**Maytag; Whirlpool Corporation**]
    j. [**Miele**]
    k. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
    l. [**Whirlpool Corporation**]

2. Type: [**Freestanding**][**Stacking**][**Undercounter**], frontloading, [**gas**][**electric**][**electric, ventless**] unit.
3. Dimensions:

    a. Width: [**23-1/2 inches (597 mm)**][**27 inches (686 mm)**][**As indicated on Drawings**].
    b. Depth: [**24 inches (610 mm)**][**31 inches (787 mm)**][**As indicated on Drawings**].
    c. Height: [**34-1/2 inches (876 mm)**][**36 inches (914 mm)**][**As indicated on Drawings**].

4. Drum: [**Manufacturer's standard**][**Perforated porcelain-enameled steel**][**Perforated stainless steel**].

    a. Capacity: [**5.7 cu. ft. (0.16 cu. m)**][**7.0 cu. ft. (0.20 cu. m)**].

5. Controls: [**Touch-pad**][**Rotary-dial**] controls for drying cycle, temperatures, and fabric selectors.
6. Electric-Dryer Power: [**240 V, 60 Hz, 1 phase, 30 A**][**As indicated on Drawings**].
7. Gas-Dryer Power: [**120 V, 60 Hz, 1 phase, 15 A electric; 22,000-Btu/h (6400-W) gas**][**As indicated on Drawings**].
8. Features:

    a. Removable lint filter.

b. Electronic temperature and moisture-level-sensor controls.
c. End-of-cycle signal.
d. Interior drum light.
e. Self-leveling legs.
f. Antibacterial cycle.
g. Auxiliary drying rack.
h. Built-in electrical power fuse.
i. Stacking kit to stack dryer over washer.
j. Pedestal: [**8-inch- (203-mm-) high**][**15-inch- (381-mm-) high**][**Manufacturer's standard height**] laundry pedestal with storage drawer, matching appliance finish.

9. Appliance Finish: [**Enamel**][**Stainless steel**].

   a. Color: [**White**][**Almond**].

10. Front-Panel Finish: [**Manufacturer's standard**][**Wood panel to match kitchen cabinets**][**Porcelain enamel**][**Stainless steel**][**Wood-panel insert specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert specified in Section 123530 "Residential Casework" to match kitchen cabinets**].

   a. Panel Color: [**White**][**Black**].

D. Clothes Washer/Dryer Combination : Complying with AHAM HLW-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Frigidaire**]
   b. [**Kenmore; Transformco SR Brands LLC**]
   c. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   d. [**Maytag; Whirlpool Corporation**]
   e. [**Whirlpool Corporation**]

2. Type: Freestanding washer/dryer unit with [**dual-drum design and electric dryer**][**dual-drum design and gas dryer**][**all-in-one, single-drum design**]; washer is [**top**][**front**] loading.
3. Dimensions:

   a. Width: [**23-1/2 inches (597 mm)**][**27 inches (686 mm)**][**As indicated on Drawings**].
   b. Depth: [**25 inches (635 mm)**][**32 inches (813 mm)**][**As indicated on Drawings**].
   c. Height: [**34-1/2 inches (876 mm)**][**71-1/2 inches (1816 mm)**][**As indicated on Drawings**].

4. Washer and Dryer Drums: [**Manufacturer's standard**][**Perforated porcelain-enameled steel**][**Perforated stainless steel**].

   a. Washer-Drum Capacity: [**1.5 cu. ft. (0.04 cu. m)**][**2.0 cu. ft. (0.06 cu. m)**][**2.6 cu. ft. (0.07 cu. m)**].
   b. Dryer-Drum Capacity: [**2.0 cu. ft. (0.06 cu. m)**][**3.4 cu. ft. (0.10 cu. m)**][**5.9 cu. ft. (0.17 cu. m)**].

5. Washer/Dryer Drum: [**Manufacturer's standard**][**Perforated stainless steel**].

   a. Drum Capacity: [**2.3 cu. ft. (0.07 cu. m)**][**3.6 cu. ft. (0.10 cu. m)**].

6. Washer Controls: [**Touch-pad**][**Rotary-dial**] controls for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.
7. Dryer Controls: [**Touch-pad**][**Rotary-dial**] controls for drying cycle, temperatures, and fabric selectors.

    a. Wash Cycles: [**Three**] wash cycles, including regular, delicate, and permanent press.
    b. Wash Temperatures: [**Three**] settings.
    c. Speed Combinations: [**Two**].

8. Electric Washer/Dryer Power: [**240 V, 60 Hz, 1 phase, 30 A**][**120 V, 60 Hz, 1 phase, 12 A**][**As indicated on Drawings**].
9. Gas Washer/Dryer Power: [**120 V, 60 Hz, 1 phase, 15 A electric; 22,000 Btu/h (6400 W) gas**][**As indicated on Drawings**].
10. Motor: Manufacturer's standard with built-in overload protector.
11. Washing Features:

    a. Self-cleaning lint filter.
    b. Unbalanced-load compensator.
    c. Inlet Hoses: Minimum length **60 inches (1525 mm)**.
    d. Drain Hoses: Minimum length **48 inches (1220 mm)**.
    e. Self-leveling legs.
    f. Automatic dispenser for [**bleach**][**fabric softener**][**and**][**detergent**].
    g. Spin-cycle safety switch.

12. Drying Features:

    a. Removable lint filter.
    b. Electronic temperature and moisture-level-sensor controls.
    c. End-of-cycle signal.
    d. Interior drum light.

13. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
14. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
15. Appliance Finish: [**Enamel**][**Stainless steel**].

    a. Color: [**White**][**Almond**].

2.7 TRASH COMPACTORS

A. Trash Compactor : Complying with AHAM TC-1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**GE Appliances; Haier Group**]
    b. [**Jennair; Whirlpool Corporation**]
    c. [**Kenmore; Transformco SR Brands LLC**]
    d. [**KitchenAid; Whirlpool Corporation**]
    e. [**Maytag; Whirlpool Corporation**]
    f. [**Viking Range, LLC; Middleby Corporation**]

g. [**Whirlpool Corporation**]

2. Type: [**Built in**][**Convertible**].
3. Width: [**15 inches (381 mm)**][**18 inches (457 mm)**].
4. Capacity: [**1.4 cu. ft. (0.04 cu. m)**][**1.7 cu. ft. (0.05 cu. m)**].
5. Features:

   a. Key-operated starting switch.
   b. Rear wheels.
   c. Removable bag carrier.
   d. Retainer for disposable bags.
   e. Odor-control mechanism.
   f. Foot-operated drawer operator.

6. Front Panel: [**Manufacturer's standard**][**Wood panel to match kitchen cabinets**][**Enameled steel**][**Stainless steel**][**Wood-panel insert specified in Section 064100 "Architectural Wood Casework" to match kitchen cabinets**][**Wood-panel insert specified in Section 064101 "Architectural Wood Casework (NAAWS Standard)" to match kitchen cabinets**][**Wood-panel insert specified in Section 123530 "Residential Casework" to match kitchen cabinets**].

   a. Panel Color: [**White**][**Black**].

2.8 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.

C. Examine walls, ceilings, and roofs for suitable conditions where [**overhead exhaust hoods**][**downdraft exhaust**][**and**][**microwave ovens with vented exhaust fans**] will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF RESIDENTIAL APPLIANCES

A. Install appliances according to manufacturer's written instructions.

B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.

C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION 11 30 13 00

Task	Specification	Specification Description
11 30 13 13	11 30 13 00	Residential Appliances
11 30 13 23	11 30 13 00	Residential Appliances
11 30 33 00	01 22 00 00	No Specification Required

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SECTION 11 40 00 00 - FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated equipment.
2. Food waste machines.
3. Cooking equipment.
4. Self-contained refrigeration equipment.
5. Walk-in refrigeration equipment.
6. Powered food-preparation equipment.
7. Warewashing equipment.
8. Serving equipment.
9. Utility distribution systems.

B. the Ownerthe Owner-Furnished Equipment: Where indicated, the Ownerthe Owner will furnish equipment for installation by Contractor.

C. Related Requirements:

1. Section 233813 "Commercial-Kitchen Hoods" for ventilation hoods.

1.2 COORDINATION

A. Coordinate foodservice equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.

B. Coordinate locations and requirements of utility service connections.

C. Coordinate sizes, locations, and requirements of the following:

1. Overhead equipment supports.
2. Equipment bases.
3. Floor depressions.
4. Insulated floors.
5. Floor areas with positive slopes to drains.
6. Floor sinks and drains serving foodservice equipment.
7. Roof curbs, equipment supports, and penetrations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data

1. Fabricated equipment.
2. Food waste machines.
3. Cooking equipment.
4. Self-contained refrigeration equipment.
5. Walk-in refrigeration equipment.
6. Powered food-preparation equipment.
7. Warewashing equipment.
8. Serving equipment.
9. Utility distribution systems.

B. Include the following:

1. Manufacturer's model number.
2. Accessories and components that will be included for Project.
3. Clearance requirements for access and maintenance.
4. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.

C. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each factory-applied color finish required, in manufacturer's standard sizes.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For foodservice facilities.

1. Indicate locations of foodservice equipment and connections to utilities.
2. Key equipment using same designations as indicated on Drawings.
3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
4. Include details of seismic bracing for equipment.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For foodservice equipment to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Product Schedule: For each foodservice equipment item, include the following:

1) Designation indicated on Drawings.
2) Manufacturer's name and model number.
3) List of factory-authorized service agencies including addresses and telephone numbers.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with foodservice equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

1.8 WARRANTY

A. Refrigeration Compressor Warranty: Manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified warranty period.

1. Failure includes, but is not limited to, inability to maintain set temperature.
2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NSF Standards: Provide equipment that bears NSF Certification Mark or UL Classification Mark certifying compliance with applicable NSF standards.

B. BISSC Standards: Provide bakery equipment that complies with BISSC/Z50.2.

1. Provide BISSC-certified equipment[with certification verified by a third-party agency].

C. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.

D. Steam Equipment: Provide steam-generating and direct-steam heating equipment that is fabricated and labeled to comply with 2013 ASME Boiler and Pressure Vessel Code.

E. Regulatory Requirements: Install equipment to comply with the following:

1. ASHRAE 15, "Safety Code for Mechanical Refrigeration."
2. NFPA 54, "National Fuel Gas Code."
3. NFPA 70, "National Electrical Code."
4. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."

F. Seismic Restraints: Comply with SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines," Appendix A, "Seismic Restraint Details," unless otherwise indicated.

2.2 FABRICATED EQUIPMENT

A. Stainless Steel Sinks :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**One**][**Two**][**Three**][**Four**]-compartment sink(s). Fabricate units of welded stainless

steel, sound deadened.

a. Bowls: Stainless steel, Type 304, [**0.078 inch (1.98 mm)**][**0.062 inch (1.59 mm)**] thick.
b. Integral Drainboards: Stainless steel, Type 304, [**0.078 inch (1.98 mm)**][**0.062 inch (1.59 mm)**] thick.
c. Body: Stainless steel, [**Type 304, 0.078 inch (1.98 mm)**][**Type 304, 0.062 inch (1.59 mm)**][**Type 430, 0.062 inch (1.59 mm)**] thick.

1) Back Splash: [**Manufacturer's standard height**][**13 inches (330 mm)**][**18 inches (457 mm)**].
2) Side Splash: [**Manufacturer's standard height**][**13 inches (330 mm)**][**18 inches (457 mm)**].

d. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
e. Accessories:

1) Vacuum breaker.
2) Lever waste[**with overflow**].
3) Basket strainer.
4) Continuous waste.
5) Scrap trough.
6) Control bracket for food waste disposer controls.
7) Scrap block and hole.
8) Stainless steel pot rack.

3. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
4. Fabrication: Prepare sink for installation of the following equipment items:

a. Water heater.
b. Food waste disposer; weld disposer cone or collar into sink.
c. Undercounter dishwasher.

5. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

B. Stainless Steel Tables :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Flat-countertop**][**Prep**][**Equipment-stand**][**Mixer-stand**][**Dish**] table.

a. Tops: Stainless steel, [**Type 304, 0.078 inch (1.98 mm)**][**Type 304, 0.062 inch (1.59 mm)**][**Type 430, 0.062 inch (1.59 mm)**] thick, reinforced and sound deadened.

1) Back Splash: [**Manufacturer's standard height**][**1-1/2 inches (38 mm)**][**5 inches (127 mm)**].
2) Edge: [**Bullnose on four sides**][**Bullnose on front edge, straight on sides and back**][**Marine edge**].

b. Welded Undershelf: [**Stainless steel, Type 304, 0.050 inch (1.27 mm) thick**][**Metallic-coated steel, 0.052-inch (1.32-mm) nominal thickness**].
c. Adjustable Undershelf: [**Stainless steel, Type 304, 0.050 inch (1.27 mm) thick**][**Metallic-coated steel, 0.052-inch (1.32-mm) nominal thickness**].
d. Crossbracing: [**Stainless steel**][**Metallic-coated steel**] tubing, [**bolted**][**welded**] to legs.

e. Cabinet:

1) Body: Stainless steel, Type 430, **0.050 inch (1.27 mm)** thick.
2) Doors: [**Sliding**][**Hinged**], stainless steel, Type 304, **0.038 inch (0.95 mm)** thick.
3) Drawers: [**Stainless steel drawer and faceplate**][**Galvanized-steel drawer and stainless steel faceplate**][**Stainless steel front and liner**][**Stainless steel front and galvanized-steel liner**].

f. Sink: Stainless steel, Type 304, **0.078 inch (1.98 mm)** thick, welded into tabletop and including the following:

1) Vacuum breaker.
2) Leverwaste[**with overflow**].
3) Basket strainer.
4) Tail piece.

g. Legs: [**Stainless steel**][**Metallic-coated steel**] tubing.
h. Feet: [**Stainless steel adjustable bullets**][**Plastic adjustable bullets**][**Stainless steel, flanged, adjustable bullets**][**Casters**].
i. Accessories:

1) Control panel.
2) Control bracket for food waste disposer controls.
3) Aluminum pan rack slides, [**six**][**three**] slides each.
4) Urn trough.
5) Spice bins.

3. Materials:

a. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
b. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B, with minimum **G90 (Z275)** coating.

4. Fabrication: Prepare table for installation of the following equipment items:

a. Food waste disposer; weld disposer cone or collar into sink.
b. Heat lamp.

5. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

C. Stainless Steel Shelf Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Table mounted, single deck**][**Table mounted, double deck**][**Wall mounted**]. Fabricate units of stainless steel, [**Type 304, 0.062 inch (1.59 mm)**][**Type 304, 0.050 inch (1.27 mm)**][**Type 430, 0.050 inch (1.27 mm)**] thick.
3. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
4. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

D. Pot Racks :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

2. Description: [**Wall mounted**][**Ceiling hung**][**Corner**]. Fabricate units of [**stainless steel**][**painted, cold-rolled steel**].

   a. Bars: [**Double**][**Single**].
   b. Hooks: [**18**] per unit.

3. Materials:

   a. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, Type 304.
   b. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

4. Finishes:

   a. Stainless Steel: [**Directional satin finish, No. 4**].
   b. Cold-Rolled Steel: Powder-coat painted finish.

E. Stainless Steel Hand Sinks :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Lavatory**] sink. Fabricate units of stainless steel, Type 304, [**0.050 inch (1.27 mm)**][**0.038 inch (0.95 mm)**] thick.

   a. Operation: [**Electronic**][**Knee valve**][**Foot pedal**][**Wrist handle**][**Handle**].
   b. Accessories:

      1) Chrome-plated tail piece and P trap, **NPS 1-1/2 (DN 40)**, with [**0.045-inch (1.1-mm)**] minimum wall thickness.
      2) Strainer basket with metal post.
      3) Liquid soap dispenser, [**splash**][**deck**] mounted.
      4) Liquid soap and towel dispenser.
      5) Towel dispenser.
      6) Tubular wall supports.
      7) Skirt assembly for support.
      8) Side splashes.

3. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
4. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

F. Floor Equipment : [**Troughs**][**Water receptacles**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**4-inch (102-mm)**][**2-inch (50-mm)**] nominal depth excluding tailpiece.

   a. Body: Stainless steel, Type 304, **0.078 inch (1.98 mm)** thick.
   b. Grate: [**Stainless steel bar, Type 304**][**Fiberglass**].
   c. Waste Connection: **NPS 3 (DN 80)**.

3. Materials:

   a. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.
   b. Stainless Steel Bars: ASTM A276, austenitic stainless steel, type as indicated.

4. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

2.3 FOOD WASTE MACHINES

A. Food Waste Disposer Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**3**][**5**][**7**] hp, with dual-direction shredding elements, and the following:

   a. [**Stainless steel**][**Corrosion-resistant**] housing.
   b. Flow control.
   c. Solenoid valve.
   d. Vacuum breaker.
   e. Fixed nozzle.
   f. Control Panel:

      1) Autoreversing and internal timed water flush.
      2) Stainless steel mounting bracket.

   g. Prerinse: Backsplash mounted with hot- and cold-water mixing valve and with [**stainless steel**][**corrosion-resistant**] exposed metal parts and the following:

      1) Wall support bracket.
      2) Flexible, **3/8-inch (10-mm)** metal-encased hose with a minimum length of **29 inches (737 mm)** and supported by spiral spring.
      3) Spray-head assembly with lockable lever handle.

   h. Accessories:

      1) Collar adaptor for [**sink**][**trough**].
      2) Cone with adaptor ring.

         a) Size: [**12 inches (305 mm)**][**15 inches (381 mm)**][**18 inches (457 mm)**].

      3) Cone cover in size that matches cone.
      4) Silver accumulator.

   i. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

B. Food Waste Pulper and Water Extractor Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: Stainless steel pulper unit, extractor unit, and control panel with water-level control

and push-button start.

a. Capacity: Not less than [600 lb (272 kg)][700 lb (318 kg)][900 lb (408 kg)] of waste per hour.
b. Accessories:

1) Feed trough connection.
2) Feed tray.
3) Feed hood assembly.
4) Under-dish-table lid.
5) Remote Water Extractor:

a) Dam, to prevent siphoning of water from pulper tank.
b) Remote piping system, [**overhead**][**below floor**].

c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

C. Food Waste Grinder and Water Extractor Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: Stainless steel construction, with off and on controls on unit, food waste hopper, silver saver, internal disposer, removable water extraction auger with internal water sprays, and discharge chute.

a. Capacity: Not less than [600 lb (272 kg)][700 lb (318 kg)] of waste per hour.
b. Accessories:

1) Reel rinse unit with spray valve.
2) Recirculation water pump.
3) Trough mount.

c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

D. Undercounter Food Waste Grinder and Water Extractors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: Stainless steel, undercounter, cleanable assembly including the following:

a. Capacity: Not less than [600 lb (272 kg)][700 lb (318 kg)] of waste per hour.
b. Separate water-extractor and disposer units.

1) Disposer: Corrosion-resistant housing, dual-direction shredding elements.

c. Piping between disposer and water extractor.
d. Vacuum breaker.
e. Solenoid valve.
f. Flow control.
g. Time-delayed relay.
h. Control Panel:

1) Autoreversing and internal timed water flush.
2) Stainless steel mounting bracket.

i. Prerinse: Backsplash mounted with hot- and cold-water mixing valve and with [**stainless steel**][**corrosion-resistant**] exposed metal parts and the following:

1) Wall support bracket.
2) Flexible, **3/8-inch (10-mm)** metal-encased hose with a minimum length of **29 inches (737 mm)** and supported by spiral spring.
3) Spray-head assembly with lockable lever handle.

j. Accessories:

1) Cone with adaptor ring.

a) Size: [**12 inches (305 mm)**][**15 inches (381 mm)**][**18 inches (457 mm)**].

2) Cone cover in size that matches cone.
3) Silver sorter.
4) Trough collar connection.

k. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

2.4 COOKING EQUIPMENT

A. Ranges :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description:

a. Top Configuration:

1) Open-Burner Unit:

a) Standard Burners: [**Four**][**Six**][**Eight**][**Four, step-up type**].

2) Griddle: [**Flat**][**Raised**].

b. Base Configuration:

1) Standard Oven(s): [**One**][**Two**].
2) Convection Oven(s): [**One**][**Two**].
3) Storage Base: One.

c. Accessories:

1) [**High**][**Double-deck**] back shelf.
2) Stainless steel sides.
3) Stainless steel back.
4) Legs for curb base.
5) Toe Base: **4 inches (102 mm)** high.

6) Oven Rack(s): [**One**] for each oven.

d. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].
e. Gas Service: [**Natural**][**Liquefied propane**] gas.

B. Deep Fat Fryers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Electric fryer, solid-state controls**][**Electric, programmable computer controls**][**Gas fryer**].

a. Oil Capacity: [**40 lb (18 kg)**][**85 lb (39 kg)**].
b. Accessories:

1) Stainless steel sides.
2) Stainless steel fry tank.
3) Stainless steel fry tank cover.
4) Automatic basket lifts.
5) Quick gas-service disconnect and flexible hose.

c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].
d. Gas Service: [**Natural**][**Liquefied propane**] gas.

C. Steam Jacketed Kettles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: Stainless Steel, Type 304.

a. Type: [**Stationary**][**Tilting**].
b. Steam Source: [**Electrically heated, self-contained**][**Direct**].

1) [**Maximum**][**Operating**] Steam Pressure: [**50 psig (345 kPa)**][**25 psig (172 kPa)**].

c. Capacity: [**10 quarts (9.5 L)**][**20 gal. (76 L)**].
d. Accessories:

1) Basket insert.
2) Lift-off cover.
3) [**Single**][**Double**]-pantry water filler.
4) Tangent Drawoff: [**2 inches (50 mm)**][**3 inches (76 mm)**].
5) Disc Strainer: **1/8 inch (3 mm)**, [**perforated**][**solid**].
6) Interior Finish: [**Manufacturer's standard**][**Stainless steel, Type 316**].
7) Cold-water jacket cooling.
8) Steam trap assemblies.
9) Kettle brush kit.

e. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

3. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, type as indicated.

4. Stainless Steel Finish: [**Directional satin finish, ASTM A480/A480M, No. 4**].

D. Ovens :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Electric convection**][**Gas convection**][**Rotisserie**].

   a. [**Single deck**][**Double deck**][**Single deck with open stand**].
   b. Accessories:

      1) Oven Rack(s): [**One**] per oven chamber.
      2) Stainless steel drip pan.
      3) Down-draft flue diverter.
      4) Stacking kit.

   c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].
   d. Gas Service: [**Natural**][**Liquefied propane**] gas.

E. Microwave Ovens :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: 1200 W cooking power.

   a. Electrical Service: Equip unit with plug and cord for 120 V service.

F. Coffee Urns :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Single**][**Twin**][**Triple**] urn.

   a. Capacity: [**3 gal. (11 L)**][**6 gal. (23 L)**][**10 gal. (38 L)**] per liner.
   b. Type: [**Electric**][**Gas**][**Steam**] heated.
   c. Agitator: [**Automatic**][**Push button**].
   d. Spray Arm: [**With**][**Without**] bypass.
   e. Timer: [**Digital**][**Electromechanical**].
   f. Accessories:

      1) Filtering: [**Permanent, stainless steel, woven-wire cloth**][**Disposable filter paper**].
      2) Finish: [**Manufacturer's standard**][**Brass body and trim**][**Copper body and brass trim**].

3. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].
4. Gas Service: [**Natural**][**Liquefied propane**] gas.
5. Operating Steam Pressure: [**As indicated on Drawings**].

2.5 SELF-CONTAINED REFRIGERATION EQUIPMENT

A. Refrigeration Equipment : [**Refrigerators**][**Freezers**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Reach-in**][**Roll-in**][**Pass-through**] type.

a. Exterior Finish: Stainless steel.
b. Interior Finish: [**Stainless steel**][**Manufacturer's standard**].
c. Doors: [**Full length**][**Half-length**][**In configuration shown on Drawings**].
d. Accessories:

1) Casters.
2) Stainless steel back with rear louvers.
3) Re-hinging feature for doors.
4) Hinged glass doors and fluorescent fixtures.

e. Electrical Service: Equip unit with plug and cord for [**service indicated on Drawings**].

B. Undercounter Refrigeration Equipment : [**Refrigerators**][**Freezers**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: Compact unit with rear-mounted, self-contained refrigeration system.

a. Accessories:

1) Stainless steel top with backsplash.
2) Stainless steel back panel.
3) Casters: [**6 inches (152 mm)**][**4 inches (102 mm)**][**3-1/2 inches (89 mm)**] high.
4) Utility Base: **6 inches (152 mm)** high.
5) Stacking kit.

b. Electrical Service: Equip unit with plug and cord for [**service indicated on Drawings**].

C. Merchandiser Refrigeration Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Curved-glass, self-contained refrigerator**][**Sliding-glass, self-contained refrigerator**][**Sliding-glass, self-contained freezer**].

a. Exterior Finish: [**Manufacturer's standard**][**Stainless steel**].
b. Interior Finish: [**Manufacturer's standard**][**Stainless steel**][**White**].
c. Accessories:

1) Door locks.

d. Electrical Service: Equip unit with plug and cord for [**service indicated on Drawings**].

D. Ice-Making Machine :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Undercounter**][**Freestanding**] units.

a. Production: Ice [**cubes**][**cubes, dice**][**cubes, half-dice**][**flakes**][**chiplets (compacted flake ice)**].
b. Accessories:

1) Stainless steel stand and legs.
2) Water filter.

c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

2.6 WALK-IN REFRIGERATION EQUIPMENT

A. Walk-in Refrigeration Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Cooler**][**Freezer**][**Two-compartment unit, with cooler and freezer compartments**].

a. Wall and Ceiling Panels: Interlocking insulating panels.
b. Floors: [**Insulated floor panels**][**Field installed; provide manufacturer's standard insulated floor screed**].
c. Doors:

1) Hinges: [**Two per door**][**Self-closing and spring loaded; three per door**].
2) Latch: [**Edge-mounted, positive-type latch with cylinder lock**].
3) Include safety-release handle that opens door from inside when door is locked.

d. Door Accessories:

1) Vision port.
2) Pressure relief port.
3) Threshold: Stainless steel, factory installed.
4) Anticondensate heater at freezer doors.

e. Refrigeration System: [**Self-contained, mounted on unit**][**Remote system with preassembled condensing unit and evaporator assemblies**].

1) Exterior Condensing Units: Include winter control, crankcase heater, and enclosed weatherproof housing.

f. Temperature Monitoring System: [**Electronic monitoring and remote audible alarm system that warns when temperatures register 10 deg F (6 deg C) above or below set temperature**].

g. Closure Panels and Trim: [**Include closure panels and trim**].
h. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

3. Finishes:

a. Exposed Exterior Finish: [**Stucco-patterned aluminum**][**Smooth, mill-finished aluminum**][**White-painted aluminum**].
b. Unexposed Exterior Finish: [**Stucco-patterned, metallic-coated steel**].
c. Interior Finish: [**Stucco-patterned aluminum**][**Smooth, mill-finished aluminum**][**White-painted aluminum**].
d. Closure Panels and Trim: [**Matched to exposed exterior finish of panels**].

2.7 POWERED FOOD-PREPARATION EQUIPMENT

A. Food-Preparation Equipment : [**Mixers**][**Slicers**][**Meat saws**][**Peelers**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Electrical Service: Equip unit with plug and cord for [**service indicated on Drawings**].

2.8 WAREWASHING EQUIPMENT

A. Warewashing Machines :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Dishwashing, single tank**][**Dishwashing, double tank**][**Dishwashing, rackless conveyor**][**Dishwashing, with circular conveyor table**][**Pot and pan washing, two racks**][**Pot and pan washing, one rack**].

a. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].

2.9 SERVING EQUIPMENT

A. Modular Counters :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Hot food**][**Refrigerated salad**][**Ice-cooled salad**][**Sliding-glass door refrigerated**][**Frost-top**][**Sandwich**][**Pizza**][**Refrigerated-chest**][**Dual-temperature**][**Tray-starter**][**Storage**][**Cashier**] module.

a. Cabinet Face Panels: [**Manufacturer's standard**].
b. Accessories:

1) Tray slide.
2) Work shelf.
3) Casters.
4) Electrical receptacle.
5) Cam-action latch locks with trigger release to mate with adjoining modular counters.
6) Tempered-glass, food-protector shield.

c. Electrical Service: Equip unit for connection to [**service indicated on Drawings**].
d. Color: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.10 UTILITY DISTRIBUTION SYSTEMS

A. Utility Distribution Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Description: [**Overhead**][**Counter**][**Island**][**Tray-slide**][**Steam**][**Wall-mounted**] system.

2.11 MISCELLANEOUS MATERIALS

A. Installation Accessories, General: NSF certified for end-use application indicated.

B. Elastomeric Joint Sealant: ASTM C920; silicone. Type S (single component), Grade NS (nonsag), Class 25, Use NT (nontraffic) related to exposure, and Use M, G, A, or O as applicable to joint substrates indicated.

1. Public Health and Safety Requirements:

a. Sealant is certified for compliance with NSF standards for end-use application indicated.
b. Washed and cured sealant complies with the FDA's regulations for use in areas that come in contact with food.

2. Cylindrical Sealant Backing: ASTM C1330, Type C, closed-cell polyethylene, in diameter greater than joint width.

2.12 FINISHES

A. Stainless Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Powder-Coat Finishes: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install foodservice equipment level and plumb, according to manufacturer's written instructions.

1. Connect equipment to utilities.
2. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

B. Complete equipment assembly where field assembly is required.

1. Provide closed butt and contact joints that do not require a filler.
2. Grind field welds on stainless steel equipment until smooth and polish to match adjacent finish.

C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.

D. Install cabinets and similar equipment on bases in a bed of sealant.

E. Install closure-trim strips and similar items requiring fasteners in a bed of sealant.

F. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

3.2 CLEANING AND PROTECTING

A. After completing installation of equipment, repair damaged finishes.

B. Clean and adjust equipment as required to produce ready-for-use condition.

C. Protect equipment from damage during remainder of the construction period.

3.3 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain foodservice equipment.

END OF SECTION 11 40 00 00

Task	Specification	Specification Description
11 41 00 00	11 40 00 00	Foodservice Equipment
11 41 13 00	11 40 00 00	Foodservice Equipment
11 41 23 00	11 40 00 00	Foodservice Equipment
11 41 31 00	11 40 00 00	Foodservice Equipment
11 41 33 00	11 40 00 00	Foodservice Equipment
11 42 00 00	11 40 00 00	Foodservice Equipment
11 42 13 00	11 40 00 00	Foodservice Equipment
11 42 16 00	11 40 00 00	Foodservice Equipment
11 42 23 00	11 40 00 00	Foodservice Equipment
11 44 00 00	11 40 00 00	Foodservice Equipment
11 44 13 00	11 40 00 00	Foodservice Equipment
11 44 16 00	11 40 00 00	Foodservice Equipment
11 44 19 00	11 40 00 00	Foodservice Equipment
11 46 00 00	11 40 00 00	Foodservice Equipment
11 46 13 00	11 40 00 00	Foodservice Equipment
11 46 16 00	11 40 00 00	Foodservice Equipment
11 46 19 00	11 40 00 00	Foodservice Equipment
11 46 83 00	11 40 00 00	Foodservice Equipment
11 48 00 00	11 40 00 00	Foodservice Equipment
11 48 13 00	11 40 00 00	Foodservice Equipment
11 48 16 00	11 40 00 00	Foodservice Equipment

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SECTION 11 52 13 00 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated, front-projection screens.
2. Electrically operated, front-projection screens.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal support framing for front-projection screens.
2. Section 061000 "Rough Carpentry" for wood backing for screen installation.
3. Section 064023 "Interior Architectural Woodwork" for [**wood trim**][**wood trim and wood ceiling closure panel**] for recessed screen installation.
4. Section 115213.19 "Rear Projection Screens."

1.2 DEFINITIONS

A. ALR: Ambient-light rejection; for specular reflective viewing surfaces, measured as the percentage of ambient light striking the viewing surface that has equal angles of incidence and reflection.

B. Gain: Ratio of light reflected from viewing-surface material to that reflected perpendicularly from a magnesium carbonate surface as determined in accordance with SMPTE RP 94.

C. Half-Gain Angle: The angle, measured from the axis of the viewing surface to the most central position on a perpendicular plane through the horizontal centerline of the viewing surface, where the gain is half of the peak gain.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show layouts and types of front-projection screens. Include the following:

1. Drop heights.
2. Location of seams in viewing surfaces.
3. For end-mounted motors, location of screen centerline relative to ends of screen case.
4. Anchorage details, including connection to supporting structure for suspended units.
5. Details of juncture of screen case or trim with adjacent finishes.
6. For electrically operated units, wiring diagrams and location of wiring connections.
7. Accessories.

C. Samples: For each type of exposed finish and for each color and finish specified, in manufacturer's standard sizes.

D. Samples for Initial Selection: For each type of exposed finish.

E. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

F. Product Schedule: For front-projection screens.[**Use same designations indicated on Drawings.**]

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For front-projection screens to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver front-projection screens until spaces are enclosed and weathertight, wet-work in installation spaces is complete and dry, and temporary or permanent HVAC system is operating and maintaining ambient temperature and humidity conditions planned for building occupants during the remainder of the construction period.

B. Store front-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.6 COORDINATION

A. Coordinate layout and installation of front-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC system components,[**fire-suppression system,**] and partitions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Projection Screens: Obtain [**front-projection screens**][**each type of front-projection screen**] from single manufacturer. Obtain viewing surfaces and accessories, including mounting hardware, from screen manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Viewing-Surface and Masking Materials:

1. Mildew-Resistance Rating: Zero or 1 when tested in accordance with ASTM G21.
2. Flame Resistance: Passes NFPA 701.
3. Flame-Spread Index: Not greater than 75 when tested in accordance with ASTM E84.

2.3 MANUALLY OPERATED, FRONT-PROJECTION SCREENS

A. General Requirements: Manufacturer's standard spring-roller-operated units, consisting of case, flexible screen, mounting accessories, and other components necessary for a complete installation.

1. Screen Mounting: Top edge securely anchored to a rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle

and pull attached to slat by screws.

B. Metal-Encased, Manually Operated Screen : Unit with free-hanging screen; with screen case fabricated from formed-steel sheet or aluminum extrusions with manufacturer's standard finish and matching end caps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alltec Screens; a brand of Alltec Pro**]
   b. [**Draper, Inc.**]
   c. [**Legrand AV Inc.; Legrand North America, LLC**]

2. Surface-Mounting Configuration: [**Mounted using manufacturer's standard projecting wall brackets**][**Mounted directly to wall or ceiling, as indicated on Drawings, with concealed mounting**][**Recessed in ceiling trough indicated on Drawings, with concealed mounting**].
3. Screen Case Color: [**As selected by Architect from manufacturer's standard options**][**White**][**Black**], as directed by the Owner.
4. Matte Viewing Surface: [**White, 1.0 minimum peak gain and 60-degree minimum half-gain angle**][**White, 1.0 minimum peak gain and material does not reach half gain**][**Gray, 0.8 minimum peak gain and material does not reach half gain**].
5. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.
6. Edge Treatment: [**Black**][**Without black**] masking borders.
7. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**40 by 64 inches (1016 by 1626 mm)**][**50 by 80 inches (1270 by 2032 mm)**][**40-1/2 by 72 inches (1029 by 1829 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**].
8. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

   a. Color: [**Same as viewing surface**][**Black**].

C. Wood-Finished, Manually Operated Screen : Unit with free-hanging screen; with screen case with flat back, hardwood finish, and concealed mounting brackets for surface mounting on wall or ceiling, as indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Screen Case Hardwood: [**Oak**][**Walnut**][**Mahogany**][**Cherry**][**As selected by Architect from manufacturer's full range of species**], as directed by the Owner.

   a. Corners: [**Radiused**][**Rectilinear**][**Traditional crown trim at top, rectilinear at sides and bottom**][**Beveled at top, eased at sides and bottom**].
   b. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Matte Viewing Surface: [**White, 1.0**][**Gray, 0.8**] minimum peak gain; material does not reach half-gain.
4. Seams: Where height of viewing surface exceeds maximum height without seams, locate

horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.

5. Edge Treatment: [**Black**][**Without black**] masking borders.
6. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**].
7. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

2.4 ELECTRICALLY OPERATED, FRONT-PROJECTION SCREENS

A. General Requirements: Manufacturer's standard units, consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation.[**Provide units that are listed and labeled as an assembly by Underwriters Laboratories Inc. (UL) or another testing and inspecting agency acceptable to authorities having jurisdiction.**]

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a metal rod, with ends of rod protected by plastic caps.

B. Surface-Mounted, Metal-Encased, Electrically Operated Screen : Motor-in-roller unit with screen case fabricated from formed-steel sheet or from aluminum extrusions with manufacturer's standard finish and matching end caps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alltec Screens; a brand of Alltec Pro**]
    b. [**Draper, Inc.**]
    c. [**Legrand AV Inc.; Legrand North America, LLC**]
    d. [**Screen Innovations**]
    e. [**Stewart Filmscreen**]

2. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
3. Controls: Remote,[**key-operated,**] three-position control switch installed in recessed device box with flush cover plate[**matching other electrical device cover plates in room where switch is installed**].

    a. Provide with [**one control switch**][**two control switches**][**number of control switches indicated on Drawings**].
    b. Provide power supply for low-voltage systems if required.
    c. Provide locking cover plates for switches.
    d. Provide key-operated, power-supply switch.
    e. Provide [**infrared**][**radio-frequency**] remote control, consisting of battery-powered

transmitter and receiver.

f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

4. Surface-Mounting Configuration: [**Mounted using manufacturer's standard projecting wall brackets**][**Mounted directly to wall or ceiling, as indicated on Drawings, with concealed mounting**][**Recessed in ceiling trough indicated on Drawings, with concealed mounting**].
5. Screen-Case Color: [**As selected by Architect from manufacturer's standard options**][**White**][**Black**], as directed by the Owner.
6. Free-Hanging, Matte Viewing Surface: [**White, 1.0 minimum peak gain and 60-degree minimum half-gain angle**][**White, 1.0 minimum peak gain and material does not reach half gain**][**Gray, 0.8 minimum peak gain and material does not reach half gain**].

   a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.
   b. Edge Treatment: [**Manufacturer's standard**][**Black**][**Without black**] masking borders.

7. Tab-Tensioned, High-Contrast-Gray Viewing Surface: Minimum peak gain of [0.6 and 60-degree][0.8 and 45-degree] minimum half-gain angle[with black backing].

   a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
   b. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.

8. Tab-Tensioned, Gain-White Viewing Surface: Minimum peak gain of [**1.3 and 75-degree**][**1.5 and 60-degree**][**1.7 and 40-degree**] minimum half-gain angle. Provide viewing surface with black backing and without seams.

   a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.

9. Tab-Tensioned, ALR Viewing Surface: Minimum peak gain of [**0.8, 57 percent ALR, and 50-degree**][**1.0, 73 percent ALR, and 35-degree**][**1.0, 82 percent ALR, and 18-degree**] minimum half-gain angle. Provide viewing surface without seams.

   a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.

10. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**87-1/2 by 140 inches (2223 by 3556 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**][**79 by 140 inches (2007 by 3556 mm)**].
11. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

C. Surface-Mounted, Wood-Finished, Electrically Operated Screen : Motor-in-roller unit with tab-tensioned screen; with screen case with flat back, hardwood finish, and concealed mounting brackets for surface

mounting on wall or ceiling, as indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
2. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
3. Controls: Remote,[**key-operated,**] three-position control switch installed in recessed device box with flush cover plate[**matching other electrical device cover plates in room where switch is installed**].

    a. Provide with [**one control switch**][**two control switches**][**number of control switches indicated on Drawings**].
    b. Provide power supply for low-voltage systems if required.
    c. Provide locking cover plates for switches.
    d. Provide key-operated, power-supply switch.
    e. Provide [**infrared**][**radio-frequency**] remote control, consisting of battery-powered transmitter and receiver.
    f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

4. Screen-Case Hardwood: [**Oak**][**Walnut**][**Mahogany**][**Cherry**][**As selected by Architect from manufacturer's full range of species**], as directed by the Owner.

    a. Corners: [**Radiused**][**Rectilinear**][**Traditional crown trim at top, rectilinear at sides and bottom**][**Beveled at top, eased at sides and bottom**].
    b. Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
6. Matte-White Viewing Surface: [**1.0 minimum peak gain; material does not reach half-gain**]. Provide viewing surface [**with**][**without**] black backing.

    a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.

7. High-Contrast-Gray Viewing Surface: [**0.6 minimum peak gain; material does not reach half gain**]. Provide viewing surface [**with**][**without**] black backing.

    a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.

8. Gain-White Viewing Surface: Minimum peak gain of [**1.3**][**1.6**][**1.8**]; material does not reach half gain. Provide viewing surface without seams and with black backing.
9. ALR Viewing Surface: Minimum peak gain of [**0.8, 57 percent ALR, and 50-degree**][**0.1, 73 percent ALR, and 35-degree**][**0.1, 82 percent ALR, and 18-degree**] minimum half-gain angle. Provide viewing surface without seams.
10. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by**

2032 mm)][57-1/2 by 92 inches (1461 by 2337 mm)][45 by 80 inches (1143 by 2032 mm)][52 by 92 inches (1321 by 2337 mm)].

11. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

D. Suspended, Electrically Operated Screen : Unit designed and fabricated for suspended mounting.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Draper, Inc.**]
    b. [**Legrand AV Inc.; Legrand North America, LLC**]
    c. [**Stewart Filmscreen**]

2. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
3. End-Mounted Motor: Instant-reversing, gear-drive motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Locate motor in its own compartment [**on right end of screen**][**on left end of screen**][**on end of screen indicated on Drawings**]. Support roller with self-aligning bearings in brackets.
4. Wiring Compartment: Metal or metal lined.
5. Controls: Remote,[**key-operated,**] three-position control switch installed in recessed device box with flush cover plate[**matching other electrical device cover plates in room where switch is installed**].

    a. Provide with [**one control switch**][**two control switches**][**number of control switches indicated on Drawings**].
    b. Provide power supply for low-voltage systems if required.
    c. Provide locking cover plates for switches.
    d. Provide key-operated, power-supply switch.
    e. Provide [**infrared**][**radio-frequency**] remote control, consisting of battery-powered transmitter and receiver.
    f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

6. Screen Case: [**Metal**][**Metal and fire-retardant materials**][**Metal, wood, wood products, and fire-retardant materials**].

    a. Ceiling Aperture: [**Open under screen compartment**][**With closure, hinged to automatically open when screen is lowered and automatically close when screen is fully raised**].

        1) Provide screen case [**with trim flange to receive ceiling finish**][**constructed to be installed with underside flush with ceiling**][**constructed to be installed with ceiling finish applied to underside**].

b. Finish on Exposed Surfaces: [**Manufacturer's standard**][**Prime painted**][**Vinyl covering or baked enamel**].

7. Free-Hanging, Matte Viewing Surface: [**White, 1.0 minimum peak gain and 60-degree minimum half-gain angle**][**White, 1.0 minimum peak gain and material does not reach half gain**][**Gray, 0.8 minimum peak gain and material does not reach half gain**].

   a. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.
   b. Edge Treatment: [**Manufacturer's standard**][**Black**][**Without black**] masking borders.

8. Tab-Tensioned, High-Contrast-Gray Viewing Surface: Minimum peak gain of [0.6 and 60-degree][0.8 and 45-degree] minimum half-gain angle[with black backing].

   a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
   b. Seams: Where height of viewing surface exceeds maximum height without seams, locate horizontal seam with full-width material at [**top**][**bottom**][**location indicated on Drawings**] of viewing surface.

9. Tab-Tensioned, Gain-White Viewing Surface: Minimum peak gain of [**1.3 and 75-degree**][**1.5 and 60-degree**][**1.7 and 40-degree**] minimum half-gain angle. Provide viewing surface with black backing and without seams.

   a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.

10. Tab-Tensioned, ALR Viewing Surface: Minimum peak gain of [**0.8, 57 percent ALR, and 50-degree**][**1.0, 73 percent ALR, and 35-degree**][**1.0, 82 percent ALR, and 18-degree**] minimum half-gain angle. Provide viewing surface without seams.

    a. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.

11. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**87-1/2 by 140 inches (2223 by 3556 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**][**79 by 140 inches (2007 by 3556 mm)**].
12. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install front-projection screens at locations indicated on Drawings to comply with screen manufacturer's

written instructions.

B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor them to supporting substrate in a manner that produces a smoothly operating screen that, when lowered, has flat viewing surface and plumb vertical edges.

1. Install low-voltage controls in accordance with NFPA 70 and complying with manufacturer's written instructions.

   a. Wiring Method: Install wiring in raceway, except in accessible ceiling spaces and in gypsum board partitions, where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables, except in unfinished spaces.

2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

END OF SECTION 11 52 13 00

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SECTION 11 52 13 00A - REAR PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rigid rear-projection screens.
2. Electrically operated, flexible rear-projection screens.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal support framing for rear-projection screens.
2. Section 061000 "Rough Carpentry" for wood backing for screen installation.
3. Section 064023 "Interior Architectural Woodwork" for [**wood trim**][**wood trim and wood ceiling closure panel**][**wood frames**] for recessed screen installation.
4. [**Section 081113 "Hollow Metal Doors and Frames"**][**Section 081116.13 "Interior Aluminum Doors and Frames"**] for metal frames for field-installed, rear-projection screens.

1.2 DEFINITIONS

A. Gain: Ratio of light refracted from viewing-surface material to that reflected perpendicularly from a magnesium carbonate surface as determined in accordance with SMPTE RP 94, except that, for measuring luminance of test viewing-surface material, projection lamp to be placed behind viewing surface at same distance as it was placed in front of magnesium carbonate surface for measuring luminance of reference standard.

B. Half-Gain Angle: The angle, measured from the axis of the viewing surface to the most central position on a perpendicular plane through the horizontal centerline of the viewing surface, where the gain is half of the peak gain.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show layouts and types of rear-projection screens. Include the following:

1. For rigid rear-projection screens:

a. Frame details.
b. Anchorage details.
c. Details of juncture of exposed projection-screen surfaces with adjacent finishes.
d. Accessories.

2. For electrically operated, flexible rear-projection screens:

a. Drop heights.
b. Anchorage details, including connection to supporting structure for suspended units.
c. Details of juncture of screen case or trim with adjacent finishes.

d. Location of wiring connections.
e. Wiring diagrams.
f. Accessories.

C. Samples: For each type of exposed finish and for each color and finish specified, in manufacturer's standard sizes.

D. Samples for Initial Selection: For each type of exposed finish.

E. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

F. Product Schedule: For rear-projection screens.[**Use same designations indicated on Drawings.**]

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For rear-projection screens to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver rear-projection screens until spaces are enclosed and weathertight, wet-work in installation spaces is complete and dry, and temporary or permanent HVAC system is operating and maintaining ambient temperature and humidity conditions planned for building occupants during the remainder of the construction period.

B. Store rear-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.6 COORDINATION

A. Coordinate layout and installation of rear-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC system components,[**fire-suppression system,**] and partitions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Rear-Projection Screens: Obtain [**rear-projection screens**][**each type of rear-projection screen**] from single manufacturer. Obtain viewing surfaces and accessories, including mounting hardware, from screen manufacturer.

1. Obtain rear-projection screens from same manufacturer as front-projection screens.

2.2 RIGID REAR-PROJECTION SCREENS

A. Rigid Rear-Projection Screen : Transparent substrate with permanently bonded optical coating; provide with gaskets, setting blocks, fasteners, and other components necessary for complete installation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Draper, Inc.**]
   b. [**Legrand AV Inc.; Legrand North America, LLC**]
   c. [**Stewart Filmscreen**]

2. Optical Coating: Minimum peak gain of [**0.5 and 43-degree**][**0.70 and 48-degree**][**0.70 and 180-degree**][**0.75 and 78-degree**][**0.90 and 71-degree**][**1.0 and 35-degree**][**1.0 and 50-degree**][**1.0 and 63-degree**][**1.3 and 33-degree**][**1.5 and 31-degree**] minimum half-gain angle applied to transparent substrate indicated below.

   a. Acrylic Substrate: Colorless, transparent, cast-acrylic sheet with a luminous transmittance of 92 percent in accordance with ASTM D1003 and complying with ASTM D4802, Category A-1 (cell cast), Finish 1 (smooth or polished), [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] thick.
   b. Semi-Rigid Acrylic Substrate: Colorless, transparent acrylic sheet that can be rolled for shipping; minimum [**1/8 inch (3 mm)**][**3/16 inch (5 mm)**] thick.
   c. Glass Substrate: Clear float glass complying with ASTM C1036 for Type I (transparent glass, flat), Class 1 (clear), and Quality q3 (glazing select), [**6.0 mm**][**10.0 mm**][**12.0 mm**] thick.
   d. Optical Tint: [**High-contrast dark gray**][**Medium neutral gray**][**Neutral white**][**Manufacturer's standard**].

3. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**87-1/2 by 140 inches (2223 by 3556 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**][**79 by 140 inches (2007 by 3556 mm)**], one piece.

B. Factory Frames: Screen manufacturer's standard frames [**of profile indicated on Drawings**], fabricated to sizes required to fit screens from aluminum extrusions complying with **ASTM B221 (ASTM B221M)** for 6063-T5 alloy and temper.

   1. Class II, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
   2. Class II, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.

      a. Color: [**Black**][**Dark bronze**][**Either black or dark bronze, as standard with manufacturer**].

2.3 ELECTRICALLY OPERATED, FLEXIBLE REAR-PROJECTION SCREENS

A. General Requirements: Manufacturer's standard units, consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation.[**Provide units that are listed and labeled as an assembly by Underwriters Laboratories Inc. (UL) or another testing and inspecting agency acceptable to authorities having jurisdiction.**]

   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a metal rod, with ends of rod protected by plastic caps.
3. Viewing-Surface and Masking Materials:

    a. Mildew-Resistance Rating: Zero or 1 when tested in accordance with ASTM G21.
    b. Flame Resistance: Passes NFPA 701.
    c. Flame-Spread Index: Not greater than 75 when tested in accordance with ASTM E84.
    d. Seamless Construction: Provide viewing surfaces, in sizes indicated, without seams.

B. Surface-Mounted, Metal-Encased, Electrically Operated Screen : Motor-in-roller unit with tab-tensioned screen and screen case fabricated from formed-steel sheet or from aluminum extrusions with manufacturer's standard finish and matching end caps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Draper, Inc.**]
    b. [**Legrand AV Inc.; Legrand North America, LLC**]
    c. [**Stewart Filmscreen**]

2. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
3. Controls: Remote,[**key-operated,**] three-position control switch installed in recessed device box with flush cover plate[**matching other electrical device cover plates in room where switch is installed**].

    a. Provide with [**one control switch**][**two control switches**][**number of control switches indicated on Drawings**].
    b. Provide power supply for low-voltage systems if required.
    c. Provide locking cover plates for switches.
    d. Provide key-operated, power-supply switch.
    e. Provide [**infrared**][**radio-frequency**] remote control, consisting of battery-powered transmitter and receiver.
    f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

4. Surface-Mounting Configuration: [**Mounted using manufacturer's standard projecting wall brackets**][**Mounted directly to wall or ceiling, as indicated on Drawings, with concealed mounting**][**Recessed in ceiling trough indicated on Drawings with concealed mounting**].
5. Screen-Case Color: [**As selected by Architect from manufacturer's standard options**][**White**][**Black**], as directed by the Owner.
6. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
7. Off-White Viewing Surface: Minimum peak gain of [**0.65 and 78-degree**][**0.9 and 65-degree**][**1.0 and 63-degree**][**1.3 and 42-degree**] minimum half-gain angle.
8. Gray Viewing Surface: Minimum peak gain of [**1.0 and 39-degree**][**1.2 and 30-degree**][**1.5 and 31-degree**] minimum half-gain angle.
9. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**87-1/2 by 140 inches (2223 by 3556 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**][**79 by 140**

inches (2007 by 3556 mm)].

10. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

C. Suspended, Electrically Operated Screen : Motor-in-roller unit designed and fabricated for suspended mounting with tab-tensioned screen.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Draper, Inc.**]
    b. [**Legrand AV Inc.; Legrand North America, LLC**]
    c. [**Stewart Filmscreen**]

2. Wiring Compartment: Metal or metal lined.
3. Motor in Roller: Instant-reversing motor of size and capacity recommended in writing by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
4. Controls: Remote,[**key-operated,**] three-position control switch installed in recessed device box with flush cover plate[**matching other electrical device cover plates in room where switch is installed**].

    a. Provide with [**one control switch**][**two control switches**][**number of control switches indicated on Drawings**].
    b. Provide power supply for low-voltage systems if required.
    c. Provide locking cover plates for switches.
    d. Provide key-operated, power-supply switch.
    e. Provide [**infrared**][**radio-frequency**] remote control, consisting of battery-powered transmitter and receiver.
    f. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.

5. Screen Case: Made from [**metal**][**metal and fire-retardant materials**].

    a. Ceiling Aperture: [**Open under screen compartment**][**With closure, hinged to automatically open when screen is lowered and automatically close when screen is fully raised**].

        1) Provide screen case [**with trim flange to receive ceiling finish**][**constructed to be installed with underside flush with ceiling**][**constructed to be installed with ceiling finish applied to underside**].

    b. Finish on Exposed Surfaces: [**Manufacturer's standard**][**Prime painted**][**Vinyl covering or baked enamel**].

6. Tab Tensioning: Durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of entire height of screen by tabs, to pull viewing surface flat horizontally.
7. Off-White Viewing Surface: Minimum peak gain of [**0.65 and 78-degree**][**0.9 and 65-degree**][**1.0 and 63-degree**][**1.3 and 42-degree**] minimum half-gain angle.

8. Gray Viewing Surface: Minimum peak gain of [**1.0 and 39-degree**][**1.2 and 30-degree**][**1.5 and 31-degree**] minimum half-gain angle.
9. Size of Viewing Surface: [**As indicated in schedule on Drawings**][**50 by 80 inches (1270 by 2032 mm)**][**57-1/2 by 92 inches (1461 by 2337 mm)**][**87-1/2 by 140 inches (2223 by 3556 mm)**][**45 by 80 inches (1143 by 2032 mm)**][**52 by 92 inches (1321 by 2337 mm)**][**79 by 140 inches (2007 by 3556 mm)**].
10. Extra Drop Height: [**As indicated in schedule on Drawings**][**As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor**][**36 inches (900 mm) at bottom of screen**].

    a. Color: [**Same as viewing surface**][**Black**].

PART 3 - EXECUTION

3.1 INSTALLATION OF RIGID REAR-PROJECTION SCREENS

A. Install rear-projection screens to comply with screen manufacturer's written instructions. Install screens using procedures and tools recommended in writing by screen manufacturer; do not abrade viewing surfaces and damage finishes.

B. Install rigid rear-projection screens with optical coating toward [**projector**][**audience**].

C. Install factory-framed, rear-projection screens in prepared wall openings. Securely anchor frames to surrounding construction, so frames are level and plumb and screen surfaces are flat.

D. Install viewing surfaces in frames specified in other Sections, to comply with screen manufacturer's written instructions. Set with viewing surfaces flat and with edges level and plumb.

3.2 INSTALLATION OF ELECTRICALLY OPERATED, FLEXIBLE REAR-PROJECTION SCREENS

A. Install rear-projection screens to comply with screen manufacturer's written instructions, and securely anchor them to supporting substrate in a manner that produces a smoothly operating screen that, when lowered, has flat viewing surface and plumb vertical edges.

1. Install low-voltage controls in accordance with NFPA 70 and complying with manufacturer's written instructions.

    a. Wiring Method: Install wiring in raceway, except in accessible ceiling spaces and in gypsum board partitions, where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables, except in unfinished spaces.

2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.

3.3 PROTECTING AND CLEANING RIGID REAR-PROJECTION SCREENS

A. Provide temporary covering of rear-projection screens until time of Substantial Completion. Use type of covering approved in writing by screen manufacturer that effectively protects screen from abrasion, breakage, or other damage.

B. Clean rear-projection screens on both faces immediately before date scheduled for inspection intended to establish date of Substantial Completion. Use methods and cleaning materials recommended in writing by screen manufacturer; do not scratch or damage optical coatings or viewing-surface substrates.

END OF SECTION 11 52 13 00A

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Task	Specification	Specification Description
11 52 13 13	01 22 00 00	No Specification Required
11 52 13 13	11 52 13 00	Projection Screens
11 52 13 13	11 52 13 00a	Rear Projection Screens
11 52 13 16	11 52 13 00	Projection Screens
11 52 13 16	11 52 13 00a	Rear Projection Screens
11 52 16 26	01 22 00 00	No Specification Required
11 53 43 00	01 22 00 00	No Specification Required
11 66 13 00	01 22 00 00	No Specification Required

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SECTION 11 68 00 00 - PLAY FIELD EQUIPMENT AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes playground equipment as follows:

1. Freestanding playground equipment.
2. Composite playground equipment.

1.2 DEFINITIONS

A. Definitions in ASTM F1487 apply to Work of this Section.

B. IPEMA: International Play Equipment Manufacturers Association.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: For each type of playground equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include fall heights and use zones for playground equipment, coordinated with the critical-height values of protective surfacing specified in Section 321816.13 "Playground Protective Surfacing."

D. Samples for Initial Selection: For each type of exposed finish.

1. Manufacturer's color charts.
2. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed finish on the following products:

1. Include Samples of accessories to verify color and finish selection.
2. Posts and Rails: Minimum **6 inches (150 mm)** long.
3. Platforms: Minimum **6 inches (150 mm)** square.
4. Molded Plastic: Minimum **3 inches (76 mm)** square.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Product Certificates: For each type of playground equipment.

C. Material Certificates: For the following items:

1. Shop finishes.
2. Wood-Preservative Treatment: Include certification by treating plant that states type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For playground equipment and finishes to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's third-party product certification service.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

F. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of playground equipment that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain playground equipment from single source from single manufacturer.

B. Playground equipment and components shall have the IPEMA Certification Seal.

C. The following playground equipment and components shall have the IPEMA Certification Seal:

2.2 PERFORMANCE REQUIREMENTS

A. Safety Standard: Provide playground equipment according to [**ASTM F1487**].

2.3 FREESTANDING PLAYGROUND EQUIPMENT

A. Swing Set : [**Traditional style with tripod angled legs**][**Contemporary style with vertical bipod arches**][**Contemporary style with single-post legs**][**Contemporary T-style**] providing upright support.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Swing Products Inc.**]
b. [**BCI Burke Company, LLC**]
c. [**Big Toys, Inc.; a PlayCore, Inc., company**]
d. [**Blue Imp Recreational Products of Canada**]
e. [**Columbia Cascade Company**]
f. [**GameTime; a PlayCore Company**]
g. [**Henderson Recreation Equipment Ltd**]
h. [**Kidstuff Playsystems, Inc.**]
i. [**Kompan, Inc**]
j. [**Krauss Craft, Inc.**]
k. [**L.A. Steelcraft, a brand of Americana Outdoor**]
l. [**Landscape Structures Inc.**]
m. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
n. [**Miracle Recreation Equipment Company**]
o. [**Play & Park Structures; a PlayCore, Inc., company**]
p. [**Playland; a division of Superior International Industries**]
q. [**SportsPlay Equipment, Inc**]

2. Metal Frame: [**Galvanized-steel**][**Aluminum**] pipe or tubing.

a. Leg Upright(s): Not less than [**1-7/8-inch (48-mm)**][**2-3/8-inch (60-mm)**][**3-1/2-inch (89-mm)**][**4-1/2-inch (114-mm)**][**5-inch (127-mm)**] OD.
b. Overhead Beam: [**Match leg upright**][**Not less than 2-3/8-inch (60-mm)**][**Not less than 3-1/2-inch (89-mm)**] OD.
c. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As**

selected by Architect from manufacturer's full range], as directed by the Owner.

3. Wood Frame: Leg upright(s) and overhead beam not less than [**4 inches (102 mm) square**][**6 inches (150 mm) square**][**6 inches (150 mm) round**] or larger.
4. Overhead Beam Height: [**96 inches (2440 mm)**][**10 ft. (3 m)**][**Height as indicated on Drawings**] from pivot point to protective surfacing below.
5. Suspension Members: [**Standard link chain**][**Short link chain not permitting finger penetration**][**Cable**][**Manufacturer's standard**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. Swing Connector: [**S-hook**][**Double clevis and bolt link**].
7. Swing Hanger: Galvanized [**stamped steel clamp and ductile-iron pivot**][**heavy-duty ductile iron**][**manufacturer's standard**].
8. Swing Seats: [**Enclosed, full-bucket infant/tot**][**Half-bucket**][**U-shaped flexible belt**][**Rigid rectangular**][**Rigid disk**][**Tire**] seat made from [**rubber**][**plastic**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

9. Capacity: [**One**][**Two**][**Three**] swing(s).
10. Age Appropriateness: [**Two through five years**][**Five through 12 years**].

B. Slide: [Single][Double-side-by-side][Double-diverging] descending chute(s)[traditional style].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Swing Products Inc.**]
   b. [**BCI Burke Company, LLC**]
   c. [**Big Toys, Inc.; a PlayCore, Inc., company**]
   d. [**Blue Imp Recreational Products of Canada**]
   e. [**Columbia Cascade Company**]
   f. [**GameTime; a PlayCore Company**]
   g. [**Henderson Recreation Equipment Ltd**]
   h. [**Kidstuff Playsystems, Inc.**]
   i. [**Kompan, Inc**]
   j. [**Krauss Craft, Inc.**]
   k. [**L.A. Steelcraft, a brand of Americana Outdoor**]
   l. [**Landscape Structures Inc.**]
   m. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   n. [**Miracle Recreation Equipment Company**]
   o. [**Play & Park Structures; a PlayCore, Inc., company**]
   p. [**Playland; a division of Superior International Industries**]
   q. [**SportsPlay Equipment, Inc**]

2. Plan Configuration: [**Straight-aligned**][**Quarter-turn**][**Half-turn**][**Three-quarter-turn**][**Full-turn spiral**][**S-shaped**] chute(s).
3. Access: [**Stair or stepladder with handrails**][**Vertical ladder**][**Vertical ladder with side handrails**].
4. Sit-Down Entrance: With [**protective barriers**][**opaque plastic panel barriers**][**canopy or hood enclosure**] and overhead [**handhold**][**and side handholds**].

5. Frame: Manufacturer's standard [**galvanized-steel pipe or tubing**][**aluminum pipe or tubing**][**wood**].
6. Sliding Surface: [**Inclined**][**Wavy**][**Washboard rollers**].
7. Sliding Surface Construction: [**Flat, continuous stainless-steel sheet with integral, full-length side rails**][**U-shaped, continuous stainless-steel sheet with integral, full-length side rails**][**One-piece plastic with integral, full-length side rails**][**Plastic tube, ID not less than 24 inches (610 mm)**][**Plastic tube, ID not less than 30 inches (760 mm)**].
8. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
9. Age Appropriateness: [**Two through five years**][**Five through 12 years**].

C. Tunnel (Crawl Tube) : Freestanding, [**straight-aligned**][**quarter-turn**][**half-turn**][**S-shaped**][**zigzag**][**wavy**][**inclined**] configuration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BCI Burke Company, LLC**]
   b. [**Big Toys, Inc.; a PlayCore, Inc., company**]
   c. [**Blue Imp Recreational Products of Canada**]
   d. [**Columbia Cascade Company**]
   e. [**GameTime; a PlayCore Company**]
   f. [**Henderson Recreation Equipment Ltd**]
   g. [**Kidstuff Playsystems, Inc.**]
   h. [**Kompan, Inc**]
   i. [**Krauss Craft, Inc.**]
   j. [**Landscape Structures Inc.**]
   k. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   l. [**Miracle Recreation Equipment Company**]
   m. [**Play & Park Structures; a PlayCore, Inc., company**]
   n. [**Playland; a division of Superior International Industries**]
   o. [**Playworld Systems, Inc.**]
   p. [**SportsPlay Equipment, Inc**]

2. Material: [**Plastic tube, ID not less than 24 inches (610 mm)**][**Plastic tube, ID not less than 30 inches (760 mm)**].
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Climber : [**Arch**][**Tower**][**Dome**][**Overhead horizontal ladder**][**Overhead pole**][**Flexible cable net**][**Flexible chain net**][**Vertical ladder**][**Vertical panel wall**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BCI Burke Company, LLC**]
   b. [**Big Toys, Inc.; a PlayCore, Inc., company**]
   c. [**Blue Imp Recreational Products of Canada**]
   d. [**Columbia Cascade Company**]
   e. [**GameTime; a PlayCore Company**]
   f. [**Henderson Recreation Equipment Ltd**]
   g. [**Kidstuff Playsystems, Inc.**]

h. [**Kompan, Inc**]
i. [**Krauss Craft, Inc.**]
j. [**L.A. Steelcraft, a brand of Americana Outdoor**]
k. [**Landscape Structures Inc.**]
l. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
m. [**Miracle Recreation Equipment Company**]
n. [**Play & Park Structures; a PlayCore, Inc., company**]
o. [**Playland; a division of Superior International Industries**]
p. [**Playworld Systems, Inc.**]
q. [**SportsPlay Equipment, Inc**]

2. Frame: Manufacturer's standard [**galvanized-steel pipe or tubing**][**aluminum pipe or tubing**][**wood**].
3. Accessories:

   a. Sliding Pole(s): [**One**][**Two**][**Three**][**Four**].
   b. Handhold rings.

4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Capacity: [**Five**][**10**] users.
6. Age Appropriateness: [**Two through five years**][**Five through 12 years**].

E. Merry-Go-Round or Whirl : Rotating [**platform**][**seating**][**hang bars**] around a vertical axis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BCI Burke Company, LLC**]
   b. [**Big Toys, Inc.; a PlayCore, Inc., company**]
   c. [**Blue Imp Recreational Products of Canada**]
   d. [**Columbia Cascade Company**]
   e. [**GameTime; a PlayCore Company**]
   f. [**Henderson Recreation Equipment Ltd**]
   g. [**Kidstuff Playsystems, Inc.**]
   h. [**Kompan, Inc**]
   i. [**Krauss Craft, Inc.**]
   j. [**Landscape Structures Inc.**]
   k. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   l. [**Miracle Recreation Equipment Company**]
   m. [**Play & Park Structures; a PlayCore, Inc., company**]
   n. [**Playland; a division of Superior International Industries**]
   o. [**SportsPlay Equipment, Inc**]

2. Rotating Mechanism: Permanently sealed and lubricated ball bearings with [hydraulic][mechanical] speed-limiting device.
3. Platform: Round, [**dish-shaped**][**flat**][**flat, dimpled**] steel sheet, not less than **0.12-inch- (3.0-mm-)** nominal thickness, with slip-resistant footing.

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Handholds and Handrails: Metal pipe or tubing.

a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Capacity: [**Single**][**Two**][**Five**] user(s).
6. Age Appropriateness: [**Two through five years**][**5 through 12 years**].

F. Rocking/Springing Equipment : [**Rocking rider**][**Rocking platform**][**Seesaw**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Swing Products Inc.**]
b. [**BCI Burke Company, LLC**]
c. [**Big Toys, Inc.; a PlayCore, Inc., company**]
d. [**Blue Imp Recreational Products of Canada**]
e. [**Columbia Cascade Company**]
f. [**GameTime; a PlayCore Company**]
g. [**Henderson Recreation Equipment Ltd**]
h. [**Kidstuff Playsystems, Inc.**]
i. [**Kompan, Inc**]
j. [**Krauss Craft, Inc.**]
k. [**L.A. Steelcraft, a brand of Americana Outdoor**]
l. [**Landscape Structures Inc.**]
m. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
n. [**Miracle Recreation Equipment Company**]
o. [**Play & Park Structures; a PlayCore, Inc., company**]
p. [**Playland; a division of Superior International Industries**]
q. [**Playworld Systems, Inc.**]
r. [**SportsPlay Equipment, Inc**]

2. Seat(s): [Cast aluminum][Molded plastic][Wood][with handholds][with handholds and footrests].

a. Seat Style: [**Animal**][**Automobile**].
b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Multiple Seating and Standing Platform: [**Manufacturer's standard platform with slip-resistant finish**].

a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Frame: [Galvanized-steel pipe or tubing][Aluminum pipe or tubing][wood] and [one][two] coil spring(s); two or more steel springs with steel base plate.

a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Capacity: [**Single**][**Two**] user(s).
6. Age Appropriateness: [**Two through five years**][**Five through 12 years**].

2.4 COMPOSITE PLAYGROUND EQUIPMENT

A. Composite Play Structure : Integral play assembly that provides more than one play activity; manufactured as a system or assembled from manufacturer's standard modular-sized units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Swing Products Inc.**]
   b. [**BCI Burke Company, LLC**]
   c. [**Big Toys, Inc.; a PlayCore, Inc., company**]
   d. [**Blue Imp Recreational Products of Canada**]
   e. [**Columbia Cascade Company**]
   f. [**GameTime; a PlayCore Company**]
   g. [**Henderson Recreation Equipment Ltd**]
   h. [**Kidstuff Playsystems, Inc.**]
   i. [**Kompan, Inc**]
   j. [**Krauss Craft, Inc.**]
   k. [**Landscape Structures Inc.**]
   l. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   m. [**Miracle Recreation Equipment Company**]
   n. [**Play & Park Structures; a PlayCore, Inc., company**]
   o. [**Playland; a division of Superior International Industries**]
   p. [**PlayTown; a brand of SportsPlay Equipment Inc.**]
   q. [**Playworld Systems, Inc.**]
   r. [**SportsPlay Equipment, Inc**]

2. Metal Frame: [Galvanized-steel][Aluminum] pipe or tubing connected with [bolts][clamps].

   a. Main Frame Posts: Not less than [**4-inch (102-mm)**][**5-inch (127-mm)**][**6-inch (150-mm)**] OD.
   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Wood Frame: Frame components connected with bolts.

   a. Main Frame Posts: Not less than [**4 inches (102 mm) square**][**6 inches (150 mm) square**][**6 inches (150 mm) round**].
   b. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Platforms: [**Perforated metal**][**Wood**][**Plastic**][**Manufacturer's standard**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Roofs: [**Perforated metal**][**Plastic**][**Wood**][**Manufacturer's standard**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. Play Structure Access Component(s): [**Ladder**][**Stepladder**][**Stairs**][**Ramp**][**Accessible crawl ramp**][**Accessible transfer platform**].

a. Handholds: [**Protective barriers**][**Guardrails**][**Handrails**][**Handholds**][**on each side**].

7. Equipment: Include the following play event components:

   a. Activity panel.
   b. Balance beam.
   c. Bridge.
   d. Climber: [**Overhead horizontal ladder**][**Vertical ladder**][**Flexible net**][**Panel**][**Pole**].
   e. Log roll.
   f. Slide.
   g. Track ride.
   h. Tunnel.
   i. Colors: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

8. Arrangement: [**As indicated on Drawings**][**Manufacturer's standard**].
9. Capacity: [**10**][**20**] users.
10. Age Appropriateness: [**Two through five years**][**Five through 12 years**].

2.5 FABRICATION

A. Provide sizes, strengths, thicknesses, wall thickness, and weights of components as required to comply with requirements in ASTM F1487. Factory drill components for field assembly. Unnecessary holes in components, not required for field assembly, are not permitted. Provide complete play structures, including supporting members and connections, means of access and egress, designated play surfaces, barriers, guardrails, handrails, handholds, and other components indicated or required for equipment indicated.

B. Metal Frame: Fabricate main-frame upright support posts from metal pipe or tubing with cross-section profile and dimensions as required. Unless otherwise indicated, provide each pipe or tubing main-frame member with manufacturer's standard drainable bottom plate or support flange. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.

C. Wood Frame: Fabricate main-frame upright support posts from wood. Fabricate secondary frame members, bracing, and connections from wood, steel, or aluminum.

D. Composite Frame: Fabricate main-frame upright support posts from metal and plastic. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.

E. Play Surfaces: Manufacturer's standard elevated drainable decks, platforms, landings, walkways, ramps, and similar transitional play surfaces, designed to withstand loads; fabricated from [**perforated or expanded metal**][**molded plastic**][**plastic panel or plank**][**polyethylene panel or plank**][**wood plank**] made into floor units with slip-resistant finish. Fabricate units in modular sizes and shapes to form assembled play surfaces indicated.

F. Protective Barriers: Fabricate according to [**ASTM F1487**]. Extend barriers to height above the protected elevated surface according to requirements for use by age group indicated. Fabricate from[**one or more of**] the following:

   1. Welded-metal pipe or tubing with vertical bars.
   2. Steel sheet with openings for vision and ventilation.
   3. Metal-pipe or -tubing frame with wire-mesh infill panels.
   4. [**Opaque**][**Transparent**] plastic panels[**with openings**].
   5. Vertical wood balusters with metal pipe or tubing or wood frame.
   6. Wood panels with openings for vision and ventilation.

G. Guardrails: Provide guardrails configured to completely surround the protected area, except for access openings. Fabricate from [**welded metal pipe or tubing**][**metal pipe or tubing, and wood**]. Extend guardrails according to requirements for use by age group indicated.

H. Handrails: Welded metal pipe or tubing, maximum OD [**between 0.95 and 1.55 inches (24 and 39 mm)**][**of 0.125 inch (3.2 mm)**].

1. Provide handrails at heights to comply with requirements for use by age group indicated according to [**ASTM F1487**].

I. Roofs and Canopies: Designed to discourage and minimize climbing by users.

1. Fabricated from [metal][metal-pipe or -tubing-framed welded wire][opaque plastic][clear polycarbonate plastic][polyethylene][wood].

J. Signs: Manufacturer's standard sign panels, fabricated from [opaque plastic with graphics molded in][wood with painted graphics], attached [to freestanding, upright support posts][directly to playground equipment].

1. Text:[**Minimum informational content according to ASTM F1487**].

2.6 MATERIALS

A. Aluminum: Material, alloy, and temper recommended by manufacturer for type of use and finish indicated.

B. Steel: Material types, alloys, and forms recommended by manufacturer for type of use and finish indicated[hot-dip galvanized].

C. Stainless-Steel Sheet: Type 304; finished on exposed faces with No. 2B finish.

D. Wood: [**Douglas fir, preservative treated after fabrication**][**Pine, preservative treated after fabrication**][**Western red cedar**], surfaced smooth on all sides and all edges rounded.

E. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

F. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

G. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

H. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

I. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

J. Plywood: PS 1, Exterior grade; smooth surfaced with rounded edges[preservative treated after fabrication].

K. Opaque Plastics: Color impregnated, UV stabilized, and mold resistant.

L. Transparent Plastic: Abrasion-resistant, UV-stabilized polycarbonate sheet; [**clear, colorless**]; not less than **3/16 inch (5 mm)** thick.

M. Suspension Chain and Fittings: ASTM A467/A467M, Class CS, 4/0 or 5/0, welded-straight-link coil chain; [hot-dip galvanized][zinc plated][PVC coated]; with commercial-quality, [hot-dip galvanized][zinc-plated] steel connectors and swing or ring hangers.

N. Suspension Cable: Manufacturer's standard [hot-dip galvanized][zinc-plated][PVC-coated] cable; with commercial-quality, [hot-dip galvanized][zinc-plated] steel connectors and swing or ring hangers.

O. Iron Castings and Hangers: Malleable iron, ASTM A47/A47M, Grade 32510, hot-dip galvanized.

P. Post Caps: [Cast aluminum][color-impregnated, UV-stabilized, mold-resistant polyethylene or polypropylene]; color to match posts.

Q. Platform Clamps and Hangers: [Cast aluminum][zinc-plated steel, not less than 0.105-inch- (2.7-mm-) nominal thickness].

R. Hardware: Manufacturer's standard; commercial-quality; corrosion-resistant; hot-dip galvanized steel and iron, stainless steel, or aluminum; of a vandal-resistant design.

S. Fasteners: Manufacturer's standard; corrosion-resistant; hot-dip galvanized or zinc-plated steel and iron, or stainless steel; permanently capped; and theft resistant.

2.7 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment: Pressure-treat wood products according to AWPA U1 and the following:

1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

2.8 CAST-IN-PLACE CONCRETE

A. Concrete Materials and Properties:

1. Comply with requirements in [Section 033000 "Cast-in-Place Concrete"][ACI 301/ (ACI 301M)] for normal-weight[air-entrained] concrete with minimum 28-day compressive strength of 3000 psi (20.7 MPa), 3-inch (76-mm) slump, and 1-inch- (25-mm-) maximum-size aggregate.
2. Dry-packaged concrete mix complying with ASTM C387/C387M and mixed at site with potable water, according to manufacturer's written instructions, for normal-weight concrete with minimum 28-day compressive strength of **3000 psi (20.7 MPa)**, **3-inch (76-mm)** slump, and **1-inch- (25-mm-)** maximum-size aggregate.

2.9 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of [**1.5 mils (0.04 mm)**], medium gloss. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of [**80 mils (2 mm)**]. Comply with coating manufacturer's written instructions for pretreatment and application.

2.10 IRON AND STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**. Comply with coating manufacturer's written instructions for pretreatment, applying, and baking.

B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of [**80 mils (2 mm)**][**100 mils (2.5 mm)**]. Comply with coating manufacturer's written instructions for pretreatment and application.

2.11 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for earthwork, subgrade elevations, surface and subgrade drainage, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading required for placing playground equipment and protective surfacing is completed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions for each equipment type unless more stringent requirements are indicated. Anchor playground equipment securely, positioned at locations and elevations indicated.

1. Maximum Equipment Height: Coordinate installed fall heights of equipment with finished elevations and critical-height values of protective surfacing. Set equipment so fall heights and elevation requirements for age group use and accessibility are within required limits. Verify that

playground equipment elevations comply with requirements for each type and component of equipment.

B. Post and Footing Excavation: Excavate holes for posts and footings as indicated in firm, undisturbed or compacted subgrade soil.

C. Post Set on Subgrade: Level bearing surfaces with drainage fill to required elevation.

D. Post Set with Concrete Footing: Comply with [**Section 033000 "Cast-in-Place Concrete"**][**ACI 301 (/ACI 301M)**][**dry-packaged concrete-mix manufacturer's written instructions**] for measuring, batching, mixing, transporting, forming, and placing concrete.

1. Set equipment posts [**in**][**on**] concrete footing. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at the correct angle, alignment, height, and spacing.

a. Place concrete around posts and vibrate or tamp for consolidation. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

2. Embedded Items: Follow equipment manufacturer's written instructions and drawings to ensure correct installation of anchorages for equipment.
3. Finishing Footings: Smooth top, and shape to shed water.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Perform inspection and testing for each type of installed playground equipment according to [**ASTM F1487**].

C. Playground equipment items will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Notify [**Architect**][**the Owner**] 48 hours in advance of date(s) and time(s) of testing and inspection, as directed by the Owner.

END OF SECTION 11 68 00 00

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Task	Specification	Specification Description
11 68 13 00	11 68 00 00	Play Field Equipment and Structures
11 68 23 00	11 68 00 00	Play Field Equipment and Structures
11 68 23 13	11 68 00 00	Play Field Equipment and Structures
11 68 23 33	11 68 00 00	Play Field Equipment and Structures
11 68 33 00	11 68 00 00	Play Field Equipment and Structures
11 68 33 13	11 68 00 00	Play Field Equipment and Structures
11 68 33 23	11 68 00 00	Play Field Equipment and Structures
11 68 33 33	11 68 00 00	Play Field Equipment and Structures

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SECTION 11 73 00 00 - PATIENT CARE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling-mounted patient-lift systems.
2. Intravenous (IV) tracks, carriers, and bottle holders.
3. Patient-bed locators.
4. Patient-bed service walls.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for above-ceiling supplementary framing for support and anchorage of patient-lift systems.
2. Section 092216 "Non-Structural Metal Framing" for supplementary metal framing and blocking for mounting items requiring anchorage.
3. Section 102123 "Cubicle Curtains and Tracks" for patient-room cubicles.
4. Section 102800 "Toilet, Bath, and Laundry Accessories" for specimen pass-through cabinets and boxes and for bedpan and urinal cabinets and boxes.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of components. Indicate location and size of each field connection.
3. Include diagrams for service connections and power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, **10 inches (254 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of accessories involving color and finish selection.

E. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:

1. Include Samples of accessories to verify color and finish selection.
2. Ceiling-Mounted Patient-Lift Systems: Not less than **10-inch- (254-mm-)** long, track sections.
3. IV Track Systems:

a. Track: Not less than **10 inches (254 mm)** long.
b. IV Carrier: Full-size unit.
c. IV Hanger: Full-size unit.

4. Patient-Bed Locators: Not less than **10 inches (254 mm)** square.
5. Patient-Bed Service Walls: Not less than **10 inches (254 mm)** square for fascia and not less than **10 inches (254 mm)** long for trim and rails.

F. Product Schedule: For patient care equipment.[**Use same designations indicated on Drawings**].

G. Delegated-Design Submittal: For above-ceiling supplementary framing for support and anchorage of patient-lift systems, signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For ceiling-mounted patient-lift systems, reflected ceiling plan(s), and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which ceiling-mounted patient-lift systems will be attached.
3. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

4. Perimeter moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For products to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical installation of the following as shown on Drawings[**as part of patient-room mockup**]:

a. Ceiling-mounted patient-lift system.
b. IV track, carrier, and bottle holder.
c. Patient-bed locators.
d. Patient-bed service walls.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design above-ceiling supplementary framing for support and anchorage of patient-lift systems.

2.2 CEILING-MOUNTED PATIENT-LIFT SYSTEMS

A. Ceiling-Mounted Patient Lift: Consisting of a motor-driven lift unit that traverses on a ceiling-mounted track system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. [**Guldmann Inc.**]
c. [**Hill-Rom Services, Inc.**]

B. Ceiling-Mounted Track System: High-strength extruded aluminum in manufacturer's standard profile and thickness to support lifting capacity indicated for lift unit. Provide track shapes and accessories as required to provide a complete system in layout indicated on Drawings.

C. Lift Unit: Steel frame system with separate 24-V dc lifting and horizontal-drive motors secured to chassis.

1. Lifting Capacity: [**440 lb (200 kg)**][**550 lb (250 kg)**][**660 lb (300 kg)**][**770 lb (350 kg)**].
2. Maximum Lift Range: [**96 inches (2438 mm)**].
3. Safety Features:

a. Emergency stop.
b. Emergency lowering device, mechanical and electrical.
c. Control of lift strap.
d. Cut-off Angle: 45 degrees along the rail; 10 degrees across the rail.

4. Electronics:

a. Control Unit: [**Walk-along, hand-held**][**Wireless remote-**]control unit.
b. On/Off Control: Soft start and stop with overload protection.
c. Battery Power: 24-V rechargeable nickel-metal hydride batteries in quantity required for lifting capacity indicated. Provide with electric battery charging station that provides maximum charge time of two hours per battery.

1) Provide [**wall**][**ceiling**]-mounted charging station at end of track.[**Provide supplemental clip-on charging station with indicator lights.**]

d. Battery Protection: Low-battery light illuminates when battery voltage is below 22 V; hoist disabled when battery voltage is below 20 V.
e. Motors: Provide in quantity required by lifting capacity indicated.

1) Lift Motors: [**2.3 inches (6 cm)**] per second lift speed at maximum capacity load.
2) Horizontal-Drive Motors: [**5.9 inches (150 mm)**] per second horizontal traverse at maximum capacity load.

D. Accessories:

1. Threaded nylon straps and polyester/nylon-net sling to support and cradle patient.
2. Room-to-room carry bar.
3. Two-point carry bar[**with locking clips**].
4. Four-point carry bar[**with locking clips**].
5. Tandem carry bar.
6. Bariatric carry bar.

2.3 IV TRACKS, CARRIERS, AND BOTTLE HOLDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alderman Acres Manufacturing, Inc.**]
2. [**AR Nelson**]
3. [**Automatic Devices Company**]
4. [**Barjan Manufacturing Ltd.**]
5. [**Covoc Corporation**]
6. [**Healthcare Curtains**]
7. [**Imperial Fastener Company, Inc.**]
8. [**Pryor Products, Inc.**]

B. IV Tracks: Extruded aluminum, not less than **1-1/4 inches wide by 3/4 inch high (32 mm wide by 19 mm high).)**

1. Track Minimum Wall Thickness: [**0.058 inch (1.47 mm)**][**0.062 inch (1.57 mm)**][**Manufacturer's standard**].
2. Curved Track: Factory-fabricated, [**12-inch- (305-mm-)**] radius bends.
3. Finish: [**Clear anodized**][**Satin anodized**][**Baked enamel, acrylic, or epoxy**].

C. IV Carriers: Four nylon rollers and [**nylon**][**steel**][**stainless-steel**] axles with hanger loop fabricated from **1/4-inch- (6-mm-)** diameter, stainless steel.

1. Provide carriers with ball bearings.

D. Stationary IV Bottle Holders: [**24-inch (610-mm)**][**30-inch (762-mm)**][**36-inch (914-mm)**][**42-inch (1067-mm)**][**48-inch (1219-mm)**] fixed height with stainless-steel shaft.

1. Arms: [**Four**][**Eight**] **1/4-inch (6-mm)** stainless-steel arms with loops.

a. Type: [**Folding**][**Nonfolding**].
b. Bottom Loop: Stainless steel.
c. Top Loop: Stainless steel, [**coated for nonconductivity**][**uncoated**].

E. Telescoping IV Bottle Holders: [**28-inch (711-mm)**][**39-inch (991-mm)**][**45-inch (1143-mm)**][**51-inch (1295-mm)**][**57-inch (1448-mm)**] overall height with a **3/4-inch (19-mm)** stainless-steel main shaft and a **3/8-inch (9.5-mm)** stainless-steel inner shaft, minimum vertical adjustment of **16 inches (406 mm)**.

1. Arms: [**Four**][**Eight**] **1/4-inch (6-mm)** stainless-steel arms with loops.

a. Type: [**Folding**][**Nonfolding**].
b. Bottom Loop: Stainless steel.
c. Top Loop: Stainless steel, [**coated for nonconductivity**][**uncoated**].

2. Adjustment Control: [**Push button**][**Release ring**].

2.4 PATIENT-BED LOCATORS

A. Patient-Bed Locator : Surface-mounted docking station with conduit raceway provisions for eight power-service connections, four on each side, that is UL listed and labeled and complying with NFPA 70, and that ensures proper positioning of patient beds and protects wall surfaces from impact and abrasion damage caused by contact with patient bed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**Hospital Systems, Inc**]

2. Enclosure: Manufacturer's standard high-impact plastic, [**one**][**two**] piece(s).

a. Color and Pattern: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Height: [**22-1/2 inches (572 mm)**, **nominal**].
c. Width: [**50 inches (1270 mm)**, **nominal**].
d. Overall Depth: [**4-5/8 inches (118 mm)**, **nominal**].

3. Power Services:

a. Normal power.
b. Critical power.
c. Low-voltage power and communication.

4. Accessories:

a. Direct and indirect lighting fixture.

2.5 PATIENT-BED SERVICE WALLS

A. Patient-Bed Service Wall : Headwall system; UL listed and labeled; complying with NFPA 70 and NFPA 99; with integrated raceways that provide single-area connection for power services and communication wiring and single connection for hard-piped and brazed medical gas piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Amico Corporation**]
b. [**Hospital Systems, Inc**]
c. [**Modular Services Company**]

2. Type: [**Horizontal**][**Vertical**][**Panel**].

   a. Unit Overall Length: [**As indicated on Drawings**].
   b. Unit Overall Width: [**As indicated on Drawings**].
   c. Panel Sizes: [**As indicated on Drawings**].

3. Fascia Panels: Removable for installation and maintenance of services, [**high-pressure plastic**][**high-pressure laminate**].

   a. Color and Pattern: [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

4. Fascia Panel Reveals: [**3/8-inch (9.5-mm) flush concave**][**3/8-inch (9.5-mm) protruding**][**Manufacturer's standard**].

   a. Reveal Finish: [**Black**][**Aluminum**].

5. Enclosure/Frame: [**Anodized aluminum**][**Galvanized steel**].
6. Mounting: [**Surface**][**Recessed, single sided**][**Recessed, double sided**].

   a. Unit Depth: [**As indicated on Drawings**][**5 inches (127 mm), nominal**][**As required by wall construction indicated on Drawings**].

7. Accessory Rails: [**Two**][**Four**][**As indicated on Drawings**].
8. Medical Gas Services:

   a. Oxygen.
   b. Medical air.

9. Medical Vacuum Services: ASME B16.22 copper vacuum-service tubes.
10. Gas Manifold: Machined aluminum block with CGA V-5 diameter, indexed safety system, gas-specific check valves.
11. Power Services:

    a. Normal power.
    b. Critical power.
    c. Low-voltage power.

12. Isolated Power Systems Equipment: UL 1047.
13. Metallic Outlet Boxes: UL 514A.
14. Accessories:

    a. Arm light, compact fluorescent.
    b. Bottle slide.
    c. Blood-pressure gage mount.
    d. Charting shelf.
    e. Glove-box mount.
    f. Light, utility track mounted.

g. Integrated diagnostic system mount.
h. ISS transfer pole with mount.
i. IV resuscitator hook, dual.
j. Ophthalmoscope mount.
k. Post-type utility mount.
l. Resuscitator bag holder.
m. Sharps-container mount.
n. Shelf, [**mayo**][**swivel**].
o. Speculum mount.
p. Universal charting light with mount.
q. Universal holder.
r. Universal light mount.
s. Universal pole holder, C-clamp.
t. Utility hook.
u. Utility otoscope mount.
v. Utility shelf.
w. Utility slide mount.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CEILING-MOUNTED PATIENT-LIFT SYSTEMS

A. Install tracks level and plumb, according to manufacturer's written instructions.

1. Support track directly from [**structure**][**overhead supplementary framing**] using manufacturer's standard supports, anchors, and fasteners at intervals required by lifting capacity indicated, but not less than [**36 inches (914 mm)**] o.c.
2. Brace direct-to-structure track supports where distance between suspended ceiling and anchors is more than **18 inches (457 mm)**.
3. Provide supports at each track end, splice, and tangent point of each corner.
4. Install track accessories, splices, end caps, connectors, coupling and joining devices, and other accessories as required for a secure and operational installation.

3.3 IV TRACKS, CARRIERS, AND BOTTLE HOLDERS

A. Install tracks level and plumb, according to manufacturer's written instructions.

B. For tracks up to **20 feet (6.0 m)** in length, provide track fabricated from single, continuous length.

C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:

1. Mechanically fasten directly to bottom of concrete deck with post-installed anchors.
2. Mechanically fasten directly to finished ceiling with toggle bolts.

3. Mechanically fasten to furring through suspended ceiling with screw and tube spacer.
4. Mechanically fasten to suspended ceiling grid with screws.
5. Attach track to suspended ceiling grid with manufacturer's proprietary clip.

D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.

E. IV Bottle Holders: Unless otherwise indicated, install one IV hook on each IV track and hang one IV hanger.

3.4 PATIENT-BED LOCATORS

A. Install bed locators level and plumb, according to manufacturer's written instructions.

B. Accurately fit, align, securely fasten, and install bed locators free from distortion or defects.

3.5 PATIENT-BED SERVICE WALLS

A. Install service walls level and plumb, according to manufacturer's written instructions.

B. Accurately fit, align, securely fasten, and install service walls free from distortion or defects.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: For patient-bed service walls, perform periodic installation inspections to ensure that products are installed according to manufacturer's written instructions.

1. Installation Inspections: Inspect product installations when installation work is [**25, 60, and 100 percent complete**].
2. Installation Inspection Reports: Indicate if product installations comply with manufacturer's written instructions and corrective actions required if any.

3.7 ADJUSTING

A. Adjust products for proper function and operation to comply with manufacturer's written instructions.

3.8 PROTECTION

A. Protect installed products from damage for the remainder of the construction period.

B. Repair damaged products according to manufacturer's written instructions. If damaged products cannot be successfully repaired, as directed by the Owner, remove and replace damaged products.

END OF SECTION 11 73 00 00

Task	Specification	Specification Description
11 73 23 00	11 73 00 00	Patient Care Equipment

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SECTION 11 82 26 00 - FACILITY WASTE COMPACTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Facility waste compactors.

B. Related Requirements:

1. Section 113013 "Residential Appliances" for residential trash compactors.
2. Section 114000 "Foodservice Equipment" for food-waste shredding, pulping, grinding, and compacting machines in foodservice facilities.
3. Section 149182 "Trash Chutes" for waste chutes and diverters servicing waste compactors.
4. Section 211000 "Water-Based Fire-Suppression Systems" for building fire sprinklers and piping connections to automatic sprinkler in hopper of each chute-fed compactor.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Inspect and discuss electrical, plumbing, and sprinkler roughing-in; equipment bases; and other preparatory work specified elsewhere.
2. Review coordination of chute[**and diverter**] locations with waste compactors.
3. Review sanitary requirements for water bibs, floor drains, and grease traps if required for Project to reduce decomposition and odors.
4. Review haul routes of waste to the compactor, route of hauler's equipment, and protections along these routes that are specified elsewhere.
5. Review required testing, inspection, and certification procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties and accessories, and finishes.

B. Shop Drawings: For each waste compactor and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Dimension chute[**and diverter**] locations that interface with waste compactors.
4. Include location and installation details of automatic sprinkler in hopper of each chute-fed compactor.
5. Indicate equipment access points and required space for equipment service and operation.

6. Include setting drawings, templates, and instructions for installing anchor bolts and other anchorages.
7. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of waste compactor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For waste compactors to include in operation and maintenance manuals.

B. Continuing Maintenance Proposal: From Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**one**][**two**] hour(s') normal travel time from Installer's place of business to Project site.

PART 2 - PRODUCTS

2.1 FACILITY WASTE COMPACTORS

A. Waste Compactor: Manufacturer's standard [stationary-horizontal][self-contained horizontal][compactor-container (combination-container)][vertical][pivoting-ram] -type stationary compactor, complying with requirements[liquidtight]; and with components, options, and accessories needed to provide a complete, functional system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Compactors, Inc.**]
b. [**Cram-A-Lot; J.V. Manufacturing, Inc.**]
c. [**Harmony Enterprises, Inc.**]
d. [**Marathon Equipment Company; a Dover company**]
e. [**Precision Machinery Systems LLC**]
f. [**PTR Baler & Compactor Company**]
g. [**Rudco Products, Inc.**]

h. [**Sebright Products, Inc.**]
i. [**SP Industries, Inc**]
j. [**Wastequip, LLC**]
k. [**Western Chutes; Buchanan Company, Inc.**]
l. [**Wilkinson Hi-Rise, LLC**]

2. Source Limitations: Obtain from single source from single manufacturer.
3. Waste-Compactor Standards: ANSI Z245.21[**including appendices**] and NFPA 82.
4. Waste-Container Standards: ANSI Z245.30 and ANSI Z245.60.
5. Rated Size (Volume): Minimum [**0.14 cu. yd. (0.11 cu. m)**][**1.00 cu. yd. (0.77 cu. m)**][**1.50 cu. yd. (1.15 cu. m)**][**2.00 cu. yd. (1.53 cu. m)**][**3.50 cu. yd. (2.68 cu. m)**][**5.00 cu. yd. (3.82 cu. m)**][**7.50 cu. yd. (5.73 cu. m)**][**10.00 cu. yd. (7.65 cu. m)**].
6. Clear Top Opening (Length by Width): Minimum [**20 by 28 inches (508 by 711 mm)**][**24 by 36 inches (610 by 914 mm)**][**30 by 48 inches (762 by 1219 mm)**][**60 by 48 inches (1524 by 1219 mm)**][**108 by 72 inches (2743 by 1829 mm)**].
7. Cycle Time: Maximum [**30**][**40**][**50**][**60**][**70**] seconds.
8. Normal/Maximum Resultant Ram Forces: [**20,000/22,000 lbf (89/98 kN)**][**36,000/40,000 lbf (160/178 kN)**][**70,000/80,000 lbf (311/356 kN)**][**125,000/150,000 lbf (556/667 kN)**].
9. Normal/Maximum System Pressures: [**1600/1800 psi (11.0/12.4 MPa)**][**2000/2400 psi (13.8/16.5 MPa)**][**2500/2800 psi (17.2/19.3 MPa)**].
10. Scale Weight: Maximum [**2500 lb (1134 kg)**][**6000 lb (2722 kg)**][**12,000 lb (5443 kg)**][**20,000 lb (9072 kg)**].
11. Electrical Characteristics:

    a. Horsepower: [**3**][**10**][**15**][**20**][**30**][**50**] hp.
    b. Voltage: [**115 V ac single phase, 60 Hertz**][**230 V ac, single phase, 60 Hertz**][**208 V ac, three phase, 60 Hertz**][**230 V ac, three phase, 60 Hertz**][**460 V ac three phase, 60 Hertz**].

12. Finish: [**Manufacturer's standard**][**Manufacturer's standard primer for field painting**].

    a. Color: [**White**][**Black**][**Gray**][**Dark green**][**Yellow**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

13. Deodorizing Device: [**Manufacturer's standard**].

B. Number of Extra Storage Containers: [**One**][**Two**].

2.2 FABRICATION

A. Fabricate waste compactors with smooth, eased, exposed edges to prevent injury to persons in vicinity of the equipment.

B. Fabricate containers, hoppers, compaction chambers, unit bodies, and similar components of steel with welded joints. Reinforce with steel members sized and spaced to withstand impacts and pressures of normal operations and to prevent deformation.

C. Fabricate equipment with replaceable parts at points of normal wear.

D. Fabricate liquidtight compactor baffles to stop liquid from leaking out.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, clearances, service rough-ins, and other conditions affecting performance of the Work.

B. Examine walls, floors, and chutes for suitable conditions where each waste compactor will be installed.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FACILITY WASTE COMPACTORS

A. Install each waste compactor according to manufacturer's written instructions, ANSI Z245.2, and ANSI Z245.21[including appendices].

B. Install automatic sprinkler in hopper of each chute-fed compactor according to NFPA 82.

C. Set waste compactors level, plumb, properly aligned, and securely in place. Anchor as required for secure operation.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to[**ANSI Z245.21, Appendix D, "Tests for Evaluation of Equipment and Performance," and**] manufacturer's written instructions.
2. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Verify unrestricted access to each firefighting access door or hose connection required by ANSI Z245.21 and NFPA 82 for compactor container(s).
4. Verify correct locations, color coding, and legibility of caution, warning, and danger markings.
5. Certify compliance with test parameters.

B. A waste compactor will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, initial maintenance service shall include [**12**] months' full maintenance by skilled employees of waste-compactor Installer. Include [**monthly**] preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper waste-compactor operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain waste compactors according to manufacturer's written instructions and ANSI Z245.2.

END OF SECTION 11 82 26 00

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SECTION 11 97 26 00 - DETENTION GUN LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pistol lockers.
2. Tilt-out pistol lockers.

B. Related Requirements:

1. Section 119814 "Detention Door Hardware" for cylinders and keying for detention gun lockers.
2. Section 125500 "Detention Furniture" for detention furniture.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention gun lockers. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to Project site in time for installation.

C. Coordinate size and location of recesses in wall construction to receive recessed detention gun lockers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for detention gun lockers.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For detention gun lockers.

1. Include plans, elevations, sections, and attachment details.
2. Indicate locations, dimensions, and profiles of wall and floor reinforcements.

3. Indicate locations and installation details of built-in anchors.
4. Show elevations and indicate dimensions of detention gun lockers, preparations for receiving anchors, and locations of anchorage.
5. Show details of attachment of detention gun lockers to built-in anchors.

D. Samples for Initial Selection: For detention gun lockers with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Examination reports documenting inspections of substrates, areas, and conditions.

C. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

D. Field quality-control reports documenting inspections of installed products.

1. Field quality-control certification signed by Contractor[**and Detention Specialist**].

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify openings for recessed detention gun lockers by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 PISTOL LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Jail Products L.L.C.**]
2. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
3. [**Detention Device Systems (DDS); DDS Group**]

4. [**Maximum Security Products Corp**]
5. [**PSI LLC**]
6. [**Southern Folger Detention Equipment Company**]
7. [**Sweeper Metal Fabricators Corp**]
8. [**Tiffin Metal Products Co.**]
9. [**Willo Products Company, Inc.**]

B. Cabinet: Minimum **20 inches (508 mm)** wide by **15 inches (381 mm)** high by **10 inches (254 mm)** deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel sheet**][**0.141-inch (3.57-mm) nominal-thickness stainless steel sheet**]. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.

1. Compartments: [**Six**].

C. Doors: Formed from [**3/16-inch- (4.8-mm-) thick steel plate**][**0.180-inch (4.55-mm) nominal-thickness steel sheet**][**same material as cabinet**], supported by heavy-duty continuous bottom hinge.

D. Locks: [**Snap**][**Cylinder**] type, keyed differently[**and master keyed**]; provide one lock for each compartment.

1. Lock Preparation: Prepare door panel to accept cylinder specified in Section 119814 "Detention Door Hardware."

E. Mounting: [**Surface**][**Recessed, with mounting flange formed from same material as body**].

F. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.

G. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: No. 3.

2.3 TILT-OUT PISTOL LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Jail Products L.L.C.**]
2. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
3. [**Detention Device Systems (DDS); DDS Group**]
4. [**Maximum Security Products Corp**]
5. [**Norix Group, Inc.**]
6. [**PSI LLC**]
7. [**Southern Folger Detention Equipment Company**]
8. [**Sweeper Metal Fabricators Corp**]
9. [**Willo Products Company, Inc.**]

B. Cabinet: Minimum **39 inches (991 mm)** wide by **15 inches (381 mm)** high by **6 inches (152 mm)** deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel sheet**][**0.141-inch (3.57-mm) nominal-thickness stainless steel sheet**].

1. Compartments: [**Six**].

C. Tilt-Out Compartments: Doors formed from [**3/16-inch- (4.8-mm-) thick steel plate**][**0.180-inch (4.55-mm) nominal-thickness steel sheet**][**same material as cabinet**], supported by heavy-duty continuous bottom hinge, with attached tilt-out compartment with formed metal sides. Line each compartment with mothproofed felt or nonabsorbing, closed-cell padding.

D. Locks: [**Snap**][**Cylinder**] type, keyed differently[**and master keyed**]; provide one lock for each compartment.

1. Lock Preparation: Prepare door panel to accept cylinder specified in Section 119814 "Detention Door Hardware."

E. Mounting: [**Surface**][**Recessed, with mounting flange formed from same material as body**].

F. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.

G. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish, consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.
2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3) Directional Satin Finish: No. 3.

2.4 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of detention gun lockers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Form and grind edges and corners to be free of sharp edges or rough areas.

E. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

F. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections, so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention gun lockers rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

H. Cut, reinforce, drill, and tap detention gun lockers as indicated to receive hardware, fasteners, and similar items.

I. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where

possible. Locate joints where least conspicuous.

2.5 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to [**4**] times the load imposed, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

D. Proprietary Built-in Masonry Anchors: Fabricated from [0.134-inch (3.42-mm) nominal-thickness steel sheet][1/4-inch (6-mm) nominal-thickness steel plate][1/2-inch (12.7-mm) nominal-thickness steel plate] into [6-inch- (152-mm-)][8-inch- (203-mm-)] deep blocks matching size of concrete masonry units[with weld nuts attached on inside to receive field-bolted attachments].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**M/BED Block Systems, LLC.**]
b. [**Peterson Detention Inc. (PDI)**]

2. Finish: [**Factory primed for field painting for anchors with field-welded attachments**][**Polyester powder coat for anchors with bolted attachments**][**Epoxy paint for anchors with bolted attachments**].

E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention gun lockers.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention gun lockers before detention gun locker installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention gun lockers.

D. Inspect built-in and cast-in anchor installations, before installing detention gun lockers, to verify that

anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention gun lockers with those indicated on Shop Drawings.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention gun lockers to in-place construction. Include threaded fasteners for [**concrete**][**and**][**masonry**] inserts and other connectors.

B. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention gun lockers. Set detention gun lockers accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into [concrete][masonry] or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Adjust doors and latches of detention gun lockers to operate easily without binding. Verify that integral locking devices operate properly.

F. Assemble detention gun lockers requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames.

3.3 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units; replace with new units.

C. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

D. Prepare field quality-control certification[endorsed by Detention Specialist,] that states installed products and their installation comply with requirements in the Contract Documents.

END OF SECTION 11 97 26 00

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Task	Specification	Specification Description
11 97 26 00	12 55 00 00	Detention Furniture

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SECTION 11 98 12 00 - DETENTION DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Detention door and frame assemblies.

B. Related Requirements:

1. Section 055963 "Detention Enclosures" for [**bar-grille assemblies**][**and**][**woven-rod-mesh assemblies**] incorporating doors for detention applications.
2. Section 119814 "Detention Door Hardware" for door hardware for detention doors.

1.2 DEFINITIONS

A. Minimum-Thickness Steel: Indicated as the specified minimum thicknesses for base metal without coatings, in accordance with NAAMM-HMMA 803.

B. Nominal-Thickness Stainless Steel: Indicated as the specified thicknesses for which over- and under-thickness tolerances apply, in accordance with ASTM A480/A480M.

1.3 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**].

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, label compliance,[**fire-resistance rating,**][**temperature-rise ratings,**] and finishes for each detention door and frame type specified.

B. Shop Drawings: In addition to requirements below, provide a schedule using same reference numbers

for details and openings as those on Drawings:

1. Elevations of each door type.
2. Direction of [**swing**][**slide**].
3. Inmate and non-inmate sides.
4. Details of doors, including vertical and horizontal edge details, and metal thicknesses.
5. Details of frames, including dimensioned profiles, and metal thicknesses.
6. Locations of reinforcement and preparations for hardware.
7. Details of each different wall opening condition.
8. Details of anchorages, joints, field splices, and connections.
9. Details of [**food-pass openings**][**louvers**][**speaking apertures**][**and**][**gun ports**].
10. Details of moldings, removable stops, and glazing.
11. Details of conduits, junction boxes, and preparations for [**electrically operated**][**and**][**pneumatic**] door hardware.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of detention door and frame assembly to demonstrate compliance with requirements for quality of materials and constructions.

1. Size: [**Manufacturers' standard size**][**12 by 12 inches (305 by 305 mm)**].
2. Detention Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
3. Detention Frames: Show profile, welded corner joint, welded hinge reinforcement, grout-cover boxes, floor and wall anchors, and silencers. Include separate section showing fixed steel panels and glazing if applicable.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For each type of detention door and frame assembly including vision and side lights, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

C. Examination Reports: For inspection of substrates, areas, and conditions.

D. Anchor Inspection Reports: For inspections of built-in and cast-in anchors.

E. Field Quality Control Reports: For inspections of installed products.

1. Field quality control certification, signed by Contractor[**and Detention Specialist**].

F. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

G. Qualification Statements: For Installer.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Security Fasteners: Furnish not less than one box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.
2. Tools: Provide [**two**] sets of tools for installing and removing security fasteners.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.
3. AWS D1.6/D1.6M.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver detention hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver detention frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store detention hollow-metal work vertically under cover at Project site with head up. Place on minimum **4-inch- (102-mm-)** high wood blocking. Provide minimum **1/4-inch (6.3-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain detention doors and frames from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings[**and temperature-rise limits**] indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

C. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

D. Detention Door and Frame Assemblies: Provide detention door and frame assemblies that comply with the following, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project:

1. Security Grade: Assemblies pass testing requirements in ASTM F1450 for security grades specified.
2. Bullet Resistance: UL-HG-C rated when tested in accordance with UL 752.
3. Tool-Attack Resistance: Small-tool-attack-resistance rated when tested in accordance with UL 437 and UL 1034.

E. Detention Frames: Provide sidelight and borrowed-light detention frames that comply with ASTM F1592 and removable stop test in accordance with ANSI/NAAMM-HMMA 863, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

2.3 DETENTION DOOR AND FRAME ASSEMBLIES

A. Detention Door and Frame Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMBICO Limited**]
b. [**Ceco Door; AADG, Inc.; ASSA ABLOY**]

c. [**Habersham Metal Products Company**]
d. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
e. [**Sweeper Metal Fabricators Corp**]
f. [**Titan Metal Products**]
g. [**Trussbilt, LLC**]

2.4 DETENTION DOORS

A. General: Provide flush-design detention doors of seamless hollow construction, **2 inches (51 mm)** thick unless otherwise indicated. Construct detention doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.

1. For single-acting swinging detention doors, bevel both vertical edges **1/8 inch in 2 inches (3 mm in 51 mm)**.
2. For sliding detention doors, square both vertical edges.

B. Core Construction: Provide the following core construction of same material as detention door face sheets, welded to both detention door faces:

1. Steel-Stiffened Core: **0.042-inch- (1.0-mm-)** thick, steel vertical stiffeners extending full-door height; with vertical webs spaced not more than **4 inches (102 mm)** apart; spot welded to face sheets at not more than **3 inches (76 mm)** o.c. Fill spaces between stiffeners with insulation.
2. Truss-Stiffened Core: **0.013-inch- (0.3-mm-)** thick, steel, truncated triangular stiffeners extending between face sheets and for full height and width of door; with stiffeners welded to face sheets at not more than **3 inches (76 mm)** o.c. vertically and **2-3/4 inches (70 mm)** horizontally. Fill spaces between stiffeners with insulation.

C. Vertical Edge Channels: **0.123-inch- (3.1-mm-)** thick, continuous channel of same material as detention door face sheets, extending full-door height at each vertical edge; welded to top and bottom channels to create a fully welded perimeter channel. Noncontiguous channel is permitted to accommodate lock-edge hardware only if lock reinforcement is welded to and made integral with channel.

D. Top and Bottom Channels: **0.123-inch- (3.1-mm-)** thick, metal channel of same material as detention door face sheets; spot welded to face sheets at not more than **4 inches (102 mm)** o.c.

1. Reinforce top edge of detention door with **0.053-inch- (1.3-mm-)** thick, closing channel; welded so channel web is flush with top door edges.

E. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention door face sheets to comply with the following minimum thicknesses:

1. Full-Mortise Hinges and Pivots: **0.167 inch (4.2 mm)** thick.
2. Maximum-Security Surface Hinges: **0.214 inch (5.4 mm)** thick.
3. Strike Reinforcements: **0.167 inch (4.2 mm)** thick.
4. Slide-Device Hanger Attachments: As recommended in writing by device manufacturer.
5. Lock Fronts, Concealed Holders, and Surface-Mounted Closers: **0.093 inch (2.3 mm)** thick.
6. All Other Surface-Mounted Hardware: **0.093 inch (2.3 mm)** thick.
7. Lock Pockets: **0.123 inch (3.1 mm)** thick at non-inmate side; welded to face sheet.

F. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware of same material as detention door face sheets; interconnected with UL-approved, **1/2-inch- (12.7-mm-)** diameter conduit and connectors.

1. Access Plates: Where indicated for wiring installation, provide access plates to junction boxes; fabricated from same material and thickness as face sheet and fastened with at least four security

fasteners spaced not more than **6 inches (152 mm)** o.c.

G. Interior Detention Doors: Construct interior doors to comply with materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances indicated in ANSI/NAAMM-HMMA 863 and as specified.

1. Security Grade 1: Provide doors with face sheets of [**0.093-inch- (2.3-mm-) minimum-thickness, cold-rolled steel**][**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
2. Security Grade 2: Provide doors with face sheets of [**0.093-inch- (2.3-mm-) minimum-thickness, cold-rolled steel**][**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
3. Security Grade 3: Provide doors with face sheets of [**0.067-inch- (1.7-mm-) minimum-thickness, cold-rolled steel**][**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled, steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].
4. Security Grade 4: Provide doors with face sheets of [**0.067-inch- (1.7-mm-) minimum-thickness, cold-rolled steel**][**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].

H. Exterior Detention Doors: Construct exterior doors to comply with materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances indicated in ANSI/NAAMM-HMMA 863 and as specified.

1. Security Grade 1: Provide doors with face sheets of [**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
2. Security Grade 2: Provide doors with face sheets of [**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
3. Security Grade 3: Provide doors with face sheets of [**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].
4. Security Grade 4: Provide doors with face sheets of [**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].

2.5 DETENTION FRAMES

A. General: Provide fully welded detention frames with integral stops, of seamless construction without visible joints or seams. Fabricate detention frames with contact edges closed tight and corners mitered, reinforced, and continuously welded full depth and width of detention frame.

B. Stop Height: Provide minimum stop height of [**0.625 inch (15.8 mm)**][**0.750 inch (19 mm)**] for detention door openings and minimum stop height of **1-1/4 inches (32 mm)** in security glazing or detention panel openings unless otherwise indicated.

C. Interior Detention Frames: Construct interior frames to comply with materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances indicated in ANSI/NAAMM-HMMA 863 and as specified.

1. Security Grade 1: Provide frames fabricated from [**0.093-inch- (2.3-mm-) minimum-thickness, cold-rolled steel**][**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
2. Security Grade 2: Provide frames fabricated from [**0.093-inch- (2.3-mm-) minimum-thickness,**

cold-rolled steel][**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].

3. Security Grade 3: Provide frames fabricated from [**0.067-inch- (1.7-mm-) minimum-thickness, cold-rolled steel**][**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].
4. Security Grade 4: Provide frames fabricated from [**0.067-inch- (1.7-mm-) minimum-thickness, cold-rolled steel**][**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].

D. Exterior Detention Frames: Construct exterior frames to comply with materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances indicated in ANSI/NAAMM-HMMA 863 and as specified.

1. Security Grade 1: Provide frames fabricated from [**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
2. Security Grade 2: Provide frames fabricated from [**0.093-inch- (2.3-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.109-inch (2.8-mm) nominal-thickness stainless steel**].
3. Security Grade 3: Provide frames fabricated from [**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].
4. Security Grade 4: Provide frames fabricated from [**0.067-inch- (1.7-mm-) minimum-thickness, metallic-coated, cold-rolled steel**][**0.078-inch (2.0-mm) nominal-thickness stainless steel**].

E. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention frame to comply with the following minimum thicknesses:

1. Hinges and Pivots: **0.167 inch (4.2 mm)** thick by **1-1/2 inches (38 mm)** wide by **10 inches (254 mm)** long.
2. Strikes: **0.167 inch (4.2 mm)** thick.
3. Flush Bolts: **0.167 inch (4.2 mm)** thick.
4. Closers: **0.167 inch (4.2 mm)** thick.
5. Surface-Mounted Hardware: **0.093 inch (2.3 mm)** thick.
6. Lock Pockets: **0.123 inch (3.1 mm)** thick at non-inmate side; welded to face sheet. Provide **0.123-inch- (3.1-mm-)** thick, lock protection plate for attachment to lock pocket with security fasteners.

F. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware; interconnected with UL-approved, **1/2-inch- (12.7-mm-)** diameter conduit and connectors.

1. Access Plates: Where indicated for wiring installation, provide access plates to junction boxes; fabricated from same material and thickness as face sheet and fastened with at least four security fasteners spaced not more than **6 inches (152 mm)** o.c.

G. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between detention frame members with concealed clip angles or sleeves of same metal and thickness as detention frame.

H. Jamb Anchors: Weld jamb anchors to detention frames near hinges and directly opposite on strike jamb or as required to secure detention frames to adjacent construction.

1. Number of Anchors: Provide two anchors per jamb plus the following:

   a. Detention Door Frames: One additional anchor for each **18 inches (457 mm)**, or fraction thereof, above **54 inches (1372 mm)** in height.
   b. Detention Frames with Security Glazing or Detention Panels: One additional anchor for each **18 inches (457 mm)**, or fraction thereof, above **36 inches (914 mm)** in height.

2. Masonry Anchors: Adjustable, corrugated or perforated, strap-and-stirrup anchors to suit detention frame size; formed of same material and thickness as detention frame; with strap not less than **2 inches (51 mm)** wide by **10 inches (254 mm)** long.
3. Embedded Anchors: Provide detention frames with removable faces at jambs where embedded anchors are indicated. Anchors consist of the following three parts:

    a. Embedded Plates: Steel plates, **0.187 inch thick by 4 inches wide by 6 inches long (4.7 mm thick by 102 mm wide by 152 mm long)**. Continuously weld two steel bars, **1/2 inch (12.7 mm)** in diameter and **10 inches (254 mm)** long with **2-inch (51-mm)** 90-degree turndown on ends, to the embedded end of each plate. Weld steel angles, **0.188 inch thick by 2 by 2 by 4 inches long (4.7 mm thick by 51 by 51 by 102 mm long)**, to the exposed end of each plate. Embed at locations to match frame angles.
    b. Frame Angles: Steel angles, **0.187 inch thick by 2 by 2 by 4 inches long (4.7 mm thick by 51 by 51 by 102 mm long)**, welded to detention frames with two **1-inch- (25-mm-)** long welds at each end of angle.
    c. Connector Angles: Steel angles, of size required, to connect frame angles and embedded plates.

4. Postinstalled Anchors: Minimum **1/2-inch- (12.7-mm-)** diameter, concealed bolts with expansion shields or inserts. Provide conduit spacer from detention frame to wall; welded to detention frame. Reinforce detention frames at anchor locations.

I. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material and thickness as detention frame, and as follows:

1. Monolithic Concrete Slabs: Clip anchors, with two holes to receive fasteners; welded to bottom of jambs and mullions with at least four spot welds per anchor or **1/2-inch (12.7-mm)** fillet welds each side.
2. Separate Topping Concrete Slabs: Adjustable anchors with extension clips, allowing not less than **2-inch (51-mm)** height adjustment; welded to jambs and mullions with at least four spot welds per anchor or **1/2-inch (12.7-mm)** fillet welds each side. Terminate bottom of detention frames at finish floor surface.

J. Rubber Door Silencers: Except on weather-stripped detention doors, drill stops in strike jambs to receive three silencers on single-detention-door frames and drill head jamb stop to receive two silencers on double-detention-door frames. Keep holes clear during construction.

K. Grout Guards: Provide factory-installed grout guards of same material as detention frame; welded to detention frame at back of hardware cutouts, silencers, and glazing-stop screw preparations to close off interior of openings and to prevent mortar or other materials from obstructing hardware operation or installation.

2.6 DETENTION PANELS

A. Provide fixed detention panels of same materials, construction, and finish as specified for adjoining detention door.

2.7 MOLDINGS AND STOPS

A. Provide fixed moldings on inmate side of glazed openings and removable stops on non-inmate side.

1. Height: As required to provide minimum **1-inch (25-mm)** glass engagement, but not less than **1-1/4 inches (32 mm)**.

2. Fixed Moldings: Formed from same material as detention door and frame face sheets, but not less than **0.093 inch (2.3 mm)** thick, and spot welded to face sheets at not more than **3 inches (76 mm)** o.c.
3. Removable Stops, Non-Security Glazing: Formed from **0.067-inch- (1.7-mm-)** thick channel, of same material as detention door face sheets. Secure with countersunk security fasteners spaced uniformly not more than **9 inches (229 mm)** o.c. and not more than **2 inches (51 mm)** from each corner, and as necessary to satisfy performance requirements. Form corners with butt or mitered hairline joints.
4. Removable Stops, Security Glazing: Formed from **0.093-inch- (2.3-mm-)** thick angle, of same material as detention door face sheets. Secure with button-head security fasteners spaced uniformly not more than **6 inches (152 mm)** o.c. and not more than **2 inches (51 mm)** from each corner, and as necessary to satisfy performance requirements. Form corners with notched or mitered hairline joints.

B. Coordinate rabbet width between fixed and removable stops with glass or panel type and installation type indicated.

2.8 SECURITY FASTENERS

A. Security Fasteners:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
   b. [**Bryce Fastener Mfg., Inc.**]
   c. [**Safety Socket LLC**]
   d. [**Tamper-Pruf Screws**]
   e. [**Tamperproof Screw Co., Inc.**]

B. Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific fastener type. Provide drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:

1. Drive-System Type: [**Pinned Torx-Plus**][**Pinned Torx**].
2. Fastener Strength: **120,000 psi (827 MPa)**.
3. Socket Button-Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, ASTM F879, Group 1 CW.

4. Socket Flat Countersunk-Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, ASTM F879, Group 1 CW.

5. Socket Head Cap Fasteners:

   a. Heat-treated alloy steel, ASTM A574.
   b. Stainless steel, ASTM F837, Group 1 CW.

6. Protective Coatings for Heat-Treated Alloy Steel:

a. Zinc and clear trivalent chromium where indicated.
b. Zinc phosphate with oil, ASTM F1137/F1137M, Grade I, or black oxide unless otherwise indicated.

2.9 SEALANTS

A. Polyurethane Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]

2. Verify sealant has a VOC content of 250 g/L or less.

B. Epoxy Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with no movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]

2. Verify sealant has a VOC content of 250 g/L or less.

2.10 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

C. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

D. Pass-Through Openings: Fabricate flush openings using **0.093-inch- (2.3-mm-)** thick, interior channels of same material as detention door faces; inverted to be flush with openings; welded to inside of both face sheets and with corners fully welded. Mount shutters on non-inmate side of detention doors. Reinforce for locks and food-pass hinges.

1. Inset Shutters: Fabricate from two steel plates, **0.123 inch (3.1 mm)** thick, of same material as detention door face sheets; spot welded together and sized to inset inside opening and to prevent inmate tampering of lock and hinges.
2. Overlapping Shutters: For surface application on non-inmate side of door. Fabricate from a single steel plate, of same material as detention door face sheets, **0.187 inch (4.7 mm)** thick, and sized to overlap food-pass openings by **1/2 inch (12.7 mm)**.

E. Detention Door Louvers: Fabricate flush louver openings using **0.093-inch- (2.3-mm-)** thick, interior steel channels of same material as detention door faces; welded to inside of both detention door face sheets and with corners fully welded. Provide welded, inverted V- or Y-shaped vanes allowing specified airflow, fabricated from same material as detention door face sheets, **0.093 inch (2.3 mm)** thick, and spaced so no rigid flat instrument can pass through.

1. Reinforcement: Reinforce louvers that exceed **18 inches (457 mm)** in height at louver midpoint with **1/4-by-1-1/2-inch- (6.3-by-38-mm-)** square, vertical rectangular steel bar or **3/4-inch- (19-mm-)** diameter, vertical steel bar.
2. Exterior Detention Door Insect Screens: Fabricated from 12-by-12 mesh of **0.028-inch- (0.71-mm-)** diameter, stainless steel wire or from perforated metal of same material and thickness as detention door face sheet with **1/8-inch- (3-mm-)** diameter holes spaced **1 inch (25 mm)** o.c.; where indicated.

F. Speaking Apertures: Consist of a rectangular pattern of holes, minimum **1 inch high by 4 inches wide (25 mm high by 102 mm wide)**, with holes **1/4 inch (6.3 mm)** in diameter. Locate holes in both face sheets directly across from each other and spaced not more than **1 inch (25 mm)** o.c. vertically and horizontally. Provide **0.067-inch- (1.7-mm-)** thick, pressed-steel baffles in interior of detention door between hole patterns to prevent passage of objects. Mount shutters on non-inmate side of detention doors. Reinforce for locks and hinges.

1. Swinging Shutters: Rectangular pan-shaped shutter fabricated from steel sheet, of same material as detention door face sheets, not less than **0.093 inch (2.3 mm)** thick with flange depth not less than **1.0 inch (25.4 mm)**, continuously welded at corners, and sized to overlap speaking aperture by **1/2 inch (12.7 mm)**. Continuous hinge of same material thickness as shutter; fastened with security fasteners or plug welds spaced not less than **1.0 inch (25.4 mm)** from each end and not less than **4.0 inch (102 mm)** o.c. Both ends of hinge welded to prevent tampering. Keeper/pull assembly welded to shutter.
2. Sliding Shutters: Sliding flat shutter and track assembly fabricated from steel sheet, of same material as detention door face sheets, not less than **0.093 inch (2.3 mm)** thick; shutter sized to overlap speaking aperture by **1/2 inch (12.7 mm)**. Track lined as required for smooth operation. Top and bottom track welded at each end to prevent tampering. Keeper/pull assembly welded to shutter.

G. Gun Ports: Fabricate units to comply with UL 752 and to resist same security designation as detention doors in which they are installed.

2.11 MATERIALS

A. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS (Commercial Steel), Type B; with **G60 (Z180)** zinc (galvanized) or **A60 (ZF180)** zinc-iron-alloy (galvannealed) coating designation.

D. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated on Drawings**].

E. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

F. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

G. Masonry Anchors: Fabricated from same steel sheet as door face.

H. Embedded Anchors: Fabricated from mild steel shapes and plates, hot-dip galvanized in accordance with ASTM A153/A153M.

I. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

J. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

K. Glazing: Comply with Section 088853 "Security Glazing."

L. Grout: Comply with ASTM C476, with a slump of not more than **4 inches (102 mm)** as measured in accordance with ASTM C143/C143M.

M. Insulation: Slag-wool-fiber/rock-wool-fiber or glass-fiber blanket insulation. ASTM C665, Type I (unfaced); with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics. Minimum **1.5-lb/cu. ft. (24-kg/cu. m)** density.

N. Bituminous Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

O. Waterborne Asphaltic Emulsion Coating: Minimum **2.5-mil (0.06-mm)** dry film thickness.

2.12 FABRICATION OF DETENTION DOORS AND FRAMES

A. Fabricate detention doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate detention doors and frames to comply with manufacturing tolerances indicated in ANSI/NAAMM-HMMA 863.

C. Removable Jamb Faces: Provide removable jamb faces where required for access to embedded anchors. Fabricate to allow secure reattachment of removable face with security fasteners.

D. Fabricate multiple-opening detention frames with mullions that have closed tubular shapes and with no visible seams or joints.

E. Exterior Detention Doors: Provide weep-hole openings in bottoms of detention doors to permit entrapped moisture to escape. Seal joints in top edges of detention doors against water penetration.

F. Hardware Preparation: Factory prepare detention doors and frames to receive mortised hardware, including cutouts, reinforcement, mortising, drilling, and tapping, in accordance with final Door Hardware Schedule and templates provided by detention door hardware supplier.

1. Reinforce detention doors and frames to receive surface-mounted door hardware. Drilling and

tapping may be done at Project site.

2. Locate door hardware in accordance with ANSI/NAAMM-HMMA 863.

G. Factory cut openings in detention doors.

H. Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

2.13 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM-NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Finish detention doors and frames after assembly.

2.14 METALLIC-COATED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Priming for Field-Painted Finish: Apply shop primer specified in "Shop Primer" Subparagraph below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than **0.7 mil (0.02 mm)**.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended in writing by primer manufacturer for zinc-coated steel; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2.15 STEEL SHEET FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with [SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning"][SSPC-SP 8, "Pickling"].

B. Factory Priming for Field-Painted Finish: Apply shop primer specified in "Shop Primer" Subparagraph below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than **0.7 mil (0.02 mm)**.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with SDI A250.10 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2.16 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention frame connections before detention frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Inspect embedded plate installations before installing detention frames to verify that plate installations comply with requirements. Prepare inspection reports.

1. Remove and replace plates where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Before installation and with shipping spreaders removed, adjust detention frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb and perpendicular to frame head.
2. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of face.
3. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of door rabbet.
4. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a perpendicular line from head to floor.

3.3 INSTALLATION OF DETENTION DOORS AND FRAMES

A. General: Install detention doors and frames plumb, rigid, properly aligned, and securely fastened in place; complying with Drawings, schedules, and manufacturer's written instructions.

B. Anchorage: Set detention frame anchorage devices in accordance with details on Shop Drawings and in accordance with anchorage device manufacturer's written instructions.

1. Masonry Anchors: Coordinate frame installation to allow for solidly filling space between frames and masonry with grout.
2. Embedded Anchors: Install embedded plates in wall surrounding frame openings to match frame angle locations.
3. Postinstalled Anchors: Drill holes in existing construction at locations to match bolt locations, and install bolt expansion shields or inserts.

C. Where detention frames are fabricated in sections due to shipping limitations, assemble frames and install angle splices at each corner, of same material and thickness as detention frame, and extend at least **4 inches (102 mm)** on both sides of joint.

1. Field splice only at approved locations. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
2. Continuously weld and finish smooth joints between faces of abutted, multiple-opening, detention frame members.
3. Field Welding: Comply with the following requirements:

   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Apply bituminous[**waterborne asphaltic emulsion**] coating to backs of frames before filling with grout.

E. Placing Detention Frames: Install detention frames of sizes and profiles indicated. Set detention frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

1. Embedded Anchors: Remove jamb faces from detention frames and set detention frames into opening. Weld steel connector angle to frame angle and to embedded plate with **1-inch- (25-mm-)** long welds at each end of connector angle to form a rigid frame assembly that is solidly anchored. Reinstall jamb faces using security fasteners.
2. Postinstalled Anchors: Install bolt. After bolt is tightened, weld bolt head to provide nonremovable condition. Grind, dress, and finish smooth the welded bolt head.
3. At fire-rated openings, install detention frames in accordance with NFPA 80.
4. Install detention frames with removable stops located on non-inmate side of opening.

F. Grout: Fully grout detention frame jambs and heads. Completely fill space between frames and adjacent substrates. Hand trowel grout and take other precautions, including bracing detention frames, to ensure that frames are not deformed or damaged by grout forces.

G. Security Sealant: Apply [**polyurethane**][**epoxy**] security sealant at all exposed gaps between detention frames and adjacent substrates.

H. Swinging Detention Doors: Fit non-fire-rated detention doors accurately in their frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: **1/8 inch (3.2 mm)**.
2. Between Edges of Pairs of Doors: **1/8 inch (3.2 mm)**.
3. Floor Clearance: Allowing for functional operation of swinging doors, but not less than **1/8 inch (3.2 mm)**.

I. Sliding Detention Doors: Fit sliding detention doors in their frames in accordance with manufacturer's

written instructions and as required to allow doors to slide without binding.

J. Fire-Rated Detention Doors: Install with clearances as specified in NFPA 80.

K. Smoke-Control Detention Doors: Install in accordance with NFPA 105.

L. Installation Tolerances: Comply with installation tolerances indicated in ANSI/NAAMM-HMMA 863.

M. Glazing: Comply with installation requirements in Section 088853 "Security Glazing" unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

1. Perform additional inspections to determine compliance of replaced or additional work.
2. Detention work will be considered defective if it does not pass tests and inspections.

B. Prepare field quality control certification[**endorsed by Detention Specialist**] that states installed products comply with requirements in the Contract Documents.

C. For verification that construction complies with requirements, select one detention door at random from detention doors delivered to Project and have it cut in half or otherwise taken apart.

1. Test Method: Verify weld strength by prying or chiseling door apart at edge seams, end channels, or stiffeners. Not more than 5 percent of welds may fail test.

a. If tested door fails, replace or rework all detention doors to bring them into compliance at Contractor's expense.
b. If tested door passes, replace tested door at Contractor's expense.

D. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including detention doors and frames that are warped, bowed, or otherwise unacceptable.

B. Clean grout and other bonding material off detention doors and frames immediately after installation.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

D. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

1. After finishing smooth field welds, apply air-drying primer.

E. Stainless Steel Surfaces: Clean surfaces in accordance with manufacturer's written instructions.

END OF SECTION 11 98 12 00

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Task	Specification	Specification Description
11 98 12 00	08 71 11 00	Detention Door Hardware
11 98 12 00	12 55 00 00	Detention Furniture

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Task	Specification	Specification Description
12 01 60 00	01 22 00 00	No Specification Required
12 01 60 00	12 61 00 00	Fixed Audience Seating

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SECTION 12 21 13 00 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal louver blinds, aluminum slats.
2. Horizontal louver blinds, wood slats.
3. Horizontal louver blinds, polymer slats.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics,[**electrical characteristics,**] and furnished accessories.

B. Shop Drawings: For horizontal louver blinds.

1. Fabrication and installation details.
2. Diagrams for power, signal, and control wiring for motorized units.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type and color of horizontal louver blind.

1. Include Samples of accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type and color of horizontal louver blind.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer

recycled content and cost.
2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): For each product.
4. Health Product Declaration (HPD): Provide HPD.
5. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.
6. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For horizontal louver blinds with polymer slats that have been tested for compliance with NFPA 701, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For horizontal louver blinds.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Horizontal Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than [**two**] units. Include brackets.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation, using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work, as directed by the Owner.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of motorized products that fail

in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Faulty operation of motorized operating system components.

2. Warranty Period: [**5**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain horizontal louver blinds from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Window Covering Safety Standard: Provide horizontal louver blinds that comply with WCMA A100.1[**and are listed and labeled as "Best for Kids" by a qualified testing agency**].

2.3 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

A. Horizontal Louver Blinds, Aluminum Slats:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CACO, Inc.**]
   b. [**Hunter Douglas Architectural**]
   c. [**Springs Window Fashions; SWFcontract**]

B. Slats: Aluminum; alloy and temper recommended in writing by producer for type of use and finish indicated; with crowned profile and radius corners.

1. Width: [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**1-3/8 inches (35 mm)**][**2 inches (51 mm)**].
2. Thickness: [**Manufacturer's standard**][**Not less than 0.006 inch (0.15 mm)**][**Not less than 0.008 inch (0.20 mm)**].
3. Spacing: [**Manufacturer's standard**].
4. Finish: [**Ionized antistatic, dust-repellent, baked polyester finish**][**Reflective finish on outside-facing surface of slat to enhance reflection of solar energy**].
5. Features:

   a. Privacy Slats: Manufacturer's standard privacy slats with no inner lift-cord route holes or with minimum size inner lift-cord route holes located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.
   b. Perforated Slats: Openness factor of [**7 to 8**] percent.
   c. Inverted slats.

C. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.

1. Type: [**Braided cord**][**Reinforced vinyl tape, manufacturer's standard width**][**Cloth tape, manufacturer's standard width**].

D. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose control mechanisms on three sides.

1. Capacity: [**One**][**Two**] blind(s) per headrail unless otherwise indicated.
2. Ends: [**Manufacturer's standard**][**Capped or plugged**].

E. Manual Corded Operation:

1. Lift Mechanism:

   a. Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within blind full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

2. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.
3. Lift Cord: Manufacturer's standard braided cord.
4. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
5. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
6. Tilt Position:

   a. Full.
   b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

7. Tilt Operator: [**Clear-plastic wand**][**Corrosion-resistant steel rod**][**Inaccessible dual cord**].
8. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-rotation of gear.
9. Tilt-Operator Length, Wand or Rod: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
10. Tilt-Operator Length, Cord: Inaccessible dual cord, not greater than **12 inches (305 mm)** in length in all phases of operation.
11. Lift-Cord and Tilt-Operator Locations: [**Manufacturer's standard**][**Right side and left side of headrail, respectively,**][**Left side and right side of headrail, respectively,**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

F. Manual Cordless Operation:

1. Lift Mechanism: Manufacturer's standard lift- or tension-control mechanism that allows blinds to be raised or lowered into position by manually pushing the bottom rail up or pulling it down.
2. Lift Operator: [**Plastic lip on bottom rail for manually raising/lowering blinds**][**Standard bottom rail, no lip**][**Manufacturer's standard**].
3. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
4. Tilt Position:

   a. Full.
   b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

5. Tilt Operator: [**Clear-plastic wand**][**Corrosion-resistant steel rod**].
6. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-

rotation of gear.

7. Tilt-Operator Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
8. Tilt-Operator Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

G. Motorized Operation: Provide factory-assembled motorized blinds with blind-operator systems of size and capacity, and with features, characteristics, and accessories required for conditions indicated. Coordinate electrical requirements with building electrical system.

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FDDR; including UL 325.
3. Function: [**Lift and tilt**][**Tilt**].
4. Power: [**Single phase, 120 V, 60 Hz ac**][**Battery, 12 V dc**][**Manufacturer's standard**].
5. Motor Type: Radio frequency.
6. Operation, Radio Frequency: [**Two**] manufacturer's standard [**multichannel**][**single-channel**] remote-control handheld transmitter for operation of up to [**12**] individual blinds or up to [**6**] groups of blinds and with operating features as follows:

    a. Tilt slats open and lift blinds; tilt slats closed and lower blinds.
    b. Tilt slats open; tilt slats closed both directions.
    c. Tilt slats up at 45 degrees from horizontal; tilt slats down at 45 degrees from horizontal.
    d. Tilt slats to stop at any angle.
    e. Tilt slats to programmable preset tilt position.
    f. Phone- or tablet-control app integration with automated timed programming capability.
    g. Override switch.
    h. Color: [**Manufacturer's standard**][**White**][**Black**].

7. Travel Limit/Stop: Adjustable control, interlocked with motor controls and set to stop blind automatically at slats fully closed tilted down and slats fully closed tilted up.
8. Provide power disconnect switch.
9. Lift Mechanism:

    a. Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within blind full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

10. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.
11. Lift Cord: Manufacturer's standard braided cord.
12. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
13. Lift-Cord Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

H. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and inner lift cords and has plastic- or metal-capped ends.

1. Type: [**Manufacturer's standard**][**Top contoured to match crowned shape of slat**][**Bottom contoured to minimize light gaps**].

I. Integrated Headrail/Valance: [**Curved face**].

J. Valance: [**Two slats**][**PVC strip**][**Manufacturer's standard**].

K. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**End**][**Wall extension**][**Two piece for pocket installation**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by horizontal louver blind manufacturer for weight and size of blind.

L. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

M. Side Channels and Perimeter Light Gap Seals: Manufacturer's standard.

N. Colors, Textures, Patterns, and Gloss:

1. Slats: [**Match Architect's samples**][**Match Architect's samples for custom color and other characteristics**][**As selected by Architect from manufacturer's full range**][**As indicated**], as directed by the Owner.
2. Components: [**Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated**].

2.4 HORIZONTAL LOUVER BLINDS, WOOD SLATS

A. Horizontal Louver Blinds, Wood Slats:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CACO, Inc.**]
b. [**Comfortex Window Fashions; Comfortex Corporation**]
c. [**Hunter Douglas Architectural**]
d. [**Springs Window Fashions; SWFcontract**]

B. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

C. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

D. Slats: Hardwood, [**manufacturer's standard species**][**North American**][**basswood**][**poplar**][**ramin**].

1. Width: [**1 inch (25 mm)**][**2 inches (51 mm)**][**2-3/8 inches (60 mm)**][**2-1/2 inches (64 mm)**].
2. Thickness: [**Manufacturer's standard**][**0.125 inch (3.2 mm)**].
3. Spacing: [**Manufacturer's standard**].
4. Profile: [**Flat**][**Flat with beaded edges**][**Flat with double beaded edges**].
5. Corners: [**Square**][**Radius**].
6. Features:

a. Privacy Slats: Manufacturer's standard privacy slats with no inner lift-cord route holes or with minimum size inner lift-cord route holes located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.

E. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.

1. Type: [**Braided cord**][**Cloth tape, manufacturer's standard width**].

F. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose control mechanisms on three sides and ends.

1. Capacity: [**One**][**Two**] blind(s) per headrail unless otherwise indicated.

G. Manual Corded Operation:

1. Lift Mechanism:

a. Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

2. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.
3. Lift Cord: Manufacturer's standard braided cord.
4. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
5. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
6. Tilt Position:

a. Full.
b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

7. Tilt Operator: [**Clear-plastic wand**][**Wood wand matching slats**][**Corrosion-resistant steel rod**][**Inaccessible dual cord**].
8. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-rotation of gear.
9. Tilt-Operator Length, Wand or Rod: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
10. Tilt-Operator Length, Cord: Inaccessible dual cord, not greater than **12 inches (305 mm)** in length in all phases of operation.
11. Lift-Cord and Tilt-Operator Locations: [**Manufacturer's standard**][**Right side and left side of headrail, respectively,**][**Left side and right side of headrail, respectively,**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.
12. Tassels: Hardwood finished to match slats, [**manufacturer's standard**].

H. Manual Cordless Operation:

1. Lift Mechanism: Manufacturer's standard lift- or tension-control mechanism that allows blinds to be raised or lowered into position by manually pushing the bottom rail up or pulling it down.
2. Lift Operator: Lift and lock button on bottom rail for manually raising/lowering blinds when pressed and held, and locking blinds into position when released.
3. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
4. Tilt Position:

a. Full.
b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

5. Tilt Operator: [**Clear-plastic wand**][**Wood wand matching slats**][**Corrosion-resistant steel rod**].
6. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-rotation of gear.

7. Tilt-Operator Length: [12 inches (305 mm)][24 inches (610 mm)][30 inches (762 mm)][36 inches (914 mm)][48 inches (1219 mm)].
8. Tilt-Operator Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

I. Motorized Operation: Provide factory-assembled motorized blinds with blind-operator systems of size and capacity, and with features, characteristics, and accessories required for conditions indicated. Coordinate electrical requirements with building electrical system.

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FDDR; including UL 325.
3. Function: Tilt.
4. Power: [**Battery, 12 V dc**][**Manufacturer's standard**].
5. Motor Type: Radio frequency.
6. Operation, Radio Frequency: [**Two**] manufacturer's standard [**multichannel**][**single-channel**] remote-control handheld transmitter for operation of up to [**12**] individual blinds or up to [**6**] groups of blinds and with operating features as follows:

    a. Tilt slats open; tilt slats closed, both directions.
    b. Tilt slats up at 45 degrees from horizontal; tilt slats down at 45 degrees from horizontal.
    c. Tilt slats to stop at any angle.
    d. Tilt slats to programmable preset tilt position.
    e. Phone- or tablet-control app integration with automated timed programming capability.
    f. Override switch.
    g. Color: [**Manufacturer's standard**][**White**][**Black**].

7. Travel Limit/Stop: Adjustable control, interlocked with motor controls and set to stop blind automatically at slats fully closed tilted down and slats fully closed tilted up.
8. Provide power disconnect switch.
9. Manual Corded Lift:

    a. Lift Mechanism:

        1) Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within blind full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

    b. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.
    c. Lift Cord: Manufacturer's standard braided cord.
    d. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
    e. Lift-Cord Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.
    f. Tassels: Hardwood finished to match slats, [**manufacturer's standard**].

10. Manual Cordless Lift:

    a. Lift Mechanism: Manufacturer's standard lift- or tension-control mechanism that allows blinds to be raised or lowered into position by manually pushing the bottom rail up or pulling it down.

b. Lift Operator: Lift and lock button on bottom rail for manually raising/lowering blinds when pressed and held, and locking blinds into position when released.

J. Bottom Rail: Secures and protects ends of ladders and inner lift cords.

1. Type: [**Manufacturer's standard**][**Hardwood, finished to match slats, with trapezoid-shaped bottom angled to minimize light gaps**][**Manufacturer's standard enclosing lift-and-lock control mechanisms on three sides**].

K. Valance: [**Manufacturer's standard**].

L. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**End**][**Wall extension**][**Two piece for pocket installation**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by horizontal louver blind manufacturer for weight and size of blind.

M. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

N. Colors, Finishes, and Gloss:

1. Slats: [**Match Architect's samples**][**Match Architect's samples for custom color and other characteristics**][**As selected by Architect from manufacturer's full range**][**As indicated**], as directed by the Owner.
2. Components: [**Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated**].

2.5 HORIZONTAL LOUVER BLINDS, POLYMER SLATS

A. Horizontal Louver Blinds, Polymer Slats:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CACO, Inc.**]
b. [**Comfortex Window Fashions; Comfortex Corporation**]
c. [**Hunter Douglas Architectural**]
d. [**Springs Window Fashions; SWFcontract**]
e. [**TimberBlindsMetroShade; Timberblinds, LLC**]

B. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

C. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

D. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Slats: Polymers that are lead free, UV stabilized, integrally colored, opaque, and will not crack or yellow; antistatic, dust-repellent treated.

1. Formulation: [**Permanently flexible, extruded PVC**][**Foam PVC**][**Polymer/wood composite**][**Manufacturer's standard**].
2. Width: [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**].
3. Thickness: [**0.125 inch (3.2 mm)**].
4. Spacing: [**Manufacturer's standard**].
5. Profile: [**Crowned**][**Manufacturer's standard**].
6. Features:

    a. Privacy Slats: Manufacturer's standard privacy slats with no inner lift-cord route holes or with minimum size inner lift-cord route holes located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.

F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.

1. Type: [**Braided cord**][**Cloth tape, manufacturer's standard width**].

G. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose control mechanisms on three sides and ends.

1. Capacity: [**One**][**Two**] blind(s) per headrail unless otherwise indicated.

H. Manual Corded Operation:

1. Lift Mechanism:

    a. Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

2. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.
3. Lift Cord: Manufacturer's standard braided cord.
4. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
5. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
6. Tilt Position:

    a. Full.
    b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

7. Tilt Operator: [**Clear-plastic wand**][**Corrosion-resistant steel rod**][**Inaccessible dual cord**].
8. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-rotation of gear.
9. Tilt-Operator Length, Wand or Rod: [**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
10. Tilt-Operator Length, Cord: Inaccessible dual cord, not greater than **12 inches (305 mm)** in length in all phases of operation.
11. Lift-Cord and Tilt-Operator Locations: [**Manufacturer's standard**][**Right side and left side of headrail, respectively,**][**Left side and right side of headrail, respectively,**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

I. Manual Cordless Operation:

1. Lift Mechanism: Manufacturer's standard lift- or tension-control mechanism that allows blinds to be raised or lowered into position by manually pushing the bottom rail up or pulling it down.

2. Lift Operator: [**Manufacturer's standard**][**Plastic lip on bottom rail for manually raising/lowering blinds**][**Bottom rail, no lip**][**Lift-and-lock button on bottom rail for manually raising/lowering blinds when pressed and held, and locking blinds into position when released**].
3. Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
4. Tilt Position:

    a. Full.
    b. [One][Two]-direction, positive stop or lockout limited at an angle of [20][60][80] degrees from horizontal[both directions].

5. Tilt Operator: [**Clear-plastic wand**][**Corrosion-resistant steel rod**].
6. Tilt Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over-rotation of gear.
7. Tilt-Operator Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
8. Tilt-Operator Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

J. Motorized Operation: Provide factory-assembled motorized blinds with blind-operator systems of size and capacity, and with features, characteristics, and accessories required for conditions indicated. Coordinate electrical requirements with building electrical system.

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FDDR; including UL 325.
3. Function: Tilt.
4. Power: [**Battery, 12 V dc**][**Manufacturer's standard**].
5. Motor Type: Radio frequency.
6. Operation, Radio Frequency: [**Two**] Manufacturer's standard [**multichannel**][**single-channel**] remote-control handheld transmitter for operation of up to [**12**] individual blinds or up to [**6**] groups of blinds and with operating features as follows:

    a. Tilt slats open; tilt slats closed both directions.
    b. Tilt slats up at 45 degrees from horizontal; tilt slats down at 45 degrees from horizontal.
    c. Tilt slats to stop at any angle.
    d. Tilt slats to programmable preset tilt position.
    e. Phone- or tablet-control app integration with automated timed programming capability.
    f. Override switch.
    g. Color: [**Manufacturer's standard**][**White**][**Black**].

7. Travel Limit/Stop: Adjustable control, interlocked with motor controls and set to stop blind automatically at slats fully closed tilted down and slats fully closed tilted up.
8. Provide power disconnect switch.
9. Manual Corded Lift:

    a. Lift Mechanism:

        1) Lift-Cord Lock: [**Variable; stops lift cord at user-selected position within blind full operating range**][**Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long**].

    b. Lift Operator: Extension of inner lift cord(s) through lift-cord lock mechanism to form lift cord.

c. Lift Cord: Manufacturer's standard braided cord.
d. Lift-Cord Length: [**Short cord, not greater than 8 inches (203 mm) when blind is fully closed**][**Inaccessible cord, not greater than 12 inches (305 mm) when blind is fully closed**].
e. Lift-Cord Location: [**Manufacturer's standard**][**Right side of headrail**][**Left side of headrail**] unless otherwise indicated.

10. Manual Cordless Lift:

a. Lift Mechanism: Manufacturer's standard lift- or tension-control mechanism that allows blinds to be raised or lowered into position by manually pushing the bottom rail up or pulling it down.
b. Lift Operator: Lift and lock button on bottom rail for manually raising/lowering blinds when pressed and held, and locking blinds into position when released.

K. Bottom Rail: Secures and protects ends of ladders and inner lift cords.

1. Type: [**Manufacturer's standard**][**Formed-steel or extruded-aluminum tube, with plastic or metal capped ends**][**Hardwood matching slats and trapezoid-shaped bottom angled for minimizing light gaps**][**Manufacturer's standard enclosing lift-and-lock control mechanisms on three sides**].

L. Valance: [**Manufacturer's standard**].

M. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**End**][**Wall extension**][**Two piece for pocket installation**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by horizontal louver blind manufacturer for weight and size of blind.

N. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

O. Colors, Textures, Patterns, and Gloss:

1. Slats: [**Match Architect's samples**][**Match Architect's samples for custom color and other characteristics**][**As selected by Architect from manufacturer's full range**][**As indicated**], as directed by the Owner.
2. Components: [**Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated**].

2.6 FABRICATION OF HORIZONTAL LOUVER BLINDS

A. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at **74 deg F (23 deg C)**:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less **1/4 inch (6 mm)** per side or **1/2 inch (13 mm)** total, plus or minus **1/8 inch (3.1 mm)**. Length equal to head-to-sill dimension of opening in which blind is installed less **1/4 inch (6 mm)**, plus or minus **1/8 inch (3.1 mm)**.
2. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.

C. Mounting Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind mounting method indicated.

D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

E. Color-Coated Finish:

1. Metal: For components exposed to view, unless anodized or plated finish is indicated, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
2. Wood: Apply [**manufacturer's standard**] factory-applied finish complying with manufacturer's written instructions for surface preparation, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances,[**locations of connections to building electrical system**] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HORIZONTAL LOUVER BLINDS

A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units in accordance with manufacturer's written instructions.

1. Locate so exterior slat edges are not closer than [**1 inch (25 mm)**][**2 inches (51 mm)**] from interior faces of glass and not closer than [**1/2 inch (13 mm)**][**1-1/2 inches (38 mm)**] from interior faces of glazing frames [**at top and bottom**][**at one side and bottom**] through full operating ranges of blinds.
2. Install mounting brackets to prevent deflection of headrails.
3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

B. Electrical Connections: Connect motorized operators to building electrical system.

3.3 ADJUSTING

A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Clean horizontal louver blind surfaces after installation in accordance with manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.

C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion, as directed by the Owner.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 12 21 13 00

Task	Specification	Specification Description
12 21 13 13	12 21 13 00	Horizontal Louver Blinds
12 21 13 13	12 21 16 00	Vertical Louver Blinds
12 21 13 33	12 21 13 00	Horizontal Louver Blinds
12 21 13 33	12 21 16 00	Vertical Louver Blinds

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SECTION 12 21 16 00 - VERTICAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertical louver blinds, aluminum vanes.
2. Vertical louver blinds, PVC vanes.
3. Vertical louver blinds, PVC vanes with fabric inserts.
4. Vertical louver blinds, fabric vanes.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting vertical louver blinds and accessories.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, and furnished accessories.

B. Shop Drawings: For vertical louver blinds.

1. Fabrication and installation details.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type and color of vertical louver blind.

1. Include Samples of accessories involving color selection.

D. Samples for Verification: Actual sample of finished product for each type and color of vertical louver blind.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For vertical louver blinds. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
3. Health Product Declaration (HPD): For each product.
4. Health Product Declaration (HPD): Provide HPD.
5. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.
6. Cradle to Cradle: For each product, provide documentation of Cradle to Cradle certification.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For vertical louver blinds with [**PVC**][**fabric**] vanes that have been tested for compliance with NFPA 701 for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For vertical louver blinds.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Vertical Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and finish indicated, but no fewer than [**two**] units. Include brackets.
2. Vanes: Furnish quantity of full-size units equal to 5 percent of quantity installed for each type, size, texture, pattern, and finish indicated, but no fewer than [**two**] units.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver vertical louver blinds in factory packages, marked with manufacturer and product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install vertical louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where vertical louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work, as directed by the Owner.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain vertical louver blinds from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Window Covering Safety Standard: Provide vertical louver blinds that comply with WCMA A100.1[**and are listed and labeled as "Best for Kids" by a qualified testing agency**].

2.3 VERTICAL LOUVER BLINDS, ALUMINUM VANES

A. Vertical Louver Blinds, Aluminum Vanes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hunter Douglas Architectural**]

B. Vanes: Aluminum, alloy, and temper recommended by producer for type of use and finish indicated; with crowned profile and not less than **3/8-inch (9.5-mm)** overlap when rotated fully closed.

1. Width: **3-1/2 inches (89 mm)**.
2. Features:

a. Perforated Vanes: Manufacturer's standard openness factor.

C. Headrail: Channel, extruded aluminum with long edges returned or rolled and ends capped. Headrail encloses control mechanisms including carrier-spacing mechanism that provides uniform vane spacing when blinds are traversed fully across headrail (closed).

D. Carriers: Engineered plastic with gears to align and synchronize vane rotation and stems that allow vane removal and replacement. Lead carriers have self-lubricating wheels or elongated bearing surfaces; remaining carriers have self-lubricating wheels.

E. Manual Corded Operation:

1. Traverse Operator: [**Nickel-plated, metal bead chain loop**][**Manufacturer's standard braided cord loop**] with WCMA A100.1-compliant tension device.

a. Tension Device Mounting: [**Wall**][**Floor**][**Sill**][**Baseboard**][**As indicated on Drawings**].

2. Rotation Operator: [**Wand**][**Inaccessible dual nickel-plated, metal bead chain**][**Automatic rotation mechanically activated by traverse control**].

a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].
c. Metal Bead Chain Length: Inaccessible dual bead chain, not greater than **12 inches**

(305 mm) in length in all phases of operation.

3. Control Locations: [**Right**][**Left**][**As indicated on Drawings**].
4. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

F. Manual Cordless Operation:

1. Traverse and Rotation Operator: Single wand operates both traverse and rotation.

   a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
   b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].

2. Control Location: [**Right**][**Left**][**As indicated on Drawings**].
3. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

G. Valance: [**Manufacturer's standard with vane insert**].

H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**For headrail recessed in pocket**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by vertical louver blind manufacturer for weight and size of blind.

I. Colors, Textures, and Patterns:

1. Vanes: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**], as directed by the Owner.
2. Components: [**Provide materials exposed to view matching or coordinating with vanes unless otherwise indicated**].

2.4 VERTICAL LOUVER BLINDS, PVC VANES

A. Vertical Louver Blinds, PVC Vanes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hunter Douglas Architectural**]
   b. [**Springs Window Fashions; SWFcontract**]

B. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

C. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

D. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Vanes: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC that will not crack or yellow; with not less than **3/8-inch (9.5-mm)** overlap when vanes are rotated fully closed.

1. Width: [**2 inches (51 mm)**][**3-1/2 inches (89 mm)**].
2. Profile: [**Flat**][**Crowned**][**S-shaped**].
3. Features:

   a. Perforated Vanes: Openness factor of [**3 to 4**][**6 to 7**][**12 to 13**] percent.
   b. Bottom chain.

F. Headrail: Channel, formed steel or extruded aluminum with long edges returned or rolled and ends capped. Headrail encloses control mechanisms including carrier-spacing mechanism that provides uniform vane spacing when blinds are traversed fully across headrail (closed).

G. Carriers: Engineered plastic with gears to align and synchronize vane rotation and stems that allow vane removal and replacement. Lead carriers have self-lubricating wheels or elongated bearing surfaces; remaining carriers have self-lubricating wheels.

H. Manual Corded Operation:

1. Traverse Operator: [**Nickel-plated, metal bead chain loop**][**Manufacturer's standard braided cord loop**] with WCMA A100.1-compliant tension device.

   a. Tension Device Mounting: [**Wall**][**Floor**][**Sill**][**Baseboard**][**As indicated on Drawings**].

2. Rotation Operator: [**Wand**][**Inaccessible dual nickel-plated, metal bead chain**][**Automatic rotation mechanically activated by traverse control**].

   a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
   b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].
   c. Metal Bead Chain Length: Inaccessible dual bead chain, not greater than **12 inches (305 mm)** in length in all phases of operation.

3. Control Locations: [**Right**][**Left**][**As indicated on Drawings**].
4. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

I. Manual Cordless Operation:

1. Traverse and Rotation Operator: Single wand operates both traverse and rotation.

   a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
   b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].

2. Control Location: [**Right**][**Left**][**As indicated on Drawings**].
3. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

J. Valance: [**Manufacturer's standard with vane insert**].

K. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**For headrail recessed in pocket**][**As indicated**].

2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by vertical louver blind manufacturer for weight and size of blind.

L. Colors, Textures, and Patterns:

1. Vanes: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**], as directed by the Owner.
2. Components: [**Provide materials exposed to view matching or coordinating with vanes unless otherwise indicated**].

2.5 VERTICAL LOUVER BLINDS, PVC VANES WITH FABRIC INSERTS

A. Vertical Louver Blinds, PVC Vanes with Fabric Inserts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hunter Douglas Architectural**]

B. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

C. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

D. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Vanes: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC that will not crack or yellow; with clear grooves for holding fabric insert and with not less than **3/8-inch (9.5-mm)** overlap when vanes are rotated fully closed.

1. Width: **3-1/2 inches (89 mm)**.
2. Fabric Insert: [**Manufacturer's standard**]; stain and fade resistant.

F. Headrail: Channel, formed steel or extruded aluminum with long edges returned or rolled and ends capped. Headrail encloses control mechanisms including carrier-spacing mechanism that provides uniform vane spacing when blinds are traversed fully across headrail (closed).

G. Carriers: Engineered plastic with gears to align and synchronize vane rotation and stems that allow vane removal and replacement. Lead carriers have self-lubricating wheels or elongated bearing surfaces; remaining carriers have self-lubricating wheels.

H. Manual Corded Operation:

1. Traverse Operator: [**Nickel-plated, metal bead chain loop**][**Manufacturer's standard braided cord loop**] with WCMA A100.1-compliant tension device.

a. Tension Device Mounting: [**Wall**][**Floor**][**Sill**][**Baseboard**][**As indicated on Drawings**].

2. Rotation Operator: [**Wand**][**Inaccessible dual nickel-plated, metal bead chain**][**Automatic rotation mechanically activated by traverse control**].

a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].
c. Metal Bead Chain Length: Inaccessible dual bead chain, not greater than **12 inches (305 mm)** in length in all phases of operation.

3. Control Locations: [**Right**][**Left**][**As indicated on Drawings**].
4. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

I. Manual Cordless Operation:

1. Traverse and Rotation Operator: Single wand operates both traverse and rotation.

a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].

2. Control Location: [**Right**][**Left**][**As indicated on Drawings**].
3. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

J. Valance: [**Manufacturer's standard with vane insert**].

K. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**For headrail recessed in pocket**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by vertical louver blind manufacturer for weight and size of blind.

L. Colors, Textures, and Patterns:

1. Vanes:

a. PVC: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**], as directed by the Owner.
b. Fabric Inserts: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**], as directed by the Owner.

2. Components: [**Provide materials exposed to view matching or coordinating with PVC vanes unless otherwise indicated**].

2.6 VERTICAL LOUVER BLINDS, FABRIC VANES

A. Vertical Louver Blinds, Fabric Vanes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hunter Douglas Architectural**]
b. [**Springs Window Fashions; SWFcontract**]

B. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

C. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

D. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Vanes: [**Manufacturer's standard**] free-hanging fabric with hemmed, nonraveling edges; stain and fade resistant; with not less than **3/8-inch (9.5-mm)** overlap when vanes are rotated fully closed.

1. Width: **3-1/2 inches (89 mm)**.
2. Features:

a. Weight, sewn in at bottom of vanes.
b. Bottom chain.

F. Headrail: Channel, formed steel or extruded aluminum with long edges returned or rolled and ends capped. Headrail encloses control mechanisms including carrier-spacing mechanism that provides uniform vane spacing when blinds are traversed fully across headrail (closed).

G. Carriers: Engineered plastic with gears to align and synchronize vane rotation and stems that allow vane removal and replacement. Lead carriers have self-lubricating wheels or elongated bearing surfaces; remaining carriers have self-lubricating wheels.

H. Manual Corded Operation:

1. Manual Traverse Control: [**Nickel-plated, metal bead chain loop**][**Manufacturer's standard braided cord loop**] with WCMA A100.1-compliant tension device.

a. Tension Device Mounting: [**Wall**][**Floor**][**Sill**][**Baseboard**][**As indicated on Drawings**].

2. Rotation Operator: [**Wand**][**Inaccessible dual nickel-plated, metal bead chain**][**Automatic rotation mechanically activated by traverse control**].

a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].
c. Metal Bead Chain Length: Inaccessible dual bead chain, not greater than **12 inches (305 mm)** in length in all phases of operation.

3. Control Locations: [**Right**][**Left**][**As indicated on Drawings**].
4. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

I. Manual Cordless Operation:

1. Traverse and Rotation Operator: Single wand operates both traverse and rotation.

a. Wand Length: [**12 inches (305 mm)**][**24 inches (610 mm)**][**30 inches (762 mm)**][**36 inches (914 mm)**][**48 inches (1219 mm)**].
b. Wand Finish: [**White**][**Off white**][**Satin nickel**][**Bronze**].

2. Control Location: [**Right**][**Left**][**As indicated on Drawings**].

3. Draw and Stack: [**One way, stack left**][**One way, stack right**][**Two way, center split**][**Two way, center stack**][**As indicated on Drawings**].

J. Valance: [**Manufacturer's standard with vane insert**].

K. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: [**Wall**][**Overhead**][**For headrail recessed in pocket**][**As indicated**].
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by vertical louver blind manufacturer for weight and size of blind.

L. Colors, Textures, and Patterns:

1. Vanes: [**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**], as directed by the Owner.
2. Components: [**Provide materials exposed to view matching or coordinating with vanes unless otherwise indicated**].

2.7 FABRICATION OF VERTICAL LOUVER BLINDS

A. Unit Sizes: Fabricate units in sizes to cover window and other openings as follows, measured at **74 deg F (23 deg C)**:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less **1/4 inch (6 mm)** per side or **1/2 inch (13 mm)** total, plus or minus **1/8 inch (3.1 mm)**. Length equal to head-to-sill or -floor dimension of opening in which blind is installed less **1/4 inch (6 mm)**, plus or minus **1/8 inch (3.1 mm)**.
2. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Rotation-and-Traverse Mechanisms: With permanently lubricated moving parts.

C. Mounting Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind mounting method indicated.

D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

E. Color-Coated Finish: For metal components exposed to view unless anodized or plated finish is indicated. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for

installation tolerances, operational clearances,[**locations of connections to building electrical system,**] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF VERTICAL LOUVER BLINDS

A. Install vertical louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units in accordance with manufacturer's written instructions.

1. Locate so exterior vane edges are not closer than [**2 inches (51 mm)**] from interior faces of glass and not closer than [**1-1/2 inches (38 mm)**] from interior faces of glazing frames [**at top and bottom**][**at one side and bottom**] through full operating ranges of blinds.
2. Install mounting brackets to prevent deflection of headrails.
3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

A. Adjust vertical louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Clean vertical louver blind surfaces after installation in accordance with manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that vertical louver blinds are without damage or deterioration at time of Substantial Completion.

C. Replace damaged vertical louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion, as directed by the Owner.

END OF SECTION 12 21 16 00

Task	Specification	Specification Description
12 21 16 13	12 21 13 00	Horizontal Louver Blinds
12 21 16 13	12 21 16 00	Vertical Louver Blinds
12 21 16 33	12 21 13 00	Horizontal Louver Blinds
12 21 16 33	12 21 16 00	Vertical Louver Blinds

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SECTION 12 22 00 00 - CURTAINS AND DRAPES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Drapery tracks.
2. Drapes.
3. Drapery fabric.

B. Related Requirements:

1. Section 057500 "Decorative Formed Metal" for drapery pockets.
2. Section 061000 "Rough Carpentry" for wood blocking to support drapery tracks.
3. Section 260010 "Supplemental Requirements for Electrical" for additional requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include fiber content [**and textile treatments**] for fabrics.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
3. Include rated capacities, operating characteristics, [**electrical characteristics,**] features, and furnished accessories

B. Shop Drawings:

1. Drapery Tracks: Indicate installation and anchorage details and locations of controls.

a. Motorized Tracks: Indicate dimensions, weights, and required clearances for track and motor and differentiate between manufacturer-installed and field-installed wiring.

2. Drapes: Show sizes, locations, and details of installation.

C. Samples for Initial Selection: Manufacturer's standard color samples, showing full range of available colors for each type of drape and drapery track.

D. Samples for Verification: Actual sample of finished products for each type of drape and drapery track. Include drapery fabric from dye lot to be used for the Work with specified texture treatments applied. Include textile trims.

1. Size: [**Manufacturers' standard size**] .

E. Product Schedule: For [**drapes**][**and**][**drapery tracks**] . Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.
3. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.
4. Laboratory Test Reports: For product, indicating compliance with VOC emissions evaluation criteria.
5. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

6. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

7. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For drapery track installation; reflected ceiling plans drawn to scale and coordinating track installation with openings and ceiling-mounted items. Indicate the following items:

1. Suspended ceiling components.
2. Motor locations for motorized tracks and supports for motors.
3. Size and location of access panels for above-ceiling motors.

B. Product Certificates: For each drapery fabric treated with flame retardant, signed by fabric supplier and indicating treatment durability and cleaning procedures required to maintain treatment effectiveness.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drapes and drapery tracks.

B. Warranty Documentation: Manufacturers' special warranties.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are

packaged with protective covering for storage and identified with labels describing contents.

1. Drapery-Track Carriers: For each size indicated, equal to [**5**] percent of quantity installed, but no fewer than [**10**] units of each size.
2. Drapery-Track Controls: For each type indicated, equal to [**5**] percent of quantity installed, but no fewer than [**10**] units of each type.
3. Drape Fabrics: For each fabric, color, and pattern indicated, from the same product run, full-width lengths equal to [**5**] percent of quantity installed, but no fewer than [**10**] yards of each fabric, color, and pattern.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: For drapes and drapery tracks, fabricator of drapes.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before drape fabrication, and indicate measurements on Shop Drawings.

B. Scheduling: Do not deliver or install drapes until after other finish work, including painting, is complete and spaces are otherwise ready for occupancy.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Defects in materials and workmanship excluding normal wear and tear.
b. Faulty operation of drapery track components.

2. Warranty Period:

a. Drape Fabric: [**3**] years from date of Substantial Completion.
b. Manually Operated Track: [**Non-transferrable limited lifetime**] .
c. Motorized Track: [**5**][**8**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DRAPERY TRACKS

A. Manually Operated Track :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Forest Drapery Hardware**]

b. [**Kirsch**]

2. Source Limitations: Obtain manually operated tracks from single source from single manufacturer.
3. Safety Standard: WCMA A100.1.
4. Construction: Extruded aluminum, slotted for mounting at interval of not more than **24 inches (610 mm)** o.c.

   a. Length and Configuration: [**As indicated on Drawings**] .
   b. Support Capability: [**Weight of drape specified**][**30 lb (14 kg)**][**45 lb (20 kg)**][**60 lb (27 kg)**][**80 lb (36 kg)**][**140 lb (64 kg)**][**210 lb (95 kg)**] mounted on track length indicated.
   c. Finish: [**Manufacturer's standard**][**White baked enamel**][**Clear anodic coating**] .

5. Cordless Operation: [**Baton attached to lead carrier**] .

   a. Draw: [**As indicated on Drawings**][**One way, stack as indicated on Drawings**][**One way, stack left**][**One way, stack right**][**Two way, center opening**] .

6. Cord Operation: Continuous-loop cord with WCMA A100.1-compliant tension device installed on by track manufacturer. Provide with permanently attached tension-device warning tag.

   a. Tension Device: Cord-tension pulley mounted on [**wall**][**baseboard**][**floor**] .
   b. Draw: [**As indicated on Drawings**][**One way, stack as indicated on Drawings**][**One way, stack left**][**One way, stack right**][**Two way, center opening**] .
   c. Operating Hardware Location: [**As indicated on Drawings**][**On stack side**][**Left**][**Right**] .

7. Carriers: [**Coordinate with drapery headings specified**] .

   a. Master Carriers: [**Butt**][**Overlap**] .

8. End Stops: Manufacturer's standard [**with track end cap**] .
9. Pulleys: [**Standard**][**Heavy**] duty.
10. Mounting Brackets: Aluminum, of type suitable for fastening track to mounting surface and designed to support weight of track assembly and drape plus force applied to operate track.

    a. Mounting Surface: [**As indicated on Drawings**][**Wall**][**Ceiling**][**Drapery pocket**].
    b. Size: [**Adjustable**] .

11. Installation Fasteners: Sized to support track assembly and drape, and fabricated from metal compatible with track components and supporting construction.

B. Motorized Track :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BTX Intelligent Fashion, LLC**]
   b. [**Forest Drapery Hardware**]
   c. [**Kirsch**]
   d. [**Lutron Electronics Co., Inc**]
   e. [**SKYCO**]
   f. [**Somfy Systems Inc.**]

2. Source Limitations: Obtain motorized tracks from single source from single manufacturer.
3. Safety Standard: WCMA A100.1.
4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

    a. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

        1) Drapery Operators: UL CCN FDDR, including UL 325.

5. Construction: Extruded aluminum, slotted for mounting at interval of not more than **24 inches (610 mm)** o.c.

    a. Length and Configuration: [**As indicated on Drawings**] .
    b. Support Capability: [**Weight of drape specified**][**30 lb (14 kg)**][**45 lb (20 kg)**][**60 lb (27 kg)**][**80 lb (36 kg)**][**140 lb (64 kg)**][**210 lb (95 kg)**] mounted on track length indicated.
    c. Finish: [**Manufacturer's standard**][**White baked enamel**][**Clear anodic coating**] .

6. Motorized Operation: Provide factory-assembled motorized drapery track with operator systems of size and capacity, and with features, characteristics, and accessories required for conditions indicated. Coordinate electrical requirements with building electrical system.

    a. Motor Type: Replaceable motor with thermal-overload switch; sized for weight of drape and track length; and equipped with mechanism to prevent overdrawing and automatic clutch that allows drapes to be pulled by hand.
    b. Power: [**Hard wired as indicated on Drawings**][**Lithium battery**][**Rechargeable battery**][**Manufacturer's standard**] .
    c. Maximum Operating-Noise Level: [**35 db**][**50 db**][**54 db**] .
    d. Travel Speed: [**6 inches (152 mm)**][**8 inches (203 mm)**][**12 inches (305 mm)**] per second.
    e. Draw: [**As indicated on Drawings**][**One-way stack as indicated on Drawings**][**Center split stack**][**Offset split stack as indicated on Drawings**][**Multi-stack as indicated on Drawings**] .
    f. Control Device: [**Wall switch**][**15-channel wireless remote**][**App-based control by mobile device**] .
    g. Touch-Motion Function: Gentle pull on drape activates motor without using control device.

7. Carriers: [**Coordinate with drapery headings specified**] .

    a. Master Carriers: [**Butt**][**Overlap**] .

8. End Stops: Manufacturer's standard [**with track end cap**] .
9. Mounting Brackets: Suitable for fastening track to mounting surface and designed to support weight of track assembly and drape plus force applied to operate track.

    a. Mounting Surface: [**As indicated on Drawings**][**Wall**][**Ceiling**][**Drapery pocket**].

10. Installation Fasteners: Sized to support track assembly and drape, and fabricated from metal compatible with track, brackets, and supporting construction. Provide two fasteners to fasten each bracket to supporting construction.

2.2 DRAPES

A. Drape :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Barjan Manufacturing Ltd.**]
   b. [**County Draperies, Inc.**]
   c. [**Design District Drapes**]
   d. [**DFB Sales, Inc.**]
   e. [**Eagle Contract Resources**]
   f. [**Fabricut, Inc.**]
   g. [**Fabtex**]
   h. [**Quiltcraft Industries, Inc.**]
   i. [**Standard Textile**]
   j. [**Wesco Fabrics; RM COCO Decor Ltd.**]

2. Source Limitations: Obtain each color and pattern of drapery fabric and trim from one dye lot.
3. Fire-Test-Response Characteristics: Provide drapes that pass NFPA 701 as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction.

   a. Permanently attach label to each fabric of drape assembly indicating whether it is inherently and permanently flame resistant or is treated with a flame retardant and whether it requires retreatment after cleaning or after a designated period of use.

4. Heading:

   a. Pinch Pleats: [**200**][**250**][**300**] percent fullness

      1) Folds (Fingers) per Pleat: [**Two**][**Three**][**Four**][**Five**] .

   b. Stack Pleats: [**60**][**80**][**100**][**120**] percent fullness.
   c. Roll Pleats: [**60**][**80**][**100**][**120**] percent fullness.
   d. Accordion Pleats: [**40**][**80**][**100**][**120**] percent fullness.
   e. Heading Accessories:

      1) Nonwoven buckram.
      2) Woven snap tape, [**7/8 inch (22 mm) wide, with nickel-plated snaps at 4 inches (102 mm) o.c.**]
      3) Hooks.

2.3 DRAPERY FABRIC

A. Drapery Fabric :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Applied Textiles**]
b. [**Arc-Com Fabrics, Inc.**]
c. [**Architex International, Inc.**]
d. [**Carnegie Fabrics, LLC.**]
e. [**Designtex; Design Tex Group Inc. (The)**]
f. [**Maharam Fabric Corporation; Herman Miller, Inc.**]
g. [**Robert Allen Design Group Holding, LLC**]
h. [**Standard Textile**]
i. [**Wesco Fabrics; RM COCO Decor Ltd.**]

2. Orientation: Run right (up the bolt).
3. Textile Treatments: [**Stain repellent**][**Flame retardant, polymer type**][**Stain repellent; and flame retardant, polymer type**] .
4. Lining Fabric: [**Selected by fabricator**].

   a. Lining Type: [**Blackout**][**Thermal reflective**][**Water resistant**].
   b. Textile Treatments for Lining Fabric: [**Stain repellent**][**Flame retardant, polymer type**][**Stain repellent; and flame retardant, polymer type**].

5. Interlining: [**Selected by fabricator**].

   a. Interlining Type: [**Acoustical, minimum 0.55 NRC in accordance with ASTM C423**][**Blackout**][**Thermal**].

6. Hem Weights: [**Lead**][**Lead-free metal**] .

   a. Type: [**Square or rectangular, individual weights**][**Tape type (string weights)**].

2.4 FABRICATION OF DRAPES

A. Fabricate drapes in heading styles and fullnesses indicated. Fabricate headings to stand erect. If less than a full width of fabric is required to produce panel of specified fullness, use equal widths of not less than one-half width of fabric located at ends of panel.

   1. One-Way-Stacking Drapes: Add **5 inches (127 mm)** to overall width for returns.
   2. Center-Opening Drapes: Add **10 inches (254 mm)** to overall width for overlap.

B. Seams: Sew vertical seams with twin-needle sewing machine with selvage trimmed and overlocked. Join widths so that patterns match and vertical seams lay flat and straight without puckering. Horizontal seams are unacceptable.

C. Side Hems: Double-turned, **1-1/2-inch- (38-mm-)** wide hems consisting of three layers of fabric, and blindstitched so that stitches are invisible on face of drape.

D. Bottom Hems: Double-turned, **4-inch- (102-mm-)** wide hems consisting of three layers of fabric, and weighted and blindstitched so that weights and stitches are invisible on face of drape.

   1. Sew in square lead weights at each seam and at panel corners.

E. Interlinings: Extend from top of drape to within **1/2 inch (13 mm)** of lining's bottom hem and to leading edge of side hems to produce full-shadowed appearance.

F. Linings: Equal to widths of drapery fabric and joined to drapery fabric at top by inside invisible seam, and hand stitched at side hems and shadowed with **1-1/2-inch (38-mm)** return of face fabric.

1. Bottom Hem: [**Hem separately from**][**Blindstitch to**] drapery fabric.

PART 3 - EXECUTION

3.1 INSTALLATION OF DRAPERY TRACKS

A. Install track systems in accordance with manufacturer's written instructions, level and plumb, and at height and location in relation to adjoining openings as indicated on Drawings.

B. Isolate metal parts of tracks and brackets from concrete, masonry, and mortar to prevent galvanic action. Use tape or another method recommended in writing by track manufacturer.

C. Locate so exterior drape edges will not be closer than [**2 inches (51 mm)**] from interior faces of glass and not closer than [**1-1/2 inches (38 mm)**] from interior faces of surrounding construction through full operating range of track.

D. Electrical Connections: Connect hard-wired motorized operators to building electrical system.

3.2 INSTALLATION OF DRAPES

A. Where drapes abut overhead construction, hang drapes so that clearance between headings and overhead construction is **1/4 inch (6.4 mm)**.

B. Where drapes extend to floor, install so that bottom hems clear finished floor by not more than **1 inch (25 mm)** and not less than **1/2 inch (13 mm)**.

C. Where drapes extend to windowsill, install so that bottom hems hang above sill line and clear sill line by not more than **1/2 inch (13 mm)**.

3.3 ADJUSTING

A. After installing drapes, test and adjust each drapery track to produce unencumbered, smooth operation.

B. Steam and dress down drapes as required to produce crease- and wrinkle-free installation.

C. Remove and replace drapes that are stained or soiled.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner’s maintenance personnel to adjust, operate, and maintain motorized operators for drapery tracks.

END OF SECTION 12 22 00 00

Task	Specification	Specification Description
12 22 13 00	12 22 00 00	Curtains and Drapes
12 22 16 00	12 22 00 00	Curtains and Drapes
12 23 13 00	12 21 13 00	Horizontal Louver Blinds
12 23 13 00	12 21 16 00	Vertical Louver Blinds

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SECTION 12 24 13 00 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated, single-roller shades.
2. Manually operated, double-roller shades.
3. Motor-operated, single-roller shades.
4. Motor-operated, double-roller shades.
5. Motor-operated, skylight roller shades.

B. Related Requirements:

1. Section 057500 "Decorative Formed Metal" for shade pockets not provided by roller window shade manufacturer.
2. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
3. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.
4. Section 260010 "Supplemental Requirements for Electrical" for additional requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, [**electrical characteristics,**] features, and furnished accessories.

B. Shop Drawings:

1. Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
2. Motor-Operated Shades: Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type and color of shadeband material and for each type of exposed finish.

1. Include Samples of accessories involving color selection.

D. Samples for Verification: Actual Sample of finished products for each type of roller shade including actual shadeband material and installation accessories.

1. Size: [**Manufacturers' standard size**].

E. Product Schedule: For roller shades. [**Use same designations indicated on Drawings.**]

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.
3. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.
4. Laboratory Test Reports: For product, indicating compliance with VOC emissions evaluation criteria.
5. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.
    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.
    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

6. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.
    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

7. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of shadeband material.

B. Product Test Reports: For each type of shadeband material, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] .

C. Qualification Statements: For Installer.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**from the same production run,**] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels

describing contents.

1. Roller Shades: Full-size units equal to [**3**][**5**] percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than [**two**] units. Include mounting accessories.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work, as directed by the Owner.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Defects in materials and workmanship beyond normal wear and tear.
b. Faulty operation of operating system components.
c. Deterioration of fabric beyond normal use.

2. Warranty Period:

a. Roller Window Shades: [**Five**][**10**][**25**] year(s) from date of Substantial Completion.
b. Motorized Components: [**Five**] year(s) from date of Substantial Completion.
c. Fabric: [**Five**][**10**][**25**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain roller shades from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Window Covering Safety Standard: Provide roller window shades that comply with WCMA A100.1 [**and are listed and labeled as "Best for Kids" by a qualified testing agency**] .

B. Fire Performance: Tested in accordance with and meeting the flame propagation performance criteria of Test 1 or Test 2, as appropriate, of NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Drapery Operators: UL CCN FDDR, including UL 325.

D. Accessibility Standards: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**] for roller window shades designated as accessible.

E. Laboratory Test Reports: For product, indicating compliance with requirements for low-emitting materials.

F. Product Data: For product, indicating compliance with requirements for formaldehyde emissions.

G. Laboratory Test Reports: For product, indicating compliance with VOC emissions evaluation criteria.

2.3 MANUALLY OPERATED ROLLER WINDOW SHADES

A. Manually Operated, Single-Roller Shades : For interior use in rectangular openings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BTX Intelligent Fashion, LLC**]
b. [**CACO, Inc.**]
c. [**DFB Sales, Inc.**]
d. [**Draper, Inc.**]
e. [**Hunter Douglas Architectural Window Coverings**]
f. [**Insolroll Window Shading Systems**]
g. [**Lafayette Interior Fashions**]
h. [**Legrand Shading Systems; Legrand North America, LLC**]
i. [**Levolor Inc.**]
j. [**Lutron Electronics Co., Inc**]
k. [**MechoShade Systems, LLC**]
l. [**Rollease Acmeda Inc.**]
m. [**Springs Window Fashions; SWFcontract**]
n. [**Standard Textile**]

2. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

    a. Roller Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].
    b. Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .
    c. Shadeband-to-Roller Attachment: [**Manufacturer's standard method**][**Adhesive strip**][**Removable spline fitting into integral channel in tube**].

3. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to six inline rollers into a multiband shade that is operated by one roller drive-end assembly.
4. Shadebands:

    a. Shadeband Material: [**Light-filtering fabric**][**Light-blocking fabric**][**Acoustical fabric**].
    b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

        1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**][**Manufacturer's standard exposed bottom bar with integral light seal**].
        2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

5. Mounting Hardware: Brackets or endcaps, with endcap covers where exposed, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and installation location and conditions indicated.
6. Installation Accessories:

    a. Front Fascia: Aluminum extrusion that conceals front and underside of roller and shadeband assembly and attaches to roller endcaps without exposed fasteners.

        1) Shape: [**L-shaped**][**Curved**] .
        2) Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than [**4 inches (102 mm)**][**3 inches (76 mm)**].

    b. Exposed Headbox: Extruded-aluminum enclosure including front fascia, L-shaped top/back cover, and removable bottom closure, that fully conceals roller and shadeband assembly, and attaches to roller endcaps without exposed fasteners.

        1) Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than [**4 inches (102 mm)**][**3 inches (76 mm)**][**height indicated on Drawings**].

    c. Recessed Shade Pocket:

        1) U-shaped, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, and with removable bottom closure panel and end caps or plates. [**Provide pocket with lip at lower edge to support acoustical ceiling panel.**]

            a) Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than [**6 inches**

(152 mm)][5 inches (127 mm)][4 inches (102 mm)][**height indicated on Drawings**].

2) As specified in Section 057500 "Decorative Formed Metal."

d. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

1) Closure-Panel Width: [**As indicated on Drawings**][2 inches (51 mm)].

e. Side Channels: Extruded aluminum "'U" channel with light seals, designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

f. Bottom (Sill) Channel or Angle: Extruded aluminum "U" channel or "L" angle with light seals, designed to eliminate light gaps at bottoms of shades when shades are closed.

g. Installation Accessories Color and Finish: [**As selected from manufacturer's full range**].

B. Manually Operated, Double-Roller Shades : For interior use in rectangular openings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BTX Intelligent Fashion, LLC**]
b. [**DFB Sales, Inc.**]
c. [**Draper, Inc.**]
d. [**Hunter Douglas Architectural Window Coverings**]
e. [**Insolroll Window Shading Systems**]
f. [**Lafayette Interior Fashions**]
g. [**Legrand Shading Systems; Legrand North America, LLC**]
h. [**Levolor Inc.**]
i. [**Lutron Electronics Co., Inc**]
j. [**MechoShade Systems, LLC**]
k. [**Rollease Acmeda Inc.**]
l. [**Springs Window Fashions; SWFcontract**]

2. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

a. Double-Roller Mounting Configuration: [**Side by side**][**Offset, outside roller over and inside roller under**].

b. Inside Roller:

1) Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].

2) Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .

c. Outside Roller:

1) Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].
2) Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .

d. Shadeband-to-Roller Attachment: [**Manufacturer's standard method**][**Adhesive strip**][**Removable spline fitting into integral channel in tube**].

3. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to six inline rollers into a multiband shade that is operated by one roller drive-end assembly.
4. Inside Shadebands:

a. Shadeband Material: [**Light-filtering fabric**][**Acoustical fabric**].
b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**].
2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

5. Outside Shadebands:

a. Shadeband Material: [**Light-blocking fabric**].
b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**][**Manufacturer's standard exposed bottom bar with integral light seal**].
2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

6. Mounting Hardware: Double roller brackets or endcaps, with endcap covers where exposed, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation location and conditions indicated.
7. Installation Accessories:

a. Double Roller Front Fascia: Aluminum extrusion that conceals front and underside of rollers and shadeband assemblies and attaches to double roller endcaps without exposed fasteners.

1) Shape: [**L-shaped**][**Curved**].
2) Height: [**Manufacturer's standard height required to conceal rollers and shadeband assemblies when shades are fully open**].

b. Double Roller Exposed Headbox: Extruded-aluminum enclosure including front fascia, L-shaped top/back cover, and removable bottom closure, that fully conceals rollers and shadeband assemblies, and attaches to double roller endcaps without exposed fasteners.

1) Size: [**Manufacturer's standard height and width required to enclose rollers and shadeband assemblies when shades are fully open**][**Size indicated on Drawings**].

c. Double Roller Recessed Shade Pocket:

1) U-shaped, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, and with removable bottom closure panel and endcaps or plates. [**Provide pocket with lip at lower edge to support acoustical ceiling panel.**]

a) Size: [**Manufacturer's standard height and width required to enclose rollers and shadeband assemblies when shades are fully open**][**Size indicated on Drawings**].

2) As specified in Section 057500 "Decorative Formed Metal."

d. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

1) Closure-Panel Width: [**As indicated on Drawings**].

e. Side Channels: Extruded aluminum "U" channel or "L" angle with light seals designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

f. Bottom (Sill) Channel or Angle: Extruded aluminum "U" channel or "L" angle with light seals designed to eliminate light gaps at bottoms of shades when shades are closed.

g. Installation Accessories Color and Finish: [**As selected from manufacturer's full range**].

2.4 MOTOR-OPERATED ROLLER WINDOW SHADES

A. Motor-Operated, Single-Roller Shades : For interior use in rectangular openings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BTX Intelligent Fashion, LLC**]
b. [**CACO, Inc.**]
c. [**DFB Sales, Inc.**]
d. [**Draper, Inc.**]
e. [**Hunter Douglas Architectural Window Coverings**]
f. [**Insolroll Window Shading Systems**]
g. [**Lafayette Interior Fashions**]
h. [**Legrand Shading Systems; Legrand North America, LLC**]
i. [**Levolor Inc.**]
j. [**Lutron Electronics Co., Inc**]
k. [**MechoShade Systems, LLC**]
l. [**PowerShades**]
m. [**Rollease Acmeda Inc.**]
n. [**Springs Window Fashions; SWFcontract**]

2. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

a. Roller Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].
b. Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .
c. Shadeband-to-Roller Attachment: [**Manufacturer's standard method**][**Adhesive strip**][**Removable spline fitting into integral channel in tube**].

3. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to six inline rollers into a multiband shade that is operated by one roller drive-end assembly.
4. Shadebands:

a. Shadeband Material: [**Light-filtering fabric**][**Light-blocking fabric**][**Acoustical fabric**].
b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**][**Manufacturer's standard exposed bottom bar with integral light seal**].
2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

5. Mounting Hardware: Brackets or endcaps, with endcap covers where exposed, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and installation location and conditions indicated.
6. Installation Accessories:

a. Front Fascia: Aluminum extrusion that conceals front and underside of roller and shadeband assembly and attaches to roller endcaps without exposed fasteners.

1) Shape: [**L-shaped**][**Curved**].
2) Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than [**4 inches (102 mm)**][**3 inches (76 mm)**].

b. Exposed Headbox: Extruded-aluminum enclosure including front fascia, L-shaped top/back cover, and removable bottom closure, that fully conceals roller and shadeband assembly, and attaches to roller endcaps without exposed fasteners.

1) Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than [**4 inches (102 mm)**][**3 inches (76 mm)**][**height indicated on Drawings**].

c. Recessed Shade Pocket:

1) U-shaped, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, and with removable bottom closure panel and end caps or plates. [**Provide pocket with lip at lower edge to support acoustical ceiling panel.**]

a) Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than [**6 inches (152 mm)**][**5 inches (127 mm)**][**4 inches (102 mm)**][**height indicated on Drawings**].

2) As specified in Section 057500 "Decorative Formed Metal."

d. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

1) Closure-Panel Width: [**As indicated on Drawings**][**2 inches (51 mm)**].

e. Side Channels: Extruded aluminum "U" channel with light seals, designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

f. Bottom (Sill) Channel or Angle: Extruded aluminum "U" channel or "L" angle with light seals, designed to eliminate light gaps at bottoms of shades when shades are closed.

g. Installation Accessories Color and Finish: [**As selected from manufacturer's full range**].

B. Motor-Operated, Double-Roller Shades : For interior use in rectangular openings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BTX Intelligent Fashion, LLC**]
b. [**DFB Sales, Inc.**]
c. [**Draper, Inc.**]
d. [**Hunter Douglas Architectural Window Coverings**]
e. [**Insolroll Window Shading Systems**]
f. [**Legrand Shading Systems; Legrand North America, LLC**]
g. [**Lutron Electronics Co., Inc**]
h. [**MechoShade Systems, LLC**]
i. [**Springs Window Fashions; SWFcontract**]

2. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

a. Double-Roller Mounting Configuration: [**Side by side**][**Offset, outside roller over and inside roller under**].

b. Inside Roller:

1) Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].
2) Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .

c. Outside Roller:

1) Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**].
2) Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .

d. Shadeband-to-Roller Attachment: [**Manufacturer's standard method**][**Adhesive strip**][**Removable spline fitting into integral channel in tube**].

3. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to six inline rollers into a multiband shade that is operated by one roller drive-end assembly.
4. Inside Shadebands:

    a. Shadeband Material: [**Light-filtering fabric**][**Acoustical fabric**].
    b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

        1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**].
        2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

5. Outside Shadebands:

    a. Shadeband Material: [**Light-blocking fabric**].
    b. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

        1) Type: [**Elliptical slat enclosed in sealed pocket of shadeband material**][**Elliptical slat with endcaps, enclosed in open pocket of shadeband material**][**Exposed flat bar with endcaps**][**Exposed round bar with endcaps**][**Exposed tube with endcaps**][**Manufacturer's standard exposed bottom bar with integral light seal**].
        2) Color and Finish: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

6. Mounting Hardware: Double roller brackets or endcaps, with endcap covers where exposed, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation location and conditions indicated.
7. Installation Accessories:

    a. Double Roller Front Fascia: Aluminum extrusion that conceals front and underside of rollers and shadeband assemblies and attaches to double roller endcaps without exposed fasteners.

        1) Shape: [**L-shaped**][**Curved**].
        2) Height: [**Manufacturer's standard height required to conceal rollers and shadeband assemblies when shades are fully open**].

    b. Double Roller Exposed Headbox: Extruded-aluminum enclosure including front fascia, L-shaped top/back cover, and removable bottom closure, that fully conceals rollers and shadeband assemblies, and attaches to double roller endcaps without exposed fasteners.

        1) Size: [**Manufacturer's standard height and width required to enclose rollers and shadeband assemblies when shades are fully open**][**Size indicated on Drawings**].

    c. Double Roller Recessed Shade Pocket:

        1) U-shaped, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, and with removable bottom closure panel and endcaps or plates. [**Provide pocket with lip at lower edge to support acoustical ceiling panel.**]

            a) Size: [**Manufacturer's standard height and width required to enclose rollers and shadeband assemblies when shades are fully open**][**Size**

indicated on Drawings].

2) As specified in Section 057500 "Decorative Formed Metal."

d. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

1) Closure-Panel Width: [**As indicated on Drawings**].

e. Side Channels: Extruded aluminum "U" channel or "L" angle with light seals designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

f. Bottom (Sill) Channel or Angle: Extruded aluminum "U" channel or "L" angle with light seals designed to eliminate light gaps at bottoms of shades when shades are closed.

8. Installation Accessories Color and Finish: [**As selected from manufacturer's full range**].

C. Motor-Operated, Skylight Roller Shades : For interior use in rectangular openings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**DFB Sales, Inc.**]
b. [**Draper, Inc.**]
c. [**Hunter Douglas Architectural Window Coverings**]
d. [**Lutron Electronics Co., Inc**]
e. [**MechoShade Systems, LLC**]
f. [**Rollease Acmeda Inc.**]
g. [**Springs Window Fashions; SWFcontract**]

2. System Type: [**Double-roller, two-motor system, one for shadeband roll-up, one for cable take-up**][**Single-motor, double-roller system, with motor in drive roller and spring in take-up roller**][**Single motor and roller, gravity drop**].
3. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

a. Drive-End Location: [**Right side of interior face of shade**][**Left side of interior face of shade**][**As indicated on Drawings**] .
b. Direction of Shadeband Roll: [**Regular, from back (exterior face) of roller**][**Reverse, from front (interior face) of roller**] .
c. Shadeband-to-Roller Attachment: [**Manufacturer's standard method**][**Adhesive strip**].

4. Shadeband Retention System: Manufacturer's standard system for guiding shadeband through range of travel and holding shadeband taut with edges of shadeband supported by side channels or angles.
5. Shadebands:

a. Shadeband Material: [**Light-filtering fabric**][**Light-blocking fabric**][**Acoustical fabric**].
b. Shadeband Bottom (Hem) Bar: Manufacturer's standard for operating mechanism

indicated.

1) Color and Finish of Exposed Bottom Bar: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

6. Mounting Hardware: Corrosion resistant and compatible with operating mechanism, installation accessories, and installation location and conditions indicated.
7. Installation Accessories:

a. Exposed Headboxes and Bottom Boxes: Extruded-aluminum enclosures including front fascia, L-shaped top/back covers, and removable closures, that fully conceal roller and shadeband assemblies, and attaches to roller endcaps without exposed fasteners.

1) Height: Manufacturer's standard height required to enclose roller and shadeband assemblies when shade is fully open, but not less than [**height indicated on Drawings**].

b. Channels or Angles: Manufacturer's standard design for operating mechanism indicated and shadeband take-up and support.
c. Installation Accessories Color and Finish: [**As selected from manufacturer's full range**].

2.5 MANUAL OPERATION

A. Manual Corded Operation:

1. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

a. Bead Chains: [**Manufacturer's standard**][**Nickel-plated metal**][**Stainless steel**][**Plastic**] bead chain with WCMA A100.1 compliant tension device installed on roller window shade by manufacturer and mounted on [**wall**][**jamb**][**sill**] .

1) Loop Length: [**Full length of roller shade**][**As indicated on Drawings**].
2) Limit Stops: Provide upper and lower ball stops.

b. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

1) Provide for shadebands that weigh more than [**10 lb (4.5 kg)**] or for shades as recommended by manufacturer, whichever criterion is more stringent.

B. Manual Cordless Operation:

1. Crank-and-Gear Operating Mechanisms: Sealed gearbox drive system controlled by crank handle.

a. Crank-Handle Type: [**Detachable**][**Permanently mounted**] .
b. Crank-Handle Length: [**6 ft. (1.8 m)**][**10 ft. (3 m)**][**Manufacturer's standard**][**As indicated on Drawings**].

2.6 MOTORIZED OPERATION

A. Motorized Operating Systems: Factory-assembled, motorized roller window shades with shade-operator

system of size and capacity and with features, characteristics, and accessories required for conditions indicated, complete with motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for complete operation. For wired controls, include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. Type:

1. Standard Motor with Wired Controls: Roller window shade manufacturer's standard tubular motor to suit conditions indicated, enclosed in roller.

   a. Motor Electrical Characteristics: [**120-V ac**][**24-V dc**].
   b. Controls:

      1) Wired Wall Switch:

         a) Single Motor Control: Wired wall-switch-operated control station for single motor control, with three switch positions for open, close, and center stop functions. [**Single station, dry-contact, three-button wall switch**][**Double station, dry-contact, three-button wall switch**][**Maintained-contact paddle switch**][**Momentary-contact paddle switch**][**Maintained-contact rocker switch**][**Momentary-contact rocker switch**][**Maintained-contact toggle switch**][**Momentary-contact toggle switch**][**Maintained-contact key switch; provide two keys per station**][**Momentary-contact key switch; provide two keys per station**] .
         b) Group Motor Control, Two Motors: Wired wall-switch-operated control station for control of two motors together with single station, with three switch positions for open, close, and center stop functions. [**Maintained**][**Momentary**] -contact, [**paddle**][**rocker**] switch.
         c) Group Motor Control, Two to Five Motors: Wired wall-switch-operated control station for control of [**two**][**three**][**four**][**five**] motors together with single station, with five switch positions for open, close, and three preset intermediate stop position functions. [**Single station, dry-contact, five- or six-button wall switch**][**Double station, dry-contact, five- or six-button wall switch**] .
         d) Color: [**White**][**Ivory**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2. Radio Frequency (RF) Motor with Wireless Controls: Roller window shade manufacturer's standard tubular radio frequency motor to suit conditions indicated, enclosed in roller, communicating to control devices through wireless RF signal.

   a. Motor Electrical Characteristics: [**120-V ac**][**24-V dc**][**12-V dc, battery**].
   b. Controls:

      1) RF Wireless Wall Switch Transmitters:

         a) Single Channel Wall Switch: Wall switch [**surface mounted**] with open, close, and stop command buttons, and one channel button for operation of one motorized shade or one group of motorized shades.
         b) Multi-Channel Wall Switch: Wall switch [**surface mounted**] with open, close, and stop command buttons and [**two**][**three**][**four**][**five**] channel buttons for operation of one motorized shade or one group of motorized shades per channel.
         c) Color: [**As selected by Architect from manufacturer's full range**] as

directed by the Owner.

2) RF Handheld Transmitters:

a) Single-Channel Handheld Remote: For operation of one motorized shade or one group of motorized shades [**and with sun sensor control**] .
b) Multi-Channel Handheld Remote: For operation of one motorized shade or one group of motorized shades per channel for up to five channels [**and with sun sensor control**] .
c) 16-Channel Handheld Remote: For operation of one motorized shade or one group of motorized shades per channel for up to 16 channels.
d) Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

3) RF Wireless Tabletop Controls:

a) Single Channel Tabletop Control: With open, close, and stop command buttons and one channel button for operation of one motorized shade or one group of motorized shades, compatible with RF wireless wall switch transmitters.
b) Multi-Channel Tabletop Control: With open, close, and stop command buttons and [**two**][**three**][**four**][**five**] channel buttons for operation of one motorized shade or one group of motorized shades per channel, compatible with RF wireless wall switch transmitters.
c) Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

4) App-Based Mobile Device and Voice Control:

a) Multi-channel control for up to [**16**][**40**] RTS channels programmable for individual or group control, schedules, scenes, or timed events, and with voice control through digital assistants.

5) RF Wireless Sensors:

a) Sun Sensor: Programmable sensor detects sun intensity and responds by automatically adjusting motorized shades.
b) Sun and Temperature Sensor: Programmable sensor detects sun intensity and temperature and responds by automatically adjusting motorized shades.

6) RF Timer Control:

a) Single-Channel Handheld Transmitter: For operation of one motorized shade or one group of motorized shades, programmable for weekday and weekend schedules with one open and close schedule per day.
b) Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

3. Intelligent Motor with Wired Controls: Roller window shade manufacturer's standard tubular intelligent motor to suit conditions indicated, enclosed in roller. Intelligent motors and controls each with individual IP addresses, communicating together with two-way communication, and connected into a digital network system.

a. Motor Electrical Characteristics: 120-V ac.
b. Network Functions:

1) Standalone network.
2) Integrate with building management system.
3) Integrate with third-party [**lighting**][**audiovisual (A/V)**] , [**HVAC**] control systems.
4) Whole building automation: Provide manufacturer's standard whole building automation system using web-based user interface and required devices to provide the following functions:

    a) Automatically adjust shade positions based on sky conditions, solar heat gain, sun tracking, direct and diffuse radiation, and occupancy.
    b) Override capability.
    c) Integrate with building management system.
    d) Integrate with third-party control systems including lighting control systems, audiovisual (A/V) systems, HVAC control systems and energy dashboards.
    e) Data logging, reporting and storage.
    f) Individual user profiles and permissions.
    g) Programming of scheduled events.
    h) Display and monitoring of current conditions.
    i) Send alerts/notifications.
    j) Configurable motor, zone, and building properties.

c. Controls:

1) Master-Controlled/Central Network Controller: Touchscreen device for whole building automation control.
2) Wired Wall Switch:

    a) Single Zone Intelligent Wall Switch: [**Push-Button**][**Touch or Swipe**] for control of one motorized shade or one zone composed of any number of motorized shades in the network.
    b) Dual Zone Intelligent Wall Switch: [**Push-Button**][**Touch or Swipe**] for control of two individual zones, each zone composed of any number of motorized shades in the network.
    c) Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

3) Wireless Handheld Remote:

    a) Multi-Channel RF Handheld Remote: [**Push-Button**][**Touch or Swipe**] for wireless control of one motorized shade or one group of motorized shades per channel for up to 32 channels. Provide manufacturer's standard network gateway device to enable use of wireless control device on wired network.
    b) Color: [**As selected by Architect from manufacturer's full range**] as directed by the Owner.

4) Wired Sensors:

    a) Internal Daylight Sensor: Measures daylight levels through glazing and responds by automatically adjusting motorized shades. Provide manufacturer's standard network interface device [**with automated glare control,**] to connect sensors to network. Interface device to allow programming for up to [**eight**] scheduled events.
    b) External Brightness Sensor: Measures brightness levels and responds by automatically adjusting motorized shades. Provide manufacturer's standard network interface device [**with automated glare control,**] to connect sensors to network. Interface device to allow programming for up to [**eight**] scheduled

events.

C. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.

D. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.

E. Maximum Total Shade Width: [**As required to operate roller shades indicated**].

F. Maximum Shade Drop: [**As required to operate roller shades indicated**].

G. Maximum Weight Capacity: [**As required to operate roller shades indicated**].

2.7 SHADEBAND MATERIALS

A. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: [**Roller shade manufacturer**].
2. Type: [**PVC-coated fiberglass**][**PVC-coated polyester**][**Woven 100 percent polyester**][**100 percent fiberglass**][**Thermoplastic Olefin (TPO)**][**Acrylic-coated polyester**][**Woven PVC-coated fiberglass and PVC-coated polyester**][**Woven polyester and PVC-coated polyester**][**PVC-coated polyester with silver backing**].
3. Weave: [**Mesh**][**Basketweave**].
4. Roll Width: [**36 inches (914 mm)**][**48 inches (1229 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**84 inches (2134 mm)**].
5. Orientation on Shadeband: [**Up the bolt**][**Railroaded**][**As indicated on Drawings**].
6. Openness Factor: [**0.5**][**1**][**3**][**5**][**10**][**11**][**22**] percent.
7. Color: [**As indicated on Drawings**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

B. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.

1. Source: [**Roller shade manufacturer**].
2. Type: [**Fiberglass with PVC film bonded to both sides**][**Fiberglass with acrylic flocked backing**][**Woven 100 percent polyester**][**Acrylic-coated polyester**][**Polyester-acrylic blend**][**Polyester with acrylic foamed backing**][**PVC-coated fiberglass with bonded PVC film**][**Fiberglass with EVA coating**][**PVC-coated polyester with silver backing**].
3. Roll Width: [**36 inches (914 mm)**][**48 inches (1229 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**84 inches (2134 mm)**].
4. Orientation on Shadeband: [**Up the bolt**][**Railroaded**][**As indicated on Drawings**].
5. Features: [**Washable**][**Antistatic treatment**].
6. Color: [**As indicated on Drawings**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

C. Acoustical Fabric: Woven fabric, stain and fade resistant.

1. Source: [**Roller shade manufacturer**].
2. Type: [**Woven 100 percent polyester**][**Thermoplastic Olefin (TPO)**][**PVC-coated fiberglass**][**PVC-coated polyester**].
3. Acoustical Performance: Sound absorption [**NRC**][**SAA**] of [**0.60 to 0.70**][**0.50 to 0.60**][**0.40 to 0.50**][**0.30 to 0.40**][**0.20 to 0.30**][**not less than 0.50**] in accordance with ASTM C423 for Type G mounting in accordance with ASTM E795.
4. Thickness: [**As required to meet acoustical performance**].
5. Weight: [**As required to meet acoustical performance**].
6. Roll Width: [**36 inches (914 mm)**][**48 inches (1229 mm)**][**60 inches (1524 mm)**][**72 inches**

(1829 mm)][84 inches (2134 mm)].
7. Orientation on Shadeband: [**Up the bolt**][**Railroaded**][**As indicated on Drawings**].
8. Features: [**Washable**][**Antistatic treatment**].
9. Openness Factor: [**0.5**][**1**][**3**][**As required to meet acoustical performance**] percent.
10. Color: [**As indicated on Drawings**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] as directed by the Owner.

2.8 FABRICATION OF ROLLER WINDOW SHADES

A. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13 mm) total, plus or minus 1/8 inch (3 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3 mm).
2. Outside of Jamb Installation: Width and length as indicated [**in window-treatment schedule**][**on Drawings**], with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

B. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than [**1:4**], provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
2. Skylight Shades: Provide battens and seams at uniform spacings along shadeband as required to ensure shadeband tracking and alignment through its full range of movement without distortion or sag of material.
3. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, [**locations of connections to building electrical system,**] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ROLLER WINDOW SHADES

A. Install roller shades level, plumb, aligned and centered on openings, and aligned with adjacent units in accordance with manufacturer's written instructions.

1. Located so shadeband is not closer than [2 inches (51 mm)] to interior face of glass. Allow

clearances for window operation hardware.

B. Roller Shade Locations: [**At exterior windows**][**As indicated in window-treatment schedule**][**As indicated on Drawings**].

C. Motor-Operated Roller Window Shades: Electrical installation.

1. Connect motor-operated roller window shades to building electrical system.
2. Comply with manufacturer's written installation instructions.

3.3 ADJUSTING

A. Adjust and balance roller window shades to operate smoothly, easily, safely, and free from binding or malfunction through full operational range.

3.4 CLEANING

A. Clean roller window shade surfaces, after installation, in accordance with manufacturer's written instructions.

B. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion as directed by the Owner.

3.5 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller window shades are without damage or deterioration at time of Substantial Completion.

B. Protect electrical [**and communications**] wiring, cabling, raceways, and boxes, after installation. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use, before time of substantial completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner’s maintenance personnel to adjust, operate, and maintain motor-operated roller window shades.

END OF SECTION 12 24 13 00

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Task	Specification	Specification Description
12 24 13 00	12 21 13 00	Horizontal Louver Blinds
12 24 13 00	12 21 16 00	Vertical Louver Blinds
12 25 09 00	01 22 00 00	No Specification Required

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SECTION 12 30 00 00 - MANUFACTURED WOOD-VENEER-FACED CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood-veneer-faced casework.
2. Hardware and accessories.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to wood-veneer-faced casework.
4. Section 123553.19 "Wood Laboratory Casework."
5. Section 123619 "Wood Countertops."

1.2 DEFINITIONS

A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

B. Keying Conference: Conduct conference at [**Project site**]. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Wood-veneer-faced casework.
2. Hardware and accessories.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content

and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
12. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
13. Chain-of-Custody Qualification Data: For manufacturer and vendor.
14. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
15. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
16. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
17. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
18. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For wood-veneer-faced casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
6. Apply [**AWI's Quality Certification**][**WI's Certified Compliance**] Program label to Shop Drawings.

D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

E. Samples: For casework and hardware finishes.

F. Samples for Initial Selection: For casework and hardware finishes.

G. Samples for Verification: For the following:

1. Casework Finishes: **8-by-10-inch (200-by-250-mm)** Samples for each type and color of finish.
2. Base Cabinet: One full-size, [**16-inch- (406-mm-)**] wide, finished base cabinet complete with

hardware, doors, and drawers but without countertop.

3. Wall Cabinet: One full-size, [**12-inch- (304-mm-)**] wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
4. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their locations, as directed by the Owner.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**casework manufacturer**][**and**][**Installer**].

B. Sample Warranty: For special warranty.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certificates.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each casework finish provided. Include fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: [**An authorized representative who is trained and approved by manufacturer**][**and**][**licensed participate in AWI's Quality Certification Program**][**licensed participate in WI's Certified Compliance Program**].

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period.[**Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."**]

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination of components or other failures of glue bond.
b. Warping of components.
c. Failure of operating hardware.
d. Deterioration of finishes.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.

1. Grade: [**Premium**][**Custom**][**Economy**].
2. Provide labels and certificates from [**AWI**][**WI**] certification program indicating that casework complies with requirements of grades specified.

a. Contractor to register the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Product Designations:

1. Drawings indicate sizes, configurations, and finish materials of manufactured wood-veneer-faced casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."
2. Drawings indicate configurations of manufactured wood-veneer-faced casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 WOOD-VENEER-FACED CASEWORK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CIF Lab Solutions LP**]
2. [**ICIscientific**]

3. [**Kewaunee Scientific Corporation**]
4. [**TMI Systems Corporation**]

B. Source Limitations: Obtain from single source from single manufacturer.

C. Design: [**Face-frame**][**Frameless**] cabinet construction with the following door and drawer-front style:

1. Lipped overlay with radiused wood edges[**and full-width, recessed finger pulls machined into faces of doors and drawers**].
2. Reveal overlay[**with recessed finger pulls machined into faces of doors and drawers**].
3. Flush overlay.

D. Wood Species: [**Red oak**][**White birch**][**Red birch**][**Alder**][**White maple**][**Hickory**].

1. Wood Stain Colors and Finishes: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

E. Face Veneer Cut: [**Plain sliced**][**Quarter sliced**][**Rift cut**][**Rotary cut**].

F. Veneer Matching:

1. None required; select and arrange veneers for compatible grain and color.
2. Provide veneers for each cabinet from a single flitch, [**book and running**][**slip and running**][**book or slip and running**][**book and balance**][**slip and balance**][**book or slip and balance**] matched.

   a. Provide continuous matching of adjacent drawer fronts within each cabinet.

3. Provide veneers for each elevation from a single flitch, [**book and running**][**slip and running**][**book or slip and running**][**book and balance**][**slip and balance**][**book or slip and balance**] matched.

   a. Provide continuous matching of adjacent drawer fronts within each cabinet and end matching between drawer fronts of adjacent cabinets.

G. Grain Direction:

1. Doors: Vertical with continuous vertical matching.
2. Drawer Fronts: [**Vertical with continuous vertical matching**][**Horizontal**].
3. Face Frame Members: Lengthwise.
4. End Panels: Vertical.
5. Bottoms and Tops of Units: Side to side.
6. Knee Space Panels: Vertical.
7. Aprons: Horizontal.

H. Exposed Materials:

1. Plywood: Hardwood plywood with face veneer of species indicated, selected for compatible color and grain. Provide backs of same species as faces.
2. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed plywood.
3. Edgebanding: [**Solid wood, minimum 1/8 inch (3 mm) thick and of same species as face veneer**][**Wood veneer of same species as face veneer**][**PVC**].

a. PVC Edgebanding Color: [**Casework manufacturer's standard**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

I. Semiexposed Materials:

1. Wood: Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.

   a. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of [**species similar in color and grain to**][**same species as**] exposed wood.
   b. Plywood: Hardwood plywood of [**species similar in color and grain to**][**same species as**] exposed wood. Provide backs of same species as faces.

2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed surfaces, except provide solid wood or hardwood plywood for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

J. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood. Provide backs of same species as faces.
3. Particleboard.
4. MDF.
5. Hardboard.

2.3 HARDWARE AND ACCESSORIES

A. Hardware: Unless otherwise indicated, provide manufacturer's standard [**satin-finish**][**mirror polished-finish**][**powder-coated**], commercial-quality, heavy-duty hardware.

1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Butt Hinges: [**Stainless steel**][**Chrome-plated**][**Powder-coated**], semiconcealed, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than **48 inches (1220 mm)** high, and provide three hinges for doors more than **48 inches (1220 mm)** high.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602[self-closing]. Provide two hinges for doors less than 48 inches (1220 mm) high, and provide three hinges for doors more than 48 inches (1220 mm) high.

1. Degrees of Opening: [**100**][**135**][**170**] degrees.

D. Wire Pulls: Solid [nylon][aluminum][stainless steel][chrome-plated brass] wire pulls, fastened from back with two screws.

1. For sliding doors, provide recessed [stainless steel][chrome-plated] flush pulls.
2. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

E. Semirecessed Pulls: Plastic. For sliding doors, provide recessed plastic flush-pulls. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

F. Door Catches: [Zinc-plated][Powder-coated], [nylon-roller spring catch][dual, self-aligning, permanent magnet catch]. Provide two catches on doors more than 48 inches (1220 mm) high.

G. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.

1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
2. Drawers: Provide one bumper on back side of drawer front at each corner.

H. Drawer Slides: ANSI/BHMA A156.9.

1. Manufacturer's standard.
2. Standard Duty (Grade 1): [**Side mount**][**Undermount**].
3. Heavy Duty (Grade 1HD-100): [**Side mount**][**Undermount**].

a. Type: [**Full**][**Full overtravel**][**Partial**] extension.
b. Material: [**Epoxy-coated polymer**][**Zinc-plated ball bearing**] slides.
c. Motion Feature: [**Soft close dampener**][**Self-closing mechanism**].

4. General-purpose drawers; provide [**100 lb (45 kg)**] load capacity.
5. File drawers; provide [**150 lb (45 kg)**] load capacity.

I. Label Holders: [Stainless steel][chrome plated], sized to receive standard label cards approximately 1 by 2 inches (25 by 51 mm), and attached with screws or brads.

1. Provide label holders [**where indicated**][**on drawers**].

J. Drawer and Hinged-Door Locks: [**Cylindrical (cam)**][**Mortise**] type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.

1. Provide a minimum of two keys per lock and six master keys.
2. Provide locks [**where indicated**][**on every door and drawer**].

a. Master key for up to [**500**] key changes.

K. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.

L. Adjustable Shelf Supports:

1. Pin-type, [**two-pin-locking plastic shelf rests complying with ANSI/BHMA A156.9, Type B04013**][**single-pin metal shelf rests complying with ANSI/BHMA A156.9, Type B04013**].
2. Mortise-type, [**zinc-plated**][**powder-coated**] steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

2.4 MATERIALS

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

G. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

H. Softwood Plywood: DOC PS 1.

I. Particleboard: ANSI A208.1, Grade M-2.

J. MDF: Medium-density fiberboard, ANSI A208.2, [**Grade 130**].

K. Hardboard: ANSI A135.4, Class 1 tempered.

L. PVC Edgebanding for Wood: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

M. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper[**and complying with requirements of ISO 4586**].

1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

N. Glass for Glazed Doors:

1. Clear float glass complying with ASTM C1036, Type I, Class 1, Quality-Q3; not less than [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**] thick.
2. Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.
3. Clear laminated annealed glass complying with ASTM C1172, Kind LA, Condition A, Type I, Class I, Quality-Q3; with two plies not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

O. Frameless Glass Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than [**5.0 mm**][**6.0 mm**] thick; with exposed edges seamed before tempering.

P. Adhesives: Do not use adhesives that contain urea formaldehyde.

Q. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

R. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

S. Adhesives: Do not use adhesives that contain urea formaldehyde.

T. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

A. Wood-Veneer-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:

1. Bottoms of Cabinets and Tops of Wall Cabinets: **3/4-inch- (19-mm-)** thick, [**veneer-core**]hardwood plywood.
2. Ends of Cabinets: **3/4-inch- (19-mm-)** thick, hardwood plywood.
3. Shelves: **3/4-inch- (19-mm-)** thick, veneer-core hardwood plywood or **1-inch- (25-mm-)** thick, particleboard-core hardwood plywood.
4. Base Cabinet Top Frames: **3/4-by-2-inch (19-by-51-mm)** solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
5. Base Cabinet Stretchers: **3/4-by-4-1/2-inch (19-by-114-mm)** plywood, particleboard, or MDF strips or solid-wood boards at front and back of cabinet, glued and pinned or screwed.[**May be provided as an option to base cabinet top frames.**]
6. Base Cabinet Subtops: **3/4-inch- (19-mm-)** thick panel product, glued and pinned or screwed.[**May be provided as an option to base cabinet top frames.**]
7. Backs of Cabinets: **3/4-inch- (19-mm-)** thick, particleboard-core hardwood plywood where exposed, [**1/4-inch- (6.4-mm-) thick hardboard**][**1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood**][**1/2-inch- (13-mm-) thick hardwood plywood**], dadoed into sides, bottoms, and tops where not exposed.
8. Drawer Fronts: **3/4-inch- (19-mm-)** thick, particleboard-core hardwood plywood or solid hardwood.
9. Drawer Sides and Backs: **1/2-inch- (13-mm-)** thick, solid-wood or [**veneer-core**]hardwood plywood, with glued dovetail or multiple-dowel joints.
10. Drawer Bottoms: **1/4-inch- (6.4-mm-)** thick, veneer-core hardwood plywood, glued and dadoed into front, back, and sides of drawers.[**Use 1/2-inch- (13-mm-) thick material for drawers more than 24 inches (600 mm) wide.**]
11. Drawer Bodies: Steel drawer pans formed from **0.036-inch- (0.91-mm-)** thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and **2 mils (0.05 mm)** for system.
12. Cabinet Doors:

    a. 48 Inches (1220 mm) or Less in Height: **3/4 inch (19 mm)** thick, with[**solid hardwood stiles and rails,**] particleboard or MDF cores, and hardwood face veneers and crossbands.
    b. 48 Inches (1220 mm) or More in Height: [**1-1/16 inches (27 mm) thick, with solid hardwood stiles and rails, honeycomb cores,**][**1-1/8 inches (29 mm) thick, with particleboard cores**] and hardwood face veneers and crossbands.

B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment.

Fabricate from same material and with same finish as casework.

2.6 FINISH

A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors and drawer fronts and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.

B. Staining: Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces as required to provide uniform color and to match approved Samples.

C. Finishing Closed-Grain Woods: Apply manufacturer's standard two-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat. Topcoat may be omitted on concealed surfaces.

D. Finishing Open-Grain Woods: Apply manufacturer's standard three-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and two coats of a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat and between topcoats. Topcoats may be omitted on concealed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within **1/16 inch (1.5 mm)** of a single plane. Align similar adjoining doors and drawers to a tolerance of **1/16 inch (1.5 mm)**. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within **1/16 inch (1.5 mm)** of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of **1/16 inch (1.5 mm)**.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise

indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity to prepare and submit report of inspection.

3.4 CLEANING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect, as directed by the Owner.

END OF SECTION 12 30 00 00

SECTION 12 30 00 00A - MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad casework.
2. Hardware and accessories.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-clad casework.
4. Section 123553.16 "Plastic-Laminate Laboratory Casework."
5. Section 123623.13 "Plastic-Laminate-Clad Countertops."

1.2 DEFINITIONS

A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

B. Keying Conference: Conduct conference at [**Project site**]. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-clad casework.
2. Hardware and accessories.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content

and cost.

2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
12. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
13. Chain-of-Custody Qualification Data: For manufacturer and vendor.
14. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
15. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
16. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
17. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
18. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
19. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
20. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
21. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
22. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
23. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For plastic-laminate-clad casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
6. Apply [**AWI's Quality Certification**][**WI's Certified Compliance**] Program label to Shop Drawings.

D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

E. Samples: For casework and hardware finishes.

F. Samples for Initial Selection: For casework and hardware finishes.

G. Samples for Verification: For the following:

1. Plastic Laminates: [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**], for each type, color, pattern, and surface finish required.

   a. Provide one Sample applied to core material with specified edge material applied to one edge.

2. Thermally Fused Laminate Panels: [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**], for each color, pattern, and surface finish.

   a. Provide edge banding on one edge.

3. Base Cabinet: One full-size, [**16-inch- (406-mm-)**] wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
4. Wall Cabinet: One full-size, [**12-inch- (304-mm-)**] wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
5. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their locations, as directed by the Owner.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**casework manufacturer**][**and**][**Installer**].

B. Sample Warranty: For special warranty.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certificates.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Installer Qualifications: [**An authorized representative who is trained and approved by**

manufacturer][**and**][**Licensed participate in AWI's Quality Certification Program**][**Licensed participate in WI's Certified Compliance Program**].

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period.[**Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."**]

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Delamination of components or other failures of glue bond.
b. Warping of components.
c. Failure of operating hardware.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.

1. Grade: [**Premium**][**Custom**][**Economy**].

2. Provide labels and certificates from [**AWI**][**WI**] certification program indicating that casework complies with requirements of grades specified.

   a. Contractor to register the Work under this Section with AWI's Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Product Designations:

   1. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."
   2. Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 PLASTIC-LAMINATE-CLAD CASEWORK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Advanced Cabinet Systems (ACS)**]
2. [**Case Systems Inc**]
3. [**CIF Lab Solutions LP**]
4. [**Hausmann Industries**]
5. [**ICIscientific**]
6. [**Mica-Tec**]
7. [**R. C. Smith Company**]
8. [**Sidney Millwork Company**]
9. [**Stevens Industries, Inc.**]
10. [**TMI Systems Corporation**]
11. [**Windham Millwork, Inc**]

B. Source Limitations: Obtain from single source from single manufacturer.

C. Design: [**Face-frame**][**Frameless**] cabinet construction with the following door and drawer-front style:

1. Lipped overlay with radiused wood edges[**and full-width, recessed finger pulls machined into faces of doors and drawers**].
2. Reveal overlay[**with recessed finger pulls machined into faces of doors and drawers**].
3. Flush overlay.

D. Grain Direction for Wood-Grain Plastic Laminate:

1. Doors: Vertical with continuous vertical matching.
2. Drawer Fronts: [**Vertical with continuous vertical matching**][**Horizontal**].
3. Face Frame Members: Lengthwise.
4. End Panels: Vertical.
5. Bottoms and Tops of Units: Side to side.
6. Knee Space Panels: Vertical.
7. Aprons: Horizontal.

E. Exposed Materials:

1. Plastic-Laminate Grade: [**HGS**][**VGS**].

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Edgebanding: [**Plastic laminate matching adjacent surfaces**][**PVC**].

   a. PVC Edgebanding Color: [**Casework manufacturer's standard**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

3. Solid Wood: Clear hardwood lumber of species indicated, selected for compatible grain and color.

   a. Wood Species: [**Red oak**][**White birch**][**Alder**][**White maple**][**Hickory**][**Cherry**].
   b. Wood Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from casework manufacturer's full range**], as

directed by the Owner.

F. Semiexposed Materials:

1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed surfaces unless otherwise indicated.

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
5. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

G. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood.
3. Plastic Laminate: Grade VGS.
4. Particleboard.
5. MDF.
6. Hardboard.

2.3 HARDWARE AND ACCESSORIES

A. Hardware: Unless otherwise indicated, provide manufacturer's standard [**satin-finish**][**mirror polished-finish**][**powder-coated**], commercial-quality, heavy-duty hardware.

1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Butt Hinges: [**Stainless steel**][**Chrome-plated**][**Powder-coated**], semiconcealed, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than **48 inches (1220 mm)** high, and provide three hinges for doors more than **48 inches (1220 mm)** high.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602[self-closing]. Provide two hinges for doors less than 48 inches (1220 mm) high, and provide three hinges for doors more than 48 inches (1220 mm) high.

1. Degrees of Opening: [**100**][**135**][**170**] degrees.

D. Wire Pulls: Solid [nylon][aluminum][stainless steel][chrome-plated brass] wire pulls, fastened from back with two screws.

1. For sliding doors, provide recessed [stainless steel][chrome-plated] flush pulls.
2. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

E. Semirecessed Pulls: Plastic. For sliding doors, provide recessed plastic flush-pulls. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

F. Door Catches: [Zinc-plated][Powder-coated], [nylon-roller spring catch][dual, self-aligning, permanent magnet catch]. Provide two catches on doors more than 48 inches (1220 mm) high.

G. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.

1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
2. Drawers: Provide one bumper on back side of drawer front at each corner.

H. Drawer Slides: ANSI/BHMA A156.9.

1. Manufacturer's standard.
2. Standard Duty (Grade 1): [**Side mount**][**Undermount**].
3. Heavy Duty (Grade 1HD-100): [**Side mount**][**Undermount**].

a. Type: [**Full**][**Full overtravel**][**Partial**] extension.
b. Material: [**Epoxy-coated polymer**][**Zinc-plated steel**] slides.
c. Motion Feature: [**Soft close dampener**][**Self-closing mechanism**].

4. General-purpose drawers; provide [**100 lb (45 kg)**] load capacity.
5. File drawers; provide [**150 lb (45 kg)**] load capacity.

I. Label Holders: [Stainless steel][chrome plated], sized to receive standard label cards approximately 1 by 2 inches (25 by 51 mm), and attached with screws or brads.

1. Provide label holders [**where indicated**][**on drawers**].

J. Drawer and Hinged-Door Locks: [**Cylindrical (cam)**][**Mortise**] type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.

1. Provide a minimum of two keys per lock and six master keys.
2. Provide locks [**where indicated**][**on every door and drawer**].

a. Master key for up to [**500**] key changes.

K. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.

1. Pin-type, [**two-pin-locking plastic shelf rests complying with ANSI/BHMA A156.9, Type B04013**][**Single-pin metal shelf rests complying with ANSI/BHMA A156.9, Type B04013**].
2. Mortise-type, [**zinc-plated**][**powder-coated**] steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

2.4 MATERIALS

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile

Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

G. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

H. Softwood Plywood: DOC PS 1.

I. Particleboard: ANSI A208.1, Grade M-2.

J. MDF: Medium-density fiberboard, ANSI A208.2, [**Grade 130**].

K. Hardboard: ANSI A135.4, Class 1 tempered.

L. Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABET Inc.**]
b. [**Arborite, Division of Wilsonart Canada ULC**]
c. [**Formica Corporation**]
d. [**Laminart LLC**]
e. [**Nevamar Company, LLC**]
f. [**Pionite; a Panolam Industries International, Inc. brand**]
g. [**Wilsonart LLC**]

2. Source Limitations: Obtain from single source from single manufacturer.

M. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

N. Thermally Fused Laminate Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper[**and complying with requirements of ISO 4586**].

1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

O. Glass for Glazed Doors:

1. Clear float glass complying with ASTM C1036, Type I, Class 1, Quality-Q3; not less than [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**] thick.
2. Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.
3. Clear laminated annealed glass complying with ASTM C1172, Kind LA, Condition A, Type I, Class I, Quality-Q3; with two plies not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

P. Frameless Glass Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than [**5.0 mm**][**6.0 mm**] thick; with exposed edges seamed before tempering.

Q. Adhesives: Do not use adhesives that contain urea formaldehyde.

R. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

S. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

T. Adhesives: Do not use adhesives that contain urea formaldehyde.

U. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:

1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: **3/4-inch (19-mm)** particleboard.
2. Shelves: [**3/4-inch- (19-mm-) thick particleboard**][**3/4-inch- (19-mm-) thick plywood or 1-inch- (25-mm-) thick particleboard**].
3. Backs of Casework: **1/2-inch- (13-mm-)** thick particleboard or MDF where exposed, [**1/4-inch- (6.4-mm-) thick hardboard**][**1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood**] dadoed into sides, bottoms, and tops where not exposed.
4. Drawer Fronts: **3/4-inch (19-mm)** particleboard.
5. Drawer Sides and Backs: **1/2-inch- (13-mm-)** thick [**solid-wood or veneer-core hardwood plywood**][**particleboard or MDF**], with glued dovetail or multiple-dowel joints.
6. Drawer Bottoms: **1/4-inch- (6.4-mm-)** thick [**hardwood plywood**][**particleboard or MDF**] glued and dadoed into front, back, and sides of drawers.[**Use 1/2-inch (13-mm) material for drawers more than 24 inches (600 mm) wide.**]
7. Drawer Bodies: Steel drawer pans formed from **0.0359-inch- (0.9-mm-)** thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and **2 mils (0.05 mm)** for system.
8. Cabinet Doors:

   a. 48 Inches (1220 mm) High or Less: **3/4 inch (19 mm)** thick, with particleboard or MDF cores[**and solid-wood stiles and rails**].

b. 48 Inches (1220 mm) or More in Height: [**1-1/16 inches (27 mm) thick, with solid hardwood stiles and rails and honeycomb**][**1-1/8 inches (29 mm) thick, with particleboard**] cores.

9. Stiles and Rails of Glazed Doors:

a. 48 Inches (1220 mm) High or Less: **3/4 inch (19 mm)** thick, with particleboard cores.
b. 48 Inches (1220 mm) or More in Height: [**1-1/16 inches (27 mm) thick, with solid wood**][**1-1/8 inches (29 mm) thick, with particleboard**] cores.

B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within **1/16 inch (1.5 mm)** of a single plane. Align similar adjoining doors and drawers to a tolerance of **1/16 inch (1.5 mm)**. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within **1/16 inch (1.5 mm)** of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of **1/16 inch (1.5 mm)**.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity to prepare and submit report of inspection.

3.4 CLEANING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect, as directed by the Owner.

END OF SECTION 12 30 00 00A

Task	Specification	Specification Description
12 31 00 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 31 00 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework

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SECTION 12 31 16 00 - STONE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Granite countertops.
2. Marble countertops.
3. Slate countertops.
4. Accessories.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for cantilever supports.
2. Section 123661 "Simulated Stone Countertops" for cultured-marble and quartz-agglomerate countertops.
3. Section 224100 "Residential Plumbing Fixtures" for non-integral sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each[**variety of stone,**] and stone accessory product.

B. Shop Drawings:

1. Plans, sections, details, edge and backsplash profiles, and attachments to other work.
2. Locations and details of joints.
3. Direction of veining, grain, or other directional pattern.
4. Locations and sizes of cutouts and holes for items installed in countertop.
5. Apply [**AWI's Quality Certification**][**WI's Certified Compliance**] Program label to Shop Drawings.

C. Samples: For each stone type, in sets not less than **12 inches (300 mm)** square.

1. Include [**two**][**three**] or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.

D. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.
11. Product Data: For installation adhesives, indicating VOC content.
12. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
13. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate locations and sizes of cutouts and holes for items installed in countertop and backsplashes.

B. Quality Standard Compliance Certificates: [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**].

C. Qualification Statements: For fabricator.

D. Material Test Reports:

1. Stone Test Reports: For[**each**] stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, in accordance with referenced ASTM standards. Base reports on testing done within previous [**three**][**five**] years.
2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone countertops. Include product data for stone-care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate stone countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

1. Shop Certification: [**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

B. Installer Qualifications: Fabricator of stone countertops.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturer, for compatibility and adhesion testing in accordance with sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication[**and indicate measurements on Shop Drawings**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Stone: Obtain[each variety of] stone,[regardless of finish,] from a single quarry[whether specified in this Section or in another Specification Section,] with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.
2. Make stone slabs available for examination by Architect, as directed by the Owner.

a. Architect will select aesthetically acceptable slabs[**and will indicate aesthetically unacceptable portions of slabs**], as directed by the Owner.
b. Segregate slabs selected for use on Project and mark backs indicating approval.
c. Mark and photograph aesthetically unacceptable portions of slabs as directed by the Owner.

2.2 PERFORMANCE REQUIREMENTS

A. General: Comply with recommendations in NSI's "Dimension Stone Design Manual."

B. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that may impair structural integrity, function, or appearance.

1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by Architect, as directed by the Owner.

C. Quality Standard: Unless otherwise indicated, comply with [**ANSI/AWI 1236**][**NAAWS**] for grades of stone countertops indicated for construction, finishes, installation, and other requirements.

1. Provide inspections of fabrication and installation together with labels and certificates from [**AWI**][**WI**] certification program indicating that countertops comply with requirements of grade specified.

2. The Contract Documents contain requirements that are more stringent than that of the referenced quality standard. Comply with requirements of the Contract Documents in addition to those of referenced quality standard.
3. Grade: [**Premium**][**Custom**][**Economy**][**Match related casework**].

2.3 GRANITE COUNTERTOPS

A. Material Standard: Comply with ASTM C615/C615M.

B. Regional Materials: Verify cast stone units are manufactured within **100 miles (160 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Regional Materials: Verify cast stone units are manufactured within **500 miles (800 km)** of Project site from aggregates[**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

D. Granite Countertop Type :

1. Characteristics: Uniform, [**fine**][**medium**]-grained, [**white**][**pink**][**gray**][**black**] stone[**without veining**].
2. Varieties and Sources: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available stone varieties that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Cut: [**Vein**][**Fleuri**].

      1) Cut stone from contiguous, matched slabs in which natural markings occur.

   b. Finish: [**Polished**][**Honed**][**Brushed**][**As indicated**][**Match Architect's sample**], as directed by the Owner.
   c. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

3. Description:

   a. Nominal Thickness: Provide thickness indicated, but not less than [**3/4 inch (20 mm)**][**7/8 inch (22 mm)**][**1-1/4 inches (32 mm)**]. Gage backs to provide units of identical thickness.
   b. Edge Profile: [**Straight, slightly eased at top**][**Bevel**][**Full bullnose**][**3/8-inch (10-mm) radius with 2-inch (50-mm) apron**][**As indicated**].
   c. Splashes: Provide **3/4-inch- (20-mm-)** thick [**backsplashes**][**and**][**end splashes**] unless otherwise indicated.

      1) Height: [**4 inches (100 mm)**][**As indicated**].
      2) Top-Edge Profile: [**Straight**][**Bevel**][**Radius**][**Match countertop edge**][**As indicated**].

4. Sink Bowls:

   a. [**Top Mount**][**Undermount**], with minimum **3/4-inch (19-mm)** wall thickness, complying with CSA B45.5/IAPMO Z124.
   b. [**Oval**][**Rectangle**][**As selected by Architect from manufacturer's full range**], as

directed by the Owner.

2.4 MARBLE COUNTERTOPS

A. Material Standard: Comply with ASTM C503/C503M[Classification I Calcite][Classification II Dolomite][Group A][Group B][Group C][Group D].

1. Stone Abrasion Resistance: Minimum value of [**10**], based on testing in accordance with ASTM C241/C241M or ASTM C1353/C1353M.
2. Regional Materials: Verify stone is fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
3. Regional Materials: Verify stone is fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

B. Marble Countertop Type :

1. Characteristics: Uniform, fine- to medium-grained, [**white**] stone with only slight veining.
2. Varieties and Sources: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available stone varieties that may be incorporated into the Work include, but are not limited to, the following**]:

a. Cut: [**Vein**][**Fleuri**].

1) Cut stone from contiguous, matched slabs in which natural markings occur.

b. Finish: [**Polished**][**Honed**][**Brushed**][**As indicated**][**Match Architect's sample**], as directed by the Owner.
c. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

3. Description:

a. Nominal Thickness: Provide thickness indicated, but not less than [**3/4 inch (20 mm)**][**7/8 inch (22 mm)**][**1-1/4 inches (32 mm)**]. Gage backs to provide units of identical thickness.
b. Edge Detail: [**Straight, slightly eased at top**][**Bevel**][**Full bullnose**][**3/8-inch (10-mm) radius with 2-inch (50-mm) apron**][**As indicated**].
c. Splashes: Provide **3/4-inch- (20-mm-)** thick [**backsplashes**][**and**][**end splashes**] unless otherwise indicated.

1) Height: [**4 inches (100 mm)**][**As indicated**].
2) Top-Edge Profile: [**Straight**][**Bevel**][**Radius**][**Match countertop edge**][**As indicated**].

4. Sink Bowls:

a. [**Top Mount**][**Undermount**], with minimum **3/4-inch (19-mm)** wall thickness, complying with CSA B45.5/IAPMO Z124.
b. [**Oval**][**Rectangle**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 SLATE COUNTERTOPS

A. Material Standard: Comply with ASTM C629/C629M[Classification I Exterior][Classification II Interior].

1. Stone Abrasion Resistance: Minimum value of [**8**], based on testing in accordance with ASTM C241/C241M or ASTM C1353/C1353M.
2. Regional Materials: Verify stone is fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
3. Regional Materials: Verify stone is fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

B. Slate Countertop Type :

1. Characteristics: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**] slate with a fine, even grain[**and unfading color,**] from clear, sound stock.
2. Varieties and Sources: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available stone varieties that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Finish: [**Honed**][**Sand Rubbed**][**Tumbled**][**As indicated**][**Match Architect's sample**], as directed by the Owner.
   b. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects, as directed by the Owner.

3. Description:

   a. Nominal Thickness: Provide thickness indicated, but not less than [**1 inch (25 mm)**][**1-1/4 inches (30 mm)**]. Gage backs to provide units of identical thickness.
   b. Edge Profile: [**Straight, slightly eased at top and bottom**][**Bevel**][**Full bullnose**][**As indicated**].
   c. Splashes: Provide **3/4-inch- (20-mm-)** thick [**backsplashes**][**and**][**end splashes**] unless otherwise indicated.

      1) Height: [**4 inches (100 mm)**][**As indicated**].
      2) Top-Edge Profile: [**Straight, slightly eased at top and bottom**][**Bevel**][**Radius**][**As indicated**].

4. Sink Bowls:

   a. [**Top Mount**][**Undermount**], with minimum **3/4-inch (19-mm)** wall thickness, complying with CSA B45.5/IAPMO Z124.
   b. [**Oval**][**Rectangle**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 ACCESSORIES

A. Grommets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Doug Mockett & Company, Inc.**]
b. [**Hafele America Co.**]
c. [**W.W. Grainger, Inc.**]

2. Wire-Management Grommets: Circular, grommets and matching caps with slot for wire passage.

a. Finish: [**Metal**][**Molded plastic**].
b. Outside Diameter: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].
c. Color: [**Brushed, nickel plated**][**Polished, chrome plated**][**Black, epoxy coated**][**Brown**][**Black**].

3. Power/Data Grommets: UL-listed [**recessed**][**pop-up**] grommet.

a. Power Outlets: [**Two**][**Three**][**Five**].
b. USB Charger: [**Type A**][**Type B**][**1 Dual**].

4. Paper-Slot Grommet: [**12 inches (305 mm)**][**17 inches (432 mm)**] long by **1-3/4 inches (45 mm)** wide by **1 inch (25 mm)** deep; molded-plastic, paper-slot liner with **1/4-inch (6.4-mm)** lip.

a. Color: [**Brown**][**Black**].

B. Support Brackets:

1. Countertop: :

a. Type: [**Hidden**][**Front mount**][**Decorative**].
b. Material: [**Steel**][**Stainless steel**][**Bronze**][**Iron**].
c. Color: [**Black**][**White**] powder coat.

2.7 MISCELLANEOUS MATERIALS

A. General: Use only adhesives formulated for stone and ceramic tile and that are recommended by their manufacturer for the application indicated.

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
2. Product Data: For installation adhesives, indicating VOC content.
3. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

B. Subtops:

1. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

a. Verify particleboard is made without urea formaldehyde.
b. Verify particleboard has formaldehyde emission rates not greater than 0.09 ppm when tested in accordance with ASTM D6007 or ASTM E1333.

2. Plywood: [**Marine Grade**][**Exterior Grade C-D Exposure 1**] complying with DOC PS 1.

C. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**Atlas Minerals & Chemicals, Inc**]
    c. [**Bostik; Arkema**]
    d. [**C-Cure**]
    e. [**Custom Building Products**]
    f. [**H.B. Fuller Construction Products Inc. / TEC**]
    g. [**Jamo Inc**]
    h. [**Laticrete International, Inc.**]
    i. [**MAPEI Corporation**]
    j. [**Parex, a Sika brand**]
    k. [**Sakrete; CRH Americas, Oldcastle APG**]
    l. [**Southern Grouts & Mortars, Inc**]
    m. [**Summitville Tiles, Inc.**]

D. Water-Cleanable Epoxy Grout: ANSI A118.3,[**with a VOC content of 65 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Minerals & Chemicals, Inc**]
    b. [**Boiardi Products Corporation; a QEP company**]
    c. [**Bostik; Arkema**]
    d. [**C-Cure**]
    e. [**Custom Building Products**]
    f. [**H.B. Fuller Construction Products Inc. / TEC**]
    g. [**Jamo Inc**]
    h. [**Laticrete International, Inc.**]
    i. [**MAPEI Corporation**]
    j. [**Parex, a Sika brand**]
    k. [**Sakrete; CRH Americas, Oldcastle APG**]
    l. [**Sauereisen**]
    m. [**Siena Tile & Stone Installation Products; Omega Products International**]
    n. [**Southern Grouts & Mortars, Inc**]
    o. [**Summitville Tiles, Inc.**]

E. Stone Adhesive: [Epoxy][polyester] formulated specifically for bonding or seaming stone to stone, with an initial set time of not more than two hours at 70 deg F (21 deg C).

1. Color: [**Clear**][**Match stone**].

F. Sealant for Countertops: Manufacturer's standard sealant that complies with applicable requirements in Section 079200 "Joint Sealants" and that will not stain the stone it is applied to.

1. Mildew-Resistant Joint Sealant: [**Mildew resistant, single component, nonsag, neutral curing, silicone**][**Single component, nonsag, mildew resistant, acid curing, silicone**].
2. Color: [**Clear**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Stone Joint Splines: Stainless steel or brass washers approximately **1 inch (25 mm)** in diameter and of thickness to fit snugly in saw-cut kerf in edge of stone units.

H. Stone Cleaner: Specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer[**and, if a sealer is specified, by sealer manufacturer**]. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

I. Stone Sealer: Stone manufacturer's recommended colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

2.8 FABRICATION

A. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated.

1. Clean sawed backs of stones to remove rust stains and iron particles.
2. Dress joints straight and at right angle to face unless otherwise indicated.
3. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.
4. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
5. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased unless otherwise indicated.
6. Finish exposed faces of stone to comply with requirements indicated for finish of each stone type required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.

B. Mark stone for final locations to produce assembled countertop units with an overall uniform appearance.

C. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

D. Joints:

1. Fabricate countertops without joints.
2. Fabricate countertops in sections for joining in field[with joints at locations indicated].
3. Joint Locations: Not within **18 inches (450 mm)** of a sink or cooktop and not where a countertop section less than **36 inches (900 mm)** long may result, unless unavoidable.
4. Joint Type, Bonded or Seamed: **1/32 inch (0.8 mm)** or less in width.
5. Joint Type, Grouted: **1/16 inch (1.5 mm)** in width.
6. Joint Type, Sealant Filled: **1/16 inch (1.5 mm)** in width.
7. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints[**where indicated**]. Make width of cuts slightly more than thickness of splines to provide snug fit.[**Provide at least three splines in each joint.**]

E. Cutouts and Holes:

1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting **3/16 inch (5 mm)** into fixture opening.
b. Provide vertical edges, rounded to **3/8-inch (10-mm)** radius at juncture of cutout edges

with top surface of countertop, slightly eased at bottom, and projecting **3/16 inch (5 mm)** into fixture opening.

c. Provide **3/4-inch (20-mm)** full bullnose edges projecting **3/8 inch (10 mm)** into fixture opening.

2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive stone countertops and conditions under which stone countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by stone countertop Installer for anchoring stone countertops. Furnish installers of other work with Drawings or templates showing locations of these items.

B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives, and rinse with clear water. Allow stone to dry before installing.

3.3 INSTALLATION OF STONE COUNTERTOPS

A. Grade: Install countertop to comply with same grade as item to be installed.

B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

C. Install countertops over subtops with full spread of water-cleanable epoxy adhesive.

D. Install countertops by adhering to supports with water-cleanable epoxy adhesive.

E. Do not field cut stone unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.

F. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

G. Set stone to comply with requirements indicated. Shim and adjust stone to locations indicated, with

uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.[**Install anchors and other attachments indicated or necessary to secure stone countertops in place.**]

H. Bond joints with stone adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in stone edges at joints[**where indicated**]. Fill kerfs with stone adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

I. Space joints with **1/16-inch (1.5-mm)** gap for filling with [**grout**][**sealant**]. Use temporary shims to ensure uniform spacing.

1. Install metal splines in kerfs in stone edges at joints[**where indicated**]. Fill kerfs with [**setting adhesive**][**sealant**] before inserting splines and remove excess immediately after adjoining units are drawn into position.
2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

J. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut stone. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

K. Install backsplashes and end splashes by adhering to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Leave **1/16-inch (1.5-mm)** gap between splashes and wall for filling with sealant. Use temporary shims to ensure uniform spacing.

L. Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave **1/16-inch (1.5-mm)** gap between countertop and splashes for filling with sealant. Use temporary shims to ensure uniform spacing.

M. Grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.

N. Apply sealant to [**joints**][**and**][**gaps specified for filling with sealant**]; comply with Section 079200 "Joint Sealants." Remove temporary shims before applying sealant.

3.4 REPAIR

A. Repair damaged and defective countertop where possible, to eliminate functional and visual defects[**and to result in interior architectural woodwork being in compliance with requirements of referenced quality standard for the specified grade**].

B. Where not possible to repair, remove and replace stone countertops of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect, as directed by the Owner.
2. Defective countertops.
3. Defective joints, including misaligned joints.
4. Interior stone countertops and joints not matching approved Samples and mockups.
5. Interior stone countertops not complying with other requirements indicated.

C. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.

3.5 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the referenced standard for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.6 ADJUSTING AND CLEANING

A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.

B. Clean stone countertops no fewer than six days after completion of [**sealant installation**][**installation**], using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that may damage stone.

C. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 12 31 16 00

Task	Specification	Specification Description
12 31 16 00	01 22 00 00	No Specification Required
12 31 16 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 31 16 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework

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SECTION 12 35 00 00 - PLASTIC-LAMINATE-CLAD LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad laboratory casework.
2. Auxiliary cabinets.
3. Countertops.
4. Laboratory accessories.
5. Water and laboratory gas service fittings.
6. Electrical and communication service fittings.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring laboratory casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to laboratory casework.
4. Section 115313 "Laboratory Fume Hoods" for fume hoods[including base cabinets and countertops under fume hoods].

1.2 DEFINITIONS

A. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.

B. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than **48 inches (1200 mm)** above floor, and visible surfaces in open cabinets or behind glass doors.

1. Ends of cabinets are defined as "exposed"[**except ends are defined as "concealed" where installed directly against and completely concealed by walls or other cabinets**].

C. Plastic Laminate: High-Pressure Decorative Laminate (HPDL).

D. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cases **78 inches (1980 mm)** or more above floor and bottoms of cabinets more than **24 inches (600 mm)**, but less than **48 inches (1200 mm)** above floor, are defined as "semiexposed."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

B. Keying Conference: Conduct conference at [**Project site**]. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of laboratory equipment.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-clad laboratory casework.
2. Auxiliary cabinets.
3. Countertops.
4. Laboratory accessories.
5. Water and laboratory gas service fittings.
6. Electrical and communication service fittings.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
8. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
9. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
10. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
12. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
13. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For laboratory casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations and types of service fittings.
6. Include details of utility spaces showing supports for conduits and piping.
7. Include details of exposed conduits, if required, for service fittings.
8. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and laboratory equipment.
9. Include coordinated dimensions for laboratory equipment specified in other Sections.

D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

E. Samples: For plastic laminate.

F. Samples for Initial Selection: For plastic laminate and other materials requiring color selection.

G. Samples for Verification: For each type of casework, exposed-hardware, and countertop-material finish, in manufacturer's standard sizes.

1. Base Cabinet: One full-size[16-inch- (406-mm-)] wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
2. Wall Cabinet: One full-size[12-inch- (304-mm-)] wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
3. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their locations, as directed by the Owner.

H. Delegated Design Submittals: For laboratory casework indicated to comply with seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Test Reports: For countertop surface material, based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface material with requirements specified for chemical and physical resistance.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet-work are complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Established Dimensions: Where laboratory casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where laboratory casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

B. Obtain [**countertops**][**sinks**][**accessories**][**and**][**service fittings**] from casework manufacturer.

C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design laboratory casework installation.

B. Seismic Performance: Laboratory casework installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Design earthquake spectral response acceleration, short period (Sds) for Project is [**indicated on Drawings**].
2. Component Importance Factor: [**1.0**][**1.5**].
3. Base Cabinet Load (Including Countertop and Load on Countertop): [**200 lb/ft. (300 kg/m)**].
4. Wall Cabinet (Upper Cabinet) Load: [**100 lb/ft. (150 kg/m)**].

2.3 CASEWORK, GENERAL

A. Casework Product Standard: Comply with SEFA 8-PL, "Laboratory Grade Plastic Laminate Casework."

B. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage,

provide units that are listed and labeled as complying with requirements in NFPA 30 by [**a testing and inspecting agency acceptable to authorities having jurisdiction**][**FM Approvals**].

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

F. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

G. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

K. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

L. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

M. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.4 PLASTIC-LAMINATE-CLAD LABORATORY CASEWORK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Case Systems Inc**]
2. [**CIF Lab Solutions LP**]
3. [**Stevens Industries, Inc.**]

4. [**TMI Systems Corporation**]

B. Design:

1. Lipped overlay with radiused wood edges[**and full-width, recessed finger pulls machined into faces of doors and drawers**].
2. Reveal overlay[**with recessed finger pulls machined into faces of doors and drawers**].
3. Flush overlay.

C. Grain Direction for Wood Grain Plastic Laminate:

1. Doors: Vertical with continuous vertical matching.
2. Drawer Fronts: [**Vertical with continuous vertical matching**][**Horizontal**].
3. Face Frame Members: Lengthwise.
4. End Panels: Vertical.
5. Bottoms and Tops of Units: Side to side.
6. Knee Space Panels: Vertical.
7. Aprons: Horizontal.

D. Exposed Materials:

1. Plastic-Laminate Grade: [**HGS**][**VGS**].

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Edgebanding: [**Plastic laminate matching adjacent surfaces**][**PVC**].

   a. PVC Edgebanding Color: [**Casework manufacturer's standard**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

3. Solid Wood: Clear hardwood lumber of species indicated, selected for compatible grain and color.

   a. Wood Species: [**Red oak**][**White birch**][**Alder**][**White maple**][**Hickory**][**Cherry**].
   b. Wood Finish: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

E. Semiexposed Materials:

1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
   b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate (TFL) panels for semiexposed surfaces unless otherwise indicated.

   a. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's**

samples][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.

3. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects.
4. Plywood: Hardwood plywood. [**Grade B**][**Grade C**] faces and Grade J crossbands. Provide backs of same species as faces.
5. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

F. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood.
3. Plastic Laminate: Grade VGS.
4. Particleboard.
5. MDF.
6. Hardboard.

2.5 PLASTIC-LAMINATE CABINET MATERIALS

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

G. MDF: Medium-density fiberboard, ANSI A208.2, [**Grade 130**].

H. Particleboard: ANSI A208.1, Grade M-2.

I. Hardboard: ANSI A135.4, Class 1 tempered.

J. Plastic Laminate: HDPL complying with ISO 4586-3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABET Inc.**]
b. [**Arborite, Division of Wilsonart Canada ULC**]
c. [**Formica Corporation**]
d. [**Laminart LLC**]
e. [**Nevamar Company, LLC**]
f. [**Wilsonart LLC**]

K. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

L. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper.

1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

M. Adhesives: Do not use adhesives that contain urea formaldehyde.

N. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

O. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

P. Adhesives: Do not use adhesives that contain urea formaldehyde.

Q. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.6 AUXILIARY CABINETS

A. Acid Storage-Cabinet Lining: **1/4-inch- (6-mm-)** thick, [**glass-fiber cement board complying with ASTM C1186**][**polyethylene or polypropylene**][**polyethylene, polypropylene, epoxy, or phenolic-composite lining material**].

B. Float Glass for Glazed Doors: Clear float glass complying with ASTM C1036, Type I, Class 1, Quality-Q3; not less than [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**] thick.

C. Tempered Glass for Glazed Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

D. Laminated Glass for Glazed Doors: Clear laminated annealed glass complying with ASTM C1172, Kind LA, Condition A, Type I, Class I, Quality-Q3; with two plies not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

E. Frameless Glass Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than [**5.0 mm**][**6.0 mm**] thick; with exposed edges seamed before tempering.

2.7 CABINET HARDWARE

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Butt Hinges: [**Stainless**][**Epoxy-coated**] steel, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors **48 inches (1200 mm)** high or less and three for doors more than **48 inches (1200 mm)** high.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602[self-closing]. Provide two for doors 48 inches (1200 mm) high or less and three for doors more than 48 inches (1200 mm) high.

1. Degrees of Opening: [**100**][**135**][**170**].

D. Hinged-Door and Drawer Pulls: [**Solid-aluminum, stainless steel, or chrome-plated-brass**][**Epoxy-coated-steel**], back-mounted pulls. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

1. Design: [**Wire pulls**][**Rectangular loop pulls**][**Rectangular loop pulls with rounded corners**][**As selected from manufacturer's full range**][**As indicated**].
2. Overall Size: [**1 by 4-1/2 inches (25 by 114 mm)**][**1-1/4 by 4-1/2 inches (32 by 114 mm)**][**1-3/8 by 5-1/2 inches (35 by 140 mm)**][**As indicated**].

E. Sliding-Door Pulls: [**Stainless steel or chrome-plated**][**Epoxy-coated-steel**] recessed flush pulls.

1. Design and Size: [**Round, 3/4-inch (19-mm) diameter by 1/8 inch (3 mm) deep**][**Round, 3/4-inch (19-mm) diameter by 3/16 inch (5 mm) deep**][**Oval, 1 by 3 inches (25 by 76 mm), 3/8 inch (10 mm) deep**][**As selected from manufacturer's full range**][**As indicated**].

F. Recessed Pulls: [**Aluminum**][**Polypropylene**]. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

G. Channel Pulls: Full-width, recessed [**aluminum**][**solid-hardwood**] pulls.

H. Door Catches: [**Nylon-roller spring**][**Dual, self-aligning, permanent magnet**] catches. Provide two catches on doors more than **48 inches (1200 mm)** high.

I. Drawer Slides: ANSI/BHMA A156.9.

1. Manufacturer's standard.
2. Standard Duty (Grade 1): [**Side mount**][**Undermount**].
3. Heavy Duty (Grade 1HD-100): [**Side mount**][**Undermount**].

a. Type: [**Full**][**Full overtravel**][**Partial**] extension.
b. Material: [**Epoxy-coated polymer**][**Zinc-plated ball bearing**] slides.
c. Motion Feature: [**Soft close dampener**][**Self-closing mechanism**].

4. General-purpose drawers; provide [**100 lb (45 kg)**] load capacity.
5. File drawers; provide [**150 lb (45 kg)**] load capacity.

J. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately **1 by 2 inches (25 by 50 mm)**, attached with screws or rivets. Provide [**where indicated**][**on drawers**].

K. Locks: Cam type, brass with chrome-plated finish; complying with ANSI/BHMA A156.11, Type E07281[

or Type E07261].

1. Tumbler: [**Disc**][**Five pin**].
2. Lock Locations: Provide [**where indicated**][**on drawers and doors**].
3. Keying: Key [**locks alike within each room; key each room separately**][**each lock separately**][**locks as directed**].

    a. Master key for up to [**225**][**500**] key changes.

4. Key Quantity: Minimum of [**two**] keys per lock.
5. Master Key System: Key locks to be operable by master key.

    a. Master Keys: Provide [**two**].

L. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and size of sliding-door units.

M. Adjustable Shelf Supports: ANSI/BHMA A156.9, powder-coated steel [**shelf rests, Type B04013**][**standards, mortise type, and shelf rests, Type B04071 and Type B04091**].

2.8 COUNTERTOPS

A. General: Provide laboratory [**tabletops**][**and**] countertops with integral [**shelf**][**trough**][**and**][**sink**] as indicated on Drawings.

B. Plastic Laminate: HDPL complying with ISO 4586-3, [**Grade HGS**][**Grade HGF**][**Grade HGP**].

1. Colors, Patterns, and Finishes: [**As indicated by manufacturer's designations**][**As selected by Architect from casework manufacturer's full range**][**As selected by Architect from plastic-laminate manufacturer's full range**][**As selected by Architect from plastic-laminate manufacturer's full range of solid colors**], as directed by the Owner.

C. Chemical-Resistant Plastic Laminate: HDPL complying with ISO 4586-3, Grade HGP, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Arborite, Division of Wilsonart Canada ULC**]
    b. [**Formica Corporation**]
    c. [**Nevamar Company, LLC**]
    d. [**Wilsonart LLC**]

2. Physical Properties: Minimum acceptable chemical-resistance performance to result in no more than four (4) Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.
3. Color: [**Black**][**As indicated by manufacturer's designations**][**As selected by Architect from chemical-resistant, plastic-laminate manufacturer's full range**], as directed by the Owner.

D. Core Materials for Plastic Laminate:

1. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

2. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
3. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
4. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
5. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
6. Composite Wood Products: Products shall be made without urea formaldehyde.
7. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
9. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

10. Composite Wood Products: Products shall be made without urea formaldehyde.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Exterior-Glue Particleboard: ANSI A208.1, Grade M-2, exterior glue.
13. Exterior Plywood: DOC PS 1, [**Exterior A-C**][**Exterior B-C**] with fully sanded face.

E. Adhesive for Bonding Plastic Laminate: [**Type I, waterproof type**][**Type II water-resistant type**] as selected by fabricator to comply with requirements.

1. Adhesives: Do not use adhesives that contain urea formaldehyde.
2. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives: Do not use adhesives that contain urea formaldehyde.
5. Adhesives: Do not use adhesives that contain urea formaldehyde.

F. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Epoxy Scientific LLC**]

b. [**Durcon; a Wilsonart Company**]
c. [**Prime Industries, Inc**]

2. Physical Properties:

a. Flexural Strength: Not less than **10,000 psi (70 MPa)**.
b. Modulus of Elasticity: Not less than **2,000,000 psi (1400 MPa)**.
c. Hardness (Rockwell M): Not less than 100.
d. Water Absorption (24 Hours): Not more than 0.02 percent.
e. Heat Distortion Point: Not less than **260 deg F (127 deg C)**.
f. Chemical Resistance: Minimum acceptable chemical-resistance performance to result in no more than four (4) Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.

3. Color: [**Black**][**Gray**][**Beige**][**White**][**As selected by Architect from epoxy manufacturer's full range**], as directed by the Owner.

G. Phenolic Composite: Solid, high-pressure decorative laminate, complying with ISO 4586-4, Grade CGS.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arborite, Division of Wilsonart Canada ULC**]
b. [**Formica Corporation**]
c. [**Nevamar Company, LLC**]
d. [**Trespa North America**]

2. Chemical Resistance: Minimum acceptable chemical-resistance performance to result in no more than four (4) Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.
3. Color: [**Black**][**Gray**][**Beige**][**White**][**As selected by Architect from phenolic-composite manufacturer's full range**], as directed by the Owner.

H. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316L**].

2.9 CABINET FABRICATION

A. Construction: Provide plastic-laminate laboratory casework of the following minimum construction:

1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: **3/4-inch- (19-mm-)** thick particleboard.
2. Shelves: **3/4-inch- (19-mm-)** thick [**particleboard**][**plywood**].
3. Exposed Backs of Cabinets: **1/2-inch- (13-mm-)** thick particleboard or MDF.
4. Backs of Cabinets: [**1/4-inch- (6.4-mm-) thick hardboard**][**1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood**] dadoed into sides, bottoms, and tops where not exposed unless otherwise indicated.
5. Drawer Fronts: **3/4-inch- (19-mm-)** thick particleboard.
6. Drawer Sides and Backs: **1/2-inch- (13-mm-)** thick [**solid-wood or veneer-core hardwood plywood**][**particleboard or MDF**], with glued dovetail or multiple-dowel joints.
7. Drawer Bottoms: **1/4-inch- (6.4-mm-)** thick [**hardwood plywood**][**particleboard or MDF**] glued and dadoed into front, back, and sides of drawers.

a. Use **1/2-inch- (13-mm-)** thick material for drawers more than **24 inches (600 mm)** wide.

8. Drawer Bodies: Steel drawer pans formed from **0.036-inch- (0.91-mm-)** thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and **2 mils (0.05 mm)** for system.
9. Doors Less Than 48 Inches (1200 mm) High: **3/4 inch (19 mm)** thick, with particleboard or MDF cores.

    a. Provide solid-wood stiles and rails.

10. Doors More Than 48 Inches (1200 mm) High: [**1-1/16 inches (27 mm) thick, with honeycomb cores and solid-hardwood stiles and rails**][**1-1/8 inches (29 mm) thick, with particleboard cores**].
11. Stiles and Rails of Glazed Doors Less Than 48 Inches (1200 mm) High: **3/4 inch (19 mm)** thick, with particleboard cores.
12. Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: [**1-1/16 inches (27 mm) thick, with solid-wood**][**1-1/8 inches (29 mm) thick, with particleboard**] cores.

B. Utility-Space Framing: Steel framing units consisting of two steel slotted channels complying with MFMA-4, not less than **1-5/8 inches (41 mm)** square by **0.105-inch (2.66-mm)** nominal thickness, that are connected at top and bottom by U-shaped brackets made from **1-1/4-by-1/4-inch (32-by-6-mm)** steel flat bars. Framing units may be made by welding channel material into rectangular frames instead of using U-shaped brackets.

C. Removable Backs: Provide backs that can be removed from within cabinets at utility spaces.

D. Filler and Closure Panels: Provide where indicated and as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as adjacent exposed casework surfaces unless otherwise indicated.

1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where [**cabinets are not installed against a wall or where space is not otherwise closed**][**indicated**].
2. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
3. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.10 COUNTERTOP FABRICATION

A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of **1 inch (25 mm)**.

B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect, as directed by the Owner.

1. Outlets: Provide with strainers and tailpieces, **NPS 1-1/2 (DN 40)**, unless otherwise indicated.
2. Overflows: [**For each sink except cup sinks,**][**Where indicated,**] provide overflow of standard beehive or open-top design with separate strainer. Height **2 inches (50 mm)** less than sink depth. Provide in same material as strainer.

C. Plastic Laminate:

1. Countertops: [**Plastic**][**Chemical-resistant plastic**] laminate shop bonded to top surface and exposed edges of core with plastic-laminate backing bonded to bottom surface. Sand surfaces to which plastic laminate is to be bonded.

a. Top Core Thickness: [3/4 inch (19 mm)][1 inch (25 mm)][1-3/16 inches (30 mm)].
b. Backsplash Core Thickness: [3/4 inch (19 mm)][1 inch (25 mm)].
c. Countertop Core: [Particleboard][exterior-glue particleboard][exterior plywood].
d. Countertop Core for Counters Containing Sinks: [Exterior-glue particleboard][exterior plywood].
e. Flat Configuration: With square edges, flat backsplashes, and flat end splashes. Finish faces and exposed edges of splashes with same plastic laminate as top.
f. Postformed Configuration: With[**raised,**] rolled edge and integral coved backsplash with rolled top edge. Construct top and backsplash from one piece of plastic laminate. Where indicated, provide separate end splashes of same material as top and fitted to top.
g. Plastic-Laminate Backer Sheet: HDPL complying with ISO 4586-3, grade to match exposed surface.

2. Shelves: [**Plastic**][**Chemical-resistant plastic**] laminate shop bonded to both faces and edges of core. Sand surfaces to which plastic laminate is to be bonded.

a. Shelf Core: [Particleboard][exterior-glue particleboard][exterior plywood].
b. Core Thickness: [3/4 inch (19 mm)][1 inch (25 mm)].

D. Epoxy:

1. Countertops: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

a. Flat Configuration: [5/8 inch (16 mm)][3/4 inch (19 mm)][1 inch (25 mm)] thick with continuous drip groove on underside 1/2 inch (13 mm) from overhang edge.

1) Edges and Corners: [**Beveled**][**Rounded**].
2) Backsplash: [**Integral coved**][**Applied**].

b. Marine-Edge Configuration: [5/8-inch (16-mm)][3/4-inch (19-mm)][1-inch (25-mm)] minimum thickness, with integral or applied raised edge.

1) Edges and Corners: [**Beveled**][**Rounded**].
2) Backsplash: [**Integral coved**][**Applied**].

c. Construction: [**Uniform throughout full thickness**][**Epoxy composition not less than 1/4 inch (6 mm) thick, laminated to backing**].
d. Product Option: Phenolic-composite countertops may be substituted for epoxy countertops at Contractor's option.

2. Sinks: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.

a. Provide with polypropylene strainers and tailpieces.
b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
c. Provide sinks for drop-in installation with 1/4-inch- (6-mm-) thick lip around perimeter of sink.
d. Provide sinks for underside installation with manufacturer's recommended adjustable support system for table- and cabinet-type installations.

E. Phenolic-Composite:

1. Countertops: Fabricate with cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

a. Flat Configuration: [1/2 inch (13 mm)][5/8 inch (16 mm)][3/4 inch (19 mm)][1 inch (25 mm)] thick with continuous drip groove on underside 1/2 inch (13 mm) from overhang edge and integral coved backsplash.

1) Edges and Corners: [**Beveled**][**Rounded**].

b. Marine-Edge Configuration: [1/2-inch (13-mm)][5/8-inch (16-mm)][3/4-inch (19-mm)][1-inch (25-mm)] minimum thickness, with raised edge and integral coved backsplash.

1) Edges and Corners: [**Beveled**][**Rounded**].

2. Shelves: Flat, [5/8 inch (16 mm)][3/4 inch (19 mm)] thick.

a. Edges and Corners: [**Beveled**][**Rounded**].

F. Stainless Steel:

1. Countertops: Made from stainless steel sheet, not less than 0.062-inch (1.59-mm) nominal thickness, with ASTM A480/A480M No. 4 satin finish.

a. Extend top down 1 inch (25 mm) at edges with a 1/2-inch (13-mm) return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
b. Form backsplash coved to and integral with top surface.
c. Provide raised (marine) edge [**around perimeter of countertops containing sinks**][**and**][**where indicated**].
d. Pitch countertops that contain sinks two ways to sink[where indicated,] without channeling or grooving.
e. Factory punch holes for service fittings.
f. Reinforce underside of countertop with channels, or use thicker metal sheet where necessary to ensure rigidity without deflection.
g. Weld shop-made joints.
h. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
i. Where stainless steel sinks and cup sinks occur in stainless steel countertops, factory weld into one integral unit.
j. After fabricating and welding, grind surfaces smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

2. Shelves: Made from stainless steel sheet, not less than 0.050-inch (1.27-mm) nominal thickness, with ASTM A480/A480M No. 4 satin finish. Weld shop-made joints. Fold [**down**][**up**] front edge 3/4 inch (19 mm); fold up back edge 3 inches (75 mm).

a. Provide integral stiffening brackets, formed by folding up ends 3/4 inch (19 mm) and welding to upturned [**back edge**][**front and back edges**].
b. After fabricating, grind welds smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

3. Sinks: Made from stainless steel sheet, not less than 0.050-inch (1.27-mm) nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch (16-mm) radius. Slope sink bottoms to outlet. Provide continuous butt-welded joints.

a. Provide double-wall construction for sink partitions with top edge rounded to at least 1/2-inch (13-mm) diameter.

b. After fabricating and welding, grind surfaces smooth and polish to produce uniform finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
c. Factory punch holes for fittings.
d. Provide with stainless steel strainers and tailpieces.
e. Provide with integral rims except where located in stainless steel countertops.
f. Apply **1/8-inch- (3-mm-)** thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.

G. Cup Sinks: Provide in material indicated, [**3-by-6-inch (75-by-150-mm) oval**][**3-by-9-inch (75-by-228-mm) oval**][**5-inch (127-mm) diameter**][**as indicated on Drawings**].

1. Epoxy Cup Sinks: Provide with polypropylene strainers and integral tailpieces.
2. Polypropylene Cup Sinks: Provide with polypropylene strainers and integral tailpieces.
3. Stainless Steel Cup Sinks: Provide with stainless steel strainers and integral tailpieces.

H. Troughs: Provide in material indicated and pitch to drains not less than **1/8 inch/foot (10 mm/m)**. Except where troughs empty into sinks, provide **NPS 1-1/2 (DN 40)** outlets with strainers and tailpieces.

1. Epoxy Troughs: Molded in one piece with smooth surfaces and coved corners; [**1/2-inch (13-mm)**][**5/8-inch (16-mm)**][**3/4-inch (19-mm)**] minimum thickness. Provide polypropylene strainers and tailpieces.
2. Stainless Steel Troughs: Made from stainless steel sheet, not less than [**0.050-inch (1.27-mm)**][**0.062-inch (1.59-mm)**] nominal thickness. Fabricate with corners rounded and coved to at least **5/8-inch (16-mm)** radius. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth and polish to produce uniform finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean. Provide stainless steel strainers and tailpieces.

2.11 LABORATORY ACCESSORIES

A. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop unless otherwise indicated.

B. Burette Rods: Aluminum or stainless steel rods, **1/2 inch (13 mm)** in diameter and **18 inches (450 mm)** long, threaded on one end to fit tapered plug adapter for flush socket receptacle. Provide with tapered plug adapter and receptacle.

C. Upright Rod Assembly and Metal Crossbar: Aluminum or stainless steel. Two vertical rods and one horizontal crossbar, **3/4 inch (19 mm)** in diameter and **36 inches (900 mm)** long unless otherwise indicated; two flush socket receptacles and two crossbar clamps. Ends of vertical rods are tapered to fit receptacles; other rod ends are rounded.

D. Greenlaw Arm Assembly: Aluminum or stainless steel vertical rod, tapered on one end to fit flush socket receptacle. Adjustable crossbar of hardwood with black, acid-resistant finish, secured to upright with adjustable clamp. Provide with receptacle.

E. Lattice Assembly: Aluminum or stainless steel, vertical and horizontal rod lattice assembly with **3/4-inch- (19-mm-)** diameter rods at approximately **12 inches (300 mm)** o.c. with two flush socket receptacles for mounting.

1. Size: [**36 inches (900 mm)**][**48 inches (1200 mm)**] wide by [**24 inches (600 mm)**][**36 inches (900 mm)**] high.

F. Plastic or Resin Pegboards: Polypropylene, epoxy, or phenolic-composite pegboards with removable polypropylene pegs and stainless steel drip troughs with drain outlet.

G. Stainless Steel Pegboards: Stainless steel pegboards with removable polypropylene pegs and stainless steel drip troughs with drain outlet.

2.12 WATER AND LABORATORY GAS SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Broen A/S**]
2. [**Chicago Faucets; Geberit Group**]
3. [**WaterSaver Faucet Co**]

B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.

1. Provide units that comply with "Vandal-Resistant Fittings" recommendations in SEFA 7.

C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

1. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.

D. Finish: [**Chromium plated**][**Chromium plated unless otherwise indicated**][**Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes**].

1. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white, or other color as approved by Architect, as directed by the Owner.

E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to **80 psig (550 kPa)**.

1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
3. Self-Closing Valves: Provide self-closing valves where indicated.

F. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than **5 lbf (22 N)** to operate. Provide units designed for working pressure up to **75 psig (520 kPa)**, with serrated outlets.

1. Locking Safety Handles: Where ball valves are indicated for fuel-gas use, provide handles that must be [pushed in][pulled up] before being turned on.

G. Ground-Key Cocks: Tapered core and handle of one-piece forged brass, ground and lapped, and held in place under constant spring pressure. Provide units designed for working pressure up to **40 psig (280 kPa)**, with serrated outlets.

H. Steam Valves: Stainless steel seat and PTFE seat disc. Provide units designed for steam working pressure up to **20 psig (140 kPa)**, with serrated outlets.

I. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.

1. Provide units designed for working pressure up to [**60 psig (410 kPa)**][**100 psig (690 kPa)**][**125 psig (860 kPa)**][**as indicated on Drawings**][**as indicated in schedules**].

J. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."

K. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.

L. Handles: Provide [three- or four-arm, forged-brass][three- or four-wing, molded-plastic or powder-coated-metal] handles for valves unless otherwise indicated.

1. Provide lever-type handles for ground-key cocks. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
2. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
3. Provide heat-resistant plastic handles for steam valves.
4. Provide knurled, molded-plastic handles for needle valves.

M. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

2.13 ELECTRICAL AND COMMUNICATION SERVICE FITTINGS

A. Service Fittings, General: Provide units complete with metal housings, receptacles, switches, pilot lights,[**data communication outlets,**] cover plates, accessories, and gaskets required for mounting on laboratory casework.

B. Electrical Wiring Devices: Comply with requirements in Section 262726 "Wiring Devices" for receptacles, switches, pilot lights, cover plates, and accessories.

C. Twisted-Pair Copper Data Outlets: Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

D. Optical Fiber Data Outlets: Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

E. Receptacles:

1. Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

   a. Standards: Comply with NEMA WD 1, UL 498, and FS W-C-596.

2. Hospital-Grade, Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, and FS W-C-596.

3. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

a. Standards: Comply with NEMA WD 1, UL 498, and FS W-C-596.

4. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 1310, and FS W-C-596.
   b. USB Receptacles: [**Single**][**Dual**][**Quad**], Type A.

5. Hospital-Grade, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1310, and FS W-C-596.
   b. Marking: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

6. USB Receptacles: [**Single**][**Dual**][**Quad**], Type A.
7. Duplex GFCI Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; [**feed**][**non-feed**]-through type with integral LED indicator light.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 943 Class A, and FS W-C-596.

8. Hospital-Grade, Duplex GFCI Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; [**feed**][**non-feed**]-through type with integral LED indicator light.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

9. Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; with LED indicator light and integral SPD in line to ground, line to neutral, and neutral to ground.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

10. Isolated-Ground, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; with LED indicator light and integral SPD in line to ground, line to neutral, and neutral to ground.

    a. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

11. Hospital-Grade, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; with integral SPD in line to ground, line to neutral, and neutral to ground.

    a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1449, and FS W-C-596.

12. Isolated-Ground, Hospital-Grade, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R; with integral SPD in line to ground, line to neutral, and neutral to ground.

    a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1449, and FS W-C-596.

13. Color of Receptacles: [**Brown**][**Ivory**][**As selected by Architect**] unless otherwise indicated or required by NFPA 70, as directed by the Owner.

F. Switches:

1. Single-Pole Switches: 120/277 V, 20 A.

   a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2. Two-Pole Switches: 120/277 V, 20 A.

   a. Comply with NEMA WD 1, UL 20, and FS W-S-896.

3. Pilot-Light Switches, Single Pole: 120/277 V, 20 A, with LED-lighted handle, illuminated when switch is off.

   a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

4. Key-Operated Switches: 120/277 V, 20 A; single pole, with factory-supplied key in lieu of switch handle.

   a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

5. Color of Switches: [**Brown**][**Ivory**][**As selected by Architect**] unless otherwise indicated or required by NFPA 70, as directed by the Owner.

G. Data Communication Outlets: Two RJ-45 jacks for terminating 100-ohm, balanced, four-pair twisted-pair cabling complying with TIA-568-C.1; complying with [**Category 5e**][**Category 6**]. Comply with UL 1863.

H. Cover Plates: Provide satin-finish, [**chrome-plated**][**Type 304, stainless steel**] cover plates with formed, beveled edges.

I. Cover-Plate Identification: Use **1/4-inch- (6-mm-)** high letters unless otherwise indicated. For stainless steel or chrome-plated metal, stamp or etch plate and fill in letters with black enamel.

1. Provide [**at every cover plate.**][**at the following locations:**]

   a. Receptacles other than standard 125-V duplex, grounding type.
   b. Switches and thermal-overload switches.
   c. Pilot lights when located remotely from associated equipment or switch, where function is not obvious.
   d. Receptacles, switches, and other locations indicated.

2. Provide the following information:

   a. Voltage and phase for receptacles other than standard 125-V duplex, grounding type.
   b. Indicate equipment being controlled by switches and thermal-overload switches.
   c. Indicate equipment being controlled for pilot lights when located remotely from associated equipment or switch, where function is not obvious.
   d. Number of the breaker in panelboard that controls device.

J. Pedestal-Type Fittings: Cast-aluminum housings with sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework. Provide holes tapped for conduits.

K. Line-Type Fittings: Provide with cast-metal boxes with threaded holes for mounting on rigid steel conduit. Provide cover plates same size as boxes.

L. Recessed-Type Fittings: Provide with galvanized-steel boxes.

M. Finishes for Service-Fitting Components: Provide housings or boxes for pedestal- and line-type fittings with manufacturer's standard baked-on, chemical-resistant enamel in color as selected by Architect from manufacturer's full range, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CASEWORK

A. Comply with installation requirements in SEFA 2. Install level, plumb, and true in line; shim as required using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: **1/16 inch in 10 feet (1.5 mm in 3 m)**.
2. Variation of Bottoms of Upper Cabinets from Level: **1/8 inch in 10 feet (3 mm in 3 m)**.
3. Variation of Faces of Casework from a True Plane: **1/8 inch in 10 feet (3 mm in 3 m)**.
4. Variation of Adjacent Surfaces from a True Plane (Lippage): **1/32 inch (0.8 mm)**.
5. Variation in Alignment of Adjacent Door and Drawer Edges: **1/16 inch (1.5 mm)**.

B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than **16 inches (400 mm)** o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than **24 inches (600 mm)** o.c. and at sides of cabinets with not less than two fasteners per side.

D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than **16 inches (400 mm)** o.c.

E. Install hardware uniformly and precisely.

F. Adjust operating hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

A. Comply with installation requirements in SEFA 2. Abut top and edge surfaces true in plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints where indicated on Shop Drawings.

B. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.

1. Plastic-Laminate Countertops: Secure field-made joints using concealed clamping devices located within **6 inches (150 mm)** of front and back edges and at intervals not exceeding **24 inches (600 mm)**. Tighten in accordance with manufacturer's written instructions to exert a

uniform heavy pressure at joints.

C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than **48 inches (1200 mm)** o.c.
3. Where necessary to penetrate countertops with fasteners, countersink heads approximately **1/8 inch (3 mm)** and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.

D. Provide holes and cutouts required for service fittings.

E. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.

F. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

G. Dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.

B. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

C. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive, and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

D. Semiflush Installation of Stainless Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

E. Installation of Epoxy and Polypropylene Cup Sinks:

1. Drop-in Installation: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
2. Surface Installation: Set sink in sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

A. Install accessories in accordance with Shop Drawings, installation requirements in SEFA 2, and manufacturer's written instructions.

B. Securely fasten adjustable shelving supports, stainless steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.

C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 INSTALLATION OF SERVICE FITTINGS

A. Comply with requirements in other Sections for installing water and laboratory gas service fittings and electrical devices.

B. Install fittings in accordance with Shop Drawings, installation requirements in SEFA 2, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect, as directed by the Owner.

B. Protect countertop surfaces during construction with **6-mil (0.15-mm)** plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of **48 inches (1200 mm)** o.c.

3.8 SERVICE-FITTING SCHEDULE

A. Water Service Fitting: Type WF-[**#**].

1. Fitting Type: [**Swing-spout mixing faucet**][**Rigid, gooseneck mixing faucet**][**Rigid, gooseneck, single-service faucet**][**Remote-control, rigid, gooseneck, single-service faucet**][**Single-service hose bib**].
2. Outlet: [**Aerator**][**Vacuum breaker and removable serrated outlet**].
3. Mounting: [**Wall**][**Deck**][**Line**] mounted.
4. Additional Requirements: [**Self-closing valves**][**For reagent-grade water**].

B. Laboratory Steam Service Fitting: Type SF-[**#**].

1. Fitting Type: [**Turret**][**Line mounted**][**Flange type**][**Remote-control turret**][**Remote-control flange type**].
2. Outlets: [**One**][**Two, at 90 degrees**][**Two, at 180 degrees**][**Three**][**Four**].
3. Outlet Type: [**Straight**][**Angled**].

C. Laboratory Gas Service Fitting: Type GF-[**#**].

1. Service: [**Air**][**Gas (fuel gas)**][**Vacuum**].

2. Fitting Type: [**Turret**][**Line mounted**][**Flange type**][**Remote-control turret**][**Remote-control flange type**].
3. Outlets: [**One**][**Two, at 90 degrees**][**Two, at 180 degrees**][**Three**][**Four**].
4. Outlet Type: [**Straight**][**Angled**].
5. Valve Type: [**Ground-key cock**][**Ball valve**][**Needle valve**].

D. Electrical Service Fitting: Type EF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex receptacle**][**Two duplex receptacles**][**Four duplex receptacles**][**One switched receptacle**][**One duplex receptacle, switch, and pilot light**].
3. Additional Requirements: [**GFCI**][**SPD**] receptacles.

E. Communication Service Fitting: Type CF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex communication receptacle**][**Two duplex receptacles**].

F. Electrical and Communication Service Fitting: Type ECF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex receptacle and one duplex communication receptacle**][**Two duplex receptacles and two duplex communication receptacles**][**One switched receptacle and one duplex communication receptacle**].
3. Additional Requirements: [**GFCI**][**SPD**] receptacles.

END OF SECTION 12 35 00 00

SECTION 12 35 00 00A - WOOD LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood laboratory casework.
2. Auxiliary cabinets.
3. Countertops.
4. Laboratory casework systems.
5. Laboratory accessories.
6. Water and laboratory gas service fittings.
7. Electrical and communication service fittings.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring laboratory casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to laboratory casework.
4. Section 115313 "Laboratory Fume Hoods" for fume hoods[including base cabinets and countertops under fume hoods].

1.2 DEFINITIONS

A. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.

B. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than **48 inches (1200 mm)** above floor, and visible surfaces in open cabinets or behind glass doors.

1. Ends of cabinets are defined as "exposed"[**except ends are defined as "concealed" where installed directly against and completely concealed by walls or other cabinets**].

C. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cases **78 inches (1980 mm)** or more above floor and bottoms of cabinets more than **24 inches (600 mm)** but less than **48 inches (1200 mm)** above floor are defined as "semiexposed."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

B. Keying Conference: Conduct conference at [**Project site**]. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of laboratory equipment.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For laboratory casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations and types of service fittings.
6. Include details of utility spaces showing supports for conduits and piping.
7. Include details of support framing system.
8. Include details of exposed conduits, if required, for service fittings.
9. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and laboratory equipment.
10. Include coordinated dimensions for laboratory equipment specified in other Sections.

D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

E. Samples: For casework finishes and materials requiring color selection.

F. Samples for Initial Selection: For casework finishes and materials requiring color selection.

G. Samples for Verification: For each type of casework, exposed-hardware, and countertop-material finish, in manufacturer's standard sizes.

1. Base Cabinet: One full-size[16-inch- (406-mm-)] wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
2. Wall Cabinet: One full-size[12-inch- (304-mm-)] wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.

3. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their locations, as directed by the Owner.

H. Delegated Design Submittals: For laboratory casework indicated to comply with seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Test Reports:

1. Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard[**and system structural performance specified in "Performance Requirements" Article**].
2. Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface material with requirements specified for chemical and physical resistance.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each type and color of casework finish provided. Include fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Mounting Clips and Related Hardware: Quantity equal to [**5**] percent of amount installed, but no fewer than [**20**] of each type.
2. Modular Countertop Units: [**Two**] extra units of each length and material installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 W.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet-work are complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Established Dimensions: Where laboratory casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where laboratory casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

B. Obtain [**countertops**][**sinks**][**accessories**][**and**][**service fittings**] from casework manufacturer.

C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

2.2 PERFORMANCE REQUIREMENTS

A. System Structural Performance: Laboratory casework and support framing system to withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:

1. Support Framing System: [**600 lb/ft. (900 kg/m)**].
2. Suspended Base Cabinets (Internal Load): [**160 lb/ft. (240 kg/m)**].
3. Work Surfaces (Including Tops of Suspended Base Cabinets): [**160 lb/ft. (240 kg/m)**].
4. Wall Cabinets (Upper Cabinets): [**160 lb/ft. (240 kg/m)**].
5. Shelves: [**40 lb/sq. ft. (200 kg/sq. m)**].

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design laboratory casework installation.

C. Seismic Performance: Laboratory casework installation to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Design earthquake spectral response acceleration, short period (Sds) for Project is [**indicated on Drawings**].
2. Component Importance Factor: [**1.0**][**1.5**].
3. Base Cabinet Load (Including Countertop and Load on Countertop): [**320 lb/ft. (480 kg/m)**].
4. Wall Cabinet (Upper Cabinet) Load: [**160 lb/ft. (240 kg/m)**].

2.3 CASEWORK, GENERAL

A. Casework Product Standard: Comply with SEFA 8 W, "Laboratory Grade Wood Casework."

B. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by [**a testing and inspecting agency acceptable to authorities having jurisdiction**][**FM Approvals**].

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

F. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

G. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

I. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

J. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

K. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

L. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

M. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.4 WOOD LABORATORY CASEWORK

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bedcolab**]
2. [**CIF Lab Solutions LP**]
3. [**Diversified Woodcrafts, Inc.**]
4. [**ICIscientific**]
5. [**Kewaunee Scientific Corporation**]
6. [**Leonard Peterson & Company, Inc**]
7. [**Mott Manufacturing Ltd**]
8. [**Sheldon Laboratory Systems**]
9. [**South Texas Woodmill, Inc.**]

B. Design: [**Lipped overlay with radiused edges**][**Reveal overlay with square edges**][**Reveal overlay with radiused edges**].

1. Provide [**1/8-inch (3.2-mm)**] reveals between doors and drawers that are adjacent.

C. Wood Species: [**Red oak**][**White birch**][**Red birch**][**Alder**][**White maple**][**Hickory**].

1. Wood Stain Colors and Finishes: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

D. Cut: [**Plain sliced/sawn**][**Quarter sliced/sawn**][**Rift cut/sawn**][**Rotary cut/plain sawn**].

E. Veneer Matching:

1. None required; select and arrange veneers for compatible grain and color.
2. Provide veneers for each cabinet from a single flitch, [**book and running**][**slip and running**][**book or slip and running**][**book and balance**][**slip and balance**][**book or slip and balance**] matched.

   a. Provide continuous matching of adjacent drawer fronts within each cabinet.

3. Provide veneers for each elevation from a single flitch, [**book and running**][**slip and running**][**book or slip and running**][**book and balance**][**slip and balance**][**book or slip and balance**] matched.

   a. Provide continuous matching of adjacent drawer fronts within each cabinet and end matching between drawer fronts of adjacent cabinets.

F. Grain Direction:

1. Doors: Vertical with continuous vertical matching.
2. Drawer Fronts: [**Vertical with continuous vertical matching**][**Horizontal**].

3. Face Frame Members: Lengthwise.
4. End Panels: Vertical.
5. Bottoms and Tops of Units: Side to side.
6. Knee Space Panels: Vertical.
7. Aprons: Horizontal.

G. Exposed Materials:

1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
2. Plywood: Hardwood plywood, either veneer core or particleboard core with face veneer of species indicated. Grade A exposed faces, at least **1/50 inch (0.5 mm)** thick, and Grade J crossbands. Provide backs of same species as faces.
3. Solid Wood: Clear hardwood lumber of species indicated.
4. Edgebanding: [**Solid wood, minimum 1/8 inch (3 mm) thick and of same species as face veneer**][**Wood veneer of same species as face veneer**][**PVC**].

   a. PVC Edgebanding Color: [**Casework manufacturer's standard**][**As selected by Architect from casework manufacturer's full range**], as directed by the Owner.

H. Semiexposed Materials:

1. Wood: Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.

   a. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of [**species similar in color and grain to**][**same species as**] exposed solid wood.
   b. Plywood: Hardwood plywood of [**species similar in color and grain to**][**same species as**] exposed plywood. Provide backs of same species as faces.

      1) Grade: [**B**][**C**] faces and Grade J crossbands.

2. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

I. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood. Provide backs of same species as faces.
3. Particleboard.
4. MDF.
5. Hardboard.

2.5 WOOD CABINET MATERIALS

A. General:

1. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

B. Composite Wood Products: Products shall be made without urea formaldehyde.

C. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

E. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

F. Composite Wood Products: Products shall be made without urea formaldehyde.

G. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

H. MDF: Medium-density fiberboard, ANSI A208.2, [**Grade 130**].

I. Particleboard: ANSI A208.1, Grade M-2.

J. Hardboard: ANSI A135.4, Class 1 tempered.

K. Adhesives: Do not use adhesives that contain urea formaldehyde.

L. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

M. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

N. Adhesives: Do not use adhesives that contain urea formaldehyde.

O. Adhesives: Do not use adhesives that contain urea formaldehyde.

P. PVC Edgebanding for Wood: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

2.6 AUXILIARY CABINETS

A. Acid Storage-Cabinet Lining: **1/4-inch- (6-mm-)** thick, [**glass-fiber cement board complying with ASTM C1186**][**polyethylene or polypropylene**][**polyethylene, polypropylene, epoxy, or phenolic-composite lining material**].

B. Float Glass for Glazed Doors: Clear float glass complying with ASTM C1036, Type I, Class 1, Quality-Q3; not less than [**3.0 mm**][**4.0 mm**][**5.0 mm**][**6.0 mm**] thick.

C. Tempered Glass for Glazed Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

D. Laminated Glass for Glazed Doors: Clear laminated annealed glass complying with ASTM C1172, Kind

LA, Condition A, Type I, Class I, Quality-Q3; with two plies not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

E. Frameless Glass Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than [**5.0 mm**][**6.0 mm**] thick; with exposed edges seamed before tempering.

2.7 CABINET HARDWARE

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Butt Hinges: [**Stainless**][**Epoxy-coated-**] steel, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors **48 inches (1200 mm)** high or less and three for doors more than **48 inches (1200 mm)** high.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602[self-closing]. Provide two for doors 48 inches (1200 mm) high or less and three for doors more than 48 inches (1200 mm) high.

1. Degrees of Opening: [**100**][**135**][**170**].

D. Hinged-Door and Drawer Pulls: [**Solid-aluminum, stainless steel, or chrome-plated-brass**][**Epoxy-coated-steel**], back-mounted pulls. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

1. Design: [**Wire pulls**][**Rectangular loop pulls**][**Rectangular loop pulls with rounded corners**][**As selected from manufacturer's full range**][**As indicated**].
2. Overall Size: [**1 by 4-1/2 inches (25 by 114 mm)**][**1-1/4 by 4-1/2 inches (32 by 114 mm)**][**1-3/8 by 5-1/2 inches (35 by 140 mm)**][**As selected from manufacturer's full range**][**As indicated**].

E. Sliding-Door Pulls: [**Stainless steel or chrome-plated**][**Epoxy-coated-steel**] recessed flush pulls.

1. Design and Size: [**Round, 3/4-inch (19-mm) diameter by 1/8 inch (3 mm) deep**][**Round, 3/4-inch (19-mm) diameter by 3/16 inch (5 mm) deep**][**Oval, 1 by 3 inches (25 by 76 mm), 3/8 inch (10 mm) deep**][**As selected from manufacturer's full range**][**As indicated**].

F. Recessed Pulls: [**Aluminum**][**Polypropylene**]. Provide two pulls for drawers more than **24 inches (600 mm)** wide.

G. Channel Pulls: Full-width, recessed solid-hardwood channels; matching exposed wood of cabinets.

H. Door Catches: [**Nylon-roller spring**][**Dual, self-aligning, permanent magnet**] catches. Provide two catches on doors more than **48 inches (1200 mm)** high.

I. Drawer Slides: ANSI/BHMA A156.9.

1. Manufacturer's standard.
2. Standard Duty (Grade 1): [**Side mount**][**Undermount**].
3. Heavy Duty (Grade 1HD-100): [**Side mount**][**Undermount**].

a. Type: [**Full**][**Full overtravel**][**Partial**] extension.
b. Material: [**Epoxy-coated polymer**][**Zinc-plated ball bearing**] slides.
c. Motion Feature: [**Soft close dampener**][**Self-closing mechanism**].

4. General-purpose drawers; provide [**100 lb (45 kg)**] load capacity.
5. File drawers; provide [**150 lb (45 kg)**] load capacity.

J. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately **1 by 2 inches (25 by 50 mm)**, attached with screws or rivets. Provide [**where indicated**][**on drawers**].

K. Locks: Cam type, brass with chrome-plated finish; complying with ANSI/BHMA A156.11, Type E07281[**or Type E07261**].

1. Tumbler: [**Disc**][**Five pin**].
2. Lock Locations: Provide [**where indicated**][**on drawers and doors**].
3. Keying: Key [**locks alike within each room; key each room separately**][**each lock separately**][**locks as directed**].

   a. Master key for up to [**225**][**500**] key changes.

4. Key Quantity: Minimum of [**two**] keys per lock.
5. Master Key System: Key locks to be operable by master key.

   a. Master Keys: Provide [**two**].

L. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and size of sliding-door units.

M. Adjustable Shelf Supports: ANSI/BHMA A156.9, powder-coated steel [**shelf rests, Type B04013**][**standards, mortise type, and shelf rests, Type B04071 and Type B04091**][**standards, surface type, and epoxy powder-coated steel shelf brackets, Type B04102 and Type B04112**].

2.8 COUNTERTOPS

A. General: Provide laboratory [**tabletops**][**and**] countertops with integral [**shelf**][**trough**][**and**][**sink**] as indicated on Drawings.

B. Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.

1. Colors, Patterns, and Finishes: [**As indicated by manufacturer's designations**][**As selected by Architect from casework manufacturer's full range**][**As selected by Architect from plastic-laminate manufacturer's full range**][**As selected by Architect from plastic-laminate manufacturer's full range of solid colors**], as directed by the Owner.

C. Chemical-Resistant Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3, Grade HGP, and as follows.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arborite, Division of Wilsonart Canada ULC**]
   b. [**Formica Corporation**]
   c. [**Nevamar Company, LLC**]
   d. [**Wilsonart LLC**]

2. Physical Properties: Minimum acceptable chemical-resistance performance is to result in no more than four Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.
3. Color: [**Black**][**As indicated by manufacturer's designations**][**As selected by Architect from chemical-resistant, plastic-laminate manufacturer's full range**], as directed by the Owner.

D. Core Materials for Plastic Laminate:

1. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
2. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
3. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
4. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
5. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
6. Composite Wood Products: Products shall be made without urea formaldehyde.
7. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
9. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

10. Composite Wood Products: Products shall be made without urea formaldehyde.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Exterior-Glue Particleboard: ANSI A208.1, Grade M-2, exterior glue.
13. Exterior Plywood: DOC PS 1, [**Exterior A-C**][**Exterior B-C**] with fully sanded face.

E. Adhesive for Bonding Plastic Laminate: [**Type I, waterproof type**][**Type II water-resistant type**] as selected by fabricator to comply with requirements.

1. Adhesives: Do not use adhesives that contain urea formaldehyde.
2. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives: Do not use adhesives that contain urea formaldehyde.
5. Adhesives: Do not use adhesives that contain urea formaldehyde.

F. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Epoxy Scientific LLC**]
   b. [**Durcon; a Wilsonart Company**]
   c. [**Prime Industries, Inc**]

2. Physical Properties:

   a. Flexural Strength: Not less than **10,000 psi (70 MPa)**.
   b. Modulus of Elasticity: Not less than **2,000,000 psi (1400 MPa)**.
   c. Hardness (Rockwell M): Not less than 100.
   d. Water Absorption (24 Hours): Not more than 0.02 percent.
   e. Heat Distortion Point: Not less than **260 deg F (127 deg C)**.

3. Chemical Resistance: Minimum acceptable chemical-resistance performance shall result in no more than four Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.
4. Color: [**Black**][**Gray**][**Beige**][**White**][**As selected by Architect from epoxy manufacturer's full range**], as directed by the Owner.

G. Phenolic Composite: Solid, high-pressure decorative laminate, complying with ISO 4586-4, Grade CGS.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arborite, Division of Wilsonart Canada ULC**]
   b. [**Formica Corporation**]
   c. [**Nevamar Company, LLC**]
   d. [**Trespa North America**]

2. Chemical Resistance: Minimum acceptable chemical-resistance performance is to result in no more than four Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.
3. Color: [**Black**][**Gray**][**Beige**][**White**][**As selected by Architect from phenolic-composite manufacturer's full range**], as directed by the Owner.

H. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316L**].

2.9 WOOD CABINET FABRICATION

A. Construction: Provide wood-faced laboratory casework complying with SEFA 8 W.

1. Bottoms of Base Cabinets and Tall Cabinets: **3/4-inch- (19-mm-)** thick, [**veneer-core**]hardwood plywood.
2. Tops and Bottoms of Wall Cabinets and Tops of Tall Cabinets: **1-inch- (25-mm-)** thick, veneer-core hardwood plywood.
3. Ends of Cabinets: **3/4-inch- (19-mm-)** thick, hardwood plywood.

4. Shelves: **1-inch- (25-mm-)** thick, veneer-core hardwood plywood.
5. Base Cabinet Top Frames: **3/4-by-2-inch (19-by-50-mm)** solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
6. Base Cabinet Stretchers: **3/4-by-4-1/2-inch (19-by-114-mm)** panel product strips or solid-wood boards at front and back of cabinet, glued and pinned or screwed.[**May be provided as an option to base cabinet top frames.**]
7. Base Cabinet Subtops: **3/4-inch- (19-mm-)** thick panel product, glued and pinned or screwed.[**May be provided as an option to base cabinet top frames.**]
8. Exposed Backs of Cabinets: **3/4-inch- (19-mm-)** thick, [**particleboard- or MDF-core**]hardwood plywood.
9. Unexposed Backs of Cabinets: [**1/4-inch- (6.4-mm-) thick hardboard**][**1/4-inch- (6.4-mm-) thick, hardwood plywood**][**1/2-inch- (13-mm-) thick, hardwood plywood**] dadoed into sides, bottoms, and tops unless otherwise indicated.
10. Drawer Fronts: **3/4-inch- (19-mm-)** thick, [**particleboard- or MDF-core**]hardwood plywood or solid hardwood.
11. Drawer Sides and Backs: **1/2-inch- (13-mm-)** thick, solid hardwood or [**veneer-core**]hardwood plywood, with glued dovetail or multiple-dowel joints.
12. Drawer Bottoms: **1/4-inch- (6.4-mm-)** thick, veneer-core hardwood plywood glued and dadoed into front, back, and sides of drawers.[**Use 1/2-inch- (13-mm-) thick material for drawers more than 24 inches (600 mm) wide.**]
13. Drawer Bodies: Steel drawer pans formed from **0.036-inch- (0.91-mm-)** thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and **2 mils (0.05 mm)** for system.
14. Doors Less Than 48 Inches (1200 mm) High: **3/4 inch (19 mm)** thick, with particleboard or MDF cores and hardwood face veneers and crossbands.

    a. Provide solid-hardwood stiles and rails.

15. Doors More Than 48 Inches (1200 mm) High: [**1-1/16 inches (27 mm) thick, with honeycomb cores, solid-hardwood stiles and rails,**][**1-1/8 inches (29 mm) thick, with particleboard cores**] and hardwood face veneers and crossbands.
16. Stiles and Rails of Glazed Doors Less Than 48 Inches (1200 mm) High: **3/4 inch (19 mm)** thick.

    a. Material: [**Solid hardwood**][**Particleboard with hardwood face veneers and crossbands**].

17. Stiles and Rails of Glazed Doors More Than 48 Inches (1200 mm) High: [**1-1/16-inch- (27-mm-) thick, solid wood**][**1-1/8-inch- (29-mm-) thick, particleboard cores**] with hardwood face veneers and crossbands.

B. Tables: Solid-hardwood legs, not less than **2 inches (50 mm)** square with solid-hardwood stretchers as needed to comply with product standard. Bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons.[**Provide leveling device at bottom of each leg.**]

1. Leg Shoes: Black vinyl or rubber, open-bottom, slip-on type.

C. Utility-Space Framing: Steel framing units consisting of two steel slotted channels complying with MFMA-4, not less than **1-5/8 inches (41 mm)** square by **0.105-inch (2.66-mm)** nominal thickness, that are connected at top and bottom by U-shaped brackets made from **1-1/4-by-1/4-inch (32-by-6-mm)** steel flat bars. Framing units may be made by welding channel material into rectangular frames instead of using U-shaped brackets.

D. Removable Backs: Provide backs that can be removed from within cabinets at utility spaces.

E. Filler and Closure Panels: Provide where indicated and as needed to close spaces between casework

and walls, ceilings, and equipment. Fabricate from same material and with same finish as adjacent exposed casework surfaces unless otherwise indicated.

1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where [**cabinets are not installed against a wall or where space is not otherwise closed**][**indicated**].
2. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
3. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.10 LABORATORY CASEWORK SYSTEMS

A. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular wood cabinets, filler and closure panels, [**wall panels,**][**undercabinet task-lighting fixtures,**] countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.

1. Cabinets can be removed and reinstalled without use of special tools for relocation within system.
2. Base cabinets can be removed without providing temporary support for, or removing, countertops.
3. Sinks are supported independent of base cabinets.
4. Support framing has provision for fastening pipe supports at utility space in not more than **1-inch (25-mm)** increments.
5. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.

B. Support Framing: Casework manufacturer's standard system consisting of vertical supports and connecting braces and rails as follows:

1. Cabinets, shelves, and countertops are supported from vertical supports[**except where floor-supported base cabinets are indicated**]. Vertical positioning of supported cabinets, shelves, and countertops can be varied in **1-inch (25-mm)** increments through full height of supports.
2. Vertical supports rest on adjustable leveling bases and are secured to floor with metal clips fastened to floor.
3. Vertical supports are installed with braces and rails, connecting them to each other and to permanent building walls to create a stable, rigid structure with framed utility spaces where indicated.

C. Undercabinet Task-Light Luminaires:

1. Lamp Type: [**LED**][**Single-tube fluorescent fixtures with ballast (sound rating A)**] with switch and heavy-duty cord and plug.
2. Finish: Baked enamel.
3. Diffusers: Virgin acrylic with high resistance to yellowing and other changes from aging, heat, and UV radiation.

D. Countertops: Provide in modular lengths indicated, without seams.

2.11 WOOD FINISH

A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other

surface blemishes.

B. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples. Apply stain to produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.

C. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard [**two**][**three**]-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.

1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 W. Acceptance level for chemical spot test to be no more than for Level 3 conditions.

2.12 COUNTERTOP FABRICATION

A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of **1 inch (25 mm)**.

B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect, as directed by the Owner.

1. Outlets: Provide with strainers and tailpieces, **NPS 1-1/2 (DN 40)**, unless otherwise indicated.
2. Overflows: [**For each sink except cup sinks,**][**Where indicated,**] provide overflow of standard beehive or open-top design with separate strainer. Height **2 inches (50 mm)** less than sink depth. Provide in same material as strainer.

C. Plastic Laminate:

1. Countertops: [**Plastic**][**Chemical-resistant plastic**] laminate shop bonded to top surface and exposed edges of core with plastic-laminate backing bonded to bottom surface. Sand surfaces to which plastic laminate is to be bonded.

a. Top Core Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-3/16 inch (30 mm)**].
b. Backsplash Core Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].
c. Countertop Core: [Particleboard][exterior-glue particleboard][exterior plywood].
d. Countertop Core for Counters Containing Sinks: [Exterior-glue particleboard][exterior plywood].
e. Flat Configuration: With square edges, flat backsplashes, and flat end splashes. Finish faces and exposed edges of splashes with same HDPL plastic laminate as top.
f. Postformed Configuration: With[**raised,**] rolled edge and integral coved backsplash with rolled top edge. Construct top and backsplash from one piece of plastic laminate. Where indicated, provide separate end splashes of same material as top and fitted to top.
g. Plastic-Laminate Grade: [**HGS**][**HGF**][**HGP**].

2. Tabletops: [**Plastic**][**Chemical-resistant plastic**] laminate shop bonded to top surface and exposed edges of core with plastic-laminate backing bonded to bottom surface. Sand surfaces to which plastic laminate is to be bonded.

a. Tabletop Core: [Particleboard][exterior plywood].
b. Core Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-3/16 inches (30 mm)**].
c. Plastic-Laminate Grade: [**HGS**][**HGF**][**HGP**].

3. Shelves: [**Plastic**][**Chemical-resistant plastic**] laminate shop bonded to both faces and edges of

core. Sand surfaces to which plastic laminate is to be bonded.

a. Shelf Core: [Particleboard][exterior-glue particleboard][exterior plywood].
b. Core Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**].
c. Plastic-Laminate Grade: [**HGS**][**HGF**][**HGP**].

D. Epoxy:

1. Countertops: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

a. Flat Configuration: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] thick with continuous drip groove on underside **1/2 inch (13 mm)** from overhang edge.

1) Edges and Corners: [**Beveled**][**Rounded**].
2) Backsplash: [**Integral coved**][**Applied**].

b. Marine-Edge Configuration: [**5/8-inch (16-mm)**][**3/4-inch (19-mm)**][**1-inch (25-mm)**] minimum thickness, with integral or applied raised edge.

1) Edges and Corners: [**Beveled**][**Rounded**].
2) Backsplash: [**Integral coved**][**Applied**].

c. Construction: [**Uniform throughout full thickness**][**Epoxy composition not less than 1/4 inch (6 mm) thick, laminated to backing**].
d. Product Option: Phenolic-composite countertops may be substituted for epoxy countertops at Contractor's option.

2. Tabletops:

a. Flat Configuration: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] thick with continuous drip groove on underside at perimeter.

1) Edges and Corners: [**Beveled**][**Rounded**].

b. Marine-Edge Configuration: [**5/8-inch (16-mm)**][**3/4-inch (19-mm)**][**1-inch (25-mm)**] minimum thickness with integral or applied raised edge.

1) Edges and Corners: [**Beveled**][**Rounded**].

c. Tabletop Construction: [**Uniform throughout full thickness**][**Epoxy composition not less than 1/4 inch (6 mm) thick, laminated to backing**].
d. Product Option: Phenolic-composite tabletops may be substituted for epoxy tabletops at Contractor's option.

3. Sinks: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; **1/2-inch (13-mm)** minimum thickness.

a. Provide with polypropylene strainers and tailpieces.
b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
c. Provide sinks for drop-in installation with **1/4-inch- (6-mm-)** thick lip around perimeter of sink.
d. Provide sinks for underside installation with manufacturer's recommended adjustable support system for table- and cabinet-type installations.

E. Phenolic Composite:

1. Countertops: Fabricate with cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

   a. Flat Configuration: [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] thick with continuous drip groove on underside **1/2 inch (13 mm)** from overhang edge and integral coved backsplash.

      1) Edges and Corners: [**Beveled**][**Rounded**].

   b. Marine-Edge Configuration: [**1/2-inch (13-mm)**][**5/8-inch (16-mm)**][**3/4-inch (19-mm)**][**1-inch (25-mm)**] minimum thickness, with raised edge and integral coved backsplash.

      1) Edges and Corners: [**Beveled**][**Rounded**].

2. Tabletops:

   a. Flat Configuration: [**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] thick with continuous drip groove on underside at perimeter.

      1) Edges and Corners: [**Beveled**][**Rounded**].

   b. Marine-Edge Configuration: [**5/8-inch (16-mm)**][**3/4-inch (19-mm)**][**1-inch (25-mm)**] minimum thickness with integral or applied raised edge.

      1) Edges and Corners: [**Beveled**][**Rounded**].

3. Shelves: Flat, [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] thick.

   a. Edges and Corners: [**Beveled**][**Rounded**].

F. Stainless Steel:

1. Countertops: Made from stainless steel sheet, not less than **0.062-inch (1.59-mm)** nominal thickness, with ASTM A480/A480M No. 4 satin finish.

   a. Extend top down **1 inch (25 mm)** at edges with a **1/2-inch (13-mm)** return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
   b. Form backsplash coved to and integral with top surface.
   c. Provide raised (marine) edge [**around perimeter of countertops containing sinks**][**and**][**where indicated**].
   d. Pitch countertops that contain sinks two ways to sink[where indicated,] without channeling or grooving.
   e. Factory punch holes for service fittings.
   f. Reinforce underside of countertop with channels, or use thicker metal sheet where necessary to ensure rigidity without deflection.
   g. Weld shop-made joints.
   h. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
   i. Where stainless steel sinks and cup sinks occur in stainless steel countertops, factory weld into one integral unit.
   j. After fabricating and welding, grind surfaces smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

2. Shelves: Made from stainless steel sheet, not less than **0.050-inch (1.27-mm)** nominal thickness, with ASTM A480/A480M No. 4 satin finish. Weld shop-made joints. Fold [**down**][**up**] front edge **3/4 inch (19 mm)**; fold up back edge **3 inches (75 mm)**.

   a. Provide integral stiffening brackets, formed by folding up ends **3/4 inch (19 mm)** and welding to upturned [**back edge**][**front and back edges**].
   b. After fabricating, grind welds smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

3. Sinks: Made from stainless steel sheet, not less than **0.050-inch (1.27-mm)** nominal thickness. Fabricate with corners rounded and coved to at least **5/8-inch (16-mm)** radius. Slope sink bottoms to outlet. Provide continuous butt-welded joints.

   a. Provide double-wall construction for sink partitions with top edge rounded to at least **1/2-inch (13-mm)** diameter.
   b. After fabricating and welding, grind surfaces smooth and polish to produce uniform finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
   c. Factory punch holes for fittings.
   d. Provide with stainless steel strainers and tailpieces.
   e. Provide with integral rims except where located in stainless steel countertops.
   f. Apply **1/8-inch- (3-mm-)** thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.

G. Cup Sinks: Provide in material indicated, [**3-by-6-inch (75-by-150-mm) oval**][**3-by-9-inch (75-by-228-mm) oval**][**5-inch (127-mm) diameter**][**as indicated on Drawings**].

1. Epoxy Cup Sinks: Provide with polypropylene strainers and integral tailpieces.
2. Polypropylene Cup Sinks: Provide with polypropylene strainers and integral tailpieces.
3. Stainless Steel Cup Sinks: Provide with stainless steel strainers and integral tailpieces.

H. Troughs: Provide in material indicated and pitch to drains not less than **1/8 inch/foot (10 mm/m)**. Except where troughs empty into sinks, provide **NPS 1-1/2 (DN 40)** outlets with strainers and tailpieces.

1. Epoxy Troughs: Molded in one piece with smooth surfaces and coved corners; [**1/2-inch (13-mm)**][**5/8-inch (16-mm)**][**3/4-inch (19-mm)**] minimum thickness. Provide polypropylene strainers and tailpieces.
2. Stainless Steel Troughs: Made from stainless steel sheet, not less than [**0.050-inch (1.27-mm)**][**0.062-inch (1.59-mm)**] nominal thickness. Fabricate with corners rounded and coved to at least **5/8-inch (16-mm)** radius. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth and polish to produce uniform finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean. Provide stainless steel strainers and tailpieces.

2.13 LABORATORY ACCESSORIES

A. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop unless otherwise indicated.

B. Burette Rods: Aluminum or stainless steel rods, **1/2 inch (13 mm)** in diameter and **18 inches (450 mm)** long, threaded on one end to fit tapered plug adapter for flush socket receptacle. Provide with tapered plug adapter and receptacle.

C. Upright Rod Assembly and Metal Crossbar: Aluminum or stainless steel. Two vertical rods and one horizontal crossbar, **3/4 inch (19 mm)** in diameter and **36 inches (900 mm)** long unless otherwise indicated; two flush socket receptacles and two crossbar clamps. Ends of vertical rods are tapered to fit receptacles; other rod ends are rounded.

D. Greenlaw Arm Assembly: Aluminum or stainless steel vertical rod, tapered on one end to fit flush socket receptacle. Adjustable crossbar of hardwood with black, acid-resistant finish, secured to upright with adjustable clamp. Provide with receptacle.

E. Lattice Assembly: Aluminum or stainless steel, vertical and horizontal rod lattice assembly with **3/4-inch- (19-mm-)** diameter rods at approximately **12 inches (300 mm)** o.c. with two flush socket receptacles for mounting.

1. Size: [**36 inches (900 mm)**][**48 inches (1200 mm)**] wide by [**24 inches (600 mm)**][**36 inches (900 mm)**] high.

F. Plastic or Resin Pegboards: Polypropylene, epoxy, or phenolic-composite pegboards with removable polypropylene pegs and stainless steel drip troughs with drain outlet.

G. Stainless Steel Pegboards: Stainless steel pegboards with removable polypropylene pegs and stainless steel drip troughs with drain outlet.

2.14 WATER AND LABORATORY GAS SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Broen A/S**]
2. [**Chicago Faucets; Geberit Group**]
3. [**WaterSaver Faucet Co**]

B. Service Fittings: Provide units that comply with SEFA 7, "Recommended Practices for Fixtures." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.

1. Provide units that comply with "Vandal-Resistant Fittings" recommendations in SEFA 7.

C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

1. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.

D. Finish: [**Chromium plated**][**Chromium plated unless otherwise indicated**][**Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes**].

1. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white, or other color as approved by Architect, as directed by the Owner.

E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to **80 psig (550 kPa)**.

1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
3. Self-Closing Valves: Provide self-closing valves where indicated.

F. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than **5 lbf (22 N)** to operate. Provide units designed for working pressure up to **75 psig (520 kPa)**, with serrated outlets.

1. Locking Safety Handles: Where ball valves are indicated for fuel-gas use, provide handles that must be [pushed in][pulled up] before being turned on.

G. Ground-Key Cocks: Tapered core and handle of one-piece forged brass, ground and lapped, and held in place under constant spring pressure. Provide units designed for working pressure up to **40 psig (280 kPa)**, with serrated outlets.

H. Steam Valves: Stainless steel seat and PTFE seat disc. Provide units designed for steam working pressure up to **20 psig (140 kPa)**, with serrated outlets.

I. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.

1. Provide units designed for working pressure up to [**60 psig (410 kPa)**][**100 psig (690 kPa)**][**125 psig (860 kPa)**][**as indicated on Drawings**][**as indicated in schedules**].

J. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."

K. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.

L. Handles: Provide [three- or four-arm, forged-brass][three- or four-wing, molded-plastic or powder-coated-metal] handles for valves unless otherwise indicated.

1. Provide lever-type handles for ground-key cocks. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
2. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
3. Provide heat-resistant plastic handles for steam valves.
4. Provide knurled, molded-plastic handles for needle valves.

M. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

2.15 ELECTRICAL AND COMMUNICATION SERVICE FITTINGS

A. Service Fittings, General: Provide units complete with metal housings, receptacles, switches, pilot lights,[**data communication outlets,**] cover plates, accessories, and gaskets required for mounting on laboratory casework.

B. Electrical Wiring Devices: Comply with requirements in Section 262726 "Wiring Devices" for receptacles, switches, pilot lights, cover plates, and accessories.

C. Twisted-Pair Copper Data Outlets: Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

D. Optical Fiber Data Outlets: Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

E. Receptacles:

1. Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

   a. Standards: Comply with NEMA WD 1, UL 498, and FS W-C-596.

2. Hospital-Grade, Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, and FS W-C-596.

3. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R.

   a. Standards: Comply with NEMA WD 1, UL 498, and FS W-C-596.

4. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 1310, and FS W-C-596.
   b. USB Receptacles: [**Single**][**Dual**][**Quad**], Type A.

5. Hospital-Grade, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1310, and FS W-C-596.
   b. Marking: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

6. USB Receptacles: [**Single**][**Dual**][**Quad**], Type A.
7. Duplex GFCI Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, [**feed**][**non-feed**]-through type with integral LED indicator light.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 943 Class A, and FS W-C-596.

8. Hospital-Grade, Duplex GFCI Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, [**feed**][**non-feed**]-through type with integral LED indicator light.

   a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

9. Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, with LED indicator light and integral SPD in line to ground, line to neutral, and neutral to ground.

   a. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

10. Isolated-Ground, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, with LED indicator light and integral SPD in line to ground, line to neutral, and neutral to ground.

    a. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

11. Hospital-Grade, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, with integral SPD in line to ground, line to neutral, and neutral to ground.

a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1449, and FS W-C-596.

12. Isolated-Ground Hospital-Grade, Duplex SPD Convenience Receptacles: 125 V, 20 A; NEMA WD 6, Configuration 5-20R, with integral SPD in line to ground, line to neutral, and neutral to ground.

a. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1449, and FS W-C-596.

13. Color of Receptacles: [**Brown**][**Ivory**][**As selected by Architect**] unless otherwise indicated or required by NFPA 70, as directed by the Owner.

F. Switches:

1. Single-Pole Switches: 120/277 V, 20 A.

a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2. Two-Pole Switches: 120/277 V, 20 A.

a. Comply with NEMA WD 1, UL 20, and FS W-S-896.

3. Pilot-Light Switches, Single Pole: 120/277 V, 20 A, with LED-lighted handle, illuminated when switch is off.

a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

4. Key-Operated Switches: 120/277 V, 20 A; single pole, with factory-supplied key in lieu of switch handle.

a. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

5. Color of Switches: [**Brown**][**Ivory**][**As selected by Architect**] unless otherwise indicated or required by NFPA 70, as directed by the Owner.

G. Data Communication Outlets: Two RJ-45 jacks for terminating 100-ohm, balanced, four-pair twisted-pair cabling complying with TIA-568-C.1; complying with [**Category 5e**][**Category 6**]. Comply with UL 1863.

H. Cover Plates: Provide satin-finish, [**chrome-plated**][**Type 304, stainless steel**] cover plates with formed, beveled edges.

I. Cover-Plate Identification: Use **1/4-inch- (6-mm-)** high letters unless otherwise indicated. For stainless steel or chrome-plated metal, stamp or etch plate and fill in letters with black enamel.

1. Provide [**at every cover plate.**][**at the following locations:**]

a. Receptacles other than standard 125-V duplex, grounding type.
b. Switches and thermal-overload switches.
c. Pilot lights when located remotely from associated equipment or switch, where function is not obvious.
d. Receptacles, switches, and other locations indicated.

2. Provide the following information:

a. Voltage and phase for receptacles other than standard 125-V duplex, grounding type.

b. Indicate equipment being controlled by switches and thermal-overload switches.
c. Indicate equipment being controlled for pilot lights when located remotely from associated equipment or switch, where function is not obvious.
d. Number of the breaker in panelboard that controls device.

J. Pedestal-Type Fittings: Cast-aluminum housings with sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework. Provide holes tapped for conduits.

K. Line-Type Fittings: Provide with cast-metal boxes with threaded holes for mounting on rigid steel conduit. Provide cover plates same size as boxes.

L. Recessed-Type Fittings: Provide with galvanized-steel boxes.

M. Finishes for Service-Fitting Components: Provide housings or boxes for pedestal- and line-type fittings with manufacturer's standard baked-on, chemical-resistant enamel in color as selected by Architect from manufacturer's full range, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CASEWORK

A. Comply with installation requirements in SEFA 2. Install level, plumb, and true in line; shim as required using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: **1/16 inch in 10 feet (1.5 mm in 3 m)**.
2. Variation of Bottoms of Upper Cabinets from Level: **1/8 inch in 10 feet (3 mm in 3 m)**.
3. Variation of Faces of Casework from a True Plane: **1/8 inch in 10 feet (3 mm in 3 m)**.
4. Variation of Adjacent Surfaces from a True Plane (Lippage): **1/32 inch (0.8 mm)**.
5. Variation in Alignment of Adjacent Door and Drawer Edges: **1/16 inch (1.5 mm)**.

B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than **16 inches (400 mm)** o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than **24 inches (600 mm)** o.c. and at sides of cabinets with not less than two fasteners per side.

D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than **16 inches (400 mm)** o.c.

E. Install hardware uniformly and precisely.

F. Adjust operating hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

A. Comply with installation requirements in SEFA 2. Abut top and edge surfaces true in plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints where indicated on Shop Drawings.

B. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.

1. Plastic-Laminate Countertops: Secure field-made joints using concealed clamping devices located within **6 inches (150 mm)** of front and back edges and at intervals not exceeding **24 inches (600 mm)**. Tighten in accordance with manufacturer's written instructions to exert a uniform heavy pressure at joints.

C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than **48 inches (1200 mm)** o.c.
3. Where necessary to penetrate countertops with fasteners, countersink heads approximately **1/8 inch (3 mm)** and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.

D. Provide holes and cutouts required for service fittings.

E. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.

F. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

G. Dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.

B. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

C. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended

adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive, and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

D. Semiflush Installation of Stainless Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

E. Installation of Epoxy and Polypropylene Cup Sinks:

1. Drop-In Installation: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
2. Surface Installation: Set sink in sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

A. Install accessories in accordance with Shop Drawings, installation requirements in SEFA 2, and manufacturer's written instructions.

B. Securely fasten adjustable shelving supports, stainless steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.

C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 INSTALLATION OF SERVICE FITTINGS

A. Comply with requirements in other Sections for installing water and laboratory gas service fittings and electrical devices.

B. Install fittings in accordance with Shop Drawings, installation requirements in SEFA 2, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect, as directed by the Owner.

B. Protect countertop surfaces during construction with **6-mil (0.15-mm)** plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of **48 inches (1200 mm)** o.c.

3.8 SERVICE-FITTING SCHEDULE

A. Water Service Fitting: Type WF-[**#**].

1. Fitting Type: [**Swing-spout mixing faucet**][**Rigid, gooseneck mixing faucet**][**Rigid, gooseneck, single-service faucet**][**Remote-control, rigid, gooseneck, single-service faucet**][**Single-service hose bib**].
2. Outlet: [**Aerator**][**Vacuum breaker and removable serrated outlet**].
3. Mounting: [**Wall**][**Deck**][**Line**] mounted.
4. Additional Requirements: [**Self-closing valves**][**For reagent-grade water**].

B. Laboratory Steam Service Fitting: Type SF-[**#**].

1. Fitting Type: [**Turret**][**Line mounted**][**Flange type**][**Remote-control turret**][**Remote-control flange type**].
2. Outlets: [**One**][**Two, at 90 degrees**][**Two, at 180 degrees**][**Three**][**Four**].
3. Outlet Type: [**Straight**][**Angled**].

C. Laboratory Gas Service Fitting: Type GF-[**#**].

1. Service: [**Air**][**Gas (fuel gas)**][**Vacuum**].
2. Fitting Type: [**Turret**][**Line mounted**][**Flange type**][**Remote-control turret**][**Remote-control flange type**].
3. Outlets: [**One**][**Two, at 90 degrees**][**Two, at 180 degrees**][**Three**][**Four**].
4. Outlet Type: [**Straight**][**Angled**].
5. Valve Type: [**Ground-key cock**][**Ball valve**][**Needle valve**].

D. Electrical Service Fitting: Type EF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex receptacle**][**Two duplex receptacles**][**Four duplex receptacles**][**One switched receptacle**][**One duplex receptacle, switch, and pilot light**].
3. Additional Requirements: [**GFCI**][**SPD**] receptacles.

E. Communication Service Fitting: Type CF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex communication receptacle**][**Two duplex receptacles**].

F. Electrical and Communication Service Fitting: Type ECF-[**#**].

1. Fitting Type: [**Pedestal, single faced**][**Pedestal, double faced**][**Recessed**][**Line mounted**].
2. Device: [**One duplex receptacle and one duplex communication receptacle**][**Two duplex receptacles and two duplex communication receptacles**][**One switched receptacle and one duplex communication receptacle**].
3. Additional Requirements: [**GFCI**][**SPD**] receptacles.

END OF SECTION 12 35 00 00A

Task	Specification	Specification Description
12 35 00 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 35 00 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 35 59 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 35 59 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 35 59 00	12 35 00 00	Plastic-Laminate-Clad Laboratory Casework
12 35 59 00	12 35 00 00a	Wood Laboratory Casework
12 35 70 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 35 70 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 35 70 00	12 35 00 00	Plastic-Laminate-Clad Laboratory Casework
12 35 70 00	12 35 00 00a	Wood Laboratory Casework
12 35 70 13	01 22 00 00	No Specification Required
12 35 70 13	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 35 70 13	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 35 70 13	12 35 00 00	Plastic-Laminate-Clad Laboratory Casework
12 35 70 13	12 35 00 00a	Wood Laboratory Casework
12 36 00 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 00 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 36 23 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 23 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework

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SECTION 12 36 23 13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad countertops.
2. Accessories.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for cantilever supports.
2. Section 224100 "Residential Plumbing Fixtures" for non-integral sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Plans, sections, details, edge and backsplash profiles, and attachments to other work.
2. Locations and details of joints.
3. Locations and sizes of cutouts and holes for items installed in countertop.
4. Apply [**AWI's Quality Certification**][**WI's Certified Compliance**] Program label to Shop Drawings.

C. Samples for Initial Selection: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.

D. Samples for Verification:

1. Plastic Laminates: For each type, color, pattern, and surface finish required, [**8 by 10 inches (200 by 250 mm)**][**12 by 12 inches (300 by 300 mm)**] in size.
2. Wood-Grain Plastic Laminates: For each type, color, pattern, and surface finish required, [**12 by 24 inches (300 by 600 mm)**][**24 by 24 inches (600 by 600 mm)**] in size.
3. Fabrication Sample: For each type and profile of countertop required, provide one sample applied to core material with specified edge material applied to one edge.

E. Sustainable Design Submittals:

1. Laboratory Test Reports: For laminating adhesives, indicating compliance with requirements for low-emitting materials.
2. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate locations and sizes of cutouts and holes for items installed in countertop and backsplashes.

B. Product Certificates: For the following:

1. Composite wood products.
2. High-pressure decorative laminate.
3. Chemical-resistant, high-pressure decorative laminate.

C. Quality Standard Compliance Certificates: [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**].

D. Qualification Statements: For [**Installer**][**Fabricator**].

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Shop Certification: [**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

B. Installer Qualifications: [**Fabricator of products**][**AWI's Quality Certification Program accredited participant**][**WI's Certified Compliance Program licensee**].

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.

B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.6 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between [**25 and 55**][**43 and 70**][**20 and 50**] percent during the remainder of the construction period.

C. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop

Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

D. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD COUNTERTOPS

A. Plastic-Laminate-Clad Countertop Type :

B. Fabricators: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following**]:

C. Quality Standard: Unless otherwise indicated, comply with [**ANSI/AWI 1236**][**NAAWS**] for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

1. Provide inspections of fabrication and installation together with labels and certificates from [**AWI**][**WI**] certification program indicating that countertops comply with requirements of grade specified.
2. The Contract Documents contain requirements that are more stringent than that of the referenced quality standard. Comply with requirements of the Contract Documents in addition to those of referenced quality standard.

D. Grade: [**Premium**][**Custom**][**Economy**][**Match related casework**].

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

E. Certified Wood: Verify product is certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

F. Certified Wood: Verify product is labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

G. Certified Wood: Verify product is certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. High-Pressure Decorative Laminate: ISO 4586-3, [**Grade HGS**][**Grade HGF**][**Grade HGP**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABET Inc.**]
b. [**Formica Corporation**]

c. [**Laminart LLC**]
d. [**Nevamar Company, LLC**]
e. [**Pionite; a Panolam Industries International, Inc. brand**]
f. [**Wilsonart LLC**]

I. Chemical-Resistant, High-Pressure Decorative Laminate: ISO 4586-3, Grade HGP, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Formica Corporation**]
b. [**Pionite; a Panolam Industries International, Inc. brand**]
c. [**Wilsonart LLC**]

2. Physical Properties: Minimum acceptable chemical-resistance performance to result in no more than four (4) Level 3 conditions when tested with indicated reagents in accordance with SEFA 3.

J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by manufacturer's designations.
2. Match Architect's sample, as directed by the Owner.
3. As selected by Architect from manufacturer's full range in the following categories:, as directed by the Owner

a. Solid colors, [**gloss**][**matte**] finish.
b. Solid colors with core same color as surface, [**gloss**][**matte**] finish.
c. Wood grains, [**gloss**][**matte**] finish with grain running parallel to length of countertop.
d. Patterns, [**gloss**][**matte**] finish.

K. Edge Treatment: [**Same as laminate cladding on horizontal surfaces**][**PVC edging**][**ABS edging**][**As indicated on Drawings**].

L. Core Material: [**Fire rated**][**Particleboard or MDF**][**Particleboard**][**MDF**][**Veneer-core plywood**][**As selected by fabricator to comply with quality standard**].

M. Core Material at Sinks: [Particleboard made with exterior glue][MDF made with exterior glue][veneer-core plywood made with Type II adhesive].

N. Core Thickness: [**3/4 inch (19 mm)**][**1-1/8 inches (29 mm)**].

1. Build up countertop thickness to **1-1/2 inches (38 mm)** at front, back, and ends with additional layers of core material laminated to top.
2. Provide drip groove [**1/8 by 1/8 inch (3.2 and 3.4 mm) set back 3/8 inch (9.5 mm)**] from front edge of countertop.

O. Backer Sheet: Provide plastic-laminate backer sheet, ISO 4586-3, grade to match exposed surface, on underside of countertop substrate.

P. Paper Backing: Provide paper backing on underside of countertop substrate.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

B. Composite Panel Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.

1. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
2. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

   a. Hardwood Plywood: 0.05 ppm.
   b. Particleboard: 0.09 ppm.
   c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
   d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

3. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
4. Medium-Density Fiberboard (MDF): ANSI A208.2[MR 10][MR 30][MR 50].

   a. [**Grade 130**][**Grade 155**][**Grade 130 or better; complying with performance requirements specified**].

5. Particleboard: ANSI A208.1[MR 10][MR 30][MR 50].

   a. [**Grade M-2**][**Grade M3**][**Grade M-2 or better; complying with performance requirements specified**].

6. Veneer-Core Hardwood Plywood: ANSI/HPVA HP-1.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested in accordance with ASTM E84.

1. For panels **3/4 inch (19 mm)** thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, **1600 psi (11 MPa)**; modulus of elasticity, **300,000 psi (2070 MPa)**; internal bond, **80 psi (550 kPa)**; and screw-holding capacity on face and edge, **250 and 225 lbf (1100 and 1000 N)**, respectively.
2. For panels **13/16 to 1-1/4 inches (20 to 32 mm)** thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, **1300 psi (9 MPa)**; modulus of elasticity, **250,000 psi (1720 MPa)**; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, **250 and 175 lbf (1100 and 780 N)**, respectively.

D. Fire-Retardant MDF: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

2.4 ACCESSORIES

A. Grommets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Doug Mockett & Company, Inc.**]
   b. [**Hafele America Co.**]
   c. [**W.W. Grainger, Inc.**]

2. Wire-Management Grommets: Circular, grommets and matching caps with slot for wire passage.

   a. Finish: [**Metal**][**Molded plastic**].
   b. Outside Diameter: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].
   c. Color: [**Brushed, nickel plated**][**Polished, chrome plated**][**Black, epoxy coated**][**Brown**][**Black**].

3. Power/Data Grommets: UL-listed [**recessed**][**pop-up**] grommet.

   a. Power Outlets: [**2**][**3**][**5**].
   b. USB Charger: [**Type A**][**Type B**][**1 Dual**].

4. Paper-Slot Grommet: [**12 inches (305 mm)**][**17 inches (432 mm)**] long by **1-3/4 inches (45 mm)** wide by **1 inch (25 mm)** deep; molded-plastic, paper-slot liner with **1/4-inch (6.4-mm)** lip.

   a. Color: [**Brown**][**Black**].

2.5 MISCELLANEOUS MATERIALS

A. Adhesives: Use adhesives that comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Adhesives: Do not use adhesives that contain urea formaldehyde.

C. Adhesive for Bonding Plastic Laminate: [**Type I, waterproof type**][**Type II water-resistant type**] as selected by fabricator to comply with requirements.

1. Adhesive for Bonding Edges: Hot-melt adhesive[**or adhesive specified above for faces**].

D. Installation Adhesive: Manufacturer's standard product that is recommended for application indicated.

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.6 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of **1 inch (25 mm)** over base cabinets. Ease edges to radius indicated for the following:

1. Solid-Wood (Lumber) Members: **1/16 inch (1.5 mm)** unless otherwise indicated.

C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of dates and times countertop fabrication will be complete, as directed by the Owner.
2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.3 INSTALLATION OF PLASTIC-LAMINATE-CLAD COUNTERTOPS

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where indicated on Shop Drawings.

1. Secure field joints in countertops with concealed clamping devices located within **6 inches (150 mm)** of front and back edges and at intervals not exceeding **24 inches (600 mm)**. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

E. Countertop Installation:

1. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
3. Anchor wall cleating necessary for proper setting for countertops not supported by casework.
4. Install countertops level and true in line. Use concealed shims as required to maintain not more

than **1/8-inch-in-96-inch (3-mm-in-2400-mm)** variation from a straight, level plane.

5. Secure backsplashes [**to tops with concealed metal brackets at 16 inches (400 mm) o.c.**][**and**][**to walls with adhesive**].
6. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.4 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through [**AWI's Quality Certification Program**][**WI's Certified Compliance Program**] certifying that woodwork, including installation, complies with requirements of the referenced standard for the specified grade.

1. Inspection entity is to prepare and submit report of inspection.

3.5 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where impossible to repair, replace countertops. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semiexposed surfaces.

C. Protection: Provide kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of **48 inches (1220 mm)** o.c. Remove protection at Substantial Completion.

END OF SECTION 12 36 23 13

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Task	Specification	Specification Description
12 36 23 13	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 23 13	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework

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SECTION 12 36 61 00 - SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cultured marble countertops.
2. Solid surface material countertops.
3. Quartz agglomerate countertops.
4. Accessories.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for cantilever supports.
2. Section 224100 "Residential Plumbing Fixtures" and Section 224200 "Commercial Plumbing Fixtures" for non-integral sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of countertop material[**and sink**].

B. Shop Drawings:

1. Plans, sections, details, edge and backsplash profiles, and attachment to other work.
2. Locations and details of joints.
3. Locations, quantity, and type of supports/brackets.
4. Direction of directional pattern, if any.
5. Locations and sizes of cutouts and holes for items installed in countertop.
6. Apply [**AWI's Quality Certification**][**WI's Certified Compliance**] Program label to Shop Drawings.

C. Samples for Initial Selection: For each type of material exposed to view.

D. Samples for Verification:

1. Countertop material, **6 inches (152 mm)** square.
2. One full-size countertop, with front edge[**and backsplash**], **8 by 10 inches (203 by 254 mm)**, of construction and in configuration specified.

E. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate locations and sizes of cutouts and holes for items installed in countertops or backsplashes.

B. Qualification Statements: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include product data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.

B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.7 FIELD CONDITIONS

A. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of countertops by field measurements[**after base cabinets are installed but**] before countertop fabrication is complete and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work..

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Quality Standard: Unless otherwise indicated, comply with [**ANSI/AWI 1236**][**NAAWS**] for grades of simulated stone countertops indicated for construction, finishes, installation, and other requirements.

1. Provide inspections of fabrication and installation together with labels and certificates from [**AWI**][**WI**] certification program indicating that countertops comply with requirements of grade specified.
2. The Contract Documents contain more stringent requirements than that of the referenced quality standard. Comply with requirements of the Contract Documents in addition to those of referenced quality standard.

2.2 CULTURED MARBLE COUNTERTOPS

A. Cultured Marble Countertop Type :

1. Grade: [**Premium**][**Custom**][**Economy**][**Match related casework**].

B. Cultured Marble Material: Gel-coated solid fabrication of filled plastic resin complying with CSA B34.5/IAPMA Z124.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Marblecraft Company, Inc.**]
b. [**MarCraft, Inc.**]
c. [**Rynone Manufacturing Corp.**]
d. [**Tiffany Marble Inc.**]
e. [**Wolf Home Products**]

2. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Countertop:

a. Thickness: **3/4 inch (19 mm)**.
b. Exposed Edge Treatment: [**Bevel**][**Ogee**][**Radius**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
c. Provide drip groove [**1/8 inch (3.2 mm) by 1/8 inch (3.2 mm) set back 3/8 inch (9.5 mm)**] from front edge of countertop.
d. Backsplash: [**Integral coved**][**Detached straight**].

1) Height: [**4 inches (101.6 mm)**].
2) Thickness: [**1/2 inch (12.7 mm)**][**Matching countertop**].

e. End Splash: [**Matching backsplash**][**None**].

4. Sink Bowls:

a. [**Integral**][**Top mounted**][**Separate unit for under-counter mounting**].
b. Material: [**PMMA**][**Acrylic**][**Composite**][**Enameled cast-iron**][**Enameled steel**][**Solid surface**][**Stainless steel**][**Vitreous china**].
c. Shape: [**Oval**][**Rectangle**].
d. Color: [**White**][**Match countertop**].

2.3 SOLID SURFACE MATERIAL COUNTERTOPS

A. Solid Surface Countertop Type :

1. Grade: [**Premium**][**Custom**][**Economy**][**Match related casework**].

B. Solid Surface Material: Homogeneous fabrication of mineral fillers and pigments bound together with a matrix of polymers and resins, complying with ISFA 2-01.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
b. [**Avonite Surfaces; a Brand of Aristech Surfaces LLC**]
c. [**DuPont; DuPont de Nemours, Inc.**]
d. [**Durasein Solid Surface; a brand of Relang International, LLC**]
e. [**Formica Corporation**]
f. [**LG Hausys, Ltd.**]
g. [**Lotte Chemical Co., LTD**]
h. [**Meganite Inc.**]
i. [**Swan Surfaces LLC (Swanstone)**]
j. [**Transolid**]
k. [**Wilsonart LLC**]

2. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Countertop:

a. Type: [**Standard**][**Special Purpose**][**Veneer**].
b. Thickness:

1) [**1/2-inch- (12.7-mm-)**][**3/4-inch- (19-mm-)**] thick, solid surface material[**with front edge built up with same material**].

c. Exposed Edge Treatment: [**Bevel**][**Ogee**][**Radius**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
d. Provide drip groove [**1/8 inch (3.2 mm) by 1/8 inch (3.2 mm) set back 3/8 inch (9.5 mm)**] from front edge of countertop.
e. Backsplash: [**Integral coved**][**Detached straight**].

1) Height: [**4 inches (101.6 mm)**].
2) Thickness: [**1/2 inch (12.7 mm)**][**Matching countertop**].

f. End Splash: [**Matching backsplash**][**None**].

4. Sink Bowls:

a. [**Integral**][**Top Mounted**][**Separate unit for under-counter mounting**].
b. Material: [**PMMA**][**Acrylic**][**Composite**][**Enameled cast iron**][**Enameled steel**][**Solid surface**][**Stainless steel**][**Vitreous china**].
c. Shape: [**Oval**][**Rectangle**].
d. Color: [**White**][**Match countertop**].

2.4 QUARTZ AGGLOMERATE COUNTERTOPS

A. Quartz Agglomerate Countertop Type :

1. Grade: [**Premium**][**Custom**][**Economy**][**Match related casework**].

B. Quartz Agglomerate Material: Homogenous fabrication of natural quartz aggregates and pigments bound together with a matrix of polymers and resins, complying with ISFA 3-01.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cambria**]
    b. [**Cosentino North America; C&C North America, Inc.**]
    c. [**DuPont; DuPont de Nemours, Inc.**]
    d. [**Durasein Solid Surface; a brand of Relang International, LLC**]
    e. [**Lotte Chemical Co., LTD**]
    f. [**TechniStone; Wilsonart LLC**]
    g. [**Vicostone USA**]
    h. [**Wilsonart LLC**]

2. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
3. Countertop:

    a. Thickness: [**0.787 inch (2 cm)**][**1.18 inch (3 cm)**].
    b. Exposed Edge Treatment: [**Chamfer**][**Eased**][**Bullnose**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
    c. Provide drip groove [**1/8 inch (3.2 mm) by 1/8 inch (3.2 mm) set back 3/8 inch (9.5 mm)**] from front edge of countertop.
    d. Backsplash: [**Integral coved**][**Detached straight**].

        1) Height: [**4 inches (101.6 mm)**].

    e. End Splash: [**Matching backsplash**][**None**].

4. Sink Bowls:

    a. [**Integral**][**Top mounted**][**Separate unit for under-counter mounting**].
    b. Material: [**PMMA**][**Acrylic**][**Composite**][**Enameled cast iron**][**Enameled steel**][**Solid surface**][**Stainless steel**][**Vitreous china**].
    c. Shape: [**Oval**][**Rectangle**].
    d. Color: [**White**][**Match countertop**].

2.5 ACCESSORIES

A. Grommets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Doug Mockett & Company, Inc.**]
    b. [**Hafele America Co.**]
    c. [**W.W. Grainger, Inc.**]

2. Wire-Management Grommets: Circular, grommets and matching caps with slot for wire passage.

    a. Finish: [**Metal**][**Molded plastic**].
    b. Outside Diameter: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**].
    c. Color: [**Brushed, nickel plated**][**Polished, chrome plated**][**Black, epoxy**

coated][**Brown**][**Black**].

3. Power/Data Grommets: UL-listed [**recessed**][**pop-up**] grommet.

   a. Power Outlets: [**Two**][**Three**][**Five**].
   b. USB Charger: [**Type A**][**Type B**][**1 dual**].

4. Paper Slot Grommet: [**12 inches (305 mm)**][**17 inches (432 mm)**] long by **1-3/4 inches (45 mm)** wide by **1 inch (25 mm)** deep; molded-plastic, paper-slot liner with **1/4-inch (6.4-mm)** lip.

   a. Color: [**Brown**][**Black**].

B. Support Brackets:

1. Countertop :

   a. Type: [**Hidden**][**Front mount**][**Decorative**].
   b. Material: [**Steel**][**Stainless steel**][**Bronze**][**Iron**].
   c. Color: [**Black**][**White**] powder coat.

2.6 FABRICATION

A. Fabricate countertops in sizes and shapes required to comply with requirements indicated.

B. Fabricate tops with shop-applied edges[**and backsplashes**] unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.
2. Install integral sink bowls in countertops in the shop.

C. Joints:

1. Fabricate countertops without joints.
2. Fabricate countertops in sections for joining in field[with joints at locations indicated].

   a. Joint Locations: Not within **18 inches (450 mm)** of a sink or cooktop and not where a countertop section less than **36 inches (900 mm)** long would result, unless unavoidable.
   b. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints[**where indicated**]. Make width of cuts slightly more than thickness of splines to provide snug fit.[**Provide at least three splines in each joint.**]

D. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures[**in shop**] using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

   a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting **3/16 inch (5 mm)** into fixture opening.
   b. Provide vertical edges, rounded to **3/8-inch (9.5-mm)** radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting **3/16 inch (5 mm)** into fixture opening.

c. Provide **3/4-inch (19-mm)** full bullnose edges projecting **3/8 inch (9.5 mm)** into fixture opening.

2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for grommets, plumbing fittings, undercounter soap dispensers, and similar items.
4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.7 INSTALLATION MATERIALS

A. Particleboard: ANSI A208.1, [**Grade M-2**][**Grade M-2-Exterior Glue**].

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

1. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
2. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
3. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

a. Hardwood Plywood: 0.05 ppm.
b. Particleboard: 0.09 ppm.
c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

C. Adhesive: Product recommended by manufacturer.

1. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

D. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive countertops and conditions under which countertops will be installed,

with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.3 INSTALLATION OF SIMULATED STONE COUNTERTOPS

A. Grade: Install countertops to comply with specified grade.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts not finished in the shop. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

C. Countertop Installation:

1. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
3. Anchor wall cleating necessary for proper setting for countertops not supported by casework.
4. Install countertops level to a tolerance of **1/8 inch in 8 ft. (3.2 mm in 2.4 m)**, **1/4 inch (6.4 mm)** maximum. Do not exceed **1/64-inch (0.4-mm)** difference between planes of adjacent units.
5. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
6. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
7. Secure countertops to subtops with adhesive according to manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
8. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

   a. Install metal splines in kerfs in countertop edges at joints[**where indicated**]. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
   b. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

9. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask

areas of countertops and splashes adjacent to joints to prevent adhesive smears.

10. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
11. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls. Comply with Section 079200 "Joint Sealants."

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semi-exposed surfaces.

C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of **48 inches (1220 mm)** o.c. Remove protection at Substantial Completion.

END OF SECTION 12 36 61 00

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Task	Specification	Specification Description
12 36 61 00	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 61 00	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 36 61 16	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 61 16	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 36 61 16	12 31 16 00	Stone Countertops
12 36 61 16	12 36 61 00	Simulated Stone Countertops
12 36 61 19	12 30 00 00	Manufactured Wood-Veneer-Faced Casework
12 36 61 19	12 30 00 00a	Manufactured Plastic-Laminate-Clad Casework
12 36 61 19	12 31 16 00	Stone Countertops
12 36 61 19	12 36 61 00	Simulated Stone Countertops

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SECTION 12 48 13 00 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roll-up rail mats.
2. Resilient entrance mats.
3. Resilient-tile entrance mats.
4. [**Recessed**][**Surface-mounted**] frames.

B. Related Requirements:

1. Section 124816 "Entrance Floor Grilles" for rigid floor grilles and frames.

1.2 COORDINATION

A. Coordinate size and location of recesses in concrete to receive floor mats and frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.

B. Shop Drawings:

1. Items penetrating floor mats and frames, including door control devices.
2. Divisions between mat sections.
3. Perimeter floor [**moldings**][**frames**].
4. Custom Graphics: Scale drawing indicating colors.

C. Samples: For the following products, in manufacturer's standard sizes:

1. Floor Mat: Assembled sections of floor mat.
2. Tread Rail: Sample of each type and color.
3. Frame Members: Sample of each type and color.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For floor mats and frames to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for

storage and identified with labels describing contents.

1. Resilient-Tile Entrance Mats: Full-size tile units equal to [**2**] percent of amount installed, but no fewer than [**10**] units.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

A. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:

1. Uniform floor load of [**300 lbf/sq. ft. (14.36 kN/sq. m)**].
2. Wheel load of [**350 lb (159 kg)**] per wheel.

B. Accessibility Standard: Comply with applicable provisions in [**the DOJ's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**].

2.2 ROLL-UP RAIL MATS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amarco Products**]
2. [**Babcock-Davis**]
3. [**Balco; a CSW Industrials Company**]
4. [**Construction Specialties, Inc.**]
5. [**Durable Corporation**]
6. [**Forbo Flooring Systems**]
7. [**JL Industries; Activar Construction Products Group, Inc.**]
8. [**K.N. Crowder Mfg. Inc**]
9. [**Kadee Industries, Inc**]
10. [**Matco International**]
11. [**Mats Inc.**]
12. [**Matter Surfaces**]
13. [**Milliken & Company**]
14. [**Nystrom, Inc.**]
15. [**Pawling Corporation**]
16. [**ProSpec; H.B. Fuller Construction Products Inc.**]
17. [**Reese Enterprises, Inc**]
18. [**The R.C. Musson Rubber Co.**]
19. [**van Gelder, Inc**]

B. Roll-up, Aluminum-Rail Hinged Mats: Extruded-aluminum tread rails [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] wide by **3/8 inch (9.5 mm)** thick, sitting on continuous vinyl cushions.

1. Tread Inserts: [**Plain serrated aluminum treads**][**Textured-surface, resilient vinyl**][**Ribbed-design-surface, resilient vinyl**][**Mineral abrasive particles bonded to or embedded in vinyl**][**Aluminum-oxide or silicon-carbide grit in epoxy matrix**][**1/4-inch- (6.4-mm-) high, 28-oz./sq. yd. (950-g/sq. m) weight, level-cut, nylon-pile, fusion-bonded carpet**].
2. Colors, Textures, and Patterns of Inserts: [**As indicated by manufacturer's**

designations][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
3. Rail Color: [**Mill finish**][**Clear**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.
4. Hinges: [**Plastic**][**Aluminum**].
5. Mat Size: [**As indicated**].

C. Roll-up, Vinyl-Rail Hinged Mats: Vinyl-acrylic tread rails [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] wide by **3/8 inch (9.5 mm)** thick, with slotted or perforated hinges.

1. Tread Inserts: [**Textured-surface, resilient vinyl**][**Ribbed-design-surface, resilient vinyl**][**Mineral abrasive particles bonded to or embedded in vinyl**][**Aluminum-oxide or silicon-carbide grit in epoxy matrix**][**1/4-inch- (6.4-mm-) high, 28-oz./sq. yd. (950-g/sq. m) weight, level-cut, nylon-pile, fusion-bonded carpet**].
2. Colors, Textures, and Patterns of Inserts: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
3. Rail Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
4. Hinges: [**Vinyl**][**Aluminum**].
5. Mat Size: [**As indicated**].

2.3 RESILIENT ENTRANCE MATS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amarco Products**]
2. [**American Floor Mats**]
3. [**American Floor Products Company, Inc**]
4. [**Babcock-Davis**]
5. [**Cactus Mat Mfg. Co.**]
6. [**Consolidated Plastics Company, Inc**]
7. [**Construction Specialties, Inc.**]
8. [**Durable Corporation**]
9. [**Entrance Inc**]
10. [**Forbo Flooring Systems**]
11. [**JL Industries; Activar Construction Products Group, Inc.**]
12. [**K.N. Crowder Mfg. Inc**]
13. [**Kadee Industries, Inc**]
14. [**Matco International**]
15. [**Mats Inc.**]
16. [**Matter Surfaces**]
17. [**Milliken & Company**]
18. [**Pawling Corporation**]
19. [**ProSpec; H.B. Fuller Construction Products Inc.**]
20. [**Reese Enterprises, Inc**]
21. [**SBEMCO Matting By Design**]
22. [**The R.C. Musson Rubber Co.**]
23. [**van Gelder, Inc**]
24. [**Wearwell, Inc**]

B. Resilient Link Mats: Reversible [vinyl][rubber][rubber-tire] link mats, [3/8 inch (9.5 mm)][7/16 inch (11

mm)] thick, with [galvanized-spring][stainless]-steel wire link rods, vulcanized edge-nosing trim, steel-reinforced end trim, and links consisting of rectangular units or continuous strips in a [heel-proof, solid-weave pattern with no openings between links][heel-proof, close-weave pattern with openings between links not exceeding 1/8 inch (3.2 mm) wide by 1 inch (25.4 mm) long][open-weave pattern].

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Mat Size: [**As indicated**].

C. [Rubber][Vinyl] Mats: [1/4-inch- (6.4-mm-)][3/8-inch- (9.5-mm-)][7/16-inch- (11-mm-)][1/2-inch- (13-mm-)] thick mats; with [square edges for recessed installations][beveled edges for surface applications] and with [solid-sheet (no perforations) style][perforated style, 1/4-inch (6.4-mm) diameter on standard spacing][perforated style, 3/16 by 3/4 inch (5 by 19 mm) on standard spacing], [standard pyramid design][standard wide-wale corrugated][hi-rib, narrow-wale corrugated] top profile, and [low-rib, narrow-wale corrugated][standard knob-base][flat-base] bottom surface.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Mat Size: [**As indicated**].

D. Cocoa Mats: Constructed from cocoa fiber yarn permanently bonded to PVC backing for dimensional stability and resistance to shedding; [**5/8- to 3/4-inch (16- to 19-mm) overall thickness; 1.5-lb/sq. ft. (7.3-kg/sq. m)**][**1-inch (25.4-mm) overall thickness; 2.0-lb/sq. ft. (10-kg/sq. m)**][**1-1/4-inch (32-mm) overall thickness; 2.5-lb/sq. ft. (12-kg/sq. m)**] weight.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Mat Size: [**As indicated**].

E. Rubber-Tire Mats: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form **3/8- to 7/16-inch- (9.5- to 11-mm-)** thick, **12-inch- (300-mm-)** wide, continuous linear strip up to **25 feet (7.6 m)** long.

1. Mat Size: [**As indicated**].

F. Carpet-Type Mats: [**Nylon**][**Polypropylene**][**Olefin**][**Polyester**] carpet bonded to **1/8- to 1/4-inch- (3.2- to 6.4-mm-)** thick, flexible vinyl backing to form mats **3/8 or 7/16 inch (9.5 or 11 mm)** thick with nonraveling edges.

1. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Mat Size: [**As indicated**].

G. Loop Filament Mats: Loop filament vinyl material [**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] thick, with [**solid vinyl**][**foam**] sheet backing and with built-in chemical agents to reduce fungus and mildew.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Mat Size: [**As indicated**].

H. Graphics: Custom inlaid or woven-in graphic [**design,**][**logo,**][**emblem,**][**characters,**] as indicated.

2.4 RESILIENT-TILE ENTRANCE MATS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amarco Products**]
2. [**Cactus Mat Mfg. Co.**]
3. [**Consolidated Plastics Company, Inc**]
4. [**Durable Corporation**]
5. [**Entrance Inc**]
6. [**Matco International**]
7. [**Mats Inc.**]
8. [**Matter Surfaces**]
9. [**Milliken & Company**]
10. [**Pawling Corporation**]
11. [**The R.C. Musson Rubber Co.**]
12. [**Turtle Plastics**]

B. Rubber-Tire Tiles: Units of edge-grain-laminated and chenille-buffed, rubber-tire wall cuts; bonded to sheet rubber or other durable flexible backing sheet to form **3/8- to 7/16-inch- (9.5- to 11-mm-)** thick, square tile.

1. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Tile Size: [**12 inches (300 mm)**][**As indicated**].

C. [Rubber][Vinyl] Tiles: [5/8-inch- (16-mm-)][7/16-inch- (11-mm-)] thick, [solid][open-grid][rubber][vinyl] compound molded tiles with [concealed interlocking joint tabs][1/4-inch- (6.4-mm-) deep, serpentine-grooved top face and knob-base back face on solid tile].

1. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Tile Size: [**As indicated**].

D. Carpet-Type Tiles: [**Nylon**][**Polypropylene**][**Olefin**][**Polyester**] carpet bonded to **1/8- to 1/4-inch- (3.2- to 6.4-mm-)** thick, flexible vinyl backing to form mats **3/8 or 7/16 inch (9.5 or 11 mm)** thick with nonraveling edges.

1. Colors, Textures, and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
2. Tile Size: [**As indicated**].

2.5 FRAMES

A. Recessed Frames: Manufacturer's standard extrusion.

1. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.

a. Color: [**Mill finish**][**Clear**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

2. Architectural Bronze: ASTM B455, Alloy UNS No. C38500.

B. Surface-Mounted Frames:

1. Tapered Frames: Tapered [flexible vinyl edge-][aluminum]frame members, not less than [2 inches (50 mm)][1-1/2 inches (38 mm)] wide[attached to mat at all four edges,] with welded mitered corners.

a. Vinyl Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.
b. Aluminum Color: [**Mill finish**][**Clear**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

2.6 CONCRETE FILL AND GROUT MATERIALS

A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.7 FABRICATION

A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.

1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

C. Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and postinstalled expansion anchors.

D. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

2.8 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.9 COPPER-ALLOY (BRONZE) FINISHES

A. Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finishes, as defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.

B. CDA Mechanical Finish Designation: [**M11, specular, as fabricated**][**M32, directionally textured, medium satin**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, sizes, [**minimum recess depth,**]and other conditions affecting installation of floor mats and frames.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install recessed mat frames and mats to comply with manufacturer's written instructions so that tops of mats will be flush with adjoining finished flooring. Set mats with tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.

1. For installation in terrazzo flooring areas, allow for grinding and polishing of terrazzo without grinding surface of recessed frames. Coordinate with other trades as required.
2. Install necessary shims, spacers, and anchorages for proper location, and secure attachment of frames.
3. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.
4. Delay setting mats until construction traffic has ended.

B. Install surface-type units to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.

1. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.

3.3 PROTECTION

A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12 48 13 00

Task	Specification	Specification Description
12 48 13 13	12 48 13 00	Entrance Floor Mats and Frames
12 48 13 16	12 48 13 00	Entrance Floor Mats and Frames

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SECTION 12 55 00 00 - DETENTION FURNITURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Detention bunks.
2. Detention mattresses.
3. Detention desks.
4. Detention tables.
5. Detention seating.

B. Related Requirements:

1. Section 102813.63 "Detention Toilet Accessories" for detention toilet and bath accessories.
2. Section 111916 "Detention Gun Lockers" for detention gun lockers.
3. Section 119814 "Detention Door Hardware" for security key cabinets.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

B. Coordinate installation of anchorages for detention furniture. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to Project site in time for installation.

C. Coordinate size and location of recesses in wall construction to receive detention furniture.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for detention furniture.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For sealants, indicating VOC content.

3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For detention furniture.

1. Include plans, elevations, sections, and attachment details.
2. Indicate locations, dimensions, and profiles of wall and floor reinforcements.
3. Indicate locations and installation details of built-in anchors.
4. Show elevations of detention furniture and indicate dimensions of furniture, preparations for receiving anchors, and locations of anchorage.
5. Show details of attachment of detention furniture to built-in anchors.

D. Samples for Initial Selection: For detention furniture with factory-applied color finishes.

E. Samples for Verification: For each type of detention furniture indicated.

1. Furniture: Full-size units. Approved Samples may become part of the completed Work.
2. Detention Mattresses: Not less than **6 inches (152 mm)** square by full depth, including core and cover fabric.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Examination reports, documenting inspections of substrates, areas, and conditions.

C. Anchor inspection reports, documenting inspections of built-in and cast-in anchors.

D. Field quality-control reports, documenting inspections of installed products.

1. Field quality-control certification, signed by Contractor[**and Detention Specialist**].

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For detention mattresses to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Security Fasteners: Furnish not less than one box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.
2. Tools: Provide [**two**] sets of tools for installing and removing security fasteners.

1.8 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup of typical detention cell with furniture as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Detention Mattresses: Deliver wrapped to provide protection during transit and Project-site storage. Protect from contact with moisture.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify openings for recessed detention furniture by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 DETENTION BUNKS

A. Freestanding Single Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]
b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Detention Device Systems (DDS); DDS Group**]
d. [**Maximum Security Products Corp**]
e. [**Norix Group, Inc.**]
f. [**PSI LLC**]
g. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[perforated with at least six holes].

a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with bunk pan **14 inches (356 mm)** above floor.
b. Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawer: Minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Legs and Frames: Formed from **2-by-2-by-3/16-inch (51-by-51-by-4.8-mm)** steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.

5. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.

B. Freestanding Double Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Detention Device Systems (DDS); DDS Group**]
   d. [**Maximum Security Products Corp**]
   e. [**Norix Group, Inc.**]
   f. [**PSI LLC**]
   g. [**Sweeper Metal Fabricators Corp**]
   h. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[each pan perforated with at least six holes].

   a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with lower bunk pan **14 inches (356 mm)** above floor and upper bunk pan at least **49 inches (1245 mm)** above floor.
   b. Upper Bunk Edges: Turn up edges of back and sides and turn down edge of front, with minimum **2-inch (51-mm)** flanges.
   c. Lower Bunk Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawers: Two; minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Legs and Frames: Formed from **2-by-2-by-3/16-inch (51-by-51-by-4.8-mm)** steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk.
5. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.
6. Assembly: [**Factory assembled**][**Knocked down for field assembly**].

C. Wall-Mounted Bunks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Detention Device Systems (DDS); DDS Group**]
   d. [**Maximum Security Products Corp**]
   e. [**Norix Group, Inc.**]
   f. [**PSI LLC**]
   g. [**Sweeper Metal Fabricators Corp**]
   h. [**Willo Products Company, Inc.**]

2. Bunk Pan: Formed from [0.134-inch (3.42-mm)][0.105-inch (2.66-mm)] nominal-thickness steel sheet[perforated with at least six holes].

   a. Size: Minimum **27 inches (689 mm)** wide by **76 inches (1930 mm)** long with bunk pan **2 inches (51 mm)** from wall.
   b. Edges: Turn up edges of [**back and sides and turn down edge of front**][**back, sides, and front**], with minimum **2-inch (51-mm)** flanges.

3. Drawer: Minimum **21 inches (533 mm)** wide by **24 inches (610 mm)** deep by **5 inches (127 mm)** high, with [**full-width integral pull formed from steel sheet**][**solid-steel bar pull**]; formed from **0.134-inch (3.42-mm)** nominal-thickness steel sheet.
4. Combination End Panel/Mounting Plate: Formed from **3/16-inch- (0.048-mm-)** thick steel sheet welded at connections to bunk pan, with **2-inch (51-mm)** flange for wall mounting; provide two end panel/mounting plates for each bunk.

D. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.

E. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.2 DETENTION MATTRESSES

A. Detention Mattresses: Comply with 16 CFR 1633 and California Technical Bulletin 121 as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   b. [**Chestnut Ridge Foam, Inc**]
   c. [**Derby Industries**]
   d. [**Norix Group, Inc.**]
   e. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]

B. Core: [**Fire-resistive solid foam**][**Fire-resistive densified polyester**][**Cotton, with 10 percent boric acid treatment, tufted to nylon netting to retain shape**].

C. Cover Fabric: Vinyl bonded to nylon scrim; with a minimum total weight of 10 oz./sq. yd. (339 g/sq. m).

Fabricate cover using [all sealed-seam construction with radio-frequency welded inverted seams][four-corner box construction with seams facing inside of detention mattress except end closing seam located at foot of mattress; sew with nylon thread in a double-lock stitch][with integral pillow].

1. Color: [**Clear**][**Manufacturer's standard**].

D. Thickness: [**4 inches (102 mm)**][**6 inches (152 mm)**].

2.3 DETENTION DESKS

A. Single-Seat, Floor-Mounted Desks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Jail Products L.L.C.**]
   b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
   c. [**Maximum Security Products Corp**]
   d. [**PSI LLC**]
   e. [**Sweeper Metal Fabricators Corp**]
   f. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
   g. [**Willo Products Company, Inc.**]

2. Desk Top: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

   a. Size: Minimum **36 inches (914 mm)** wide by **15-1/2 inches (381 mm)** deep.

3. Pedestal: Provide two storage shelves with sides and shelves formed from **0.134-inch (3.42-mm)** nominal-thickness steel.
4. Legs: Formed from **1-1/2-inch-square by 3/16-inch- (38-mm-square by 4.8-mm-)** thick steel tubing welded to desk top and mounting plate for an overall desk height of not less than **30 inches (762 mm)**.
5. Seat: **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch (3.42-mm)** nominal-thickness steel sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.
6. Swivel Seat Support: Formed from **1-by-2-by-0.075-inch (25-by-51-by-1.90-mm)** nominal-thickness steel tubing, **2-inch-OD-by-0.075-inch (51-mm-OD-by-1.90-mm)** nominal-thickness steel tubing, or **3/8-inch- (9.5-mm-)** thick, steel plate bar; with **1/2-inch (12.7-mm)** pivot pin welded to legs.
7. Towel Bar: Formed from **1/4-by-1-1/2-inch (6-by-38-mm)** [**steel**][**stainless steel**] plate, mounted on one side of desk.
8. Mounting Plates: Formed from **1/4-inch- (6-mm-)** thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.

B. Wall-Mounted Desk and Seat:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**American Jail Products L.L.C.**]
b. [**Maximum Security Products Corp**]
c. [**Norix Group, Inc.**]
d. [**Willo Products Company, Inc.**]

2. Desk: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

   a. Size: Minimum [**12 inches (305 mm) wide by 18 inches (457 mm) deep**][**18 inches (457 mm) wide by 18 inches (457 mm) deep**][**24 inches (610 mm) wide by 18 inches (457 mm) deep**][**30 inches (762 mm) wide by 20 inches (508 mm) deep**].

3. Seat: Minimum **12 inches (305 mm)** wide by [**16 inches (406 mm)**][**18 inches (457 mm)**] deep; formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

C. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.

D. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: [**No. 3**][**No. 4**].

2.4 DETENTION TABLES

A. Pedestal-Style Table:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Jail Products L.L.C.**]
    b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
    c. [**Detention Device Systems (DDS); DDS Group**]
    d. [**Maximum Security Products Corp**]
    e. [**PSI LLC**]
    f. [**Sweeper Metal Fabricators Corp**]
    g. [**Willo Products Company, Inc.**]

2. Tabletop: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with steel shapes or steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.

    a. Size: Minimum [**30 inches (762 mm)**][**40 inches (1016 mm)**] wide by length required for capacity by [**30 inches (762 mm)**][**35 inches (889 mm)**] high.
    b. Game Top: Engrave, or otherwise integrally incorporate, checkerboard into tabletop.

3. Seats: **12-inch (305-mm)** diameter, formed from [**0.105-inch (2.66-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch (3.42-mm)** nominal-thickness steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.
4. Pedestal Supports: Formed from [**3-inch-square by 3/16-inch- (76-mm-square by 4.8-mm-)**][**4-inch-square by 0.134-inch- (102-mm-square by 3.42-mm-)**] thick, steel tubing welded to top and base plate.[**Provide two pedestals for tables with capacity of more than four persons.**]
5. Seat Framing: Formed from [**3-inch-square by 0.134-inch- (76-mm-square by 3.42-mm-)**][**3-by-2-by-3/16-inch- (76-by-51-by-4.8-mm-)**] thick, steel tubing welded to pedestal supports.
6. Base Plate: Minimum **16-inch- (406-mm-)** square, **1/4-inch- (6-mm-)** thick, steel plate punched with four holes for floor anchorage.
7. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

B. Bench-Style Table:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Jail Products L.L.C.**]
    b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
    c. [**Maximum Security Products Corp**]
    d. [**Norix Group, Inc.**]
    e. [**PSI LLC**]
    f. [**Sweeper Metal Fabricators Corp**]
    g. [**Willo Products Company, Inc.**]

2. Tabletop: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**] sheet; reinforced with steel channel frame or steel plate, with minimum **1-1/2-inch (38-mm)** flanged edges.

    a. Size: Minimum **24 inches (610 mm)** wide by length required for capacity by [**30 inches**

(762 mm)][35 inches (889 mm)] high.

3. Benches: 12 inches (305 mm) deep by length of tabletop, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet, with minimum 1-1/2-inch (38-mm) flanged edges.
4. Vertical Supports: Formed from 8-inch (203-mm) hot-rolled steel channels or 0.164-inch- (4.18-mm-) thick, formed-steel channels; braced and welded, with steel base plates punched for floor anchorage.[**Provide three supports for tables with capacity of more than four persons.**]
5. Bench Supports: Formed from 2-by-2-1/2-by-1/4-inch- (51-by-64-by-6-mm-) thick, steel angle or 2-inch-square by 1/4-inch- (51-mm-square by 6-mm-) thick, steel tubing; welded to vertical supports.
6. Floor Anchor: Formed from steel angle punched for floor anchorage.
7. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

C. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.

D. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: [**No. 3**][**No 4**].

2.5 DETENTION SEATING

A. Floor-Mounted Stool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Jail Products L.L.C.**]
b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Detention Device Systems (DDS); DDS Group**]
d. [**Maximum Security Products Corp**]
e. [**Norix Group, Inc.**]
f. [**PSI LLC**]
g. [**UNICOR, Federal Prison Industries, Inc. (FPI)**]
h. [**Willo Products Company, Inc.**]

2. Seats: Minimum **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.125-inch- (3.18-mm-) thick, stainless steel**][**0.062-inch- (1.59-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch- (3.42-mm-)** thick steel sheet cut to interior dimension of seat, with minimum **1-1/2-inch (38-mm)** flanged edges.
3. Seat Support: Formed from steel pipe or **2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-)** thick, steel tubing welded to seat reinforcement and base plate for an overall stool height of not less than **18 inches (457 mm)**.
4. Base Plate: Minimum **6-by-1/4-inch- (152-by-6-mm-)** thick, [**square**][**round**][**steel**] punched with four holes for floor anchorage.

B. Wall-Mounted Stool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]
b. [**Maximum Security Products Corp**]
c. [**PSI LLC**]
d. [**Willo Products Company, Inc.**]

2. Seat: Minimum **12-inch (305-mm)** diameter, formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.075-inch (1.90-mm) nominal-thickness steel**][**0.125-inch- (3.18-mm-) thick, stainless steel**][**0.078-inch- (1.98-mm-) thick, stainless steel**] sheet; reinforced with **0.134-inch- (3.42-mm-)** thick steel sheet cut to interior dimension of seat, with minimum **1-1/2-inch (38-mm)** flanged edges.
3. Seat Support: Formed from **1-by-2-by-0.075-inch- (25-by-51-by-1.90-mm-)** thick, steel tubing; **2-inch-OD-by-0.075-inch- (51-mm-OD-by-1.90-mm-)** thick, steel tubing; or **3/8-inch- (9.5-mm-)** thick, steel plate bar; welded to seat reinforcement and wall bracket.
4. Swivel Wall Bracket: Minimum **1/2-inch (12.7-mm)** pivot pin, with **3/8-inch- (9.5-mm-)** thick, steel plate [**for welding to embedded steel plate**][**for welding to steel wall**][**punched with four holes for wall anchorage**].

C. Floor-Mounted Bench:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Jail Products L.L.C.**]

b. [**BarkerBuilt, Division of Bob Barker Company, Inc**]
c. [**Maximum Security Products Corp**]
d. [**Norix Group, Inc.**]
e. [**PSI LLC**]
f. [**Willo Products Company, Inc.**]

2. Bench Top: Formed from [**0.134-inch (3.42-mm) nominal-thickness steel**][**0.105-inch (2.66-mm) nominal-thickness steel**][**0.141-inch- (3.57-mm-) thick, stainless steel**][**0.109-inch- (2.78-mm-) thick, stainless steel**] sheet, with minimum **1-1/2-inch (38-mm)** flanged edges.

   a. Size: Minimum **12 inches (305 mm)** deep by [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long.

3. Supports: Formed from **0.164-inch- (4.18-mm-)** thick, formed-steel channels or **2-1/2-inch-OD-by-0.0677-inch- (64-mm-OD-by-1.7-mm-)** thick, steel tubing; welded to bench and base plate for an overall bench height of not less than **18 inches (457 mm)**.[**Provide three supports for benches with length of more than 72 inches (1829 mm).**]
4. Handcuff Ring: Formed from **3/8-inch- (9.5-mm-)** diameter, stainless steel rod;welded to [**front**][**back**][**both sides**] of each support.
5. Base Plates: Minimum **8-inch-square by 1/4-inch- (203-mm-square by 6-mm-)** thick, steel plate punched with four holes for floor anchorage.
6. Capacity: [**Four persons**][**Six persons**][**Eight persons**][**As indicated on Drawings**].

D. Materials:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, CS (Commercial Steel), Type B; suitable for exposed applications.
3. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
5. Steel Tubing: ASTM A513/A513M, Type B unless otherwise indicated; thickness indicated or required by structural loads.
6. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless another weight is indicated or required by structural loads.

E. Finishes:

1. Steel Factory Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
2. Steel Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Stainless Steel Finish:

   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded

foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: [**No. 3**][**No 4**].

2.6 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of detention furniture with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Form and grind edges and corners to be free of sharp edges or rough areas.

1. Fabricate detention furniture with no more than **1/32-inch (0.8-mm)** gap between component materials. Weld edges that cannot be crimped to meet tolerance so as to provide a seamless joint with no place for concealment of contraband.

E. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

F. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention furniture rigidly in place and to support expected loads. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

H. Cut, reinforce, drill, and tap detention furniture as indicated to receive hardware, security fasteners, and similar items.

I. Form exposed work true to line and level with accurate angles, surfaces, and straight sharp edges.

J. Form exposed connections with hairline joints, flush and smooth using concealed fasteners where possible. Use exposed security fasteners of type indicated or, if not indicated, flat-head (countersunk) security fasteners. Locate joints where least conspicuous.

K. Attach [**drawer slides**][**shelves**] to furniture [**by welding**][**with security fasteners**].

2.7 SECURITY FASTENERS

A. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific type of fastener. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
   b. [**Bryce Fastener Mfg., Inc.**]
   c. [**Safety Socket LLC**]
   d. [**Tamper-Pruf Screws**]

2. Drive-System Type: [**Pinned Torx-Plus**][**Pinned Torx**].
3. Fastener Strength: **120,000 psi (827 MPa)**.
4. Socket Button Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

5. Socket Flat Countersunk Head Fasteners:

   a. Heat-treated alloy steel, ASTM F835.
   b. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

6. Socket Head Cap Fasteners:

   a. Heat-treated alloy steel, ASTM A574.
   b. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

7. Protective Coatings for Heat-Treated Alloy Steel:

   a. Zinc and clear trivalent chromium where indicated.
   b. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.8 SECURITY SEALANTS

A. Polyurethane Security Sealants: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Master Builders Solutions**]
   b. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Epoxy Security Sealants: Manufacturer's standard, non-sag, tamper-resistant sealant for joints with no movement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**Master Builders Solutions**]
   c. [**Pecora Corporation**]

2. Sealant shall have a VOC content of 250 g/L or less.
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.9 ACCESSORIES

A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining,

without failure, a load equal to [**four**] times the load imposed, as determined by testing per ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below:

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized per ASTM A153/A153M or ASTM F2329/F2329M.

C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum **3/16 inch (4.8 mm)** thick; with minimum **1/2-inch- (12.7-mm-)** diameter, headed studs welded to back of plate.

D. Proprietary Built-in Masonry Anchors: Fabricated from [0.134-inch (3.42-mm) nominal-thickness steel sheet][1/4-inch (6-mm) nominal-thickness steel plate][1/2-inch (12.7-mm) nominal-thickness steel plate] into [6-inch- (152-mm-)][8-inch- (203-mm-)] deep blocks matching size of concrete masonry units[with weld nuts attached on inside to receive field-bolted attachments].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**M/BED Block Systems, LLC.**]
   b. [**Peterson Detention Inc. (PDI)**]

2. Finish: [**Factory primed for field painting for anchors with field-welded attachments**][**Polyester powder coat for anchors with bolted attachments**][**Epoxy paint for anchors with bolted attachments**].

E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention furniture.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of detention furniture before detention furniture installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention furniture.

D. Inspect built-in and cast-in anchor installations, before installing detention furniture, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention furniture with those indicated on Shop Drawings.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention furniture to in-place construction. Include threaded fasteners for [**concrete**][**and**][**masonry**] inserts, security fasteners, and other connectors.

B. Cutting, Fitting, and Placement: Obtain manufacturer's written approval for cutting, drilling, and fitting required for installing detention furniture. Set detention furniture accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into [concrete][masonry] or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Fillet Welds:

   a. Minimum size of **1/8 inch by 1-1/2 inches (3 mm by 38 mm)** long, spaced not greater than **12 inches (305 mm)** o.c. Fill spaces between welds with [**polyurethane**][**epoxy**] security sealant where weld is exposed.
   b. Continuous.

F. Assemble detention furniture requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames.

G. Anchor furniture [**with security fasteners**][**by welding**][**as indicated on Drawings**] to floors and walls at intervals required by expected loads, but not more than **12 inches (305 mm)** o.c.

1. Install anchors through backup reinforcing plates where necessary to avoid metal distortion.
2. Use security fasteners with head styles appropriate for installation requirements, strength, and finish of adjacent materials, except that a maximum of two different sets of tools shall be required to operate security fasteners for Project.[**Provide stainless steel security fasteners in painted materials.**]
3. Weld nuts onto cast-in-place anchors after installation so as to be nonremovable.

H. Apply [**polyurethane**][**epoxy**] security sealant at all exposed gaps between detention furniture and adjacent construction greater than **1/16 inch (1.6 mm)**.

I. Install one detention mattress for each detention bunk.

3.3 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

B. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units; replace with new units.

C. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

D. Prepare field quality-control certification[**endorsed by Detention Specialist**] that states installed products and their installation comply with requirements in the Contract Documents.

3.4 CLEANING AND PROTECTION

A. Touchup Painting:

1. Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
2. Cleaning and touchup painting of bolted connections and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

END OF SECTION 12 55 00 00

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Task	Specification	Specification Description
12 55 13 00	12 55 00 00	Detention Furniture
12 55 16 00	12 55 00 00	Detention Furniture
12 55 19 00	12 55 00 00	Detention Furniture
12 55 23 00	12 55 00 00	Detention Furniture
12 55 26 00	10 28 13 63	Detention Toilet Accessories
12 55 26 00	12 55 00 00	Detention Furniture
12 55 86 00	12 55 00 00	Detention Furniture

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SECTION 12 61 00 00 - FIXED AUDIENCE SEATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed audience seating.
2. Lecture-hall tables.

B. Related Requirements:

1. Section 126313 "Stadium and Arena Bench Seating" for continuous bench- or plank-type seating.

1.2 DEFINITIONS

A. Pan: An exposed, supporting seat bottom made of steel.

B. Shell: An exposed, supporting seat bottom or back made of materials other than steel.

C. Tablet Arm: A flat surface attached to a chair that has the primary function to support tasks such as writing and short-term reference-material handling.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data:

1. Fixed audience seating.
2. Lecture-hall tables.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of components, and finishes for fixed audience seating.
2. Include electrical characteristics of electrical components, devices, and accessories.

C. Sustainable Design Submittals:

1. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
2. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

4. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
5. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Seating Layout: Show seating layout, aisle widths, aisle-end alignment or stepping, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
3. Lecture-Hall Tables: Show table layout.
4. Accessories: Show locations and features of accessories, including [**left- and right-hand tablet arms**][**electrical devices**][**bookracks**], and accessibility provisions.
5. Include diagrams for power, signal, and control wiring.

E. Samples for Initial Selection: For each type of exposed color, finish, texture, and pattern indicated.

1. Include Samples of accessories involving color and finish selection.

F. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Chair Unit: Full-size unit of each type[**and combination of finishes**].
2. Molded Plastic: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
3. Plastic Laminate: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
4. Baked-on Coating Finishes: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
5. Aluminum Finishes: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
6. Wood and Plywood Materials and Finishes: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
7. Upholstery Fabric: Full width by [**36-inch- (914-mm-)**] long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.
8. Row-Letter and Chair-Number Plates: Full-size units with letters and numbers marked.
9. Aisle Lighting: Full-size unit.
10. Power and Data Service Devices: Full-size units.
11. Bookracks: Full-size unit.
12. Exposed Fasteners: Full-size units of each type.
13. Full-size samples[**of chair units**], if approved, will be returned to Contractor for use in Project.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Coordinate location of electrical wiring and devices eating layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.
2. Coordinate location of diffuser pedestals with HVAC work and with properties of diffuser pedestals to ensure alignment, proper air diffusion, and correct seat locations.

B. Product Certificates: For each type of fixed audience seating.

C. Material Certificates: For each type of flame-retardant treatment of upholstery fabric.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fixed audience seating to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance of self-rising seat mechanisms, folding armrests, and other operating components.
b. Adjustment of self-rising seat mechanisms to align seats.
c. Maintenance of electrical components, devices, and accessories.
d. Methods for maintaining upholstery fabric.
e. Precautions for cleaning materials and methods that could be detrimental to seating finishes and performance.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Chair Seats and Backs: [**5**] percent of quantity installed for each type and size of chair seat and back.
2. Upholstered, Slip-on Cushions: [**5**] percent of quantity installed for each type and size of cushion.
3. Fabric: [**5**] percent on the bolt of quantity installed for each type.
4. Tablet Arms: [**5**] percent of quantity installed for each type and size of tablet arm; left- and right-hand mounted.
5. Armrests: [**5**] percent of quantity installed for each type of armrest.
6. Power Receptacles: [**5**] percent of quantity installed.
7. Data Ports: [**5**] percent of quantity installed.
8. Chair Seat Hinges: [**5**] percent of quantity installed.
9. Aisle-Lighting Fixture Bulbs: [**5**] percent of quantity installed.
10. Donor Plates: [**100**].
11. Bookracks: [**5**] percent of quantity installed.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including standards, beams, and pedestals.
b. Faulty operation of self-rising seat mechanism.
c. Faulty operation of electrical components.
d. Wear and deterioration of fabric and stitching beyond normal use.
e. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Periods: As follows, from date of Substantial Completion.

a. Structural: [**Five years**][**10 years**][**Lifetime**].
b. Operating Mechanisms: [**Three years**][**Five years**][**Lifetime**].
c. Electrical Components: [**Three**][**Five**] years.
d. Plastic, Wood, and Paint Components: [**Two**][**Three**][**Five**] years.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.

1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics of Upholstered Chairs:

1. Fabric and Padding:

a. Fabric: Class 1 in accordance with DOC CS 191 or 16 CFR 1610, tested in accordance with California Technical Bulletin 117-2000.
b. Padding: Comply with California Technical Bulletin 117-2000.

2. Upholstery Assembly: Assembly to comply with component-testing requirements of California Technical Bulletin 117-2013.
3. Full-Scale Fire Test: Comply with California Technical Bulletin 133.

B. Strength and Durability Performance: Chairs and components to pass testing in accordance with BIFMA X5.4.

2.3 FIXED AUDIENCE SEATING

A. Fixed Audience Seating : [**Assembly-space seating in permanent arrangement**] as indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Seating Company**]
b. [**Ducharme Seating**]
c. [**Hussey Seating Company**]
d. [**Interkal LLC**]
e. [**Irwin Seating Company**]
f. [**KI**]
g. [**Preferred Seating Company**]
h. [**Seating Concepts LLC**]
i. [**SERIES Seating LLC**]

j. [**Sitmatic**]
k. [**Southern Bleacher Company Inc.**]
l. [**TSI Group**]

B. Chair Mounting Standards: [**Floor**][**Riser**] attached of the following material:

1. Steel: One-piece, heavy-tube or reinforced sheet with welded mounting plate and welded connections for seat pivots, backs, armrests, and end panels.
2. Cast Metal: One-piece [**iron**][**aluminum**] castings with integral mounting points and attachment anchoring points for seat pivots, backs, and armrests.
3. Molded Plastic: One-piece, solid injection-molded plastic with integral reinforcing ribs for attachment and anchoring points for seat pivots, backs, and armrests.

C. Chair Mounting Beam: Steel horizontal beam mounted on [**floor**][**riser**]-attached steel support pedestals spaced at intervals of 2 to 2-1/2 chair widths.[**Chair attachments equipped with 180-degree rotation capability, returning to forward position when unoccupied.**]

D. Chair Mounting Pedestal: Floor-attached pedestal, manufacturer's standard [**base with 90-degree left and right rotation capability**][**base with 360-degree rotation capability**][**diffuser pedestal at location(s) indicated**].

E. End Panels: [**Steel**][**Cast iron with design**][**Cast aluminum with design**][**Plastic laminate**][**Hardwood-veneer plywood**][**Solid hardwood**][**Fabric upholstered**][**Molded plastic**].

1. Cast-Metal Design: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
2. Decorative Insert: [**Plastic laminate**][**Hardwood-veneer plywood**][**Solid hardwood**][**Fabric upholstered**][**Molded plastic**][**Customized medallion**].
3. Style: [**Rectangular**][**Oval**][**Teardrop**][**Tapered**][**Panel to floor (pew)**] with [**square**][**rounded**] corners.

F. Fabric Upholstered Chairs:

1. Back:

a. Padding Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**].
b. Outer Back Surface: [**Steel**][**Molded plastic**][**Fabric upholstered with 1/4-inch (6-mm) padding**][**Plastic laminate**][**Hardwood-veneer plywood**], with [**concealed**][**exposed**] fasteners.
c. Top Corners: [**Square**][**Rounded**].
d. Upholstery Options: [**Tufting**][**decorative stitching**][**and**][**welt cord trim**].

2. Seat: [**Two part, top and bottom construction**][**One part, fully upholstered construction**][**One part, fully upholstered construction with removable upholstery cover**] and as follows:

a. Top Padding Thickness: Minimum [**1-1/2 inches (38 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**] at front and rear edges.
b. Seat Bottom: [**Steel sheet seat pan**][**Perforated-steel sheet seat pan with acoustical insulation**][**Hardwood-veneer-faced, formed plywood shell**][**Molded-plastic shell**][**Fabric upholstered**].

G. Plastic Chairs: [**Single**][**Double**]-wall molded plastic and as follows:

1. Back: [**Smooth surface**][**Textured surface**][**Formed slats**][**Smooth surface with upholstered inserts**][**Textured surface with upholstered inserts**] with [**square**][**rounded**] top corners

2. Seat: [**Smooth surface**][**Textured surface**][**With simulated slats**][**Smooth surface with upholstered inserts**][**Textured surface with upholstered inserts**].
3. Upholstered Inserts: Padding and fabric covering over **1/8-inch (3-mm)** plywood or MDF backing board, recessed [**3/16 inch (5 mm)**] into plastic surface, centered, and attached with hidden, vandal-resistant fasteners.

H. Formed Hardwood-Veneer Chairs: Hardwood-veneer-faced, formed plywood backs and seats, with [**concealed**][**exposed**] fasteners.

1. Back Top Corners: [**Square**][**Rounded**].

I. Chair Width: [**Vary chair widths to optimize sightlines and row lengths**][**Single-width chair in each row**], with [**minimum**]chair width of [**18 inches (457 mm)**][**19 inches (483 mm)**][**20 inches (508 mm)**][**21 inches (533 mm)**][**22 inches (559 mm)**][**23 inches (584 mm)**][**24 inches (610 mm)**] from center to center of armrests.

J. Back Height: [**31 inches (787 mm)**][**32-1/2 inches (826 mm)**][**35 inches (889 mm)**][**38 inches (965 mm)**][**40 inches (1016 mm)**][**42 inches (1069 mm)**][**44 inches (1117 mm)**] high from the floor.

K. Back Pitch: [**Fixed**][**Variable at set angles (planetarium)**][**Variable, hinged (rocker)**].

1. Back Angle: [**Angle for optimum viewing comfort**][**Different angles within manufacturer's available range, for optimum viewing comfort at each location**][**16 degrees**][**18 degrees**][**20 degrees**][**21 degrees**][**24 degrees**].
2. Chair Back Hinges: Self-lubricating type with noiseless mechanism that raises back to vertical position when chair is unoccupied.

L. Chair Seat Hinges: Self-lubricating, with noiseless [**self-rising seat mechanism passing ASTM F851**][**manual operation**], positive internal stops cushioned with rubber or neoprene, and requiring no maintenance.

1. Self-Rising Seat Mechanism: [**Spring actuated, three-quarter fold**][**Spring actuated, full fold**][**Gravity actuated, full fold**].
2. Reclining Mechanism: Manufacturer's standard mechanism for reclining planetarium chairs.

M. Armrests: [Molded plastic][Solid hardwood][Upholstered][Plastic laminate on MDF][Integral scrolled cast iron] with rounded edges[integral cup holder,] and concealed mounting.

1. Folding Armrests: Equip seating with [**folding aisle armrests where indicated**][**and**][**folding center armrests**].

N. Aisle-Lighting Fixtures: Manufacturer's standard [**round**][**rectangular-louvered**][**concealed-in-armrest**] fixtures.

1. Bulb: [LED][incandescent].
2. Power: [12][24][120] V.
3. For low-voltage lighting, provide manufacturer's voltage-reduction device housed in safety enclosure equipped with fuses, terminal blocks, and safety disconnect.

O. Power and Data Service Package: [**Manufacturer's standard service**][**Service**] to each seat position[**indicated**], including terminal devices and wiring with **18 inches (457 mm)** of extra length and as follows:

1. Power Receptacles: 120 V with wiring and[**duplex**] receptacle.
2. Data Ports: Data-port terminal with wiring and receptacle jack [**of type indicated**].

3. Location: [**Manufacturer's standard location**][**On raceway beneath the seating**][**In the armrest**][**Beneath the armrest on front or side of the standard**][**In back panel of seat in front**].

P. Tablet Arms: [**Manufacturer's standard-size**][**Manufacturer's oversize**], [**fixed**][**foldaway**] tablet arm with plastic-laminate writing surface over MDF or plywood core and with rounded, matching PVC edges.

1. Mounting: [**Right-hand mounted unless otherwise indicated**].
2. Fold-Away Mechanism: Cast-iron or steel hinge and swivel mechanism that give positive support in open position and semiautomatic return to stored position below arm block and parallel to chair.

Q. Accessible Seating:

1. Provide [**removable**][**rollaway**][**swing-away**] chair for each wheelchair space unless otherwise indicated.
2. Provide chairs with folding armrest on aisle side in locations indicated, but not less than 5 percent of aisle seats, dispersed through the audience seating area. Identify these seats with a sign or marker.

R. Row-Letter and Chair-Number Plates: [**Manufacturer's standard**].

1. Material: [**Aluminum**][**Bronze**][**Stainless steel**] with black embossed characters.
2. Location: [**As indicated on Drawings**][**Row letter on top of aisle armrest**][**Chair number on front edge of seat**][**and**][**Chair number on top edge of back**].
3. Attachment: [**Manufacturer's standard method**][**Adhesive**][**Minimum of two mechanical fasteners**].

S. Accessibility-Logo Plates: [**Manufacturer's standard**].

1. Material: [**Aluminum**][**Bronze**][**Stainless steel**] with black embossed characters.
2. Location: [**As indicated on Drawings**][**Top of armrest**][**Front of chair back**].
3. Attachment: [**Manufacturer's standard method**][**Adhesive**][**Minimum of two mechanical fasteners**].

T. Donor Plates: [**Manufacturer's standard**].

1. Material: [**Aluminum**][**Bronze**][**Stainless steel**] with black embossed characters.
2. Location: [**As indicated on Drawings**][**Top of armrest**][**Front of chair back**].
3. Attachment: [**Manufacturer's standard method**][**Adhesive**][**Minimum of two mechanical fasteners**].

U. Bookracks: Manufacturer's standard [under-chair][back-of-chair] boxes, matching material and finish of mounting surface.

2.4 LECTURE-HALL TABLES

A. Lecture-Hall Tables : [**Continuous tables in permanent arrangement**] as indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Seating Company**]

b. [**Ducharme Seating**]
c. [**Hussey Seating Company**]
d. [**Irwin Seating Company**]
e. [**KI**]
f. [**Sitmatic**]
g. [**TSI Group**]

B. Supports: Attached to [**floor**][**fixed audience seating**] and matching construction and finish structure for fixed audience seating.

C. Table Top: Manufacturer's standard construction, [plastic laminate on MDF][hardwood-veneer plywood] with rounded edges[integral pencil groove,] and concealed mounting.

1. Depth: [**Manufacturer's standard**].

D. Modesty Panels: Manufacturer's standard construction, [**matching table top**][**plastic laminate on MDF**][**hardwood-veneer plywood**][**perforated steel**][**fabric upholstered**].

1. Height: [**Full height to 1 inch (25 mm) above floor**][**24 inches (610 mm)**][**14 inches (356 mm)**].

E. Power and Data Service Package: [**Manufacturer's standard service**][**Service**] to each seat position[**indicated**], including terminal devices and wiring with **18 inches (457 mm)** of extra length and as follows:

1. Power Receptacles: 120 V with wiring and[**duplex**] receptacle.
2. Data Ports: Data-port terminal with wiring and receptacle jack [**of type indicated**].
3. Location: [**Manufacturer's standard location**][**On raceway beneath the table top**].

2.5 MATERIALS AND FINISHES

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
4. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. MDF (Medium-Density Fiberboard): ANSI A208.2, Grade MD.

G. Concealed Plywood: HPVA HP-1 hardwood plywood or DOC PS 1 softwood plywood as standard with manufacturer.

H. Exposed Plywood: HPVA HP-1, Face Grade A, hardwood-veneer core with color-matched hardwood-veneer faces.

I. Hardwood Lumber and Veneer Faces: [**American black walnut**][**Red oak**][**Teak**][**Birch**][**Cherry**][**Maple**] selected to be free of visible defects.

1. Stain and Finish: [**Manufacturer's standard, transparent, UV-resistant, protective finish**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

J. Plastic Laminate: ISO 4586-3, manufacturer's standard grade.

1. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

K. Molded Plastic: High-density polyethylene or polypropylene, blow or injection molded, with surface that is mar and dent resistant.

1. Provide with UV inhibitors to retard fading.
2. Color and Texture: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

L. Fabric: Manufacturer's standard [**100 percent nylon**][**100 percent polyolefin**] with flame-retardant treatment if required to meet performance requirements.

1. Weight: [**12 oz./linear yd. (0.37 kg/linear m)**][**16 oz./linear yd. (0.50 kg/linear m)**][**18 oz./linear yd. (0.56 kg/linear m)**][**20 oz./linear yd. (0.62 kg/linear m)**].
2. Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

M. Upholstery Padding: Flexible, cellular, molded or slab polyurethane foam.

1. Pounding-Fatigue Performance: Grade AP (heavy-duty use) for seats and Grade BP (normal duty use) for backs; in accordance with ASTM D3453.

N. Metal Finish: Finish exposed metal parts with manufacturer's standard [**polyurethane**][**baked-on**][**minimum 1.5-mil- (0.04-mm-) thick, polyester baked-on powder**][**minimum 1.5-mil- (0.04-mm-) thick, epoxy baked-on powder**][**minimum 70 percent by weight, PVDF fluoropolymer resin baked-on powder**] coating.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

O. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 FABRICATION

A. Floor Attachments: Fabricate to conform to floor slope so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project.

B. For beam-mounted chairs[**and tables**] in curved patterns, curve the beam uniformly to the various radii required for the rows.

C. Upholstery: Fabricate fabric-covered cushions with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.

D. Upholstered Chairs: Fabricate as follows:

1. Two-Part Upholstered Back: Padded cushion glued to a curved [steel][plywood][molded-plastic] inner panel and covered with easily replaceable fabric; with curved [steel][molded-plastic] outer back shell that fully encloses upholstery edges.
2. Two-Part, Steel-Pan Seats: Upper part, an upholstered cushion with molded padding over no fewer than [**five**] serpentine springs attached to reinforced steel frame, with weight-distributing and abrasion-resistant sheeting separating padding from springs, and removable for reupholstering without removing steel pan from chair. Lower part, a steel pan, reinforced at stress points and completely enclosing hinges and self-rising mechanism.
3. Two-Part, Molded-Plastic Seats: Upper part, an upholstered cushion with formed padding over a five-ply plywood panel[**with fabric cover conforming to shape of cushion to conceal inner seat structure and hinge mechanism**]. Lower part, a molded-plastic shell.
4. One-Part Seats: Double-wall plastic shells [**fitted with a padded upholstered cushion and covered with easily replaceable fabric**][**padded and fully upholstered**].

E. Double-Wall, Molded-Plastic Chairs: Contoured seat and back fabricated of double-wall, blow-molded plastic; both sides of seat and back components are finished surfaces. Reinforce plastic with interior steel plates at attachment points.

F. Single-Wall, Molded-Plastic Chairs: Contoured plastic shell with smoothly rolled edges and reinforcing ribs on underside of shell. Fabricate for attachment of chair to support with self-threading, corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Verify that electrical connections are properly located.

C. Verify that HVAC air-distribution locations are correct.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install seating[**and tables**] in locations indicated and fasten to substrates in accordance with manufacturer's written installation instructions.

1. Install seating with each chair capable of complying with performance requirements without failure or other conditions that might impair the chair's usefulness.

2. Install standards and pedestals plumb.
3. Install seating so moving components operate smoothly and quietly.

B. Install seating[**and tables**] with end standards aligned or stepped as indicated from first to last row and with backs and seats varied in [**width**][**and**][**spacing**] to optimize sightlines.

C. Install riser-mounted standards and attachments to maintain uniform chair heights above floor.

D. Where seating is indicated in curved rows, install seating[**and tables**] at a constant radius unless otherwise indicated.

E. Install wiring conductors and cables concealed in components of seating[**and tables**] and accessible for servicing.

1. Connect electrical service at junction-box locations in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Connect data communication service at junction-box locations in accordance with [**Section 271513 "Communications Copper Horizontal Cabling."**][**Section 271523 "Communications Optical Fiber Horizontal Cabling."**]

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect components, assemblies, and equipment, including connections, to verify proper, complete, and sturdy installation in accordance with manufacturer's written instructions and product specifications.
2. Verify that self-rising seats return to uniform at-rest, raised position.
3. Test power receptacles as specified in Section 262726 "Wiring Devices" when power is activated.
4. Test data ports when data connection is activated.

B. Fixed audience seating will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust chair backs so that they are at required angles and aligned with each other in uniform rows.

B. Adjust hardware and moving parts to function smoothly so they operate easily. Lubricate bearings and sliding parts as recommended in writing by manufacturer.

C. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.

D. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.

E. Replace damaged and malfunctioning components that cannot be acceptably repaired.

F. Replace upholstery fabric damaged during installation or work of other trades.

END OF SECTION 12 61 00 00

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Task	Specification	Specification Description
12 61 13 00	12 61 00 00	Fixed Audience Seating
12 61 16 00	12 61 00 00	Fixed Audience Seating
12 61 19 00	12 61 00 00	Fixed Audience Seating
12 61 21 00	12 61 00 00	Fixed Audience Seating

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SECTION 12 62 23 00 - TELESCOPING STANDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall-attached telescoping stands.
2. Recessed telescoping stands.
3. Freestanding telescoping stands.

1.2 DEFINITIONS

A. Forward Folding: Wall- or floor-attached bleachers that open in the forward direction by moving the front row away from the stack to the fully extended position.

B. Reverse Folding: Floor attached at the first row, that open in the backward direction - by moving the last row away from the stack to the fully extended position. The stacked unit becomes a divider wall.

C. Freestanding: Being free or away from a permanent wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for telescoping stands.
2. Include load capacities, assembly characteristics, and furnished accessories.
3. Include electrical characteristics of electrical components, devices, and accessories.

B. Shop Drawings: For telescoping stands in both stacked and extended positions.

1. Include plans, elevations, sections, and attachment details.
2. Include load capacities.
3. Show seating layout, aisle widths, row-lettering and seat-numbering scheme, and wheelchair accessibility provisions.
4. Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For each type of exposed product and for each color and texture required.

1. Include Samples of accessories involving color and finish selection.

D. Samples for Verification: For the following products prepared on Samples of size indicated below:

1. Decking: **6-inch- (150-mm-)** square Samples of finished material.
2. Metal Components: **6-inch- (150-mm-)** square Sample of each color and finish indicated.
3. Seating Material: **6-inch- (150-mm-)** square Sample of each seating material, color, and finish indicated.
4. Seat Unit: Full-size unit of each type.
5. Upholstery Fabric: **12-inch- (300-mm-)** square Sample of fabric from dye lot to be used for the Work, with specified treatments applied.[**Show complete pattern repeat. Mark top and face of fabric.**]
6. Signage: Full-size units for [**row letters**][**seat numbers**][**each type of accessibility sign**][**and**][**custom graphics**].

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of telescoping stand assembly.

C. Material Certificates: For each type of flame-retardant treatment of upholstery fabric.

D. Field quality-control reports.

E. Qualification Statements: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For telescoping stands.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Procedures for conducting periodic inspections.
b. Precautions for cleaning materials and methods that could be detrimental to telescoping-stand finishes and performance.
c. Methods for maintaining upholstery fabric.

1.7 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-

accredited certification body.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

D. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of telescoping stand assembly that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including bench seating and attached components.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Periods: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Telescoping stands to withstand the effects of gravity loads, operational loads, and other loads and stresses in accordance with ICC 300.

B. Fire-Test-Response Characteristics of Upholstered Chairs: Comply with California Technical [**Bulletin 117**][**and**][**Bulletin 133**].

C. Accessibility Standard: Comply with applicable provisions in [**the DOJ's "2010 ADA Standards for Accessible Design"**][**the ABA Standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

2.2 WALL-ATTACHED TELESCOPING STANDS

A. Wall-Attached Telescoping Stands : Forward-folding system, in which the bleachers open in the forward direction by moving the front row away from the stack to the fully extended position and the rear of bleacher understructure permanently attaches to wall construction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hussey Seating Company**]
b. [**Interkal LLC**]
c. [**Irwin Seating Company**]

d. [**Royal Stewart Ltd.**]

2. Row Spacing: [**22 inches (560 mm)**][**26 inches (660 mm)**][**32 inches (813 mm)**][**As indicated on Drawings**].
3. Row Rise: [**one dimension between 11 and 12 inches (279 and 305 mm)**][**16 inches (406 mm)**][**As indicated on Drawings**].
4. Seat Type: [**Benches**][**Chairs**].
5. Elevated Front Row: [**Height indicated on Drawings**].
6. Operation: [**Manually operated**][**Electrically operated, with friction-type, integral power unit**][**Electrically operated, with non-friction-type, integral power unit**].
7. Electrical Characteristics for Each Seating Section:

   a. Horsepower: [**1/2**][**1-1/2**][**2**].
   b. Single-Phase Voltage: [**115 V ac**][**208 V ac**][**230 V ac**], 60 Hz.
   c. Three-Phase Voltage: [**208 V ac**][**230 V ac**][**460 V ac**], 60 Hz.

8. Electrical Controls:

   a. Control Devices: [**Wall-attached**][**Walk-along pendant**][**Wireless**] control system.
   b. Limit Switches: Automatically stop power system when telescoping stands reach fully opened or closed positions.
   c. Motion Monitor: Flashing light with self-contained warning horn, rated at 85 dB at **10 ft. (3 m)**, mounted under telescoping seating for audio and visual warning during operation.
   d. Transformer: As required to coordinate current characteristics of motor and control station with building electrical system.

2.3 RECESSED TELESCOPING STANDS

A. Recessed Telescoping Stands : Forward-folding system, in which the bleachers open in the forward direction by moving the front row away from the stack to the fully extended position and the rear of bleacher understructure permanently attaches to building construction so that closed stands are recessed in opening.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hussey Seating Company**]
   b. [**Interkal LLC**]
   c. [**Irwin Seating Company**]
   d. [**Royal Stewart Ltd.**]

2. Row Spacing: [**22 inches (560 mm)**][**26 inches (660 mm)**][**32 inches (813 mm)**][**As indicated on Drawings**].
3. Row Rise: [**one dimension between 11 and 12 inches (279 and 305 mm)**][**16 inches (406 mm)**][**As indicated on Drawings**].
4. Seat Type: [**Benches**][**Chairs**].
5. Elevated Front Row: [**Height indicated on Drawings**].
6. Operation: [**Manually operated**][**Electrically operated, with friction-type, integral power unit**][**Electrically operated, with non-friction-type, integral power unit**].
7. Electrical Characteristics for Each Seating Section:

   a. Horsepower: [**1/2**][**1-1/2**][**2**].

b. Single-Phase Voltage: [**115 V ac**][**208 V ac**][**230 V ac**], 60 Hz.
c. Three-Phase Voltage: [**208 V ac**][**230 V ac**][**460 V ac**], 60 Hz.

8. Electrical Controls:

a. Control Devices: [**Wall-attached**][**Walk-along pendant**][**Wireless**] control system.
b. Limit Switches: Automatically stop power system when telescoping stands reach fully opened or closed positions.
c. Motion Monitor: Flashing light with self-contained warning horn, rated at 85 dB at **10 ft. (3 m)**, mounted under telescoping seating for audio and visual warning during integral power operation.
d. Transformer: As required to coordinate current characteristics of motor and control station with building electrical system.

2.4 FREESTANDING TELESCOPING STANDS

A. Freestanding, Forward-Folding, Telescoping Stands : Floor-attached system, in which the bleachers open in the forward direction, by moving the front row away from the stack to the fully extended position, and the rear of bleacher understructure permanently attaches to floor construction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hussey Seating Company**]
b. [**Interkal LLC**]
c. [**Irwin Seating Company**]
d. [**Royal Stewart Ltd.**]

2. Row Spacing: [**22 inches (560 mm)**][**26 inches (660 mm)**][**32 inches (813 mm)**][**As indicated on Drawings**].
3. Row Rise: [**one dimension between 11 and 12 inches (279 and 305 mm)**][**16 inches (406 mm)**][**As indicated on Drawings**].
4. Seat Type: [**Benches**][**Chairs**].
5. Elevated Front Row: [**Height indicated on Drawings**].
6. Operation: [**Manually operated**][**Electrically operated, with friction-type, integral power unit**][**Electrically operated, with non-friction-type, integral power unit**].
7. Electrical Characteristics for Each Seating Section:

a. Horsepower: [**1/2**][**1-1/2**][**2**].
b. Single-Phase Voltage: [**115 V ac**][**208 V ac**][**230 V ac**], 60 Hz.
c. Three-Phase Voltage: [**208 V ac**][**230 V ac**][**460 V ac**], 60 Hz.

8. Electrical Controls:

a. Control Devices: [**Wall-attached**][**Walk-along pendant**][**Wireless**] control system.
b. Limit Switches: Automatically stop power system when telescoping stands reach fully opened or closed positions.
c. Motion Monitor: Flashing light with self-contained warning horn, rated at 85 dB at **10 ft. (3 m)**, mounted under telescoping seating for audio and visual warning during integral power operation.
d. Transformer: As required to coordinate current characteristics of motor and control station with building electrical system.

B. Freestanding, Reverse-Folding, Telescoping Stands : Floor-attached, reverse-opening system, in which the bleachers open in the backward direction, by moving the last row away from the stack to the fully extended position, and the front of bleacher understructure permanently attaches to floor construction.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hussey Seating Company**]
   b. [**Interkal LLC**]
   c. [**Irwin Seating Company**]
   d. [**Royal Stewart Ltd.**]

2. Row Spacing: [**22 inches (560 mm)**][**26 inches (660 mm)**][**32 inches (813 mm)**][**As indicated on Drawings**].
3. Row Rise: [**one dimension between 11 and 12 inches (279 and 305 mm)**][**16 inches (406 mm)**][**As indicated on Drawings**].
4. Seat Type: [**Benches**][**Chairs**].
5. Elevated Front Row: [**Height indicated on Drawings**].
6. Aisle Recovery: Equip unit with ability to create a front cross-aisle [**36 inches (914 mm)**][**42 inches (1067 mm)**] wide when stand is open.
7. Operation: [**Manually operated**][**Electrically operated, with friction-type, integral power unit**][**Electrically operated, with non-friction-type, integral power unit**].
8. Electrical Characteristics for Each Seating Section:

   a. Horsepower: [**1/2**][**1-1/2**][**2**].
   b. Single-Phase Voltage: [**115 V ac**][**208 V ac**][**230 V ac**], 60 Hz.
   c. Three-Phase Voltage: [**208 V ac**][**230 V ac**][**460 V ac**], 60 Hz.

9. Electrical Controls:

   a. Control Devices: [**Wall-attached**][**Walk-along pendant**][**Wireless**] control system.
   b. Limit Switches: Automatically stop power system when telescoping stands reach fully opened or closed positions.
   c. Motion Monitor: Flashing light with self-contained warning horn, rated at 85 dB at **10 ft. (3 m)**, mounted under telescoping seating for audio and visual warning during integral power operation.
   d. Transformer: As required to coordinate current characteristics of motor and control station with building electrical system.

2.5 COMPONENTS

A. Benches: Seats and skirts.

1. Material: [**Lumber with transparent finish**][**Molded plastic with contour surfaces**][**Steel sheet with vinyl-clad finish**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**Manufacturer's standard**][**As selected by Architect from manufacturer's standard**], as directed by the Owner.

2. Bench Height: [**Not less than 16 inches (406 mm) or more than 18 inches (457 mm)**].
3. Bench Depth: [**10 inches (254 mm)**][**12 inches (305 mm)**].

4. Backs: Folding backrests permanently attached to bench units.

   a. Material: [**Lumber with transparent finish**][**Molded plastic with contour support surface in color matching seat**].
   b. Operation: [**Manual**][**Automatic**].

B. Chairs: Rotating from upright, locked position to folded-down position that allows supporting platform to telescope for storage.[**In upright position, seats fold up to allow passage of persons within row.**]

1. Operation: [**Manual**][**Spring-assisted, manual fold-up. Automatic release from upright position except for first row, and automatic fold-down to stored position**][**Automatic**].
2. Chair Width: [**As indicated on Drawings**].
3. Seat Height: [**Not less than 17 inches (432 mm) or more than 18 inches (457 mm)**].
4. Seats: [**Molded plastic**][**Molded plastic with padded upholstery insert**][**Fully upholstered, self-rising, folding**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**Manufacturer's standard**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

5. Backs: [**Molded plastic**][**Molded plastic with padded upholstery insert**][**Fully upholstered**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**Manufacturer's standard**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

6. Armrests: [**Molded plastic**][**Molded plastic, self-rising and self-storing**][**with cup holder**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**Manufacturer's standard**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Wheelchair-Accessible Seating: Locate [**seating cutouts**][**retractable truncated benches**][**removable modular chairs**][**aisle seats without armrests, with folding armrests, or with removable armrests**] to provide wheelchair-accessible seating at locations indicated on Drawings.

1. Equip tiers adjacent to wheelchair-accessible seating with front rails as required by ICC 300.
2. Equip cutouts with full-width front closure panels that match decking construction and finish and that extend from underside of tiers adjacent to cutouts to **1-1/2 inches (38 mm)** from finished floor.

D. Deck: [**Aluminum**][**Plywood, 5/8 inch (16 mm) thick**][**Plywood, 3/4 inch (19 mm) thick**][**Manufacturer's standard laminated panel**].

1. Finish: [**Mill**][**Clear anodized**][**Color anodized**][**Polyethylene textured overlay bonded to substrate with exterior glue**][**Transparent**][**Paint**][**Manufacturer's standard carpet bonded to substrate**][**Manufacturer's standard**].

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**Manufacturer's standard**][**As selected by Architect from manufacturer's standard colors**], as directed by the Owner.

E. Risers: Steel sheet with manufacturer's standard, rust-inhibiting coating or hot-dip galvanized finish.

F. Safety Rails: Steel, finished with manufacturer's standard powder coat system.

1. [**Removable**][**Folding**][**Self-storing**] mid-aisle handrails located at centerline of each aisle with seating on both sides.
2. End rails (guards) that are [**telescoping and self-storing**][**removable**].
3. Back rails (guards) along rear of units where required by ICC 300.
4. [**Removable**][**Fixed**] front rails (guards) along front of units where required by ICC 300.
5. [**Removable**][**Fixed**] rails around accessible seating cutouts and truncations.
6. Removable, programming-support front rails to allow seating in upper rows while lower rows remain in the stored position.
7. Color: [**Black**][**Match Architect's sample**][**Manufacturer's standard neutral color**], as directed by the Owner.

G. Understructure: Structural steel.

1. Finish: [**Manufacturer's standard**][**Water-based acrylic**][**Alkyd-enamel, two-coat system,**][**Epoxy-resin-based, textured, powder coat system,**] rust-inhibiting finish.
2. Color: [**Manufacturer's standard**].

H. Support Column Wheels: Nonmarring, soft, rubber-face wheel assembly under each support column.

1. Include wheels of size, number, and design required to support stands and operate smoothly without damaging the flooring surface, but no fewer than four per column or less than **4 inches (100 mm)** in diameter and **1-1/2 inches (38 mm)** wide.

I. Control Devices:

1. Wall Attached: [**Manufacturer's standard**][**Keyed-switch**] control station, located within full view of each stand and its movement area.[**Provide two keys per station.**]
2. Walk-Along Pendant: Manufacturer's standard unit, which plugs into first row of each operating section. Provide [**one unit**][**two units**][**three units**][**one unit for each operating section**].
3. Wireless: Hand-held, wireless transmission unit that operates wireless receivers in each operating section, with a transmission range to keep handheld control unit within close proximity and with full view of stand and its movement area. Provide [**one unit**][**two units**][**three units**][**one unit for each operating section**].

J. Fasteners: Vibration proof, in manufacturer's standard size and material.

2.6 ACCESSORIES

A. Steps:

1. Slip-resistant, abrasive tread [**nosings**][**surfaces**] at aisles.
2. Intermediate aisle steps, fully enclosed, at each aisle.
3. Transitional top step, fully enclosed, at each aisle where last row of telescoping stands is adjacent to a cross aisle.
4. Removable front steps, fully enclosed, at each aisle, that engage with front row to prevent accidental separation or movement and are equipped with a minimum of four skid-resistant feet.

B. Portable Stairs: Portable access-stair units equipped with handrails, with no fewer than four full-swiveling, nonmarring wheels and a locking mechanism to prevent movement during use.

C. Ramps: Portable access-ramp units, slope [**as indicated on Drawings**][**to comply with requirements of accessibility standard**], equipped with handrails, with no fewer than four full-swiveling, nonmarring wheels and a locking mechanism to prevent movement during use.

D. Closure Panels and Void Fillers:

1. Aisle closures at foot level that produce flush vertical face at aisles when system is stored.
2. End panels covering exposed ends of stands in the stored position.
3. Back panels covering rear of freestanding units. Panels extend full height and width of unit.
4. Panels at cutouts and truncations for accessible seating.
5. Rear fillers including supports for closing openings between top row and rear wall of adjoining construction.
6. Gap fillers for closing openings between stand units or between stand units and adjoining construction.

E. Spanner Seats: Removable, designed to span area between adjacent stand units[in locations indicated on Drawings].

F. Signage:

1. Row letters at each row end.
2. Seat numbers [**at 18 inches (457 mm) o.c. on benches**][**and**][**on each chair**].
3. Accessibility signs at each accessible space[**and accessible aisle seat**].
4. Custom graphics as indicated on Drawings [**on benches**][**on end panels**][**on rear panels**][**on whole seating array**].

G. Scorer's Table: Removable unit that attaches to mounting sockets installed in telescoping stand unit.

2.7 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Certified Wood: Verify product is certified as "FSC Pure"[**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Verify product is labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

D. Certified Wood: Verify product is certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

E. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in CARB 93120, "Airborne Toxic Control Measure (ATCM) for Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

F. Composite Wood Products: Verify formaldehyde emission rates are not greater than the following when tested in accordance with ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

G. Lumber: Kiln dried, surfaced four sides; southern pine complying with SPIB's "Standard Grading Rules for Southern Pine Lumber" for [**B & B finish (B and better)**][**C & Btr finish (C and better)**] grade-of-finish requirements.

H. Plywood: PS 1 as standard with manufacturer.

I. Molded Plastic: High-density polyethylene; blow or injection molded, color-pigmented, textured, impact-resistant, with integral reinforcing ribs for attachment and anchoring points. Provide with UV inhibitors to retard fading.

2.8 FABRICATION

A. Fabricate telescoping stands to operate easily without special tools or separate fasteners unless otherwise indicated.

B. Round corners and edges of components and exposed fasteners to reduce snagging and pinching hazards.

C. Form exposed work with flat, flush surfaces, level and true in line.

D. Supports: Fabricate supports to withstand, without damage to components, the forces imposed by use of stands without failure or other conditions that might impair their usefulness.

1. Cantilever bench seat supports to produce toe space uninterrupted by vertical bracing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install telescoping stands in accordance with ICC 300 and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. ICC 300 Inspection: Inspect installed telescoping stands to verify that construction, installation, and operation are in accordance with ICC 300 requirements.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Telescoping stands will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust backrests so that they are at proper angles and aligned with each other in uniform rows.

B. Adjust hardware and moving parts to function smoothly, and lubricate, test, and adjust each telescoping stand unit to operate in accordance with manufacturer's written instructions.

C. Clean installed telescoping stands on exposed and semiexposed surfaces. Touch up factory-applied finishes or replace components as required to restore damaged or soiled areas.

D. Replace upholstery fabric damaged during installation or work of other trades.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to inspect, adjust, operate, and maintain telescoping stands.

END OF SECTION 12 62 23 00

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Task	Specification	Specification Description
12 62 23 00	01 22 00 00	No Specification Required

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Task	Specification	Specification Description
13 34 00 00	13 34 23 16	Fabricated Control Booths
13 34 16 00	13 34 23 16	Fabricated Control Booths
13 34 16 13	13 34 23 16	Fabricated Control Booths

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SECTION 13 34 19 00 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal building systems.
2. Structural-steel framing.
3. Metal roof panels.
4. Metal wall panels.
5. Foamed-insulation-core metal wall panels.
6. Metal soffit panels.
7. Thermal insulation.
8. Personnel doors and frames.
9. Horizontal sliding doors.
10. Windows.
11. Translucent panels.
12. Accessories.

B. Related Requirements:

1. Division 03 concrete Sections for anchor rod installation, concrete, reinforcement, and formwork requirements.
2. Section 077253 "Snow Guards" for devices designed to hold snow on the roof surface.
3. Section 083323 "Overhead Coiling Doors" for coiling vehicular doors in metal building systems.
4. Section 083613 "Sectional Doors" for sectional vehicular doors in metal building systems.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Division 03 concrete Sections.

B. Coordinate imposed load of [**cranes**] [**HVAC**] specified in other Sections with structural performance requirements specified in this Section.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conferences: Conduct conferences [**at Project site**] [**by web conference**].

1. Metal Building Systems Conference: Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Metal Building Roof Panel Conference: Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
b. Structural limitations of purlins and rafters during and after roofing.
c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
d. Temporary protection requirements for metal roof panel assembly during and after installation.
e. Roof observation and repair after metal roof panel installation.

3. Metal Building Wall Panel Conference: Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
b. Structural limitations of girts and columns during and after wall panel installation.
c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
d. Temporary protection requirements for metal wall panel assembly during and after installation.
e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: By manufacturer of metal building systems. Indicate components by others. Include full building plan, elevations, sections, details, and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.

2. Structural-Framing Drawings: Indicate complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Indicate provisions for attaching [**mezzanines**] [**roof curbs**] [**service walkways**] [**platforms**] [**and**] [**pipe racks**].

3. Metal Panel Layout Drawings: Indicate [**roof**] [**and**] [**wall**]. layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; indicate locations of exposed fasteners.

    a. Indicate roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Indicate wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
    c. Indicate translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than [**1-1/2 inches per 12 inches (1:8)**]

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.
    d. Service walkways.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Panels: [**Manufacturers' standard size**]. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: [**Manufacturers' standard size**]. Include fasteners and other exposed accessories.
3. Vapor-Retarder Facings: Minimum 6-inch- (150-mm-) square Samples.
4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
5. Accessories: Samples for each type of accessory.

E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets, indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail the Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

F. Delegated Design Submittals: For metal building systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, in accordance with governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

B. Welding certificates.

C. Material Test Reports: For each of the following products, by a qualified testing agency:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, and bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

D. Source quality control reports.

E. Field quality control reports.

F. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor that performed surveys certify their accuracy.

G. Qualification Statements: For [**manufacturer**] [**erector**] [**land surveyor**] [**door inspector**].

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

H. Delegated Design Engineer Qualifications: For metal building system.

I. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes[**and door hardware**].

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[from the same production run,] to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Accreditation: Manufacturer's facility accredited in accordance with IAS AC472.
2. Engineering Responsibility: Metal building system design and preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

E. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

F. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and with the following:

1. DHI Fire and Egress Door Assembly Inspector (FDAI) certification.

G. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies is to comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and with the following:

1. DHI Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed in accordance with manufacturers' written installation instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**25**] [**20**] [**10**] years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: [**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with procedures in MBMA's "Metal Building Systems Manual":

1. Design Loads: [**As indicated on Drawings**].
2. Deflection and Drift Limits:

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC's "Design Guide No. 3: Serviceability Design Considerations for Steel Buildings."
b. Deflection to be no greater than the following:

1) Purlins and Rafters: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] of the span.
2) Girts: Horizontal deflection of [**1/120**] [**1/180**] [**1/240**] of the span.
3) Metal Roof Panels: Vertical deflection of [**1/150**] [**1/240**] [**1/360**] of the span.
4) Metal Wall Panels: Horizontal deflection of [**1/180**] [**1/240**] of the span.
5) Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
6) Lateral Drift: Maximum of [**1/60**] [**1/100**] [**1/200**] [**1/400**] of the building height.

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL Product iQ, FM Approvals' "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

H. Structural Performance for Metal Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.

I. Air Infiltration for Metal Roof Panels: Air leakage of not more than [**0.04 cfm/sq. ft. (0.2 L/s per sq. m)**] [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E1680[**or ASTM E283/E283M**] at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

J. Air Infiltration for Metal Wall Panels: Air leakage of not more than [**0.04 cfm/sq. ft. (0.2 L/s per sq. m)**] [**0.06 cfm/sq. ft. (0.3 L/s per sq. m)**] when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: [**1.57 lbf/sq. ft. (75 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

K. Water Penetration for Metal Roof Panels: No water penetration when tested in accordance with ASTM E1646[**or ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

L. Water Penetration for Metal Wall Panels: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: [**2.86 lbf/sq. ft. (137 Pa)**] [**6.24 lbf/sq. ft. (300 Pa)**].

M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

N. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Approvals' "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- [**60**] [**75**] [**90**] [**105**] [**120**].
2. Hail Resistance: [**MH**] [**SH**].

O. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values when tested in accordance with ASTM C1363 or ASTM C518:

2.3 METAL BUILDING SYSTEMS

A. System Description: Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

1. Primary-Frame Type:

a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
b. Rigid Modular: Solid-member, structural-framing system with interior columns.
c. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.
d. Truss-Frame Modular: Truss-member, structural-framing system with interior columns.
e. Lean-to: Solid- or truss-member, structural-framing system, designed to be partially supported by another structure.

2. End-Wall Framing:

a. Manufacturer's standard, for buildings not required to be expandable, consisting of [**primary frame, capable of supporting one-half of a bay design load, and end-wall columns**] [**load-bearing end-wall and corner columns and rafters**].
b. Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

3. Secondary-Frame Type: Manufacturer's standard purlins and joists and [**flush-framed**] [**partially inset-framed**] [**exterior-framed (bypass)**] girts.

4. Eave Height: [16 ft. (4.9 m)] [20 ft. (6.1 m)] [24 ft. (7.3 m)] [28 ft. (8.5 m)] [**Manufacturer's standard height, as indicated by nominal height on Drawings**].
5. Bay Spacing: [20 ft. (6.1 m)] [25 ft. (7.6 m)] [30 ft. (9.1 m)] [**As determined by manufacturer**] [**As indicated on Drawings**].
6. Roof Slope: [1/4 inch per 12 inches (1:48)] [1/2 inch per 12 inches (1:24)] [1 inch per 12 inches (1:12)] [4 inches per 12 inches (1:3)] [**Manufacturer's standard for frame type required**].
7. Roof System: Manufacturer's standard [**standing-seam, vertical-rib,**] [**standing-seam, trapezoidal-rib,**] [**lap-seam, tapered-rib**] metal roof panels.

   a. Liner Panels: Tapered rib.

8. Exterior Wall System: Manufacturer's standard [**exposed-fastener, tapered-rib,**] [**exposed-fastener, reverse-rib,**] [**concealed-fastener, flush-profile,**] [**foamed-insulation-core**] metal wall panels.

   a. Liner Panels: [**Tapered rib**] [**Flush profile**].

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360.

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI S100 for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

   a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect, as directed by the Owner.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
4. Truss-Frame, Clear-Span Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
5. Truss-Frame Modular Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
6. Long-Bay Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
7. Frame Configuration: [**Single gable**] [**One-directional, sloped**] [**Lean-to, with high side connected to and supported by another structure**] [**Multiple gable**] [**Load-bearing wall**] [**Multistory**].
8. Exterior Column: [**Uniform depth**] [**Tapered**].

9. Rafter: [**Uniform depth**] [**Tapered**].

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

   a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
   b. Steel joists of depths indicated on Drawings.

      1) Depth: [**As indicated on Drawings**] [**As needed to comply with system performance requirements**].

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.

   a. Depth: [**As indicated on Drawings**] [**As required to comply with system performance requirements**].

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: [**Straight-beam, eave type**] [**Purlin-extension type**] [**Tapered-beam, below-eave type**] [**As indicated**].

H. Bracing: Provide adjustable wind bracing[**using any method**] as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.

9. Joist Girders: Manufactured in accordance with "Standard Specifications for Joist Girders," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
10. Steel Joists: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
11. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563/A563M carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

12. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

13. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts[**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**]; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
14. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**] [**round**] head assemblies consisting of steel structural bolts with splined ends; ASTM A563/A563M, Grade DH (Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: [**Plain**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**] [**Mechanically deposited zinc coating, ASTM B695, Class 50, baked-epoxy coated**].

15. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

    a. Configuration: Straight.
    b. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436/F436M, hardened carbon steel.
    e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

16. Headed Anchor Rods: [**ASTM F1554, Grade 36**] [**ASTM A307, Grade A**].

    a. Configuration: Straight.
    b. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436/F436M, hardened carbon steel.
    e. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

17. Threaded Rods: [**ASTM A193/A193M**] [**ASTM A572/A572M, Grade 50 (345)**] [**ASTM A36/A36M**] [**ASTM A307, Grade A**].

    a. Nuts: ASTM A563/A563M, [**heavy-**]hex carbon steel.
    b. Washers: [**ASTM F436/F436M, hardened**] [**ASTM A36/A36M**] carbon steel.
    c. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM F2329, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 METAL ROOF PANELS

A. Solar Reflectance Index:

B. Roof Solar Reflectance: Provide roof panels with one of the following when tested in accordance with CRRC-1:

1. Three-year, aged, solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged, Solar Reflectance Index (SRI) of not less than [**64**] when calculated in accordance with ASTM E1980.

C. Standing-Seam, Vertical-Rib, Metal Roof Panels : Formed with vertical ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**16 inches (406 mm)**].
5. Panel Height: [**2 inches (51 mm)**].

D. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels : Formed with raised trapezoidal ribs at panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Clips: [**One-piece fixed**] [**Two-piece floating**] to accommodate thermal movement.
3. Joint Type: [**Panels snapped together**] [**Mechanically seamed**].
4. Panel Coverage: [**24 inches (610 mm)**].
5. Panel Height: [**3 inches (76 mm)**].
6. Uplift Rating: [**UL 30**] [**UL 60**] [**UL 90**].

E. Exposed Fastener, Tapered-Rib, Metal Roof Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be

installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

F. Exposed-Fastener, Tapered-Rib, Metal Liner Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
    b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

G. Finishes:

1. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.6 METAL WALL PANELS

A. Exposed-Fastener, Tapered-Rib, Metal Wall Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

B. Exposed-Fastener, Reverse-Rib, Metal Wall Panels : Formed with recessed, trapezoidal major valleys and [**intermediate stiffening valleys symmetrically spaced**] [**flat pan**] between major valleys; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

C. Concealed-Fastener, Flush-Profile, Metal Wall Panels : Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**16 inches (406 mm)**].
3. Panel Height: [**3 inches (76 mm)**].

D. Tapered-Rib, Metal Liner Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Siliconized polyester**] [**Acrylic enamel**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

E. Flush-Profile, Metal Liner Panels: [**Solid**] [**Perforated**] panels formed with vertical panel edges and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between panel edges; with flush joint between panels; designed for interior side of metal wall panel assemblies and installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Finish: [**Siliconized polyester**] [**Polyester**] [**Acrylic enamel**].
   b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Sound Absorption: NRC not less than [**0.65**] [**0.85**] [**1.00**] when tested in accordance with ASTM C423.
3. Panel Coverage: [**12 inches (305 mm)**].
4. Panel Height: [**1.5 inches (38 mm)**].

F. Finishes:

1. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.7 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels : Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Facing Material: Fabricate panel with exterior and interior facings of same material and thickness. Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

   a. Exterior Surface: [**Smooth, flat**] [**Striated**] [**Shallow ribs**] [**Shallow V grooves**].
   b. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
   c. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**36 inches (914 mm)**] [**42 inches (1067 mm)**] nominal.
3. Panel Thickness: [**2 inches (51 mm)**] [**2.5 inches (64 mm)**] [**3 inches (76 mm)**] [**4 inches (102 mm)**] [**5 inches (127 mm)**] [**6 inches (152 mm)**].
4. Insulation Core: Modified polyisocyanurate or polyurethane foam using a non-CFC blowing agent, foamed-in-place or board type, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

   a. Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.
   b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested in accordance with ASTM D1622.
   c. Compressive Strength: Minimum 20 psi (140 kPa) when tested in accordance with ASTM D1621.
   d. Shear Strength: 26 psi (179 kPa) when tested in accordance with ASTM C273/C273M.

5. Fire-Test-Response Characteristics: Class A in accordance with ASTM E108.
6. Surface-Burning Characteristics: Flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

B. Finishes:

1. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.8 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal [**roof**] [**wall**] panels.

1. Finish: [**Match finish and color of metal roof panels**] [**Match finish and color of metal wall panels**] [**As indicated on Drawings**].

C. Exposed-Fastener, Tapered-Rib-Profile, Metal Soffit Panels : Formed with raised, trapezoidal major ribs and [**intermediate stiffening ribs symmetrically spaced**] [**flat pan**] between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Siliconized polyester**].
b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Major-Rib Spacing: [**6 inches (152 mm)**] [**12 inches (305 mm)**] o.c.
3. Panel Coverage: [**36 inches (914 mm)**].
4. Panel Height: [**0.75 inch (19 mm)**] [**1.125 inches (29 mm)**] [**1.188 inches (30 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**].

D. Concealed-Fastener, Flush-Profile, Metal Soffit Panels : Formed with vertical panel edges and [**a single wide recess, centered between panel edges**] [**flush surface**]; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners[**and factory-applied sealant**] in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.024-inch (0.61-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: [**Fluoropolymer**] [**Siliconized polyester**].
b. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2. Panel Coverage: [**12 inches (305 mm)**] [**16 inches (406 mm)**].
3. Panel Height: [**1 inch (25 mm)**] [**1.5 inches (38 mm)**].

2.9 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Unfaced Metal Building Insulation: ASTM C991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

C. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
2. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
3. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

D. Faced, Polyisocyanurate Board Insulation: ASTM C1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core. Provide units tested for interior exposure without an approved thermal barrier.

E. Retainer Strips: For securing insulation between supports, 0.025-inch (0.64-mm) nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

F. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested in accordance with ASTM E96/E96M, Desiccant Method.
1. Composition:

a. White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.
b. Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.
c. White [**polypropylene**] [**vinyl**] film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
d. White polypropylene film facing and fiberglass-polyester-blend fabric backing.

G. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.10 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames:

1. As specified in Section 081113 "Hollow Metal Doors and Frames."
2. Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and at hinges to receive factory- and field-applied hardware in accordance with BHMA A156 Series.

a. Steel Doors: 1-3/4 inches (44.5 mm) thick; fabricated from metallic-coated steel face sheets, 0.036-inch (0.91-mm) nominal uncoated steel thickness, of [**seamed**] [**seamless**], hollow-metal construction; with 0.060-inch (1.52-mm) nominal uncoated steel thickness, inverted metallic-coated steel channels welded to face sheets at top and bottom of door.

1) Design: [**Flush panel**] [**As indicated on Drawings**].
2) Core:

a) Kraft honeycomb with U-factor rating of at least 0.47 Btu/sq. ft. x h x deg F (2.67 W/sq. m x K).
b) Polystyrene foam with U-factor rating of at least 0.16 Btu/sq. ft. x h x deg F (0.91 W/sq. m x K).
c) Polyurethane foam with U-factor rating of at least 0.07 Btu/sq. ft. x h x deg F (0.40 W/sq. m x K).

3) Glazing Frames: Steel frames to receive field-installed glass.
4) Glazing: As specified in Section 088000 "Glazing."

b. Steel Frames: Fabricate 2-inch- (51-mm-) wide face frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness.

1) Type: [**Knocked down for field assembly**] [**Factory welded**].

c. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.
d. Hardware:

1) Provide hardware for each door leaf, as follows:

a) Hinges: BHMA A156.1. Three [**plain**] [**antifriction**]-bearing, standard-weight, full-mortise, stainless steel or bronze, template-type hinges; 4-1/2 by 4-1/2 inches (114 by 114 mm), with nonremovable pin.
b) Lockset: BHMA A156.2. [**Key-in-lever cylindrical**] [**Mortise, with lever handle**] type.
c) Exit Device: BHMA A156.3. Touch- or push-bar type.
d) Threshold: BHMA A156.21. Extruded aluminum.
e) Silencers: Pneumatic rubber; three silencers on strike jambs of single door frames and two silencers on heads of double door frames.
f) Closer: BHMA A156.4. Surface-applied, standard-duty hydraulic type.
g) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.

2) Provide each pair of double doors with the following hardware in addition to that specified for each leaf:

a) Astragal: Removable type.
b) Surface Bolts: Top and bottom of inactive door.

e. Anchors and Accessories: Manufacturer's standard units, galvanized in accordance with ASTM A123/A123M.
f. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush, and invisible.

B. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, CS, Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A653/A653M, CS, Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

C. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard, complying with SDI A250.3 for performance and acceptance criteria.

a. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.11 HORIZONTAL SLIDING DOORS

A. Horizontal-Sliding Doors: Manufacturer's standard horizontal-sliding door assembly including structural frame, door panels, brackets, guides, tracks, hardware, and installation accessories.

1. Door Frames: Channels and zees; metallic-coated steel sheet or structural-steel shapes, 0.060-inch (1.52-mm) nominal uncoated steel thickness.
2. Door Panels: Same material and finish as metal wall panels.
3. Hardware: Manufacturer's standard metallic-coated steel track, bottom guides, lock angles for side closure, and brackets. Support each door leaf by two four-wheel trolleys. Provide metallic-coated steel handle for each leaf, and slide bolt or padlock hasp. Flash top of track with metallic-coated steel sheet hood.

2.12 WINDOWS

A. Aluminum Windows:

1. As specified in Section 085113 "Aluminum Windows."
2. Metal building system manufacturer's standard, with self-flashing mounting fins, and as follows:

a. Type, Performance Class, and Performance Grade: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 and as follows:

1) Horizontal-Sliding Units: [**HS-LC25**] [**HS-CW30**].
2) Single-Hung Units: [**H-LC25**] [**H-CW30**].
3) Fixed Units: [**FW-LC25**] [**FW-CW30**] [**FW-AW40**].

b. Aluminum Extrusions: ASTM B221 (ASTM B221M), alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.064-inch (1.63-mm) thickness at any location for main frame and sash members.

1) Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

c. Mullions: Between adjacent windows, fabricated of extruded aluminum matching finish of window units.

d. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners are not to be exposed, except for attaching hardware.

1) Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch (3.26 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.

e. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

1) Cam-action sweep sash lock and keeper at meeting rails.
2) Spring-loaded, snap-type lock at jambs.
3) Pole-operated, cam-action locking device on meeting rail where rail is more than 72 inches (1830 mm) above floor.
4) Lift handles for single-hung units.
5) Nylon sash rollers for horizontal-sliding units.
6) Steel or bronze operating arms.

f. Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric; complying with AAMA 701/702.

g. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, and as follows:

1) Aluminum Wire Fabric: 18-by-18 (1.1-by-1.1-mm), 18-by-16 (1.1-by-1.3-mm), or 18-by-14 (1.1-by-1.5-mm) mesh of 0.013-inch- (0.3-mm-) diameter, coated aluminum wire.
2) Glass-Fiber Mesh Fabric: 18-by-16 (1.1-by-1.3-mm) or 18-by-14 (1.1-by-1.5-mm) mesh of PVC-coated, glass-fiber threads, woven and fused to form a fabric mesh; complying with ASTM D3656/D3656M.
3) Fabric: Manufacturer's standard aluminum wire fabric or glass-fiber mesh fabric.

B. Glazing: Comply with requirements specified in Section 088000 "Glazing."

1. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear), 3 mm thick.
2. Heat-Treated Float Glass: ASTM C1048, Type I, Quality-Q3, Class I (clear), Condition A, 3 mm thick.
3. Tinted Float Glass: ASTM C1036, Type I, Quality-Q3, Class 2, 3 mm thick.

a. Tint Color: [**Blue**] [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] [**Manufacturer's standard color**].

4. Patterned Glass: ASTM C1036, Type II, Quality-Q6, Class 1 (clear), Form 3, Pattern P3 (random), 3 mm thick.
5. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of 2.5-mm-thick clear float glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
6. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.

a. Provide safety glazing labeling.

7. Glazing Stops: Screw-applied or snap-on glazing stops coordinated with Section 088000 "Glazing" and with glazing system indicated. Match material and finish of window frames.

8. Factory-Glazed Fabrication: Glaze window units in the factory to greatest extent possible and practical for applications indicated. Comply with requirements in Section 088000 "Glazing."

C. Finish:

1. Mill finish.
2. Baked-Enamel Finish, Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 0.7 mil (0.02 mm), medium gloss.

a. Color: [**As indicated by manufacturer's designations**] [**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.13 TRANSLUCENT PANELS

A. Uninsulated Translucent Panels: Glass-fiber-reinforced polyester, translucent plastic; complying with ASTM D3841, [**Type CC2 (general purpose)**] [**Type CC1 (limited flammability)**], Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Roof Panel Weight: Not less than 8 oz./sq. ft. (2441 g/sq. m).
2. Wall Panel Weight: Not less than 6 oz./sq. ft. (1831 g/sq. m).
3. Light Transmittance: Not less than [**55**] percent in accordance with ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**].

B. Insulated Translucent Panels: Fabricate insulating units of two sheets of glass-fiber-reinforced polyester, translucent plastic separated by an air space; complying with ASTM D3841, Type CC1 (limited flammability), Grade 1 (weather resistant); smooth finish on both sides. Match profile of adjacent metal panels.

1. Exterior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**].
2. Interior Panel Weight: Not less than [**8 oz./sq. ft. (2441 g/sq. m)**] [**6 oz./sq. ft. (1831 g/sq. m)**] [**4 oz./sq. ft. (1221 g/sq. m)**].
3. Light Transmittance: Not less than [**42**] percent in accordance with ASTM D1494.
4. Metal Edge: Fabricate full length of each side of panel with metal edge for seaming into standing-seam roof panel joint.
5. Color: [**White**].

C. Mastic for Translucent Panels: Nonstaining, saturated vinyl polymer as recommended by translucent panel manufacturer for sealing laps.

D. Performance:

1. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**] or less.
b. Smoke-Developed Index: [**450**] or less.

2.14 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from [**steel**] [**stainless steel**] sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from [**steel**] [**stainless steel sheet or nylon-coated aluminum**] sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch (25-mm) standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, [**0.018-inch (0.46-mm)**] [**0.030-inch (0.76-mm)**] nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake

trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized in accordance with manufacturer's written instructions.

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-ft.- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Service Walkways: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness, steel plank grating; with slip-resistant pattern; [**18-inch (457-mm)**] [**24-inch (610-mm)**] [**36-inch (914-mm)**] overall width. Support walkways on framing system anchored to metal roof panels without penetrating panels; with predrilled holes and clamps or hooks for anchoring.

H. Roof Ventilators: Gravity type, complete with hardware, flashing, closures, and fittings.

1. Circular-Revolving Type: Minimum [**20-inch- (508-mm-)**] diameter throat opening; zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness, with coil coating; finished to match metal roof panels; with matching base and rain cap.

   a. Type: [**Directional**] [**Stationary**] revolving.
   b. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.
   c. Dampers: Spring-loaded, butterfly type; pull-chain operation; with pull chain of length required to reach within 36 inches (914 mm) of floor.
   d. Reinforce and brace units, with joints properly formed and edges beaded to be watertight under normal positive-pressure conditions.
   e. Mount ventilators on square-to-round bases for ridge or on-slope mounting, designed to match roof pitch and roll formed to match metal roof panel profile.

2. Continuous or Sectional-Ridge Type: Factory-engineered and -fabricated, continuous unit; Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal roof panels. Fabricated in minimum 10-ft.- (3-m-) long sections. Provide throat size and total length indicated, complete with side baffles, ventilator assembly, end caps, splice plates, and reinforcing diaphragms.

   a. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; or aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.6-mm) wire.
   b. Dampers: Manually operated, spring-loaded, vertically rising type; chain and worm gear operator; with pull chain of length required to reach within 36 inches (914 mm) of floor.
   c. Throat Size: [9 inches (229 mm)] [12 inches (305 mm)][as standard with manufacturer, and as required to comply with ventilation requirements].

I. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch (0.91-mm) nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

1. Blades:

   a. Fixed.
   b. Adjustable type, with weather-stripped edges, and manually operated by hand crank or pull chain.

2. Free Area: Not less than [**7.0 sq. ft. (0.65 sq. m)**] for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
3. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire; with rewirable frames, removable and secured with clips; fabricated of same kind and form of metal and with same finish as louvers.

   a. Mounting: [**Interior**] [**Exterior**] face of louvers.

4. Vertical Mullions: Provide mullions at spacings recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

J. Roof Curbs: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch (1.21-mm) nominal uncoated steel thickness prepainted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.

   1. Curb Subframing: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.060-inch (1.52-mm) nominal uncoated steel thickness, angle-, C-, or Z-shaped metallic-coated steel sheet.
   2. Insulation: 1-inch- (25-mm-) thick, rigid type.

K. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

L. Materials:

   1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
   2. Fasteners for Metal Roof Panels:

      a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
      b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

   3. Fasteners for Metal Wall Panels:

      a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws[with EPDM sealing washers bearing on weather side of metal panels].
      b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head[with EPDM sealing washers bearing on weather side of metal panels].

   4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
   5. Blind Fasteners: High-strength aluminum or stainless steel rivets.
   6. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

7. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
8. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.15 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming in accordance with SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming in accordance with SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.16 SOURCE QUALITY CONTROL

A. Special Inspection: the Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed in accordance with Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted in accordance with manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system in accordance with manufacturer's written instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, in accordance with AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

   a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists[girders,] and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joint Installation:

   a. Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.
   b. Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
   c. Weld joist seats to supporting steel framework.

5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 INSTALLATION OF METAL PANELS, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

   a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types used in tested assemblies meeting "Performance Requirements" Article.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 INSTALLATION OF METAL ROOF PANELS

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge[**and hip**] caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at [**peaks**] [**rake edges**] [**rake walls**] [**and**] each side of ridge[**and hip**] caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 INSTALLATION OF METAL WALL PANELS

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer[**using sealants and gaskets as required for a watertight installation**].

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches (1067 mm) o.c., spaced not more than manufacturer's written instruction. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m), noncumulative; level, plumb, and on location lines; and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 INSTALLATION OF TRANSLUCENT PANELS

A. Translucent Panels: Attach translucent panels to structural framing with fasteners in accordance with manufacturer's written instructions. Install panels perpendicular to supports unless otherwise indicated. Anchor translucent panels securely in place, with provisions for thermal and structural movement.

1. Provide end laps of not less than 6 inches (152 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal roof panels.
2. Provide end laps of not less than 4 inches (102 mm) and side laps of not less than 1-1/2-inch (38-mm) corrugations for metal wall panels.
3. Align horizontal laps with adjacent metal panels.
4. Seal intermediate end laps and side laps of translucent panels with translucent mastic.

3.8 INSTALLATION OF METAL SOFFIT PANELS

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.9 INSTALLATION OF THERMAL INSULATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.
3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

D. Board Wall Insulation: Extend board insulation in thickness indicated to cover entire wall. Hold in place by metal wall panels fastened to secondary framing. Comply with manufacturers' written instructions.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.10 INSTALLATION OF DOORS AND FRAMES

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place in accordance with manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames in accordance with NAAMM-HMMA 840. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: 1/8 inch (3 mm).
2. Between Edges of Pairs of Doors: 1/8 inch (3 mm).
3. At Door Sills with Threshold: 3/8 inch (9.5 mm).
4. At Door Sills without Threshold: 3/4 inch (19.1 mm).
5. At fire-rated openings, install frames in accordance with, and doors with clearances specified in, NFPA 80.

C. Sliding Service Doors: Bolt support angles to opening head members through factory-punched holes. Bolt door tracks to support angles at maximum 24 inches (610 mm) o.c. Set doors and operating equipment with necessary hardware, jamb and head mold stops, continuous hood flashing, anchors, inserts, hangers, and equipment supports.

D. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."

E. Door Hardware:

1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's TDH-009.
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.11 INSTALLATION OF WINDOWS

A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place in accordance with manufacturer's written instructions. Coordinate installation

with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.

1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

B. Set sill members in bed of sealant or with gaskets, for weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Mount screens directly to frames with tapped screw clips.

3.12 INSTALLATION OF ACCESSORIES

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

H. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.13 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Door Inspections:

1. Door Inspection Agency: [**the Owner will engage**] [**Engage**] a qualified inspector to perform inspections and to furnish reports to Architect, as directed by the Owner.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
4. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
5. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
6. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in [**NFPA 80**] [**and**] [**NFPA 101**].
7. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

C. Windows: Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and at weather stripping to ensure smooth operation and weathertight closure. Lubricate hardware and moving parts.

D. Roof Ventilators and Adjustable Louvers: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily, free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weathertight when in closed position.

3.15 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing[bearing plates,] and accessories.

a. Clean and prepare surfaces by SSPC-SP 2 or SSPC-SP 3.
b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

E. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer.

1. Immediately before final inspection, remove protective wrappings from doors and frames.

F. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.

G. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as directed by the Owner, remove damaged units and replace with new units.

a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 13 34 19 00

Task	Specification	Specification Description
13 34 19 00	13 34 23 16	Fabricated Control Booths
13 34 23 00	13 34 23 16	Fabricated Control Booths
13 34 23 13	13 34 19 00	Metal Building Systems
13 34 23 13	13 34 23 16	Fabricated Control Booths
13 34 23 14	13 34 23 16	Fabricated Control Booths

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SECTION 13 34 23 16 - FABRICATED CONTROL BOOTHS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control booths.
2. Include rated capacities, operating characteristics, and electrical characteristics, for included systems.

C. Shop Drawings: For control booths. Include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.

1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates. Include location, diameter, and projection of anchor bolts required to attach control booths to foundation. Indicate post reactions at each location.

D. Samples: For each exposed product and for each color and texture specified, approximately **8-1/2 by 11 inches (215 by 280 mm)** in size.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For each type of exposed finish in manufacturer's standard sizes.

1. Include Samples of wall panels and accessories to verify finish selection.

G. Delegated Design Submittals: For fabricated control booths, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For control booths to include in maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair finish or replace control booths that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated control booths.

B. Structural Performance: Fabricated control booths to withstand the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]

1. Loads: [**As indicated on Drawings**].

C. Seismic Performance: Fabricated control booths to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. Loads: [**As indicated on Drawings**].

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

E. Ballistic Resistance: Provide components, including windows, walls, and doors, identical to those tested for compliance with requirements indicated, and as follows:

1. UL Rating: [**Listed and labeled as**][**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**] when tested in accordance with UL 752.
2. NIJ Classification: [**Type I**][**Type IIA**][**Type II**][**Type IIIA**][**Type III**][**Type IV**] when tested in accordance with NIJ STD-0108.01.

F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and marked for intended location and application.

G. Safety Glazing: Comply with 16 CFR 1201, Category II.

1. Safety Glazing Labeling: Permanently mark glazing with certification label of [the SGCC][the SGCC or another certification agency acceptable to authorities having jurisdiction][manufacturer], indicating manufacturer's name, glass type, thickness, and safety glazing standard with which glass complies.

H. Regulatory Requirements: Comply with applicable provisions in [**the U.S. Department of Justice's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**].

2.2 FABRICATED STEEL CONTROL BOOTHS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Austin Mohawk and Company, Inc.**]
2. [**B.I.G. Enterprises, Inc**]
3. [**Delta Scientific Corporation**]
4. [**Keystone Structures, Inc.**]
5. [**Little Buildings, Inc.**]
6. [**Panel Built, Inc.**]
7. [**Par-Kut International, Inc**]
8. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
9. [**United Partition Systems, Inc.**]

B. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

C. Structural Framework: Fabricated from **2-by-2-by-0.075-inch (51-by-51-by-1.90-mm)** steel structural or mechanical tubing. Connect framework by welding.

D. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

E. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

F. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**] glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from [0.064-inch (1.63-mm)][0.052-inch (1.32-mm)] nominal-thickness, galvanized-steel sheet; with [2-inch- (51-mm-)][3-inch- (76-mm-)] thick, [rigid fiberglass][polystyrene board] insulation in cavity between exterior and interior face panels.

H. Raised Base Assembly: [**4-inch- (102-mm-)**][**3-inch- (76-mm-)**] high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from **2-by-4-inch (51-by-102-mm)** galvanized-steel structural tubing; **0.108-inch (2.74-mm)** nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from **1/4-inch- (6-mm-)** thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.

1. Tread Plate Floor Assembly: **0.108-inch (2.74-mm)** nominal-thickness, galvanized, rolled steel tread plate.
2. Insulated Floor Assembly: Assembly consisting of **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by **0.125-inch- (3.18-mm-)** thick, aluminum rolled tread plate; with overall assembly thickness of **2 inches (51 mm)**.
3. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of **3/4-inch- (19-mm-)** thick plywood or oriented strand board with [**0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

I. Flush Base Assembly: No perimeter frame, with finished floor fabricated from **0.108-inch (2.74-mm)** nominal-thickness, galvanized, rolled steel tread plate.

J. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

K. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from [0.079-inch (2.01-mm)][0.064-inch (1.63-mm)] nominal-thickness, galvanized-steel sheet; with [painted finish][EPDM membrane], continuously welded seams[and full-perimeter gutter].
2. Interior Ceiling Panel: Fabricated from **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from **0.028-inch (0.71-mm)** nominal-thickness, galvanized-steel sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].

   a. Height: [**6 inches (152 mm)**][**8 inches (203 mm)**].
   b. Configuration:

      1) Overhang [**3 inches (76 mm)**] beyond face of walls below.
      2) Flush with face of walls below.

5. Downspouts: Integral, extending **3 inches (76 mm)** beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

L. Work Counters: Full width of control booth, reinforced; with **16-inch- (406-mm-)** wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: [**0.078-inch- (1.98-mm-) thick, stainless steel sheet**][**0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet**][**1/2-inch- (13-mm-) thick particleboard with plastic-laminate finish**].
2. Depth: [**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**].

M. Electrical:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-**

wire][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.

2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices, as directed by the Owner.
4. Power Connections:

    a. [**One**] duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**] duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**] Type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

    a. Booth Interior: LED. Provide 20-fc (200-lux) average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[dimmable from 100 percent to 10 percent,] on counter work surfaces.
    b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
    c. Vehicle and Pedestrian Circulation:

        1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1-fc (10-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.8-fc (8-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **0.8-fc (8-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.6-fc (6-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

    d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with**

manual override located on wall inside booth door].

N. Communications:

1. [**One**] communications outlet(s) under counter(s) with [**two**][**four**] TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

O. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**], electric heater with fan-forced operation and with capacity of not less than [**5000 Btu/h (1470 W)**][**7500 Btu/h (2200 W)**]. Enclose in enameled-steel cabinet[**and mount under work counter**].

P. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [**10,000 Btu/h (2930 W)**][**12,000 Btu/h (3520 W)**][**13,500 Btu/h (3960 W)**]. Enclose in enameled-steel cabinet.

Q. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Ventilation fan.
6. Insect screens on operable openings.
7. Rollup shutters on doors and windows.
8. Intercom.
9. Traffic control lights.
10. Bollards.

R. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from non-ferrous or corrosion-resistant materials, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

S. Materials:

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, commercial quality, **G90 (Z275)** coating designation; mill phosphatized.
2. Galvanized Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D); hot-dip galvanized in accordance with ASTM A123/A123M.
3. Steel Structural Tubing: ASTM A500/A500M, Grade B.
4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
5. Steel Mechanical Tubing: ASTM A513/A513M, welded-steel mechanical tubing.
6. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized in accordance with ASTM A123/A123M.
7. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

   a. Sheet: ASTM B209/B209M.
   b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
   c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

8. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
9. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
10. Plywood: DOC PS 1, Exterior grade.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality

q3; [**6 mm thick**].

13. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**] and with manufacturer's standard dual seal. Provide tempered lites where indicated.
14. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

T. Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 FABRICATED ALUMINUM CONTROL BOOTHS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Modular Building Systems, Inc.**]
2. [**Austin Mohawk and Company, Inc.**]
3. [**Keystone Structures, Inc.**]
4. [**Mardan Fabrication, Inc.**]
5. [**NRB Modular Solutions Inc.**]
6. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
7. [**Portafab Corporation**]
8. [**Starrco**]

B. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

C. Structural Framework: Fabricated from **2-by-2-by-0.125-inch (51-by-51-by-3.18-mm)** aluminum tubing, channel, angle, or tee extrusions; with [**clear**][**color**] anodic finish. Connect framework with[**exposed**] mechanical fasteners.

D. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

E. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**] glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

F. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**] glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from [0.032-inch- (0.81-mm-)][0.063-inch- (1.60-mm-)] thick aluminum sheet, and interior face panel fabricated from [0.032-inch- (0.81-mm-)][0.050-inch- (1.27-mm-)] thick aluminum sheet; with 2-inch- (51-mm-) thick [polystyrene][polyisocyanurate board insulation] in cavity between exterior and interior face panels.

H. Raised Base Assembly: **4-inch- (102-mm-)** high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from **2-by-4-by-0.125-inch (51-by-102-by-3.18-mm)** aluminum tubing or aluminum angles. Include anchor clips fabricated from **1/4-inch- (6-mm-)** thick aluminum, predrilled and welded to exterior of integral floor frame.

1. Insulated Floor Assembly: Assembly consisting of **0.032-inch- (0.81-mm-)** thick, aluminum sheet underside with plywood and rigid insulation core; covered by **0.125-inch- (3.18-mm-)** thick, aluminum rolled tread plate; with overall assembly thickness of **2 inches (51 mm)**.
2. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of **3/4-inch- (19-mm-)** thick plywood or oriented strand board with [**0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

I. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

J. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet; with protective plastic sheet finish and full-perimeter gutter.
2. Interior Ceiling Panel: Fabricated from **0.125-inch- (3.18-mm-)** thick hardboard; with polyisocyanurate board insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from **0.063-inch- (1.60-mm-)** thick aluminum sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].

   a. Height: [**6 inches (152 mm)**][**8 inches (203 mm)**].
   b. Configuration:

      1) Overhang [**3 inches (76 mm)**] beyond face of walls below.
      2) Flush with face of walls below.

5. Downspouts: Integral, extending **3 inches (76 mm)** beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

K. Work Counters: Full width of control booth, reinforced; with **16-inch- (406-mm-)** wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: **1/2-inch- (13-mm-)** thick particleboard with plastic-laminate finish.
2. Depth: [**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**].

L. Electrical Power Service:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-wire**][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.
2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices, as directed by the Owner.
4. Power Connections:

    a. [**One**] duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**] duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**] type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

    a. Booth Interior: LED. Provide 20-fc (200-lux) average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[dimmable from 100 percent to 10 percent,] on counter work surfaces.
    b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
    c. Vehicle and Pedestrian Circulation:

        1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1-fc (10-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.8-fc (8-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **0.8-fc (8-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.6-fc (6-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with manual override located on wall inside booth door**].

M. Communications:

1. [**One**] communications outlet(s) under counter(s) with [**two**][**four**] TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

N. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**] electric heater with fan-forced operation and with capacity of not less than [**5000 Btu/h (1470 W)**][**7500 Btu/h (2200 W)**]. Enclose in enameled-steel cabinet[**and mount under work counter**].

O. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [**10,000 Btu/h (2930 W)**][**12,000 Btu/h (3520 W)**][**13,500 Btu/h (3960 W)**]. Enclose in enameled-steel cabinet.

P. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Ventilation fan.
6. Insect screens on operable openings.
7. Rollup shutters on doors and windows.
8. Intercom.
9. Traffic control lights.
10. Bollards.

Q. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from stainless steel, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

R. Materials:

1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

   a. Sheet: ASTM B209/B209M.
   b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
   c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
3. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
4. Plywood: DOC PS 1, Exterior grade.
5. Particleboard: ANSI A208.1, Grade M-2.
6. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality q3; [**6 mm thick**].
7. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**] and with manufacturer's standard dual seal. Provide tempered lites where indicated.
8. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

S. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

T. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

U. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 FABRICATION

A. Factory fabricate complete control booths, with accessories and options installed at factory.

B. Factory preglaze windows and doors.

C. Factory prewire control booths, ready for connection to service at Project site.

D. Fabricate control booths with [**forklift pockets in base of booth**][**removable lifting eye centered in roof**].

E. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:

1. Provide service windows located no higher than **34 inches (865 mm)** above exterior grade.
2. Provide door opening with minimum **32-inch (813-mm)** clear width.
3. Provide minimum **60-inch (1525-mm)** clear turning spacing within the booth.
4. Provide minimum **27-inch (685-mm)** clearance beneath interior work surfaces. Locate work surfaces **28 inches (710 mm)** minimum and **34 inches (865 mm)** maximum above the floor.
5. Locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **48 inches (1219 mm)** above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **46 inches (1170 mm)** above the floor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before control booth installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install control booths in accordance with manufacturer's written instructions.

B. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.

C. Set control booths plumb and aligned. Level baseplates true to plane, with full bearing on concrete bases.

D. Fasten control booths securely to concrete base with anchorage indicated.

E. Connect to electrical power service and communication systems.

F. Perform startup checks of [**heating**][**and**][**cooling**] units in accordance with manufacturer's written instructions.

3.3 ADJUSTING

A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

B. Adjust interior and exterior lighting controls.

C. Lubricate hardware and other moving parts.

D. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 13 34 23 16

Task	Specification	Specification Description
13 34 23 16	11 12 00 00	Parking Control Equipment
13 34 23 31	13 34 19 00	Metal Building Systems
13 34 23 31	13 34 23 16	Fabricated Control Booths
13 42 63 16	12 55 00 00	Detention Furniture

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SECTION 13 46 13 00 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lightning protection system for ordinary structures.

B. Section Includes: Lightning protection system for the following:

1. Ordinary structures.
2. <**Insert one or more miscellaneous structures or special occupancies**>.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
    b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. [**UL Master Label Certificate**][**UL Letter of Findings Limited Scope Inspection Report**][**LPI Master Certificate**][**LPI Limited Scope Certification**].

1.5 QUALITY ASSURANCE

A. Installer Qualifications: [**UL-listed installer, category OWAY**][**or**][**LPI Master Installer**].

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION FOR STRUCTURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]
11. [**VFC Lightning Protection**]
12. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]

11. [**VFC Lightning Protection**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for [**Class I**][**Class II**] buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for [**Class I**][**Class II**] buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. [**Copper**][**Stainless steel**][**or**][**Aluminum**] unless otherwise indicated.
2. [**3/8-inch (10-mm)**][**1/2-inch (12.7-mm)**][**5/8-inch (16-mm)**] diameter by [**10 inches (254 mm)**][**12 inches (305 mm)**][**15 inches (380 mm)**][**18 inches (450 mm)**][**24 inches (610 mm)**]<**Insert length of air terminal**> long.
3. [**Pointed**][**Rounded**] tip.
4. [**Integral base support**][**Threaded base support**].

B. Air Terminal Bracing:

1. [**Aluminum**][**Copper**][**Stainless steel**][**Galvanized steel**].
2. [**1/4-inch (6-mm)**]<**Insert size**> diameter rod.

C. Class I Main Conductors:

1. [**Stranded Copper: 57,400 circular mils in diameter**][**Aluminum: 98,600 circular mils in diameter**].

D. Class II Main Conductors:

1. [**Stranded Copper: 115,000 circular mils in diameter**][**Aluminum: 192,000 circular mils in diameter**].

E. Secondary Conductors:

1. [**Stranded Copper: 26,240 circular mils in diameter**][**Aluminum: 41,400 circular mils in diameter**].

F. Ground Loop Conductor: [**Stranded copper**][**Tinned copper**].

G. Ground Rods:

1. Material: [**Solid copper**][**Copper-clad steel**][**Stainless steel**].
2. Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].
3. Rods shall be not less than **120 inches (3050 mm)** long.
4. [**Sectional type, with integral threads**].

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to [**UL 96A**][**NFPA 780**].

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and **8 inches (203 mm)** in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within **200 feet (60 m)** of building. Comply with requirements for [**concealed installations in UL 96A**][**concealed systems in NFPA 780**].

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: [**bolted connectors**][**exothermic weld**][**high compression**][**crimp**].

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 13 46 13 00

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SECTION 13 47 13 00 - CATHODIC PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnesium anodes, Type II.
2. Magnesium/manganese alloy anodes.
3. Zinc anodes for buried service, Type Z-1.
4. Permanent reference electrodes.
5. Wire and cable.
6. Test stations.
7. Sealing, potting, and dielectric compounds.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design, supervise, test, and inspect the installation of cathodic protection systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Design cathodic protection for pipelines in accordance with NACE RP0169.
2. Design cathodic protection for metal underground storage tanks in accordance with NACE RP0285.

B. Survey site and determine soil or water corrosivity (resistivity), current requirements, potential surveys, stray currents, and water chemistry/corrosivity (pH).

C. Select anodes and accessories relevant to level of protection. Design anodes for an estimated life of [**15**][**30**] years before replacement.

D. Cathodic protection systems provide protective potential that complies with referenced NACE standards. Insulators are required if needed to insulate protected metals from other structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For cathodic protection. Include plans, evaluations, sections, details, and attachments to other work.

1. Detail locations of cathodic protection equipment, devices, and outlets, with characteristics and cross-references to products.
2. Include calculations and details of anode designs.
3. Include labeling and identifying scheme for wires, cables, and test boxes.

C. Delegated Design Submittals: For cathodic protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified corrosion engineer responsible for their preparation.

1. Conduct site tests necessary for design, including soil resistivity, close-interval potential surveys, testing during construction, interference testing, and training of the Owner's personnel.
2. Provide system design calculations, stating the maximum recommended anode current output density, and the rate of gaseous production, if any, at that current density.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, and coordinating connections to [**piping**][**and**][**tanks**].

B. Professional Engineer Qualification Data: Submit evidence of current license, corporate authorization (if applicable) of the engineering business, and NACE certifications.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Basic system operation, outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown.
2. Instructions for pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring.
3. Instructions for dielectric connections, interference and sacrificial-anode bonds; and precautions to ensure safe conditions during repair of pipe, tank or other metallic systems. Instructions are to be neatly bound.
4. Locations of all anodes, test stations, and insulating joints.
5. Structure-to-reference cell potentials as measured during the tests required by "Field Quality Control" Article.
6. Recommendations for maintenance testing, including instructions for pipe-to-reference cell potential measurements and frequency of testing.
7. Precautions to ensure safe conditions during repair of pipe system.

1.6 QUALITY ASSURANCE

A. Corrosion Engineer Qualifications: A qualified professional engineer who has education and experience in cathodic protection of buried and submerged metal structures and has NACE accreditation or certification as a Corrosion Specialist or Cathodic Protection Specialist.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect anodes from exposure to rain and direct sunlight.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace permanent reference electrodes that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**15**][**30**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MAGNESIUM ANODES, TYPE II

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Comply with ASTM B843.

C. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.010 maximum.
2. Manganese: 0.50 to 1.3.
3. Zinc: 0.05 maximum.
4. Silicon: 0.50 maximum.
5. Copper: 0.02 maximum.
6. Nickel: 0.001 maximum.
7. Iron: 0.03 maximum.
8. Other Impurities: 0.05 each; 0.3 maximum total.
9. Magnesium: Remainder.

D. Anode Core: Galvanized steel with anode wire silver-soldered to the core. Connection is to be recessed and epoxy insulated for 600-V rating. Connection is to be covered with heat-shrinkable tubing, and insulation is to be extended over connection.

E. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

F. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.2 MAGNESIUM/MANGANESE ALLOY ANODES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.01 maximum.
2. Manganese: 0.50 to 1.3.
3. Copper: 0.02 maximum.
4. Nickel: 0.001 maximum.
5. Iron: 0.03 maximum.
6. Other Impurities: 0.05 each; 0.3 maximum total.
7. Magnesium: Remainder.

C. Bare Anode Weight: **40 lb (18 kg)**, not including core, and a nominal length of **60 inches (1520 mm)**.

D. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

E. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.3 ZINC ANODES FOR BURIED SERVICE, TYPE Z-1

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]
4. [**ELTECH Systems Corporation USA**]
5. [**Farwest Corrosion Control Company**]
6. [**Loresco International**]
7. [**MATCOR**]

B. Comply with ASTM B418, Type II.

C. Chemical composition as percent of weight is to be as follows:

1. Aluminum: 0.005 maximum.

2. Cadmium: 0.003 maximum.
3. Iron: 0.0014 maximum.
4. Zinc: Remainder.

D. Bare Anode Ingot Weight: **30 lb (13.6 kg)**, **2 inches (50 mm)** square and **30 inches (760 mm)** long. Packaged weight of anode bag is to be **70 lb (32 kg)**.

E. Anode Wires: Factory-installed cables, with copper conductors, suitable for direct burial; not less than No. 10 AWG with Type THWN insulation in accordance with ASTM D1248 and NEMA WC 70/ICEA S-95-658; long enough to extend to accompanying junction box without splicing.

F. Anode Backfill: Backfill materials packaged in water-permeable fabric sack or cardboard container. Anodes are to be factory installed in packaged backfill using methods that result in dense packing of fill with factory-installed anode spacers to ensure centering of anode in packaged anode backfill. Backfill material is to have the following chemical composition by weight:

1. Hydrated Gypsum: 75 percent.
2. Bentonite Clay: 20 percent.
3. Anhydrous Sodium Sulfate: 5 percent.

2.4 PERMANENT REFERENCE ELECTRODES

A. [**Copper/copper sulfate (Cu/CuSO4)**], suitable for direct burial. Electrode is to be guaranteed by supplier for [**15**][**30**] years' service in the installed environment.

2.5 WIRE AND CABLE

A. Anode Header Cable: Single-conductor, Type HMWPE, insulated cable specifically designed for direct-buried dc service in cathodic protection installations.

1. Conductor: Stranded, annealed, uncoated copper, not less than No. 8 AWG, complying with ASTM B3 and ASTM B8.
2. Insulation: High-molecular-weight polyethylene, complying with NEMA WC 70/ICEA S-95-658.
3. Minimum Average Thickness of Insulation: **110 mils (2.8 mm)** for Nos. 8 through 2 AWG, and **125 mils (3.2 mm)** for Nos. 1 through 4/0 AWG; rated at 600 V.
4. Connectors: [Copper-compression type][exothermic welds].

B. Conductors and Cables: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Bonding Conductors for Joint and Continuity Bonds: Not less than No. 8 AWG, stranded, Type THWN copper conductors.
2. Flexible Pipe Coupling Bonds: Flexible copper straps with electrical resistance equal to No. 1/0 AWG stranded copper wire and with five holes for five exothermic welds to pipe.
3. Test Wires: No. 12 AWG, Type THWN copper conductors.
4. Resistance Wires: No. 16 or No. 22 AWG nickel-chromium wire.
5. Cables for Installation in Conduit: Type THWN copper conductors.

2.6 TEST STATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Corrpro Companies, Inc.**]
2. [**Cott Manufacturing Company**]
3. [**CPMasters, Inc.**]

B. Plastic Test Stations: Flush-mounted type, manufactured of high-impact-resistant PVC or polycarbonate with watertight conduit connections and cover and removable terminal board having at least five terminals.

C. Test Station Mounting Enclosures:

1. Non-Traffic-Area Boxes: Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
2. Traffic-Area Boxes: Comply with requirements in Section 260543 "Underground Ducts and Raceways for Electrical Systems." Boxes are to have cast-iron covers with a welded bead legend "CP TEST."

2.7 SEALING, POTTING, AND DIELECTRIC COMPOUNDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Chase Corporation - Chase Specialty Coatings**]
3. [**Farwest Corrosion Control Company**]

B. Sealing and Dielectric Insulating Compound: Comply with NACE RP0188. Black, rubber based, soft, permanently pliable, tacky, moldable, and unbacked; [**0.125 inch (3 mm)**][**0.5 inch (13 mm)**] thick.

C. Potting Compound: Comply with NACE RP0188. Cast-epoxy, two-package type; fabricated for this purpose and covered with heat-shrinkable tape.

D. Pressure-Sensitive, Vinyl-Plastic Electrical Tape: Comply with UL 510.

2.8 EXOTHERMIC WELDING MATERIALS

A. Exothermic Weld Kits: Specifically designed by manufacturer for welding materials and shapes required.

B. Exothermic Weld Caps: Dome of high-density polyethylene, **10-mil (0.254-mm)** minimum thickness, filled with mastic and containing a tunnel portion to separate lead wire from exothermic weld.

2.9 COATING REPAIR MATERIALS

A. Touchup Coating Materials: Comply with requirements in Section 099600 "High-Performance Coatings" for coating systems for touchup of factory-applied coatings.

B. Adhesive-Applied Coating Materials: Coating materials are to be compatible with factory-applied coating system.

1. Nominal thickness of coating materials is to be not less than [**8 mils (0.2 mm)**][**16 mils (0.4 mm)**][**24 mils (0.6 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**], plus or minus 5 percent.

2. Coating materials are to be one of the following supplied by factory-applied coating system manufacturer:

   a. Polyvinyl-chloride, pressure-sensitive, adhesive tape.
   b. High-density polyethylene/bituminous rubber compound tape.
   c. Butyl rubber tape.
   d. Coal-tar epoxy.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS, GENERAL

A. Comply with ANSI/IEEE C2 and NFPA 70.

B. Make connections to ferrous pipe[**and metal tanks**] using exothermic welding.

C. Coat welds with the coating repair material and apply an exothermic weld cap.

3.2 INSTALLATION OF MAGNESIUM ANODES, TYPE II

A. Install magnesium anodes at locations that clear obstructions. Install at least **36 inches (900 mm)** and no more than **10 feet (3 m)** from pipe[**or tank**] to be protected. Install in augered holes with top of anode [**24 inches (600 mm) below pipe invert elevation**][**a minimum of 36 inches (900 mm) below finished grade**]. In soils that will collapse into augered holes, use casing of galvanized sheet steel.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in **6-inch (150-mm)** layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within **6 inches (150 mm)** of finished grade, pour approximately **5 gal. (20 L)** of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

C. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

D. Install anodes spaced as indicated, [**directly connected**][**connected through a test station**] to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.

E. For tank protection, connect groups of anodes to collector cable. Make contact, through a test station, with tank to be protected.

F. Do not use resistance wires to reduce current output of individual or group anodes.

3.3 INSTALLATION OF MAGNESIUM/MANGANESE ALLOY ANODES

A. Install magnesium anodes at locations that clear obstructions. Install at least **36 inches (900 mm)** and no more than **10 feet (3 m)** from pipe[**or tank**] to be protected. Install in augered holes with top of anode [**24 inches (600 mm) below pipe invert elevation**][**a minimum of 36 inches (900 mm) below finished grade**]. In soils that will collapse into augered holes, use casing of galvanized sheet steel.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable permanent container that houses anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in **6-inch (150-mm)** layers; compact each layer using hand tools. Do not strike anode or connecting wire during backfilling and compacting. After backfilling and compacting to within **6 inches (150 mm)** of finished grade, pour approximately **5 gal. (20 L)** of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

C. If rock strata are encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

D. Install anodes spaced as indicated, [**directly connected**][**connected through a test station**] to the pipeline, allowing slack in connecting wire to compensate for movement during backfill operation.

E. For tank protection, connect groups of anodes to collector cable. Make contact, through a test station, with tank to be protected.

F. Do not use resistance wires to reduce current output of individual or group anodes.

3.4 INSTALLATION OF ZINC ANODES FOR BURIED SERVICE, TYPE Z-1

A. Install zinc anode horizontally in a hole at least **3 inches (76 mm)** larger than anode. Install anode under new copper water tubing, including service lines, blowoffs, and air releases. Separate piping and anode by at least **24 inches (600 mm)**, but not more than **60 inches (1520 mm)**.

B. Install anode midway between both ends of piping. Install anode wire in piping trench and connect to piping at an accessible location. Install anode wire in PVC conduit where rising out of the ground to the aboveground connection.

3.5 INSTALLATION OF PERMANENT REFERENCE ELECTRODES

A. Install directly beneath the buried metallic component being protected.

3.6 INSTALLATION OF WIRE AND CABLE

A. Install conductors, except anode wires, in PVC conduit with waterproof PVC junction boxes. Comply with requirements in Section 260533.13 "Conduit for Electrical Systems" for conduit and its installation.

B. Anode Wire Installation: Cover trench bottom for the anode wire with **3-inch (76-mm)** layer of sand or stone-free earth. Center wire on backfill layer and do not stretch or kink the conductor. Place backfill over wire in layers not exceeding **6 inches (150 mm)** deep, and compact each layer. Use clean fill, free from roots, vegetable matter, and refuse. Place cable underground-line warning tape within **18 inches (460 mm)** of finished grade, above cable and conduit.

C. Bonding Conductors: Install conductors on metallic pipe and tanks, to and across buried flexible couplings, mechanical joints, and flanged joints except at places where insulating joints are specified. Welded and threaded joints are considered electrically continuous and do not require bonding.

1. Install at least two bonds between parts requiring bonding.
2. Bonding conductors must contain sufficient slack for anticipated movement between structures. Bonding conductors across pipe joints are to have not less than a **4-inch (100-mm)** slack for pipe

expansion, contraction, and soil stress.

3. Connect bonding conductors to pipe, coupling follower rings and coupling middle ring or sleeve. Connect bonding conductors with exothermic welds.

D. For wire splicing, use compression connectors or exothermic welds.

3.7 INSTALLATION OF TEST STATIONS

A. Install test stations as follows:

1. At **1000-foot** **(300-m)** intervals.
2. At insulating joints.
3. At both ends of casings when casing material is included in the cathodic protection system.
4. Where pipe crosses other metal pipes.
5. Where pipe connects to existing piping system.
6. Where pipe connects to dissimilar metal pipe.
7. At each tank component.

B. Install test stations on backfill complying with requirements for trench bottom fill for anode wires unless otherwise indicated.

C. Terminate test conductors on terminal boards and install a spare set of test leads at each testing location.

3.8 INSTALLATION OF PIPE JOINTS

A. Insulating Flange Sets: Cover flanges with sealing and dielectric compound.

B. Insulating Unions: Install electrical isolation at each building entrance and at other locations indicated on approved Delegated Design Drawings. Cover unions with sealing and dielectric compound.

3.9 INSTALLATION OF INSULATING PIPE SLEEVES

A. Install insulating sleeves between metallic piping and metal buildings, hangers, supports, and other metal structures. Completely surround the metallic pipe for the full length of the steel contact and effectively prevent contact between the cathodically protected metallic pipe and other metallic structures. Support insulating sleeve to prevent damage to coating and to accommodate relative movement, vibrations, and temperature differentials.

3.10 DISSIMILAR METALS

A. Underground Dissimilar Piping: Coat insulating joint and pipe at joints of dissimilar piping material with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of joint.

B. Underground Dissimilar Valves: Coat dissimilar ferrous valves and pipe with sealing and dielectric compound for a minimum distance of 10 pipe diameters on both sides of valve.

C. Aboveground Dissimilar Pipe and Valves: If dissimilar metal pipe joints and valves are not buried and are exposed only to atmosphere, coat connection or valve, including pipe, with sealing and dielectric compound for a minimum distance of three pipe diameters on both sides of junction.

3.11 COATINGS

A. Field Joints: Apply adhesive-applied coating system in a thickness to achieve corrosion protection equal to adjacent factory-applied coating.

3.12 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify anode wires and anode header cables with marker tape.
2. Identify underground wires and cables with underground-line warning tape.
3. Identify text boxes with engraved, laminated acrylic or melamine label, permanently attached to text box.

3.13 FIELD QUALITY CONTROL

A. Comply with NACE RP0169 and NACE RP0285.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Static Pull Test: Choose, at random, one completed anode of each type for this destructive test. Demonstrate that anode wire connections have enough strength to withstand a minimum tensile load of **300 lb (136 kg)**. If test fails, replace all anodes and repeat test at another randomly selected anode.
2. Insulation Testing: Before anode system is connected to [**pipe**][**and**][**tank**], test insulation at each insulating joint and fitting. Demonstrate that no metallic contact, or short circuit, exists between the two insulated sections of [**pipe**][**and**][**tank**]. Replace defective joints or fittings.
3. Bonding Tests: Test for electrical continuity across all bonded joints. Repair or add additional bonds until electrical continuity is achieved.
4. Baseline Potentials: After backfilling of [**pipe and**][**pipe, tank, and**] anodes is completed, but before anodes are connected to [**pipe**][**and**][**tank**], measure the static potential of [**pipe**][**and**][**tank**] to soil. Record initial measurements.
5. Anode Output: Measure electrical current as anodes or groups of anodes are connected to [**pipe**][**and**][**tank**]. Use a low-resistance ammeter. Record current, date, time, and location of each measurement.
6. Reference Electrode Potential Measurements: On completion of installation of entire cathodic protection system, make electrode potential measurements of [**pipe**][**and**][**tank**] in accordance with NACE RP0169, using a copper/copper-sulfate reference electrode and a potentiometer-voltmeter, or a dc voltmeter with an internal resistance (sensitivity) of not less than 100,000 ohms per volt and a full scale of 1 or 2 V. Make measurements at same locations as those used for baseline potentials. Record voltage, date, time, and location of each measurement, using one of the following two methods:

   a. 0.85 V Negative Voltage: With cathodic system in operation, measure a negative voltage of at least minus 0.85 V between [pipe][tank] and a saturated copper/copper-sulfate reference electrode contacting the earth directly over [pipe][tank].

b. 100-mV Polarization Voltage: Determine polarization voltage shift by interrupting protective current and measuring polarization decay. An immediate voltage shift will occur if protective current is interrupted. Use voltage reading, after immediate shift, as base reading from which to measure polarization decay. Measure at least a minimum polarization voltage shift of 100 mV between [pipe][tank] and a saturated copper/copper-sulfate reference electrode contacting the earth directly over [pipe][tank].

E. Location of Measurements for Piping: For coated piping or conduit, measure from reference electrode in contact with the earth directly over pipe. Measure at intervals not exceeding **400 feet (120 m)**. Make additional measurements at each distribution service riser, with reference electrode placed directly over service line.

F. Location of Measurements for Tanks: For underground tanks, measure from reference electrode located as follows:

1. Directly over center of tank.
2. At a point directly over tank and midway between each pair of anodes.
3. At each end of tank.

G. Interference Testing: Test interference with cathodic protection from any foreign [**pipes**][**and**][**tanks**] in cooperation with the Owner of foreign [**pipes**][**and**][**tanks**]. Report results and recommendations.

H. Stray Current Measurements: Perform at each test station. Mitigate stray currents due to lightning or overhead ac power transmission lines as provided for in NACE standards.

I. Inspect coatings; comply with NACE RP0188. Repair imperfections of factory-applied coatings as specified in "Coatings" Article.

1. Use electronic holiday detectors to detect coating imperfections.
2. All damage to the protective coating during transit and handling is to be repaired before installation.
3. Repair factory-applied coatings to have equal or better corrosion resistance than the factory-applied coating system. Field-repair material is to be of the type approved by, and is to be applied as recommended by, manufacturer of the coating material.

3.14 ADJUSTING

A. Adjust cathodic current using resistors as recommended by corrosion engineer who prepared the Delegated Design Submittal in Part 1.

B. During the first year after Substantial Completion, test, inspect, and adjust cathodic protection system every three months to ensure its continued compliance with specified requirements.

3.15 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain cathodic protection system.

END OF SECTION 13 47 13 00

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Task	Specification	Specification Description
13 47 13 13	13 47 13 00	Cathodic Protection
13 47 13 16	13 47 13 00	Cathodic Protection

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SECTION 13 49 00 00 - RADIATION PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lead sheet, strip, and plate.
2. Lead bricks.
3. Borated polyethylene sheets.
4. High-density concrete blocks.
5. Lead-lined gypsum board.
6. Lead-lined softwood plywood.
7. Lead glass.
8. Lead glazing plastic.
9. Lead-lined hollow-metal doors.
10. Lead-lined hollow-metal frames.
11. Lead-lined flush wood doors.
12. Lead-lined split-core wood doors.
13. Lead-lined modular shielding partitions.
14. Informational signs.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete floor topping over lead shielding in concrete slabs.
2. Section 055000 "Metal Fabrications" for steel framing members for bracing [**lead-brick**][**and**][**high-density concrete block**] wall shielding.

1.2 DEFINITIONS

A. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to radiation protection, including, but not limited to, the following:

a. Sequence and schedule of radiation protection work in relation to other work.
b. Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.
c. Methods of attaching other construction and equipment to lead-lined finishes.
d. Notification procedures for work that requires modifying radiation protection.

e. Requirements for field quality control.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Lead sheet, strip, and plate.
2. Lead bricks.
3. Borated polyethylene sheets.
4. High-density concrete blocks.
5. Lead-lined gypsum board.
6. Lead-lined softwood plywood.
7. Lead glass.
8. Lead glazing plastic.
9. Lead-lined hollow-metal doors.
10. Lead-lined hollow-metal frames.
11. Lead-lined flush wood doors.
12. Lead-lined split-core wood doors.
13. Lead-lined modular shielding partitions.
14. Informational signs.

B. Product Data Submittals:

1. Doors and Frames: Include construction details, material descriptions, core descriptions, [**fire-resistance ratings,**][**temperature-rise ratings,**] and finishes.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings: Show layout of radiation-protected areas, indicating lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.

1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.
2. Show details of joints between radiation protection materials.
3. Show details of securing [**lead bricks**][**and**][**high-density concrete blocks**] to structure.
4. Include door details, including elevations, frame dimensions and profile, [**glazed light,**][**louver cutouts,**]and clearances and undercuts.

E. Samples: For units with factory-applied color finishes.

F. Product Schedule: For [**observation windows and**]doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For assemblies with radiation protection materials, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Miscellaneous metal members that support [**lead bricks**][**and**][**high-density concrete blocks**].
2. Items penetrating radiation protection materials, including the following:

a. Electrical services.
b. Air outlets and inlets.
c. Sprinklers.
d. Access panels.

B. Sample Warranty: For warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lead-Lined Gypsum Panels and Plywood: Store inside under cover, and keep dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

B. Lead-Lined, Hollow-Metal Doors and Frames: Comply with requirements in Section 081113 "Hollow Metal Doors and Frames" for delivery, storage, and handling.

C. Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors" for delivery, storage, and handling.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and

weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

A. Warranty for Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of radiation protection product from single source from single manufacturer[**unless otherwise indicated**].

2.2 PERFORMANCE REQUIREMENTS

A. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

B. Materials, thicknesses, and configurations of radiation protection products indicated are based on radiation protection design prepared by the Owner's radiation health physicist. This design is available to Contractor upon request.

C. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in lead-lined assemblies of not less than lead thickness indicated for assemblies in which they are installed.

D. Lead Glazing: Unless otherwise indicated, provide lead equivalence of not less than that indicated for assembly in which glazing is installed.

E. Fire-Rated and Smoke-Control Door and Frame Assemblies: Comply with [**Section 081113 "Hollow Metal Doors and Frames"**][**and**][**Section 081416 "Flush Wood Doors"**].

2.3 LEAD SHEET, STRIP, AND PLATE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**El Dorado Metals, Inc**]
4. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
5. [**Mayco Industries**]
6. [**MediRay**]
7. [**NELCO Worldwide**]
8. [**New Shield, Inc.**]

9. [**Pitts Little Corporation**]
10. [**Radiation Protection Products, Inc**]
11. [**Ray-Bar Engineering Corp**]
12. [**Ultraray Radiation Protection**]

B. Lead Sheet, Strip, and Plate: ASTM B749, Alloy UNS No. L51121 (chemical-copper lead).

2.4 LEAD BRICKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**El Dorado Metals, Inc**]
4. [**Global Partners in Shielding, Inc.**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**Mayco Industries**]
7. [**MediRay**]
8. [**NELCO Worldwide**]
9. [**New Shield, Inc.**]
10. [**Pitts Little Corporation**]
11. [**Radiation Protection Products, Inc**]
12. [**Ray-Bar Engineering Corp**]
13. [**Ultraray Radiation Protection**]

B. Lead Bricks: Cast- or extruded-lead bricks with interlocking tongue and grooves or wedge-shape edges, made from pig lead complying with ASTM B29 with 0.5 percent antimony added.

2.5 BORATED POLYETHYLENE SHEETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**Accurate Radiation Shielding, Inc.**]
3. [**El Dorado Metals, Inc**]
4. [**Global Partners in Shielding, Inc.**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**NELCO Worldwide**]
7. [**Pitts Little Corporation**]
8. [**Ultraray Radiation Protection**]

B. Borated Polyethylene Sheets: High-density polyethylene containing not less than [**5**][**30**] percent boron.

1. Color: [**As selected by Architect from manufacturer's standard selection**], as directed by the Owner.

2.6 HIGH-DENSITY CONCRETE BLOCKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**El Dorado Metals, Inc**]
2. [**Global Partners in Shielding, Inc.**]
3. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
4. [**Pitts Little Corporation**]
5. [**Ultraray Radiation Protection**]
6. [**Veritas Medical Solutions**]

B. High-Density Concrete Blocks: High-density cast concrete blocks with curved or wedge-shaped interlocking edges for dry-stack installation; [**145 lb/cu. ft. (2320 kg/cu. m)**][**250 lb/cu. ft. (4000 kg/cu. m)**][**300 lb/cu. ft. (4800 kg/cu. m)**] density.

2.7 LEAD-LINED GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**Accurate Radiation Shielding, Inc.**]
4. [**El Dorado Metals, Inc**]
5. [**Global Partners in Shielding, Inc.**]
6. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
7. [**Mayco Industries**]
8. [**NELCO Worldwide**]
9. [**New Shield, Inc.**]
10. [**Pitts Little Corporation**]
11. [**Radiation Protection Products, Inc**]
12. [**Ray-Bar Engineering Corp**]
13. [**Ultraray Radiation Protection**]

B. Lead-Lined Gypsum Board: **5/8-inch- (15.9-mm-)** thick gypsum board complying with Section 092900 "Gypsum Board," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.

1. Lead Sheet Lining: Full width [**and length of board**][**of board and length necessary to extend from floor to 84 inches (2134 mm) above floor**][**of board and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch (25.4 mm) beyond one vertical edge of board.**]
2. Furnish [**2-inch- (50-mm-)**] wide lead strips for backing joints.
3. Furnish finishing materials, accessories, and trim for lead-lined gypsum board complying with Section 092900 "Gypsum Board."

2.8 LEAD-LINED SOFTWOOD PLYWOOD

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**Accurate Radiation Shielding, Inc.**]

3. [**El Dorado Metals, Inc**]
4. [**General Veneer Manufacturing Co**]
5. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
6. [**Mayco Industries**]
7. [**NELCO Worldwide**]
8. [**New Shield, Inc.**]
9. [**Pitts Little Corporation**]
10. [**Radiation Protection Products, Inc**]
11. [**Ray-Bar Engineering Corp**]

B. Lead-Lined Softwood Plywood: DOC PS 1, Exposure 1; [**fire-retardant-treated**]with touch-sanded C-plugged veneer on face to receive lead lining. [**5/8-inch- (15.9-mm-)**][**3/4-inch- (19-mm-)**] thick plywood of width and length required for support spacing, with a single sheet of lead laminated to the back of the panel.

1. Lead Sheet Lining: Full width [**and length of panel**][**of panel and length necessary to extend from floor to 84 inches (2133 mm) above floor**][**of panel and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch (25.4 mm) beyond one vertical edge of panel.**]
2. Furnish [**2-inch- (50-mm-)**] wide lead strips for backing joints.
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
5. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
6. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
7. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.9 LEAD GLASS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&L Shielding Inc.**]
2. [**ABM Lead Corporation**]
3. [**Accurate Radiation Shielding, Inc.**]
4. [**Amerope Enterprises, Inc**]
5. [**El Dorado Metals, Inc**]
6. [**Global Partners in Shielding, Inc.**]
7. [**Hot Cell Services Corporation**]
8. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
9. [**Mayco Industries**]
10. [**McGrory Glass, Inc**]
11. [**NELCO Worldwide**]
12. [**New Shield, Inc.**]
13. [**Pitts Little Corporation**]

14. [**Radiation Protection Products, Inc**]
15. [**Ray-Bar Engineering Corp**]
16. [**Schott North America, Inc.**]
17. [**Ultraray Radiation Protection**]

B. Lead Glass: Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.

1. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
2. Tempered Safety Glass: ASTM C1048, Kind FT (fully tempered), lead glass with thickness [**as needed to provide lead equivalence indicated**][**as indicated**].
3. Laminated Safety Glass: ASTM C1172 lead glass with thickness [**as needed to provide lead equivalence indicated**][**as indicated**] laminated with polyvinyl butyral interlayer to clear float glass on [**one side**][**both sides**]of lead glass.

2.10 LEAD GLAZING PLASTIC

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
2. [**Mayco Industries**]
3. [**NELCO Worldwide**]
4. [**Ultraray Radiation Protection**]

B. Lead Glazing Plastic: Transparent acrylic sheet impregnated with an organolead compound and containing 30 percent lead by weight.

1. Thickness: [**As needed to provide lead equivalence indicated**][**As indicated**].

2.11 LEAD-LINED HOLLOW-METAL DOORS

A. Lead-Lined Hollow-Metal Doors: Steel doors complying with NAAMM-HMMA 861, except as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A&L Shielding Inc.**]
b. [**Accurate Radiation Shielding, Inc.**]
c. [**DCI Hollow Metal on Demand**]
d. [**Deronde Products**]
e. [**El Dorado Metals, Inc**]
f. [**Global Partners in Shielding, Inc.**]
g. [**Karpen Steel Custom Doors & Frames**]
h. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
i. [**NELCO Worldwide**]
j. [**New Shield, Inc.**]
k. [**Pitts Little Corporation**]
l. [**Ray-Bar Engineering Corp**]

m. [**Republic Doors and Frames; a Allegion brand**]
n. [**Security Metal Products; a brand of ASSA ABLOY**]
o. [**Ultraray Radiation Protection**]

2. Provide single continuous sheet of lead of thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**] extending from top to bottom and edge to edge, supported by hat-channel stiffeners. Do not weld stiffeners through lead lining.
3. Line-inverted channels at top and bottom of doors with lead sheet of same thickness used in door and close with filler channels to provide flush top and bottom edges.
4. Shield cutouts for locksets with lead sheet of same thickness used in door. Overlap lining of cutouts with lining of door by **1 inch (25 mm)**.
5. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; Factory cut and trim openings through doors. Furnish removable stops for glazed openings.
6. Furnish lead-lined astragals for pairs of doors.
7. Factory fit doors to suit frame-opening sizes indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom.
8. Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**][**factory-applied paint**].

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

C. Lead Door Louvers: Louvers with [**20**][**30**] percent free area made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Fit and assemble louvers in doors at factory.

2.12 LEAD-LINED HOLLOW-METAL FRAMES

A. Hollow-Metal Frames: Steel frames complying with NAAMM-HMMA 861, except as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A&L Shielding Inc.**]
   b. [**ABM Lead Corporation**]
   c. [**Accurate Radiation Shielding, Inc.**]
   d. [**DCI Hollow Metal on Demand**]
   e. [**Deronde Products**]
   f. [**El Dorado Metals, Inc**]
   g. [**Global Partners in Shielding, Inc.**]
   h. [**Karpen Steel Custom Doors & Frames**]
   i. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
   j. [**NELCO Worldwide**]
   k. [**New Shield, Inc.**]
   l. [**Pioneer Industries; AADG, Inc.; ASSA ABLOY**]
   m. [**Pitts Little Corporation**]
   n. [**Radiation Protection Products, Inc**]

o. [**Ray-Bar Engineering Corp**]
p. [**Republic Doors and Frames; a Allegion brand**]
q. [**Security Metal Products; a brand of ASSA ABLOY**]
r. [**Ultraray Radiation Protection**]

2. Provide knocked down frames [**where indicated**][**and**][**where installed in existing partitions**].
3. Provide borrowed lite observation window frames of split or telescoping design with welded corners, allowing frame to be installed after construction of partition.

   a. Construct so lead lining overlaps glazing material perimeter by at least **3/8 inch (9.5 mm)**, and furnish removable stops.
   b. Form sill with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

4. Provide [**door**][**and**][**observation window**] frames from steel sheet with minimum thickness of **0.0667 inch (1.7 mm)**.
5. Furnish with additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.
6. Line frame with lead sheet of thickness not less than that required for doors and walls where frames are used. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.
7. Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**][**factory-applied paint**].

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.13 LEAD-LINED FLUSH WOOD DOORS

A. Lead-Lined Flush Wood Doors: Solid-core wood doors with lead sheet laminated to each side of core, with faces applied over lead lining.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A&L Shielding Inc.**]
   b. [**Accurate Radiation Shielding, Inc.**]
   c. [**General Veneer Manufacturing Co**]
   d. [**Lambton Doors**]
   e. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
   f. [**Masonite Architectural**]
   g. [**Oshkosh Door Company**]
   h. [**Poncraft Door Company**]
   i. [**Radiation Protection Products, Inc**]
   j. [**Ray-Bar Engineering Corp**]
   k. [**Ultraray Radiation Protection**]
   l. [**Vancouver Door Company**]
   m. [**VT Industries, Inc.**]

2. Construction: Hot pressed, bonded (vertical and horizontal edging is bonded to core), with entire

unit abrasive planed before applying lead lining and faces.

3. Core: [**Mineral**][**Particleboard**][**Structural composite lumber**].
4. Lead Lining: Continuous sheets of lead extending from top to bottom and edge to edge; with total lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].
5. Wood Veneer Faces: Wood veneer applied to crossbands over core.

    a. Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

6. Plastic-Laminate Faces: High-pressure decorative laminate complying with ISO 4586-3, [**Grade HGS**][**Grade HDS**]; applied to crossbands over core.
7. ANSI/WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

B. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

D. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

E. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

F. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. Adhesives: Do not use adhesives that contain urea formaldehyde.
7. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesives: Use adhesives that meet the testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

9. Adhesives: Do not use adhesives that contain urea formaldehyde.
10. Adhesives: Do not use adhesives that contain urea formaldehyde.

G. Lead Door Louvers: Louvers with [**20**][**30**] percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

H. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]

I. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

J. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

K. Furnish lead-lined astragals for pairs of doors.

L. Factory fit doors to suit frame openings indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

2.14 LEAD-LINED SPLIT-CORE WOOD DOORS

A. Lead-Lined Split-Core Wood Doors: Solid-core wood doors with lead lining in center of core; with lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A&L Shielding Inc.**]
   b. [**ABM Lead Corporation**]
   c. [**Accurate Radiation Shielding, Inc.**]
   d. [**Ampco by AJW**]
   e. [**El Dorado Metals, Inc**]
   f. [**Global Partners in Shielding, Inc.**]
   g. [**NELCO Worldwide**]
   h. [**New Shield, Inc.**]
   i. [**Pitts Little Corporation**]
   j. [**Radiation Protection Products, Inc**]
   k. [**Ray-Bar Engineering Corp**]

2. Construction: Split core with lead lining in center of core; bonded (vertical and horizontal edging is bonded to core). Assemble lead lining and core with poured-lead fasteners or steel bolts. Space fasteners not more than **1-1/2 inches (38 mm)** from door edge and about **8 inches (200 mm)** o.c. Countersink bolt heads and cover with lead.
3. Core: [**Mineral**][**Particleboard**][**Structural composite lumber**].
4. Lead Lining: Provide continuous sheet of lead extending from top to bottom and edge to edge;

with total lead thickness [**not less than that required for partition in which door is installed**][**as indicated on Drawings**].

5. Wood Veneer Faces: Wood veneer applied to crossbands over core.

    a. Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

6. Plastic-Laminate Faces: High-pressure decorative laminate complying with ISO 4586-3, [**Grade HGS**][**Grade HDS**]; applied to crossbands over core.
7. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
8. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
9. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
10. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
11. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
12. Composite Wood Products: Products shall be made without urea formaldehyde.
13. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
14. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
15. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
    d. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

16. Composite Wood Products: Products shall be made without urea formaldehyde.
17. Adhesives: Do not use adhesives that contain urea formaldehyde.
18. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
19. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
20. Adhesives: Do not use adhesives that contain urea formaldehyde.
21. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Lead Door Louvers: Louvers with [**20**][**30**] percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

C. Prepare doors to receive [**glazed lights**][**and**][**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]

D. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; [factory primed for paint][with baked-enamel- or powder-coated] finish[and approved for use in doors of fire-protection rating indicated].

E. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

F. Furnish lead-lined astragals for pairs of doors.

G. Factory fit doors to suit frame openings indicated with [**1/16-inch (1.6-mm)**] clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

2.15 LEAD-LINED MODULAR SHIELDING PARTITIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accurate Radiation Shielding, Inc.**]
2. [**Amerope Enterprises, Inc**]
3. [**Global Partners in Shielding, Inc.**]
4. [**MarShield Custom Radiation Shielding Products, a division of Mars Metal Company**]
5. [**New Shield, Inc.**]
6. [**Radiation Protection Products, Inc**]
7. [**Ray-Bar Engineering Corp**]
8. [**S&S Technology**]
9. [**Ultraray Radiation Protection**]

B. Lead-Lined Modular Shielding Partitions: Partial-height modular partitions assembled from factory-finished standard components consisting of lead-lined, steel or aluminum framing members; lead-lined opaque panels; lead glass or glazing plastic vision panels; and hardware necessary for assembly and for securing to other construction. Fabricate opaque panels from honeycomb-core metal panels with polyurethane paint finish.

1. Lead Equivalence for Opaque Panels: [**1/16 inch (1.6 mm)**].
2. Lead Equivalence for Framing Members: [**1/16 inch (1.6 mm)**].
3. Lead Equivalence for Vision Panels: [**1/16 inch (1.6 mm)**].
4. Color of Panels and Framing: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.16 INFORMATIONAL SIGNS

A. Panel Signs: Comply with Section 101423 "Panel Signage."

1. Color: As selected by Architect from manufacturer's full range of colors, as directed by the Owner.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in **inches (millimeters)**.

B. High-Pressure-Laminate Signs: High-pressure laminate engraving stock with contrasting face and core, machine engraved from master templates for accurately formed letters, numbers, and symbols.

1. Color: As selected by Architect from manufacturer's full range of colors, as directed by the Owner.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in **inches (millimeters)**.

C. Rooms Where the Level of Protection Is Uniform Throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.

D. Rooms Where the Level of Protection Is Not Uniform Throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

E. Rooms Where Some Partitions Are without Radiation Protection: Provide one sign for each partition that contains radiation protection, and indicate its lead equivalence. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.

F. Rooms Where Only the Door Has Radiation Protection: Provide one sign for each door indicating its lead equivalence.

G. Mounting: Provide manufacturer's standard [two-faced tape][adhesive].

2.17 DOOR AND DOOR FRAME FABRICATION

A. Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with door hardware schedule and templates furnished, as specified in [**Section 087100 "Door Hardware."**][**Section 087111 "Door Hardware (Descriptive Specification)."**]

2.18 MISCELLANEOUS MATERIALS

A. Glazing Compounds, Gaskets, and Accessories: Comply with requirements in Section 088000 "Glazing."

B. Accessories and Fasteners: Manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

C. Asphalt Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

D. Asphalt Felt: ASTM D226/D226M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates with Installer present for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LEAD SHEET, STRIP, AND PLATES

A. Proceed with installation only after concrete surfaces are clean, dry, and free of depressions and sharp projections that could damage or penetrate lead sheet.

B. Coat concrete surfaces with asphalt emulsion before installing lead sheet.

C. Lead Sheet, 1/8 Inch (3.18 mm) Thick or Less: Install in a single layer with a **2-inch (50-mm)** minimum lap at joints.

D. Lead Sheet More Than 1/8 Inch (3.18 mm) Thick: Install in two or more layers with a **2-inch (50-mm)** minimum lap at joints, or in a single layer with joints butted and covered with a **4-inch- (100-mm-)** wide lead strip of same thickness.

E. Extend lead sheet at least **12 inches (300 mm)** beyond radiation shielding in walls of treatment room.

F. In floor slabs above shielded rooms, where lead sheet is indicated, extend lead sheet at least **12 inches (300 mm)** beyond radiation shielding in walls of room below.

G. At door openings, extend lead sheet at least 12 inches (300 mm) beyond radiation protection in walls and at least 12 inches (300 mm) beyond door opening on both sides[except where lead-lined thresholds are provided].

H. After installation, apply [**one coat**][**two coats**] of asphalt emulsion on top surface of lead sheet and protect from damage until concrete topping is placed.

3.3 INSTALLATION OF LEAD BRICKS

A. Remove projections from concrete surfaces to receive lead bricks, and apply one layer of asphalt felt to prevent contact between lead bricks and concrete.

1. At recesses in concrete floors to receive lead bricks, turn up asphalt felt at perimeter of recess.

B. Install lead bricks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut bricks neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.

C. Secure lead bricks to structure, as indicated on approved Shop Drawings.

3.4 INSTALLATION OF HIGH-DENSITY CONCRETE BLOCKS

A. Dry-stack blocks in running bond, using methods recommended in writing by high-density concrete block manufacturer.

B. Install concrete blocks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.

C. Secure concrete blocks to structure, as indicated on approved Shop Drawings.

3.5 INSTALLATION OF LEAD-LINED GYPSUM BOARD

A. Install and finish lead-lined gypsum board in accordance with Section 092900 "Gypsum Board."

B. Install lead-lined gypsum board panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints.[**Install using construction adhesive and supplementary fasteners.**]

C. Install lead-lined gypsum board panels in sequence, so lead lining that extends beyond edge of gypsum board is covered by next panel installed.

D. At joints where lead lining does not extend beyond edge of gypsum board panels, install lead strips **2 inches (50 mm)** wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.

E. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform plane across panel surfaces.

F. Fasten lead-lined gypsum board to framing, with steel drill screws spaced as recommended in writing by lead-lined gypsum board manufacturer.

G. Two-Layer System: Apply a facing sheet of gypsum board vertically over base sheet, using laminating adhesive recommended in writing by gypsum board manufacturer. Offset joints in finish layer from joints in base layer, and fasten at top and bottom of sheet to support finish panel until adhesive has set.

H. Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least **1 inch (25 mm)**. Arrange board around openings, so neither horizontal nor vertical joints occur at corners of openings.

I. Install control and expansion joints where indicated, with appropriate trim accessories. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.

3.6 INSTALLATION OF LEAD-LINED SOFTWOOD PLYWOOD

A. Install fastener shields to framing before installing lead strips at joints.

B. Install lead strips **2 inches (50 mm)** wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.

C. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform, plane across panel surfaces.

D. Install lead-lined plywood panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Fasten lead-lined plywood panels to framing, with adhesive and steel drill screws spaced as recommended in writing by panel manufacturer.

3.7 INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES

A. Install lead-lined steel [**doors**][**and**][**door frames**] in accordance with Section 081113 "Hollow Metal Doors and Frames."

1. Apply a coat of asphalt mastic or paint to lead lining in door frames where lead comes in contact with masonry or concrete.

B. Install lead-lined wood doors in accordance with Section 081416 "Flush Wood Doors."

C. Lead-Lined Hollow-Metal Door Frames: Comply with ANSI/NAAMM-HMMA 840 unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.

1. Provide three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.
2. In masonry construction, use wire or T-strap anchors, and apply a coat of asphalt mastic or paint to lead lining where lead comes in contact with masonry or grout.
3. In metal stud construction, use wall anchors attached to studs with screws.
4. In wood stud construction, use strap anchors attached to studs with screws.

D. Lead-Lined Split-Frame Observation Windows: Install lead-lined hollow-metal frames with split or telescoping design, with leaded side of frame on radiation side of wall.

E. Lap lead lining of frames over lining in walls at least **1 inch (25 mm)**.

F. Lead Lining of Frames: Line inside of frames with lead of thickness of not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least **1 inch (25 mm)**.

G. Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least **1 inch (25 mm)**.

H. Lead Glazing: Comply with installation requirements in Section 088000 "Glazing" and with manufacturer's written instructions.

I. Line astragals with lead sheet.

J. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See Section 087100 "Door Hardware" for other installation requirements.

3.8 INSTALLATION OF LEAD-LINED MODULAR SHIELDING PARTITIONS

A. Install partitions after finishes are complete in spaces where partitions are located. Install in accordance with manufacturer's written instructions and approved Shop Drawings.

B. Cut and remove wall base where modular shielding partitions meet other walls, so partition fits tightly to wall.

C. Secure partition framing to floor with **1/4-inch (6.35-mm)** expansion anchors **16 inches (400 mm)** o.c., and fasten to walls and ceilings as indicated. Brace partitions with tie rods fastened to walls or ceilings as indicated.

3.9 INSTALLATION OF PENETRATING ITEMS

A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness of not less than that required in assembly being penetrated.

C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.

D. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least **1 inch (25 mm)**. Wrap conduit with lead sheet for a distance of not less than **10 inches (250 mm)** from box.

E. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to 3 times the largest opening dimension. Lap lead sheet with adjacent lead lining at least **1 inch (25 mm)**.

F. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than **10 inches (250 mm)** from point of penetration.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

B. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

3.11 PROTECTION

A. Lock radiation-protected rooms once doors and locks are installed, and limit access to only those persons performing work in the rooms.

END OF SECTION 13 49 00 00

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Task	Specification	Specification Description
13 49 13 00	13 49 00 00	Radiation Protection
13 49 16 00	13 49 00 00	Radiation Protection
13 49 19 00	13 49 00 00	Radiation Protection
13 49 19 16	13 49 00 00	Radiation Protection

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Task	Specification	Specification Description
14 01 30 71	14 21 00 00	Electric Traction Elevators
14 01 30 71	14 24 00 00	Hydraulic Elevators
14 01 30 71	14 30 00 00	Escalators

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SECTION 14 21 00 00 - ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Electric traction elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by the Owner and assigned to Contractor.
2. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
5. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.

6. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.
    e. Pit ladders.
    f. Cants made from steel sheet in hoistways.

7. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
8. Section 057000 "Decorative Metal" for combination hall push-button stations.
9. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
10. Section 102213 "Wire Mesh Partitions" for guards between adjacent elevator pits.
11. Section 142113 "Electric Traction Freight Elevators" for electric traction elevators used primarily for carrying freight and inaccessible to the general public.
12. Section 142123.16 "Machine Room-Less Electric Traction Passenger Elevators."
13. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
14. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling for telephone service for elevators[**and for connection to elevator controllers for remote monitoring of elevator performance**].
15. [Section 284600 "Fire Detection and Alarm"][and][Section 284614 "Single- and Multiple-Station Alarms"] for smoke detectors in elevator lobbies to initiate emergency recall operation[for heat detectors in shafts and machine rooms to disconnect power from elevator equipment on or before sprinkler activation,] and for connection to elevator controllers.

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station[**and standby power operation control panel**].
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; **3-inch- (75-mm-)** square Samples of sheet materials; and **4-inch (100-mm)** lengths of running trim members.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service[**including standby power generator**], as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44[including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal:

1. Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
2. Submit a continuing maintenance proposal from Installer to the Owner with terms, conditions, and obligations as set forth in, and in same form as, a "Draft of Elevator Maintenance Agreement," starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or

aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain electric traction elevators[including freight and hydraulic elevators specified in other Sections,] from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, to be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] and to comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].
3. Elevator Component Importance Factor: [**1.5**][**1.0**].
4. Provide earthquake equipment required by ASME A17.1/CSA B44.
5. Provide seismic switch required by ASCE/SEI 7.

2.3 ELECTRIC TRACTION ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fujitec America, Inc**]
2. [**KONE Inc**]
3. [**MEI**]
4. [**Mitsubishi Electric US, Inc.**]
5. [**Otis Worldwide Corporation**]
6. [**Schindler Elevator Corp**]
7. [**Schumacher Elevator Co**]
8. [**ThyssenKrupp Elevator**]

B. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components to be used, as included in standard elevator systems and as required for complete system.

C. Elevator Description: .

1. Machine Type: [**Geared**][**Gearless**] traction.
2. Rated Load: [**2000 lb (908 kg)**][**2100 lb (953 kg)**][**2500 lb (1135 kg)**][**3000 lb (1362 kg)**][**3500 lb (1589 kg)**][**4000 lb (1816 kg)**][**4500 lb (2043 kg)**][**5000 lb (2270 kg)**].
3. Freight Loading Class for Service Elevator(s): Class A.
4. Rated Speed: [**200 fpm (1.0 m/s)**][**350 fpm (1.8 m/s)**][**400 fpm (2.0 m/s)**][**450 fpm (2.3 m/s)**][**500 fpm (2.5 m/s)**][**700 fpm (3.6 m/s)**][**800 fpm (4.1 m/s)**][**1000 fpm (5.1 m/s)**][**1200 fpm (6.1 m/s)**][**1400 fpm (7.1 m/s)**].
5. Operation System: [**Selective-collective automatic operation**][**Group automatic operation**][**Group automatic operation with demand-based dispatching**][**Destination-based group automatic operation**].
6. Auxiliary Operations:

    a. Standby power operation.
    b. Standby-powered lowering.
    c. Battery-powered automatic evacuation.
    d. Automatic dispatching of loaded car.
    e. Nuisance-call cancel.
    f. Loaded-car bypass.
    g. Distributed parking.
    h. Off-peak operation.
    i. Automatic operation of lights and ventilation fans.
    j. [**Emergency hospital**][**Priority**] service at [**all**] floors.
    k. Independent service for [**service elevator**][**one car in group**][**all cars in group**].

7. Security Features: [**Card-reader operation**][**Keyswitch operation**][**Keypad operation**][**Car-to-lobby feature**].
8. Dual Car-Control Stations: Provide two car-control stations[**in each elevator**]; equip only one with required keyswitches if any.
9. Car Enclosures:

    a. Inside Width: [**Not less than**][**64 inches (1626 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**70 inches (1778 mm)**][**80 inches (2032 mm)**][**89-1/2 inches (2273 mm)**][**92 inches (2337 mm)**] from side wall to side wall.
    b. Inside Depth: [**Not less than**][**51 inches (1295 mm)**][**53 inches (1346 mm)**][**56-1/2 inches (1435 mm)**][**60 inches (1524 mm)**][**64-1/2 inches (1638 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**88 inches (2235 mm)**][**89 inches (2261 mm)**][**90-1/2 inches (2298 mm)**][**93-1/2 inches (2375 mm)**][**95 inches (2413)**][**96-1/2 inches (2451 mm)**][**101 inches (2565 mm)**][**102 inches (2591 mm)**][**104 inches (2641 mm)**][**108 inches (2743 mm)**] from back wall to front wall (return panels).
    c. Inside Height: Not less than [**93 inches (2362 mm)**] to underside of ceiling.
    d. Front Walls (Return Panels): [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
    e. Car Fixtures: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
    f. Side and Rear Wall Panels: [**Enameled or powder-coated steel**][**Plastic laminate**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Satin bronze, lacquered**].
    g. Reveals: [**Black**][**Enameled or powder-coated steel**][**Anodized aluminum**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
    h. Door Faces (Interior): [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel,**

ASTM A480/A480M, No. 4 finish][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

i. Door Sills: [**Aluminum**][**Bronze**][**Nickel silver**].

j. Ceiling: [**Luminous ceiling**][**Enameled or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Reflective metallic-finish, plastic-laminate, stainless steel**][**Reflective metallic-finish, plastic-laminate, bronze**].

k. Handrails: [**1-1/2 inches (38 mm) round**][**1/2 by 2 inches (13 by 50 mm) rectangular**][**anodized aluminum**][**mirror-polished stainless steel**][**satin stainless steel**][**mirror-polished bronze, lacquered**][**satin bronze, lacquered**], at [**sides**][**and**][**rear**] of car.

l. Floor: Manufacturer's standard carpet.

m. Floor prepared to receive carpet (specified in Section 096816 "Sheet Carpeting").

n. Floor prepared to receive resilient flooring (specified in Section 096516 "Resilient Sheet Flooring").

o. Floor recessed and prepared to receive [**dimension stone tile (specified in Section 093033 "Stone Tiling")**][**ceramic tile (specified in Section 093013 "Ceramic Tiling")**].

10. Hoistway Entrances:

a. Width: [**36 inches (914 mm)**][**42 inches (1067 mm)**][**48 inches (1219 mm)**][**54 inches (1372 mm)**].

b. Height: [**84 inches (2134 mm)**].

c. Type: [**Single-speed side sliding**][**Two-speed side sliding**][**Single-speed center opening**][**Two-speed center opening**].

d. Frames: [**At first floor.**][**At basement floor.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Primed or powder-coated steel to receive stone**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Steel subframes to receive stone**].

e. Frames at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].

f. Doors and Transoms: [**At first floor.**][**At basement floor.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

g. Doors and Transoms at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

h. Sills: [**At first floor.**][**At basement floor.**][**Aluminum**][**Bronze**][**Nickel silver**].

i. Sills at Other Floors: [**Aluminum**][**Bronze**][**Nickel silver**].

11. Hall Fixtures: [**At first floor.**][**At basement floor.**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].

12. Hall Fixtures at Other Floors: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].

13. Additional Requirements:

a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from [**polished stainless steel, ASTM A480/A480M, No. 8 finish**][**satin stainless steel, ASTM A480/A480M, No. 4 finish**][**polished bronze, lacquered**][**satin bronze, lacquered**].
b. Provide hooks for protective pads in [**service car**][**all cars**] and [**one**][**two**] complete set(s) of full-height protective pads.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Variable-voltage, variable-frequency, ac-type hoisting machines[**or variable-voltage dc-type hoisting machines**] and solid-state power converters.

1. Provide [regenerative][nonregenerative] system.
2. Provide regenerative system that complies with the IgCC.
3. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
4. Provide means for absorbing regenerated power when elevator system is operating on standby power.
5. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Fluid for Hydraulic Buffers: Fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: [Roller guides][polymer-coated, nonlubricated sliding guides]. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Group Automatic Operation with Demand-Based Dispatching: Provide[**reprogrammable**] group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger [**wait time**][**time to destination**]. System automatically adjusts to demand changes for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

C. Destination-Based Group Automatic Operation: Provide reprogrammable group automatic system that assigns elevators leaving the main lobby in the up direction to a selected group of floors and directs passengers to an elevator serving their destination floor. System dispatches cars in a regulated sequence for optimum system efficiency; dispatch is based on origin and destination of calls. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

D. Auxiliary Operations:

1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire-command station**]. Manual operation causes automatic operation to cease.
2. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
3. Single-Car Battery-Powered Automatic Evacuation: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it moves to the next floor above or below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
4. Group Standby Power Operation:

    a. On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire-command station**]. Manual operation causes automatic operation to cease.
    b. On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at [**main lobby**][**fire-command station**].

5. Group Battery-Powered Automatic Evacuation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are moved one at a time to the next floor above or below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
6. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
7. Nuisance-Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls[**and predetermined weight**] can be adjusted.
8. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
9. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone to include the main floor and adjacent floors; remaining floors to be divided into approximately equal zones.
10. Off-Peak Operation: During periods of low traffic, half of the elevators in a group to be taken out of service and switched to low power mode.
11. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
12. Priority Service: Service is initiated by a [**keyswitch**][**card reader**][**remote switch**] at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks[**and a lighted sign directs passengers to exit elevator**]. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

13. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.

E. Security features are not to not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at [**car-control stations**][**and**][**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space for card reader in car**][**Provide stripe-swipe card reader integral with each car-control station**].

   a. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**][**and**][**hall push-button stations**]. Key is removable [**only in deactivated**][**in either**] position.
3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time after landing button is pressed.

   a. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes [**car**][**all cars in a group**] to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer sounds and doors begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. Provide [**enameled or powder-coated steel car enclosures to receive removable**][**steel-framed car enclosures with nonremovable**] wall panels, with [**removable**]car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
2. See "Allowances" Paragraph in "Summary" Article for items to be provided under the Elevator Car Allowance. Provide items not included in the Elevator Car Allowance as needed for finished car[**including materials and finishes specified below**].

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor:

   a. Exterior, underlayment grade plywood, not less than **5/8-inch (15.9-mm)** nominal thickness.
   b. Exterior, C-C Plugged grade plywood, not less than **7/8-inch (22.2-mm)** nominal thickness.

2. Floor Finish:

   a. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from full range of industry colors, as directed by the Owner.

3. Enameled or Powder-Coated Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
5. Bronze Wall Panels: Flush, formed-metal construction; fabricated from bronze sheet.
6. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to [**1/2-inch (13-mm) fire-retardant-treated particleboard**][**manufacturer's standard honeycomb core**][**manufacturer's standard formed metal panels**] with[**plastic-laminate panel backing and**] manufacturer's standard protective edge trim. Panels to have a flame-spread index of [**25**][**75**] or less, when tested according to ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
7. Fabricate car with recesses and cutouts for signal equipment.
8. Fabricate car door frame integrally with front wall of car.
9. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
10. Primed or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied, rust-resistant primer or powder-coating for field painting.
11. Stainless Steel Doors: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
12. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
13. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled or powder-coated steel doors and covering edges with protective edge trim[**matching return panels**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
14. Unfinished-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
15. Sight Guards: Provide sight guards on car doors.
16. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
17. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
18. Ceiling: [**Metal**][**Metallic-finish, plastic-laminate**] flush panels, with [**incandescent downlights in the center of**][**four low-voltage downlights in**] each panel.[**Align ceiling panel joints with joints between wall panels.**]
19. Light Fixture Efficiency: Not less than 35 lumens/W.
20. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile to accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames to be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies to comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, based on testing at as close-to-neutral pressure as possible according to [NFPA 252][UL 10B].

1. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
2. Primed or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
3. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
4. Stainless Steel Frames: Formed from stainless steel sheet.
5. Bronze Frames: Formed from cold- or hot-rolled steel sheet, with enamel or powder-coat finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
6. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than **3 inches (76 mm)** high, on both jambs of hoistway door frames.
7. Enameled or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
8. Primed or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
9. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
10. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
11. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled or powder-coated steel doors and covering edges with protective edge trim[**matching door frames**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
12. Unfinished-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
13. Sight Guards: Provide sight guards on doors matching door edges.
14. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
15. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

A. Provide [**hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled**][**signal equipment designed for destination-based system**]. Provide[**vandal-resistant**] buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard [recessed][semirecessed] car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide [**flush-mounted cabinet**][**telephone jack**] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

F. Car Position Indicator: Provide [**illuminated,**]digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

G. Hall Push-Button Stations: [**Provide one hall push-button station at each landing**][**Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group**][**Provide hall push-button stations at each landing as indicated**].

1. Provide [**manufacturer's standard wall-mounted units**][**units with flat faceplate for mounting with body of unit recessed in wall**].
2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
3. Equip units with [buttons][touch screen] for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.

   a. Provide a means for passengers to indicate that they have disabilities so control system can allow extra room in assigned car.
   b. Provide for connecting units that require destination registration to building security access system so a card reader can be used to register calls.

4. Provide telephone jack in each unit for firefighters' two-way telephone communication service

specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

H. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide[**one of**] the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
3. Units mounted in both jambs of entrance frame[**for each elevator**].
4. Units mounted in both car door jambs[may be used only for single elevators or for two-car groups].

I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

J. Hall Position Indicators: Provide [**illuminated,**]digital-display-type position indicators, located above[**each**] hoistway entrance at ground floor. Provide units with flat faceplate and with body of unit recessed in wall.

1. Integrate ground-floor hall lanterns with hall position indicators.

K. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.[**For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.**]

L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.

1. Metal surface is [**satin polished**][**satin relieved**][**titanium nitride colored**][**oxide colored**][**satin polished and titanium nitride colored**][**satin relieved and titanium nitride colored**][**satin polished and oxide colored**][**satin relieved and oxide colored**][**color coated and satin**

relieved][**color coated and bright relieved**] after texturing.

E. Stainless Steel Bars: ASTM A276/A276M, Type 304.

F. Stainless Steel Tubing: ASTM A554, Grade MT 304.

G. Bronze Plate and Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal).

H. Bronze Extrusions: ASTM B455/B455M, Alloy UNS No. C38500 (architectural bronze).

I. Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

J. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063.

K. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or UNS No. C77600.

L. Plastic Laminate: High-pressure type complying with ISO 4586-3, [**Type HGS for flat applications**][**Type HGL for flat applications**][**Type HGP for postformed applications**][**and**][**Type BKV for panel backing**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ELECTRIC TRACTION ELEVATORS

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

F. Leveling Tolerance: **1/8 inch (3 mm)**, up or down, regardless of load and travel direction.

G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of **72 inches (1829 mm)** above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Operating Test: Load [**elevator**][**each elevator**][**one elevator of each type, capacity, speed, and travel distance**] to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

C. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators, as directed by the Owner.

3.4 PROTECTION

A. Temporary Use: [**Limit temporary use for construction purposes to one elevator.**]Comply with the following requirements for[**each**] elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of[**each**] elevator with the Owner's personnel present before date of Substantial Completion[**and again not more than one month before end of warranty period**]. Determine that

operation systems and devices are functioning properly.

END OF SECTION 14 21 00 00

SECTION 14 21 13 00 - ELECTRIC TRACTION FREIGHT ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric traction freight elevators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
3. Section 051200 "Structural Steel Framing" for the following:

   a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
   b. Divider beams.
   c. Hoist beams.
   d. Structural-steel shapes for [**subsills**][**and**][**hoistway door frames**] that are part of steel frame.

4. Section 055000 "Metal Fabrications" for the following:

   a. Attachment plates and angle brackets for supporting guide-rail brackets.
   b. Divider beams.
   c. Hoist beams.
   d. Structural-steel shapes for [**subsills**][**and**][**hoistway door frames**].
   e. Pit ladders.
   f. Cants made from steel sheet in hoistways.

5. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
6. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
7. Section 102213 "Wire Mesh Partitions" for guards between adjacent elevator pits.
8. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair conductor telephone service for elevators[**and for Internet connection to elevator controllers for remote monitoring of elevator performance**].
9. [**Section 284621.11 "Addressable Fire-Alarm Systems"**][**Section 284621.13 "Conventional Fire-Alarm Systems"**] for smoke detectors in elevator lobbies to initiate emergency recall operation[**and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation**] and for connection to elevator controllers.

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing,[**machine room layout,**] coordination with building structure, relationships with other construction, and locations of equipment.
2. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and [**machine room**][**control closet**] layout and dimensions, as shown on Drawings, and electrical service[**including standby power generator**], as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, according to ASME A17.1[**including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel**].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to the Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work relating to electric traction freight elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 ELECTRIC TRACTION FREIGHT ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fujitec America, Inc**]
2. [**KONE Inc**]
3. [**MEI**]
4. [**Mitsubishi Electric US, Inc.**]

5. [**Otis Worldwide Corporation**]
6. [**Schindler Elevator Corp**]
7. [**Schumacher Elevator Co**]
8. [**ThyssenKrupp Elevator**]

B. Source Limitations: Obtain freight elevators[including hydraulic freight elevators specified in Section 142413 "Hydraulic Freight Elevators,"] from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].
3. Elevator Component Importance Factor: [**1.5**][**1.0**].
4. Provide earthquake equipment required by ASME A17.1/CSA B44.
5. Provide seismic switch required by ASCE/SEI 7.

2.3 FREIGHT ELEVATORS

A. Elevator System, General: Manufacturer's standard electric traction freight elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Elevator Type: [**Geared**][**Gearless**] traction.
2. Machine Location: [**Machine room above hoistway**][**Hoistway; no machine room is provided**].
3. Rated Load: [**2000 lb (908 kg)**][**2500 lb (1135 kg)**][**3000 lb (1362 kg)**][**4000 lb (1816 kg)**][**5000 lb (2270 kg)**][**6000 lb (2720 kg)**][**8000 lb (3632 kg)**][**10,000 lb (4540 kg)**].
4. Freight Loading Class: [**Class A**][**Class B**][**Class C1**][**Class C2**][**Class C3**].
5. Rated Speed: [**75 fpm (0.38 m/s)**][**100 fpm (0.51 m/s)**][**150 fpm (0.76 m/s)**][**200 fpm (1.0 m/s)**][**350 fpm (1.8 m/s)**].
6. Operation System: [**Single automatic**][**Car-switch automatic floor stop**][**Selective-collective automatic**].
7. Auxiliary Operations:

   a. Standby power operation.
   b. Battery-powered automatic evacuation.
   c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.

d. Load-weighing device.
e. Automatic operation of lights and ventilation fans.

8. Security Feature: [**Card-reader**][**Keyswitch**] operation.
9. Auxiliary Car-Control Station: Provide additional car-control station mounted on side of car at height to facilitate operation by forklift-truck operator without leaving truck.
10. Car Enclosures:

a. Platform Width: [**64 inches (1626 mm)**][**76 inches (1930 mm)**][**88 inches (2235 mm)**][**100 inches (2540 mm)**].
b. Platform Depth: [**84 inches (2134 mm)**][**96 inches (2438 mm)**][**120 inches (3048 mm)**][**144 inches (3658 mm)**][**168 inches (4267 mm)**].
c. Ceiling Height: [**84 inches (2134 mm)**][**96 inches (2438 mm)**][**108 inches (2743 mm)**].
d. Walls and Ceiling: [**Prime-painted or powder-coated steel**][**Prime-painted or powder-coated, metallic-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**].
e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
f. Floor: [**Rolled steel floor plate**][**Aluminum-alloy rolled tread plate**][**Rolled stainless steel floor plate**].
g. Car Gate Type: [**Vertical biparting**][**Single-speed vertical lift**][**Two-speed vertical lift**].
h. Car Gate Operation: [**Manual**][**Power operated**].
i. Car Gate Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel**].
j. Car Sill: Steel angle.
k. Lighting:

1) [**One**][**Two**][**Three**] **48-inch (1219-mm)**, [**suspended,**][**surface-mounted,**] two-tube fluorescent light fixture(s) with [**white reflectors**][**and**][**wire lamp guards**].
2) [**One**][**Two**] **48-inch (1219-mm)**, recessed, [**two**][**three**]-tube fluorescent light fixture(s) with UV-stabilized acrylic diffusers not less than **0.125 inch (3.2 mm)** thick.

l. Light Fixture Efficiency: Not less than 35 lumens/W.
m. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

11. Hoistway Entrances:

a. Width: [**56 inches (1422 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**].
b. Height: [**84 inches (2134 mm)**][**96 inches (2438 mm)**].
c. Door Type: [**Vertical biparting**][**Single-speed vertical lift**][**Two-speed vertical lift**].
d. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].
e. Door Operation: [**Manual**][**Power operated with door reopening device**].
f. Door Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**].
g. Door Frame Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**].

12. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
13. Auxiliary Hall Stations: Provide additional pendant-mounted, hall push-button stations[**where indicated**], mounted at height to facilitate operation by forklift-truck operator without leaving truck.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Variable-voltage, variable-frequency, ac-type hoisting machines[**or variable-voltage dc-type hoisting machines**] and solid-state power converters.

1. Provide [regenerative][nonregenerative] system.
2. Provide regenerative system that complies with IgCC.
3. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
4. Provide means for absorbing regenerated power when elevator system is operating on standby power.
5. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system from solid-state converters.

B. Fluid for Hydraulic Buffers: If using hydraulic buffers, use only fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Welded[**or bolted**]-steel units.

1. Provide special heavy-duty units where indicated for power truck loading, designed to withstand impacts and wheel loadings indicated.

F. Guides: [Roller guides][polymer-coated, nonlubricated sliding guides]. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power by a switch in control panel located at [**main lobby**][**fire command station**].

C. Single-Car Battery-Powered Automatic Evacuation: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it moves to the next floor above or below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

D. Group Standby Power Operation: On activation of standby power, cars are returned one car at a time to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch in the control panel located at [**main lobby**][**fire command station**].

E. Group Battery-Powered Automatic Evacuation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are moved one at a time to the next floor above or below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

F. Load-Weighing Device: When car load exceeds 80 percent of rated capacity, a signal lamp lights and remains lit in the car-control station; when car load exceeds rated capacity, car does not respond to car or hall calls.

G. Security Features: Security features shall not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at [**car-control stations**][**and**][**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space as indicated for card reader in car**][**Provide stripe-swipe card reader integral with each car-control station**].

    a. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**][**and**][**hall push-button stations**]. Key is removable [**only in deactivated position**][**in either position**].

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with a uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

2.7 CAR ENCLOSURES

A. Provide car enclosures as indicated, including ventilation, lighting, finishes, access doors, thresholds, trim, and accessories. Fabricate with recesses and cutouts for signal equipment.

1. Provide power door operators with linkages for hoistway door operation.
2. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Fabrication: Provide manufacturer's standard, flush panel, welded construction made from metal sheet, of metal indicated, not less than **0.067 inch (1.7 mm)** and reinforced at **16-inch (406-mm)** maximum spacing.

1. Provide perforated panels for ceiling and for walls above **72 inches (1829 mm)** from car floor, unless required to be solid by ASME A17.1/CSA B44.

2.8 HOISTWAY ENTRANCES

A. Unless otherwise indicated, provide hoistway entrance doors of type indicated below, with truckable sill bars and resilient safety meeting-rail gaskets.

1. Equip for power operation by coordinated linkage with power-operated car door.
2. Where gypsum board wall construction is indicated, provide fire-resistance-rated, hollow-metal, door-and-frame hoistway entrances. Provide self-supporting frames with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close-to-neutral pressure as possible according to [NFPA 252][UL 10B].

C. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:

1. Metal Door Panels: Constructed of metal sheets, flush on room side, welded and reinforced in steel framing with vertical reinforcing spaced not more than **24 inches (610 mm)** o.c. Fabricate panel faces from metal sheet, of metal indicated, not less than **0.097 inch (2.5 mm)** thick.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements of acrylic or other permanent, non-yellowing translucent plastic.

B. Car-Control Stations: Provide manufacturer's standard car-control station. Mount adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Mount controls at heights complying with the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Firefighters' Two-Way Telephone Communication Service: Provide [**flush-mounted cabinet**][**telephone jack**] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in [**Section 284621.11 " Addressable Fire-Alarm Systems."**][**Section 284621.13 "Conventional Fire-Alarm Systems."**]

E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station.

F. Hall Push-Button Stations: Provide hall push-button station at each landing as indicated.

1. Provide single-button stations with [**position**][**"in-use"**] indicator.

G. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in [**Section 284621.11 "Addressable Fire-Alarm Systems."**][**Section 284621.13 "Conventional Fire-Alarm Systems."**]

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, commercial steel, with **G60 (Z180)** zinc coating (galvanized) or **A60 (ZF180)** zinc-iron-alloy coating (galvannealed).

D. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

E. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.

F. Stainless Steel Bars: ASTM A276, Type 304.

G. Stainless Steel Tubing: ASTM A554, Grade MT 304.

H. Rolled Steel Floor Plate: ASTM A786/A786M.

I. Rolled Stainless Steel Floor Plate: ASTM A793.

J. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Pattern 1, Alloy 6061-T6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Operating Test: Load [**elevator**][**each elevator**][**one elevator of each type, capacity, speed, and travel distance**] to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

C. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests

are to be performed on elevators, as directed by the Owner.

3.4 PROTECTION

A. Temporary Use: [**Limit temporary use for construction purposes to one elevator.**]Comply with the following requirements for[**each**] elevator used for construction purposes:

1. Provide protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
2. Do not load elevators beyond their rated weight capacity.
3. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide the same parts and supplies as those used in the manufacture and installation of original equipment.
4. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of[**each**] elevator with the Owner's personnel present and before date of Substantial Completion[**and not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 21 13 00

Task	Specification	Specification Description
14 21 13 00	14 21 00 00	Electric Traction Elevators

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SECTION 14 21 23 00 - MACHINE ROOM-LESS ELECTRIC TRACTION PASSENGER ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Machine room-less electric traction elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by the Owner and assigned to Contractor.
2. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
5. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.

6. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.
    e. Pit ladders.
    f. Cants made from steel sheet in hoistways.

7. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
8. Section 057000 "Decorative Metal" for combination hall push-button stations.
9. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
10. Section 102213 "Wire Mesh Partitions" for guards between adjacent elevator pits.
11. Section 142113 "Electric Traction Freight Elevators" for electric traction elevators used primarily for carrying freight and inaccessible to the general public.
12. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
13. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cable for telephone service for elevators[**and for connection to elevator controllers for remote monitoring of elevator performance**].
14. [Section 284600 "Fire Detection and Alarm"][and][Section 284614 "Single- and Multiple-Station Alarms"] for smoke detectors in elevator lobbies to initiate emergency recall operation[for heat detectors in shafts and machine rooms to disconnect power from elevator equipment before or on sprinkler activation,] and for connection to elevator controllers.

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
2. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station[**and standby power operation control panel**].
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For each type of exposed finish involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; **3-inch- (75-mm-)** square Samples of sheet materials; and **4-inch (100-mm)** lengths of running trim members.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway and pit layout and dimensions, as indicated on Drawings, and electrical service[**including standby power generator**], as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's or Installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44[**including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel**].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal:

1. Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
2. Submit a continuing maintenance proposal from Installer to the Owner with terms, conditions, and obligations as set forth in, and in same form as, a "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways and pits.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive

malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].
3. Elevator Component Importance Factor: [**1.5**][**1.0**].
4. Provide earthquake equipment required by ASME A17.1/CSA B44.
5. Provide seismic switch required by ASCE/SEI 7.

2.2 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Rated Load: [**2000 lb (908 kg)**][**2100 lb (953 kg)**][**2500 lb (1135 kg)**][**3000 lb (1362 kg)**][**3500 lb (1589 kg)**][**4000 lb (1816 kg)**][**4500 lb (2043 kg)**][**5000 lb (2270 kg)**].
2. Freight Loading Class for Service Elevator(s): Class A.
3. Rated Speed: [**100 fpm (0.5 m/s)**][**150 fpm (0.75 m/s)**][**200 fpm (1.0 m/s)**][**350 fpm (1.8 m/s)**][**400 fpm (2.0 m/s)**][**450 fpm (2.3 m/s)**][**500 fpm (2.5 m/s)**].
4. Operation System: [**Selective-collective automatic operation**][**Group automatic operation**][**Group automatic operation with demand-based dispatching**].
5. Auxiliary Operations:

   a. Standby power operation.
   b. Standby-powered lowering.
   c. Battery-powered automatic evacuation.
   d. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
   e. Automatic dispatching of loaded car.
   f. Nuisance-call cancel.
   g. Loaded-car bypass.
   h. Distributed parking.

i. Off-peak operation.
j. Automatic operation of lights and ventilation fans.
k. [**Emergency hospital**][**Priority**] service at [**all**] floors.
l. Independent service for [**service elevator**][**one car in group**][**all cars in group**].

6. Security Features: [**Card-reader operation**][**Keyswitch operation**][**Keypad operation**][**Car-to-lobby feature**].
7. Dual Car-Control Stations: Provide two car-control stations[**in each elevator**]; equip only one with required keyswitches if any.
8. Car Enclosures:

a. Inside Width: Not less than [**64 inches (1626 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**70 inches (1778 mm)**][**80 inches (2032 mm)**][**89-1/2 inches (2273 mm)**][**92 inches (2337 mm)**] from side wall to side wall.
b. Inside Depth: Not less than [**51 inches (1295 mm)**][**53 inches (1346 mm)**][**56-1/2 inches (1435 mm)**][**60 inches (1524 mm)**][**64-1/2 inches (1638 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**88 inches (2235 mm)**][**89 inches (2261 mm)**][**90-1/2 inches (2298 mm)**][**93-1/2 inches (2375 mm)**][**95 inches (2413)**][**96-1/2 inches (2451 mm)**][**101 inches (2565 mm)**][**102 inches (2591 mm)**][**104 inches (2641 mm)**][**108 inches (2743 mm)**] from back wall to front wall (return panels).
c. Inside Height: Not less than [**93 inches (2362 mm)**] to underside of ceiling.
d. Front Walls (Return Panels): [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
e. Car Fixtures: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
f. Side and Rear Wall Panels: [**Enameled or powder-coated steel**][**Plastic laminate**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Satin bronze, lacquered**].
g. Reveals: [**Black**][**Enameled or powder-coated steel**][**Anodized aluminum**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
h. Door Faces (Interior): [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].
i. Door Sills: [**Aluminum**][**Bronze**][**Nickel silver**].
j. Ceiling: [**Luminous ceiling**][**Enameled or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Reflective metallic-finish, plastic-laminate, stainless steel**][**Reflective metallic-finish, plastic-laminate, bronze**].
k. Handrails: [**1-1/2 inches (38 mm) round**][**1/2 by 2 inches (13 by 50 mm) rectangular**][**anodized aluminum**][**mirror-polished stainless steel**][**satin stainless steel**][**mirror-polished bronze, lacquered**][**satin bronze, lacquered**], at [**sides**][**and**][**rear**] of car.
l. Floor: Manufacturer's standard carpet.
m. Floor prepared to receive carpet (specified in Section 096816 "Sheet Carpeting").
n. Floor prepared to receive resilient flooring (specified in Section 096516 "Resilient Sheet Flooring").
o. Floor recessed and prepared to receive [**dimension stone tile (specified in Section 093033 "Stone Tiling")**][**ceramic tile (specified in Section 093013 "Ceramic Tiling")**].

9. Hoistway Entrances:

a. Width: [36 inches (914 mm)][42 inches (1067 mm)][48 inches (1219 mm)][54 inches (1372 mm)].
b. Height: [84 inches (2134 mm)].
c. Type: [**Single-speed side sliding**][**Two-speed side sliding**][**Single-speed center opening**][**Two-speed center opening**].
d. Frames: [**At first floor.**][**At basement floor.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Primed or powder-coated steel to receive stone**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Steel subframes to receive stone**].
e. Frames at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].
f. Doors and Transoms: [**At first floor.**][**At basement floor.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].
g. Doors and Transoms at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].
h. Sills: [**At first floor.**][**At basement floor.**][**Aluminum**][**Bronze**][**Nickel silver**].
i. Sills at Other Floors: [**Aluminum**][**Bronze**][**Nickel silver**].

10. Hall Fixtures: [**At first floor.**][**At basement floor.**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].
11. Hall Fixtures at Other Floors: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].
12. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from [**polished stainless steel, ASTM A480/A480M, No. 8 finish**][**satin stainless steel, ASTM A480/A480M, No. 4 finish**][**polished bronze, lacquered**][**satin bronze, lacquered**].
    b. Provide hooks for protective pads in [**service car**][**all cars**] and [**one**][**two**] complete set(s) of full-height protective pads.

2.3 MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Canton Elevator, Inc.**]
2. [**Fujitec America, Inc**]
3. [**KONE Inc**]
4. [**MEI**]
5. [**Mitsubishi Electric US, Inc.**]

6. [**Otis Worldwide Corporation**]
7. [**Schindler Elevator Corp**]
8. [**ThyssenKrupp Elevator**]

B. Source Limitations: Obtain elevators[including freight elevators specified in other Sections,] from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Permanent magnet, variable-voltage, variable-frequency, ac-type hoisting machines and solid-state power converters.

1. Provide [regenerative][nonregenerative] system.
2. Provide regenerative system that complies with the IgCC.
3. Limit total harmonic distortion of regenerated power to 5 percent in accordance with IEEE 519.
4. Provide means for absorbing regenerated power when elevator system is operating on standby power.
5. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Fluid for Hydraulic Buffers: Fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: [Roller guides][polymer-coated, nonlubricated sliding guides]. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Group Automatic Operation with Demand-Based Dispatching: Provide[**reprogrammable**] group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger [**wait time**][**time to destination**]. System automatically adjusts to demand changes for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fujitec America, Inc**]
b. [**KONE Inc**]
c. [**Mitsubishi Electric US, Inc.**]
d. [**Otis Worldwide Corporation**]
e. [**Schindler Elevator Corp**]
f. [**ThyssenKrupp Elevator**]

C. Auxiliary Operations:

1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire-command station**]. Manual operation causes automatic operation to cease.
2. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
3. Single-Car Battery-Powered Automatic Evacuation: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it moves to the next floor above or below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
4. Group Standby Power Operation:

   a. On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire-command station**]. Manual operation causes automatic operation to cease.
   b. On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at [**main lobby**][**fire-command station**].

5. Group Battery-Powered Automatic Evacuation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are moved one at a time to the next floor above or below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
6. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
7. Nuisance-Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls[**and predetermined weight**] can be adjusted.
8. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
9. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone to include the main floor and adjacent floors; remaining floors to be divided into approximately equal zones.
10. Off-Peak Operation: During periods of low traffic, half of the elevators in a group to be taken out of service and switched to sleep, low power mode.
11. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors

closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.

12. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
13. Priority Service: Service is initiated by a [**keyswitch**][**card reader**][**remote switch**] at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks[**and a lighted sign directs passengers to exit elevator**]. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

D. Security features may not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at [**car-control stations**][**and**][**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space for card reader in car**][**Provide stripe-swipe card reader integral with each car-control station**].

   a. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**][**and**][**hall push-button stations**]. Key is removable [**only in deactivated**][**in either**] position.
3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time after landing button is pressed.

   a. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes [**car**][**all cars in a group**] to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer sounds and doors begins to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. Provide [**enameled or powder-coated steel car enclosures to receive removable**][**steel-framed car enclosures with nonremovable**] wall panels, with [**removable**]car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
2. See "Elevator Car Allowances" Paragraph in "Allowances" Article for items to be provided under the Elevator Car Allowance. Provide items not included in the Elevator Car Allowance as needed for finished car including materials and finishes specified below.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor:

   a. Exterior, underlayment grade plywood, not less than **5/8-inch (15.9-mm)** nominal thickness.
   b. Exterior, C-C Plugged grade plywood, not less than **7/8-inch (22.2-mm)** nominal thickness.

2. Floor Finish:

   a. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from full range of industry colors, as directed by the Owner.

3. Enameled or Powder-Coated Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
5. Bronze Wall Panels: Flush, formed-metal construction; fabricated from bronze sheet.
6. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to [**1/2-inch (13-mm) fire-retardant-treated particleboard**][**manufacturer's standard honeycomb core**][**manufacturer's standard formed metal panels**] with[**plastic-laminate panel backing and**] manufacturer's standard protective edge trim. Panels to have a flame-spread index of [**25**][**75**] or less, when tested in accordance with ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
7. Fabricate car with recesses and cutouts for signal equipment.
8. Fabricate car door frame integrally with front wall of car.
9. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
10. Primed or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied, rust-resistant primer or powder-coating for field painting.
11. Stainless Steel Doors: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
12. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
13. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled or powder-coated steel doors and covering edges with protective edge trim[**matching return panels**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by

the Owner.

14. Unfinished-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
15. Sight Guards: Provide sight guards on car doors.
16. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
17. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
18. Ceiling: [**Metal**][**Metallic-finish, plastic-laminate**] flush panels, with [**incandescent downlights in the center of**][**four low-voltage downlights in**] each panel.[**Align ceiling panel joints with joints between wall panels.**]
19. Light Fixture Efficiency: Not less than 35 lumens/W.
20. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile to accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames to be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies to comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible in accordance with [NFPA 252][UL 10B].

1. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
2. Primed or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
3. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
4. Stainless Steel Frames: Formed from stainless steel sheet.
5. Bronze Frames: Formed from cold- or hot-rolled steel sheet, with enamel or powder-coat finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
6. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than **3 inches (76 mm)** high, on both jambs of hoistway door frames.
7. Enameled or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
8. Primed or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
9. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].

10. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled or powder-coated steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
11. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled or powder-coated steel doors and covering edges with protective edge trim[**matching door frames**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
12. Unfinished-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
13. Sight Guards: Provide sight guards on doors matching door edges.
14. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
15. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide[**vandal-resistant**] buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard [recessed][semirecessed] car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide [**flush-mounted cabinet**][**telephone jack**] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

F. Car Position Indicator: Provide [**illuminated,**]digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

G. Hall Push-Button Stations: [**Provide one hall push-button station at each landing**][**Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less**

than one station for each four elevators in a group][**Provide hall push-button stations at each landing as indicated**].

1. Provide [**manufacturer's standard wall-mounted units**][**units with flat faceplate for mounting with body of unit recessed in wall**].
2. Equip units with buttons for calling elevator and for indicating desired direction of travel.

    a. Provide for connecting units to building security access system so a card reader can be used to register calls.

3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

H. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide[**one of**] the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
3. Units mounted in both jambs of entrance frame[**for each elevator**].
4. Units mounted in both car door jambs[may be used only for single elevators or for two-car groups].

I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

J. Hall Position Indicators: Provide [**illuminated,**]digital-display-type position indicators, located above[**each**] hoistway entrance at ground floor. Provide units with flat faceplate and with body of unit recessed in wall.

1. Integrate ground-floor hall lanterns with hall position indicators.

K. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.[**For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.**]

L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.

1. Metal surface is [**satin polished**][**satin relieved**][**titanium nitride colored**][**oxide colored**][**satin polished and titanium nitride colored**][**satin relieved and titanium nitride colored**][**satin polished and oxide colored**][**satin relieved and oxide colored**][**color coated and satin relieved**][**color coated and bright relieved**] after texturing.

E. Stainless Steel Bars: ASTM A276/A276M, Type 304.

F. Stainless Steel Tubing: ASTM A554, Grade MT 304.

G. Bronze Plate and Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal).

H. Bronze Extrusions: ASTM B455/B455M, Alloy UNS No. C38500 (architectural bronze).

I. Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

J. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063.

K. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or UNS No. C77600.

L. Plastic Laminate: High-pressure type complying with ISO 4586-3, [**Type HGS for flat applications**][**Type HGL for flat applications**][**Type HGP for postformed applications**][**and**][**Type BKV for panel backing**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, and pits as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

F. Leveling Tolerance: **1/8 inch (3 mm)**, up or down, regardless of load and travel direction.

G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of **72 inches (1829 mm)** above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Operating Test: Load [**elevator**][**each elevator**][**one elevator of each type, capacity, speed, and travel distance**] to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

C. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators, as directed by the Owner.

3.4 PROTECTION

A. Temporary Use: [**Limit temporary use for construction purposes to one elevator.**]Comply with the following requirements for[**each**] elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.

6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of[**each**] elevator with the Owner's personnel present before date of Substantial Completion[**and again not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 21 23 00

Task	Specification	Specification Description
14 21 23 00	14 21 00 00	Electric Traction Elevators
14 21 23 13	14 21 23 00	Machine Room-Less Electric Traction Passenger Elevators

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SECTION 14 24 00 00 - HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Hydraulic elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by the Owner and assigned to Contractor.
2. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
5. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other structural-steel preparations for fastening guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills that are part of steel frame.

6. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.
    e. Pit ladders.
    f. Cants made from steel sheet in hoistways.

7. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
8. Section 057000 "Decorative Metal" for combination hall push-button stations.
9. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
10. Section 102213 "Wire Mesh Partitions" for guards between adjacent elevator pits.
11. Section 142413 "Hydraulic Freight Elevators" for hydraulic elevators that are used primarily for carrying freight and are inaccessible to the general public.
12. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
13. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair conductors used for telephone service for elevators[**and for Internet connection to elevator controllers for remote monitoring of elevator performance if required**].
14. [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single- and Multiple-Station Alarms"**] for smoke detectors in elevator lobbies to initiate emergency recall operation[**and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation**] and for connection to elevator controllers.
15. Section 312000 "Earth Moving" for excavating well hole to accommodate cylinder assembly and for the disposition of excavated material from the cylinder well hole.

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
2. Include large-scale layout of car-control station[**and standby-power operation control panel**].
3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes, **3-inch- (75-mm-)** square Samples of sheet materials and **4-inch (100-mm)** lengths of running trim members.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service[**including standby-power generator**], as indicated and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44[**including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel**].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal:

1. Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
2. Submit a continuing maintenance proposal from Installer to the Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Furnish well casing and coordinate delivery with related excavation work.

C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 HYDRAULIC ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Crescent Elevator Mfg., Corp.**]
2. [**Fujitec America, Inc**]
3. [**KONE Inc**]
4. [**MEI**]
5. [**Mowrey Elevator Co.**]
6. [**Otis Worldwide Corporation**]
7. [**Schindler Elevator Corp**]
8. [**Schumacher Elevator Co**]
9. [**ThyssenKrupp Elevator**]

B. Source Limitations: Obtain elevators[including freight and electric traction passenger elevators specified in other Sections,] from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, are manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Standard: Comply with applicable provisions in [**the United States Access Board's ADA-ABA Accessibility Guidelines**][**and**][**ICC A117.1**].

C. Seismic Performance: Elevator system withstands the effects of earthquake motions determined according to [**ASCE/SEI 7**] and complies with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].
3. Elevator Component Importance Factor: [**1.5**][**1.0**].
4. Provide earthquake equipment required by ASME A17.1/CSA B44.
5. Provide seismic switch required by ASCE/SEI 7.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components are used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Type:

a. Under-the-car single cylinder.
b. Holeless, beside-the-car, single-acting, [**single**][**dual**] cylinder.
c. Holeless, beside-the-car, telescoping, [**single**][**dual**] cylinder.
d. Holeless, beside-the-car, roped hydraulic, [**single**][**dual**] cylinder.

2. Rated Load: [**2000 lb (908 kg)**][**2100 lb (953 kg)**][**2500 lb (1135 kg)**][**3000 lb (1362 kg)**][**3500 lb (1589 kg)**][**4000 lb (1816 kg)**][**4500 lb (2043 kg)**][**5000 lb (2270 kg)**].
3. Freight Loading Class for Service Elevators: Class A.
4. Rated Speed: [**75 or 80 fpm (0.38 or 0.41 m/s)**][**100 fpm (0.51 m/s)**][**125 fpm (0.64 m/s)**][**150 fpm (0.76 m/s)**][**175 fpm (0.89 m/s)**][**200 fpm (1.0 m/s)**].
5. Operation System: [**Single automatic operation**][**Selective-collective automatic operation**][**Group automatic operation**].
6. Auxiliary Operations:

a. Standby-power operation.
b. Standby-powered lowering.
c. Battery-powered lowering.
d. Automatic dispatching of loaded car.
e. Nuisance call cancel.
f. Loaded-car bypass.
g. Off-peak operation
h. Automatic operation of lights and ventilation fans.
i. [**Emergency hospital**][**Priority**] service at [**all**] floors.
j. Independent service for [**service elevator**][**one car in group**][**all cars in group**].

7. Security Features: [**Card-reader operation**][**Keyswitch operation**][**Keypad operation**][**Car-to-lobby feature**].
8. Dual Car-Control Stations: Provide two car-control stations[**in each elevator**]; equip only one with required keyswitches if any.
9. Car Enclosures:

a. Inside Width: [**Not less than**][**64 inches (1626 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**70 inches (1778 mm)**][**80 inches (2032 mm)**][**89-1/2 inches (2273 mm)**][**92 inches (2337 mm)**] from side wall to side wall.
b. Inside Depth: [**Not less than**][**51 inches (1295 mm)**][**53 inches (1346 mm)**][**56-1/2 inches (1435 mm)**][**60 inches (1524 mm)**][**64-1/2 inches (1638 mm)**][**66 inches (1676 mm)**][**68 inches (1727 mm)**][**88 inches (2235 mm)**][**89 inches (2261 mm)**][**90-1/2 inches (2298 mm)**][**93-1/2 inches (2375 mm)**][**95 inches (2413)**][**96-1/2 inches (2451 mm)**][**101 inches (2565 mm)**][**102 inches (2591 mm)**][**104 inches (2641 mm)**][**108 inches (2743 mm)**] from back wall to front wall (return panels).
c. Inside Height: Not less than [**93 inches (2362 mm)**] to underside of ceiling.
d. Front Walls (Return Panels): [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**] with integral car door frames.
e. Car Fixtures: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin**

bronze, lacquered].

f. Side and Rear Wall Panels: [**Enameled or powder-coated steel**][**Plastic laminate**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Satin bronze, lacquered**].

g. Reveals: [**Black**][**Enameled or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].

h. Door Faces (Interior): [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

i. Door Sills: [**Aluminum**][**Bronze**][**Nickel silver**].

j. Ceiling: [**Luminous ceiling**][**Enameled or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Reflective metallic-finished plastic laminate, resembling stainless steel**][**Reflective metallic-finished plastic laminate, resembling bronze**].

k. Handrails: [**1-1/2 inches (38 mm) round**][**1/2 by 2 inches (13 by 50 mm) rectangular**][**anodized aluminum**][**mirror-polished stainless steel**][**satin stainless steel**][**mirror-polished bronze, lacquered**][**satin bronze, lacquered**], at [**sides**][**and**][**rear**] of car.

l. Floor: Manufacturer's standard carpet.

m. Floor prepared to receive carpet (specified in Section 096816 "Sheet Carpeting").

n. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").

o. Floor recessed and prepared to receive [**dimension stone tile (specified in Section 093033 "Stone Tiling")**][**ceramic tile (specified in Section 093013 "Ceramic Tiling")**].

10. Hoistway Entrances:

a. Width: [**36 inches (914 mm)**][**42 inches (1067 mm)**][**48 inches (1219 mm)**][**54 inches (1372 mm)**].

b. Height: [**84 inches (2134 mm)**].

c. Type: [**Single-speed side sliding**][**Two-speed side sliding**][**Single-speed center opening**][**Two-speed center opening**].

d. Frames: [**At first floor.**][**At basement floors.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].

e. Frames at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**].

f. Doors and Transoms: [**At first floor.**][**At basement floors.**][**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

g. Doors and Transoms at Other Floors: [**Enameled or powder-coated steel**][**Primed or powder-coated steel**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Plastic laminate**].

h. Sills: [**At first floor.**][**At basement floors.**][**Aluminum**][**Bronze**][**Nickel silver**].

i. Sills at Other Floors: [**Aluminum**][**Bronze**][**Nickel silver**].

11. Hall Fixtures: [**At first floor.**][**At basement floors.**][**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].
12. Hall Fixtures at Other Floors: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Polished bronze, lacquered**][**Satin bronze, lacquered**][**Recessed type with no exposed-metal surfaces**].
13. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from [**polished stainless steel, ASTM A480/A480M, No. 8 finish**][**satin stainless steel, ASTM A480/A480M, No. 4 finish**][**polished bronze, lacquered**][**satin bronze, lacquered**].
    b. Provide hooks for protective pads in [**service car**][**all cars**] and [**one**][**two**] complete set(s) of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

1. Pump is [submersible type with submersible squirrel-cage induction motor, and suspended inside oil tank from vibration isolation mounts][is tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and is mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board].
2. Motor has [wye-delta][solid-state] starting.
3. Motor has variable-voltage, variable-frequency control.

B. Hydraulic Silencers: System has hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.

C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.

1. Cylinder units are connected with dielectric couplings.
2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D1785, joined with PVC fittings complying with ASTM D2466 and solvent cement complying with ASTM D2564.

D. Hydraulic Fluid:

1. Hydraulic Fluid, Manufacturer's Standard: Elevator manufacturer's standard [**fire-resistant**]fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
2. Hydraulic Fluid, Nontoxic and Biodegradable: Nontoxic, biodegradable[fire-resistant] fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Hydro Safe Oil Division, Inc.**]

E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing

guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

F. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than **1-inch (25-mm)** clearance from cylinder and extending above pit floor. Casing has means of monitoring effectiveness to comply with ASME A17.1/CSA B44.

G. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below **60 deg F (16 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hydro Safe Oil Division, Inc.**]
   b. [**Union Gard; a division of Enduratech LLC**]

H. Car Frame and Platform: Welded[**or bolted**] steel units.

I. Guides: [Roller guides][Polymer-coated, nonlubricated sliding guides][sliding guides with guide-rail lubricators]. Provide guides at top and bottom of car frame.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

B. Auxiliary Operations:

1. Single-Car Standby-Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire command station**]. Manual operation causes automatic operation to cease.
2. Single-Car Standby-Powered Lowering:

   a. On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down.
   b. On activation of standby power, car is lowered to the lowest floor, opens its doors, and shuts down.

3. Single-Car Battery-Powered Lowering:

   a. If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
   b. When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

4. Group Standby-Power Operation:

   a. On activation of standby power, cars are returned to a designated floor and parked with doors open. Only one car is moved upward at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**][**fire command station**]. Manual operation causes automatic operation to cease.
   b. On activation of standby power, cars are returned to lowest floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch located at [**main lobby**][**fire command station**].

5. Group Standby-Powered Lowering:

   a. On activation of standby power, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down.
   b. On activation of standby power, cars are lowered to the lowest floor, open their doors, and shut down.

6. Group Battery-Powered Lowering:

   a. If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
   b. When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

7. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.
8. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls[**and predetermined weight**] can be adjusted.
9. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
10. Off-Peak Operation: During periods of low traffic, half of the elevators in a group are taken out of service and switched to low-power mode.
11. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
12. Priority Service: Service is initiated by a [keyswitch][card reader][remote switch] at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks[and a lighted sign directs passengers to exit elevator]. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car returns to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.
13. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-

energized before car doors open.

C. Security Features: Security features do not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at [**car-control stations**][**and**][**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space for card reader in car**][**Provide stripe-swipe card reader integral with each car-control station**].

   a. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**][**and**][**hall push-button stations**]. Key is removable [**only in deactivated position**][**in either position**].
3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

   a. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes [**car**][**all cars in a group**] to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.6 DOOR-REOPENING DEVICES

A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer sounds and doors begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. Provide [**enameled- or powder-coated-steel car enclosures to receive removable**][**steel-framed car enclosures with nonremovable**] wall panels, with [**removable**]car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
2. See "Allowances" Article for items to be provided under the Elevator Car Allowance. Provide items not included in the Elevator Car Allowance as needed for finished car[including materials and finishes specified below].

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor:

   a. Exterior, underlayment-grade plywood, not less than **5/8-inch (15.9-mm)** nominal thickness.
   b. Exterior, C-C Plugged grade plywood, not less than **7/8-inch (22.2-mm)** nominal thickness.

2. Floor Finish:

   a. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from manufacturer's full range, as directed by the Owner.

3. Enameled- or Powder-Coated-Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
4. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
5. Bronze Wall Panels: Flush, formed-metal construction; fabricated from bronze sheet.
6. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to [**1/2-inch (13-mm) fire-retardant-treated particleboard**][**manufacturer's standard honeycomb core**][**manufacturer's standard formed metal panels**] with[**plastic-laminate panel backing and**] manufacturer's standard protective edge trim. Panels have a flame-spread index of [**25**][**75**] or less, when tested according to ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
7. Fabricate car with recesses and cutouts for signal equipment.
8. Fabricate car door frame integrally with front wall of car.
9. Enameled- or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
10. Primed or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder coating for field painting.
11. Stainless Steel Doors: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
12. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
13. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled- or powder-coated-steel doors and covering edges with protective edge trim[**matching return panels**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
14. Unfinished-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder coating.
15. Sight Guards: Provide sight guards on car doors.
16. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
17. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
18. Ceiling: [**Metal**][**Metallic-finish, plastic-laminate**] flush panels, with [**incandescent downlights in the center of**][**four low-voltage downlights in**] each panel.[**Align ceiling panel joints with joints between wall panels.**]
19. Light Fixture Efficiency: Not less than 35 lumens/W.
20. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames are self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to [NFPA 252][UL 10B].

1. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled- or Powder-Coated-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
2. Primed or Powder-Coated-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder coating for field painting.
3. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
4. Stainless Steel Frames: Formed from stainless steel sheet.
5. Bronze Frames: Formed from cold- or hot-rolled steel sheet, with enamel or powder-coat finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
6. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than **3 inches (76 mm)** high, on both jambs of hoistway door frames.
7. Enameled- or Powder-Coated-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
8. Primed or Powder-Coated-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
9. Stainless Steel Doors and Transoms: Flush, hollow-metal construction; fabricated [from stainless steel sheet][by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning].
10. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
11. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled- or powder-coated-steel doors and covering edges with protective edge trim[**matching door frames**]. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
12. Unfinished-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet, with factory-applied enamel or powder-coating.
13. Sight Guards: Provide sight guards on doors matching door edges.
14. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
15. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide[**vandal-resistant**] buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard [recessed][semirecessed] car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide [**flush-mounted cabinet**][**telephone jack**] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

F. Car Position Indicator: Provide [**illuminated,**]digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

G. Hall Push-Button Stations: [**Provide one hall push-button station at each landing**][**Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group**][**Provide hall push-button station at each landing as indicated**].

1. Provide [**manufacturer's standard wall-mounted units**][**units with flat faceplate for mounting with body of unit recessed in wall**][**jamb-mounted units**].
2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

H. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide[**one of**] the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
3. Units mounted in both jambs of entrance frame[**for each elevator**].

4. Units mounted in both car door jambs[may be used only for single elevators or for two-car groups].

I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

J. Hall Position Indicators: Provide [**illuminated,**]digital-display-type position indicators, located above[**each**] hoistway entrance at ground floor.

1. Provide units [**with flat faceplate for mounting and with body of unit recessed in wall**][**integral with entrance head jamb**].
2. Integrate ground-floor hall lanterns with hall position indicators.

K. Standby-Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.[**For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.**]

L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby-power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304, with embossed texture rolled into exposed surface.

1. Metal surface is [**satin polished**][**satin relieved**][**titanium nitride colored**][**oxide colored**][**satin polished and titanium nitride colored**][**satin relieved and titanium nitride colored**][**satin polished and oxide colored**][**satin relieved and oxide colored**][**color coated and satin relieved**][**color coated and bright relieved**] after texturing.

E. Stainless Steel Bars: ASTM A276/A276M, Type 304.

F. Stainless Steel Tubing: ASTM A554, Grade MT 304.

G. Bronze Plate and Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal).

H. Bronze Extrusions: ASTM B455/B455M, Alloy UNS No. C38500 (architectural bronze).

I. Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

J. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063.

K. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or No. C77600.

L. Plastic Laminate: High-pressure type complying with ISO 4586-3, [**Type HGS for flat applications**][**Type HGL for flat applications**][**Type HGP for postformed applications**][**and**][**Type BKV for panel backing**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HYDRAULIC ELEVATORS

A. Excavation for Cylinder: Drill well hole in[**each**] elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."

B. Provide[**waterproof**] well casing[**as necessary**] to retain well-hole walls.

C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole[**and provide permanent waterproof seal at bottom of well casing**].

1. Fill void space between protective casing and cylinder with corrosion-protective filler.
2. Align cylinder and fill space around protective casing with fine sand.

D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between [**well**][**protective**] casing and pit floor with **4 inches (100 mm)** of nonshrink, nonmetallic grout.

E. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.

F. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.

G. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

H. Install piping above the floor, where possible. Install underground piping in casing.

1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."

I. Lubricate operating parts of systems as recommended by manufacturers.

J. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

K. Leveling Tolerance: **1/4 inch (6 mm)**, up or down, regardless of load and travel direction.

L. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

M. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of **72 inches (1829 mm)** above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators, as directed by the Owner.

3.4 PROTECTION

A. Temporary Use: [**Limit temporary use for construction purposes to one elevator.**]Comply with the following requirements for[**each**] elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of[**each**] elevator with the Owner's personnel present before date of Substantial Completion[**and again not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 24 00 00

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SECTION 14 24 13 00 - HYDRAULIC FREIGHT ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydraulic freight elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by the Owner and assigned to Contractor.
2. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry.
5. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills[**and entrance frames**] that are part of steel frame.

6. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for [**subsills**][**and**][**entrance frames**].
    e. Pit ladders.
    f. Cants made from steel sheet in hoistways.

7. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
8. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
9. Section 102213 "Wire Mesh Partitions" for guards between adjacent elevator pits.
10. Section 271513 "Communications Copper Horizontal Cabling" for telephone service for elevators.
11. [**Section 284621.11 "Addressable Fire-Alarm Systems"**][**Section 284621.13 "Conventional Fire-Alarm Systems"**] for smoke detectors in elevator lobbies to initiate emergency recall operation[**and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation**] and for connection to elevator controllers.
12. Section 312000 "Earth Moving" for excavating well hole to accommodate cylinder assembly.

C. Unit Prices: Rock excavation for cylinder well holes is paid for under the unit price indicated in the Contract and as specified in Section 012200 "Unit Prices."

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
2. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service[**including standby power generator**], as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, according to ASME A17.1[**including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel**].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal:

1. Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
2. Submit a continuing maintenance proposal from Installer to the Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.

B. Furnish well casing and coordinate delivery with related excavation work.

C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic freight elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 HYDRAULIC FREIGHT ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**American Crescent Elevator Mfg., Corp.**]
2. [**Fujitec America, Inc**]
3. [**KONE Inc**]
4. [**MEI**]
5. [**Mowrey Elevator Co.**]
6. [**Otis Worldwide Corporation**]
7. [**Schindler Elevator Corp**]
8. [**Schumacher Elevator Co**]
9. [**ThyssenKrupp Elevator**]

B. Source Limitations: Obtain freight elevators[including electric traction freight elevators specified in Section 142100 "Electric Traction Elevators,"] from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].
3. Elevator Component Importance Factor: [**1.5**][**1.0**].

2.3 FREIGHT ELEVATORS

A. Elevator System, General: Manufacturer's standard hydraulic freight elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Type:

   a. Under-the-car [single][dual] cylinder.
   b. Holeless, beside-the-car, single-acting, [**single**][**dual**] cylinder.
   c. Holeless, beside-the-car, telescoping, [**single**][**dual**] cylinder.
   d. Holeless, beside-the-car, roped hydraulic, [**single**][**dual**] cylinder.

2. Rated Load: [**2000 lb (908 kg)**][**2500 lb (1135 kg)**][**3000 lb (1362 kg)**][**4000 lb (1816 kg)**][**5000 lb**

(2270 kg)][6000 lb (2720 kg)][8000 lb (3632 kg)][10,000 lb (4540 kg)].

3. Freight Loading Class: [**Class A**][**Class B**][**Class C1**][**Class C2**][**Class C3**].
4. Rated Speed (Up): [**50 fpm (0.25 m/s)**][**75 or 80 fpm (0.38 or 0.41 m/s)**][**100 fpm (0.51 m/s)**].
5. Operational Speed (Down): [**Approximately 30 percent more than**][**Same as**] rated speed (up).
6. Operation System: [**Single automatic**][**Car-switch automatic floor stop**][**Selective-collective automatic**].
7. Auxiliary Operations:

    a. Battery-powered lowering.
    b. Standby power operation.
    c. Load-weighing device.
    d. Automatic operation of lights and ventilation fans.

8. Security Features: [**Card-reader**][**Keyswitch**] operation.
9. Auxiliary Car-Control Station: Provide additional car-control station mounted on side of car at height to facilitate operation by forklift-truck operator without leaving truck.
10. Car Enclosures:

    a. Platform Width: [**60 inches (1524 mm)**][**64 inches (1626 mm)**][**66 inches (1676 mm)**][**76 inches (1930 mm)**][**78 inches (1981 mm)**][**88 inches (2235 mm)**][**100 inches (2540 mm)**][**102 inches (2591 mm)**][**124 inches (3150 mm)**][**126 inches (3200 mm)**].
    b. Platform Depth: [**72 inches (1829 mm)**][**84 inches (2134 mm)**][**96 inches (2438 mm)**][**120 inches (3048 mm)**][**144 inches (3658 mm)**][**168 inches (4267 mm)**].
    c. Ceiling Height: [**84 inches (2134 mm)**][**96 inches (2438 mm)**][**108 inches (2743 mm)**].
    d. Walls and Ceiling: [**Prime-painted or powder-coated steel**][**Prime-painted or powder-coated, metallic-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**][**Textured stainless steel**].
    e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
    f. Floor: [**Rolled steel floor plate**][**Aluminum-alloy rolled tread plate**][**Rolled stainless steel floor plate**].
    g. Car Gate Type: [**Vertical biparting**][**Single-speed vertical lift**][**Two-speed vertical lift**].
    h. Car Gate Operation: [**Manual**][**Power operated**].
    i. Car Gate Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel**].
    j. Car Sill: Steel angle.
    k. Lighting:

        1) [**One**][**Two**][**Three**] **48-inch (1219-mm)**, [**suspended,**][**surface-mounted,**] two-tube fluorescent light fixture(s) with [**white reflectors**][**and**][**wire lamp guards**].
        2) [**One**][**Two**] **48-inch (1219-mm)**, recessed, [**two**][**three**]-tube fluorescent light fixture(s) with UV-stabilized acrylic diffusers not less than **0.125 inch (3.2 mm)** thick.

    l. Light Fixture Efficiency: Not less than 35 lumens/W.
    m. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

11. Hoistway Entrances:

    a. Width: [**56 inches (1422 mm)**][**60 inches (1524 mm)**][**62 inches (1575 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**][**98 inches (2489 mm)**][**120 inches (3048 mm)**][**122 inches (3099 mm)**].
    b. Height: [**84 inches (2134 mm)**][**96 inches (2438 mm)**].
    c. Door Type: [**Vertical biparting**][**Single-speed vertical lift**][**Two-speed vertical lift**].
    d. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].
    e. Door Operation: [**Manual**][**Power operated with door reopening device**].
    f. Door Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**].

g. Door Frame Material: [**Prime-painted or powder-coated steel**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**].

12. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
13. Auxiliary Hall Stations: Provide additional pendant-mounted, hall push-button stations[**where indicated**] mounted at height to facilitate operation by forklift-truck operator without leaving truck.

2.4 SYSTEMS AND COMPONENTS

A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

1. Pump shall be [submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts][tank-top-mounted type with fan-cooled, squirrel-cage induction motor and shall be mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board].
2. Motor shall have [wye-delta][solid-state] starting.

B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.

C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.

1. Cylinder units shall be connected with dielectric couplings.
2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D1785, joined with PVC fittings complying with ASTM D2466 and solvent cement complying with ASTM D2564.

D. Hydraulic Fluid:

1. Elevator manufacturer's standard [**fire-resistant**]fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
2. Fluid: Nontoxic, biodegradable[fire-resistant] fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.
3. Product: Subject to compliance with requirements, provide "Hydro Safe" by Hydro Safe Oil Division, Inc.

E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

F. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than **1-inch (25-mm)** clearance from cylinder and extending above pit floor. Casing shall have method of monitoring effectiveness of complying with ASME A17.1/CSA B44.

G. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler shall be electrically nonconductive, displace or absorb water, and gel or solidify at temperatures below **60 deg F (16 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Hydro Safe Oil Division, Inc.**]
b. [**Union Gard; a division of Enduratech LLC**]

H. Car Frame and Platform: Welded[**or bolted**] steel units.

1. Provide special heavy-duty units for power truck loading, designed to withstand impacts and wheel loadings indicated.

I. Guides: [Roller guides][Polymer-coated, nonlubricated sliding guides][sliding guides with guide-rail lubricators]. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

B. Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

C. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power by a switch in control panel located at [**main lobby**][**fire command station**].

D. Group Standby Power Operation: On activation of standby power, cars, including passenger elevator cars specified in other sections, are returned one car at a time to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch in control panel located at [**main lobby**][**fire command station**].

E. Load-Weighing Device: When car load exceeds 80 percent of rated capacity, a signal light is lit in the car-control station; when car load exceeds rated capacity, car does not respond to car or hall calls.

F. Security Features: Security features shall not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at [**car-control stations**][**and**][**hall push-button stations**] to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. [**Allow space for card reader in car**][**Provide stripe-swipe card reader integral with each car-control station**].

a. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at [**car-control stations**][**and**][**hall push-button stations**]. Key is removable [**only in deactivated position**][**in either position**].

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams

shall cause doors to stop and reopen.

2.7 CAR ENCLOSURES

A. Provide car enclosures as indicated, including ventilation, lighting, finishes, access doors, thresholds, trim, and accessories. Fabricate with recesses and cutouts for signal equipment.

1. Provide power door operators with linkages for hoistway door operation.
2. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Fabrication: Provide manufacturer's standard, flush panel, welded construction made from metal sheet, of metal indicated, not less than **0.067 inch (1.7 mm)** and reinforced at **16-inch (406-mm)** maximum spacing.

1. Provide perforated panels for ceiling and for walls above **72 inches (1829 mm)** from car floor unless required to be solid by ASME A17.1/CSA B44.

2.8 HOISTWAY ENTRANCES

A. Unless otherwise indicated, provide hoistway entrance doors of type indicated below, with truckable sill bars and resilient safety meeting-rail gaskets.

1. Equip for power operation by coordinated linkage with power-operated car door.
2. Where gypsum board wall construction is indicated, provide fire-resistance-rated, hollow-metal, door-and-frame hoistway entrances. Provide self-supporting frames with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as-close-to-neutral pressure as possible according to [NFPA 252][UL 10B].

C. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:

1. Metal Door Panels: Constructed of metal sheets, flush on room side, welded and reinforced in steel framing with vertical reinforcing spaced not more than **24 inches (610 mm)** o.c. Fabricate panel faces from metal sheet, of metal indicated, not less than **0.097 inch (2.5 mm)** thick.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with LEDs or of acrylic or other permanent, nonyellowing translucent plastic.

B. Car-Control Stations: Provide manufacturer's standard car-control station. Mount adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Mount controls at heights complying with the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Emergency Communication System: Two-way voice communication system, with visible signal that dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Firefighters' Two-Way Telephone Communication Service: Provide [**flush-mounted cabinet**][**telephone jack**] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in [**Section 284621.11 "Addressable Fire-Alarm Systems."**][**Section 284621.13 "Conventional Fire-Alarm Systems."**]

E. Car Position Indicator: Provide illuminated digital-type car position indicator, located above car door or above car-control station.

F. Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.

1. Provide single-button stations with [**position**][**"in-use"**] indicator.
2. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in [**Section 284621.11 "Addressable Fire-Alarm Systems."**][**Section 284621.13 "Conventional Fire-Alarm Systems."**]

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, commercial steel, with **G60 (Z180)** zinc coating (galvanized) or **A60 (ZF180)** zinc-iron-alloy coating (galvannealed).

D. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

E. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.

F. Stainless Steel Bars: ASTM A276, Type 304.

G. Stainless Steel Tubing: ASTM A554, Grade MT 304.

H. Rolled Steel Floor Plate: ASTM A786/A786M.

I. Rolled Stainless Steel Floor Plate: ASTMA 793.

J. Aluminum-Alloy Rolled Tread Plate: ASTMB 632/B632M, Pattern 1, Alloy 6061-T6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Excavation for Cylinder: Drill well hole in[**each**] elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."

B. Provide[**waterproof**] well casing[**as necessary**] to retain well-hole walls.

C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole[**and provide permanent waterproof seal at bottom of well casing**].

1. Fill void space between protective casing and cylinder with corrosion-protective filler.
2. Align cylinders and fill space around protective casing with fine sand.

D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between [**well**][**protective**] casing and pit floor with **4 inches (100 mm)** of nonshrink, nonmetallic grout.

E. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.

F. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualifications standards.

G. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

H. Install piping above the floor, where possible. Install underground piping in casing.

1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."

I. Lubricate operating parts of systems as recommended by manufacturers.

J. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators, as directed by the Owner.

3.4 PROTECTION

A. Temporary Use: [**Limit temporary use for construction purposes to one elevator.**]Comply with the following requirements for[**each**] elevator used for construction purposes:

1. Provide protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
2. Do not load elevators beyond their rated weight capacity.
3. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation. Provide the same parts and supplies as those used in the manufacture and installation of original equipment.
4. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of[**each**] elevator with the Owner's personnel present and before date of Substantial Completion[**and not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 24 13 00

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Task	Specification	Specification Description
14 24 13 00	14 24 00 00	Hydraulic Elevators
14 24 23 00	14 24 00 00	Hydraulic Elevators

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SECTION 14 26 00 00 - LIMITED-USE_LIMITED-APPLICATION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Limited-use/limited-application elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by the Owner and assigned to Contractor.
2. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
3. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry.
4. Section 051200 "Structural Steel Framing" for attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
5. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
6. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair communications cable used for telephone service for elevators[**and for connection to elevator controllers for remote monitoring of elevator performance**].

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to Work of this Section.

B. LU/LA: Limited use/limited application.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal equipment.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
2. Indicate loads imposed on building structure at points of support and power requirements.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car finishes, hoistway doors, and frames; **3-inch- (75-mm-)** square Samples.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchoring provisions.
3. Detailed description of equipment anchoring devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service, as indicated and specified, are adequate for elevator being provided.

D. Preinstallation Examination Report: Indicating dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44[**including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel**].

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction, for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work relating to LU/LA elevators including sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 LIMITED-USE/LIMITED-APPLICATION ELEVATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Crescent Elevator Mfg., Corp.**]
2. [**Custom Elevator Manufacturing, Inc.**]
3. [**Federal Elevator**]
4. [**Liftavator, Inc**]
5. [**National Wheel-O-Vator**]
6. [**Nationwide Lifts, Inc.**]
7. [**Savaria**]
8. [**Schumacher Elevator Co**]

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for LU/LA elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] and comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Project Seismic Design Category: [**C**][**D**][**E**][**F**].

3. Elevator Component Importance Factor: [**1.5**][**1.0**].

2.3 SYSTEMS AND COMPONENTS

A. Elevator System, General: Manufacturer's standard LU/LA elevator. Unless otherwise indicated, manufacturers' standard components are to be used, as included in standard LU/LA elevators and as required for complete system.

1. Rated Load: [**1400 lb (635 kg)**].
2. Rated Speed: [**25 to 30 fpm (0.13 to 0.15 m/s)**].

B. Machine Type: Hydraulic, holeless, beside the car; direct-acting hydraulic or roped hydraulic.

C. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

1. Pump to be submersible type,[**with submersible squirrel-cage induction motor,**] suspended inside oil tank from vibration isolation mounts.
2. Motor to have [**solid-state starting**][**variable-voltage, variable-frequency motor control**].
3. System to have hydraulic silencer and flexible piping connectors at pump unit.

D. Hydraulic Fluid: Elevator manufacturer's standard [**fire-resistant**]fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.

E. Inserts: Furnish required concrete and masonry inserts and similar anchoring devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

2.4 OPERATION SYSTEMS

A. Provide manufacturer's standard[**microprocessor**] operation system for [**single**][**selective-collective**] automatic operation.

B. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put into service on standby power, either for return operation or for regular operation, by switches in control panel located at [**main lobby**]. Manual operation causes automatic operation to cease.

C. Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its car and hoistway doors, and shuts down. System includes rechargeable battery and automatic recharging system.

D. Provide automatic operation of lights and ventilation fans.

E. Emergency Operation: [**None required**][**Phase I emergency recall operation**][**Phase I emergency recall operation and Phase II emergency in-car operation**].

F. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitch. Key is removable [**only in deactivated position**][**in either position**].

G. Card-Reader Operation: System uses card reader to authorize calls. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access

system equipment, and elevator controllers. Allow space for card reader in car.

1. Security access system equipment is [**specified in Section 281500 "Access Control Hardware Devices."**][**not in the Contract.**]

2.5 DOOR REOPENING DEVICES

A. Infrared Array: Provide door-reopening devices with a uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

2.6 CAR ENCLOSURES

A. Provide steel-framed car enclosures with wall panels, car roof, access doors, power door operators, and ventilation. Provide finished car including materials and finishes specified below.

B. Clear Inside Dimensions:

1. Inside Width: [**36 inches (915 mm)**][**42 inches (1065 mm)**][**48 inches (1219 mm)**] from sidewall to sidewall.
2. Inside Depth: [**48 inches (1219 mm)**][**54 inches (1370 mm)**][**60 inches (1524 mm)**] from back wall to front wall (return panels).
3. Inside Height: [**84 inches (2134 mm)**] to underside of ceiling.

C. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Floor Finish:

   a. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from manufacturer's full range, as directed by the Owner.

2. Enameled or Powder-Coated Steel Wall Panels: Flush, formed-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
3. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet; [**polished, ASTM A480/A480M, No. 8**][**satin, ASTM A480/A480M, No. 4**] finish.
4. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard [**core**][**metal panels**] with[**plastic-laminate panel backing and**] manufacturer's standard protective edge trim. Panels to have a flame-spread index of [**25**][**75**] or less, when tested in accordance with ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
5. Sills: Extruded or machined aluminum, with grooved surface, **1/4 inch (6.4 mm)** thick.
6. Metal Ceiling: Flush panels, fabricated from cold-rolled steel sheet. Provide panels with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
7. Lighting: Not less than two downlights.[**Provide battery backup power source with automatic charging.**]

   a. Light Fixture Efficiency: Not less than 35 lumens/watt.

8. Handrail: [**1-1/2 inches (38 mm) round**][**1/2 by 2 inches (13 by 50 mm) rectangular**][**Manufacturer's standard**][**polished stainless steel**][**satin stainless steel**] [**on one side**][**on both sides**][**at rear**] of car.

D. Car Doors: Manufacturer's standard units complete with track systems, hardware, sills, and accessories.

1. Operation: [**Manual**][**Power-operated, automatic**].
2. Type: [**Horizontal sliding**][**Horizontally operated, folding**].
3. Clear Opening Width: [**32 inches (815 mm)**][**36 inches (915 mm)**].
4. Door Height: [**80 inches (2032 mm)**][**84 inches (2134 mm)**].
5. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
6. Primed-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, corrosion-resistant primer or powder-coating for field painting.
7. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet or by laminating stainless steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.[**Polished, ASTM A480/A480M, No. 8**][**Satin, ASTM A480/A480M, No. 4**] finish.
8. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.
9. Aluminum Folding Doors: Aluminum extrusions with edges forming full-height hinges connected by stainless steel rod.

2.7 HOISTWAY ENTRANCES

A. Provide manufacturer's standard door-and-frame hoistway entrances, same size as car doors, complete with track systems, hardware, sills, and accessories.

1. Operation: [**Manual**][**Power-operated, automatic**].
2. Type: [**Horizontal sliding**][**Side hinged**].

B. Coordinate frame size and profile with hoistway wall construction.

1. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
2. Primed-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied, corrosion-resistant primer or powder-coating for field painting.
3. Stainless Steel Frames: Formed from stainless steel sheet; [**polished, ASTM A480/A480M, No. 8**][**satin, ASTM A480/A480M, No. 4**] finish.
4. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range, as directed by the Owner.
5. Primed-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied, corrosion-resistant primer or powder-coating for field painting.
6. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet or by laminating stainless steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.[**Polished, ASTM A480/A480M, No. 8**][**Satin, ASTM A480/A480M, No. 4**] finish.
7. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic

laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim. Plastic-laminate color, texture, and pattern as selected by Architect from [**plastic-laminate**][**elevator**] manufacturer's full range, as directed by the Owner.

8. Sills: Extruded or machined aluminum, with grooved surface, **1/4 inch (6.4 mm)** thick.
9. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

D. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies to comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as-close-to-neutral pressure as possible according to [NFPA 252][UL 10B].

1. Fire-Protection Rating: [**1 hour**][**1-1/2 hours**][**with 30-minute temperature rise of 450 deg F (250 deg C)**].

2.8 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide[**vandal-resistant**] buttons and lighted elements illuminated with light-emitting diodes.

1. Finish: [**Polished stainless steel, ASTM A480/A480M, No. 8 finish**][**Satin stainless steel, ASTM A480/A480M, No. 4 finish**].

B. Car-Control Stations: Provide manufacturer's standard car-control stations. Mount in side panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Car Position Indicator: Provide digital-type position indicator in elevator car. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

E. Hall Push-Button Stations: Wall-mounted or jamb-mounted units equipped with buttons for calling elevator and for indicating desired direction of travel where applicable.

F. Hall Lanterns: Wall-mounted or jamb-mounted units with illuminated arrows; but provide single arrow at terminal landings.

G. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on car.

H. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.9 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Stainless Steel Bars: ASTM A276/A276M, Type 304.

E. Stainless Steel Tubing: ASTM A554, Grade MT 304.

F. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063.

G. Plastic Laminate: High-pressure type complying with ISO 4586-3, [**Type HGS for flat applications**][**Type HGL for flat applications**][**and**][**Type BKV for panel backing**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LIMITED-USE/LIMITED-APPLICATION ELEVATORS

A. Install cylinder plumb and accurately located for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.

B. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise from elevator system.

C. Lubricate operating parts of systems as recommended by manufacturers.

D. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Reduce clearances to minimum, safe, workable dimension at each landing.

E. Leveling Tolerance: **1/4 inch (6 mm)**, up or down, regardless of load and direction of travel.

F. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

G. Locate hall lanterns either above or beside hoistway entrance at a minimum of **72 inches (1829 mm)** above finished floor unless hall lanterns are built into entrance frames.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use, perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by authorities having jurisdiction.

B. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed, as directed by the Owner.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] elevator(s).

B. Check operation of elevator with the Owner's personnel present before date of Substantial Completion[**and again not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 26 00 00

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SECTION 14 30 00 00 - ESCALATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Escalators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Section 051200 "Structural Steel Framing" for attachment plates, angle brackets, and other structural-steel preparations for supporting escalator trusses.
3. Section 083113 "Access Doors and Frames" for wall and ceiling access panels and access doors in escalator enclosures.
4. Section 101423 "Panel Signage" for "Caution" signs required by ASME A17.1/CSA B44.
5. [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single- and Multiple-Station Alarms"**] for smoke detectors that activate escalator alarm and, after at least 15 seconds, cause the interruption of power to the escalator motor and brake and for connection of alarm system to escalator controllers.

1.2 DEFINITIONS

A. High-Traffic Escalators: Escalators designed specifically for high-traffic-volume use that produces dense occupancy, resulting in structural, machinery, and brake loads much higher than normal.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, safety features, finishes, and similar information.

B. Shop Drawings:

1. Include plans, elevations, sections, and details indicating coordination with building structure and relationships with other construction.
2. Indicate maximum loads imposed on building structure at points of support and power requirements.
3. Indicate access and ventilation for escalator machine space.

C. Samples for Initial Selection: For exposed materials involving color selection.

D. Samples for Verification: For exposed escalator finishes, **3-inch- (75-mm-)** square Samples of sheet materials and **4-inch (100-mm)** lengths of running trim members.

E. Delegated Design Submittals: For escalators.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For escalator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by manufacturer, certifying that escalator layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for escalator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For escalators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted escalator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal, from Installer to the Owner, in the form of a standard [**one-year**][**two-year**][**five-year**] maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Escalator manufacturer[**or an authorized representative who is trained and approved by manufacturer**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, escalator equipment with integral anchors, and other items that are embedded in concrete or masonry for escalator equipment. Furnish templates, sleeves, escalator equipment with integral anchors, and installation instructions; deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work relating to escalators, including sumps and floor drains in pits; electrical outlets, lights, and switches in pits; and electrical service.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace escalator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design escalators.

C. Drive System Energy Performance: Provide regenerative drive system and motor that complies with requirements of the International Green Construction Code (IgCC).

D. Step/Skirt Performance Index: Not more than 0.15.

E. Seismic Performance: Escalators shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Project's Seismic Design Category: [**A**][**B**][**C**][**D**][**E**][**F**].
2. Escalator Component Importance Factor: 1.0.

F. Structural and Mechanical Performance for High-Traffic Escalators: For the purposes of structural design and driving machine, power transmission, and brake calculations, design high-traffic escalators for loads of not less than [**two**] times the design loads required by ASME A17.1/CSA B44.

G. Structural Performance of Balustrades, Deck Barricades, and Handrails: Provide components and assemblies capable of withstanding the effects of loads indicated in ASCE/SEI 7 for handrail assemblies and guardrail systems.

2.2 ESCALATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fujitec America, Inc**]
2. [**KONE Inc**]
3. [**Mitsubishi Electric US, Inc.**]
4. [**Otis Worldwide Corporation**]
5. [**Schindler Elevator Corp**]
6. [**ThyssenKrupp Elevator**]

B. Source Limitations: Obtain escalators [and elevators][and moving walks][elevators, and moving walks] from single manufacturer.

C. Escalators, General: Manufacturer's standard escalators complying with requirements. Unless otherwise indicated, manufacturer's standard components shall be used as included in standard escalator systems and as required for complete system.

D. High-Traffic Escalators, General: Manufacturer's high-traffic escalators complying with requirements. Unless otherwise indicated, manufacturer's heavy-duty components shall be used as included in standard high-traffic escalator systems and as required for complete system.

E. Design and equip escalators to run in either direction.

F. Provide escalators with [**two**][**three**][**four**] flat steps at top and bottom landings.

G. Rated Speed: [90 fpm (0.46 m/s)][100 fpm (0.5 m/s)].

2.3 MATERIALS

A. Stainless Steel: ASTM A240/A240M, [**Type 304**][**Type 316**][**Type 304, except use Type 316 for exterior escalators**].

1. Satin Finish: No. 4 directional satin.
2. Polished Finish: No. 8 mirror polish.
3. Gold-Colored Satin Finish: No. 4 directional satin with gold-colored oxide or titanium nitride finish.
4. Gold-Colored Mirror Finish: No. 8 mirror polish with gold-colored oxide or titanium nitride finish.

B. Satin Bronze Sheet: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal), fine satin finish, lacquered.

C. Satin Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (architectural bronze), fine satin finish, lacquered.

D. Steel Sheet: Cold-rolled steel sheet, ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

E. Clear Tempered Glass: ASTM C1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**][**12.0**] mm thick.

F. Tinted Tempered Glass: ASTM C1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 2 (tinted), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**][**12.0**] mm thick.

1. Color: [**Bronze**][**Gray**][**Green**].

2.4 COMPONENTS

A. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim, to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

B. Opaque Balustrades: Manufacturer's standard profile or arrangement of moving handrails on fully paneled guide rail, with interior balustrade panels, deck covers, skirts, trim, and accessories.[**Prepare for exterior finish (specified in another Section) below the deck covers.**]

C. Transparent Balustrades: Manufacturer's standard profile or arrangement of moving handrails on guide rail that is supported by tempered glass panels, with deck covers, skirts, trim, and accessories.[**Prepare for exterior finish (specified in another Section) below the deck covers.**]

D. Direction Indicator Lights: Provide red and green indicator lights at least **2 inches (50 mm)** in diameter in [**right-hand**][**both**] balustrade newels at both upper and lower landings. Green light indicates entrance end, and red light indicates exit end. When escalator is stopped, red lights are illuminated at both ends.

E. Guards at Ceiling Intersection: Clear plastic.

F. Handrails: Smooth, jointless, reinforced neoprene.

1. Color: [**Black**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Deck Covers and Trim: [**Satin stainless steel**][**Polished stainless steel**][**Gold-colored, satin stainless steel**][**Gold-colored, polished stainless steel**][**Satin bronze**].

H. Antislide Devices: [**Satin stainless steel**][**Polished stainless steel**][**Gold-colored, satin stainless steel**][**Gold-colored, polished stainless steel**][**Satin bronze**].

I. Balustrade Interior Panels: [**Satin stainless steel**][**Polished stainless steel**][**Gold-colored, satin stainless steel**][**Gold-colored, polished stainless steel**][**Satin bronze**].

J. Balustrade Exterior Panels and Escalator Soffits: [**Satin stainless steel**][**Polished stainless steel**][**Gold-colored, satin stainless steel**][**Gold-colored, polished stainless steel**][**Satin bronze**].

K. Skirt Panels, if Applicable: [**Satin stainless steel**][**Polished stainless steel**][**Satin stainless steel with exposed surface coated with clear PTFE**][**Steel panels with exposed surface coated with PTFE**][**Manufacturer's standard low-friction material**].

L. Skirt Deflector Devices: Manufacturer's standard brush-type device.

M. Steps: One piece made of die-cast aluminum with demarcation grooves at front and rear of tread surface.

1. Finish: Powder-coated [**gray**][**black**].
2. Step Demarcation: Yellow stripe at sides and backs of step treads.
3. Nosing Demarcation: **2-inch- (50-mm-)** wide yellow stripe at nosings of step treads.

N. Combs: [**Integrally colored structural plastic**][**Cast aluminum**][**Cast aluminum with powder-coated finish**].

1. Comb Color: [**Yellow**][**Black**][**Gray**][**Red**].

O. Combplate Lights: Provide recessed light fixtures with flush lenses mounted in skirt panels at each side of combplates to illuminate combplate steps.

P. Floor Plates: [**Cast or extruded aluminum**][**Stainless steel**] with grooved or patterned surface[**and with abrasive material embedded in or metallically bonded to floor-plate surface**].

2.5 FEATURES

A. Operational Control: Provide key-operated starter switches[**and key-operated switches for directional control**] located on exterior deck above newel base at both upper and lower landings of escalators.

B. Fault Indicator: Provide escalators with a microprocessor unit that monitors safety devices, motor temperature, and escalator speed and records in nonvolatile memory the date, time, and device identification if a safety device is activated or escalator malfunctions.

1. Provide built-in[**or plug-in**] unit to display recorded information.

C. Reduced-Current Starting: Provide escalator motors with wye-delta or solid-state starting.

D. Energy-Saving Feature: Provide escalator motors and controls designed for motors running on partial windings (at reduced power) when not under full load.

E. Standby Speed Feature: Provide variable-speed controls that comply with ASME A17.1/CSA B44 and the following:

1. Controls decelerate the escalator to a speed of no more than **20 fpm (0.10 m/s)** after the escalator is unoccupied and no passengers are approaching escalator for a predetermined time interval.
2. Controls detect approaching passengers and accelerate the escalator to rated speed by the time passengers reach the combplate.

F. Provide motors complying with NEMA MG 1, Insulation Class B.

G. Brake-Saving Feature: Provide stopping mechanism that allows escalator to coast to a stop before applying brakes unless stopping is initiated by a safety device.

H. Equip step drive mechanism with automatic step-chain lubricators.

I. Oil Drip Pan: Provide metal pan under full width and length of escalator to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of **250 lbf (1.1 kN)** on a **1.0-sq. ft. (0.9-sq. m)** area at any location without permanent deflection.

J. Upper-Landing, Step Upthrust Device: Activated if a step is displaced against upthrust track at upper curve in passenger-carrying line of track system.

K. Comb-Step Impact Device:

1. Activated if a horizontal force in direction of travel is applied exceeding **400 lbf (1780 N)** at either side or **800 lbf (3560 N)** at center of front edge of combplate, or a resultant force in upward direction is applied exceeding **150 lbf (670 N)** at center of front edge of combplate.

2. Activated if a horizontal force in direction of travel is applied exceeding **112 lbf (500 N)** at either side or **225 lbf (1000 N)** at center of front edge of combplate, or a resultant force in upward direction is applied exceeding **150 lbf (670 N)** at center of front edge of combplate.

2.6 EXTERIOR ESCALATORS

A. Fabricate exposed components from [**stainless steel**][**bronze**] unless otherwise indicated.

B. Hot-dip galvanize escalator trusses and other structural components to comply with ASTM A123/A123M. Use only stainless-steel or zinc-plated fasteners.

C. Fabricate oil drip pan from galvanized-steel sheet. Provide drain and oil/water separator in oil drip pan.

D. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.

E. Provide enclosures complying with NEMA 250, Type 4 for electrical connections, switches, and equipment.

F. Provide totally enclosed motors complying with NEMA MG 1, Insulation Class B.

G. Equip step drive mechanism with automatic step-chain lubricators.

H. Provide electric heaters with integral thermostats in escalator truss space to maintain temperature above **40 deg F (4.4 deg C)**.

I. Equip combplates with 400-W electric heaters to prevent ice and snow accumulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine escalator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine supporting structure, machine spaces, and pits; verify critical dimensions; and examine conditions under which escalators are to be installed.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ESCALATORS

A. Comply with manufacturer's written instructions.

B. Set escalators true to line and level, properly support, and anchor to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.

C. Adjust installed components for smooth, efficient operation, complying with required tolerances and ensuring they are free of hazardous conditions. Lubricate operating parts, including bearings, tracks,

chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices.[**Install oil drip pans and verify that no oil drips outside of pans.**]

D. Repair damaged finishes so no evidence remains of correction work. Return items to the shop that cannot be refinished in the field, make required repairs, and refinish entire unit, or provide new units as required.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of escalator installation and before permitting escalator use, perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by authorities having jurisdiction.

1. For escalators specified to comply with requirements more stringent than those of ASME A17.1/CSA B44, perform tests for compliance with specified requirements. Test safety devices that are not required by ASME A17.1/CSA B44 as well as those that are.

B. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed, as directed by the Owner.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate[adjust, and maintain] escalators.

B. Check operation of escalators with the Owner's personnel present before date of Substantial Completion[**and not more than one month before end of warranty period**]. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 30 00 00

Task	Specification	Specification Description
14 31 00 00	14 30 00 00	Escalators

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SECTION 14 41 19 00 - STAIRWAY CHAIRLIFTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Inclined stairway chairlifts.

B. Related Requirements:

1. Section 144200 "Wheelchair Lifts" for inclined platform lifts that transport persons in wheelchairs along a stairway.

1.2 DEFINITIONS

A. Definitions in ASME A18.1 apply to Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts.
2. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.

B. Shop Drawings: For each lift.

1. Include plans, elevations, sections, attachment details, and required clearances.
2. Indicate dimensions, weights, loads, and points of load to building structure.
3. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For surfaces and components with factory-applied color finishes.

1. Include Samples of integrally colored materials and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:

1. Metal Finish: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
2. Tubular Products and Running Trim: Manufacturer's standard-size unit, **6 inches (150 mm)** long.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of lift.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lift to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Parts list with sources indicated.
b. Recommended parts inventory list.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one**][**two**][**five**]-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Three**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standard: Comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."

2.2 INCLINED STAIRWAY CHAIRLIFT

A. Inclined Stairway Chairlifts: Preengineered, inclined, stairway lift system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Acorn Stairlifts Inc.**]
b. [**Bruno Independent Living Aids, Inc.**]
c. [**Garaventa Lift**]
d. [**Harmar**]
e. [**Savaria**]

B. Rated Capacity: Minimum [**250 lb (115 kg)**][**400 lb (180 kg)**].

C. Rated Speed: [**20 fpm (0.10 m/s)**].

D. Electrical Characteristics:

1. Horsepower: [**1/4**][**1/3**][**1/2**][**3/4**].
2. AC Voltage: [**115 V ac**][**208 V ac**][**230 V ac**], single phase, 60 Hz.
3. DC Voltage: [**24 V dc battery with 115 V ac, 60-Hz, single-phase charger**].

E. Emergency Operation:

1. Battery Operation: Provide battery-operated drive with automatic charging system.
2. Manual Lowering: Provide means to manually lower units in case of malfunction or power loss.

F. Folding Units: When not in use, units are to be capable of manually folding up against wall to minimize projection into stairway.

G. Support to Structure: Provide brackets to support vertical loads from floor or stair treads and to support lateral loads from walls. Fabricate brackets from steel plates, shapes, or bars.

H. Accessories: Provide units with the following accessories:

1. Tubular-steel, manually operated safety arms designed to restrain and provide grab bar for occupant.
2. Retractable seatbelt.
3. Seat with back and two handgrips or arms.

2.3 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STAIRWAY CHAIRLIFTS

A. General: Comply with ASME A18.1 and manufacturer's written instructions for installation of lifts unless otherwise indicated.

B. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and route conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

C. Adjust stops for accurate stopping at each landing.

D. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.

E. Test safety devices and verify smoothness of required protective enclosures and other surfaces.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.

B. Operating Test: In addition to acceptance testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.

C. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on lifts, as directed by the Owner.

3.4 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service will include [**three**][**12**] months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

B. Check operation of lifts with the Owner's personnel present and before date of Substantial Completion. Determine that operating systems and devices are functioning properly.

C. Check operation of lifts with the Owner's personnel present not more than one month before end of

warranty period. Determine that operating systems and devices are functioning properly.

END OF SECTION 14 41 19 00

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Task	Specification	Specification Description
14 41 19 00	14 42 00 00	Wheelchair Lifts

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SECTION 14 42 00 00 - WHEELCHAIR LIFTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. [**Vertical**][**Private-residence, vertical**] platform lifts.
2. Courtroom vertical platform lifts.
3. [**Inclined**][**Private-residence, inclined**] platform lifts.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry.
3. Section 064400 "Ornamental Woodwork" for runway-enclosure walls and doors.
4. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] for runway-enclosure door hardware including monitored, electric door strikes if not included in lift work.
5. Section 099113 "Exterior Painting" for field painting of lift equipment.
6. Section 099123 "Interior Painting" for field painting of lift equipment.

1.2 DEFINITIONS

A. Definitions in ASME A18.1 apply to Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts.
2. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
6. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For each lift.

1. Include plans, elevations, sections, attachment details, and required clearances.
2. Indicate dimensions, weights, loads, and points of load to building structure.
3. Include details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For surfaces and components with factory-applied color finishes.

1. Include Samples of integrally colored materials and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:

1. Metal Finish: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
2. Wood Finish: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
3. Fiberglass Finish: Manufacturer's standard-size unit, not less than **3 inches (75 mm)** square.
4. Tubular Products and Running Trim: Manufacturer's standard-size unit, **6 inches (150 mm)** long.
5. Glass and Glazing: Units **12 inches (300 mm)** square.
6. Hardware: Manufacturer's standard, exposed, door-operating device.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**][**vendor**][**and**] Installer.

B. Product Certificates: For each type of lift.

1. Include statement that runway, ramp or pit, dimensions as shown on Drawings, and electrical service as shown and specified are adequate for lift being provided.

C. Evaluation Reports: For [**post-installed anchors**][**and**][**power-actuated fasteners**], from ICC-ES.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lift to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Parts list with sources indicated.
b. Recommended parts inventory list.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to the Owner, in the form of a standard [**one**][**two**][**five**]-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement

period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Three**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

B. Regulatory Requirements: Comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."

C. Fire-Rated, Runway-Enclosure Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to [NFPA 252][UL 10B].

1. Temperature-Rise Limit: Provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.

2.2 VERTICAL PLATFORM LIFT

A. Vertical Platform Lifts: Preengineered lift system[private residence].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ascension, Division of AGM Container Controls, Inc.**]
b. [**Bruno Independent Living Aids, Inc.**]
c. [**Butler Mobility Products**]
d. [**Florlift of New Jersey, Inc.**]
e. [**Garaventa Lift**]
f. [**Inclinator Company of America, Inc.**]
g. [**Lift-U**]
h. [**Liftavator, Inc**]
i. [**Savaria**]

B. Number of Stops: [**As indicated on Drawings**][**Two**][**Three**].

C. Platform Size: [**34 by 54 inches (864 by 1372 mm)**][**35 by 48 inches (889 by 1220 mm)**][**35 by 51 inches (889 by 1295 mm)**][**36 by 56 inches (914 by 1422 mm)**][**36 by 60 inches (914 by 1524 mm)**].

D. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; [**end door with minimum 32-inch (815-mm)**][**and**][**side door with minimum 42-inch (1065-mm)**] clear opening width.

E. Rated Speed: [**8 fpm (0.04 m/s)**][**10 fpm (0.05 m/s)**][**17 fpm (0.09 m/s)**][**20 fpm (0.10 m/s)**][**30 fpm (0.15 m/s)**].

F. Power Supply: [**Electric**][**Hydraulic**].

1. Electrical Characteristics:

a. Horsepower: [**1/2**][**1**][**2**][**3**].
b. Single-Phase AC Voltage: [**115-V ac**][**230-V ac**], single phase, 60 Hz.
c. Three-Phase AC Voltage: [**208-V ac**], three phase, 60 Hz.
d. DC Voltage: [**24-V dc battery with 115-V ac, 60-Hz, single-phase charger**].

G. Emergency Operation: Provide [**manual operation**][**and**][**battery power system**][**connection to indicated standby (emergency) power**] to raise or lower unit to a landing in case of malfunction or power loss.

H. Attendant Operation: Provide attendant call device at each landing[**at locations shown**].

I. Self-Supporting Unit: Support vertical loads of unit only at base, with lateral support only at landing levels.

J. [**Partial**]Runway Enclosure: Manufacturer's standard[**weather-resistant**] enclosure assembly.

1. Runway Enclosure:

a. Rectangular[hot-dip-galvanized, steel][steel]-tube frame with flush [galvanized-steel-

sheet][steel-sheet] panels.
b. Extruded-aluminum frame with flush [**galvanized-steel**][**aluminum**]-sheet panels.
c. Rectangular steel-tube frame with wood panels and trim.
d. Rectangular wood frame with wood panels and trim.
e. Rectangular steel-tube frame with fiberglass panels.

2. Glazed Runway Enclosure: Rectangular, glazed extruded-aluminum frame with an acrylic dome roof.

a. Acrylic Glazing: 6.0 mm thick; [**clear**][**bronze tinted**][**color matching Architect's sample**][**color as selected by Architect from manufacturer's full range**], as directed by the Owner.
b. Glass Glazing: [**Float**][**tempered safety**][**and**][**laminated safety**] glass, 6.0 mm thick; [**clear**][**bronze tinted**][**color matching Architect's sample**][**color as selected by Architect from manufacturer's full range**], as directed by the Owner.

3. Runway-Enclosure Doors:

a. Rectangular steel-tube frame with flush steel-sheet panels.
b. Rectangular wood frame with wood panels and trim.
c. Rectangular steel-tube frame with fiberglass panels.
d. Rectangular steel-tube frame glazed with 6.0-mm-thick, [**clear**][**bronze-tinted**] acrylic glazing and with **12-inch- (300-mm-)** high, steel kick panels.
e. Wide-stile aluminum entrance doors glazed with [**clear**][**bronze-tinted**] tempered safety glass, 6.0 mm thick.
f. Enclosure doors matching appearance of adjacent [**glass-supported**] railings, complying with Section 057300 "Decorative Metal Railings."

4. Fire-Rated, Runway-Enclosure Door: Provide [**where shown**][**at upper landing**][**at lower landing**].

a. Fire-Protection Rating: 1-1/2 hours.
b. Equip door with wired glass vision panel, delay-action door closer, dead latch, dummy trim door handle, and electric strike.

K. Platform:

1. Steel sheet or galvanized-steel sheet with [**matte or primed finish suitable to accept flooring**][**manufacturer's standard black rubber flooring**].
2. Stainless-steel floor plate with [**checkered**] texture.
3. Aluminum floor plate with [**nonskid**][**diamond-pattern**] surface texture.

L. Platform Low-Profile Carriage: Fabricate platform floor assembly to a total thickness not exceeding **1-1/2 inches (38 mm)**.

M. Platform Enclosure and Door:

1. Rectangular[hot-dip-galvanized,] steel-tube frame with flush [galvanized-]steel-sheet panels.
2. Extruded-aluminum frame with flush [**galvanized-steel**][**aluminum**]-sheet panels.
3. Rectangular steel-tube frame with wood panels and trim.
4. Rectangular steel-tube frame with fiberglass panels.

N. Platform Top: Provide a non-load-bearing top, matching construction of enclosure walls. Permanently mark top to indicate that it cannot sustain a load.

O. Ramp: [**Fixed ramp matching platform to provide transition from floor to lift platform at bottom**

landing][**Retractable ramp matching platform to provide transition from lower floor to lift platform. Ramp lowers to floor automatically when lifts reach lower landing and door opens. Ramp rises automatically when lift control is activated for lift to leave lower landing**].

1. Ramp Size: [**End ramps a minimum of 32 inches (815 mm)**][**and**][**side ramps a minimum of 42 inches (1065 mm)**] wide; length as required for slope.
2. Ramp Slope: [**As indicated**][**Maximum 1:12**].
3. Ramp Finish: [**Finish ramps to match lift platform**][**As indicated on Drawings**].

P. Accessories: Provide units with the following accessories:

1. Fold-down seat with seatbelt.
2. Forced Ventilation System: Minimum one air change per minute, [**continuously operating**][**thermostatically controlled to activate at 90 deg F (32.2 deg C)**], and with auxiliary power source to operate ventilation for one hour in case of power failure.
3. Lighting system within lift enclosures as [**indicated on Drawings**][**selected by Architect from manufacturer's available products**], as directed by the Owner.

2.3 COURTROOM VERTICAL PLATFORM LIFT

A. Courtroom Vertical Platform Lift: Preengineered lift system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Lift-U**]

B. Number of Stops: [**As indicated on Drawings**][**Two**][**Three**].

C. Platform Size: [**36 by 48 inches (914 by 1220 mm)**][**36 by 51 inches (914 by 1295 mm)**][**60 by 60 inches (1524 by 1524 mm)**].

D. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; [**end door with minimum 32-inch (815-mm)**][**and**][**side door with minimum 42-inch (1065-mm)**] clear opening width.

E. Rated Speed: [**8 fpm (0.04 m/s)**][**10 fpm (0.05 m/s)**].

F. Electrical Characteristics:

1. Horsepower: [**1/2**][**1**][**2**].
2. Voltage: [**115-V ac**], single phase, 60 Hz.

G. Emergency Operation: Provide [**manual operation**][**and**][**battery power system**][**connection to indicated standby (emergency) power**] to raise or lower unit to a landing in case of malfunction or power loss.

H. Attendant Operation: Provide attendant call device at each landing[**at locations shown**].

I. Self-Supporting Unit: Support vertical loads of unit only at base, with lateral support only at landing levels.

J. Platform: Steel sheet or galvanized-steel sheet with [**matte or primed finish suitable to accept flooring**][**manufacturer's standard black rubber flooring**].

K. Sidewalls, Doors, and Guards: Platform-mounted sidewalls and platform-mounted guards according to ASME A18.1 and as follows:

1. Sidewalls:
2. Rectangular steel-tube frame with flush steel-sheet panels.
3. Rectangular wood frame with wood panels and trim.
4. Rectangular steel-tube frame with fiberglass panels.

L. Ramp: [**Fixed ramp matching platform to provide transition from floor to lift platform at bottom landing**][**Retractable ramp matching platform to provide transition from lower floor to lift platform. Ramp lowers to floor automatically when lifts reach lower landing and door opens. Ramp rises automatically when lift control is activated for lift to leave lower landing**].

1. Ramp Size: [**End ramps a minimum of 32 inches (815 mm)**][**and**][**side ramps a minimum of 42 inches (1065 mm)**] wide; length as required for slope.
2. Ramp Slope: [**As indicated**][**Maximum 1:12**].
3. Ramp Finish: [**Finish ramps to match lift platform**][**As indicated on Drawings**].

2.4 INCLINED PLATFORM LIFT

A. Inclined Platform Lift: Preengineered lift system[private residence].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Butler Mobility Products**]
b. [**Garaventa Lift**]
c. [**Savaria**]

B. Number of Stops: [**As indicated on Drawings**][**Two**][**Three**].

C. Platform Size: [**29 by 33 inches (737 by 838 mm)**][**28 by 35 inches (711 by 889 mm)**][**30 by 35 inches (760 by 889 mm)**][**30 by 36 inches (760 by 914 mm)**][**31 by 39 inches (787 by 991 mm)**][**30 by 41 inches (760 by 1041 mm)**][**30 by 42 inches (760 by 1067 mm)**][**31 by 43 inches (787 by 1092 mm)**][**30 by 48 inches (760 by 1220 mm)**].

D. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; [**end door with minimum 32-inch (815-mm)**][**and**][**side door with minimum 42-inch (1065-mm)**] clear opening width.

E. Rated Speed: [**12 fpm (0.06 m/s)**][**15 fpm (0.08 m/s)**][**20 fpm (0.10 m/s)**][**30 fpm (0.15 m/s)**].

F. Electrical Characteristics:

1. Horsepower: [**3/4**][**1**][**2**][**3**].
2. AC Voltage: [**115-V ac**][**208-V ac**][**230-V ac**], single phase, 60 Hz.
3. DC Voltage: [**24-V dc battery with 115-V ac, 60-Hz, single-phase charger**].

G. Emergency Operation: Provide [**manual operation**][**and**][**battery power system**][**connection to indicated standby (emergency) power**] to raise or lower units to a landing in case of malfunction or

power loss.

H. Attendant Operation: Provide attendant call device at each landing[**at locations shown**].

I. Platform:

1. Steel sheet or galvanized-steel sheet with [**matte or primed finish suitable to accept flooring**][**manufacturer's standard black rubber flooring**].
2. Stainless-steel floor plate with [**checkered**] texture.
3. Aluminum floor plate with nonskid surface texture.

J. Automatic Folding Platforms: When not in use, platforms shall automatically fold up against wall to minimize projection into stairway.

K. Manual Folding Platforms: When not in use, platforms shall be capable of manually folding up against wall to minimize projection into stairway.

L. Platform Guarding: Guard platform with [**passenger-restraining arms**][**enclosure**].

1. Passenger-Restraining Arms: [**Steel**][**Galvanized-steel**][**Stainless-steel**] tubing, [**manually**][**power**] operated.
2. Platform Enclosure (Side Walls and Self-Closing Door):

a. Rectangular steel-tube frame with flush steel-sheet panels.
b. Enclosure walls and doors matching appearance of adjacent [**glass-supported**] railings, complying with Section 057300 "Decorative Metal Railings."

M. Platform Guarding for Private Residences: Guard platform with [**automatically**][**manually**] actuated, retractable metal guard on lower access end of platform.

N. Ramp: [**Fixed ramp matching platform to provide transition from floor to lift platform at bottom landing**][**Retractable ramp matching platform to provide transition from floor to lift platform. Ramp lowers to floor automatically when lifts reach landing and enclosure door opens. Ramp rises automatically when lift control is activated for lift to leave landing**].

1. Ramp Size: [**End ramps a minimum of 32 inches (815 mm)**][**and**][**side ramps a minimum of 42 inches (1065 mm)**] wide; length as required for slope.
2. Ramp Slope: [**As indicated**][**Maximum 1:12**].
3. Ramp Finish: [**Finish ramps to match lift platform**][**As indicated on Drawings**].

O. Support to Structure: Provide framing and brackets to support vertical loads from floor or stair treads and only lateral loads from walls. Fabricate framing and brackets from [**steel**][**stainless-steel**] rectangular tubing, plates, shapes, and bars.

P. Guide Rails: Fabricate from [steel][stainless-steel] tubing.

Q. Accessories: Provide units with the following accessories:

1. Fold-down seat with seatbelt.
2. Caution sign as required by ASME A18.1.

2.5 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Tubing: ASTM A500/A500M.

C. Steel Pipe: ASTM A53/A53M; standard weight (Schedule 40) unless otherwise indicated or required by loads.

D. Steel Sheet: ASTM A1008/A1008M, cold-rolled commercial steel (CS) or ASTM A1011/A1011M hot-rolled, commercial steel (CS); as required for each use.

E. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** zinc coating.

F. Galvanizing: Hot-dip galvanize items complying with the following:

1. ASTM A123/A123M, for galvanizing steel and iron products.
2. ASTM A153/A153M, for galvanizing steel and iron hardware.

G. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; manufacturer's standard strengths and thicknesses for type of use.

1. Extruded Aluminum: **ASTM B221 (ASTM B221M)**.
2. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**.

H. Stainless-Steel Bars and Shapes: ASTM A276/A276M, Type 304.

I. Stainless-Steel Tubing: ASTM A554, Grade MT-304.

J. Stainless-Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.

K. Stainless-Steel Floor Plate: ASTM A793.

L. Wood and Wood Panel Products Specified in Other Section: Comply with requirements in Section 064400 "Ornamental Woodwork."

M. Wood and Wood Panel Products:

1. Wood: Clear, vertical-grain, straight, kiln-dried wood; of [**manufacturer's standard species.**][**one of the following species:**][**the following species:**]

   a. [**Red oak**].

2. Fire-Retardant-Treated Wood: Clear, vertical-grain, straight, kiln-dried wood; fire-retardant treated to have flame-spread index of [**75**][**25**] or less and smoke-developed index of 450 or less according to ASTM E84; of [**manufacturer's standard species.**][**one of the following species:**][**the following species:**]

   a. [**Red oak**].

3. Composite Wood Products: Products shall be made without urea formaldehyde.
4. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins

as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

6. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

7. Composite Wood Products: Products shall be made without urea formaldehyde.
8. Wood Panels: Provide wood panels consisting of wood veneer and wood panel as follows:

    a. Wood Veneer: Laminated to core with moisture-resistant adhesive.

        1) Species: [**Red oak**].
        2) Cut: [**Plain sawn**].

    b. Particleboard: ANSI A208.1.
    c. Medium-Density Fiberboard: ANSI A208.2.
    d. Plywood: DOC PS 1.

9. Fire-Retardant-Treated Wood Panels: Fire-retardant-treated, wood-veneered panels having flame-spread index of [**75**][**25**] or less and smoke-developed index of 450 or less according to ASTM E84.

    a. Wood Veneer: Laminated to core with moisture-resistant adhesive.

        1) Species: [**Red oak**].
        2) Cut: [**Plain sawn**].

    b. Particleboard: ANSI A208.1.
    c. Medium-Density Fiberboard: ANSI A208.2.
    d. Plywood: DOC PS 1.

N. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light-stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and manufacturer's standard finish.

O. Glass Specified in Other Section: Comply with requirements in Section 088000 "Glazing."

P. Glass: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**] and complying with ASME A18.1, as directed by the Owner.

1. Safety Glass Products: Glass tested according to laminated-glass requirements of 16 CFR 1201, Category II, or ANSI Z97.1, Class A.
2. Safety Glass Marking: Glass permanently marked with certification label of [SGCC or another certification agency][manufacturer] acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, safety glazing standard with which glass complies, and be located so as to be visible after installation.

Q. Acrylic Glazing: ASTM D4802, Category A-1 (cell-cast) or Category A-2 (continuous cast), Finish 1 (smooth or polished), clear or tinted as indicated.

R. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing structural members, guide rails, machines, and other lift components where installation of devices is specified in another Section.

S. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FASTENERS

A. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on [ICC-ES AC01][ICC-ES AC193][ICC-ES AC58][ICC-ES AC308] as appropriate for the substrate.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: [**Alloy Group 1 (A1)**][**Alloy Group 2 (A4)**] stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

B. Power-Actuated Fasteners: [**Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70**][**Do not use power-actuated fasteners**].

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 FINISHES

A. [**Steel**][**and**][**Galvanized-Steel**] Factory Finish:

1. Baked-Enamel or Powder-Coat Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat.
2. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

B. Stainless-Steel Finishes:

1. Floor Plate Finish: [**Mill**][**Abrasive blasted**].
2. Grab Rail Finish: [**As selected by Architect from manufacturer's full range**][**Directional satin finish No. 4**], as directed by the Owner.

C. Aluminum Finishes:

1. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

2. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

   a. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
   b. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

   a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Wood Finish Specified in Other Section: [**As specified in Section 099300 "Staining and Transparent Finishing."**]

E. Wood Finish: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as follows:, as directed by the Owner

   1. Type: [**Transparent finish**][**Transparent finish over stain**] over wood variety indicated.

F. Fiberglass Color and Gloss: [**As indicated by manufacturer's designations**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance of the Work.

B. Minimum Headroom Clearance, ADA: Verify that installed lift will have a minimum headroom of **80 inches (2032 mm)** above any point on platform floor at any point of travel.

C. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom of [**79 inches (2000 mm) at any point during travel**][**60 inches (1500 mm) at any point during travel and minimum of 79 inches (2000 mm) where the platform is positioned for boarding**].

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with ASME A18.1 and manufacturer's written instructions for installation of lifts unless otherwise indicated.

B. Secure lifts to building construction as follows unless otherwise indicated:

1. For concrete and solid masonry anchorage, use post-installed anchors.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into [**fire-retardant-treated**]wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

C. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and route conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.

E. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.

F. Coordinate platform doors with platform travel and positioning.

G. Adjust stops for accurate stopping[**and leveling**] at each landing, within required tolerances.

1. Leveling Tolerance: **1/4 inch (6 mm)** up or down, regardless of load and direction of travel.

H. Adjust retractable ramps to meet maximum allowable slope and change-in-elevation requirements, and to lie fully against landing surfaces.

I. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.

J. Test safety devices and verify smoothness of required protective enclosures and other surfaces.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.

B. Operating Test: In addition to acceptance testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.

C. Advise the Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on lifts, as directed by the Owner.

3.4 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**12**] months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

B. Check operation of lifts with the Owner's personnel present and before date of Substantial Completion. Determine that operating systems and devices are functioning properly.

C. Check operation of lifts with the Owner's personnel present not more than one month before end of warranty period. Determine that operating systems and devices are functioning properly.

END OF SECTION 14 42 00 00

Task	Specification	Specification Description
14 42 13 00	14 42 00 00	Wheelchair Lifts
14 42 16 00	14 42 00 00	Wheelchair Lifts

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SECTION 14 91 82 00 - TRASH CHUTES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Waste chutes.
2. Waste doors.
3. Diverters.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal supporting framework at floor penetrations.
2. Section 076200 "Sheet Metal Flashing and Trim" for roof-vent flashing.
3. Section 077200 "Roof Accessories" for prefabricated roof curbs.
4. Section 211000 "Water-Based Fire-Suppression Systems" for fire-suppression water-service connections to automatic sprinklers in the chute.
5. Section 221116 "Domestic Water Piping" for water-service connections to chute-flushing or -sanitizing equipment.

1.2 DEFINITIONS

A. Access Door: Door other than an intake or discharge door that penetrates the chase wall for service access to devices in the chase.

B. Chase: The shaft that encloses a chute.

C. Discharge Door: Door or hatch at the bottom of a chute, through which materials exit the chute.

D. Intake Door: Door or hatch that penetrates the chase wall and chute, and through which materials are fed into the chute.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chutes.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include dimensions, weights, loads, required clearances, method of field assembly, components,

and location and size of each field connection.
3. Include each type and location of intake, discharge, and access door.
4. Include diagrams for power, signal and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fire-rated door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Coordination Drawings: Plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Size and construction of chase enclosing each chute; locations for power, signal, and control wiring; and sprinkler-piping and water-service connections.
2. Chute-discharge locations coordinated with compactor-intake or container locations.

C. Product Certificates: For each type of chute.

D. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For chutes to include in operation and maintenance manuals.

1. Include manufacturer's recycling plan guidelines.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than [**two**] hours' normal travel time from Installer's place of business to Project site.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80 section 5.2.3.1, plus the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 TRASH CHUTES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Chute, LLC**]
2. [**Century Chute LLC.**]
3. [**Chute Source, LLC**]
4. [**Chutes International**]
5. [**Midland Chutes**]
6. [**U.S. Chutes; U.S.C. Group**]
7. [**Valiant Products, Inc.**]
8. [**Western Chutes; Buchanan Company, Inc.**]
9. [**Wilkinson Hi-Rise, LLC**]

B. Source Limitations: Obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**].

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing and inspecting agency, for fire-protection ratings indicated.

1. Test Pressure: Test at atmospheric (neutral) pressure according to NFPA 252 or UL 10B.
2. Intake Doors: Labeled, [**1**][**1-1/2**]-hour fire-resistance rated[**with 30-minute temperature rise of 250 deg F (140 deg C)**].
3. Access Doors: Labeled, [**1**][**1-1/2**]-hour fire-resistance rated[**with 30-minute temperature rise of 250 deg F (140 deg C)**].

C. Discharge-Door Assemblies: [**Fire-resistive door construction**][**Labeled, 1-hour fire-resistance rated**][**Labeled, 1-1/2-hour fire-resistance rated**] according to NFPA 252 or UL 10B requirements for fire-rated door assemblies.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Standard: Provide chutes complying with NFPA 82[**unless otherwise indicated**].

2.3 WASTE CHUTES

A. Chute Metal: [**Aluminum-coated, cold-rolled, commercial steel sheet; ASTM A463/A463M, Type 1, with not less than T1-40 (T1M-120) coating**][**Type 430 stainless steel, ASTM A240/A240M**][**Type 304 stainless steel, ASTM A240/A240M**].

1. Thickness: [**0.0625 inch (1.587 mm)**][**0.0750 inch (1.900 mm)**].

B. Chute Size: [**24-inch (610-mm) diameter**][**As indicated on Drawings**].

C. External Reinforcing for Offsets: Additional thickness of [**0.11-inch- (1.7-mm-)**] thick chute metal with bracing to structure.

2.4 WASTE DOORS

A. Intake-Door Assemblies: ASTM A240/A240M, Type 304, stainless steel self-closing units with positive

latch and latch handle, with stainless steel trim; constructed as required for performance requirements indicated; and with frame suitable for the enclosing chase construction.

1. Door Type: [**Hopper**][**Type as indicated on Drawings**].
2. Size: Manufacturer's standard size for door type, chute type, and diameter indicated.
3. Finish: Manufacturer's standard satin or ASTM A480/A480M No. 3 directional polish.
4. Lockset: [**T-handle-type**][**Lever-handle-type**] cylinder lock that releases latch with key that is removable only when cylinder is locked.

    a. Lock Cylinder: Cylinders [**specified in Section 087100 "Door Hardware."**][**specified in Section 087111 "Door Hardware (Descriptive Specification)."**][**standard with manufacturer.**]
    b. Keying: For each chute, key cylinders [**alike**][**differently for each floor**][**to master key system**].
    c. Keys: [**Two**][**Three**] for each cylinder.

5. Latchset: [**T-handle type that unlatches door**][**Lever-handle type that unlatches door**][**Foot-operated type that unlatches and opens door when foot pedal is depressed**].
6. Accessible Automatic Door Operating System: Manufacturer's standard system complying with applicable provisions of the cited accessibility standard.
7. Mechanical Interlocks: Interlock system for system servicing, operated from discharge door to automatically lock intake doors.
8. Electrical Interlocks: Interlock system that is energized by opening one intake door; remaining intake doors automatically lock when system is energized.
9. Baffles: Rubber backdraft baffles at each intake.

B. Discharge-Door Assemblies: Aluminum-coated steel; direct vertical-discharge type, inclined, and horizontally closing and latching; constructed as required for performance requirements indicated; and equipped with [**165 deg F (74 deg C)**] fusible links that cause doors to close in the event of fire.

C. Detector System: Heat-[**and smoke-**]detecting interlock system with temperature-rise elements that locks chute doors when temperature in chute reaches a predetermined, adjustable temperature.

    1. Locate smoke detector outside discharge door with solenoid to close discharge door.

D. Access-Door Assemblies: Manufacturer's standard ASTM A240/A240M, Type 302/304, stainless steel doors with trim; constructed as required for performance requirements indicated; with frame suitable for the enclosing chase construction; in satin or ASTM A480/A480M No. 3 directional polish finish; equipped with cylinder locks that release latch with keys that are removable only when cylinder is locked.

    1. Lock Cylinder: Cylinders [**specified in Section 087100 "Door Hardware."**][**specified in Section 087111 "Door Hardware (Descriptive Specification)."**][**standard with manufacturer.**]
    2. Keying: Key access-door cylinders [**alike**][**to master key system**].
    3. Keys: [**Two**][**Three**] for each cylinder.

E. Manual Control System: Control system with manual switches that lock chute doors during shutdown hours and service operations.

2.5 DIVERTERS

A. Diverters: Manufacturer's standard motorized system for distributing materials from one chute into [**two**][**three**] containers in the discharge room as indicated on Drawings. Integrate diverter controls with controls at intake doors.

B. Construction: Welded steel-plate housing with powered, internal steel blade(s) to deflect materials from chute into appropriate containers.

C. Controls: Integrated, electronic master control unit in discharge room and electronic controls at each intake door, including self-diagnostic program for whole system.

D. Motor Characteristics: Size sufficient to operate diverter blades without exceeding nameplate rating or service factor; complying with NEMA MG 1 and the following:

1. Horsepower: [**Manufacturer's standard**].
2. Volts: [**115 V**].
3. Phase: [**Single phase**].
4. Hertz: 60.
5. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 feet (1005 m)** above sea level.

E. Recycling Containers: Industry standard, [**90-gal. (340-L) containers for comingled recyclables**][**and**][**2-cu. yd. (1.5-cu. m) containers for newspaper**] as recommended by diverter manufacturer for compatibility with diverter system.

2.6 ACCESSORIES

A. Chute Fire Sprinklers: NFPA 13; manufacturer's standard, recessed, automatic, **NPS 1/2 (DN 13)** sprinklers; ready for piping connections.

B. Flushing Spray Unit: **NPS 3/4 (DN 19)** spray-head unit located in chute above highest intake door, ready for hot-water piping connection, and with access door for spray-head and piping maintenance.

C. Sanitizing Unit: **NPS 3/4 (DN 19)** disinfecting and sanitizing spray-head unit located in chute above highest intake door, including **1-gal. (3.8-L)** tank and adjustable proportioning valve with bypass for manual control of sanitizing and flushing operation, ready for hot-water piping connection, and with access door for spray-head and piping maintenance.

D. Intake-Door Baffles: Rubber baffles, **1/8 inch (3 mm)** thick.

E. Sound Dampening: Manufacturer's standard [**sound-deadening coating on exterior of chute**][**sound and vibration isolator pads at supporting frame at each floor penetration**][**and**][**sound-insulating wrap around exterior of chute and intake assemblies**].

2.7 FABRICATION

A. Factory-assemble chutes to greatest extent practicable with nonleaking, continuously welded or lock-seamed joints without bolts, rivets, or clips projecting into chute interior. Include intake-door assemblies, metal supporting framing at each floor, and chute expansion joints between each support point.

B. Offsets: Construct offsets where indicated on Drawings. Fabricate so that installed chute is without obstructions that might prevent materials from free falling within chute.

1. Offsets below Intake Doors: Unless otherwise indicated, do not exceed a 15-degree maximum offset angle at any point, or place offset closer than **48 inches (1220 mm)** to nearest door above offset.
2. Offset above Top Intake Door: Do not exceed a 45-degree maximum offset angle between the highest intake door and the upper termination of chute.
3. Offsets at Floors: Complete offset between floors by returning chute to plumb before penetrating

floors.

4. External Reinforcing: Externally reinforce impact area of offsets located below top intake door. Install vibration isolators where braced to structure.

C. Roof Vent: Fabricate vent unit as full-size extension of chute, open to the atmosphere. Extend vent to height above roofing surface as indicated on Drawings. Equip vent with full insect screening and metal explosion-release cap. Fabricate with roof-deck flange, counterflashing, and clamping ring of nonferrous metal compatible with chute metal.

D. Chute Fire Sprinklers: Install internally within chute, recessed out of the chute area through which material travels, and according to NFPA 13. Locate fire sprinklers at or above the top intake door of chutes, within the chute at alternate floor levels in buildings more than two stories tall, and at the lowest service level.

E. Equipment Access: Fabricate chutes with access for maintaining equipment located within the chute, such as flushing and sanitizing units, fire sprinklers, and plumbing and electrical connections.

PART 3 - EXECUTION

3.1 INSTALLATION OF WASTE CHUTES

A. Install and test chutes before installing enclosing chase construction.

B. Install chutes[**and diverters**] according to NFPA 82 and manufacturer's written instructions. Assemble components with tight, nonleaking joints. Anchor chutes securely to supporting structure to withstand impacts and stresses. Install chute and components to maintain fire-resistive performance of chute and the enclosing chase construction.

C. Install chutes plumb, without obstructions that might prevent materials from free falling within chutes.

D. Anchor flanges of chute vents to roof curbs before installing roofing and flashing. Install chute-vent counterflashing after roofing and roof-penetration flashing are installed.

3.2 INSTALLATION OF WASTE DOORS

A. Intake and Discharge Doors: Interface door units with throat sections of chutes for safe, snag-resistant, sanitary depositing of materials in chutes.

1. Coordinate installation of foot-pedal door operator with installation of door and the enclosing chase construction.
2. Interconnect sanitizer control with door interlock system.

B. Electrical Interlock System: Install according to applicable NECA 1 recommendations.

3.3 FIELD QUALITY CONTROL

A. Test chute components after installation.

1. Operate doors, locks, and interlock systems to demonstrate that hardware operates properly and smoothly and electrical wiring is connected correctly.

2. Complete test operations before installing chase enclosures.

B. Test heat- [**and smoke-**]sensing devices for proper operation.

C. Inspections:

1. Fire-rated door inspections: Inspect each fire-rated door according to NFPA 80, section 5.2
2. Repair or remove and replace door installations where inspections indicate that they do not comply with specified requirements.
3. Reinspect repaired or replaced doors to determine if replaced or repaired door installations comply with specified requirements.
4. Prepare and submit separate inspection report for each fire-rated door indicating compliance with each item listed in [**NFPA 80**][**and**][**NFPA 101**].

D. Plumbing Access Doors: After construction of chase enclosure, verify that access doors have been correctly located and properly installed for their purpose.

3.4 ADJUSTING

A. Adjust doors for smooth and balanced movement.

B. Operate sanitizing unit through one complete cycle of chute use and cleanup, and replenish chemicals or cleaning fluids in unit containers.

3.5 CLEANING

A. After completing chase enclosure, clean exposed surfaces of chute system's components. Do not remove labels of testing and inspecting agencies.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain each chute and related equipment.

B. Demonstrate replenishment of sanitizing-unit chemicals or cleaning fluids.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of chute Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper chute[**and diverter**] operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

END OF SECTION 14 91 82 00

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SECTION 21 01 10 91 - COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Cx process requirements for the following fire-suppression systems, assemblies, and equipment:

a. Water-based fire-suppression systems.
b. Fire-extinguishing systems.
c. Fire pumps.
d. Fire-suppression water storage.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 21 Sections specifying fire-suppression systems, system components, equipment, and products.

1.2 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IgCC: International Green Construction Code.

D. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fire-suppression testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and NFPA 3 and to resolve any issues with the CxA.
2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to fire-suppression system to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements" and NFPA 3.

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx

tests by Contractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

A. Fire-Suppression Testing Technician Qualifications: Technicians to perform fire-suppression Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of fire-suppression system, electrical concepts, and building operations.
2. Minimum [**three years'**] experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Clean-Agent Fire-Suppression Systems Testing Technician Qualifications: Technicians to perform clean-agent fire-suppression system Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, fire-suppression systems, or similar field. Degree requirement may be offset by three years' experience in servicing fire-suppression systems in the clean-agent fire-suppression systems industry. Generally, required knowledge includes clean-agent fire-suppression systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of fire-suppression system equipment, assemblies, and systems.
2. Minimum [**three years'**] experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by

equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Fire-suppression system proprietary test instrumentation and tools become property of the Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 Cx PROCESS

A. Perform Cx process for fire-suppression system in accordance with the following:

1. Section 019113 "General Commissioning Requirements."
2. NFPA 3.
3. [**IgCC, which requires compliance with ASHRAE 202.**]
4. [**Cx standards acceptable to the authority having jurisdiction.**]

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each fire-suppression system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in NFPA 3 [**and IgCC**]. Contractor performs the following:

1. Review fire-suppression system preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**] days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each fire-suppression system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**NFPA 3**][**and IgCC**].

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
3. Use only construction checklists marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

C. Systems Required to Be Commissioned under IgCC:

1. Water-pumping and -mixing systems over **5 hp (4 kW)** and purification systems.

D. Additional Systems Required to Be Commissioned:

1. Facility fire-suppression water-distribution piping outside the building, including the following:

    a. Fire-suppression water piping, fittings, and specialties outside the building.
    b. Hydrants and fire-department connections.
    c. Fire-alarm devices.
    d. Meters and meter pits.
    e. Outdoor water-storage tanks.
    f. Sleeves and sleeve seals.
    g. Meters and gauges.
    h. General-duty and specialty valves.
    i. Hangers and supports.
    j. Heat tracing.
    k. Vibration isolation[**and seismic restraints**].
    l. Identification.
    m. Insulation.

2. Fire-suppression standpipes, including the following:

    a. Fire-suppression water piping, fittings, and specialties inside the building.
    b. Fire-department connections.
    c. Fire pumps, motors, accessories, and controls.
    d. Pressure-maintenance pumps, motors, accessories, and controls.
    e. Sleeves and sleeve seals.
    f. Indoor water-storage tanks.
    g. Meters and gauges.
    h. General-duty and specialty valves.
    i. Hangers and supports.
    j. Heat tracing.
    k. Vibration isolation[**and seismic restraints**].
    l. Identification.
    m. Insulation.

3. Fire-suppression sprinkler systems, including the following:

    a. Wet-pipe sprinkler piping, fittings, sprinklers, and specialties.
    b. Dry-pipe sprinkler piping, fittings, sprinklers, and specialties.
    c. Pre-action, deluge sprinkler piping, fittings, sprinklers, and specialties.
    d. Fire pumps, motors, accessories, and controls.
    e. Pressure-maintenance pumps, motors, accessories, and controls.
    f. Compressed-air piping, compressors, motors, accessories, and controls.
    g. Sleeves and sleeve seals.
    h. Meters and gauges.
    i. General-duty and specialty valves.
    j. Hangers and supports.
    k. Heat tracing.
    l. Vibration isolation[**and seismic restraints**].
    m. Identification.
    n. Insulation.

4. Clean-agent fire-extinguishing systems, including the following:

    a. Piping, fittings, outlets, and specialties.
    b. Storage tanks, manifolds, mounting devices, controls, and accessories.
    c. Sleeves and sleeve seals.
    d. Meters and gauges.

e. General-duty and specialty valves.
f. Hangers and supports.
g. Vibration isolation[**and seismic restraints**].
h. Identification.
i. Insulation.

5. Documentation:

a. Fire-suppression system operating manuals.
b. Documentation of required Cx.
c. Documentation of required operator training.

3.3 Cx TESTING PREPARATION

A. Certify that fire-suppression systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that fire-suppression system instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions, as directed by the Owner.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the fire-suppression system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests, as directed by the Owner.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO FIRE-SUPPRESSION SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks,

control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 21 Sections specifying fire-suppression systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."**][**Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."**]
2. Components to Be Tested:

   a. Vibration isolation control devices in water-based fire-suppression systems.
   b. [**Seismic control devices for proper device selection and installation.**]
   c. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation[**and proper installation of seismic**] control devices.
4. Test Conditions: Measure vibration of the facility structure at [**three**] locations designated by the Owner's witness while the isolated equipment operates.

   a. Maximum speed.
   b. Minimum speed.
   c. Critical speed.

5. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Supervision of Fire-Protection Valves in Water-Based Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for valves specified in the following Sections:

   a. Section 210523 "General-Duty Valves for Water-Based Fire Protection Piping."
   b. Section 211000 "Water-Based Fire-Suppression Systems."
   c. Section 284600 "Fire Detection and Alarm."
   d. Section 284614 "Single- and Multiple-Station Alarms."
   e. Section 331415 "Site Water Distribution Piping."

2. Equipment and Systems to Be Tested:

   a. Supervised valves in water-based fire-suppression systems.

b. Division 28 fire-detection and -alarm systems.

3. Test Purpose: Verify generation of supervisory alarm at the fire-alarm control panel in response to activation of valve supervision device or tamper switch.
4. Test Conditions:

a. Fire-alarm system operating in normal, automatic mode.
b. Activate valve supervision devices and tamper switches, one at a time.

5. Acceptance Criteria: Activation of valve supervision device or tamper switch generates supervisory alarm at fire-alarm control panel.

C. Heat Tracing in Water-Based Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for heat tracing specified in water-based fire-suppression systems. Comply with requirements in Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Equipment and Systems to Be Tested:

a. Self-regulating, parallel-resistance heating cables.
b. Heater trace circuit controller.
c. Interface with fire-alarm control panel.

3. Test Purpose:

a. Evaluate response to ambient temperature below freeze-protection set point.
b. Evaluate heating cable fault alarm.

4. Test Conditions:

a. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**] above freeze-protection set point (initial set point [**41 deg F (5 deg C)**]). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is energized.
b. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**] below freeze-protection set point (initial set point [**41 deg F (5 deg C)**]). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is de-energized.
c. Simulate an electrical fault on the heating cable.

5. Acceptance Criteria:

a. Freeze-protection circuit is energized at set-point temperature of minus **2 deg F (1 deg C)**.
b. Freeze-protection circuit is de-energized at set-point temperature of plus **2 deg F (1 deg C)**.
c. Heater trace circuit controller initiates an alarm of cable fault. Alarm is correctly reported at the fire-alarm control panel.

3.7 Cx TESTS FOR DRY-PIPE SPRINKLER PIPING, FITTINGS, SPRINKLERS, AND SPECIALTIES

A. Air Compressor Run Time:

1. Prerequisites: Acceptance of results of construction checklists specified in Section 211316 "Dry-Piping Sprinkler Systems."
2. Systems and Equipment to Be Tested:

a. Air compressors in fire-suppression systems.
b. Associated compressed air piping, valves, and appurtenances.
c. Associated air pressure controllers.

3. Test Purpose: Evaluate air compressor run time and number of compressor starts.
4. Test Conditions:

a. Keep compressed air and associated sprinkler piping openings closed during test.
b. For systems with multiple compressors, lock out compressor motors on all but one compressor. Repeat test for each compressor in turn.
c. Record number of air compressor motor starts during a 14-day period.
d. Record air compressor motor run time during the same 14-day period.

5. Acceptance Criteria:

a. Number of compressor motor starts during test period shall not exceed [**20**].
b. Compressor motor run time during test period shall not exceed [**60 minutes**].

3.8 Cx TESTS FOR CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

A. Carbon-Dioxide Concentration in Carbon-Dioxide Fire-Extinguishing System:

1. Prerequisites:

a. Acceptance of results of construction checklists specified in Section 212113.13 "High-Pressure, Carbon-Dioxide Fire-Extinguishing Systems."
b. Acceptance of results of construction checklists specified in Section 212113.16 "Low-Pressure, Carbon-Dioxide Fire-Extinguishing Systems."
c. Acceptance of construction checklists specified in Division 23 for systems and equipment serving the protected space.
d. Partitions, ceilings, doors, and other openings complete in the vicinity of the protected space.

2. Systems and Equipment to Be Tested:

a. High-pressure, carbon-dioxide fire-extinguishing systems.
b. Low-pressure, carbon-dioxide fire-extinguishing systems.
c. Protected space enclosure.
d. HVAC system protected space isolation equipment.

3. Test Purpose: Evaluate initial and final carbon-dioxide concentration in the protected space following carbon-dioxide release.
4. Test Conditions:

a. HVAC systems operating in normal, occupied, automatic control.
b. Fire-detection and -alarm systems operating in normal, occupied, automatic control.
c. Carbon-dioxide fire-extinguishing system charged and operating in normal, occupied, automatic control.
d. Protected space air temperature is **70 deg F (21 deg C)**.
e. Create a fire-alarm event in the carbon-dioxide protected space, resulting in discharge of carbon-dioxide fire-extinguishing system.
f. Measure and record carbon-dioxide concentration at [**four**] locations selected by the CxA when the carbon dioxide is completely dispersed and at the end of holding time.

5. Acceptance Criteria: Carbon-dioxide concentration is no less than [**34**] percent concentration by volume at **70 deg F (21 deg C)**.

B. Clean-Agent Concentration in Clean-Agent Fire-Extinguishing System:

1. Prerequisites:

   a. Acceptance of results of construction checklists for Section 212200 "Clean-Agent Fire-Extinguishing Systems."
   b. Acceptance of construction checklists specified in Division 23 for systems and equipment serving the protected space.
   c. Partitions, ceilings, doors, and other openings complete in the vicinity of the protected space.

2. Systems and Equipment to Be Tested:

   a. Clean-agent fire-extinguishing systems.
   b. HVAC system protected space isolation equipment.
   c. Protected space enclosure.

3. Test Purpose: Evaluate initial and final clean-agent concentration in the protected space following carbon-dioxide release.
4. Test Conditions:

   a. HVAC systems operating in normal, occupied, automatic control.
   b. Fire-detection and -alarm systems operating in normal, occupied, automatic control.
   c. Clean-agent fire-extinguishing system charged and operating in normal, occupied, automatic control.
   d. Protected space air temperature is **70 deg F (21 deg C)**.
   e. Create a fire-alarm event in the clean-agent protected space, resulting in discharge of clean-agent fire-extinguishing system.
   f. Measure and record clean-agent concentration at [**four**] locations selected by the CxA when the clean agent is completely dispersed and at the end of holding time.

5. Acceptance Criteria: Clean-agent concentration is no less than [**34**] percent concentration by volume at **70 deg F (21 deg C)**.

END OF SECTION 21 01 10 91

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SECTION 21 05 00 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.

   a. Include construction details, material descriptions, and dimensions of components.
   b. Include operating characteristics and furnished accessories.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

   a. For motors with 2:1 speed ratio, consequent pole, single winding.
   b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Multiple Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**].
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**] and larger; rolled steel for motor frame sizes smaller than [**324T**].

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box,

suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

   a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
   b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [120 V][240 V] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [Circuit board][digital speed controller/LED display].
4. Building Automation System Interface: Via [AC voltage signal][DC voltage signal][Digital Serial Interface (DSI)].

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]

2. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**Zurn Industries, LLC**]

2. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]
    e. [**Proco Products, Inc**]

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

    a. Hydrostatic Seal: **20 psig (137 kPa)** minimum.
    b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
    c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
    d. Connecting Bolts and Nuts: [**Carbon steel, with ASTM B633 coating**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]

   b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Pecora Corporation**]
      2) [**Sika Corporation**]
      3) [**The Dow Chemical Company**]
      4) [**Tremco Incorporated**]

   b. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Smooth-On**]

4. Sealant shall have a VOC content of [**250**] g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.3 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]

B. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**] annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**] above finished floor level.

3. Using [grout][silicone sealant], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [grout][silicone sealant], seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (75 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [Sleeves with waterstops][stack-sleeve fittings].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece[steel][cast brass][or split plate steel] with polished, chrome-plated finish.
3. Insulated Piping:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

END OF SECTION 21 05 00 00

Task	Specification	Specification Description
21 05 00 00	21 05 33 00	Heat Tracing for Fire-Suppression Piping

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SECTION 21 05 23 00 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.2 DEFINITIONS

A. NRS: Nonrising stem.

B. OS&Y: Outside screw and yoke.

C. SBR: Styrene-butadiene rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Fire Main Equipment: HAMV - Main Level.

a. Indicator Posts, Gate Valve: HCBZ - Level 1.
b. Ball Valves, System Control: HLUG - Level 3.
c. Butterfly Valves: HLXS - Level 3.
d. Check Valves: HMER - Level 3.
e. Gate Valves: HMRZ - Level 3.

2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.

a. Valves, Trim and Drain: VQGU - Level 1.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.
3) Miscellaneous valves.

C. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B31.9 for building services piping valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NFPA Compliance for Valves:

1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves **NPS 2 (DN 50)** and smaller.

2.3 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
2. [**NIBCO INC.**]
3. [**Victaulic Company**]

B. Description:

1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal or external.
11. End Connections for Valves **NPS 1 (DN 25)** through **NPS 2 (DN 50)**: Threaded ends.
12. End Connections for Valves **NPS 2-1/2 (DN 65)**: Grooved ends.

2.4 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ALEUM USA**]
2. [**Globe Fire Sprinkler Corporation**]
3. [**Milwaukee Valve Company**]

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: **175 psig (1200 kPa)**.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: [**Bronze**][**Stainless steel**][**with EPDM coating**].
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.

9. Ends Connections for Valves **NPS 1 (DN 25)** through **NPS 2 (DN 50)**: Threaded ends.
10. Ends Connections for Valves **NPS 2-1/2 (DN 65)**: Grooved ends.

2.5 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ALEUM USA**]
2. [**Anvil; an ASC Engineered Solution**]
3. [**Globe Fire Sprinkler Corporation**]
4. [**Kennedy Valve Company; a division of McWane, Inc.**]
5. [**NIBCO INC.**]
6. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**Victaulic Company**]
8. [**Zurn Industries, LLC**]

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Body Material: Cast or ductile iron[**with nylon, EPDM, epoxy, or polyamide coating**].
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, [**nickel plated**][**and EPDM or SBR coated**].
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.
9. Body Design: [**Lug or wafer**][**Grooved-end connections**].

2.6 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ALEUM USA**]
2. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
3. [**Anvil; an ASC Engineered Solution**]
4. [**FEBCO; A WATTS Brand**]
5. [**Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International**]
6. [**Globe Fire Sprinkler Corporation**]
7. [**Kennedy Valve Company; a division of McWane, Inc.**]
8. [**Matco-Norca**]
9. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
10. [**NIBCO INC.**]
11. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
12. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
13. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North**

America]
14. [**United Brass Works, Inc**]
15. [**Venus Fire Protection Ltd.**]
16. [**Victaulic Company**]
17. [**Viking Group Inc.**]
18. [**WATTS; A Watts Water Technologies Company**]
19. [**Wilson & Cousins Inc.**]
20. [**Zurn Industries, LLC**]

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel[**with elastomeric seal**].
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.7 BRONZE OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Milwaukee Valve Company**]
2. [**NIBCO INC.**]
3. [**United Brass Works, Inc**]
4. [**Zurn Industries, LLC**]

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.8 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**Clow Valve Company; a subsidiary of McWane, Inc.**]

3. [**FNW; Ferguson Enterprises, Inc.**]
4. [**Hammond Valve**]
5. [**Kennedy Valve Company; a division of McWane, Inc.**]
6. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
7. [**NIBCO INC.**]
8. [**Victaulic Company**]
9. [**WATTS; A Watts Water Technologies Company**]
10. [**Zurn Industries, LLC**]

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze[**with elastomeric coating**].
5. Wedge Seat: Cast or ductile iron, or bronze[**with elastomeric coating**].
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: [**Flanged**][**Grooved**][**Threaded**].

2.9 NRS GATE VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
3. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
4. [**NIBCO INC.**]
5. [**Victaulic Company**]
6. [**Zurn Industries, LLC**]

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron[**with elastomeric coating**].
5. Wedge Seat: Cast or ductile iron, or bronze[**with elastomeric coating**].
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: [**Flanged**][**Grooved**][**Threaded**].

2.10 INDICATOR POSTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**American Cast Iron Pipe Company**]
2. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
3. [**Kennedy Valve Company; a division of McWane, Inc.**]
4. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
5. [**NIBCO INC.**]

B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: [**Underground**][**Pit**][**Wall**][**Upright**].
3. Base Barrel Material: [**Cast or ductile iron**][**PVC**].
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: [**Wrench**][**Handwheel**].

2.11 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Croker; a Division of Morris Group International**]
   c. [**Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International**]
   d. [**Flowserve Corporation**]
   e. [**Jomar Valve**]
   f. [**KITZ Corporation**]
   g. [**Metso Automation USA Inc.**]
   h. [**Milwaukee Valve Company**]
   i. [**NIBCO INC.**]
   j. [**Potter Roemer LLC; a Division of Morris Group International**]
   k. [**Red-White Valve Corp.**]
   l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**Victaulic Company**]
   n. [**WATTS; A Watts Water Technologies Company**]
   o. [**Zurn Industries, LLC**]

2. Description:

   a. Pressure Rating: [**175 psig (1200 kPa)**][**250 psig (1720 kPa)**][**300 psig (2070 kPa)**].
   b. Body Design: Two piece.
   c. Body Material: Forged brass or bronze.
   d. Port size: Full or standard.
   e. Seats: PTFE.
   f. Stem: Bronze or stainless steel.
   g. Ball: Chrome-plated brass.
   h. Actuator: Handlever.

i. End Connections for Valves **NPS 1 (DN 25)** through **NPS 2-1/2 (DN 65)**: Threaded ends.
j. End Connections for Valves **NPS 1-1/4 and NPS 2-1/2 (DN 32 and DN 65)**: Grooved ends.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International**]
b. [**NIBCO INC.**]
c. [**United Brass Works, Inc**]

2. Description:

a. Pressure Rating: [**175 psig (1200 kPa)**][**250 psig (1720 kPa)**][**300 psig (2070 kPa)**].
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**NIBCO INC.**]
b. [**United Brass Works, Inc**]

2. Description:

a. Pressure Rating: [**175 psig (1200 kPa)**][**250 psig (1720 kPa)**][**300 psig (2070 kPa)**].
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special

packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:

1. Section 211000 "Water-Based Fire-Suppression Systems" for application of valves in fire-suppression standpipes; wet-pipe, fire-suppression sprinkler systems; and dry-pipe, fire-suppression sprinkler systems.
2. Section 211339 "Foam-Water Systems" for application of valves in AFFF piping.
3. Section 331415 "Site Water Distribution Piping" for application of valves in fire-suppression water-service piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.

C. Install double-check valve assembly in each fire-protection water-supply connection.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 21 05 23 00

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Task	Specification	Specification Description
21 05 23 00	21 01 10 91	Commissioning Of Fire Suppression

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SECTION 21 05 29 00 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports for fire-suppression piping - carbon steel.
2. Pipe/tube hangers and supports for fire-suppression piping - copper.
3. Pipe hangers - metal, trapeze type.
4. Thermal hanger shield insert for fire-suppression piping - polyisocyanurate.
5. Thermal hanger shield insert for fire-suppression piping - phenolic.
6. Thermal hanger shield insert for fire-suppression piping - cellular glass.
7. Fastener systems.
8. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. [**Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment"**][**Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment"**] for vibration isolation devices [**and seismic restraints**] .

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: [**Signed and sealed by a qualified professional engineer.**] Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For structural-steel and pipe welding.

B. Delegated Design Engineer Qualifications: For trapeze hangers.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2025 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**].

1. Design supports for multiple pipes, including pipe stands capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment [**and obtain approval from authorities having jurisdiction**] .

C. NFPA Compliance: Comply with [**NFPA 13**][**NFPA 13R**].

D. UL Compliance: Comply with UL 203.

2.2 PIPE HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING - METAL

A. Pipe Hangers and Supports for Fire-Suppression Piping - Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: Factory-fabricated components, NFPA approved, UL listed, or FM Global approved for fire-suppression piping support.
3. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**][**stainless steel**].

B. Pipe/Tube Hangers and Supports for Fire-Suppression Piping - Copper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Anvil; an ASC Engineered Solution**]
    b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM Global approved for fire-suppression piping support.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-coated steel**][**stainless steel**].

2.3 PIPE HANGERS FOR FIRE-SUPPRESSION PIPING - METAL, TRAPEZE TYPE

A. Pipe Hangers - Metal, Trapeze Type: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon steel shapes, with NFPA-approved, UL-listed, or FM Global-approved carbon steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER SHIELD INSERTS

A. Thermal Hanger Shield Insert for Fire-Suppression Piping - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Buckaroos, Inc.**]
    b. [**KB Enterprise**]
    c. [**National Pipe Hanger Corporation**]
    d. [**Value Engineered Products, Inc.; an ASC Engineered**]

2. Insulation-Insert Material: ASTM C591, Type VI, Grade 1 polyisocyanurate with **125 psi (862 kPa)** minimum compressive strength and vapor barrier.

    a. ASTM E84, Flame Spread/Smoke Developed: 25/450.

3. Application: For insulated piping not in return-air plenums.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

B. Thermal Hanger Shield Insert for Fire-Suppression Piping - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Buckaroos, Inc.**]

2. Insulation-Insert Material: Rigid phenolic foam insulation, ASTM C1126, Type III, with ASTM E96 zero perm vapor barrier.

   a. Minimum Compressive Strength, ASTM D1621: [**40 psi (276 kPa) minimum perpendicular to rise and 50 psi (345 kPa) minimum parallel to rise**][**70 psi (483 kPa) minimum perpendicular to rise and 90 psi (620 kPa) minimum parallel to rise**] .
   b. ASTM E84, Flame Spread/Smoke Developed: 25/50.

3. Application: For insulated piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

C. Thermal Hanger Shield Insert for Fire-Suppression Piping - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Rilco Manufacturing Co., Inc**]

2. Insulation-Insert Material: Water-repellent-treated, ASTM C552, Type II cellular glass with **100 psi (688 kPa)** minimum compressive strength.

   a. ASTM E84, Flame Spread/Smoke Developed: 0/0.

3. Application: For insulated piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover lower 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Fastener System - NFPA/UL/FM Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM Global-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hilti, Inc.**]

b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
c. [**MKT Fastening, LLC**]

B. Fastener System - NFPA/UL/FM Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM Global-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
b. [**Empire Industries, Inc.**]
c. [**Hilti, Inc.**]
d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
e. [**MKT Fastening, LLC**]

2. Indoor Applications: [**Zinc-coated**][**stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Equipment Support: NFPA-approved, UL-listed, or FM Global-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon steel shapes.

2.7 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION OF HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and

installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to comply with NFPA 13 requirements, minimum [**5 times**] the water-filled weight of piping and supported components plus [**250 lb (114 kg)**].

3.2 INSTALLATION OF HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] and larger [**and at changes in direction of piping**] . Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

F. Pipe Hangers and Supports - Metal: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

G. Pipe Hangers - Metal, Trapeze Type: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

H. Thermal Hanger Shield Inserts: Install in pipe hanger or shield for insulated piping.

I. Fastener Systems:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches (100 mm)** thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners in accordance with powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions. Install in accordance with approvals and listings.

J. Hangers and Supports, General: Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Supports:

1. Fabricate from welded-structural-steel shapes.
2. Grouting: Place grout under supports for floor-mounted equipment and make bearing surface smooth.
3. Provide lateral bracing, to prevent swaying.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. MSS SP-58, Type 39 Option: Thermal hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

   a. MSS SP-58, Type 40 Option: Thermal hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): **12 inches (305 mm)** long and **0.048 inch (1.22 mm)** thick.
   b. NPS 4 (DN 100): **12 inches (305 mm)** long and **0.06 inch (1.52 mm)** thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): **18 inches (457 mm)** long and **0.06 inch (1.52 mm)** thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): **24 inches (610 mm)** long and **0.075 inch (1.91 mm)** thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): **24 inches (610 mm)** long and **0.105 inch (2.67 mm)** thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [**trapeze pipe hangers**][**and**][**equipment supports**] .

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop

welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches (40 mm)**].

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.

2. Comply with requirements in [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**Section 099600 "High-Performance Coatings"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Comply with requirements in [**Section 099114 "Exterior Painting (MPI Standards)"**][**Section 099124 "Interior Painting (MPI Standards)"**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
4. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon steel [**pipe hangers and supports**][**and**][**metal trapeze pipe hangers**] and attachments for general service applications.

F. Use [**stainless steel**] pipe hangers and [**stainless steel**][**corrosion-resistant**] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**][**stainless steel**] attachments for copper piping and tubing.

H. Use thermal hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
2. Steel Pipe Clamps (MSS Type 4): For suspension of **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8 (DN 10 to DN 200)**.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3 (DN 10 to DN 80)**.
6. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36 (DN 65 to DN 900)** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
2. Carbon Steel or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24 (DN 20 to DN 600)** if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Comply with NFPA requirements.

L. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

M. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use [**powder-actuated fasteners**][**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29 00

Task	Specification	Specification Description
21 05 29 00	21 05 33 00	Heat Tracing for Fire-Suppression Piping

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SECTION 21 05 33 00 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance heating cables.

B. Related Requirements:

1. Section 220533 "Heat Tracing for Plumbing Piping."
2. Section 230533 "Heat Tracing for HVAC Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chromalox, Inc.**]
2. [**RAYCHEM; brand of nVent Electrical plc**]
3. [**Thermon, Inc.**]

B. Source Limitations: Obtain all heat tracing from one manufacturer.

C. Standard: IEEE 515.1.

D. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**], stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Grounding Cover: [**Copper**][**Tinned-copper**] braid.

G. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.

H. Terminate cable with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.

I. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].

J. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].

K. Electrical Components, Devices, and Accessories: Listed and labeled for fire protection use as defined in NFPA 70 and NFPA 13 by a qualified testing agency, and marked for intended location and application. All heating cable used on branch sprinkler piping is to be listed and labeled by a qualified testing agency specifically for this use.

L. Capacities and Characteristics:

1. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**].
2. Electrical Characteristics for Single-Circuit Connection:

   a. Volts: [**120**][**208**][**240**][**277**][**480**] V.

2.2 CONTROLS

A. Control Panel:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.

2. Remote temperature sensor senses outside air temperature; programmable to energize the cable when temperature falls below [**34 to 44 deg F (1 to 7 deg C)**].
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and temperature sensors.
4. Minimum 30 A contactor to energize cable or close other contactors.
5. Ground-fault protection.
6. Single-point control of heat tracing for freeze protection.
7. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by fire-alarm system. Coordinate type of connection ports with [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

B. Warning Labels: See Section 210553 "Identification for Fire-Suppression Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least **3 mils (0.08 mm)** thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than **6 Inches (150 mm)**: **3/4 inch (19 mm)** minimum.
2. Width for Markers on Pipes with OD, Including Insulation, **6 Inches (150 mm)** or Larger: **1-1/2 inches (38 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable at locations indicated and install in accordance with NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 210700 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install temperature-control units in an accessible location and according to manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

I. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

J. Install and connect outside air and pipe temperature sensors.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system in accordance with NFPA 13. Comply with requirements in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

D. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

E. Connect remote electronic temperature sensors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 21 05 33 00

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SECTION 21 05 48 00 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Elastomeric hangers.
5. Snubbers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.
9. Post-installed concrete anchors.
10. Concrete inserts.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" specifies devices for plumbing equipment and systems.
3. Section 230548 "Vibration and Seismic Controls for HVAC" specifies devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, mechanical, electrical, plumbing, or fire-protection system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professional: Engage qualified professional structural engineer to design seismic and wind restraints.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

    a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
    b. Include load rating for each seismic-[**and wind-**]restraint device.
    c. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-**]restraint component.
    d. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].
    e. Annotate to indicate application of each product submitted and compliance with requirements.
    f. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic[**and wind**] restraints for components with other systems and equipment in the vicinity, including other supports and other seismic restraints.

C. Delegated Design Submittal:

1. All delegated design and submittals for [**seismic**][**and**][**wind**] restraints must be signed and sealed by a qualified professional structural engineer responsible for their preparation. Structural engineer is to possess qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete attachments.
2. For each seismic-restraint device, including [**seismic-restrained mounting,**][**pipe-riser resilient support,**][**snubber,**][**seismic restraint,**][**seismic-restraint accessory,**][**and**][**concrete anchor and insert**] that is required by this Section or is indicated on Drawings, submit the following:

    a. Seismic Restraint, and Vibration Isolator Selection: Select and submit seismic restraints [**and vibration isolators**] complying with performance requirements, design criteria, and analysis data.
    b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    c. Post-Installed Concrete Anchors and Concrete Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for reinforcement use.
    d. Seismic Design Calculations: Submit all input data and loading calculations.

3. For each wind-restraint device, including [**restraint - rigid,**][**restraint - cable,**][**restraint accessory,**][**concrete anchor,**][**and**][**concrete insert**] that is required by this Section or is indicated on Drawings, submit the following:

    a. Wind Restraints: Select and submit wind restraints complying with performance requirements, design criteria, and analysis data.
    b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated

seismic loads. Include certification that device is approved by an NRTL for reinforcement use.

c. Wind-Restraint Design Calculations: Submit all input data and loading calculations.

4. Seismic- and Wind-Restraint Detail Drawing:

a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

5. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).

6. Riser Supports: Include riser diagrams and calculations showing initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-**] and seismic-restraint devices for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**][**and**][**testing agency**].

C. Welding certificates.

D. Field quality-control reports.

1.6 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and Shop Drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**], as directed by the Owner

1.7 QUALIFICATIONS

A. Professional Structural Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete foundations.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional structural engineer to prepare seismic- and wind-restraint calculations in accordance with criteria specified in Section 018123 "Facility Seismic and Wind Criteria."

B. Seismic- and Wind-Restraint-Device Ratings: Devices are to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices are to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ED product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to the authorities having jurisdiction**].

C. Consequential Damage: Provide additional seismic[**and wind**] restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a nonessential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals are to have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be labeled as such.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components are to be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]

e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]

2. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
6. Surface Pattern: Smooth, ribbed, or waffle pattern.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**].

   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]

2. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
3. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

4. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]

2. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
3. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Kinetics Noise Control, Inc**]
e. [**Mason Industries, Inc.**]
f. [**NOVIA; a division of Carpenter & Paterson**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]

2. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
3. Description: Elastomeric hanger mounted in a steel frame with upper and lower steel hanger rods.
4. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
5. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]

B. Source Limitations: Obtain snubbers from single manufacturer.

C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14, Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.7 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]

B. Source Limitations: Obtain rigid-type restraints from single manufacturer.

C. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel

channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]

B. Source Limitations Obtain cable-type restraints from single manufacturer.

C. Seismic- and Wind-Restraint Cables: [**ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

D. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]

B. Source Limitations: Obtain restraint accessories from single manufacturer.

C. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid restraints**][**and**][**restraint cables**].

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]

2. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]

2. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)** that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.11 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]

B. Source Limitations: Obtain concrete inserts from single manufacturer.

C. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation[wind-restraint,] and seismic-restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where

required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Assemblies: Where not specifically indicated otherwise, select sizes of components so strength is adequate to carry static[wind load,] and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROLS AND SEISMIC RESTRAINTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic-Restraint, and Wind-Restraint Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic-Restraint, and Wind-Restraint Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[wind restraints,] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.

F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.

G. Equipment Restraints:

1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
3. Install seismic-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

H. Piping Restraints:

1. Comply with all requirements in NFPA 13.
2. Design piping sway bracing in accordance with NFPA 13.

   a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
   b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.

I. Install seismic-[**and wind-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211000 "Water-Based Fire-Suppression Systems" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with the Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice, as directed by the Owner.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members, as directed by the Owner.
4. Test at no fewer than [**four**] of each type and size of installed anchors and fasteners selected by Architect, as directed by the Owner.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 21 05 48 00

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SECTION 21 05 48 13 - VIBRATION CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Elastomeric hangers.
5. Snubbers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.
9. Post-installed concrete anchors.
10. Concrete inserts.

B. Related Requirements:

1. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device [**and wind-load-restraint**]component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

    a. Wind-Load-Restraint Selection: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
    b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
    d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
    e. Qualified Professional Engineer: All designated-design submittals for wind-load-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Wind-Load-Restraint Detail Drawing:

    a. Design Analysis: To support selection and arrangement of wind-load restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
    c. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

3. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-load reinforcement**]device installation for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**][**and**][**testing agency**].

C. Welding certificates.

D. Field quality-control reports.

E. Wind-Load Performance Certification: Provide special certification for fire-suppression system components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated fire suppression system device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
3. The following fire-suppression system systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind load and impact damage must be provided by manufacturer.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wind-load-restraint system.

1. Wind-Load Performance: Equipment must be designed and secured to withstand effects of high wind events determined in accordance with [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**].

B. Wind-Load Design Calculations:

1. Comply with wind-load-restraint requirements of all applicable codes and authorities having jurisdiction.
2. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**] Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

   a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
   b. Coordinate design wind-load calculations with vibration isolation calculations for equipment requiring both wind-load reinforcement and vibration isolation. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

3. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

    a. PART 1: Low-Rise Buildings.
    b. PART 2: Low-Rise Buildings (Simplified).
    c. PART 3: Buildings with "h" less than **60 ft. (18.3 m)**.
    d. PART 4: Buildings with "h" greater than **60 ft. (18.3 m)** and less than **160 ft. (48.8 m)**.
    e. PART 5: Open Buildings.

4. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

    a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
    b. Exposure Category: [**B**][**C**][**D**].
    c. qz = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
    d. qh = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
    e. G = Gust-Effect Factor: [**0.85**].

5. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using the methods in ASCE/SEI 7-10, Ch. 30. Perform calculations according to PART 1: -Rise Buildings, PART 2: Low-Rise Buildings (Simplified), PART 3: Buildings with "h" greater than **60 ft. (18.3 m)**, PART 4: Buildings with "h" less than **160 ft. (48.8 m)**, or PART 5: Open Buildings, as appropriate.
6. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

    a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
    b. Exposure Category: [**B**][**C**][**D**].
    c. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
    d. qh = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
    e. G = Gust-Effect Factor: [**0.85**].

7. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

    a. Exposure Category: [**B**][**C**][**D**].
    b. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
    c. qh = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.

d. G = Gust-Effect Factor: [**0.85**].
e. Cf = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
f. Af = Projected Area Normal to the Wind: Except where Cf is specified for the actual surface area, value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

C. Consequential Damage: Provide additional restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**] so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All devices and components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of [**ASCE/SEI 7-05 Section 13.6**][**ASCE/SEI 7-10 Section 13.6**][**ASCE/SEI 7-16 Section 13.6**].

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.

6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**].

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Mason Industries, Inc.**]
    h. [**NOVIA; a division of Carpenter & Paterson**]
    i. [**Vibration Eliminator Co., Inc**]
    j. [**Vibration Isolation**]
    k. [**Vibration Management Corp.**]
    l. [**VMC GROUP**]

2. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil and water resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]

d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Kinetics Noise Control, Inc**]
e. [**Mason Industries, Inc.**]
f. [**NOVIA; a division of Carpenter & Paterson**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]

5. [**VMC GROUP**]

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14 Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.7 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]

B. Seismic-Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]

B. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**][**and**][**restraint cables**].

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and

as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)** that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.11 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation[**and wind-force-restraint**] devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to high wind forces.

C. Strength of Support and Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind load within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND WIND-LOAD-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation [**and Wind-Load-Restraints**]Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide wind-load-restraint devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation [**and Wind-Load-Restraints**]Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**and wind-load restraints**] must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.

G. Piping Restraints:

1. Comply with all requirements in NFPA 13.
2. Design piping sway bracing according to NFPA 13.

   a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
   b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.

H. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL STRUCTURAL MOTION

A. Install flexible connections in piping where they cross structural construction joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211000 "Water-Based Fire-Suppression Systems" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with the Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice, as directed by the Owner.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members, as directed by the Owner.
4. Test at no fewer than [**four**] of each type and size of installed anchors and fasteners selected by Architect, as directed by the Owner.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 21 05 48 13

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Task	Specification	Specification Description
21 05 48 13	21 05 48 00	Vibration And Seismic Controls For Fire-Suppression Piping And Equipment

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SECTION 21 05 53 00 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: Provide for fire-suppression piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**Champion America**]
   d. [**Craftmark Pipe Markers**]
   e. [**emedco**]
   f. [**Kolbi Pipe Marker Co.**]
   g. [**LEM Products Inc.**]

h. [**Marking Services Inc.**]
i. [**Pipemarker.com; Brimar Industries, Inc.**]
j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: [**Brass, 0.032 inch (0.8 mm)**][**stainless steel, 0.025 inch (0.64 mm)**][**aluminum, 0.032 inch (0.8 mm)**][**anodized aluminum, 0.032 inch (0.8 mm)**] thick, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
5. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**Craftmark Pipe Markers**]
e. [**emedco**]
f. [**Kolbi Pipe Marker Co.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Pipemarker.com; Brimar Industries, Inc.**]
j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.
5. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
6. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brady Corporation**]
2. [**Carlton Industries, LP**]
3. [**Champion America**]
4. [**Craftmark Pipe Markers**]
5. [**emedco**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**National Marker Company**]
9. [**Pipemarker.com; Brimar Industries, Inc.**]
10. [**Seton Identification Products; a Brady Corporation company**]
11. [**Stranco, Inc.**]

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.

E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.

F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E[and other applicable codes and standards].

J. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brady Corporation**]
2. [**Craftmark Pipe Markers**]
3. [**National Marker Company**]
4. [**Pipemarker.com; Brimar Industries, Inc.**]
5. [**Seton Identification Products; a Brady Corporation company**]

B. Material: Vinyl.

C. Minimum Thickness: **0.005 inch (0.12 mm)**.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: **160 deg F (70 deg C)**.

G. Minimum Width: [**2 inches (50 mm)**][**4 inches (100 mm)**].

2.4 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
2. [**Brady Corporation**]
3. [**Carlton Industries, LP**]
4. [**Champion America**]
5. [**Craftmark Pipe Markers**]
6. [**emedco**]
7. [**Kolbi Pipe Marker Co.**]
8. [**LEM Products Inc.**]
9. [**Marking Services Inc.**]
10. [**Pipemarker.com; Brimar Industries, Inc.**]
11. [**Seton Identification Products; a Brady Corporation company**]

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [**partially cover**][**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**].

2.5 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Craftmark Pipe Markers**]
   b. [**Kolbi Pipe Marker Co.**]
   c. [**Marking Services Inc.**]
   d. [**Pipemarker.com; Brimar Industries, Inc.**]

2. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**].
3. Stencil Material: Aluminum, brass, or fiberboard.
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
   2. [**Brady Corporation**]
   3. [**Carlton Industries, LP**]
   4. [**Champion America**]
   5. [**Craftmark Pipe Markers**]
   6. [**emedco**]
   7. [**Kolbi Pipe Marker Co.**]
   8. [**LEM Products Inc.**]
   9. [**Marking Services Inc.**]
   10. [**Pipemarker.com; Brimar Industries, Inc.**]
   11. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping-system abbreviation and **1/2-inch (13-mm)** numbers.

   1. Tag Material: [Brass, 0.04 inch (1.0 mm)][stainless steel, 0.024 inch (0.61 mm)][aluminum, 0.031 inch (0.79 mm)][anodized aluminum, 0.031 inch (0.79 mm)] thick, with predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass [wire][link chain][beaded chain][S-hook].

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

   1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brady Corporation**]
2. [**Champion America**]
3. [**Craftmark Pipe Markers**]
4. [**emedco**]
5. [**Kolbi Pipe Marker Co.**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**Pipemarker.com; Brimar Industries, Inc.**]
9. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Preprinted[**or partially preprinted,**] accident-prevention tags, of plasticized card stock[**with matte finish suitable for writing**].

1. Size: [**3 by 5-1/4 inches (75 by 133 mm) minimum**][**Approximately 4 by 7 inches (100 by 178 mm)**].
2. Fasteners: [**Brass grommet and wire**][**Reinforced grommet and wire or string**].
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of fire-suppression equipment.

B. Sign and Label Colors:

1. [**White letters on an ANSI Z535.1 safety-red background**].

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E[and other applicable codes and standards].

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: [**Yellow background with black diagonal stripes**].

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than **6 ft. (2 m)** of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe-Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1,[**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within **3 ft. (1 m)** of each valve and control device.
2. At access doors, manholes, and similar access points that permit a view of concealed piping.
3. Within **3 ft. (1 m)** of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of [**25 ft. (8 m)**] along each run. Reduce intervals to [**10 ft. (3 m)**] in areas of congested piping and equipment.

E. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Fire-Suppression Pipe Label Color Schedule:

1. Fire-Suppression Pipe Labels: [**White letters on an ANSI Z535.1 safety-red background**].

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-

suppression system valve tags.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Fire-Suppression Standpipe: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].
b. Wet-Pipe Sprinkler System: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].
c. Dry-Pipe Sprinkler System: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].
d. Foam-Water System: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].
e. Clean-Agent Fire-Extinguishing System: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].
f. Preaction System: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**], [**round**][**square**].

2. Valve-Tag Color: [**White letters on an ANSI Z535.1 safety-red background**].

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: [**Black letters on an ANSI Z535.1 safety-yellow background**].

B. Attach warning tags, with proper message, to equipment and other items where [**indicated on Drawings**][**scheduled**].

END OF SECTION 21 05 53 00

SECTION 21 07 00 00 - FIRE-SUPPRESSION SYSTEMS INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium silicate fire-suppression system insulation.
2. Cellular glass fire-suppression system insulation.
3. Flexible elastomeric fire-suppression system insulation.
4. Glass-fiber fire-suppression system insulation.
5. Mineral wool fire-suppression system insulation.
6. Phenolic fire-suppression system insulation.
7. Polyisocyanurate fire-suppression system insulation.
8. Polyolefin fire-suppression system insulation.
9. Insulating cements.
10. Insulation adhesives.
11. Insulation mastics and coatings.
12. Insulation sealants.
13. Field-applied insulation jackets.
14. Field-applied fabric-reinforcing mesh for insulation.
15. Field-applied cloths for insulation.
16. Vapor-retarder tapes.
17. Insulation securements.
18. Insulation corner angles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail attachment and covering of heat tracing inside insulation.
4. Detail insulation application at pipe expansion joints for each type of insulation.
5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
6. Detail removable insulation at piping specialties and equipment connections.
7. Detail application of field-applied jackets.
8. Detail application at linkages of control devices.
9. Detail field application for fire-suppression water storage tanks.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.

2. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
3. Jacket Materials for Pipe: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
4. Sheet Jacket Materials: **12 inches (300 mm)** square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [certified by the Department of Labor, Bureau of Apprenticeship and Training] .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size [as well as ASTM standard designation, and maximum use temperature] .

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 210529 "Hangers and Supports for Fire-Suppression Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and with equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems [**and after installing and testing heat tracing**] . Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 FIRE-SUPPRESSION SYSTEM INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Diesel Fire Pump Engine Exhaust Insulation Schedule"; "Fire-Suppression Equipment Insulation Schedule"; "Fire-Suppression System Piping Insulation Schedule, General"; "Indoor Fire-Suppression System Piping Insulation Schedule"; and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM SILICATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Calcium Silicate, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]

2. Description: ASTM C533, flat-, curved-, and grooved-block sections of noncombustible, inorganic,

hydrous calcium silicate with a non-asbestos fibrous reinforcement, Type I.
3. Standard: ASTM C533, Type I.
4. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR GLASS FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Cellular Glass, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Owens Corning**]

2. Description: Cellular-glass insulation of inorganic, incombustible, foamed, or cellulated glass with annealed, rigid, hermetically sealed cells.
3. Standard: ASTM C552.
4. Block Insulation: Type I.
5. Special-Shaped Insulation: Type III.
6. Board Insulation: Type IV.
7. Factory-fabricate shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
8. Without Insulation Facing: Type II, Class 1.
9. Factory-Applied Insulation Facing: Type II, Class 2.

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.5 FLEXIBLE ELASTOMERIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]

2. Description: Closed-cell or expanded-rubber flexible elastomeric pipe insulation.
3. Standard: ASTM C534/C534M, Type I, for tubular materials; Type II for sheet materials.
4. Suitable for maximum use temperature between **minus 70 and plus 220 deg F (minus 57 and plus 104 deg C)**.

2.6 GLASS-FIBER FIRE-SUPPRESSION SYSTEM INSULATION

A. Equipment Insulation - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]

2. Description: Glass-fiber board equipment insulation consisting of glass fibers bonded with a thermosetting resin.
3. Standard: ASTM C612, Type IA or Type IB.
4. Suitable for maximum use temperature between **35 and 250 deg F (1.7 and 121 deg C)** for jacketed and between **35 and 450 deg F (1.7 and 232 deg C)** for unfaced in accordance with ASTM C411.
5. Unfaced.
6. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

B. Pipe Insulation - Glass-Fiber, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Knauf Insulation**]
   c. [**Manson Insulation Inc.**]
   d. [**Owens Corning**]

2. Description: Glass fibers bonded with a thermosetting resin.
3. Suitable for maximum use temperature up to **850 deg F (454 deg C)** in accordance with ASTM C411. Comply with ASTM C547.
4. Preformed Pipe Insulation: Type I, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.

d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

C. Pipe Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]

2. Description: Glass fibers bonded with a thermosetting resin.
3. Standard: ASTM C1393.
4. Suitable for maximum use temperature between **35 and 850 deg F (1.7 and 454 deg C)**, in accordance with ASTM C411.
5. Semirigid board material.
6. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 MINERAL WOOL FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Mineral Wool, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]

2. Description: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447. Comply with ASTM C547.
3. Standard: ASTM C547.
4. Preformed Pipe Insulation: Type II, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]

2. Description: Mineral wool fibers bonded with a thermosetting resin.
3. Standard: ASTM C1393.
4. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
5. Semirigid board material.
6. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
c. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 PHENOLIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Kingspan Tarec Industrial Insulation NV**]
c. [**Polyguard Products, Inc.**]
d. [**Resolco Inc.**]

2. Description: Prefabricated phenolic pipe insulation of rigid, expanded, closed-cell structure.
3. Standard: ASTM C1126.
4. Prefabricated Pipe Insulation: Type III.

5. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ+: Aluminum-foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
    c. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 POLYISOCYANURATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Duna USA Inc.**]
    b. [**Dyplast Products**]
    c. [**Johns Manville; a Berkshire Hathaway company**]

2. Description: Prefabricated, rigid cellular polyisocyanurate pipe insulation intended for use as thermal insulation.
3. Standard: ASTM C591.
4. Type IV, except thermal conductivity (k-value) to not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
5. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less for thickness up to **1-1/2 inches (38 mm)** as tested in accordance with ASTM E84.
6. Fabricate shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.10 POLYOLEFIN FIRE-SUPPRESSION SYSTEM INSULATION

A. Pipe Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Armacell LLC**]

2. Description: Polyethylene type of polyolefin thermal plastic insulation.

3. Standard: ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials [self-seal] .

2.11 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]

2. Standard: ASTM C449.

2.12 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]

2. Standard: MIL-A-3316C, Class I, Grade A.
3. Adhesives to be compatible with insulation materials, jackets, and substrates.
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
5. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
6. Color: White.
7. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**] g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]

2. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
3. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular-Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]

2. Description: Two-component, thermosetting urethane containing no flammable solvent, with a service temperature range of minus **100 to plus 200 deg F (minus73 to plus 93 deg C)**.
3. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**Foster Brand; H. B. Fuller**]
   d. [**K-Flex USA**]

2. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
3. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less as tested

in accordance with ASTM E84.
4. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
5. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
6. Color: [**Black**].
7. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**] g/L or less.

F. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]

2. Standard: MIL-A-3316C, Class 2, Grade A.
3. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
4. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

G. Insulation Adhesive - for Phenolic and Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]

2. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.

H. Adhesive: As recommended by phenolic and polyisocyanate manufacturer and with a VOC content of 50 g/L or less.

I. Insulation Adhesive for ASJ, FSK, and PVDC Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]

2. Description: Insulation adhesive for bonding ASJ, FSK, and PVDC facing/jacket insulation lap seams and joints.
3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Verify adhesives have a VOC content of 80 g/L or less.
5. Verify adhesives have a VOC content of 80 g/L or less.

J. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]

2. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.
3. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.13 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]

2. Description: Insulation vapor-retarder mastic, water based, and suitable for indoor use on below-ambient services.
3. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
4. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
5. Standard: MIL-PRF-19565C, Type II, for permeance requirements [with supplier listing on DOD's Qualified Products Database] .
6. Color: [**White**].

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]

2. Description: Insulation vapor-retarder mastic, solvent based, and suitable for indoor use on below-ambient services.
3. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
4. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
5. Color: [**White**].

D. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Knauf Insulation**]
d. [**Mon-Eco Industries, Inc.**]
e. [**Vimasco Corporation**]

2. Description: Insulation breather mastic, water based, and suitable for indoor and outdoor use on above-ambient surfaces.
3. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at manufacturer's recommended dry film thickness.
4. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
5. Color: [**White**].

2.14 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
4. Color: White or gray.
5. Verify sealant has a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]

2. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
5. Color: Aluminum.
6. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]

2. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
5. Color: White.
6. Verify sealant has a VOC content of 420 g/L or less.

2.15 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Insulation Jacket, Field Applied - PVC: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Airex Manufacturing Inc.**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**P.I.C. Plastics, Inc.**]
    d. [**Proto Corporation**]
    e. [**Speedline Corporation**]

2. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
3. Thickness: As indicated in "Outdoor, Field-Applied Insulation Jacket Schedule" Article.
4. Jacket: Roll stock ready for shop or field cutting and forming.
5. Adhesive: As recommended by jacket material manufacturer.
6. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] , as directed by the Owner.
7. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, and end caps.

8. Factory-fabricated tank heads and tank side panels.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]

2. Jacket Material - Aluminum:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" Articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are unavailable.

3. Jacket Material - Stainless Steel:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM A240/A240M.
    c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" Articles.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene**

and kraft paper][**3-mil- (0.075-mm-) thick polysurlyn**] .

e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .

f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are unavailable.

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MFM Building Products Corp.**]
b. [**Polyguard Products, Inc.**]

2. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
3. Vapor Barrier/Waterproofing Membrane: **60-mil (1.5-mm)** thickness.

F. Insulation Jacket, Field Applied - Indoor/Outdoor Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]

2. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
3. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
4. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.
5. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
6. Flame Spread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
7. Aluminum Finish: [**Embossed**][**Smooth**] .
8. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

2.16 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Fabric for Fire-Suppression System Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]

2. Description: Woven glass-fiber fabric for covering pipe and pipe fittings insulation.
3. Weight: Approximately **4 oz./sq. yd. (114 g/sq. m)**.
4. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.

B. Woven Glass-Fiber Fabric for Fire-Suppression System Equipment Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]

2. Description: Woven glass-fiber fabric for covering equipment insulation.
3. Weight: Approximately **6 oz./sq. yd. (203 g/sq. m)**.
4. Thread Count: **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)**.

C. Woven Polyester Fabric for Fire-Suppression System Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Foster Brand; H. B. Fuller**]
b. [**Vimasco Corporation**]

2. Description: Woven polyester fabric for covering pipe, fittings, and equipment insulation.
3. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
4. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
5. Weave Type: Leno.

2.17 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alpha Associates, Inc.**]

2. Description: Woven glass-fiber cloth.
3. Standard: MIL-C-20079H, Type I.
4. Weave: Plain.
5. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.18 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]

2. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
3. Standard: ASTM C1136.
4. Width: [**3 inches (75 mm)**].
5. Thickness: [**11.5 mils (0.29 mm)**].
6. Adhesion: [**90 ounces force/inch (1.0 N/mm)**] in width.
7. Elongation: [**2**] percent.
8. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**] in width.
9. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]

2. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
3. Standard: ASTM C1136.
4. Width: [**3 inches (75 mm)**].
5. Thickness: [**6.5 mils (0.16 mm)**].
6. Adhesion: [**90 ounces force/inch (1.0 N/mm)**] in width.
7. Elongation: [**2**] percent.
8. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**] in width.
9. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]

2. Description: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
3. Application: Suitable for indoor and outdoor applications.
4. Width: [**2 inches (50 mm)**].
5. Thickness: [**6 mils (0.15 mm)**].
6. Adhesion: [**64 ounces force/inch (0.7 N/mm)**] in width.
7. Elongation: [**500**] percent.
8. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**] in width.

D. Vapor-Retarder Tape Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]

2. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
3. Width: [**2 inches (50 mm)**].
4. Thickness: [**3.7 mils (0.093 mm)**].
5. Adhesion: [**100 ounces force/inch (1.1 N/mm)**] in width.
6. Elongation: [**5**] percent.
7. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**] in width.

2.19 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]

2. Insulation Bands - Stainless Steel: ASTM A240/A240M, [Type 304][Type 316] ; 0.015 inch (0.38 mm) thick, [1/2 inch (13 mm)][3/4 inch (19 mm)] wide with [wing seal][closed seal] .
3. Insulation Bands - Aluminum: ASTM B209 (ASTM B209M); Alloy 3003, 3005, 3105, or 5005; Temper H-14; 0.020 inch (0.51 mm) thick, [1/2 inch (13 mm)][3/4 inch (19 mm)] wide with [wing seal][closed seal] .
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Hangers - Metal, Adhesively Attached, Perforated Base:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]

b. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
c. Baseplate: Perforated, galvanized carbon steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
d. Spindle: [**Copper- or zinc-coated, low carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
e. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation Hangers - Self-Sticking-Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]

b. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
c. Baseplate Material: Galvanized carbon steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
d. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
e. Adhesive-backed base with a peel-off protective cover.

3. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]

b. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]

2. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.20 INSULATION CORNER ANGLES

A. Insulation Corner Angles - PVC:

1. Thickness: [**30 mils (0.8 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Insulation Corner Angles - Aluminum:

1. Thickness: [**0.040 inch (1.0 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**; Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angles - Stainless Steel:

1. Thickness: [**0.024 inch (0.61 mm)**].
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [Type 304][Type 316] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with epoxy primer **5 mils (0.127 mm)** thick and epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range of between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF FIRE-SUPPRESSION SYSTEM INSULATION, GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [unless otherwise approved by engineer of record] .

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

R. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [prefabricated fitting insulation][mitered or routed fittings] made from same material and density as adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [prefabricated fitting insulation][sectional pipe insulation] of same material

and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using [prefabricated fitting insulation][sectional pipe insulation] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [prefabricated fitting insulation][sectional pipe insulation] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

S. Insulate instrument connections for pressure gauges, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

T. Install removable insulation covers [**at locations indicated on Drawings**] . Installation complies with the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF GLASS-FIBER FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral wool blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Insulation Installation on Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated sections are unavailable, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF MINERAL WOOL FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

   a. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
   d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral wool blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated sections are unavailable, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF CALCIUM SILICATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

   a. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
   b. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
   c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

2. Pipe Flanges:

   a. Install prefabricated pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
   d. Finish flange insulation same as pipe insulation.

3. Pipe Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
   b. When prefabricated insulation sections of insulation are unavailable, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   c. Finish fittings insulation same as pipe insulation.

4. Valves and Pipe Specialties:

a. Install pipe insulation, quads, hex sections, or beveled lag segments, adhered together, to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
b. Install insulation to flanges as specified for flange insulation application.
c. Finish valve and specialty insulation same as pipe insulation.

3.8 INSTALLATION OF CELLULAR-GLASS FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as straight segments of pipe insulation when available.
b. When preformed sections of insulation are unavailable, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

a. Install prefabricated sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF FLEXIBLE ELASTOMERIC FIRE-SUPPRESSION SYSTEM INSULATION

A. Installation on the following:

1. Equipment and Tanks:

a. Apply [**100**] percent coverage of adhesive to surface with manufacturer's recommended adhesive.
b. Seal longitudinal seams and end joints.

2. Pipe Flanges:

a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

a. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

a. Install preformed valve covers manufactured of same material as pipe insulation when available.
b. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Finish: After adhesive has fully cured, apply two coats of insulation and manufacturer's recommended protective coating.

3.10 INSTALLATION OF PHENOLIC FIRE-SUPPRESSION SYSTEM INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.

B. Insulation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.

c. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

3. Pipe Fittings and Elbows:

a. Install prefabricated insulation sections, or mitered or routed fittings, of same material as straight segments of pipe insulation.

4. Valves and Pipe Specialties:

a. Install preformed insulation sections of same material as straight segments of pipe insulation.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE FIRE-SUPPRESSION SYSTEM INSULATION

A. Insulation on the following:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
b. For insulation with jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation is tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

2. Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed **1-1/2-inch (38-mm)** thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

3. Fittings and Elbows:

   a. Install prefabricated sections of same material as straight segments of pipe insulation.

4. Valves and Pipe Specialties:

   a. Install prefabricated sections of polyisocyanurate insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

3.12 INSTALLATION OF POLYOLEFIN FIRE-SUPPRESSION SYSTEM INSULATION

A. Insulation on the following:

1. Straight Pipes and Tubes:

   a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive [or via self-seal mechanism] to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Flanges:

   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

   a. Install mitered sections of polyolefin pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

   a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 INSTALLATION OF WOVEN GLASS-FIBER CLOTH FOR INSULATION

A. Where woven glass-fiber cloths are indicated, install directly over bare insulation or insulation with factory-applied facings.

1. Draw cloths smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.14 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints.
2. Seal with manufacturer's recommended adhesive.
3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.15 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in [**Section 099113 "Exterior Painting"**][**Section 099114 "Exterior Painting (MPI Standards)**] and [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

1. Flat Acrylic Finish: [**Two**] finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work, as directed by the Owner.

C. Do not field paint aluminum or stainless steel jackets.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**] location(s) for each type of equipment defined in the "Fire-Suppression Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance, as directed by the Owner.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**] locations of straight pipe, [**three**] locations of threaded fittings, [**three**] locations of welded fittings, [**two**] locations of threaded strainers, [**two**] locations of welded strainers, [**three**] locations of threaded valves, and [**three**] locations of flanged valves for each pipe service defined in the "Fire-Suppression System Piping Insulation Schedule, General" Article, as directed by the Owner.
3. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.17 DIESEL FIRE PUMP ENGINE EXHAUST INSULATION SCHEDULE

A. Indoor and Outdoor, Exposed, Rigid, Engine Exhaust Pipe and Silencer:

1. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

3.18 FIRE-SUPPRESSION EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Fire-suppression water storage tank insulation is to be one of the following:

1. Fire-Suppression System Insulation - Cellular Glass: [**2 inches (50 mm)**] thick.
2. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**] thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**] thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Pipe Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**] thick.
5. Pipe Insulation - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**] thick.
6. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**] thick.
7. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**] thick.

3.19 FIRE-SUPPRESSION SYSTEM PIPING INSULATION SCHEDULE, GENERAL

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Indoor fire-suppression piping.
2. Underground piping.

3.20 INDOOR FIRE-SUPPRESSION SYSTEM PIPING INSULATION SCHEDULE

A. Indoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.

B. Indoor Fire Pump Engine Exhaust Piping and Silencer:

1. All Pipe Sizes: Insulation is to be the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Fire-Suppression Water Piping:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Phenolic: [**2 inches (50 mm)**] thick.

B. Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.

C. Outdoor Fire Pump Engine Exhaust Piping and Silencer:

1. All Pipe Sizes: Insulation is to be the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**] thick.

D. Outdoor Fire-Suppression Piping Filled with Water:

1. All Pipe Sizes: Insulation is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**] thick.
b. Pipe Insulation Flexible Elastomeric: [**2 inches (50 mm)**] thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**] thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**] thick.
e. Pipe Insulation - Phenolic: [**2 inches (50 mm)**] thick.
f. Pipe Insulation - Polyisocyanurate: [**2 inches (50 mm)**] thick.
g. Pipe Insulation - Polyolefin: [**2 inches (50 mm)**] thick.

3.22 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

4. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.23 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Equipment, Exposed, up to **48 Inches (1200 mm)** in Diameter or with Flat Surfaces up to **72 Inches (1800 mm)**:

1. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

2. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed][with Z-shaped locking seam] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed, Larger Than **48 Inches (1200 mm)** in Diameter or with Flat Surfaces Larger Than **72 Inches (1800 mm)**:

1. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) as recommended deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

2. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Stainless Steel: [Type 304][Type 316] , [smooth,][stucco embossed,] with [1-1/4-inch- (32-mm-) deep corrugations][2-1/2-inch- (65-mm-) deep corrugations][4-by-1-inch (100-by-25-mm) box ribs] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

F. Outdoor Exposed Piping:

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [Type 304][Type 316] , [smooth No. 2B finish][corrugated][stucco embossed][with Z-shaped locking seam] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

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SECTION 21 10 00 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-suppression piping, fittings, and appurtenances.
2. Fire department connections.
3. Hose connections and hose stations.
4. System control valves.
5. Dry-sprinkler system nitrogen generator with purge/vent.
6. Preaction sprinkler system nitrogen generator with purge/vent.
7. Fire-suppression piping specialties.
8. Cover systems for sprinkler piping.
9. Sprinklers.
10. Alarm devices.
11. Manual control stations.
12. Control panels.
13. Pressure gauges.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for site fire-suppression water-service and backflow prevention devices.

1.2 DEFINITIONS

A. Standard-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure of **175 psig (1200 kPa)** maximum.

B. High-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure higher than standard **175 psig (1200 kPa)**, but not higher than [**250 psig (1725 kPa)**][**300 psig (2070 kPa)**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Include construction details, material descriptions, dimensions of individual components and profiles.
   b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Shop Drawings:

1. Prepare in accordance with [**NFPA 13**][**and**][**NFPA 14**] section "Working Plans."

   a. Include plans, elevations, and sections of the system piping and details.
   b. Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-suppression system.
   c. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Prepare computer-generated hydraulic calculations in accordance with the following:

   a. Minimum operating pressure at hydraulically most remote fire hose valve is to be [**100 psig (690 kPa)**].
   b. Name of hydraulic program used.
   c. Water supply information, including fire hydrant flow test data report.

3. Submit documents and calculations [**signed and sealed by qualified professional engineer responsible for their preparation**][**and**][**prepared by NICET Level III-certified technician, "Water-Based Systems Layout."**][**prepared by NICET Level IV-certified technician, "Water-Based Systems Layout."**][**NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.**]
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For fire-suppression systems indicated to comply with performance requirements and design criteria, including analysis data, [**signed and sealed by the qualified professional engineer responsible for their preparation.**][**prepared by NICET Level III-certified technician, "Water-Based Systems Layout."**][**prepared by NICET Level IV-certified technician, "Water-Based Systems Layout."**][**NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.**]

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fire-suppression system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For fire-suppression equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For qualified Installer[**and professional engineer**][**and NICET-certified technician**].

D. Design Data: Approved fire-suppression piping working plans, prepared in accordance with [**NFPA**

13][**and**][**NFPA 14**], including documented approval by AHJs, and including hydraulic calculations if applicable.

E. Welding certificates.

F. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in [**NFPA 13**][**and**][**NFPA 14**]. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
2. System control valves.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by [**qualified professional engineer.**][**NICET Level III-certified technician, "Water-Based Systems Layout."**][**NICET Level IV-certified technician, "Water-Based Systems Layout."**]

B. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

1.8 FIELD CONDITIONS

A. Interruption of Existing Fire-Suppression Service: Do not interrupt fire-suppression service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**the Owner**] no fewer than [**seven**] days in advance of proposed interruption of fire-suppression service, as directed by the Owner.
2. Do not proceed with interruption of fire-suppression service without [**Architect's**][**Construction Manager's**][**the Owner's**] written permission, as directed by the Owner.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Automatic wet-type, [**Class I**][**Class II**][**Class III**] standpipe system.

B. Automatic dry-type, [**Class I**][**Class II**][**Class III**] standpipe system.

C. Semiautomatic dry-type, [**Class I**][**Class II**][**Class III**] standpipe system.

D. Manual wet-type, Class I standpipe system.

E. Manual dry-type, Class I standpipe system.

F. Automatic combination wet-type standpipe sprinkler system.

G. Automatic wet-pipe sprinkler system.

H. Automatic dry-pipe sprinkler.

I. Automatic deluge sprinkler system.

J. Automatic single-interlock preaction sprinkler system.

K. Automatic double-interlock preaction sprinkler system.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-suppression system piping to withstand the effects of earthquake motions determined in accordance with [**NFPA 13**][**NFPA 14**][**and**][**ASCE/SEI 7**]. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

B. Fire-Suppression System Components, Devices, and Accessories: Listed in ULSE's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Fire-suppression system equipment, specialties, accessories, installation, and testing to comply with [**NFPA 13**][**NFPA 13R**][**NFPA 14**][**NFPA 13D**][**and**][**ASME A17.1**].

E. Standard-Pressure Piping System Component: Listed for **175 psig (1200 kPa)** minimum working pressure.

F. High-Pressure Piping System Component: Listed for [**250 psig (1725 kPa) minimum**][**300 psig (2070 kPa)**] working pressure.

G. Delegated Design: Engage a [**qualified professional engineer**][**NICET Level III-certified technician, "Water-Based Systems Layout"**][**NICET Level IV-certified technician, "Water-Based Systems Layout"**] to design fire-suppression systems.

1. Fire-Hydrant Flow Test:

   a. Fire-hydrant flow test must be performed within previous [**12**] months prior to completion of design documents and hydraulic calculations.

2. Margin of Safety for Available Water Flow and Pressure: [**10**][**20**] percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:

   a. Automobile Parking and Showrooms: [**Ordinary Hazard, Group 1**].
   b. Churches: [**Light Hazard**].
   c. Dry Cleaners: [**Ordinary Hazard, Group 2**].
   d. Educational: [**Light Hazard**].
   e. Electrical Equipment Rooms: [**Ordinary Hazard, Group 1**].
   f. Elevator Machine Room and Hoistway: [**Ordinary Hazard, Group 1**].
   g. Exterior Loading Docks, Only Handling Ordinary Combustibles: [**Ordinary Hazard, Group 2**].
   h. General Storage Areas: [**Ordinary Hazard, Group 1**].
   i. Hospitals, including Animal Hospitals and Veterinary Facilities: [**Light Hazard**].
   j. Institutional: [**Light Hazard**].
   k. Laundries: [**Ordinary Hazard, Group 1**].
   l. Libraries, except Large Stack Rooms: [**Light Hazard**].
   m. Libraries, Large Stack Rooms: [**Ordinary Hazard, Group 2**].
   n. Machine Shops: [**Ordinary Hazard, Group 2**].
   o. Mechanical Equipment Rooms: [**Ordinary Hazard, Group 1**].
   p. Mercantile: [**Ordinary Hazard, Group 2**].
   q. Museums: [**Light Hazard**].
   r. Nursing or Convalescent Homes: [**Light Hazard**].
   s. Offices, including Data Processing: [**Light Hazard**].
   t. Plastics Processing Areas: [**Extra Hazard, Group 2**].
   u. Post Offices: [**Ordinary Hazard, Group 2**].
   v. Printing Plants: [**Extra Hazard, Group 1**].
   w. Printing and Publishing: [**Ordinary Hazard, Group 2**].
   x. Repair Garages: [**Ordinary Hazard, Group 2**].
   y. Residential: [**Light Hazard**].
   z. Restaurant Seating Areas: [**Light Hazard**].
   aa. Restaurant Service Areas: [**Ordinary Hazard, Group 1**].
   bb. Solvent Cleaning Areas: [**Extra Hazard, Group 2**].
   cc. Stages: [**Ordinary Hazard, Group 2**].
   dd. Theaters and Auditoriums, excluding Stages and Prosceniums: [**Light Hazard**].
   ee. Upholstering Plants: [**Extra Hazard, Group 1**].

4. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Residential (Dwelling) Occupancy: [**0.05 gpm/sq. ft. over 400 sq. ft. (2.04 mm/min. over 37.2 sq. m)**] area.
   b. Light-Hazard Occupancy: [**0.10 gpm/sq. ft. over 1500 sq. ft. (4.1 mm/min. over 140 sq. m)**] area.
   c. Ordinary-Hazard, Group 1 Occupancy: [**0.15 gpm/sq. ft. over 1500 sq. ft. (6.1 mm/min. over 140 sq. m)**] area.
   d. Ordinary-Hazard, Group 2 Occupancy: [**0.20 gpm/sq. ft. over 1500 sq. ft. (8.2 mm/min. over 140 sq. m)**] area.

e. Extra-Hazard, Group 1 Occupancy: [**0.30 gpm/sq. ft. over 2500 sq. ft. (12.2 mm/min. over 230 sq. m)**] area.
f. Extra-Hazard, Group 2 Occupancy: [**0.40 gpm/sq. ft. over 2500 sq. ft. (16.3 mm/min. over 230 sq. m)**] area.
g. Special Occupancy Hazard: As determined by AHJs.

5. Minimum Density for Deluge-Sprinkler Piping Design:

a. Ordinary-Hazard, Group 1 Occupancy: [**0.15 gpm/sq. ft. (6.1 mm/min.)**] over entire area.
b. Ordinary-Hazard, Group 2 Occupancy: [**0.20 gpm/sq. ft. (8.2 mm/min.)**] over entire area.
c. Extra-Hazard, Group 1 Occupancy: [**0.30 gpm/sq. ft. (12.2 mm/min.)**] over entire area.
d. Extra-Hazard, Group 2 Occupancy: [**0.40 gpm/sq. ft. (16.3 mm/min.)**] over entire area.
e. Special Occupancy Hazard: As determined by AHJs.

6. Maximum protection area per sprinkler in accordance with ULSE listing.
7. Maximum Protection Area per Sprinkler:

a. Residential Areas: [**400 sq. ft. (37 sq. m)**].
b. Office Spaces: [**120 sq. ft. (11.1 sq. m)**][**225 sq. ft. (20.9 sq. m)**].
c. Storage Areas: [**130 sq. ft. (12.1 sq. m)**].
d. Mechanical Equipment Rooms: [**130 sq. ft. (12.1 sq. m)**].
e. Electrical Equipment Rooms: [**130 sq. ft. (12.1 sq. m)**].
f. Other Areas: In accordance with [**NFPA 13**][**NFPA 13R**][**NFPA 13D**] recommendations unless otherwise indicated.

8. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: [**100 gpm (6.3 L/s) for 30 minutes**].
b. Ordinary-Hazard Occupancies: [**250 gpm (15.75 L/s) for 60 to 90 minutes**].
c. Extra-Hazard Occupancies: [**500 gpm (31.5 L/s) for 90 to 120 minutes**].

9. Minimum residual pressure at each hose-connection outlet is as follows:

a. NPS 1-1/2 (DN 40) Hose Connections: [**65 psig (450 kPa)**].
b. NPS 2-1/2 (DN 65) Hose Connections: [**100 psig (690 kPa)**].

H. Obtain documented approval of fire-suppression system design from AHJs.

2.3 FIRE-SUPPRESSION PIPING, FITTINGS, AND APPURTENANCES

A. Steel Pipe, Fittings, and Appurtenances:

1. Schedule 40 Steel Pipe: [**Galvanized-**][**and**][**black-**]steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.

a. Standards:

1) UL 852.
2) FM 1630.

b. Factory-applied exterior coating.
c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced

corrosion.
d. Pipe ends may be factory or field formed to match joining method.

2. Schedule 10 Steel Pipe: [**Galvanized-**][**and**][**black-**]steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.

   a. Standards:

      1) UL 852.
      2) FM 1630.

   b. Factory-applied exterior coating.
   c. Factory-applied bacterial resistant internal coating to reduce microbiologically influenced corrosion.
   d. Pipe ends may be factory or field formed to match joining method.

3. Engineered Light-Wall Steel Pipe: [**Galvanized-**][**and**][**black-**]steel pipe, ASTM A135/A135M or ASTM A795/A795M with wall thickness less than Schedule 40. Outside dimension is to be equivalent to Schedule 40.

   a. Standards:

      1) UL 852.
      2) FM 1630.

   b. Factory-applied exterior coating.
   c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
   d. Pipe ends may be factory or field formed to match joining method.

4. Steel Pipe Nipples: [**Galvanized**][**and**][**black**] steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
5. Steel Couplings: [**Galvanized**][**and**][**uncoated**] steel, ASTM A865/A865M, threaded.
6. Gray-Iron Threaded Fittings: [**Galvanized**][**and**][**uncoated**] gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
7. Malleable- or Ductile-Iron Unions: ASME B16.3.
8. Cast-Iron Flanges: ASME B16.1, Class 125.
9. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

   a. Pipe-Flange Gasket Materials: [AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick][ASME B16.21, nonmetallic and asbestos free][EPDM rubber gasket].

      1) Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
      2) Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

   b. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.

10. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

    a. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

11. Plain-End-Pipe Fittings:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Gruvlok; an ASC Engineered Solution**]
2) [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
3) [**Victaulic Company**]

b. Pressure Rating: [**175 psig (1200 kPa)**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**] minimum.
c. Plain-End Fittings for Steel Piping: [**Galvanized**][**Painted**][**Uncoated**] plain-end fittings, ASTM A53/A53M, carbon steel or ASTM A106/A106M, forged steel with dimensions matching steel pipe.
d. Plain-End-Pipe Couplings for Steel Piping: Rigid pattern for steel-pipe dimensions, ductile-iron or malleable-iron housing. Include EPDM-rubber gasket, and bolts and nuts.

12. Grooved-Joint, Steel-Pipe Appurtenances:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**CPS Products, Inc.**]
2) [**Gruvlok; an ASC Engineered Solution**]
3) [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
4) [**Smith-Cooper International**]
5) [**SPF/Anvil; an ASC Engineered Solution**]
6) [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
7) [**Victaulic Company**]

b. Pressure Rating: [**175 psig (1200 kPa)**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**] minimum.
c. Grooved-End Fittings for Steel Piping: [**Galvanized**][**Painted**][**Uncoated**] grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
d. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

13. Carbon Steel Pressure-Seal Fittings: UL 213, FM Approvals-approved, **175 psig (1200 kPa)** pressure rating with carbon steel-, zinc-nickel-coated housing, EDPM O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Mueller Streamline Co.; a company of Mueller Industries**]
2) [**Viega LLC**]

B. Stainless Steel Pipe, Fittings, and Appurtenances:

1. Stainless Steel Pipe: ASTM A312/A312M, [**Type 304/304L**][**Type 316/316L**], Schedule 10S, dimensions conforming to ASME B36.19M.
2. Stainless Steel Pipe Fittings: ASTM A403/A403M.
3. Fittings for Grooved-End, Stainless Steel Pipe:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**GroovJoint**]

    b. Source Limitations: Obtain appurtenance for grooved-end, stainless steel pipe from single manufacturer.
    c. Standards: ASTM A743; ASTM A193/A193M, Class 2; and ASTM A194/A194M, Type 304, Grade 8M.
    d. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**GroovJoint**]

    b. AWWA C606 for stainless steel pipe dimensions.
    c. Stainless steel housing sections.
    d. Stainless steel bolts and nuts.
    e. EPDM-rubber gaskets suitable for hot and cold water.
    f. Minimum Pressure Rating:

        1) NPS 8 (DN 200) and Smaller: [**600 psig (4137 kPa)**].
        2) NPS 10 and NPS 12 (DN 250 to DN 300): [**400 psig (2758 kPa)**].
        3) NPS 14 to NPS 24 (DN 350 to DN 600): [**250 psig (1725 kPa)**].

5. Stainless Steel Piping, Pressure-Seal-Joint Fittings:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**GroovJoint**]
        2) [**Merit Brass Company**]
        3) [**Victaulic Company**]
        4) [**Viega LLC**]

    b. Source Limitations: Obtain pressure-seal-joint fittings from single manufacturer.
    c. Material: [**Type 304**][**Type 316**] stainless steel, ASTM A312/A312M.
    d. Fittings: [**Type 304**][**Type 316**] stainless steel with EPDM O-ring seal in each end, and FM approved for fire protection applications.

C. Copper Tube, Fittings, and Appurtenances:

1. Copper Tube, Drawn Temper: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**].
2. Solder-Joint Fittings, Cast Copper: ASME B16.18 pressure fittings.
3. Solder-Joint Fittings, Wrought Copper: ASME B16.22 pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Unions, Cast Copper: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
6. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
7. Copper Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**T-DRILL Industries Inc**]

    b. Description: Tee formed in copper tube in accordance with ASTM F2014.

8. Grooved, Mechanical-Joint, Copper-Tube Appurtenances:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Gruvlok; an ASC Engineered Solution**]
        2) [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
        3) [**Victaulic Company**]

    b. Standard: UL 213.
    c. Grooved-End Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
    d. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum [**180 deg F (80 deg C)**] for use with ferrous housing and steel bolts and nuts; **300 psig (2070 kPa)** minimum CWP pressure rating.

9. Copper-Tube, Pressure-Seal-Joint Fittings:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Viega LLC**]

    b. Fittings: Cast brass, cast bronze, or wrought copper with EPDM O-ring seal in each end.
    c. Minimum **200 psig (1379 kPa)** working-pressure rating at **250 deg F (121 deg C)**.

D. CPVC Pipe, Fittings, and Appurtenances:

1. CPVC Pipe: ASTM F442/F442M and UL 1821, SDR 13.5, for **175 psig (1200 kPa)** rated pressure at **150 deg F (62 deg C)**, with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE"

markings.

2. CPVC Fittings: [UL listed][FM Approvals approved], for 175 psig (1200 kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.

    a. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F438 and UL 1821, Schedule 40, socket type.
    b. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F439 and UL 1821, Schedule 80, socket type.
    c. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
    d. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
    e. Flanges: CPVC, one or two pieces.

3. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
4. Product Data: Verify adhesive primer has a VOC content of 550 g/L or less.
5. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
8. Product Data: Verify CPVC welding solvent cement has a VOC content of 490 g/L or less.
9. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
10. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
11. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
12. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connection, Exposed Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Croker; a Division of Morris Group International**]
b. [**Elkhart Brass Mfg. Co., Inc**]
c. [**Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International**]
d. [**Guardian Fire Equipment, Inc**]
e. [**Potter Roemer LLC; a Division of Morris Group International**]
f. [**Wilson & Cousins Inc.**]

2. Standard: UL 405.
3. Description: Exposed, projecting, for wall mounting.
4. Pressure Rating: **175 psig (1200 kPa)** minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: [**Two**][**Three**].
11. Escutcheon Plate Marking: [**"AUTO SPKR & STANDPIPE"**][**"STANDPIPE"**][**"AUTO SPKR"**].
12. Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].
13. Outlet Size: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**].

B. Fire Department Connection, Flush Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Croker; a Division of Morris Group International**]
b. [**Elkhart Brass Mfg. Co., Inc**]
c. [**Guardian Fire Equipment, Inc**]
d. [**Potter Roemer LLC; a Division of Morris Group International**]
e. [**Wilson & Cousins Inc.**]

2. Standard: UL 405.
3. Description: Flush, for wall mounting.
4. Pressure Rating: **175 psig (1200 kPa)** minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: [**Horizontal**][**Square**][**Vertical**].
11. Number of Inlets: [**Two**][**Three**][**Four**][**Six**].
12. Outlet Location: [**Back**][**Bottom**][**Left side**][**Right side**][**Top**].
13. Escutcheon Plate Marking: [**"AUTO SPKR & STANDPIPE"**][**"STANDPIPE"**][**"AUTO SPKR"**].
14. Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].
15. Outlet Size: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**][**NPS 8 (DN 200)**].

C. Fire Department Connection, Yard Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Croker; a Division of Morris Group International**]
    b. [**Elkhart Brass Mfg. Co., Inc**]
    c. [**Guardian Fire Equipment, Inc**]
    d. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Standard: UL 405.
3. Description: Exposed, freestanding.
4. Pressure Rating: [**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: [**Two**][**Three**][**Four**].
11. Sleeve: [**Brass**][**Not required**].
12. Sleeve Height: **18 inches (460 mm)**.
13. Escutcheon Plate Marking: [**"AUTO SPKR & STANDPIPE"**][**"STANDPIPE"**][**"AUTO SPKR"**].
14. Finish, Including Sleeve: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].
15. Outlet Size: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**].

D. Fire Department Connection, Auxiliary Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Croker; a Division of Morris Group International**]
    b. [**Guardian Fire Equipment, Inc**]
    c. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Standard: UL 405.
3. Type: [**Exposed**][**Flush**][**Yard (Freestanding)**].
4. Pressure Rating: **175 psig (1200 kPa)** minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Universal, threadless (Storz) connector in accordance with NFPA 1963.
7. Caps: Corrosion-resistant metal, with gasket and chain.
8. Escutcheon Plate: Round, brass.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: One.
11. Escutcheon Plate Marking: [**"AUTO SPKR & STANDPIPE"**][**"STANDPIPE"**][**"AUTO SPKR"**].
12. Finish: [**Polished chrome plated**][**Polished brass**][**Powder coat**].
13. Outlet Size: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**].

2.5 HOSE CONNECTIONS AND HOSE STATIONS

A. Hose Connections, Adjustable Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brooks Equipment Co., Inc**]
    b. [**Croker; a Division of Morris Group International**]
    c. [**Elkhart Brass Mfg. Co., Inc**]
    d. [**Guardian Fire Equipment, Inc**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. [**Wilson & Cousins Inc.**]
    g. [**Zurn Industries, LLC**]

2. Standards:

    a. UL 668.
    b. UL 1468.

3. Description: Fire hose valve, with integral reducing or restricting pressure-control device, for connecting fire hose.
4. Pressure Rating: **175 psig (1200 kPa)** maximum inlet.
5. Material: Brass or bronze.
6. Size: **NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65)**, as indicated.
7. Inlet: Female pipe threads.
8. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
9. Pattern: [Angle][gate].
10. Pressure-Control Device Type: Pressure [**reducing**][**restricting**].
11. Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].

B. Hose Connections, Nonadjustable Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brooks Equipment Co., Inc**]
    b. [**Croker; a Division of Morris Group International**]
    c. [**Elkhart Brass Mfg. Co., Inc**]
    d. [**Guardian Fire Equipment, Inc**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. [**Wilson & Cousins Inc.**]
    g. [**Zurn Industries, LLC**]

2. Standard: UL 668.
3. Description: Fire hose valve for connecting fire hose.
4. Pressure Rating: **300 psig (2070 kPa)** minimum.
5. Material: Brass or bronze.
6. Size: **NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65)**, as indicated.
7. Inlet: Female pipe threads.
8. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
9. Pattern: [Angle][gate].
10. Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].

C. Hose Stations, Rack Type, NPS 1-1/2 (DN 40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brooks Equipment Co., Inc**]
   b. [**Croker; a Division of Morris Group International**]
   c. [**Guardian Fire Equipment, Inc**]
   d. [**Potter Roemer LLC; a Division of Morris Group International**]
   e. [**Wilson & Cousins Inc.**]

2. Hose Rack:

   a. Standard: UL 47.
   b. Material: [**Brass or bronze with polished chrome-plated**][**Steel with red-enamel**] finish.
   c. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
   d. Operation: Semiautomatic.
   e. Sized to hold fire hose.

3. Hose Valve:

   a. Standards:

      1) UL 668.
      2) UL 1468.

   b. **NPS 1-1/2 (DN 40)**, for connecting fire hose.
   c. Type: [**Adjustable**][**Nonadjustable**].
   d. Pressure-Control Device: [Pressure reducing][pressure restricting], UL 1468 integral or for field installation if indicated.
   e. Design Outlet Pressure Setting: [**Not applicable**].
   f. Hose Valve and Trim Finish: [**Polished chrome-plated**][**Rough brass or bronze**][**Rough chrome-plated**].
   g. Pressure Rating: **300 psig (2070 kPa)** minimum.
   h. Pattern: Angle.
   i. Material: Brass or bronze.
   j. Size: **NPS 1-1/2 (DN 40)**.
   k. Inlet: Female pipe threads.
   l. Outlet: Male hose threads in accordance with NFPA 1963 and matching local fire department threads.

4. Hose:

   a. Standards:

      1) NFPA 1961.
      2) UL 219.
      3) UL 401.

   b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
   c. Size: **NPS 1-1/2 (DN 40)**.
   d. Length: [**50 ft. (15 m)**][**75 ft. (23 m)**][**100 ft. (30 m)**].
   e. Jacket: [**Combination of natural and synthetic threads**][**Natural thread**][**Synthetic**

thread].

f. Lining: [**Rubber, plastic, or combination of rubber and plastic compounds**][**Combination of rubber and plastic compounds**][**Rubber compound**][**Plastic compound**].

g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.

h. Nozzle:

1) Material: [**Brass**][**Polished brass**][**Rough chrome-plated brass**][**Polished chrome-plated brass**][**Polycarbonate plastic**].

2) Type: [**Plain, for nonadjustable water stream**][**Spray, adjustable from shutoff to fog spray or straight stream**][**Spray, adjustable from shutoff to full fog; for use on electrical fires**].

D. Hose Stations, Rack Type, NPS 1-1/2 by NPS 2-1/2 (DN 40 by DN 65):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brooks Equipment Co., Inc**]

b. [**Croker; a Division of Morris Group International**]

c. [**Guardian Fire Equipment, Inc**]

d. [**Potter Roemer LLC; a Division of Morris Group International**]

e. [**Wilson & Cousins Inc.**]

2. Hose Rack:

a. Standard: UL 47.

b. Material: [**Brass or bronze with polished chrome-plated**][**Steel with red-enamel**] finish.

c. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.

d. Operation: Semiautomatic.

e. Sized to hold fire hose.

3. Hose Valve:

a. Standards:

1) UL 668.

2) UL 1468.

3) NFPA 1963.

b. **NPS 2-1/2 (DN 65)**, for connecting fire hose.

c. Type: [**Adjustable**][**Nonadjustable**].

d. Pressure-Control Device: [Pressure reducing][pressure restricting], UL 1468 integral or for field installation if indicated.

e. Design Outlet Pressure Setting: [**Not applicable**].

f. Hose Valve and Trim Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].

g. Pressure Rating: **300 psig (2070 kPa)** minimum.

h. Pattern: Angle.

i. Material: Brass or bronze.

j. Size: **NPS 2-1/2 (DN 65)**.

k. Inlet: Female pipe threads.

l. Outlet: Male hose threads and matching local fire department threads.
m. Reducer Adapter: **NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40)**.

4. Hose:

a. Standards:

1) UL 219.
2) UL 401.
3) NFPA 1961.

b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
c. Size: **NPS 1-1/2 (DN 40)**.
d. Length: [**50 ft. (15 m)**][**75 ft. (23 m)**][**100 ft. (30 m)**].
e. Jacket: [**Combination of natural and synthetic threads**][**Natural thread**][**Synthetic thread**].
f. Lining: [**Rubber, plastic, or combination of rubber and plastic compounds**][**Combination of rubber and plastic compounds**][**Rubber compound**][**Plastic compound**].
g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
h. Nozzle: Spray nozzle unless plain nozzle is indicated.

1) Material: [**Brass**][**Polished brass**][**Rough chrome-plated brass**][**Polished chrome-plated brass**][**Polycarbonate plastic**].
2) Type: [**Plain, for nonadjustable water stream**][**Spray, adjustable from shutoff to fog spray or straight stream**][**Spray, adjustable from shutoff to full fog; for use on electrical fires**].

E. Hose Stations, Reel Type, NPS 1-1/2 (DN 40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brooks Equipment Co., Inc**]
b. [**Croker; a Division of Morris Group International**]
c. [**Guardian Fire Equipment, Inc**]
d. [**Potter Roemer LLC; a Division of Morris Group International**]
e. [**Wilson & Cousins Inc.**]

2. Hose Reel:

a. Standard: UL 47.
b. Hose Reel and Bracket Material: Steel.
c. Description: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
d. Operation: Semiautomatic.
e. Sized to hold fire hose.
f. Finish: Red enamel.

3. Hose Valve:

a. Standards:

1) UL 668.

2) UL 1468.
3) NFPA 1963.

b. **NPS 1-1/2 (DN 40)**, for connecting fire hose.
c. Type: [**Adjustable**][**Nonadjustable**].
d. Pressure-Control Device: [Pressure reducing][pressure restricting], UL 1468 integral or for field installation if indicated.
e. Design Outlet Pressure Setting: [**Not applicable**].
f. Hose Valve and Trim Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].
g. Pressure Rating: **300 psig (2070 kPa)** minimum.
h. Pattern: Angle.
i. Material: Brass or bronze.
j. Size: **NPS 1-1/2 (DN 40)**.
k. Inlet: Female pipe threads.
l. Outlet: Male hose threads and matching local fire department threads.

4. Hose:

a. Standards:

1) UL 219.
2) UL 401.
3) NFPA 1961.

b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
c. Size: **NPS 1-1/2 (DN 40)**.
d. Length: [**50 ft. (15 m)**][**75 ft. (23 m)**][**100 ft. (30 m)**].
e. Jacket: [**Combination of natural and synthetic threads**][**Natural thread**][**Synthetic thread**].
f. Lining: [**Rubber, plastic, or combination of rubber and plastic compounds**][**Combination of rubber and plastic compounds**][**Rubber compound**][**Plastic compound**].
g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
h. Nozzle:

1) Material: [**Brass**][**Polished brass**][**Rough chrome-plated brass**][**Polished chrome-plated brass**][**Polycarbonate plastic**].
2) Type: Spray, adjustable from shutoff to [**fog spray or straight stream**][**full fog; for use on electrical fires**].

2.6 SYSTEM CONTROL VALVES

A. Listed in ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Valves: **175 psig (1200 kPa)** minimum.
2. High-Pressure Piping Valves: [**250 psig (1725 kPa) minimum**][**300 psig (2070 kPa)**].

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. System Control Valve, Alarm Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   b. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   c. [**Venus Fire Protection Ltd.**]
   d. [**Victaulic Company**]
   e. [**Viking Group Inc.**]

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges,[**retarding chamber,**] and fill-line attachment with strainer.
5. Drip cup assembly pipe drain [**without valves and separate from main drain piping**][**with check valve to main drain piping**].

G. System Control Valve, Dry-Pipe Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   b. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   c. [**Venus Fire Protection Ltd.**]
   d. [**Victaulic Company**]
   e. [**Viking Group Inc.**]

2. Standards:

   a. UL 260.
   b. UL 1486.

3. Design: Differential-pressure type.
4. Include quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
5. Air-Pressure Maintenance Device for Dry-Pipe Valve:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**General Air Products, Inc**]
      2) [**Potter Electric Signal Company, LLC**]
      3) [**Reliable Automatic Sprinkler Co., Inc. (The)**]
      4) [**Tyco Fire Products; brand of Johnson Controls International plc, Building**

Solutions North America]
5) [**Venus Fire Protection Ltd.**]
6) [**Victaulic Company**]
7) [**Viking Group Inc.**]

b. Standard: UL 260.
c. Description: Automatic device to maintain minimum air pressure in piping.
d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with **14 to 60 psig (95 to 410 kPa)** adjustable range, and [**175 psig (1200 kPa)**][**300 psig (2070 kPa)**] outlet pressure.

6. Air Compressor for Dry-Pipe Valve:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Gast Manufacturing Inc**]
2) [**General Air Products, Inc**]
3) [**Viking Group Inc.**]

b. Motor Horsepower: Fractional.
c. Power: 120 V ac, 60 Hz, single phase.
d. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
e. Include filters, relief valves, coolers, automatic drains, and gauges.

H. System Control Valve, Deluge Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BERMAD Control Valves**]
b. [**CLA-VAL**]
c. [**OCV Control Valves**]
d. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
e. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. [**Venus Fire Protection Ltd.**]
g. [**Victaulic Company**]
h. [**Viking Group Inc.**]

2. Standard: UL 260.
3. Design: Hydraulically operated, differential-pressure type.
4. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
5. Wet, Pilot-Line Trim Set: Include gauge to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.

I. System Control Valve, Preaction Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BERMAD Control Valves**]
   b. [**OCV Control Valves**]
   c. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   d. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   e. [**Venus Fire Protection Ltd.**]
   f. [**Victaulic Company**]
   g. [**Viking Group Inc.**]

2. Standard: UL 260.
3. Design: Hydraulically operated, differential-pressure type.
4. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
5. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gauges; low-air-pressure warning switch; air-relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
6. Air-Pressure Maintenance Device for Preaction Valve:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Reliable Automatic Sprinkler Co., Inc. (The)**]
      2) [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
      3) [**Venus Fire Protection Ltd.**]
      4) [**Victaulic Company**]
      5) [**Viking Group Inc.**]

   b. Standard: UL 260.
   c. Description: Automatic device to maintain minimum air pressure in piping.
   d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with **14 to 60 psig (95 to 410 kPa)** adjustable range, and [**175 psig (1200 kPa)**][**300 psig (2070 kPa)**] outlet pressure.

7. Air Compressor for Preaction Valve:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Gast Manufacturing Inc**]

2) [**General Air Products, Inc**]
3) [**Viking Group Inc.**]

b. Motor Horsepower: Fractional.
c. Power: 120 V ac, 60 Hz, single phase.
d. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
e. Include filters, relief valves, coolers, automatic drains, and gauges.

2.7 DRY-SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Engineered Corrosion Solutions**]
2. [**General Air Products, Inc**]
3. [**Potter Electric Signal Company, LLC**]
4. [**South-Tek Systems, LLC**]
5. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
6. [**UNITED Fire Systems**]

B. Description: Nitrogen generator system to serve dry sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.

C. Standards:

1. FM 1035.
2. UL 508A.

D. Nitrogen Generator:

1. [Wall-mounted][skid-mounted][stand-alone] nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
2. Power: 120 V ac.
3. Bypass mode and nitrogen-generating mode.
4. Minimum Capacity: [**As recommended by manufacturer**].

E. Air Compressor:

1. Standard: ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
2. Motor Horsepower: Fractional.

   a. Power: 120 V ac, 60 Hz, single phase.

3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
4. Include filters, relief valves, coolers, automatic drains, and gauges.

5. Minimum Capacity: Match capacity of nitrogen generator.

F. Automatic Purge Vent/Valve:

1. Vents oxygen during system nitrogen fill.
2. Automatically closes when 98 percent minimum nitrogen has been reached.
3. Sized to allow correct purge rate per manufacturer's written instructions and with [**14 days**].
4. Provide one venting device for each dry/preaction sprinkler system zone.
5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.

G. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:

1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of the automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.

H. BAS Alarm Integration:

1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller[**and connect to BAS**].

   a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
   b. Air bypass alarm is to activate if nitrogen-generation system is bypassed by air compressor.

2.8 PREACTION SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Engineered Corrosion Solutions**]
2. [**General Air Products, Inc**]
3. [**Potter Electric Signal Company, LLC**]
4. [**South-Tek Systems, LLC**]

B. Description: Nitrogen generator system to serve preaction sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.

C. Standards:

1. FM 1035.
2. UL 508A.

D. Nitrogen Generator:

1. [Wall-mounted][skid-mounted][stand-alone] nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
2. Power: 120 V ac.
3. Bypass mode and nitrogen-generating mode.

4. Minimum Capacity: [**As recommended by manufacturer**].

E. Air Compressor:

1. Standard: ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
2. Motor Horsepower: Fractional.

   a. Power: 120 V ac, 60 Hz, single phase.

3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
4. Include filters, relief valves, coolers, automatic drains, and gauges.
5. Minimum Capacity: Match capacity of nitrogen generator.

F. Automatic Purge Vent/Valve:

1. Vents oxygen during system nitrogen fill.
2. Automatically closes when 98 percent minimum nitrogen has been reached.
3. Sized to allow correct purge rate per manufacturer's written instructions and with [**14 days**].
4. Provide one venting device for each dry/preaction sprinkler system zone.
5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.

G. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:

1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.

H. BAS Alarm Integration:

1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller[**and connect to BAS**].

   a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
   b. Air bypass alarm is to alarm if nitrogen-generation system is bypassed by air compressor.

2.9 FIRE-SUPPRESSION PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   b. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   c. [**Victaulic Company**]

2. Standard: UL 213.
3. Pressure Rating: [**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AGF Manufacturing, Inc.**]
   b. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   c. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   d. [**Victaulic Company**]

2. Standard: ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
3. Pressure Rating: [**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AGF Manufacturing, Inc.**]
   b. [**Croker; a Division of Morris Group International**]
   c. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Standard: UL 199.
3. Pressure Rating: **175 psig (1200 kPa)**.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AGF Manufacturing, Inc.**]
   b. [**Reliable Automatic Sprinkler Co., Inc. (The)**]

c. [**Viking Group Inc.**]

2. Standard: ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
3. Pressure Rating: [**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aegis Technologies, Inc.**]

2. Standard: UL 1474.
3. Pressure Rating: [**250 psig (1725 kPa) minimum**][**300 psig (2070 kPa)**].
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALEUM USA**]
   b. [**Easyflex, Inc.**]
   c. [**Flexhead; an ASC Engineered Solution**]
   d. [**Gateway Tubing, Inc.**]
   e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   f. [**Victaulic Company**]

2. Standards:

   a. UL 2443.
   b. FM 1637.

3. Description: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: [**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
5. Size: Same as connected piping, for sprinkler.

G. Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CLA-VAL**]
b. [**Croker; a Division of Morris Group International**]
c. [**Elkhart Brass Mfg. Co., Inc**]
d. [**Guardian Fire Equipment, Inc**]
e. [**OCV Control Valves**]
f. [**Potter Roemer LLC; a Division of Morris Group International**]
g. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
h. [**Victaulic Company**]
i. [**Wilson & Cousins Inc.**]
j. [**Zurn Industries, LLC**]

2. UL 668 hose valve, with integral UL 1468 reducing device.
3. Pressure Rating: **300-psig (2070-kPa)** minimum.
4. Material: Brass or bronze.
5. Inlet: Female pipe threads.
6. Outlet: Threaded with or without adapter having male hose threads.
7. Pattern: [Angle][gate].
8. Finish: [**Polished chrome plated**][**Rough brass or bronze**][**Rough chrome plated**].

H. Automatic (Ball-Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
b. [**Viking Group Inc.**]

2. Pressure Rating: **175 psig (1200 kPa)** minimum.
3. Type: Automatic draining, ball check.
4. Size: **NPS 3/4 (DN 20)**.
5. End Connections: Threaded.

I. Manual Air Vent/Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGF Manufacturing, Inc.**]

2. Description: Ball valve that requires human intervention to vent air.
3. Body: Forged brass.
4. Ends: Threaded.
5. Minimize Size: **1/2 inch (13 mm)**.
6. Minimum Water Working Pressure Rating: **300 psig (2070 kPa)**.

J. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGF Manufacturing, Inc.**]
b. [**CLA-VAL**]
c. [**Engineered Corrosion Solutions**]
d. [**Metraflex Company (The)**]
e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]

2. Description: Automatic air vent that automatically vents trapped air without human intervention. Approved for use in wet-pipe fire-suppression system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: **175 psig (1207 kPa)**.

K. Automatic Air Vent Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AGF Manufacturing, Inc.**]
b. [**Engineered Corrosion Solutions**]
c. [**South-Tek Systems, LLC**]

2. Description: Automatic [**dual**]air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly. Approved for use in wet-pipe fire-suppression system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: **175 psig (1207 kPa)**.

2.10 COVER SYSTEMS FOR SPRINKLER PIPING

A. Cover System, Extruded PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DecoShield Systems, Inc.**]

2. Description: System of support brackets and covers designed to protect sprinkler piping.
3. Brackets: Per cover manufacturer.
4. Covers: Factory-fabricated extruded-PVC cover with concealed attachment clips.

B. Cover System, Fabricated Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JG Innovations, Inc.**]

2. Description: System of support brackets and covers designed to protect sprinkler piping.
3. Brackets: Per cover manufacturer.
4. Covers: Factory-fabricated steel cover with concealed attachment clamps.

    a. Stainless Steel with #4 Finish: [**16**][**18**][**20**][**22**][**24**] gauge.
    b. Cold-Rolled Steel: [**18**][**20**][**22**][**24**] gauge.

        1) Zinc-galvanized treated to accept painting but not painted.
        2) Zinc galvanized, factory treated, and factory painted in colors selected by Architect from manufacturers standard/custom colors, as directed by the Owner.
        3) Zinc galvanized, factory treated, and factory primed.

2.11 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
2. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
3. [**Victaulic Company**]
4. [**Viking Group Inc.**]

B. Standards:

1. UL 199.
2. UL 1626.
3. UL 1767.
4. FM 2000.
5. FM 2008.
6. FM 2030.

C. Listed in ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

D. Pressure Rating for Sprinklers:

1. Standard Automatic Sprinklers: **175 psig (1200 kPa)** minimum.
2. High-Pressure Automatic Sprinklers: [**250 psig (1725 kPa) minimum**][**300 psig (2070 kPa)**].
3. Residential Sprinklers: **175 psig (1200 kPa)** maximum.

E. Sprinklers, Automatic Wet with Heat-Responsive Element:

1. Characteristics: Nominal **1/2-inch (13-mm)** orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
2. Standard Spray, Standard Response:

    a. Upright.
    b. Pendent.
    c. Recessed pendent.
    d. Flat, concealed pendent.
    e. Vertical sidewall.
    f. Horizontal sidewall.

3. Standard Spray, Quick Response:

a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Vertical sidewall.
f. Horizontal sidewall.
g. Flat, concealed horizontal sidewall.

4. Extended Coverage:

a. Upright.
b. Pendent.
c. Flat, concealed pendent.
d. Horizontal sidewall.
e. Flat, concealed horizontal sidewall.

5. Residential:

a. Recessed pendent.
b. Flat, concealed pendent.
c. Flat, concealed horizontal sidewall.

F. Sprinklers, Automatic Dry with Heat-Responsive Element:

1. Standard Spray, Standard Response:

a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Horizontal sidewall.

2. Standard Spray, Quick Response:

a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Horizontal sidewall.
f. Flat, concealed horizontal sidewall.

G. Special Sprinklers:

1. Attic.
2. Combustible, concealed.
3. ESFR.
4. Flat spray.
5. Hallway.
6. Institutional.
7. MRI/Non-Ferrous, concealed.
8. Window.

H. Open Sprinklers and Nozzles:

1. Nominal Orifice:

a. **1/2 inch (13 mm)**, with discharge coefficient K between [**5.3 and 5.8**].
b. **17/32 inch (13.5 mm)** with discharge coefficient K between [**7.4 and 8.2**].

I. Sprinkler Finishes: [**Chrome plated**][**bronze**][**and**][**painted**].

J. Special Coatings: [**Wax**][**lead**][**and**][**corrosion-resistant paint**].

K. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: [**Chrome-plated steel, one piece, flat**][**Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment**][**Plastic, white finish, one piece, flat**].
2. Sidewall Mounting: [**Chrome-plated steel**][**Plastic, white finish**], one piece, flat.

L. Sprinkler Guards and Water Shields:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
b. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
c. [**Victaulic Company**]
d. [**Viking Group Inc.**]

2. Standard: UL 199.
3. Description: Wire cage with fastening device for attaching to sprinkler.

2.12 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
b. [**Victaulic Company**]
c. [**Viking Group Inc.**]

2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: [8-1/2-inch (216-mm)][10-inch (250-mm)] diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: **NPS 3/4 (DN 20)**.
8. Outlet: **NPS 1 (DN 25)** drain connection.

C. Electrically Operated Notification Appliances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Notifier; Honeywell International, Inc.**]
    b. [**Potter Electric Signal Company, LLC**]

2. Electric Bell:

    a. Standard: UL 464.
    b. Type: Vibrating, metal alarm bell.
    c. Size: [**6-inch (150-mm) minimum-**][**8-inch (200-mm) minimum-**][**10-inch (250-mm)**] diameter.
    d. Voltage: [**120 V ac, 60 Hz, single phase**][**24 V dc**].
    e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.

3. Strobe/Horn:

    a. Standard: UL 464.
    b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
    c. Voltage: 120 V ac, 60 Hz.
    d. Effective Intensity: 110 cd.
    e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
    f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police or fire department.

D. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Potter Electric Signal Company, LLC**]
    b. [**System Sensor; Honeywell International, Inc.**]
    c. [**Viking Group Inc.**]

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: **250 psig (1725 kPa)**.
7. Design Installation: Horizontal or vertical.

E. Pressure Switches - Water-Flow Alarm Detection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Potter Electric Signal Company, LLC**]
b. [**System Sensor; Honeywell International, Inc.**]

2. Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
3. Components: Two single-pole, double-throw switches with normally closed contacts.
4. Design Operation: Rising pressure to [**6 psi (40 kPa), plus or minus 2 psi (13.8 kPa)**] signals water flow.
5. Adjustability: Each switch is to be independently adjustable.
6. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.

F. Pressure Switches - Low/High Air Pressure Supervisory:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Potter Electric Signal Company, LLC**]
b. [**System Sensor; Honeywell International, Inc.**]

2. Description: Electrically supervised pressure supervisory switch.
3. Components: Two single-pole, double-throw switches.
4. Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
5. Adjustability: Each switch is to be independently adjustable.
6. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.

G. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kennedy Valve Company; a division of McWane, Inc.**]
b. [**Potter Electric Signal Company, LLC**]
c. [**System Sensor; Honeywell International, Inc.**]

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Design: Signals that controlled valve is in other than fully open position.
5. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. OS&Y Valve Supervisory Switches:

a. One or two single-pole, double-throw switches.
b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully

open.
d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
e. Trip Rod Length: Adjustable

8. Butterfly Valve Supervisory Switches:

a. Two single-pole, double-throw switches.
b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Removable nipple.
d. Trip Rod Length: Adjustable

9. Ball Valve Supervisory Switches:

a. One single-pole, double-throw switch.
b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to **NPS 2 (DN 50)**.

H. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Potter Electric Signal Company, LLC**]
b. [**System Sensor; Honeywell International, Inc.**]

2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.13 MANUAL CONTROL STATIONS

A. Listed in ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide"

B. Description: For hydraulic operation, with union, **NPS 1/2 (DN 15)** pipe nipple, and bronze ball valve.

C. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.14 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.

1. Listed in ULSE's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.

2. Electrical characteristics are 120 V ac, 60 Hz, with 24 V dc rechargeable batteries.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Manual Control Stations, Electric Operation: Metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

C. Manual Control Stations, Hydraulic Operation: Provide union, **NPS 1/2 (DN 15)** pipe nipple, and bronze ball valve. Include metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

D. Panel Components:

1. Power supply.
2. Battery charger.
3. Standby batteries.
4. Field-wiring terminal strip.
5. Electrically supervised solenoid valves and polarized fire-alarm bell.
6. Lamp test facility.
7. Single-pole, double-throw auxiliary alarm contacts.
8. Rectifier.

2.15 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AGF Manufacturing, Inc.**]
2. [**Ametek U.S. Gauge**]
3. [**Ashcroft Inc**]
4. [**Brecco Corporation**]
5. [**WIKA Instrument Corporation**]

B. Standard: UL 393.

C. Dial Size: **3-1/2- to 4-1/2-inch (90- to 115-mm)** diameter.

D. Pressure Gauge Range: [**0 to 250 psig (0 to 1725 kPa) minimum**][**0 to 300 psig (0 to 2070 kPa)**].

E. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gauge: Include[**retard feature and**] "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.

1. Flow test is to be performed to meet the criteria established by [**NFPA 13**][**and**][**NFPA 14**].

2. Flow test is to be conducted in accordance with NFPA 291.
3. Test is to be performed during a period of ordinary demand for the water system.

    a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.

4. Pitot readings are to be taken at the **2-1/2-inch (65-mm)** orifice connection.
5. The pitot reading is to range from **10 to 35 psig (68.9 kPa to 241.3 kPa)**.
6. Open additional hydrant outlets as needed to control pitot readings.
7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.

B. Flow Test Data Written Report:

1. Flow data report is to be written in accordance with NFPA 291.
2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.

C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.

D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.

E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.2 INSTALLATION OF FIRE-SUPPRESSION WATER-SERVICE PIPING

A. Comply with requirements for fire-suppression water-service piping in Section 331415 "Site Water Distribution Piping."

3.3 INSTALLATION OF DOMESTIC WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression water piping to building's interior domestic water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 331415 "Site Water Distribution Piping."

3.4 INSTALLATION OF FIRE-SUPPRESSION PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from AHJs. File

written approval with Architect before deviating from approved working plans, as directed by the Owner.

2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with [**NFPA 13**][**and**][**NFPA 14**] requirements for installation of fire-suppression piping.

C. Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.

G. Install inspector's test connections in sprinkler system piping, complete with shutoff valve, and sized and located in accordance with NFPA 13.

H. Install fire-suppression system piping with drains for complete system drainage. Extend drain piping to exterior of building where possible.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to exterior of building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe/sprinkler supply. Include pressure gauges with connection not less than **NPS 1/4 (DN 8)** and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

N. Pressurize and check [**dry-pipe**][**preaction**] standpipe or sprinkler system piping and [**air-pressure maintenance devices**][**air compressors**].

O. Fill wet-type fire-suppression system piping with water.

P. Drain dry-type fire-suppression system piping.

1. Install electric heating cables and pipe insulation on fire-suppression piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

3.5 INSTALLATION OF PIPING JOINTS

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end

fittings in accordance with AWWA C606 for steel-pipe grooved joints.

M. Brazed Joints: Join copper tube and fittings in accordance with Copper Development Association's "Copper Tube Handbook," "Brazed Joints" chapter.

N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

P. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3.6 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install wall-type fire department connections.

B. Install yard-type fire department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

C. Install [**two**][**three**] protective pipe bollards [**around**][**on sides of**] each fire department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."

D. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

3.7 INSTALLATION OF HOSE CONNECTIONS AND HOSE STATIONS

A. Examine roughing-in for hose connections and hose stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and hose stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install hose connections adjacent to standpipes.

E. Install freestanding hose connections and hose stations for access and minimum passage restriction.

F. Install **NPS 1-1/2 (DN 40)** hose-connection and hose-station valves with flow-restricting device unless otherwise indicated.

G. Install **NPS 2-1/2 (DN 65)** hose connections with quick-disconnect **NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40)** reducer adapter and flow-restricting device unless otherwise indicated.

H. Install wall-mounted-type hose connections and wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

I. Install freestanding hose stations with support or bracket attached to standpipe.

J. Install hose-reel hose stations on wall with bracket.

3.8 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping in accordance with manufacturer's installation manual and in accordance with NFPA 13 or NFPA 13R for supports.

3.9 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-suppression system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and AHJ.

B. Install listed fire-suppression system shutoff valves in supervised open position, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. System Control Valves:

1. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
2. Install [**dry-pipe**][**and**][**preaction**] valves with trim sets for air supply, drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.

   a. Install air compressor and compressed-air-supply piping.
   b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with [**14 to 60 psig (95 to 410 kPa)**] adjustable range; and [**175 psig (1200 kPa)**] maximum inlet pressure.
   c. Install compressed-air-supply piping from building's compressed-air piping system.

3. Install deluge valves with trim sets for drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.

D. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe fire-suppression system in accordance with NFPA standards. Connect vent into top of fire-suppression piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air

vent.
3. Pipe from outlet of air vent to drain.

3.10 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings symmetrically in center of[**narrow dimension of**] acoustical ceiling panels within tolerance of [**1/2 inch (12.7 mm)**]. Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.11 INSTALLATION OF NITROGEN GENERATOR WITH PURGE/VENT SYSTEM

A. Install in accordance with manufacturer's written installation instructions.

B. Locate purge vent/valve in accordance with manufacturer's written installation instructions.

C. Route alarm signals in code-approved electrical conduit from nitrogen generator system control panel to the supervisory circuit of BAS.

3.12 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect fire-suppression systems in accordance with NFPA standards.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire department equipment.
9. Verify that sprinklers' original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.

C. Fire-suppression piping system will be considered defective if it does not pass tests and inspections.

D. Fire-suppression piping system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.

E. Prepare test and inspection reports.

3.14 CLEANING

A. Clean dirt and debris from fire-suppression system piping, system control valves, sprinklers, and associated components.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.15 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain [**system control valves**][**and**][**pressure-maintenance pumps**].

3.16 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [**threaded ends, cast-iron threaded fittings, and threaded**][**grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved**] joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

D. CPVC pipe, [**Schedule 40**][**Schedule 80**] CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.

E. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 (DN 50) and Smaller, to Be One of the Following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
4. Schedule 40, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
5. Schedule 40, black-steel pipe with [cut-][roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
6. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

8. [Schedule 10][engineered light-wall], steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
9. [Schedule 10][engineered light-wall], steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
10. [Schedule 10][engineered light-wall], steel pipe with plain ends; welding fittings; and welded joints.
11. [Schedule 40][Schedule 10S] steel pipe; steel pressure-seal fittings; and pressure-sealed joints.
12. [Type L (Type B)][Type M (Type C)], hard copper tube with plain ends; [cast-][wrought-]copper, solder-joint fittings; and brazed joints.
13. [**Type L (Type B)**][**Type M (Type C)**], hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
14. **NPS 2 (DN 50)**, [**Type L (Type B)**][**Type M (Type C)**], hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

F. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), to Be One of the Following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40, black-steel pipe with [cut-][roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. [Schedule 10][engineered light-wall], steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. [Schedule 10][engineered light-wall], steel pipe with plain ends; welding fittings; and welded joints.
8. [Type L (Type B)][Type M (Type C)], hard copper tube with plain ends; [cast-][wrought-]copper, solder-joint fittings; and brazed joints.
9. [**Type L (Type B)**][**Type M (Type C)**], hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
10. [**Type L (Type B)**][**Type M (Type C)**], hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

G. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 5 (DN 125) and Larger, to Be One of the Following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40, black-steel pipe with [cut-][roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. [Schedule 10][engineered light-wall], steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. [Schedule 10][engineered light-wall], steel pipe with plain ends; welding fittings; and welded joints.
8. [Type L (Type B)][Type M (Type C)], hard copper tube with plain ends; [cast-][wrought-]copper, solder-joint fittings; and brazed joints.
9. [**Type L (Type B)**][**Type M (Type C)**], hard copper tube with roll-grooved ends; copper, grooved-

end fittings; grooved-end-tube couplings; and grooved joints.

H. High-Pressure, Wet-Pipe Sprinkler System, NPS 4 (DN 100) and Smaller, to Be One of the Following:

1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. [Schedule 10][engineered light-wall], steel pipe with plain ends; welding fittings; and welded joints.

I. High-Pressure, Wet-Pipe Sprinkler System, NPS 5 (DN 125) and Larger, to Be One of the Following:

1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. [Schedule 10][engineered light-wall], steel pipe with plain ends; welding fittings; and welded joints.

3.17 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: [**Upright sprinklers**].
2. Rooms with Suspended Ceilings: [**Pendent sprinklers**][**Recessed sprinklers**][**Flat concealed sprinklers**][**Vertical sidewall sprinklers**][**Pendent, recessed, flat concealed, vertical sidewall sprinklers as indicated**].
3. Wall Mounting: [**Horizontal sidewall sprinklers**][**Flat concealed sidewall sprinklers**][**Horizontal sidewall, flat concealed sidewall sprinklers as indicated**].
4. Spaces Subject to Freezing: [**Upright sprinklers**][**Dry pendent sprinklers**][**Dry sidewall sprinklers**][**Upright sprinklers, dry pendent sprinklers, and dry sidewall sprinklers as indicated**].
5. Deluge-Sprinkler Systems: [**Upright**][**and**][**pendent**], open sprinklers.
6. Special Applications: [**Extended-coverage, flow-control, and quick-response sprinklers where indicated**][**Attic sprinklers**][**Combustible concealed space sprinklers**][**Institutional space sprinklers**].

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces and locations not generally exposed to view; and wax coated where exposed to acids, chemicals, or other corrosive fumes.
2. Recessed Sprinklers: Bright chrome, with [**bright chrome**][**factory-painted white**] escutcheon.
3. Flat Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
4. Residential Sprinklers: Dull chrome.

END OF SECTION 21 10 00 00

Task	Specification	Specification Description
21 10 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 11 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 11 00 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 11 19 00	21 01 10 91	Commissioning Of Fire Suppression
21 11 19 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 12 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 12 00 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 12 13 00	21 01 10 91	Commissioning Of Fire Suppression
21 12 13 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 12 23 00	21 01 10 91	Commissioning Of Fire Suppression
21 12 23 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 12 29 00	21 01 10 91	Commissioning Of Fire Suppression
21 12 29 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 00 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 13 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 13 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 16 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 19 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 19 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 26 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 26 00	21 10 00 00	Water-Based Fire-Suppression Systems

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SECTION 21 13 39 00 - FOAM-WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Foam-water systems.

1.2 DEFINITIONS

A. AFFF: Aqueous film-forming foam.

B. AR-AFFF: Alcohol-resistant aqueous film-forming foam.

C. Discharge Devices: Include, but are not limited to, sprinklers, spray nozzles, and hose nozzles.

1.3 SYSTEM DESCRIPTION

A. Description: Engineered, fixed, [**wet-pipe**][**dry-pipe**][**preaction**][**deluge**], automatically actuated, low-expansion, [**AR-**]AFFF fire-extinguishing system for flammable-liquid fires. System includes diaphragm proportioning tanks and devices as described in NFPA 16.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:

1. Piping, valves, fittings, and hangers.
2. Seismic restraints for all equipment.
3. Foam concentrate storage tanks.
4. Foam concentrate.
5. Discharge devices. Include flow characteristics.
6. Monitoring and alarm devices. Include electrical data and supervision method.
7. Foam-concentrate pumps. Include power supply and controller.
8. Foam-concentrate storage tanks.
9. Strainers.
10. Test connections.

B. Shop Drawings: For foam-water systems. Prepare in accordance with requirements of NFPA 16, to include, but not be limited to, the following:

1. Include plans, elevations, sections, and attachment details.
2. Include design calculations.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.
5. Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.

C. Delegated-Design Submittal: For foam-water systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for fire-extinguishing-agent containers and control panels, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For foam-water fire-extinguishing system to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Valves and specialties.
b. Bladder tanks and proportioning devices.
c. Foam concentrate.
d. Discharge devices. Include flow characteristics.
e. Monitoring and alarm devices. Include supervision method.
f. Foam-concentrate pumps. Include controller.
g. Foam-concentrate storage tanks.
h. Strainers.
i. Test connections.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to the Owner.

1. Discharge Devices: Not less than [**20**] percent of amount of each type installed.
2. Foam Concentrate: Not less than [**200**] percent of amount installed.

1.8 QUALITY ASSURANCE

A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."

C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

D. Standard Working Pressure of Piping-System Component: Listed for a minimum of **175 psig (1200 kPa)**.

E. Unless authorities having jurisdiction have stricter requirements, minimum design parameters are as follows:

1. Solution: [**3**] percent foam-water solution.
2. Sprinkler Spacing: Maximum of [**100 sq. ft. (9.5 sq. m)**] per sprinkler, and maximum [**12-foot (3.7-m)**] spacing.
3. Design Density: Minimum [**0.16 gpm/sq. ft. (0.108 L/s per sq. m)**].
4. Foam Supply: Minimum [**10**]-minute discharge time.
5. Water Supply: Minimum [**60**] minutes.
6. Remote Area: Minimum [**5000-sq. ft. (476-sq. m)**] design area for closed-sprinkler systems. Open-sprinkler systems shall discharge over the entire system area.
7. Sprinkler Temperature Rating: Maximum **250 to 300 deg F (121 to 149 deg C)** at a roof or ceiling, and **135 to 170 deg F (57 to 77 deg C)** for intermediate sprinklers.

F. Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with [**NFPA 13**][**and**][**ASCE/SEI 7**].

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].

2.2 CONCENTRATE PIPING MATERIALS

A. Comply with requirements specified in Section 211000 "Water-Based Fire-Suppression Systems" for pipes, fittings, joining materials, and valves.

B. Schedule 40, Black Steel Pipe: ASTM A53/A53M, [**Type E**] [**Grade B**] or ASTM A795/A795M, [**Type E**]. Pipe ends may be factory or field formed to match joining method.

1. Gray Iron Threaded Fittings, Classes 125 and 250: ASME B16.4.
2. Gray Iron Pipe Flanges and Flanged Fittings: ASME B16.1.

3. Malleable Iron Threaded Fittings, Classes 150 and 300: ASME B16.3.

C. Stainless Steel Pipe: ASTM A312/A312M, Schedule 40, [Type 304][Type 316], with factory-formed threaded or beveled ends; ASTM A376/A376M for seamless pipe; or ASTM A213/A213M, ASTM A249/A249M, and ASTM A269/A269M for seamless and welded tubing.

1. Class 150 Threaded Fittings: ASME B16.3 and MSS SP-114.
2. Butt-Weld Fittings: ASTM A403/A403M.
3. Flanges, Forged Fittings and Flanges, and Socket-Weld Fittings: ASTM A182/A182M.
4. Bar Stock and Compression Fittings: ASTM A276/A276M and ASTM A479/A479M.

D. Red Brass Pipe: ASTM B43, Schedule 40, with factory- or field-formed threaded ends.

1. Threaded Fittings: ASME B16.11.

2.3 VALVES

A. Comply with requirements specified in Section 210523 "General-Duty Valves for Fire Protection Piping."

1. UL listed or FM Approved for use in fire-protection systems.
2. Compatible with type of foam concentrate used.

2.4 FOAM-WATER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Chemguard; brand of Johnson Controls International plc, Building Solutions North America**]
3. [**National Foam**]
4. [**Viking Group Inc.**]

B. Source Limitations: Obtain system components from single source from single manufacturer.

C. System components to be in accordance with NFPA 16, be compatible with the foam concentrate, and be designed to be drained and cleaned.

D. Foam-Concentrate Storage Tanks:

1. Buna-N, bladder-type proportioning tank complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII; designed for use with foam-concentrate pumps and for specific type of foam concentrate used. Include bladder, internal piping, fill and drain, glass sight gage, piping, and valves. Contain concentrate in the bladder.

   a. Orientation: [**Horizontal design with saddle**][**Vertical design with skirt**] support.

2. Atmospheric type, complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII; designed for use with foam-concentrate pumps and for specific type of foam concentrate used. Include pressure-vacuum vent, fill and drain, glass sight gauge, piping, and valves.

E. Foam-Concentrate Pumps: Listed for use in foam-water systems in accordance with NFPA 20. Include supply-side pressure relief valve and drain cock or valve.

F. Proportioning Controllers: Venturi type complying with UL 162 and of capacity to match design at minimum and maximum flow.

G. Concentrate Control Valves: Water-operated ball or deluge valve designed to open with flow through the proportioning controller.

H. Concentrate Strainers: Bronze body and stainless steel mesh strainer with minimum **0.125-inch (3.2-mm)** perforations to remove solids that would block system components.

I. Pressure Gauges: Comply with UL 393; with **3-1/2-inch (90-mm)** minimum-diameter dial, **0- to 300-psig (0- to 2070-kPa)** dial range, and caption "WATER" or "CONCENTRATE" on dial face.

2.5 FOAM CONCENTRATE

A. Description: [**AR-**]AFFF liquid concentrate, complying with NFPA 11 and UL 162, for making foam-water fire-extinguishing foam solution.

2.6 DISCHARGE DEVICES

A. Discharge devices shall be UL listed or FM Approved.

B. Sprinklers: [**Closed,**][**Open,**][**non-**]air-aspirating type; UL listed or FM Approved and listed for use with type of foam concentrate used.

C. Spray Nozzles: For foam water; include foam generator and distributing deflector to distribute foam or water.

2.7 MONITORING DEVICES

A. Valve Supervisory Switches: Single pole, double throw, with normally closed contacts complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when valve is in other than fully open position.

B. Pressure Switches: Single pole, double throw, UL listed or FM Approved and complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when switch is in other than fully open position.

C. Flow Switches: Single pole, double throw, UL listed or FM Approved and complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when switch is in other than fully open position.

2.8 ALARM DEVICES

A. Description: UL listed or FM Approved, low voltage, and surface mounting. Alarm and monitoring devices are specified in Section 284600 "Fire Detection and Alarm" or Section 284614 "Single- and Multiple-Station Alarms."

PART 3 - EXECUTION

3.1 CONCENTRATE STORAGE TANK INSTALLATION

A. Equipment Mounting:

1. Install concentrate storage tanks on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

B. Install concentrate storage tanks anchored to substrate in accordance with tank manufacturer's written instructions.

C. Install tanks level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

D. [**Install seismic restraints for tanks.**]Anchor tanks to substrate.

3.2 PIPING INSTALLATION

A. Install piping and components level and plumb.

B. Install pipe and fittings, valves, and discharge devices in accordance with requirements listed in NFPA 16, "Installation of Foam-Water Sprinkler and Foam-Water Spray Systems."

1. Support piping using supports and methods in accordance with NFPA 13.
2. Install seismic restraints for concentrate storage tanks and piping systems.
3. Install monitoring and alarm devices in accordance with NFPA 16 and NFPA 72.

C. Install flanges, flange adapters, or couplings for grooved-end piping on piping, valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.

D. Ream ends of pipes and tubes and remove burrs.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for foam concentrate. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

J. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems and with foam concentrate.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Provide concentrate control and drain valves with piping to permit maintenance of foam concentrate with continuous sprinkler-system service.

C. Install proportioning controller in fire-suppression piping to provide coverage to area indicated on Drawings.

D. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

E. Connect electrical devices to building's fire-alarm system. Comply with requirements for wiring and connections in Section 284600 "Fire Detection and Alarm" or Section 284614 "Single- and Multiple-Station Alarms."

F. Install a fire-department connection on the supply side of the proportioning controller when required.

3.5 LABELING

A. Install labeling on piping, equipment, and panels in accordance with Section 210553 "Identification for Fire-Suppression Piping and Equipment."

3.6 CHARGING SYSTEM

A. Fill proportioning tanks with foam concentrate after field quality-control testing is complete and satisfactory results have been achieved.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Comply with operating instructions and procedures in NFPA 16, Chapter "Acceptance Tests." Include the following tests and inspections to demonstrate compliance with requirements:

1. Engage the services of a qualified professional engineer to inspect installed fire-extinguishing systems, prepare installation report, and certify that installation complies with the Contract Documents, calculations, and requirements of authorities having jurisdiction.
2. Check mechanical items.
3. Inspect equipment and check mountings for adequate anchoring to substrate.
4. Check electrical systems.
5. Flush supply piping.
6. Perform hydrostatic pressure test.
7. Perform acceptance test.
8. Perform proportioning system test.
9. Perform discharge test.
10. Flush system piping.
11. Correct malfunctioning equipment; retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or does not perform as specified and indicated; retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
12. After installing foam-water fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with NFPA 16.
13. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
14. Operational Test: After electrical circuitry has been energized, start systems to confirm proper unit operation.
15. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Foam fire-extinguishing piping system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 21 13 39 00

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Task	Specification	Specification Description
21 13 39 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 39 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 13 41 00	21 01 10 91	Commissioning Of Fire Suppression
21 13 41 00	21 10 00 00	Water-Based Fire-Suppression Systems
21 20 00 00	21 01 10 91	Commissioning Of Fire Suppression

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SECTION 21 21 00 00 - HIGH-PRESSURE, CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carbon dioxide.
2. Pipes and fittings.
3. High-pressure flexible-hose connectors.
4. Carbon-dioxide cylinders.
5. Cylinder valves.
6. Discharge nozzles.
7. Hangers and supports.
8. Fire-control panels.
9. Detection devices.
10. Manual stations.
11. Switches.
12. Alarm devices

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For high-pressure, carbon-dioxide fire-extinguishing system, signed and sealed by a qualified professional engineer.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For high-pressure, carbon-dioxide fire-extinguishing system, signed and sealed by a qualified professional engineer.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. Design Calculations: For weight, volume, and concentration of extinguishing agent required for each hazard area.
3. Reflected Ceiling Plans:

a. Show ceiling penetrations.
b. Ceiling-mounted carbon-dioxide fire-extinguishing system items.
c. Extinguishing-agent containers if mounted above floor.
d. Piping, discharge nozzles, detectors, and accessories.
e. Hangers and supports, including hanger types and spacing and methods for attaching

hangers to building structure.

f. Coordination with items mounted in and above ceiling other than carbon-dioxide fire-extinguishing systems, including ceiling construction components.

4. Occupied Work Area Plans:

a. Controls and alarms.
b. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
c. Coordination with equipment and furnishings protected by the system.

5. Access Floor Space Plans:

a. Extinguishing-agent containers, piping, discharge nozzles, detectors, and accessories.
b. Method of supporting piping.

1.3 INFORMATIONAL SUBMITTALS

A. Design Data:

1. Permit-Approved Drawings: Working plans, including design calculations prepared according to NFPA 12, that have been approved by authorities having jurisdiction.

B. Seismic Qualification Data: Certificates, for container foundations, cylinder racks, supports, hangers, braces, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Maintenance service agreement.

B. Operation and Maintenance Data: For carbon-dioxide fire-extinguishing system to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to the Owner.

1. Detection Devices: Not less than [**20**] percent of amount of each type installed.
2. Container Valves: Not less than [**10**] percent of amount of each size and type installed.
3. Nozzles: Not less than [**20**] percent of amount of each type installed.
4. Extinguishing Agent: Not less than [**100**] percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design a high-pressure, carbon-dioxide fire-extinguishing system, and obtain approval from authorities having jurisdiction.

1. Total-Flooding System Design Criteria:

a. Hazard Type: [**Data-processing center**][**Manufacturing process**][**Power generation**][**Telecommunications center**][**Electrical equipment room**].
b. Discharge carbon dioxide for [**60 seconds**] and maintain [**34**] percent concentration by volume at **70 deg F (21 deg C)** for [**10-minute**] holding time in hazard areas.
c. Provide system with separate zones above and below the ceiling [**and beneath the raised floor**].
d. Operations and Controls: Discharge extinguishing agent in the underfloor zone only if smoke is detected below the raised floor. Discharge extinguishing agent in zones above and below the ceiling, and below the floor if smoke is detected below the ceiling. Discharge extinguishing agent only in the zone above the ceiling if smoke is detected above the ceiling.

2. Local-Application System Design Criteria:

a. Single zone with an individual nozzle protecting indicated hazard surface.
b. Determine discharge rate by the listing information on the nozzle and as recommended by the fire-extinguishing system manufacturer.

3. High-Pressure Piping Design Criteria:

a. Comply with ASME B31.1.
b. Internal Pressure: **2800 psig (19 306 kPa)**.

B. Seismic Performance: Cylinder racks, supports, hangers, and braces shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[and the system will be fully operational after the seismic event]."

2. Component Importance Factor is [**1.5**][**1.0**].

2.2 SYSTEM DESCRIPTION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Fike Corporation**]

B. Total-Flooding System: Pre-engineered carbon-dioxide fire-extinguishing system designed for total flooding of the hazard area, including the room cavity above the ceiling, below the ceiling, and below the raised floor.

C. Local Application: Pre-engineered carbon-dioxide fire-extinguishing system designed for local application directly on indicated hazards and adjacent areas.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Compliance: Fire-extinguishing system, equipment, and components shall comply with NFPA 12.

F. FM Global Compliance: Provide components that are FM Approved and that are listed in FM's "Approval Guide."

G. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

2.3 CARBON DIOXIDE

A. Vapor Phase: Equal to or more than 99.5 percent carbon dioxide.

B. Taste and Odor: None detectable.

C. Water Content: Comply with CGA G-6.2.

D. Oil Content: Equal to or less than 10 ppm by weight.

2.4 PIPES AND FITTINGS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 12, Section "Distribution," for charging pressure of system.

B. Steel Pipe: ASTM A53/A53M, Grade B, Schedule 40, [**Type E**][**Type S**] or ASTM A106/A106M, [**Grade A**][**Grade B**][**Grade C**], [**black**][**and**][**galvanized**] finish, seamless-steel pipe.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.

2. Welding Fittings: ASME B16.9.
3. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

    a. ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.

4. Flange Bolts and Nuts: ASME B18.2.1 carbon steel.
5. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Stainless Steel Pipe: ASTM A269/A269M or ASTM A312/A312M, [Grade TP304][Grade TP316][Grade TP304L][Grade TP316L].

1. Stainless Steel Fittings: ASTM A182/A182M, Class 3000.

2.5 HIGH-PRESSURE FLEXIBLE-HOSE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Fike Corporation**]

B. Description: Teflon-lined, braided hose with stainless steel wire-braid covering.

1. Design Standard: ASME B31.1.
2. Burst Pressure: **5000 psi (34 474 kPa)** minimum.
3. End Connections: Threaded male couplings.

2.6 CARBON-DIOXIDE CYLINDERS

A. Operating Pressure: Between **2400 psi (16 547 kPa)** and **3000 psi (20 684 kPa)**.

1. Pressure Relief Device: Rupture-disk type.

    a. Sized and fitted according to 49 CFR 178.

B. Ambient Storage Conditions: Less than **120 deg F (49 deg C)** and more than **32 deg F (0 deg C)**.

C. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders, as indicated, or provide equivalent manufactured wall racks.

D. Freestanding Storage Racks: Fabricate racks, as indicated, or provide equivalent manufactured storage racks.

E. Storage Cylinder Nominal Size: [**50 lb (23 kg)**][**75 lb (34 kg)**][**100 lb (45 kg)**].

F. Containers:

1. Minimum Manufacturing Standard: ASME Boiler & Pressure Vessel Code, Section VIII, Division 1.

2. Housing: [Steel][fiberglass].
3. Working Pressure: **363 psi (2503 kPa)**.
4. Maintenance Pressure Requirements: **300 psi (2068 kPa)** and **0 deg F (minus 18 deg C)** with a design pressure of **325 psi (2241 kPa.)**
5. Bulk System Storage Container Nominal Size: [**3/4 ton (680 kg)**][**2 tons (1814 kg)**][**10 tons (9070 kg)**].
6. Mini-Bulk System Storage Container Nominal Size: [**800 lb (363 kg)**][**1000 lb (454 kg)**][**1500 lb (680 kg)**].

2.7 CYLINDER VALVES

A. Bursting Pressure Rating:

1. Valves under Constant Pressure: **6000 psi (41 369 kPa)**.
2. Valves Not under Constant Pressure: **5000 psi (34 474 kPa)**.

B. Discharge Valves:

1. Actuation: [**Pneumatic**][**Electric**][**Manual**].
2. Solenoid Actuator: [**12-V dc**][**24-V dc**].
3. Pilot Hose: [**Rigid**][**Flexible**].
4. Valve Material: Brass or stainless steel.
5. Slave Valve Material: Brass.
6. Lock-Out: Key-operation selector, for prevention of discharge during maintenance.

2.8 DISTRIBUTION VALVES

A. Selector Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.
2. Design: [**Ball**][**Butterfly**], with spring-return actuator.

   a. Minimum Burst Pressure: **5000 psi (34 474 kPa)**.
   b. Minimum Pressure without Permanent Distortion: **1800 psi (12 411 kPa)**.

B. Master Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.
2. Design: [**Ball**][**butterfly**], with spring-return actuator.

   a. Minimum burst pressure: **5000 psi (34 474 kPa)**.
   b. Minimum pressure without permanent distortion: **1800 psi (12 411 kPa)**.

2.9 DISCHARGE NOZZLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]

B. Equipment manufacturer's standard material of working pressure, size, discharge pattern, and capacity required for application.

C. Corrosion-resistant metal.

D. Stamped with orifice size and type.

2.10 HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod with compatible nuts and washers made of [**carbon steel**][**stainless steel**].

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod with compatible nuts and washers made of stainless steel.

2.11 FIRE-CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Fike Corporation**]

B. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

C. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

D. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.

1. Mounting: [**Recessed flush with surface**][**Surface**].

E. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
2. Manual pull-station circuit.

3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. Emergency power-off circuit.

F. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance, with visual status indication on the annunciator panel.

G. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.

H. Standby Power: [**Sealed lead calcium**][**Sealed, valve-regulated, recombinant lead acid**][**Vented, wet-cell pocket, plate nickel cadmium**] batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high, depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.12 DETECTION DEVICES

A. General Requirements for Detection Devices:

1. Comply with NFPA 12, NFPA 72, and UL 268.
2. 24-V dc, nominal.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Remote Air-Sampling Detector System: Include air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.

1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of **0.05 inch wg (12.5 Pa)** at all sampling ports.
4. Control Unit: Multizone unit as indicated on Drawings. Include same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
5. Signals to the Central Fire-Alarm Control Panel: Report local system trouble to the central fire-alarm control panel as a composite "trouble" signal. Individually report alarms on each system zone to the central fire-alarm control panel as separately identified zones.

2.13 MANUAL STATIONS

A. Description: [**Surface**][**Semirecessed**], FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, with red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Emergency Power-Off Switch: "EPO" caption, with yellow finish.

2.14 SWITCHES

A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction.

1. Control Voltage: [**120-V ac**] compatible with controls.
2. Include contacts for connection to control panel.
3. Discharge Pressure Switches: Pneumatic operation for shutdown of equipment.
4. Power-Transfer Switches: Key-operation selector for transfer of release circuit signal from main supply to reserve supply.
5. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.15 ALARM DEVICES

A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction; low voltage and surface mounting.

B. Bells: Minimum **6-inch (150-mm)** diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in NFPA 12.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-

compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and for branch connections.

K. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 12, Section "Distribution Systems."

1. Install pressure-relief devices in piping systems.
2. Install seismic restraints for carbon-dioxide cylinders and piping systems.
3. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 12, Section "Detection, Actuation, and Control," as required for supervised system application.

L. Install carbon-dioxide cylinders in racks anchored to substrate.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices [**and seismic restraints**].

B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] and larger, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

F. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes to facilitate draining moisture and to not exceed maximum pipe deflections allowed by ASME B31.9 for building-services piping.

H. Install carbon-steel hangers and supports for steel piping and stainless steel hangers and supports for stainless steel piping.

I. Vertical Piping: MSS Type 8 or 42 clamps.

J. Individual, Straight, Horizontal Piping Runs:

1. **100 Feet (30 m)** and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than **100 Feet (30 m)**: MSS Type 43, adjustable, roller hangers.

K. Base of Vertical Piping: MSS Type 52 spring hangers.

L. Support horizontal piping within **12 inches (300 mm)** of each fitting and coupling.

M. Support vertical runs of piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

N. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

O. Install seismic restraints on piping. Comply with requirements in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

3.4 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Piping Connections for **NPS 1/4 to 1/2 (DN 6 to DN 12)**: Braided stainless steel hose with threaded male couplings.

3.5 ELECTRICAL CONNECTIONS

A. Connect electrical devices to control panel. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553

"Identification for Electrical Systems."

2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.6 CONTROL CONNECTIONS

A. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 IDENTIFICATION

A. Identify system components and equipment. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 12.

D. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected by a carbon-dioxide fire-extinguishing system.

E. Install signs at entry doors to advise persons outside the room of the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections according to NFPA 12[**with the assistance of a factory-authorized service representative**]:

1. Visual Inspections:

a. Inspect piping, equipment, and nozzles for proper size and location.
b. Verify that locations of alarms and manual emergency releases comply with approved Drawings.
c. Compare actual hazard configuration to original specification.
d. Inspect system for openings or other possible leakage paths.
e. Inspect labeling of devices and equipment for proper identification and nameplate data.

2. Testing: After installing carbon-dioxide fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.

a. Perform nondestructive operational tests on all equipment.
b. Perform full-discharge test on all hazards.
c. Perform each electrical test and visual and mechanical inspection stated in NETA's "Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems," Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
d. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
e. Operational Test: After electrical circuitry has been energized, start units to confirm proper

motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

f. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Carbon-dioxide fire-extinguishing system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is complete and clean.
2. Check system for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.
3. Energize circuits.

C. Adjust operating controls.

3.10 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of carbon-dioxide system Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper carbon-dioxide fire-extinguishing system operation. Service to include manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain carbon-dioxide fire-extinguishing system.

END OF SECTION 21 21 00 00

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SECTION 21 21 00 00A - LOW-PRESSURE, CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Low-pressure, carbon-dioxide fire-extinguishing systems.
2. Low-pressure flexible-hose connectors.
3. Discharge nozzles.
4. Fire-control panel.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For low-pressure, carbon-dioxide fire-extinguishing system, signed and sealed by a qualified professional engineer.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For low-pressure, carbon-dioxide fire-extinguishing system, signed and sealed by a qualified professional engineer.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. Design Calculations: For weight, volume, and concentration of extinguishing agent required for each hazard area.
3. Reflected Ceiling Plans:

   a. Show ceiling penetrations.
   b. Ceiling-mounted carbon-dioxide fire-extinguishing system items.
   c. Extinguishing-agent containers if mounted above floor.
   d. Piping, discharge nozzles, detectors, and accessories.
   e. Hangers and supports, including hanger types and spacing and methods for attaching hangers to building structure.
   f. Coordination with items mounted in and above ceiling other than carbon-dioxide fire-extinguishing systems, including ceiling construction components.

4. Occupied Work Area Plans:

   a. Controls and alarms.

b. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
c. Coordination with equipment and furnishings protected by the system.

5. Access Floor Space Plans:

a. Extinguishing-agent containers, piping, discharge nozzles, detectors, and accessories.
b. Method of supporting piping.

1.3 INFORMATIONAL SUBMITTALS

A. Design Data:

1. Permit-Approved Drawings: Working plans including design calculations prepared according to NFPA 12, that have been approved by authorities having jurisdiction.

B. Seismic Qualification Data: Certificates, for container foundations, container racks, supports, hangers, braces, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Maintenance service agreement.

B. Operation and Maintenance Data: For carbon-dioxide fire-extinguishing system to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to the Owner.

1. Detection Devices: Not less than [**20**] percent of amount of each type installed.
2. Container Valves: Not less than [**10**] percent of amount of each size and type installed.
3. Nozzles: Not less than [**20**] percent of amount of each type installed.
4. Extinguishing Agent: Not less than [**100**] percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design a low-pressure, carbon-dioxide fire-extinguishing system, and obtain approval from authorities having jurisdiction.

1. Total-Flooding System Design Criteria:

a. Hazards: [**Printing presses**][**Transformer vaults**][**Rolling mills**][**Open pits**][**Dip tanks**][**Manufacturing process**][**Power generation**][**Telecommunications center**][**Electrical equipment room**].
b. Discharge carbon dioxide for [**60 seconds**] and maintain [**34**] percent concentration by volume at **70 deg F (21 deg C)** for [**10-minute**] holding time in hazard areas.
c. Provide system with separate zones above and below the ceiling [**and beneath the raised floor**].
d. Operations and Controls: Discharge extinguishing agent in the underfloor zone only if smoke is detected below the raised floor. Discharge extinguishing agent in zones above and below the ceiling, and below the floor if smoke is detected below the ceiling. Discharge extinguishing agent only in the zone above the ceiling if smoke is detected above the ceiling.

2. Local-Application System Design Criteria:

a. Single zone with an individual nozzle protecting indicated hazard surface.
b. Determine discharge rate by the listing information on the nozzle and as recommended by the fire-extinguishing system manufacturer.

3. Low-Pressure Piping Design Criteria:

a. Comply with ASME B31.1.
b. Internal Pressure: [**750 psig (5171 kPa)**][**300 psig (2068 kPa)**].

B. Seismic Performance: Container foundations, supports, hangers, and braces to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[and the system will be fully operational after the seismic event]."
2. Component Importance Factor is [**1.5**][**1.0**].

2.2 LOW-PRESSURE, CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Victaulic Company**]

B. Total-Flooding System: Pre-engineered carbon-dioxide fire-extinguishing system designed for total flooding of the hazard area, including the room cavity above the ceiling, below the ceiling, and below the raised floor.

C. Local Application: Pre-engineered carbon-dioxide fire-extinguishing system designed for local application directly on indicated hazards and adjacent areas.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Compliance: Fire-extinguishing system, equipment, and components to comply with NFPA 12.

F. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."

G. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

2.3 CARBON DIOXIDE

A. Vapor Phase: Equal to or more than 99.5 percent carbon dioxide.

B. Taste and Odor: None detectable.

C. Water Content: Comply with CGA G-6.2.

D. Oil Content: Equal to or less than 10 ppm by weight.

2.4 PIPES AND FITTINGS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 12, Section "Distribution," for charging pressure of system.

B. Steel Pipe: ASTM A53/A53M, Schedule 40, Grade B, [**Type E**][**Type S**] or ASTM A106/A106M, [**Grade A**][**Grade B**][**Grade C**], [**black**][**and**][**galvanized**] finish, seamless-steel pipe.

1. Threaded Fittings:

   a. Malleable-Iron Fittings: ASME B16.3, Class 300.
   b. Flanges and Flanged Fittings: ASME B16.5, Class 300.

2. Welding Fittings: ASME B16.9.
3. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

   a. ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness

unless thickness or specific material is indicated.

4. Flange Bolts and Nuts: ASME B18.2.1 carbon steel.
5. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Stainless Steel Pipe: ASTM A269/A269M or ASTM A312/A312M, [Grade TP304][Grade TP316][Grade TP304L][Grade TP316L].

1. Stainless Steel Fittings: ASTM A182/A182M, Class 2000.

a. Threaded: [Type 304][Type 316].
b. Welded: [Type 304][Type 316][Type 304L][Type 316L].

2.5 LOW-PRESSURE FLEXIBLE-HOSE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Fike Corporation**]

B. Description: Teflon-lined, braided hose with stainless steel wire-braid covering.

1. Design Standard: ASME B31.1.
2. Internal Pressure: **450 psi (3101 kPa)**.
3. Burst Pressure: **1800 psi (12 411 kPa)** minimum.
4. End Connections: Threaded male couplings.

2.6 CARBON-DIOXIDE CYLINDERS

A. Operating Pressure: Between **300 psi (2068 kPa)** and **325 psi (2241 kPa)**.

1. Pressure Relief Device: Rupture-disk type.

a. Sized and fitted according to 49 CFR 178.

B. Ambient Storage Conditions: Less than **120 deg F (49 deg C)** and more than **32 deg F (0 deg C)**.

C. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders, as indicated, or provide equivalent manufactured wall racks.

D. Freestanding Storage Racks: Fabricate racks, as indicated, or provide equivalent manufactured storage racks.

E. Storage Cylinder Nominal Size: [**50 lb (23 kg)**][**75 lb (34 kg)**][**100 lb (45 kg)**].

F. Containers:

1. Minimum Manufacturing Standard: ASME Boiler & Pressure Vessel Code, Section VIII, Division 1.
2. Housing: [Steel][fiberglass].

3. Working Pressure: **363 psi (2503 kPa)**.
4. Maintenance Pressure Requirements: **300 psi (2068 kPa)** and **0 deg F (minus 18 deg C)** with a design pressure of **325 psi (2241 kPa.)**
5. Bulk System Storage Container Nominal Size: [**3/4 ton (680 kg)**][**2 tons (1814 kg)**][**10 tons (9070 kg)**].
6. Mini-Bulk System Storage Container Nominal Size: [**800 lb (363 kg)**][**1000 lb (454 kg)**][**1500 lb (680 kg)**].

2.7 CYLINDER VALVES

A. Manual Shutoff Valve:

1. Bleeder Valve: [**341 psi (2352 kPa)**].
2. Relief Valve: [**357 psi (2462 kPa)**].

B. Gauges:

1. Liquid level.
2. Pressure.

C. High- and Low-Pressure Supervisory Alarm:

1. Maximum Pressure Set Point: 90 percent of allowable working pressure.
2. Minimum Pressure Set Point: **250 psi (1724 kPa)**.

D. Refrigeration System:

1. Maintenance Pressure: **300 psi (2068 kPa)** at maximum expected temperature.
2. Pressure Switch:

   a. Start Pressure: **295 psi (2034 kPa)**.
   b. Stop Pressure: **305 psi (2103 kPa)**.

3. Compressor: Commercial grade.
4. Refrigeration Coil Location: Lengthwise near top.
5. Motor:

   a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."
   b. Efficiency: Premium efficient.
   c. Electrical Characteristics:

      1) Horsepower: [**1**][**1-1/2**][**3**] hp.
      2) Volts: [**120**][**208**][**230**][**460**] V.
      3) Phase: [**Single**][**Poly**].
      4) Hertz: 60.
      5) Full-Load Amperes: A.

E. Heating System:

1. Maintenance Temperature: **32 deg F (0 deg C)** at minimum expected temperature.

2.8 DISTRIBUTION VALVES

A. Selector Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.
2. Design: [**Ball**][**Butterfly**], with spring-return actuator.

a. Minimum Burst Pressure: **5000 psi (34 474 kPa)**.
b. Minimum Pressure without Permanent Distortion: **1800 psi (12 411 kPa)**.

B. Master Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.
2. Design: [**Ball**][**butterfly**], with spring-return actuator.

a. Minimum burst pressure: **5000 psi (34 474 kPa)**.
b. Minimum pressure without permanent distortion: **1800 psi (12 411 kPa)**.

2.9 DISCHARGE NOZZLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Kidde; Carrier Global Corporation**]

B. Equipment manufacturer's standard material of working pressure, size, discharge pattern, and capacity required for application.

C. Corrosion-resistant metal.

D. Stamped with orifice size and type.

2.10 HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dip-galvanized.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod with compatible nuts and washers made of [**carbon steel**][**stainless steel**].

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod with compatible nuts and washers made of stainless steel.

2.11 FIRE-CONTROL PANEL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]

B. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

C. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

D. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.

1. Mounting: [**Recessed flush with surface**][**Surface**].

E. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
2. Manual pull-station circuit.
3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. Emergency power-off circuit.

F. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance, with visual status indication on the annunciator panel.

G. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.

H. Standby Power: [**Sealed lead calcium**][**Sealed, valve-regulated, recombinant lead acid**][**Vented, wet-cell pocket, plate nickel cadmium**] batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high, depending on battery voltage and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.12 DETECTION DEVICES

A. General Requirements for Detection Devices:

1. Comply with NFPA 12, NFPA 72, and UL 268.
2. 24-V dc, nominal.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Remote Air-Sampling Detector System: Include air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.

1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of **0.05 inch wg (12.5 Pa)** at all sampling ports.
4. Control Unit: Multizone unit as indicated on Drawings. Include same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
5. Signals to the Central Fire-Alarm Control Panel: Report local system trouble to the central fire-alarm control panel as a composite "trouble" signal. Individually report alarms on each system zone to the central fire-alarm control panel as separately identified zones.

2.13 MANUAL STATIONS

A. Description: [**Surface**][**Semi-recessed**], FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, with red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Emergency Power-Off Switch: "EPO" caption, with yellow finish.

2.14 SWITCHES

A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction.

1. Control Voltage: [**120-V ac**] compatible with controls.
2. Include contacts for connection to control panel.
3. Discharge Pressure Switches: Pneumatic operation for shutdown of equipment.
4. Power-Transfer Switches: Key-operation selector for transfer of release circuit signal from main supply to reserve supply.
5. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.15 ALARM DEVICES

A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction; low voltage and surface mounting.

B. Bells: Minimum **6-inch (150-mm)** diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in NFPA 12.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and for branch connections.

K. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 12,

Section "Distribution Systems."

1. Install pressure-relief devices in piping systems.
2. Install seismic restraints for carbon-dioxide containers and piping systems.
3. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 12, Section "Detection, Actuation, and Control," as required for supervised system application.

L. Install dirt trap, minimum **2 inches (51 mm)** long, with capped nipple at end of each pipe run.

M. Install carbon-dioxide containers in racks anchored to substrate.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices[**and seismic restraints**].

B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] and larger, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

F. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes to facilitate draining moisture and to not exceed maximum pipe deflections allowed by ASME B31.9 for building-services piping.

H. Install carbon-steel hangers and supports for steel piping and stainless steel hangers and supports for stainless steel piping.

I. Vertical Piping: MSS Type 8 or 42 clamps.

J. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

K. Base of Vertical Piping: MSS Type 52 spring hangers.

L. Support horizontal piping within **12 inches (300 mm)** of each fitting and coupling.

M. Support vertical runs of piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

N. Install seismic restraints on piping. Comply with requirements in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

3.4 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Piping Connections for NPS 1/4 to NPS 1/2 (DN 6 to DN 12): Braided stainless steel hose with threaded male couplings.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 IDENTIFICATION

A. Identify system components and equipment. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 12.

D. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected by a carbon-dioxide fire-extinguishing system.

E. Install signs at entry doors to advise persons outside the room of the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections according to NFPA 12[**with the assistance of a factory-authorized service representative**]:

1. Visual Inspections:

a. Inspect piping, equipment, and nozzles for proper size and location.
b. Verify that locations of alarms and manual emergency releases comply with approved Drawings.
c. Compare actual hazard configuration to original specification.
d. Inspect system for openings or other possible leakage paths.
e. Inspect labeling of devices and equipment for proper identification and nameplate data.

2. Testing: After installing carbon-dioxide fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.

a. Perform nondestructive operational tests on all equipment.
b. Perform full-discharge test on all hazards.
c. Perform each electrical test and visual and mechanical inspection stated in NETA's "Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems," Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
d. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
e. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
f. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Carbon-dioxide fire-extinguishing system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is complete and clean.
2. Check system for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.
3. Energize circuits.

C. Adjust operating controls.

3.10 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service to include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of carbon-dioxide system Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper carbon-dioxide fire-extinguishing system operation. Service to include manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain carbon-dioxide fire-extinguishing system.

END OF SECTION 21 21 00 00A

Task	Specification	Specification Description
21 21 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 21 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 21 16 00	21 21 00 00	High-Pressure, Carbon-Dioxide Fire-Extinguishing Systems
21 21 16 00	21 21 00 00a	Low-Pressure, Carbon-Dioxide Fire-Extinguishing Systems

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SECTION 21 22 00 00 - CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clean-agent systems.
2. Fire-extinguishing clean agent.

1.2 DEFINITIONS

A. EPO: Emergency Power Off.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: Documentation that clean-agent chemicals are compliant.

C. Shop Drawings: Prepare in accordance with requirements of NFPA 2001, to include, but not be limited to, the following:

1. Include plans, elevations, sections, and attachment details.
2. Include design calculations.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.
5. Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.

D. Delegated-Design Submittal: For clean-agent fire-extinguishing systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Coordinate for enclosure integrity in accordance with NFPA 2001 requirements.

B. Seismic Qualification Data: Certificates for extinguishing-agent containers and control panels, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of

assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clean-agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to the Owner.

1. Detection Devices: Not less than [**20**] percent of amount of each type installed.
2. Container Valves: Not less than [**10**] percent of amount of each size and type installed.
3. Nozzles: Not less than [**20**] percent of amount of each type installed.
4. Extinguishing Agent: Not less than [**100**] percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.7 QUALITY ASSURANCE

A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."

C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

D. Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with [**NFPA 13**][**and**][**ASCE/SEI 7**].

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2. Component Importance Factor: [**1.5**][**1.0**].

2.2 CLEAN-AGENT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Fike Corporation**]
3. [**Kidde; Carrier Global Corporation**]
4. [**Siemens Industry, Inc., Building Technologies Division**]

B. Source Limitations: Obtain clean-agent systems from single source from single manufacturer.

C. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

D. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for [**Class A**][**Class B**][**Class C**] fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

E. Performance Requirements, Discharge HFC 227ea: Within 10 seconds and maintain 7.1 percent concentration by volume at **70 deg F (21 deg C)** for 10-minute holding time in hazard areas.

1. HFC 227ea concentration in hazard areas greater than [**9.0**] percent immediately after discharge or less than [**5.8**] percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
2. System Capabilities: Minimum **620-psig (4278-kPa)** calculated working pressure and **360-psig (2484-kPa)** initial charging pressure.

F. Performance Requirements, Discharge FK-5-1-12: Within 10 seconds and maintain 6.6 percent concentration by volume at **70 deg F (21 deg C)** for 10-minute holding time in hazard areas.

1. FK-5-1-12 concentration in hazard areas greater than [**10.0**] percent immediately after discharge or less than [**6.5**] percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
2. System Capabilities: Minimum **620-psig (4278-kPa)** calculated working pressure and **360-psig (2484-kPa)** initial charging pressure.

G. Performance Requirements, Discharge IG-541: Within 60 seconds and maintain 38 percent concentration by volume at **70 deg F (21 deg C)** for 10-minute holding time in hazard areas.

1. IG-541 concentration in hazard areas greater than [**40**] percent immediately after discharge or less than [**32**] percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
2. System Capabilities: Minimum **2175-psig (15-MPa)** calculated working pressure upstream from orifice union, minimum **1000-psig (6895-kPa)** calculated working pressure downstream from orifice union, and **2175-psig (15-MPa)** initial charging pressure.

H. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in another zone.

I. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

J. System Operating Sequence for [ionization smoke detectors][photoelectric smoke detectors][combination of ionization and photoelectric smoke detectors]:

1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for [**30**] seconds, and discharge extinguishing agent.[**On agent discharge, release preaction valve to allow water to fill sprinkler system.**]
3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.

K. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:

1. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
2. Air-Sampling System:

   a. First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
   b. Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
   c. Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire-alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area[and release preaction valve to allow water flow to sprinkler system].
   d. Fourth Detection Level (Fire 2): Same as Fire 1.

L. Manual stations shall immediately discharge extinguishing agent when activated.

M. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release hand pressure on the switch to cause agent discharge after the time delay has expired.

N. EPO: Will terminate power to protected equipment immediately on actuation.

O. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.

P. Power Transfer Switch: Transfer from normal to standby power source.

2.3 PIPE AND FITTINGS

A. See [**"HFC 227ea Agent Piping Applications"**][**"IG-541 Agent Piping Applications"**][**"FK-5-1-12 Agent Piping Applications"**] Article for applications of pipe, tube, fitting, and joining materials.

B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

C. Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M, [**Grade A**][**and**][**Grade B**]; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
c. Fittings Working Pressure: **620 psig (4278 kPa)** minimum.
d. Flanged Joints: Class 300 minimum.

2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.

D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch- (3.2-mm-)** maximum thickness unless thickness or specific material is indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

A. General Valve Requirements:

1. UL listed or FM Approved for use in fire-protection systems.
2. Compatible with type of clean agent used.

B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: [**Red**][**Manufacturer's standard color**], enamel or epoxy paint.
2. Manifold:

a. Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
b. Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.

3. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

A. HFC 227ea Clean Agent: Heptafluoropropane.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont**]

2. Source Limitations: Obtain clean agents from single source from single manufacturer.

B. FK-5-1-12 Clean Agent: Dodecaflouro-2-methylpentan-3-one.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M**]

2. Source Limitations: Obtain clean agents from single source from single manufacturer.

C. IG-541 Clean Agent: Mixture of nitrogen, argon, and carbon dioxide inert gases.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]

2. Source Limitations: Obtain clean agents from single source from single manufacturer.

2.7 DISCHARGE NOZZLES

A. Description: Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

B. Material: Corrosion-resistant metal.

C. Stamped with orifice size and type.

2.8 MANIFOLD AND ORIFICE UNIONS

A. Description: NRTL-listed device with minimum **2175-psig (15-MPa)** pressure rating, to control flow and reduce pressure of IG-541 gas in piping.

1. NPS 2 (DN 50) and Smaller: Piping assembly with orifice, sized for system design requirements.
2. NPS 2-1/2 (DN 65) and Larger: Piping assembly with nipple, sized for system design requirements.

2.9 FIRE CONTROL PANELS

A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

B. Power Requirements: 120/240 V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.

1. Mounting: [**Recessed flush with surface**][**Surface**].

D. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to required number of zones, or addressable devices assigned to required number of zones.
2. Manual pull-station circuit.
3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. EPO circuit.

E. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.

G. Standby Power: [**Sealed lead calcium**][**Sealed, valve-regulated, recombinant lead acid**][**Vented, wet-cell pocket, plate nickel cadmium**] batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.10 DETECTION DEVICES

A. Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.

1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of **0.05 inch wg (12.5 Pa)** at all sampling ports.
4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.

E. Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

A. Description: [**Surface**][**Semirecessed**] FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Abort Switch: "ABORT" caption, momentary contact, with green finish.

D. EPO Switch: "EPO" caption, with yellow finish.

2.12 SWITCHES

A. Description: FM Approved or NRTL listed, where available, [**120-V**] ac or low-voltage compatible with controls. Include contacts for connection to control panel.

1. Low-Agent Pressure Switches: Pneumatic operation.
2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main

supply to reserve supply.

3. Door Closers: Magnetic retaining and release device or electrical interlock to cause door operator to drive the door closed.

2.13 ALARM DEVICES

A. Description: FM Approved or NRTL listed, low voltage, and surface mounting. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems" for alarm and monitoring devices.

B. Bells: Minimum **6-inch (150-mm)** diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

E. Oxygen Deficiency Monitor.

1. Sampling Method and Range: Diffusion, zero to 25 percent O2.
2. 24 V dc.
3. Wall mounted with bracket.
4. Built-in audible alarm 90 dBA.
5. Backlit LCD.
6. 10-year no-calibration sensor.
7. No maintenance required.
8. Signal Outputs: Standard 4- to 20-mA analog.
9. Connections for system control data acquisition system and/or programmable logic controller.
10. Plus or minus 1 percent accuracy of full scale.
11. Operating temperature of **minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HFC 227ea AGENT PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 (DN 65) and Larger: Schedule 40, steel pipe; [**forged-steel welding fittings; and welded**][**steel, grooved-end fittings; steel, keyed couplings; and grooved**] joints.

3.3 IG-541 AGENT PIPING APPLICATIONS

A. Piping between Storage Containers and Orifice Union: Schedule [**80**][**160**], steel pipe; [**forged-steel welding fittings; and welded**][**malleable-iron fittings with threaded or flanged**] joints.

B. Piping Downstream from Orifice Union: Schedule [**40**][**80**], steel pipe; [**forged-steel welding fittings; and welded**][**malleable-iron fittings with threaded or flanged**] joints.

3.4 FK-5-1-12 AGENT PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 (DN 65) and Larger: Schedule 40, steel pipe; [**forged-steel welding fittings; and welded**][**steel, grooved-end fittings; steel, keyed couplings; and grooved**] joints.

3.5 CLEAN-AGENT SYSTEM INSTALLATION

A. Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.

B. Clean-Agent Container Mounting:

1. Install clean-agent containers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Grooved Piping Joints: Groove pipe ends in accordance with AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant in accordance with manufacturer's written instructions.

D. Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."

1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods in accordance with NFPA 13.
3. Install seismic restraints for extinguishing-agent piping systems.
4. Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.6 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.7 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

E. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems."

3.8 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.9 IDENTIFICATION

A. Identify system components and equipment. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

B. Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 2001.

C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

D. Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
2. Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
3. Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."

3.11 CLEANING

A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.12 OPERATIONAL CONDITION SYSTEM FILLING

A. Preparation:

1. Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
2. Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
3. Verify complete enclosure integrity.
4. Verify operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled containers.
3. Energize circuits.
4. Adjust operating controls.

3.13 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00 00

Task	Specification	Specification Description
21 22 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 22 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 22 16 00	21 22 00 00	Clean-Agent Fire-Extinguishing Systems
21 23 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 23 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 24 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 24 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 30 00 00	21 01 10 91	Commissioning Of Fire Suppression
21 30 00 00	21 31 13 00	Electric-Drive, Centrifugal Fire Pumps
21 30 00 00	21 31 16 00	Diesel-Drive, Centrifugal Fire Pumps
21 31 00 00	21 01 10 91	Commissioning Of Fire Suppression

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SECTION 21 31 13 00 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire pumps - electric drive.
2. Fire-pump controllers - electric drive.
3. Fire-pump accessories and specialties.
4. Fire-pump controller remote alarm panels.
5. Grout.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on Project.
3. Section 210548 "Vibration and Seismic Controls for Fire Suppression Systems" specifies seismic restraint and vibration isolation of fire suppression equipment and piping.
4. Section 260010 "Supplemental Requirements for Electrical" specifies requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.
5. Section 260573 "Power System Studies" specifies arc flash hazard analyses and arc flash hazard labeling.
6. Section 284600 "Fire-Detection and Alarm" specifies supervisory connections to fire-alarm system.

1.2 DEFINITIONS

A. PID: Proportional integral derivative.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire pump and fire-pump controller.
2. Include rated capacities, operating characteristics, factory-certified performance test curves, electrical characteristics, and furnished accessories and specialties.

B. Shop Drawings: For packaged fire-pump and electric-drive, fire-pump controller and fire-pump accessories and specialties.

1. Provide fabrication and installation details including plans, elevations, sections, and mounting and attachment details.
2. Provide details of equipment assemblies. Indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical

characteristics; and location and size of each field connection.
3. Provide wiring diagrams for power, signal, and control wiring.
4. For fire pump controllers, show the following:

   a. Each installed unit's type and details.
   b. Enclosure types and details for types other than NEMA 250, Type 2.
   c. Factory-installed devices.
   d. Nameplate legends.
   e. Short-circuit current rating of integrated unit.
   f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
   g. Specified modifications.

C. Delegated Design Submittals: For fire pump and fire-pump controller.

   1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, controllers, accessories, and components, from manufacturer.

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of fire pump and fire-pump controller, from manufacturer.

C. Source quality control reports.

D. Field acceptance testing and inspection reports for fire-pump controllers.

E. Field quality control reports.

F. Certified shop test curves showing head capacity and brake horsepower for each pump.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps and fire-pump controllers to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match fire-pump controllers installed and that are packaged with protective coverings for storage and identified with labels describing contents.

   1. Auxiliary Contacts: [**One**] for each size and type of magnetic contactor installed.

2. Power Contacts: [**Three**] for each size and type of magnetic contactor installed.
3. Contactor Coils: [**One**] for each size and type of magnetic controller installed.
4. Relay Boards: [**One**] for each size and type of relay board installed.
5. Operator Interface: [**One**] microprocessor board(s), complete with display and membrane keypad.

1.7 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace fire pumps and controllers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of fire pumps and controllers, including [**auxiliary contacts for magnetic contactors**][**power contacts for magnetic contactors**][**contactor coils for magnetic contactors**][**relay boards**][**operator interface microprocessor boards**] that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>, [**NFPA 13**], [**NFPA 14**], and NFPA 20. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: 1.5.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 FIRE PUMPS - ELECTRIC DRIVE

A. Fire Pump - Electric Drive, End Suction:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Aurora; a Pentair brand**]
d. [**Fairbanks Nijhuis; a Pentair brand**]
e. [**Patterson Pump Company; a Gorman-Rupp company**]
f. [**Peerless Pump Company**]
g. [**Reddy-Buffaloes Pump Company**]
h. [**Ruhrpumpen, Inc**]

2. Source Limitations:

   a. Obtain fire pump and electric drive from single manufacturer.
   b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-assembled and -tested fire-pump and electric drive.

   a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
   b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

   a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

   a. Standard: [**UL 448**], for end-suction pumps for fire service.
   b. Casing: Top centerline discharge, self-venting, cast iron, with ASME B16.1 pipe-flange connections.
   c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Steel shaft with [**bronze**][**stainless steel**] sleeves.

      1) Shaft Bearings: Grease-lubricated, back-to-back thrust ball bearings and one radial roller bearing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

   f. Mounting: Back pullout design, allowing complete rotating assembly removal without disturbing the casing piping connections. Horizontal pump and driver shafts with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling/shaft guard.
8. Driver:

   a. Type: Electric motor; NEMA MG 1, [**polyphase Design B**][**inverter-duty, for variable-speed controller**].
   b. Standard: [**UL 1004-1**][**UL 1004-5**].

9. Controller Type: [**Full service**][**Variable speed**].
10. Capacities and Characteristics:

    a. Inlet Flange: [**Class 125**][**Class 250**].
    b. Outlet Flange: [**Class 125**][**Class 250**].
    c. Electrical Characteristics:

       1) Volts: [**208**][**230**][**460**] V.
       2) Phase: Three.
       3) Hertz: 60.

11. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

        1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

B. Fire Pump - Electric Drive, In Line:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A C Fire Pump; a Xylem brand**]
    b. [**Armstrong Fluid Technology**]
    c. [**Aurora; a Pentair brand**]
    d. [**Fairbanks Nijhuis; a Pentair brand**]
    e. [**Patterson Pump Company; a Gorman-Rupp company**]
    f. [**Peerless Pump Company**]
    g. [**Plad Equipment, Ltd.**]
    h. [**Reddy-Buffaloes Pump Company**]
    i. [**Ruhrpumpen, Inc**]

2. Source Limitations:

    a. Obtain fire pump and electric drive from single manufacturer.
    b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-assembled and -tested fire-pump and electric drive.

    a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
    b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

    a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

    a. Standard: [**UL 448**]<**Insert standard**>, for in-line pumps for fire service.
    b. Casing: Cast iron, with ASME B16.1 pipe-flange connections.
    c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
    d. Wear Rings: Replaceable bronze.
    e. Shaft and Sleeve: Steel shaft with bronze sleeve.

        1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
        2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

f. Mounting: Vertical pump and driver shaft with motor above pump and pump on mounting foot. Motor and pump rotating assembly are to be removable from top without removing the pump casing from the piping.

7. Coupling: None or rigid.
8. Driver:

a. Standard: [**UL 1004-1**][**UL 1004-5**].
b. Type: Electric motor; NEMA MG 1, [**polyphase Design B**][**inverter-duty, for variable-speed controller**].

9. Controller Type: [**Full service**][**Variable speed**].
10. Capacities and Characteristics:

a. Inlet Flange: [**Class 125**][**Class 250**].
b. Outlet Flange: [**Class 125**][**Class 250**].
c. Electrical Characteristics:

1) Volts: [**208**][**230**][**460**] V.
2) Phase: Three.
3) Hertz: 60.

11. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1) Verification of Performance: Rate fire pumps in accordance with UL 448.

b. Prepare test and inspection reports.

C. Fire Pump - Electric Drive, Split Case, Horizontally Mounted, Single Stage:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Aurora; a Pentair brand**]
d. [**Fairbanks Nijhuis; a Pentair brand**]
e. [**Patterson Pump Company; a Gorman-Rupp company**]
f. [**Peerless Pump Company**]
g. [**Plad Equipment, Ltd.**]
h. [**Reddy-Buffaloes Pump Company**]
i. [**Ruhrpumpen, Inc**]

2. Source Limitations:

a. Obtain fire pump and electric drive from single manufacturer.
b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-assembled and -tested fire-pump and electric drive.

a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

a. Standard: [**UL 448**], for split-case pumps for fire service.
b. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.
c. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.

1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

f. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver:

a. Standard: [**UL 1004-1**][**UL 1004-5**].
b. Type: Electric motor; NEMA MG 1, [**polyphase Design B**][**inverter-duty, for variable-speed controller**].

9. Controller Type: [**Full service**][**Variable speed**].

a. Standard: [**UL 1004-1**][**UL 1004-5**].
b. Type: Electric motor; NEMA MG 1, polyphase Design B.

10. Capacities and Characteristics:

a. Inlet Flange: [**Class 125**][**Class 250**].
b. Outlet Flange: [**Class 125**][**Class 250**].
c. Electrical Characteristics:

1) Volts: [**208**][**230**][**460**] V.
2) Phase: Three.
3) Hertz: 60.

d. Rotation [**Clockwise**][**Counterclockwise**].

11. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1) Verification of Performance: Rate fire pumps in accordance with UL 448.

b. Prepare test and inspection reports.

D. Fire Pump - Electric Drive, Split Case, Horizontally Mounted, Two Stage:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A C Fire Pump; a Xylem brand**]
   b. [**Fairbanks Nijhuis; a Pentair brand**]
   c. [**Patterson Pump Company; a Gorman-Rupp company**]
   d. [**Peerless Pump Company**]
   e. [**Ruhrpumpen, Inc**]

2. Source Limitations:

   a. Obtain fire pump and electric drive from single manufacturer.
   b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-assembled and -tested fire pump and electric drive.

   a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
   b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

   a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

   a. Standard: [**UL 448**], for split-case pumps for fire service.
   b. Number of Stages: Two.
   c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   d. Impeller: Single suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
   e. Wear Rings: Replaceable bronze.
   f. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.

      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

   g. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver:

a. Type: Electric motor; NEMA MG 1, [**polyphase Design B**][**inverter-duty, for variable-speed controller**].
b. Standard: [**UL 1004-1**][**UL 1004-5**].

9. Controller Type: [**Full service**][**Variable speed**].
10. Capacities and Characteristics:

a. Inlet Flange: [**Class 125**][**Class 250**].
b. Outlet Flange: [**Class 125**][**Class 250**].
c. Electrical Characteristics:

1) Volts: [**208**][**230**][**460**] V.
2) Phase: Three.
3) Hertz: 60.

11. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1) Verification of Performance: Rate fire pumps in accordance with UL 448.

b. Prepare test and inspection reports.

E. Fire Pump - Electric Drive, Split Case, Vertically Mounted, Single Stage:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aurora; a Pentair brand**]

2. Source Limitations:

a. Obtain fire pump and electric drive from single manufacturer.
b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-assembled and -tested fire pump and electric drive.

a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

a. Standard: [**UL 448**], for split-case pumps for fire service.
b. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.

c. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.

1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

f. Mounting: Vertical pump and driver shafts with motor above pump and pump on base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver:

a. Type: Electric motor; NEMA MG 1, [**polyphase Design B**][**inverter-duty, for variable-speed controller**].
b. Standard: [**UL 1004-1**][**UL 1004-5**].

9. Controller Type: [**Full service**][**Variable speed**].
10. Capacities and Characteristics:

a. Inlet Flange: [**Class 125**][**Class 250**].
b. Outlet Flange: [**Class 125**][**Class 250**].
c. Electrical Characteristics:

1) Volts: [**208**][**230**][**460**] V.
2) Phase: Three.
3) Hertz: 60.

11. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1) Verification of Performance: Rate fire pumps in accordance with UL 448.

b. Prepare test and inspection reports.

2.3 FIRE-PUMP CONTROLLERS - ELECTRIC DRIVE

A. Fire-Pump Controller - Electric Drive, Full Service:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Firetrol**]
c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]

2. Source Limitations:

   a. Obtain full-service controllers from single manufacturer.
   b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description:

   a. Factory fabricated, assembled, wired, and tested; continuous-duty rated electric-drive full-service fire-pump controller.
   b. Operation: [**Combined automatic and nonautomatic**][**Nonautomatic**].
   c. Listed as arc resistant.
   d. Provided with arc flash mitigation.

4. Standards:

   a. Comply with NFPA 20, including the personnel protection requirements for arc flash mitigation.
   b. Comply with NFPA 70E.
   c. Comply with NFPA 72.
   d. IEEE Compliance: Fabricate and test enclosed controllers in accordance with IEEE 344 to withstand seismic forces defined in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."

5. Listing Criteria: Investigated, labeled, and marked by UL Solutions Inc. in accordance with guide information and standards specified for the following product categories:

   a. Fire-Pump Controllers: UL CCN QYZS, including UL 508 and UL 218.
   b. Fire-Pump Controllers Over 600 V: UL CCN QYZS, including UL 218 and UL 347.
   c. Fire-Pump Controllers for use in Hazardous Locations: UL CCN RCYW, including UL 508 and UL 218.

6. Method of Starting:

   a. Actuation: [**Pressure**][**Nonpressure**]-switch actuated.

      1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      2) Programmable minimum-run-time relay to prevent short cycling.
      3) Programmable timer for weekly tests.

   b. Full-Voltage Starting: [**Across-the-line**][**Autotransformer**][**Part-winding**][**Primary-resistor**][**Primary-reactor**][**Wye-delta (open transition)**][**Wye-delta (closed transition)**] type magnetic controller.
   c. Reduced-Voltage Starting: [**Reduced-voltage**] type solid-state controller.
   d. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of electric or pressure actuators.

7. Method of Stopping: [**Automatic and nonautomatic shutdown after automatic starting**][**Nonautomatic**].
8. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current rating equal to or greater than short-circuit current available at controller location.
9. Alternate-Source Isolating and Disconnecting Means:

a. Integral molded-case switch, with an externally mounted operating handle.
b. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker must be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

10. Enclosure:

a. NEMA 250, Type [**2**][**3R**][**4**][**4X**][**12**], IP31 minimum.
b. Comply with environmental conditions at installed location and NFPA 20.
c. Enclosure Color: [**Manufacturer's standard "fire-pump-controller red"**].
d. Overcurrent protection device must be located in a separate enclosure or separate compartment attached to the fire-pump controller.
e. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
f. Arc Flash Mitigation for Personnel Protection:

1) Locate controllers isolating switch, with instantaneous-only overcurrent protection, in a separate enclosure or compartment attached to the controller.
2) Construction of the separate enclosure or compartment must be able to totally isolate incoming normal power from the main enclosure and must be marked to prohibit energized work.
3) Controllers must be listed as arc resistant.

g. Features:

1) Floor stands, **12 inches (305 mm)** high, for floor-mounted controllers.
2) Space heater, [120 V(ac)][240 V(ac)][with humidistat][with thermostat].
3) Tropicalization.

11. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.

1) Pressure and Event Recorder capable of logging pressure data and operational events with time and date stamp for the life of the controller. Data to be retrievable and downloadable to a flash memory drive via a USB port accessible to the user without having to open the controller door.

b. Touch Screen Operator Interface:

1) Provide minimum 7-inch LCD Color Touch Screen powered by an embedded microprocessor with software.
2) Provide in addition to push-button operation for START/STOP/RUN TEST and graphic display of system operations, the control is to allow programming of Cut-In and Cut-Out pressures, Minimum Runtime and allow for on-screen viewing of corresponding the Owner's Manual in chosen language.

c. Local and Remote Alarm and Status Indications:

1) Local Alarms are to visually indicate and differentiate by color the following:

a) Locked rotor current.
b) Fail to start.

c) Under current.
d) Over current.
e) Under voltage.
f) Over voltage.
g) Phase unbalance.
h) Check weekly test solenoid valve.
i) Weekly test cut-in not reached.
j) Transducer fault.
k) Control voltage not healthy.
l) Motor trouble.
m) Pump room alarm.
n) Invalid cut-in.
o) Phase reversal.
p) Power loss.
q) Phase loss L1.
r) Phase loss L2.
s) Phase loss L3.
t) Low water level.
u) Pump on demand.
v) Low ambient temperature.
w) Service required.

2) Remote Alarms: Provide double pole/double throw dry contact relays for Remote Alarms for the following:

a) Power or phase failure and/or circuit breaker in open position.
b) Phase reversal.
c) Pump run.
d) Common pump room alarm (field re-assignable).
e) Field programmable.

d. Audible alarm with Push to Silence button.
e. Nonautomatic START and STOP push buttons or switches.

12. Features:

a. Extra Output Contacts:

1) [**One**] NO contact(s) for motor running condition.
2) [**One**] set(s) of contacts for loss-of-line power.
3) [**One**] each, Form C contacts for high and low reservoir level.

b. Operator Interface Communications Ports: USB, Ethernet, and TIA-485-A.
c. Communications Protocol Capability: Modbus with TCP/IP frame format and shielded female RJ45 connector.

13. Automatic Transfer Switch:

a. Complies with NFPA 20, [**UL 218**], and [**UL 1008**].
b. Integral with controller as a listed combination fire-pump controller and power transfer switch.
c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
d. Allows manual transfer from one source to the other.
e. Alternate-Source Isolating and Disconnecting Means:

1) Integral molded-case switch, with an externally mounted operating handle.
2) Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker must be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

f. Local and Remote Alarm and Status Indications:

1) Normal source available.
2) Alternate source available.
3) In normal position.
4) In alternate position.
5) Isolating means open.

g. Audible alarm with Push to Silence button.
h. Nonautomatic (manual, nonelectric) means of transfer.
i. Engine test push button.
j. Start generator output contacts.
k. Timer for weekly generator tests.

14. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire-pump controllers in accordance with requirements in NFPA 20 and [**UL 218**].

1) Verification of Performance: Rate controllers in accordance with operation of functions and features specified.

b. Prepare test and inspection reports.

B. Fire-Pump Controller - Electric Drive, Variable Speed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Firetrol**]
b. [**Master Control Systems, Inc**]
c. [**Tornatech**]

2. Source Limitations:

a. Obtain variable-speed controllers from single manufacturer.
b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description:

a. Factory fabricated, assembled, wired, and tested; continuous-duty rated electric-drive variable-speed fire-pump controller.
b. Operation: [**Combined automatic and nonautomatic**][**Nonautomatic**] .
c. Listed as arc resistant.
d. Provided with arc flash mitigation.

4. Standards:

    a. Comply with NFPA 20, including the personnel protection requirements for arc flash mitigation.
    b. Comply with NFPA 70E.
    c. Comply with NFPA 72.
    d. IEEE Compliance: Fabricate and test enclosed controllers in accordance with IEEE 344 to withstand seismic forces defined in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

5. Listing Criteria - Investigated, labeled, and marked by UL Solutions Inc. in accordance with guide information and standards specified for the following product categories:

    a. Fire-Pump Controllers: UL CCN QYZS, including UL 508 and UL 218.
    b. Fire-Pump Controllers Over 600 V: UL CCN QYZS, including UL 218 and UL 347.
    c. Fire-Pump Controllers for use in Hazardous Locations: UL CCN RCYW, including UL 508 and UL 218.

6. Method of Starting:

    a. Actuation: [**Pressure**][**Nonpressure**]-switch actuated.

        1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
        2) Programmable minimum-run-time relay to prevent short cycling.
        3) Programmable timer for weekly tests.

7. Method of Stopping: [**Automatic and nonautomatic shutdown after automatic starting**][**Nonautomatic**].
8. Variable-Speed Controller:

    a. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
    b. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
    c. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 12**], with hinged full-front access door with lock and key.
    d. Externally Operated Disconnect: [**Door-interlocked disconnect switch**][**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
    e. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**] A.
    f. Technology: Pulse-width-modulation (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
    g. Controller is to consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
    h. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
    i. Output signal is to be programmed to not cause mechanical vibration issues with pump drive assembly.
    j. Operating Requirements:

        1) Input AC Voltage Tolerance: [**10**] percent.
        2) Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
        3) Capable of driving full motor load, without derating.

4) Minimum Efficiency: [**96 percent**] at 60 Hz, full load.
5) Minimum Displacement Primary-Side Power Factor: [**95 percent**].
6) Overload Capability: [**1.05**] times the full-load current for 7 seconds.
7) Starting Torque: As required by pump and motor drive assembly.
8) Speed Regulation: [**1**] percent.
9) Speed Range: [**10:1**] speed range.
10) To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller will not operate continuously.
11) Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

k. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.

l. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions is not to result in component failure or need for replacement:

1) Surge suppression.
2) Loss of input signal protection.
3) Critical frequency rejection.
4) Overtemperature.
5) Short circuit at controller output.
6) Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.
7) Open circuit at controller output.
8) Input undervoltage.
9) Input overvoltage.
10) Loss of input phase.
11) Reverse phase.
12) AC line switching transients.
13) Instantaneous overload, line to line, or line to ground.
14) Sustained overload exceeding 100 percent of controller rated current.
15) Starting a rotating motor.

m. Motor Protection: Controller is to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

n. Automatic Reset and Restart:

1) Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
2) Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

o. Visual Indication: On face of controller; indicating the following conditions:

1) Power on.
2) Run.
3) Overcurrent and overvoltage.
4) Motor speed (percentage).
5) Various faults with alarm status.
6) Input kilovolt amperes.
7) Power factor.
8) Input kilowatts and kilowatt-hours.
9) Three-phase input and output voltage.
10) Three-phase input and output current.
11) Output frequency.
12) Elapsed operating time (hours).

13) Diagnostic and service parameters.

p. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
q. Hardwired Control Signal Interface: A minimum of [**two**] analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**] programmable digital inputs.
r. Remote Communication Interface: [**ASHRAE 135 BACnet MS/TP**][**ASHRAE 135 BACnet IP**].
s. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

t. Bypass Controller:

1) Bypass Controller/Variable-Frequency Controller Selector Switch: Include manual selector switch on face of enclosure for local operator control of preferred controller.
2) Bypass Mode: [**Field-selectable automatic**].

a) In automatic mode, include fail-safe control logic to automatically transfer pump motor operation from failed variable-frequency controller to bypass controller.

3) Type: Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate pump motor if variable-frequency controller is not operational.
4) Arrangement: Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating pump motor through bypass controller for safe servicing of variable-frequency controller.
5) Enclosure: Install bypass controller in same enclosure as variable-frequency controller.
6) Remote Monitoring: Include control relay for remote indication of bypass controller operation.

9. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current rating equal to or greater than short-circuit current available at controller location.
10. Alternate-Source Isolating and Disconnecting Means:

a. Integral molded-case switch, with an externally mounted operating handle.
b. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker must be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

11. Enclosure:

a. NEMA 250, Type [**2**][**3R**][**4**][**4X**][**12**], IP31 minimum.
b. Comply with environmental conditions at installed location and NFPA 20.
c. Enclosure Color: [**Manufacturer's standard "fire-pump-controller red"**].
d. Overcurrent protection device must be located in a separate enclosure or separate compartment attached to the fire-pump controller.
e. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
f. Arc Flash Mitigation for Personnel Protection:

1) Locate controllers isolating switch, with instantaneous-only overcurrent protection, in a separate enclosure or compartment attached to the controller.
2) Construction of the separate enclosure or compartment must be able to totally isolate incoming normal power from the main enclosure and must be marked to prohibit energized work.
3) Controllers must be listed as arc resistant.

g. Features:

1) Floor stands, **12 inches (305 mm)** high, for floor-mounted controllers.
2) Space heater, [120 V(ac)][240 V(ac)][with humidistat][with thermostat].
3) Tropicalization.

12. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.

1) Pressure and Event Recorder capable of logging pressure data and operational events with time and date stamp for the life of the controller. Data to be retrievable and downloadable to a flash memory drive via a USB port accessible to the user without having to open the controller door.

b. Touch Screen Operator Interface:

1) Provide minimum 7-inch LCD Color Touch Screen powered by an embedded microprocessor with software.
2) Provide in addition to push-button operation for START/STOP/RUN TEST and graphic display of system operations, the control is to allow programming of Cut-In and Cut-Out pressures, Minimum Runtime and allow for on-screen viewing of corresponding the Owner's Manual in chosen language.

c. Local Alarms and Status Indications: To visually indicate and differentiate by color the following:

1) Controller power on.
2) Motor running condition.
3) Loss-of-line power.
4) Line-power phase reversal.
5) Line-power single-phase condition.
6) Audible alarm with Push to Silence button.
7) Nonautomatic START and STOP push buttons or switches.
8) Set pressure and system pressure.

d. Remote Alarms and Status Indications: Provide double pole/double throw dry contacts relays for remote alarms for the following:

1) Power or phase failure and/or circuit breaker in open position.
2) Phase reversal.
3) Pump run.
4) Common pump room alarm (field re-assignable).
5) Field programmable..
6) Audible alarm with Push to Silence button.
7) Nonautomatic START and STOP push buttons or switches.
8) Set pressure and system pressure.

13. Features:

    a. Extra Output Contacts:

        1) [**One**] NO contact(s) for motor running condition.
        2) [**One**] set(s) of contacts for loss-of-line power.
        3) [**One**] each, Form C contacts for high and low reservoir level.

    b. Operator Interface Communications Ports: USB, Ethernet, and TIA-485-A.
    c. Communications Protocol Capability: Modbus with TCP/IP frame format and shielded female RJ45 connector.

14. Automatic Transfer Switch:

    a. Complies with NFPA 20, [**UL 218**], and [**UL 1008**].
    b. Integral with controller as a listed combination fire-pump controller and power transfer switch.
    c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
    d. Allows manual transfer from one source to the other.
    e. Alternate-Source Isolating and Disconnecting Means:

        1) Integral molded-case switch, with an externally mounted operating handle.
        2) Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker must be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

    f. Local and Remote Alarm and Status Indications:

        1) Normal source available.
        2) Alternate source available.
        3) In normal position.
        4) In alternate position.
        5) Isolating means open.

    g. Audible alarm with Push to Silence button.
    h. Nonautomatic (manual, nonelectric) means of transfer.
    i. Engine test push button.
    j. Start generator output contacts.
    k. Timer for weekly generator tests.

15. Variable-Speed Drive Operational Modes:

    a. Operated in a proportional, integral, and derivative (PID) process control loop to control the centrifugal fire-pump speed to limit the system pressure.
    b. PID controller receives signal from the pressure transducer that measures the system pressure.
    c. PID output controls the current frequency of the pump motor regulating the pump speed to maintain the system pressure at the set point.
    d. Upon detection of a drive failure, the drive is bypassed and the motor runs at full speed.
    e. Once set point pressure is maintained for a set period, the drive soft stops the pump motor.
    f. Provides both soft start and soft stop of the pump motor.

16. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire-pump controllers in accordance with requirements in NFPA 20 and [**UL 218**].

1) Verification of Performance: Rate controllers in accordance with operation of functions and features specified.

b. Prepare test and inspection reports.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

D. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

E. Discharge Cone: [**Closed**][**Open**][**Closed or open**] type.

F. Fire-Pump Relief Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BERMAD Control Valves**]
b. [**CLA-VAL**]
c. [**Kunkle Valve**]
d. [**OCV Control Valves**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]

2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

G. Fire-Pump Test Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Fire Supply**]
b. [**CLA-VAL**]
c. [**Croker; a Division of Morris Group International**]
d. [**Guardian Fire Equipment, Inc**]
e. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Standards:

a. NFPA 20.

b. UL 405, except outlets without clappers instead of inlets.

3. Description: [**Flush, for wall mounting**][**Freestanding**].
4. Pressure Rating: **175 psig (1200 kPa)**minimum.
5. Body Material: Corrosion-resistant metal with number of outlets required by NFPA 20.
6. Escutcheon Plate: Brass or bronze.
7. Hose Valves: UL 668, bronze, with outlet threaded in accordance with NFPA 1963 and matching local fire-department threads. Include caps and chains.
8. Exposed Parts Finish: [Polished][Rough][brass][chrome plated].
9. Escutcheon Plate Marking: [**FIRE-PUMP TEST CONNECTION**].

H. Fire-Pump Flowmeter Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fire Research Corp**]
   b. [**Gerand Engineering Co**]
   c. [**Hyspan Precision Products, Inc**]
   d. [**Victaulic Company**]

2. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.
3. Pressure Rating: [**175 psig (1200 kPa) minimum**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**].
4. Sensor: [**Venturi**][**Paddlewheel**]. Sensor size is to match pipe, tubing, flowmeter, and fittings.
5. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than **4-1/2 inches (115 mm)** in diameter.[**Include bracket or device for remote mounting.**]

   a. Tubing Package: **NPS 1/8 or NPS 1/4 (DN 6 or DN 10)** plastic tubing with copper or brass fittings and valves.

6. Portable Flowmeter: Compatible with flow sensor; with dial not less than **4-1/2 inches (115 mm)** in diameter and with two **12-foot- (3.7-m-)** long hoses in carrying case.

2.5 FIRE-PUMP CONTROLLER REMOTE ALARM PANELS

A. Fire-Pump Controller Remote Alarm Panel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Firetrol**]
   c. [**Master Control Systems, Inc**]
   d. [**Metron Eledyne; a Hubbell Company**]
   e. [**Tornatech**]

2. Source Limitations: Obtain remote alarm panels from single manufacturer.
3. Standards:

   a. Comply with NFPA 20.

4. Description:

   a. Factory fabricated, assembled, wired, and tested.

5. Supervisory and Normal Control Voltage: [**120 V(ac)**][**208 V(ac)**]; [**single**][**dual**] source.
6. Audible and Visual Alarm and Status Indications for Electric-Driven Pump Controllers:

   a. Driver running.
   b. Loss of phase.
   c. Phase reversal.
   d. Supervised power on.
   e. Trouble Alarm: [**Common**][**Separate**] trouble on the controller.
   f. Controller connected to alternate power source.

7. Audible alarm, with silence push button.
8. Pump REMOTE START push button.

2.6 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces to receive equipment, equipment bases and anchorage provisions, with installing contractor(s)[Architect][Engineer][Construction Manager], and Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the fire pump and fire-pump controller, as directed by the Owner.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION OF FIRE-PUMP CONTROLLERS

A. Temporary Heating: Apply temporary heat to maintain temperature in accordance with manufacturer's written instructions until enclosed fire-pump controllers are ready to be energized and placed into service.

B. Replace fire-pump controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.3 INSTALLATION OF FIRE PUMPS - ELECTRIC DRIVE

A. Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings. Comply with requirements for pressure gauges specified in Section 211000 "Water-Based Fire-Suppression Systems."

G. Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20, [**NFPA 13,**][**and**][**NFPA 14**].

H. Install flowmeters and sensors. Install flowmeter-system components and make connections in accordance with NFPA 20 and manufacturer's written instructions.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 ALIGNMENT OF FIRE PUMPS

A. Align [**end-suction**][**and**][**split-case**] pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment in accordance with HI 1.4 and to tolerances specified by manufacturer.

3.5 PIPING CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.6 INSTALLATION OF FIRE-PUMP CONTROLLERS - ELECTRIC DRIVE

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2 m)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than **12 inches (305 mm)** above finished floor. Comply with requirements for concrete bases specified in Section 260529 "Hangers and Supports for Electrical Systems."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Seismic Bracing: Comply with requirements specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."

H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

I. Comply with NEMA ICS 15.

J. Installation of Power Wiring.

1. Install power wiring between fire-pump controllers and their services or sources, and between fire-pump controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70 (including Article 695 "Fire Pumps"), and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

K. Installation of Control and Alarm Wiring:

1. Install wiring between fire-pump controllers and remote devices[**and facility's central monitoring system**]. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
2. Install wiring between remote alarm panels and fire-pump controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
3. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284600 "Fire Detection and Alarm."
4. Bundle, train, and support wiring in enclosures.
5. Connect remote manual and automatic activation devices where applicable.

L. Field Acceptance Testing and Inspection:

1. Acceptance Testing Preparation:

   a. Inspect and Test Each Component:

      1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
      2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
      3) Test continuity of each circuit.

   b. Verify and Test Each Electric-Drive Controller:

      1) Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for motor, notify [**Architect**][**Construction Manager**][**the Owner**] before starting the motor(s), as directed by the Owner.
      2) Test each motor for proper phase rotation.
      3) Verify short-circuit current rating.

   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Representatives from manufacturers of fire-pump controllers must be present during acceptance tests and inspections in accordance with NFPA 20.
3. Acceptance tests and inspections must be witnessed by [**Architect**][**Construction Manager**][**the Owner**][**authorities having jurisdiction**], as directed by the Owner.
4. Acceptance Tests and Inspections:

   a. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [**Architect**][**Construction Manager**][**the Owner**] and authorities having jurisdiction, as directed by the Owner.
   b. Prior to starting, notify authorities having jurisdiction of the time and place of the

acceptance testing.
c. Engage manufacturer's factory-authorized service representative to be present during the testing.
d. Perform field acceptance tests as outlined in NFPA 20.

5. Nonconforming Work:

a. Controllers will be considered defective if they do not pass tests and inspections.
b. Remove and replace defective units with new units and retest.

6. Prepare and submit field acceptance testing and inspection reports.

3.7 INSTALLATION OF FIRE-PUMP CONTROLLER REMOTE ALARM PANELS

A. Install panels on walls with tops not higher than [**72 inches (1829 mm)**] above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For panels not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.8 IDENTIFICATION OF FIRE PUMPS AND FIRE-PUMP CONTROLLERS

A. Comply with NFPA 20 requirements for marking of fire pumps and fire-pump controllers.

B. Field label controllers for arc flash risk in accordance with NFPA 70E.

C. Permanently mark fire-pump controller enclosure and overcurrent protective device enclosure to prohibit energized work in accordance with NFPA requirements.

D. Identify equipment, system components, piping, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment and Section 260553 "Identification for Electrical Systems."

3.9 STARTUP SERVICE FOR FIRE PUMPS AND CONTROLLERS

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.10 ADJUSTING

A. Adjust fire-pump controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.11 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test in accordance with NFPA 20 for acceptance and performance testing.

   a. Prior to initial startup and acceptance testing, complete and check all electric wiring serving fire-pump motor, pressure-maintenance pump motor, and fire-pump controller, including control interwiring, normal power, and alternate power.
   b. Perform arc flash risk assessment for all electric fire-pump controllers in accordance with NFPA 70E or other code required by the authorities having jurisdiction.
   c. Field label electric fire-pump controllers for arc flash risk in accordance with NFPA 70E or other code required by the authorities having jurisdiction.

3. Leak Test: After installation, fill system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain fire pump and associated controller.

END OF SECTION 21 31 13 00

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SECTION 21 31 13 00A - PRESSURE-MAINTENANCE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure-maintenance pumps - vertical, multistage.
2. Pressure-maintenance pumps - vertical turbine.
3. Pressure-maintenance pump controllers.
4. Grout.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on Project.
3. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies seismic restraint and vibration isolation of fire suppression equipment and piping.
4. Section 260010 "Supplemental Requirements for Electrical" specifies requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.
5. Section 260573 "Power System Studies" specifies arc flash hazard analyses and arc flash hazard labeling.
6. Section 284600 "Fire Detection and Alarm" specifies supervisory connections to fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for pressure-maintenance pump and pressure-maintenance pump controller.
2. Include rated capacities, operating characteristics, factory-certified performance test curves, electrical characteristics, and furnished accessories and specialties.

B. Shop Drawings: For pressure-maintenance pumps, pressure-maintenance pump controllers, and pressure-maintenance pump accessories and specialties.

1. Provide fabrication and installation details, including plans, elevations, sections, and mounting and attachment details.
2. Provide details of equipment assemblies. Indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Provide wiring diagrams for power, signal, and control wiring.
5. For pressure-maintenance pump controllers, show the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.

C. Delegated Design Submittal: For pressure-maintenance pump and pressure-maintenance pump controller.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For pressure-maintenance pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of pressure-maintenance pump and pressure-maintenance pump controller, from manufacturer.

C. Source quality-control reports.

D. Field-acceptance testing and inspection reports for fire-pump controllers.

E. Field quality-control reports.

F. Certified shop test curves showing head capacity and brake horsepower for each pump.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure-maintenance pumps and pressure-maintenance pump controllers to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Auxiliary Contacts: [**One**] for each size and type of magnetic contactor installed.
2. Power Contacts: [**Three**] for each size and type of magnetic contactor installed.
3. Contactor Coils: [**One**] for each size and type of magnetic controller installed.

4. Relay Boards: [**One**] for each size and type of relay board installed.
5. Operator Interface: [**One**] microprocessor board(s), complete with display and membrane keypad.

1.6 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace pressure-maintenance pumps and controllers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of pressure-maintenance pumps and controllers, including [**auxiliary contacts for magnetic contactors**][**power contacts for magnetic contactors**][**contactor coils for magnetic contactors**][**relay boards**][**operator interface microprocessor boards**] that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Pressure-maintenance pumps are to withstand the effects of earthquake motions determined in accordance with NFPA 20 [**and**][**ASCE/SEI 7**][**NFPA 13**][**NFPA 14**].

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: 1.5.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by a qualified electrical testing agency recognized by authorities having jurisdiction and marked for intended location and application.

2.2 PRESSURE-MAINTENANCE PUMPS

A. Pressure-Maintenance Pumps - Vertical, Multistage:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A C Fire Pump; a Xylem brand**]
   b. [**Armstrong Fluid Technology**]

2. Source Limitations:

   a. Obtain vertical, multistage, pressure-maintenance pump and electric drive from single manufacturer.
   b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100 km)** radius of Project site.

3. Description: Factory-fabricated, -assembled, and -tested, multistage, barrel-type vertical

pressure-maintenance pump, as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

4. Pump Construction:

   a. Barrel: Stainless steel.
   b. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
   c. Pump Head/Motor Mount: Cast iron.
   d. Impellers: Stainless steel, balanced, and keyed to shaft.
   e. Pump Shaft: Stainless steel.
   f. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
   g. Wear Rings: Teflon.
   h. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
   i. Chamber-Base Bearing: Tungsten carbide.
   j. O-Rings: [**EPDM**][**NBR**][**Viton**].

5. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."

   a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Description: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head.

6. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
7. Capacities and Characteristics:

   a. Working Pressure: [**175 psig (1200 kPa) minimum**][**230 psig (1586 kPa)**][**300 psig (2070 kPa)**].
   b. Inlet and Outlet Size: [**NPS 1-1/4 (DN 32)**].
   c. Discharge and Suction Flanges: [**Class 250**].
   d. Electrical Characteristics:

      1) Volts: [**120**][**208**].
      2) Phases: [**Single**][**Three**].
      3) Hertz: [**60**].

B. Pressure-Maintenance Pumps - Vertical Turbine:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Fluid Technology**]
   b. [**Aurora Pump; Pentair Ltd.**]
   c. [**Patterson Pump Company; a Gorman-Rupp company**]
   d. [**Peerless Pump Company**]
   e. [**Ruhrpumpen, Inc**]
   f. [**Sulzer Pumps Inc.**]

2. Source Limitations:

   a. Obtain vertical-turbine, pressure-maintenance pump and driver from single manufacturer.
   b. Equipment provider is to provide services of a factory-authorized service representative

and have a service facility located within a **60-mile (100 km)** radius of Project site.

3. Description: Factory-fabricated, -assembled, and -tested, vertical, multistate, open-line-shaft turbine pressure-maintenance pump, as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.
4. Pump Construction:

    a. Pump Head: Cast iron, for surface discharge, with flange, except connections may be threaded in sizes in which flanges are not available.
    b. Pump Head Seal: Stuffing box and stuffing.
    c. Line Shaft and Bearings for Water-Lubricated Bearings: Static water levels of **50 ft. (15 m)** or less.

        1) Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
        2) Line Shaft Bearings: Rubber sleeve, water lubricated.

    d. Line Shaft and Bearings for Oil-Lubricated Bearings: Static water levels between **50 and 200 ft. (15 and 61 m)**.

        1) Line Shaft: Steel.
        2) Line Shaft Bearings: Corrosion resistant, oil lubricated.

    e. Impeller Shaft: Monel metal or stainless steel.
    f. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
    g. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections **10 ft. (3 m)** or less, with strainer of cast or fabricated bronze or stainless steel at bottom.

5. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."

    a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    b. Description: Single speed with permanently lubricated ball bearings.

6. Base: Cast iron or steel with hole for electrical cable.
7. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
8. Capacities and Characteristics:

    a. Flange: [**Class 125**].
    b. Electrical Characteristics:

        1) Volts: [**120**][**208**].
        2) Phases: [**Single**][**Three**].
        3) Hertz: [**60**].

2.3 PRESSURE-MAINTENANCE PUMP CONTROLLERS

A. Pressure-Maintenance Pump Controller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Firetrol**]
c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]

2. Source Limitations: Obtain pressure-maintenance pump controllers from a single manufacturer.
3. Description:

   a. Type: UL 508A, factory-assembled, -wired, and -tested, across-the-line controller; for combined automatic and manual operation.
   b. Enclosure: NEMA, Type 2 for wall mounting.
   c. Finish: Manufacturer's standard color paint.

4. Standards:

   a. Listed in accordance with UL 508A.

5. Rate controller for scheduled horsepower and include the following:

   a. Fusible disconnect switch.
   b. Pressure switch.
   c. Hand-off-auto selector switch.
   d. Pilot light.
   e. Running period timer.

2.4 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surface to receive equipment, equipment bases and anchorage provisions, with Installing Contractor(s), [**Architect**][**engineer**][**Construction Manager**][**and**] Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the pressure-maintenance pump and pressure-maintenance pump controller.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before pressure-maintenance pump installation.

C. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION OF PRESSURE-MAINTENANCE PUMP CONTROLLERS

A. Replace pressure-maintenance pump controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.3 INSTALLATION OF PRESSURE-MAINTENANCE PUMPS

A. Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Equipment Mounting:

1. Install multistage pressure-maintenance pumps in accordance with HI 1.4.
2. Install vertical-turbine, pressure-maintenance pumps in accordance with HI 2.4.
3. Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
4. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."
5. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Support piping and pumps separately, so weight of piping does not rest on pumps.

D. Install isolation valves in both inlet and outlet pipes near the pump. Comply with requirements for valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

E. Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20 [**NFPA 13**][**and**][**NFPA 14**].

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect pressure-maintenance pumps to their controllers

3.5 INSTALLATION OF PRESSURE-MAINTENANCE-PUMP CONTROLLERS

A. Coordinate installation of controllers with other construction, including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of pressure-maintenance-pump drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2 m)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."

E. Installation of Power Wiring:

1. Install power wiring between pressure-maintenance-pump controllers and their services or sources, and between pressure-maintenance-pump controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70 (including Article 695, "Fire Pumps"), and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Field-Acceptance Testing and Inspection.

1. Acceptance Testing Preparation:

a. Inspect and Test Each Component:

1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
3) Test continuity of each circuit.

b. Verify and Test Each Electric-Drive Controller:

1) Verify that voltages at controller locations are within 1 percent of motor nameplate rated voltages, with motors off. If outside this range for motor, notify [**Architect**][**Construction Manager**][**Owner**] before starting the motor(s).
2) Test each motor for proper phase rotation.
3) Verify short-circuit current rating.

c. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Acceptance tests and inspections must be witnessed by [**Architect**][**Construction Manager**][**Owner**][**authorities having jurisdiction**].
3. Acceptance Tests and Inspections:

a. Do not begin field-acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [**Architect**][**Construction Manager**][**Owner**] and authorities having jurisdiction.
b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
c. Engage manufacturer's factory-authorized service representative to be present during the testing.

d. Perform field-acceptance tests as outlined in NFPA 20.

4. Nonconforming Work:

a. Controllers will be considered defective if they do not pass tests and inspections.
b. Remove and replace defective units with new units and retest.

5. Prepare and submit field-acceptance testing and inspection reports.

3.6 STARTUP SERVICE FOR PRESSURE-MAINTENANCE PUMPS AND CONTROLLERS

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pressure-maintenance-pump controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable pressure switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recordings, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Lubricate pumps as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Test each pressure-maintenance pump with its controller as a unit.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test in accordance with NFPA 20 for acceptance and performance testing.

a. Prior to initial startup and acceptance testing, complete and check all electric wiring serving pressure-maintenance pump motor and interwiring, normal power, and alternate power.
b. Perform arc flash risk assessment for all electric pressure-maintenance pump controllers in accordance with NFPA 70E or other code required by authorities having jurisdiction.
c. Field label electric pressure-maintenance pump controllers for arc flash risk in accordance with NFPA 70E or other code required by authorities having jurisdiction.

3. Leak Test: After installation, fill system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 21 31 13 00A

Task	Specification	Specification Description
21 31 13 00	21 01 10 91	Commissioning Of Fire Suppression

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SECTION 21 31 16 00 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire pumps - diesel drive, centrifugal.
2. Diesel engine driver.
3. Fire-pump controller - for diesel-drive fire pumps.
4. Fire-pump accessories and specialties.
5. Fire-pump controller remote alarm panel.
6. Fuel oil storage.
7. Grout.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.

1.2 DEFINITIONS

A. ECM: Electronic control module.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire pump and fire-pump controller.
2. Include rated capacities, operating characteristics, factory-certified performance test curves, electrical characteristics, and furnished accessories and specialties.

B. Shop Drawings: For packaged fire pump and diesel driver, fire-pump controller, and fire-pump accessories and specialties.

1. Provide fabrication and installation details including plans, elevations, sections, and mounting and attachment details.
2. Provide details of equipment assemblies. Indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Provide wiring diagrams for power, signal, and control wiring.
5. For fire-pump controllers, show the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
f. Specified modifications.

C. Delegated Design Submittals: For fire pump and fire-pump controller.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, controllers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of fire pump and fire-pump controller, from manufacturer.

C. Source quality control reports.

D. Field acceptance testing and inspection reports for fire-pump controllers.

E. Field quality control reports.

F. Certified shop test curves showing head capacity and brake horsepower for each pump.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps and fire-pump controllers to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match fire-pump controllers installed and that are packaged with protective coverings for storage and identified with labels describing contents.

1. Auxiliary Contacts: [**One**] for each size and type of magnetic contactor installed.
2. Power Contacts: [**Three**] for each size and type of magnetic contactor installed.
3. Contactor Coils: [**One**] for each size and type of magnetic controller installed.
4. Relay Boards: [**One**] for each size and type of relay board installed.
5. Operator Interface: [**One**] microprocessor board(s), complete with display and membrane keypad.

1.7 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace fire pumps and controllers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of fire pumps and controllers, including [**auxiliary contacts for magnetic contactors**][**power contacts for magnetic contactors**][**contactor coils for magnetic contactors**][**relay boards**][**operator interface microprocessor boards**] that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps are to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7]<Insert requirement>[NFPA 13][NFPA 14], and NFPA 20. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.Seismic Performance: Fire pumps are to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7]<Insert requirement>[NFPA 13][NFPA 14], and NFPA 20. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: 1.5.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 FIRE PUMPS - DIESEL DRIVE, CENTRIFUGAL

A. Fire Pump - Diesel Drive, End Suction Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A C Fire Pump; a Xylem brand**]
   b. [**Armstrong Fluid Technology**]
   c. [**Patterson Pump Company; a Gorman-Rupp company**]
   d. [**Pentair Aurora; Pentair Pump Group**]
   e. [**Reddy-Buffaloes Pump Company**]
   f. [**Ruhrpumpen, Inc**]

2. Source Limitations:

   a. Obtain fire pump and diesel drive from single manufacturer.

b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-fabricated, -assembled, and -tested fire pump and diesel drive.

   a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
   b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

   a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

   a. Standard: [**UL 448**], for end-suction pumps for fire service.
   b. Casing: Top centerline discharge self-venting cast iron with ASME B16.1 pipe-flange connections.
   c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Steel shaft with [**bronze**][**stainless steel**] sleeves.

      1) Shaft Bearings: Grease-lubricated, back-to-back thrust ball bearings and one radial roller bearing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

   f. Mounting: Back pullout design allowing complete rotating assembly removal without disturbing the casing piping connections. Pump and driver shafts are horizontal, with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver: Diesel engine.
9. Controller: Diesel engine drive.
10. Capacities and Characteristics:

    a. Inlet Flange: [**Class 125**][**Class 250**]..
    b. Outlet Flange: [**Class 125**][**Class 250**]..

11. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

       1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

B. Fire Pump - Diesel Drive, Split Case, Horizontally Mounted, Single Stage, Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Peerless Pump Company**]
e. [**Pentair Aurora; Pentair Pump Group**]
f. [**Plad Equipment, Ltd.**]
g. [**Reddy-Buffaloes Pump Company**]
h. [**Ruhrpumpen, Inc**]

2. Source Limitations:

   a. Obtain fire pump and diesel drive from single manufacturer.
   b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-fabricated, -assembled, and -tested fire-pump and diesel drive.

   a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
   b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

   a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

   a. Standard: [**UL 448**], for split-case pumps for fire service.
   b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   c. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.

      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

   f. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver: Diesel engine.
9. Controller: Diesel engine drive.
10. Capacities and Characteristics:

    a. Inlet Flange: [**Class 125**][**Class 250**]..
    b. Outlet Flange: [**Class 125**][**Class 250**]..
    c. Rotation [**Clockwise**][**Counterclockwise**].

11. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

        1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

C. Fire Pump - Diesel Drive, Split Case, Horizontally Mounted, Two Stage, Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A C Fire Pump; a Xylem brand**]
    b. [**Patterson Pump Company; a Gorman-Rupp company**]
    c. [**Peerless Pump Company**]
    d. [**Pentair Aurora; Pentair Pump Group**]
    e. [**Ruhrpumpen, Inc**]

2. Source Limitations:

    a. Obtain fire pump and diesel driver from single manufacturer.
    b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description: Factory-fabricated, -assembled, and -tested fire pump and diesel drive.

    a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**] minimum.
    b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

4. Standards:

    a. Comply with NFPA 20.

5. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
6. Pump:

    a. Standard: [**UL 448**], for split-case pumps for fire service.
    b. Number Stages: Two.
    c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
    d. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
    e. Wear Rings: Replaceable bronze.
    f. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.

        1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
        2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

g. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

7. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
8. Driver: Diesel engine.
9. Controller: Diesel engine drive.
10. Capacities and Characteristics:

    a. Inlet Flange: [**Class 125**][**Class 250**]..
    b. Outlet Flange: [**Class 125**][**Class 250**]..

11. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

        1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

2.3 DIESEL ENGINE DRIVER

A. Diesel Engine Driver:

1. Fuel: Fuel oil, [**Grade DF-2**]..
2. Horsepower Rating: Not less than 110 percent of maximum brake horsepower (after derating for temperature and elevation in accordance with NFPA 20).
3. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
4. Controls:

    a. Adjustable governor.
    b. Over-speed shutdown.
    c. Manual reset, speed switch.
    d. Instrument panel with tachometer, oil pressure gauge, water temperature gauge, and hour meter.

5. Fuel System:

    a. Comply with NFPA 20.
    b. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
    c. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
    d. Flexible metallic fuel lines.
    e. Inline fuel filter.
    f. Oil pressure safety switch.
    g. Air cleaner.
    h. Engine-driven oil pump.
    i. Enclosed control wiring electric starter with voltage regulator.
    j. Storage Tank:[Double wall,] size indicated, but not less than required by NFPA 20; with floor legs, direct-reading level gauge[and secondary containment tank having capacity at least equal to storage tank].Storage Tank:[Double wall,] size indicated, but not less than required by NFPA 20; with floor legs, direct-reading level gauge[and secondary containment tank having capacity at least equal to storage tank].

6. Exhaust System:

    a. Piping: ASTM A53/A53M, Type E or S, Schedule 40 black steel pipe; ASME B16.9 weld-type pipe fittings; ASME B16.5 steel flanges; and ASME B16.21 nonmetallic gaskets.
    b. Fabricate double-wall, ventilated thimble from steel pipe.
    c. Flexible exhaust connector.
    d. [**Industrial-**][**Residential-**][**Critical-**][**Super Critical-**][**Hospital-**][**Hospital Plus-**][**Extreme-**] grade exhaust silencer with spark arrestor.

7. Rated Engine Speed: 1800 rpm.
8. Maximum Piston Speed for Four-Cycle Engines: **2250 fpm (11.4 m/s)**.
9. Engine- or Skid-Mounted Lubrication System:

    a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
    b. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is to be capable of full flow and is designed to be fail-safe.
    c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

10. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.
11. Cooling System, Factory-Mounted Radiator:

    a. Factory installed, closed loop, liquid cooled, with radiator factory mounted on fire-pump mounting frame and integral engine-driven coolant pump.
    b. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    c. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    d. Expansion Tank: Constructed of welded-steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
    e. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
    f. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

        1) Rating: **50 psig (345 kPa)** maximum working pressure, with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.
        2) End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

12. Cooling System, Remote Radiator:

    a. Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
    b. Configuration: [**Vertical**][**Horizontal**] air discharge.
    c. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
    d. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    e. Expansion Tank: Constructed of welded-steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
    f. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
    g. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water,

with anticorrosion additives as recommended by engine manufacturer.

h. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

13. Muffler/Silencer, Industrial Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**15 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**25 ft. (8 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

14. Muffler/Silencer, Residential Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**20 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

15. Muffler/Silencer, Critical Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**25 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

16. Muffler/Silencer, Super Critical Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**30 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

17. Muffler/Silencer, Hospital Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**35 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

18. Muffler/Silencer, Hospital Plus Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**35 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

19. Muffler/Silencer, Extreme Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of [**40 dBA**] at 500 Hz.
b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

20. Muffler/Silencer, Super Extreme Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**45 dBA**] at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**] from exhaust discharge after installation is complete is to be [**85**] dBA or less.

21. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
22. Starting System: [**12**][**24**]-V dc, with negative ground.

    a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
    b. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
    c. Cranking Cycle: [**60**] seconds.
    d. Battery: Adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.
    e. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
    f. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is to be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place.
    g. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
    h. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit is to comply with UL 1236 and include the following features:

        1) Operation: Equalizing-charging rate of 10 A is to be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit is then to be automatically switched to a lower float-charging mode and is to continue to operate in that mode until battery is discharged again.
        2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
        3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
        4) Ammeter and Voltmeter: Flush mounted in door. Meters are to indicate charging rates.
        5) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition is to close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
        6) Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.4 FIRE-PUMP CONTROLLER - FOR DIESEL-DRIVE FIRE PUMPS

A. Fire-Pump Controllers - For Diesel-Drive Fire Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Firetrol**]
   c. [**Master Control Systems, Inc**]
   d. [**Metron Eledyne; a Hubbell Company**]
   e. [**Tornatech**]

2. Source Limitations:

   a. Obtain diesel-drive controllers from single manufacturer.
   b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

3. Description:

   a. Factory fabricated, assembled, wired, and tested.
   b. Operation: [**Combined automatic and nonautomatic**][**Nonautomatic**] operation.

4. Standards:

   a. Comply with NFPA 20.

5. Method of Starting:

   a. Actuation: [**Pressure**][**Nonpressure**]-switch actuated.

      1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      2) Programmable minimum-run-time relay to prevent short cycling.
      3) Programmable timer for weekly tests.

   b. Dual, redundant dc-voltage battery units, with automatic changeover.
   c. Emergency Control: Bypasses automatic control circuits during manual starting and running.
   d. Automatic engine start on loss of ac power to the controller.

6. Method of Stopping: [**Automatic and nonautomatic shutdown after automatic starting**][**Nonautomatic**].
7. Enclosure:

   a. NEMA 250, Type [**2**][**3R**][**4**][**4X**][**12**] minimum.

      1) Comply with environmental conditions at installed location and NFPA 20.

   b. Enclosure Color: [**Manufacturer's standard "fire-pump-controller red"**]..
   c. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals,

listings, and other pertinent data.

d. Features:

1) Floor stands, 12 inches (305 mm) high, for floor-mounted controllers.
2) Space heater, [120 V(ac)][240 V(ac)][with humidistat][with thermostat].Space heater, [120 V(ac)][240 V(ac)][with humidistat][with thermostat].
3) Tropicalization.

8. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.

1) Pressure and Event Recorder capable of logging pressure data and operational events with time and date stamp for the life of the controller. Data to be retrievable and downloadable to a flash memory drive via a USB port accessible to the user without having to open the controller door.

b. Touch Screen Operator Interface:

1) Provide minimum 7-inch LCD Color Touch Screen powered by an embedded microprocessor with software.
2) Provide in addition to push-button operation for START/STOP/RUN TEST and graphic display of system operations, the control is to allow programming of Cut-In and Cut-Out pressures, Minimum Runtime and is to allow for on-screen viewing of corresponding the Owner's Manual in chosen language.

c. Local and Remote Alarm and Status Indications:

1) Status LEDs - green color for the following:

a) Low Pressure.
b) Engine Run.
c) Remote Start.
d) Interlock On.
e) Deluge Valve (if applicable).
f) One Programmable LED.

2) Alarm LEDs - red color for the following:

a) Battery #1 Failure.
b) Charger #1 Failure.
c) Battery #2 Failure.
d) Charger #2 Failure
e) Low Pressure.
f) System Over Pressure.
g) Low Suction Pressure.
h) Low Fuel.
i) Fail to Start.
j) High Engine Temp.
k) Low Oil Pressure.
l) Engine Over Speed.
m) ECM Selector in Alt Position.
n) Fuel Injection Malfunction.
o) ECM Warning.

p) ECM Failure.
q) High Raw Water Temp.
r) Low Engine Temperature
s) Fuel Spill
t) One Programmable LED.

d. Audible alarm with Push to Silence button.
e. Nonautomatic START and STOP push buttons or switches.
f. Set pressure and system pressure.

9. Features:

a. Extra Output Contacts:

1) [**One**] Form C contact(s) for low pump-room temperature.
2) [**One**] each, Form C contact(s) for high and low fuel levels.
3) [**One**] each, Form C contact(s) for high and low reservoir levels.

b. Operator Interface Communications Ports: USB, Ethernet, and TIA-485-A.
c. Communications Protocol Capability: Modbus with TCP/IP frame format and shielded female RJ45 connector.
d. Powered louver contacts.
e. Powered engine-oil heater contacts.

10. Battery Charger System:

a. Built-in, independent, dual battery chargers with automatic changeover; [**12 V(dc)**][**24 V(dc)**] for [**lead-acid**][**nickel-cadmium**] batteries.
b. Standard: [**UL 1236**]..

11. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire-pump controllers in accordance with requirements in NFPA 20 and [**UL 218**]..

1) Verification of Performance: Rate controllers in accordance with operation of functions and features specified.

b. Prepare test and inspection reports.

2.5 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, bronze or cast iron, spring loaded; for installation in pump-discharge piping.

C. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

D. Outlet Fitting: Concentric tapered reducer at pump-discharge outlet.

E. Discharge Cone: [**Closed**][**Open**][**Closed or open**] type.

F. Fire-Pump Relief Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**BERMAD Control Valves**]
    b. [**CLA-VAL**]
    c. [**Kunkle Valve**]
    d. [**OCV Control Valves**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Zurn Industries, LLC**]

2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

G. Fire-Pump Test Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Fire Supply**]
    b. [**CLA-VAL**]
    c. [**Croker; a Division of Morris Group International**]
    d. [**Guardian Fire Equipment, Inc**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]

2. Standards:

    a. NFPA 20.
    b. UL 405, except outlets without clappers instead of inlets.

3. Description: [**Exposed, projecting, for wall mounting**][**Flush, for wall mounting**]..
4. Pressure Rating: **175 psig (1200 kPa)** minimum.
5. Body Material: Corrosion-resistant metal with number of outlets required by NFPA 20.
6. Escutcheon Plate: Brass or bronze.
7. Hose Valves: UL 668, bronze, with outlet threaded in accordance with NFPA 1963 and matching local fire-department threads. Include caps and chains.
8. Exposed Parts Finish: [Polished][Rough][brass][chrome plated].Exposed Parts Finish: [Polished][Rough][brass][chrome plated].
9. Escutcheon Plate Marking: [**FIRE-PUMP TEST CONNECTION**].

H. Fire-Pump Flowmeter Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Fire Research Corp**]
    b. [**Gerand Engineering Co**]
    c. [**Hyspan Precision Products, Inc**]
    d. [**Victaulic Company**]

2. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
3. Pressure Rating: [**175 psig (1200 kPa) minimum**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**]..
4. Sensor: [**Venturi**][**Paddlewheel**].. Sensor size is to match pipe, tubing, flowmeter, and fittings.
5. Permanently Mounted Flowmeter: Compatible with flow sensor, with dial not less than **4-1/2 inches (115 mm)** in diameter.[**Include bracket or device for wall mounting.**]

    a. Tubing Package: **NPS 1/8 or NPS 1/4 (DN 6 or DN 10)** plastic tubing with copper or brass fittings and valves.

6. Portable Flowmeter: Compatible with flow sensor, with dial not less than **4-1/2 inches (115 mm)** in diameter and with two **12-ft.- (3.7-m-)** long hoses in carrying case.

2.6 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Day Tank: UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin, with a capacity of 150 percent of nominal capacity of day tank.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer**]..
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel for [**eight**] hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.7 FIRE-PUMP CONTROLLER REMOTE ALARM PANEL

A. Fire-Pump Controller Remote Alarm Panel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Firetrol**]
    c. [**Master Control Systems, Inc**]

d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]

2. Source Limitations: Obtain remote alarm panels from single manufacturer.
3. Standards:

   a. Comply with NFPA 20.

4. Description: Factory fabricated, assembled, wired, and tested.
5. Supervisory and Normal Control Voltage: [**120 V(ac)**][**240 V(ac)**]; [**single**][**dual**] source.
6. Audible and Visual Alarm and Status Indications for Diesel-Driven Pump Controllers:

   a. Normal Power On.
   b. Supervisory Power On.
   c. Engine Running.
   d. Not in Auto Mode.
   e. Low Fuel.
   f. Common Alarm.
   g. with SPDT, 8 Amp relay Output.

7. Audible alarm, with silence push button.

2.8 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces to receive equipment, equipment bases and anchorage provisions, with installing contractor(s)[Architect,][Engineer,][Construction Manager,] and Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the fire pump and fire-pump controller, as directed by the Owner.Examine areas, surfaces to receive equipment, equipment bases and anchorage provisions, with installing contractor(s)[Architect,][Engineer,][Construction Manager,] and Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the fire pump and fire-pump controller.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION OF FIRE-PUMP CONTROLLERS

A. Temporary Heating: Apply temporary heat to maintain temperature in accordance with manufacturer's written instructions until enclosed fire-pump controllers are ready to be energized and placed into service.

B. Replace fire-pump controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.3 INSTALLATION OF FIRE PUMPS

A. Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings. Comply with requirements for pressure gauges specified in Section 211000 "Water-Based Fire-Suppression Systems."

G. Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20[NFPA 13,][and][NFPA 14].Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20[NFPA 13,][and][NFPA 14].

H. Install fuel system in accordance with NFPA 20.

I. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.

J. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.

K. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.

L. Install flowmeters and sensors. Install flowmeter-system components and make connections in accordance with NFPA 20 and manufacturer's written instructions.

M. Electrical Wiring: Install electrical devices furnished by equipment manufacturers that are not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 ALIGNMENT OF FIRE PUMPS

A. Align [**end-suction**][**and**][**split-case**] pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment in accordance with HI 1.4 and to tolerances specified by manufacturer.

3.5 PIPING CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.6 INSTALLATION OF FIRE-PUMP CONTROLLERS

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2 m)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than **12 inches (305 mm)** above finished floor. Comply with requirements for concrete bases specified in Section 260529 "Hangers and Supports for Electrical

Systems."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems" and Section 018123 "Facility Seismic and Wind Criteria."

H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

I. Installation of Control and Alarm Wiring:

1. Install wiring between fire-pump controllers and remote devices[**and facility's central monitoring system**]. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
2. Install wiring between remote alarm panels and fire-pump controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
3. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284600 "Fire Detection and Alarm."
4. Bundle, train, and support wiring in enclosures.
5. Connect remote manual and automatic activation devices where applicable.

J. Field Acceptance Testing and Inspection.

1. Acceptance Testing Preparation:

   a. Inspect and Test Each Component:

      1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
      2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
      3) Test continuity of each circuit.

2. Representatives from manufacturers of fire-pump controllers must be present during acceptance tests and inspections in accordance with NFPA 20.
3. Acceptance tests and inspections must be witnessed by [**Architect**][**Construction Manager**][**the Owner**][**authorities having jurisdiction**]., as directed by the Owner.
4. Acceptance Tests and Inspections:

   a. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [**Architect**][**Construction Manager**][**the Owner**] and authorities having jurisdiction, as directed by the Owner.
   b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
   c. Engage manufacturer's factory-authorized service representative to be present during the testing.
   d. Perform field acceptance tests as outlined in NFPA 20.

5. Nonconforming Work:

a. Controllers will be considered defective if they do not pass tests and inspections.
b. Remove and replace defective units with new units and retest.

6. Prepare and submit field acceptance testing and inspection reports.

3.7 INSTALLATION OF FIRE-PUMP CONTROLLER REMOTE ALARM PANEL

A. Install panels on walls with tops not higher than [**72 inches (1829 mm)**] above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For panels not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.8 IDENTIFICATION OF FIRE PUMPS AND FIRE-PUMP CONTROLLERS

A. Comply with NFPA 20 requirements for marking of fire pumps and fire-pump controllers.

B. Identify equipment, system components, piping, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment and Section 260553 "Identification for Electrical Systems."

3.9 STARTUP SERVICE FOR FIRE PUMPS AND CONTROLLERS

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.10 ADJUSTING

A. Adjust fire-pump controllers and battery charger systems to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.11 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test in accordance with NFPA 20 for acceptance and performance testing.

    a. Prior to initial startup and acceptance testing, complete and check all electric wiring serving fire-pump controller and pressure-maintenance pump motor including control interwiring, normal power, and alternate power.

3. Leak Test: After installation, fill system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain fire pumps, and fire-pump controllers.

END OF SECTION 21 31 16 00

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Task	Specification	Specification Description
21 31 16 00	21 01 10 91	Commissioning Of Fire Suppression
21 31 16 00	21 31 13 00a	Pressure-Maintenance Pumps

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Task	Specification	Specification Description
22 01 40 81	22 45 00 00	Emergency Plumbing Fixtures

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SECTION 22 05 00 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packless expansion joints.
3. Grooved-joint expansion joints, lead free.
4. Alignment guides and anchors.
5. Sleeves without waterstop.
6. Sleeves with waterstop.
7. Stack-sleeve fittings.
8. Sleeve-seal systems.
9. Grout.
10. Silicone sealants.
11. Escutcheons.
12. Thermometers, bimetallic actuated, lead free.
13. Thermometers, filled system, lead free.
14. Thermometers, liquid in glass, lead free.
15. Thermometers, light activated, lead free.
16. Thermowells, lead free.
17. Pressure gauges, dial type, lead free.
18. Gauge attachments, lead free.
19. Test plugs, lead free.
20. Test-plug kits, lead free.
21. Sight flow indicators, lead free.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters.
2. Section 221513 "General-Service Compressed-Air Piping" for compressed air gauges.
3. Section 331415 "Site Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

   a. Include construction details, material descriptions, and dimensions of individual

components, and finishes.
b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**][**and**][**gauge**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water[**expansion fittings and loops**] for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

   a. For motors with 2:1 speed ratio, consequent pole, single winding.
   b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**].
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**] and larger; rolled steel for motor frame sizes smaller than [**324T**].

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

   a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
   b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [120 V][240 V] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [Circuit board][digital speed controller/LED display].
4. Building Automation System Interface: Via [AC voltage signal][DC voltage signal][Digital Serial Interface (DSI)].

2.3 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packless Expansion Joints:

1. Rubber Union Connector Expansion Joints, Lead Free: [**RUEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flexicraft Industries**]
      4) [**Flo Fab Inc**]
      5) [**General Rubber Corporation**]
      6) [**Kadant Unaflex, LLC**]
      7) [**Mason Industries, Inc.**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]

   b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
   c. Material: Twin reinforced EPDM rubber spheres[**with external restraining cables**].
   d. Minimum Pressure Rating: [**150 psig at 170 deg F (1035 kPa at 77 deg C)**] unless otherwise indicated.
   e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
   f. End Connections for Greater than NPS 2 (DN 50): Flanged.
   g. End Fittings: Stainless steel.

2. Flexible-Hose Packless Expansion Joints, Lead Free: [**FHEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld; a division of Kelco**]
      5) [**Flexicraft Industries**]
      6) [**Kadant Unaflex, LLC**]
      7) [**Mason Industries, Inc.**]
      8) [**Proco Products, Inc**]
      9) [**Unisource Manufacturing, Inc.**]

   b. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
   c. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

d. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
e. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with [**solder-joint**] end connections.

1) Bronze hoses and single-braid bronze sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **340 psig at 450 deg F (2340 kPa at 232 deg C)** ratings.
2) Bronze hoses and double-braid bronze sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **500 psig at 450 deg F (3450 kPa at 232 deg C)** ratings.

f. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with [**threaded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **300 psig at 70 deg F (2070 kPa at 21 deg C)** and **225 psig at 450 deg F (1550 kPa at 232 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **420 psig at 70 deg F (2890 kPa at 21 deg C)** and **315 psig at 450 deg F (2170 kPa at 232 deg C)** ratings.

g. Expansion Joints for Stainless Steel Piping NPS 2 (DN 50) and Smaller: Stainless steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **325 psig at 600 deg F (2250 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **515 psig at 600 deg F (3550 kPa at 315 deg C)** ratings.

h. Expansion Joints for Stainless Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **200 psig at 70 deg F (1380 kPa at 21 deg C)** and **145 psig at 600 deg F (1000 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **275 psig at 70 deg F (1900 kPa at 21 deg C)** and **200 psig at 600 deg F (1380 kPa at 315 deg C)** ratings.

i. Expansion Joints for Stainless Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **125 psig at 70 deg F (860 kPa at 21 deg C)** and **90 psig at 600 deg F (625 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

j. Expansion Joints for Stainless Steel Piping NPS 14 (DN 350) and Larger: Stainless steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with

165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

3. Metal-Bellows Packless Expansion Joints, Lead Free: [**MBEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Adsco Manufacturing LLC**]
      2) [**Badger Industries, Inc**]
      3) [**Flex-Hose Co., Inc**]
      4) [**Flex-Pression**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Flo Fab Inc**]
      8) [**Hyspan Precision Products, Inc**]
      9) [**Kadant Unaflex, LLC**]
      10) [**Mason Industries, Inc.**]
      11) [**Proco Products, Inc**]
      12) [**Senior Flexonics Pathway**]
      13) [**Tozen Corporation**]
      14) [**U.S. Bellows, Inc.**]
      15) [**Unisource Manufacturing, Inc.**]
      16) [**Universal Hose and Braid; a Hyspan Company**]

   b. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
   c. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
   d. Type: Circular, corrugated bellows[**with external tie rods**].
   e. Minimum Pressure Rating: [150 psig (1035 kPa)][175 psig (1200 kPa)][200 psig (1379 kPa)] unless otherwise indicated.
   f. Configuration: [**Single joint**][**Single joint with base**][**and**][**double joint with base**] class(es) unless otherwise indicated.
   g. Expansion Joints for Copper Tubing: [Single-][multi-]ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

      1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [Solder joint][threaded].
      2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [Solder joint][threaded].
      3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

   h. Expansion Joints for Stainless Steel Piping: [Single-][multi-]ply stainless steel bellows, stainless steel pipe ends, and carbon steel shroud.

      1) End Connections for Stainless Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
      2) End Connections for Stainless Steel Pipe NPS 2-1/2 (DN 65) and Larger: [**Flanged**][**Welded**].

4. Externally Pressurized Metal-Bellows Packless Expansion Joints, Lead Free: [**EPEJLF-01**].

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Hyspan Precision Products, Inc**]
7) [**Mason Industries, Inc.**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.

c. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**] unless otherwise indicated.

d. Description:

1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
2) Carbon-steel housing.
3) Drain plugs and lifting lug for **NPS 3 (DN 80)** and larger.
4) Bellows: With operating clearance between the internal pipe sleeves and external shrouds.
5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.
6) Joint Axial Movement: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**] of compression and [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] of extension.

e. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.

f. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

5. Rubber Packless Expansion Joints, Lead Free: [**REJLF-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Garlock Sealing Technologies**]
6) [**General Rubber Corporation**]
7) [**Kadant Unaflex, LLC**]
8) [**Mason Industries, Inc.**]
9) [**Proco Products, Inc**]

10) [**Red Valve Company, Inc**]
11) [**Tozen Corporation**]
12) [**U.S. Bellows, Inc.**]
13) [**Unisource Manufacturing, Inc.**]

b. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
c. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
d. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
e. Arch Type: [Single][multiple] arches[with external control rods].
f. Spherical Type: [Single][multiple] spheres[with external control rods].
g. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): [**225 psig (1551 kPa) at 170 deg F (77 deg C)**].

C. Grooved-Joint Expansion Joints, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]

2. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
3. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
4. Standard: AWWA C606, for grooved joints.
5. Material: ASTM A53/A53M, Schedule 40 stainless steel pipe with grooved ends.
6. Couplings: [**Five**][**Seven**][**10**][**12**], ASTM A312/A312M ductile-iron flexible type for stainless steel pipe dimensions. Include ferrous housing sections, Grade E EPDM rubber gasket or Grade P fluoroelastomer blend gasket, and bolts and nuts.

D. Alignment Guides and Anchors:

1. Alignment Guides: [**AG-01**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**ASC Engineered Solutions**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Hyspan Precision Products, Inc**]
7) [**Metraflex Company (The)**]

b. Source Limitations: Obtain alignment guides from single manufacturer.
c. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [**zinc-coated carbon**][**stainless**] steel.
2) Expansion Plug: [**Zinc-coated carbon**][**Stainless**] steel.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [**zinc-coated carbon**][**stainless**] steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

2.4 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT; a division of EnPRO Industries**]
d. [**Metraflex Company (The)**]

2. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized-steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Wade; a subsidiary of McWane Inc.**]
c. [**Zurn Industries, LLC**]

2. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**GPT; a division of EnPRO Industries**]
c. [**Metraflex Company (The)**]
d. [**Proco Products, Inc**]

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic Seal: **20 psig (137 kPa)** minimum.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating, ASTM B633**][**Stainless steel**][**Stainless steel, Type 316**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
2) [**ITW Polymers Sealants North America**]
3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
4) [**Sherwin-Williams Company (The)**]
5) [**Sika Corporation**]
6) [**The Dow Chemical Company**]
7) [**Tremco Incorporated**]

b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]

b. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]

4. Sealant shall have a VOC content of [**250**] g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended

exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.5 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]

B. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Cast brass with concealed hinge.

2.6 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermometers, Bimetallic Actuated, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]

n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide lead-free bimetallic-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Liquid-filled**][**and**][**sealed**] type(s); stainless steel with [**3-inch (75-mm)**][**5-inch (125-mm)**] nominal diameter.
5. Dial: [**Nonreflective aluminum**] with permanent scale markings and scales in [**deg F (deg C)**][**deg F and deg C**].
6. Connector Type(s): Union joint, [**adjustable angle**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
7. Stem: **0.25 or 0.375 inch (6.4 or 9.5 mm)** in diameter; [**stainless steel**][**lead-free brass**].
8. Window: [Plain glass][Safety glass][acrylic plastic].
9. Ring: Stainless steel.
10. Element: Bimetal coil.
11. Pointer: Dark-colored metal.
12. Accuracy: Plus or minus [**1**][**1.5**] percent of span.

B. Thermometers, Filled System, Lead Free - Direct Mounted, Metal Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ashcroft Inc**]
   b. [**Miljoco Corporation**]
   c. [**Palmer Wahl Instrumentation Group**]
   d. [**REOTEMP Instrument Corporation**]
   e. [**Trerice, H. O. Co**]
   f. [**Weiss Instruments, Inc**]

2. Source Limitations: Provide filled-system, lead-free, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [**Metal**][**Stainless steel**].
11. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus [**1**] percent of span.

C. Thermometers, Filled System, Lead Free - Direct Mounted, Plastic Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**REOTEMP Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**plastic**]; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [Metal][plastic].
11. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel or aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Stem Length: To match thermowell insertion length.
14. Accuracy: Plus or minus [**1**] percent of span.

D. Thermometers, Filled System, Lead Free - Remote Mounted, Metal Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Miljoco Corporation**]
   b. [**Palmer Wahl Instrumentation Group**]
   c. [**REOTEMP Instrument Corporation**]
   d. [**Trerice, H. O. Co**]
   e. [**Weiss Instruments, Inc**]
   f. [**WIKA Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.

9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [**Metal**][**Stainless steel**].
11. Connector Type(s): Union joint, [**back**][**bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free, bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Stem Length: To match thermowell insertion length.
14. Accuracy: Plus or minus [**1**] percent of span.

E. Thermometers, Filled System, Lead Free - Remote Mounted, Plastic Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**REOTEMP Instrument Corporation**]

2. Source Limitations: Provide filled-system, lead-free, remote-mounted, plastic-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Element: Lead-free [**Bourdon tube**].
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Pointer: Dark-colored metal.
9. Window: [Glass][Safety glass][acrylic plastic].
10. Ring: [Metal][plastic].
11. Connector Type(s): Union joint, threaded, [**back**][**bottom**]; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel, aluminum, or lead-free brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

F. Thermometers, Liquid in Glass, Lead Free - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]

2. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, compact-style thermometers by

single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Cast aluminum**]; **6-inch (150-mm)** nominal size.
5. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid; mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: Glass or plastic.
9. Stem: Aluminum or lead-free brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **3/4 inch (19 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

G. Thermometers, Liquid in Glass, Lead Free - Plastic Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, compact-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Plastic**]; **6-inch (150-mm)** nominal size.
5. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: Glass or plastic.
9. Stem: Aluminum or lead-free brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: **3/4 inch (19 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

H. Thermometers, Liquid in Glass, Lead Free - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]

c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Cast aluminum**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Case Form: [**Adjustable angle**][**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: [Glass][Safety glass][acrylic plastic].
9. Stem: [**Aluminum**] and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

I. Thermometers, Liquid in Glass, Lead Free - Plastic Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ernst Flow Industries**]
   b. [**Marsh Bellofram**]
   c. [**Miljoco Corporation**]
   d. [**Palmer Wahl Instrumentation Group**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Weiss Instruments, Inc**]
   g. [**Weksler Glass Thermometer Corp.**]
   h. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: [**Plastic**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Case Form: [**Adjustable angle**][**Back angle**][**Straight**] unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[**or red**] organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
8. Window: [Glass][Safety glass][acrylic plastic].
9. Stem: [**Aluminum**][**Lead-free brass**][**Stainless steel**][**Aluminum, lead-free brass, or stainless steel**] and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

J. Thermometers, Light Activated, Lead Free - Direct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Miljoco Corporation**]
   b. [**Trerice, H. O. Co**]
   c. [**Weiss Instruments, Inc**]
   d. [**Weksler Glass Thermometer Corp.**]
   e. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide light-activated, lead-free, direct-mounted thermometers from single manufacturer.
3. Case: [**Plastic**][**Metal**]; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
4. Scale Divisions: [**Deg F (deg C)**][**Deg F and deg C**].
5. Case Form: [**Adjustable angle**].
6. Connector: [**1-1/4 inches (32 mm)**], with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
7. Stem: [**Aluminum**] and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

8. Display: Digital.
9. Accuracy: Plus or minus **1 deg F (0.5 deg C)**.

K. Thermometers, Light Activated, Lead Free - Remote Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Miljoco Corporation**]

2. Source Limitations: Provide light-activated, lead-free, remote-mounted thermometers from single manufacturer.
3. Case: Plastic, for wall mounting.
4. Scale Divisions: [**Deg F (deg C)**][**Deg F and deg C**].
5. Sensor: Lead-free bulb and thermistor wire.

   a. Design for Thermowell Installation: Bare stem.

6. Display: Digital.
7. Accuracy: Plus or minus **1 deg F (0.5 deg C)**.

L. Thermowells, Lead Free:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper.
4. Material for Use with Steel Piping: [**Type 304 stainless steel**][**Type 316 stainless steel**].
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25)**, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend [**a minimum of 2 inches (50 mm) into fluid**][**one-third of pipe diameter**][**to center of pipe**][**to match thermometer stem length**].
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [**Mixture of graphite and glycerin**].

M. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ametek U.S. Gauge**]
   b. [**Ashcroft Inc**]
   c. [**Blue Ribbon Corp.**]
   d. [**Ernst Flow Industries**]
   e. [**Flo Fab Inc**]
   f. [**Marsh Bellofram**]
   g. [**Miljoco Corporation**]
   h. [**Noshok**]
   i. [**Palmer Wahl Instrumentation Group**]
   j. [**REOTEMP Instrument Corporation**]
   k. [**Tel-Tru Manufacturing Company**]
   l. [**Trerice, H. O. Co**]
   m. [**WATTS; A Watts Water Technologies Company**]
   n. [**Weiss Instruments, Inc**]
   o. [**Weksler Glass Thermometer Corp.**]
   p. [**WIKA Instrument Corporation**]
   q. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**][**Sealed**][**Open-front, pressure-relief**][**Solid-front, pressure-relief**] type(s); [**cast aluminum or drawn steel**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][plastic].

11. Ring: [**Metal**][**Brass**][**Stainless steel**].
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

N. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Flo Fab Inc**]
    d. [**Marsh Bellofram**]
    e. [**Miljoco Corporation**]
    f. [**Noshok**]
    g. [**Palmer Wahl Instrumentation Group**]
    h. [**REOTEMP Instrument Corporation**]
    i. [**Tel-Tru Manufacturing Company**]
    j. [**Trerice, H. O. Co**]
    k. [**Weiss Instruments, Inc**]
    l. [**Weksler Glass Thermometer Corp.**]
    m. [**WIKA Instrument Corporation**]
    n. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, plastic-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] type; [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

O. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Ernst Flow Industries**]
    d. [**Flo Fab Inc**]
    e. [**Marsh Bellofram**]

f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, metal-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**][**Sealed**] type; [**cast aluminum or drawn steel**][**metal**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 NPT pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Ring: [**Metal**][**Stainless steel**].
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

P. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, plastic-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] type; [**plastic**]; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**] nominal diameter with [**back**][**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or**

DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [psi (kPa)][**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [Glass][Safety glass][acrylic plastic].
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

Q. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with [NPS 1/4 (DN 8)][NPS 1/4 or NPS 1/2 (DN 8 or DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads and [**piston**][**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: [**Lead-free brass ball**][**Lead-free brass or stainless steel needle**], with [NPS 1/4 (DN 8)][NPS 1/4 or NPS 1/2 (DN 8 or DN 15)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe threads.

R. Test Plugs, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**IMI Flow Design, Inc.**]
   b. [**Miljoco Corporation**]
   c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
   d. [**Peterson Equipment Co., Inc**]
   e. [**Trerice, H. O. Co**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Weiss Instruments, Inc**]
   h. [**Weksler Glass Thermometer Corp.**]

2. Source Limitations: Provide lead-free test plugs from single manufacturer.
3. Description: Test-station fitting made for insertion into piping tee fitting.
4. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
5. Thread Size: [NPS 1/4 (DN 8)][NPS 1/2 (DN 15)], ASME B1.20.1 pipe thread.
6. Minimum Pressure and Temperature Rating: [500 psig at 200 deg F (3450 kPa at 93 deg C)].
7. Core Inserts: [**Chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber.

S. Test-Plug Kits, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ribbon Corp.**]
   b. [**Peterson Equipment Co., Inc**]

2. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
3. Furnish [**one**] test-plug kit(s) containing [**one**][**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes

are to be of diameter to fit test plugs and of length to project into piping.

4. Low-Range Thermometer, Lead Free: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 51-mm-)**] diameter dial and tapered-end sensing element. Dial range is to be at least [**25 to 125 deg F (minus 4 to plus 52 deg C)**].
5. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 51-mm-)**] diameter dial and tapered-end sensing element. Dial range is to be at least [**0 to 220 deg F (minus 18 to plus 104 deg C)**].
6. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with [**2- to 3-inch- (51- to 76-mm-)**] diameter dial and probe. Dial range is to be at least [**0 to 200 psig (0 to 1380 kPa)**].
7. Carrying Case: Metal or plastic, with formed instrument padding.

T. Sight Flow Indicators, Lead Free:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]

2. Source Limitations: Provide lead-free sight flow indicators from single manufacturer.
3. Description: Piping inline-installation device for visual verification of flow.
4. Construction: Lead-free bronze or stainless steel body, with sight glass and [**ball, flapper, or paddle wheel**] indicator, and threaded or flanged ends.
5. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1034 kPa)**].
6. Minimum Temperature Rating: [**200 deg F (93 deg C)**].
7. End Connections: [**NPS 2 (DN 50) and smaller, threaded**][**NPS 2-1/2 (DN 65) and larger, flanged**].

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.4 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [**one**][**two**] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [**four**] pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.5 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [**five**] pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [**four**] pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [**four**] pipe fittings, including tee in main.

3.6 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**] annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches (50 mm)] above finished floor level.

3. Using [grout][silicone sealant], seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.7 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [grout][silicone sealant], seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.8 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.9 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.10 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.11 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks.

H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

I. Install remote-mounted pressure gauges on panel.

J. Install valve and snubber in piping for each pressure gauge for fluids.

K. Install test plugs in piping tees.

L. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.
5. Outlet side of hot-water-balancing valve.
6. Each main hot-water-recirculating line return pipe.

M. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.12 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.13 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.14 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.15 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**] annular clear space between piping

and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

   a. [Sleeves with waterstops][stack-sleeve fittings].

4. Interior Wall and Partitions:

   a. Sleeves without waterstops.

3.16 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**][**cast brass**][**or split-casting brass**] with polished, chrome-plated finish.
3. Insulated Piping:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

   a. One piece, steel with polished, chrome-plated finish.
   b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
   c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

   a. One piece, steel with polished, chrome-plated finish.
   b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
   c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split casting, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [concealed][exposed-rivet] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

3.17 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each remote domestic water chiller are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Metal**][**Plastic**] case, [**compact**][**industrial**]-style, liquid-in-glass type.

4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

E. Thermometer stems are to be of length to match thermowell insertion length.

3.18 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

B. Scale Range for Domestic Hot-Water Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Domestic Cooled-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].

D. Insert additional paragraphs for thermometer scale ranges and applications.

3.19 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**] [**direct**][**remote**] mounted, metal case.
2. [**Sealed**] [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

3.20 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:

1. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
2. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
3. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].

B. Scale Range for Domestic Water Piping:

1. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
2. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
3. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
4. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].

C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

END OF SECTION 22 05 00 00

SECTION 22 05 00 00A - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:

   a. Domestic water booster pumps.
   b. Domestic hot-water in-line circulation pumps.
   c. General-duty air compressors.
   d. Sanitary sewage pumps.
   e. Drainage pumps.
   f. Laboratory air compressors.
   g. Laboratory vacuum pumps.

3. Pipe-leakage test verification.
4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

B. Related Requirements:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for TAB of HVAC.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. FFT: Fast Fourier transform.

C. INCE: Institute of Noise Control Engineering.

D. NC: Noise criteria.

E. NEBB: National Environmental Balancing Bureau.

F. RC: Room criteria.

G. TAB: Testing, adjusting, and balancing.

H. TABB: Testing, Adjusting, and Balancing Bureau.

I. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

J. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at [**Project site**]<**Insert location**> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of [**14**]<**Insert number**> days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Requirements for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.
e. <**Insert additional agenda items as required**>.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, provide a summary report of the examination review required in "Examination" Article, if issues are discovered that may preclude the proper testing and balancing of the systems. Submit a summary report of the examination review required in "Examination" Article.

C. Strategies and Procedures Plan: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article, to be used and filled out by systems installers verifying that systems are ready for TAB.

E. Certified TAB Reports: Within [**14**][**21**][**30**]<**Insert number**> days of completion of testing and balancing work.

1. Submit one copy of the final TAB report to the design professional of record's firm. Provide [**five**]<**Insert number**> additional copies to Contractor.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration and calibration interval.

1.5 QUALITY ASSURANCE

A. TAB Specialist Firm's Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist firm and certified by AABC.
2. TAB Technician: Employee of the TAB specialist firm and certified by AABC.

B. TAB Specialist Firm's Qualifications: Certified by [**NEBB**][**or**][**TABB**].

1. TAB Certified Professional: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**].
2. TAB Technician: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**].
3. TAB specialist firm is to be independent, third-party, and unaffiliated with Contractor.

C. Sound and Vibration Specialists: [**NEBB-certified Sound and Vibration Technician**][**TABB-certified Sound and Vibration Technician**][**INCE Board-certified professional**][**Vibration Institute Category I Certified Vibration Analyst**][**Vibration Institute Category II Certified Vibration Analyst**][**Vibration Institute Category III Certified Vibration Analyst**][**Vibration Institute Category IV Certified Vibration Analyst**][**or**][**Licensed professional engineer who specializes in acoustical engineering**]<**Insert sound and vibration certification**>.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

F. ASHRAE 188 Compliance: Comply with balancing and report requirements in Section 8.3, "Balancing."

G. Code and Authorities Having Jurisdiction Compliance: Furnish TAB services that comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS
PART 3 - EXECUTION

3.1 TAB SPECIALIST FIRMS

A. Subject to compliance with requirements, [**engage one of the following**][**available TAB specialist firm that may be engaged include, but are not limited to, the following**]:

1. <**Insert TAB specialist firm's name**>.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in system designs that may preclude proper TAB of systems and equipment. Submit Contract

Documents Examination Report summary of findings.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Note the locations of devices that are not accessible for TAB.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

E. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

F. Verify with installing Contractor that startup strainer screens have been replaced with permanent screens and that all strainers have been cleaned.

G. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

H. Observe demonstration of operating safety interlocks and controls on plumbing equipment.

I. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checklists of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. [**Booster-**][**and**][**hot-water circulating**] pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete, and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.

2. Sanitary Sewage/Drainage System:

   a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
   b. Piping is complete.
   c. Sanitary sewage pumps/drainage pumps are operational.
   d. Control valves are functioning in accordance with the sequence of operation.
   e. Shutoff valves are 100 percent open.
   f. Suitable access to equipment is provided.

3. Compressed-Air System:

   a. Leakage and pressure tests on compressed air-distribution system have been satisfactorily completed in accordance with Div. 22 requirements.
   b. Piping is complete and all points of outlet are installed.
   c. Systems are flushed, filled, and air purged.
   d. Strainers are clean.
   e. Control valves are functioning in accordance with the sequence of operation.
   f. Shutoff and balance valves are 100 percent open.
   g. Compressors are operational and of proper rotation.
   h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
   i. Variable-frequency controllers' startup is complete, and safeties are verified.
   j. Suitable access to balancing devices and equipment is provided,

4. Vacuum System:

   a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Div. 22 requirements.
   b. Piping is complete and all points of inlet are installed.
   c. Systems are flushed, filled, and purged.
   d. Strainers are clean.
   e. Control valves are functioning in accordance with the sequence of operation.
   f. Shutoff and balance valves are 100 percent open.
   g. Vacuum pumps are operational and of proper rotation.
   h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
   i. Variable-frequency controllers' startup is complete, and safeties are verified.
   j. Note location of balancing devices that aren't accessible.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [**AABC's "National Standards for Total System Balance"**][**ASHRAE 111**][**NEBB's "Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems"**][**SMACNA's "HVAC Systems - Testing, Adjusting & Balancing"**][**SMACNA's "TAB Procedural Guide"**] applicable to analogous domestic water system and plumbing equipment balancing in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

   1. Installing Contractor to Perform the Following:

      a. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.

b. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP**][**and**] units.

E. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.5 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water booster pumps.
3. Domestic water in-line pumps.
4. Domestic water heaters.
5. Sanitary sewage pumps.
6. Drainage pumps.
7. Air compressors.
8. Vacuum pumps.
9. <**Insert equipment**>.

3.6 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

A. Prepare test reports for air compressors and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:

1. Check remotest point of outlet for adequate pressure.
2. Check pressure-control valves for proper position.
3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
4. Verify that motor controllers are equipped with properly sized thermal protection.

D. Measure and record upstream and downstream pressure of pressure-reducing valves.

E. Check settings and operation of pressure-reducing valves. Record final settings.

F. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VACUUM SYSTEMS

A. Prepare test reports for vacuum pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' record Drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check remotest point of inlet for adequate vacuum.
2. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
3. Verify that motor controllers are equipped with properly sized thermal protection.

3.9 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, pump impellers are to be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

3.10 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.11 PROCEDURES FOR MOTORS

A. Motors: [**1/2**]<**Insert value**> hp and larger; test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation. Verify and report Hz at maximum and minimum flows.

3.12 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. [**Measure and**]Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** **(kW)** of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

B. Gas- and Oil-Fired Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. [**Measure and**]Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** **(kW)** of heating output.
6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

3.13 SOUND TESTS

A. After systems are balanced and Substantial Completion, with all systems operating at normal conditions and with all spaces completed and finished for occupancy, measure and record sound levels at [**five**][**10**][**15**]<**Insert number**> locations as designated by Architect. All building mechanical, electrical, and plumbing equipment, which may affect sound readings, must be operational.

B. Sound-Level Testing Meter Instrumentation - Minimum Requirements:

1. Portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.

2. Capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (Leq).
3. Capable of using one-third octave band filters to measure frequencies from 31.5 Hz to 8000 Hz.
4. Accuracy of plus/minus two decibels.
5. Current NIST-traceable annual calibration. Calibrate instruments prior to taking measurements and after taking measurements each day of use.

C. Test Procedures - Indoors:

1. Measure and record sound levels at the following rooms:

   a. <**Insert list of room numbers and names where sound testing is required**>.

2. For each room/location tested, select a measurement location that has the greatest anticipated sound level. If testing multiple locations for each room type, select at least one location that is near and at least one location that is remote from the predominant sound source.
3. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
4. Equipment is to be operating at design values.
5. Sound-testing firm is to have access to controls hardware, software, and onsite technical support at no cost to the sound-testing firm. The installing contractors are to provide a controlled, steady-state environment (flow, pressure, control, and temperature) during duration of sound testing.
6. Use a microphone suitable for the type of noise levels measured that is compatible with meter.
7. At each measurement location, record a set of background sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment off.
8. At each measurement location, record a set of sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment operating.
9. Take readings no closer than **36 inches (900 mm)** from a wall or from the operating equipment and approximately **48 inches (1200 mm)** from the floor, with the meter held or mounted on a tripod.

D. Reporting:

1. The final report is to contain the following information at a minimum:

   a. Report Title Page: Page indicating Project name, names of Project Architect, engineer, HVAC Contractor, and sound measurement firm with names, addresses, and telephone numbers.
   b. Report Certification Page: Page indicating Project name, sound measurement firm name, name of individual performing measurements, and all required sound technician certifications.
   c. Table of Contents: Identify report sections and total number of pages in each section.
   d. Report Summary/Remarks: Narrative description of system setup conditions, results, and deficiencies.
   e. Instrument Calibration Section: List of instruments to be used to verify the reported data, containing the name/type of each instrument, manufacturer, model number, serial number, calibration date and dates of use, and NIST-traceable calibration certificates.
   f. Sound Measurement Data Sheets: Record sound measurements on sound measurement report forms, indicating the decibel levels measured for both "background" and "building system operating" readings. Record each tested location on a separate NC or RC chart. Record the following information on the forms:

      1) Date and time of test.

2) Equipment Operational Parameters: Speed and frequency at time of measurements.
3) Indoor Measurements: Space location within the building, including floor level and room space number.
4) Outdoor Measurements: Location identifier such as location relative to equipment, building, or property line.
5) Indicate where measurements meet or exceed design criteria.

3.14 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than [**3**]<**Insert number**>[**for pumps and fans,**][**5**]<**Insert number**>[**for chillers and compressors**].

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter is to automatically identify engineering units, frequency resolution, filter bandwidth, amplitude, and frequency scale values.
3. The meter is to be able to measure machine vibration displacement in mils of deflection; velocity in inches per second (meters/sec); and acceleration in G's (or g-force), inches per second squared (G's, meters per second squared).
4. Calibration of instrument and transducer must be NIST traceable and must be current during the time period measurements are being made. Vibration instruments and transducers must have NIST-traceable calibration every 12 months. Verify calibration date is current for vibration meter before taking readings.

C. Pretest Procedures:

1. Before any vibration measurements are made, confirm that the following items have been completed and any deficiencies found are reported to the appropriate parties for remedy:

a. Verify that all vibration isolators are installed in accordance with respective manufacturer's written instructions.
b. Verify that piping and conduit penetrations through plumbing equipment room envelope are sealed, and that there is no rigid contact with building structure.
c. Inspect steel isolation bases for cracked welds and bending/twisting of steel members.
d. Inspect concrete isolation bases for cracked concrete. Check isolator retainer brackets to be sure they are not loose. Concrete base must be flat and true level.
e. Examine elastomeric isolators for cracks in the rubber and for loose bonds between the rubber and the steel plates and other steel components. Verify clearance is provided between bolts and the side of bolt holes to prevent short circuiting.
f. Examine steel spring isolators for loose or missing bolts, nuts, and lock washers. Verify springs are not overloaded or underloaded, completely collapsed, or cocked. Verify rubber or glass-fiber pad between bottom steel spring plate and the concrete/supporting structure is in place.
g. Inspect isolators that have seismic restraint devices to make sure that all shims have been removed and supportive nuts have been properly adjusted to allow for free floating of the isolated system.
h. Verify that seismic restraints are not preventing proper functioning of vibration isolation function.
i. Verify space under isolated bases are clean and free of debris that could cause short-circuiting.
j. Verify that shipping bolts associated with spring isolators have been removed so that they do not short-circuit the system.

k. Verify flexible piping, hoses, and expansion joint types, lengths, and locations are as specified.
l. Verify that electrical and control connections do not restrain movement of the vibration-isolated equipment.
m. Verify flexible connections between fans and ductwork "bellow" as designed when fans are operating.
n. Verify that hanger isolator rods are free of misalignment and not in rigid contact with the hanger housing.

D. Test Procedures:

1. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not adversely influence measurements of equipment being tested.
2. Observe if there is equipment in the building that might interfere with testing. Note the equipment to the construction manager and request resolution before testing begins.
3. Take measurements when exterior vibration sources, such as trains, roadway traffic, adjacent construction activities, and the like, are at a minimum level.
4. Attach and secure vibration transducer in accordance with the most current edition of [**NEBB's "Procedural Standards for Measurement of Sound and Vibration."**]<**Insert reference document.**>
5. Measure and record vibration levels [**in at least 1.25 Hz increments over a minimum frequency range of 5 to 1000 Hz**]<**Insert increment requirements**>.
6. Measure and record acceleration and/or velocity and/or displacement readings on equipment; bearing and equipment base in the vertical, horizontal, and axial planes; or as per-contract specifications, where measurements can be performed safely and where measurement locations are accessible.

   a. Pumps:

      1) Pump Bearing: Drive end and opposite end.
      2) Motor Bearing: Drive end and opposite end.
      3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
      4) Building: Floor adjacent to pump/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

   b. Compressors:

      1) Compressor Bearing: Drive end and opposite end.
      2) Motor Bearing: Drive end and opposite end.
      3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
      4) Building: Floor adjacent to compressor/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

7. FFT Analyzer Settings:

   a. Windowing: Hanning.
   b. Averages: At least two.
   c. Frequency Range: 5 to 1,000 Hz (300 to 60,000 rpm).
   d. Frequency Resolution: At least 1.25 Hz (75 rpm).
   e. Line of Resolution: At least 800.
   f. Detection: Peak, peak-to-peak, or RMS.
   g. Averaging: Exponential.

E. Reporting:

1. Vibration Measurement Report Forms:

   a. For each measurement location, record vibration measurements on appropriate test forms, showing the following information:

      1) Date of test.
      2) Equipment designation, location, motor horsepower, and equipment operational parameters (speed/frequency) at time of test.
      3) Measured acceleration, [**in units of g's (g-force), inches/seconds squared (meters/seconds squared)**]<**Insert units of measure**>.
      4) Measured deplacement, [**in units of inches, mils (millimeters)**]<**Insert units of measure**>.
      5) Vibration level plot of vibration amplitude versus frequency for each measurement location.
      6) Verify vibration amplitude level plot versus frequency for each measurement location.

2. Verify actual vibration against vibration limits. Follow the[**General Machinery Vibration Severity Chart**] or[**Vibration Acceleration General Severity Chart**] from [**ASHRAE Handbook - "HVAC Applications," Ch. "Noise and Vibration Control"**][**NEBB's "Procedural Standard for Measurement of Sound and Vibration"**][**or**][**AABC's "National Standards for Total System Balance."**] Acceptable levels of vibration are normally "smooth" to "good."
3. Include General Machinery Vibration Severity Chart with all conditions plotted.
4. Test each bearing on motor, pump, and compressor as required. Track and record vibration levels from rotating component through casing to base.
5. Include horizontal-vertical-axial measurements for tests.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

   1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the condition of filters.
   4. Check bearings and other lubricated parts for proper lubrication.
   5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB after Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

   1. New filters are installed.
   2. Bearings and other parts are properly lubricated.
   3. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

   1. Compare the indicated system flows of the renovated work to the measured flows and determine the new pump speed.
   2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the system flow rates by more than [**5**]<**Insert number**> percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is [**5**]<**Insert number**> percent or less, equipment adjustments are not required.

3.16 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>. If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
2. Compressed-Air Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>. If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
3. Vacuum Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**>.

3.17 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare [**weekly**][**biweekly**][**monthly**]<**Insert time interval**> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL TESTING AND BALANCING REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist firm and technician.
3. Project name.
4. Project location.
5. Project Architect's name, firm, and address.
6. Project engineer's name, firm, and address.
7. Project Contractor's name, firm, and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in **Btu/h (kW)**.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and speed.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.
    m. Sheave make, size in **inches (mm)**, and bore.
    n. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.

2. Test Data (Indicated and Actual Values):

    a. Total airflow rate in **cfm (L/s)**.
    b. Entering-water temperature in **deg F (deg C)**.

c. Leaving-water temperature in **deg F (deg C)**.
d. Low-fire fuel input in **Btu/h (kW)**.
e. High-fire fuel input in **Btu/h (kW)**.
f. High-temperature-limit setting in **deg F (deg C)**.
g. Operating set point in **Btu/h (kW)**.
h. Heating value of fuel in **Btu/h (kW)**.

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in **Btu/h (kW)**.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in **Btu/h (kW)**.
b. Entering-water temperature in **deg F (deg C)**.
c. Leaving-water temperature in **deg F (deg C)**.
d. High-temperature-limit setting in **deg F (deg C)**.
e. Operating set point in **deg F (deg C)**.
f. Voltage at each connection.
g. Amperage for each phase.

G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in **gpm (L/s)**.
g. Water-pressure differential in **feet of head or psig (kPa)**.
h. Required net positive suction head in **feet of head or psig (kPa)**.
i. Pump speed.
j. Impeller diameter in **inches (mm)**.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in **feet of head or psig (kPa)**.
b. Pump shutoff pressure in **feet of head or psig (kPa)**.
c. Actual impeller size in **inches (mm)**.
d. Full-open flow rate in **gpm (L/s)**.
e. Full-open pressure in **feet of head or psig (kPa)**.
f. Final discharge pressure in **feet of head or psig (kPa)**.
g. Final suction pressure in **feet of head or psig (kPa)**.
h. Final total pressure in **feet of head or psig (kPa)**.
i. Final water flow rate in **gpm (L/s)**.
j. Voltage at each connection.
k. Amperage for each phase.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.19 VERIFICATION OF TAB REPORT

A. The TAB specialist firm's test and balance technician is to conduct the final verification in the presence of [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**].

B. [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] are to randomly select measurements, documented in the final report, to be rechecked. Rechecking is to be limited to the lesser of either [**10**]<**Insert number**> percent of the total measurements recorded or the extent of measurements that can be accomplished in [**a normal 8-hour business day**]<**Insert value**>.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements are to be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than [**10**][**20**]<**Insert number**> percent of the total measurements checked during the final inspection, the TAB are to considered incomplete and are to be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists are to recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. Track all changes to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB Work.

F. Prepare test and inspection reports.

3.20 REVERIFICATION

A. TAB specialist firm technicians are to recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and request a second verification.

B. If the second verification also fails, [**Owner**][**Architect**] may contact [**AABC headquarters regarding the AABC National Performance Guaranty**][**TABB Quality Assurance Program, Customer Complaint Procedures**]<**Insert guaranty organization**>.

3.21 ADDITIONAL TESTS

A. Within [**90**]<**Insert number**> days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 22 05 00 00A

Task	Specification	Specification Description
22 05 13 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 16 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 17 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 19 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 05 23 00 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Gate valves.
5. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as Buna-N).

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.
b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves [**NPS 4 (DN 100)**] and larger.
2. Hand Lever: For quarter-turn ball valves smaller than [**NPS 4 (DN 100)**].

I. Valves in Insulated Piping:

1. Provide **2-inch (50-mm)** extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves, Lead Free, Threaded Ends - Brass, One Piece:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bonomi North America, Inc.**]
   b. [**KITZ Corporation**]
   c. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: One piece.
5. Body Material: Forged brass or bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Brass or stainless steel.
9. Ball: Chrome-plated brass or stainless steel.
10. Port: Reduced.

B. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Bonomi North America, Inc.**]
   e. [**Center Line; a Crane Co. brand**]
   f. [**DynaQuip Controls**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jenkins Valves; a Crane Co. brand**]

j. [**Jomar Valve**]
k. [**KITZ Corporation**]
l. [**Lance Valves**]
m. [**Marwin Valve; Richards Industries**]
n. [**Milwaukee Valve Company**]
o. [**Mueller Streamline Co.; a company of Mueller Industries**]
p. [**Red-White Valve Corp.**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

C. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bonomi North America, Inc.**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Milwaukee Valve Company**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110, MSS SP-145, IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

D. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless

Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Jomar Valve**]
    g. [**KITZ Corporation**]
    h. [**Lance Valves**]
    i. [**Marwin Valve; Richards Industries**]
    j. [**Milwaukee Valve Company**]
    k. [**Red-White Valve Corp.**]
    l. [**Stockham; a Crane Co. brand**]
    m. [**Viega LLC**]
    n. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

E. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Valve, Inc**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Center Line; a Crane Co. brand**]
    d. [**Hammond Valve**]
    e. [**Jomar Valve**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Viega LLC**]
    l. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.

6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RPTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

F. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Center Line; a Crane Co. brand**]
   e. [**FNW; Ferguson Enterprises, Inc.**]
   f. [**Hammond Valve**]
   g. [**Jomar Valve**]
   h. [**KITZ Corporation**]
   i. [**Lance Valves**]
   j. [**Milwaukee Valve Company**]
   k. [**Red-White Valve Corp.**]
   l. [**Stockham; a Crane Co. brand**]
   m. [**Viega LLC**]
   n. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Regular.

G. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Center Line; a Crane Co. brand**]
   e. [**Hammond Valve**]
   f. [**Jomar Valve**]

g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Marwin Valve; Richards Industries**]
j. [**Milwaukee Valve Company**]
k. [**Neles Corporation**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. [**Viega LLC**]
o. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Brass or bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

H. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bonomi North America, Inc.**]
b. [**Jomar Valve**]
c. [**Marwin Valve; Richards Industries**]
d. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

I. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DynaQuip Controls**]
b. [**Marwin Valve; Richards Industries**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.

5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

J. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Reduced.

K. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Reduced.

L. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bonomi North America, Inc.**]
c. [**Center Line; a Crane Co. brand**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

M. Ball Valves, Lead Free, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. [**Red-White Valve Corp.**]
g. [**Stockham; a Crane Co. brand**]
h. [**Viega LLC**]
i. [**Zurn Industries, LLC**]

2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

N. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

O. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.

9. Ball: Chrome-plated brass.
10. Port: Regular.

P. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Center Line; a Crane Co. brand**]
   c. [**DynaQuip Controls**]
   d. [**Hammond Valve**]
   e. [**Jenkins Valves; a Crane Co. brand**]
   f. [**Jomar Valve**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Red-White Valve Corp.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**Viega LLC**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

Q. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

R. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

S. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Regular.

T. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **600 psig (4140 kPa)**.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.

8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

U. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Full Port, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**DynaQuip Controls**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jomar Valve**]
   f. [**Lance Valves**]
   g. [**Milwaukee Valve Company**]
   h. [**Neles Corporation**]
   i. [**NIBCO INC.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**Viega LLC**]
   l. [**WATTS; A Watts Water Technologies Company**]

2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

V. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Regular Port, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**FNW; Ferguson Enterprises, Inc.**]
   c. [**Hammond Valve**]
   d. [**Jomar Valve**]
   e. [**Lance Valves**]
   f. [**Milwaukee Valve Company**]
   g. [**Neles Corporation**]
   h. [**NIBCO INC.**]
   i. [**Stockham; a Crane Co. brand**]

2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Uni-body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.

7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

W. Ball Valves, Lead Free, Flanged or Threaded Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]

2. Standards: MSS SP-72, MSS SP-110, and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

X. Ball Valves, Lead Free, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Guardian Worldwide LLC.**]
   d. [**Jomar Valve**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

Y. Ball Valves, Lead Free, Press Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Jomar Valve**]

2. Standards: MSS SP-110, MSS SP-145, IAPMO PS-117, and ICC-ES LC1002.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Seats: PTFE.
9. Stem: Type 316 stainless steel.
10. Ball: Type 316 stainless steel.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

Z. Ball Valves - CPVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: CPVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

AA. Ball Valves - CPVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)**. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: CPVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

BB. Ball Valves - PVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: PVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable union with socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: PVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

CC. Ball Valves - PVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]

2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature.
4. Body Material: PVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: PVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

2.4 BALL VALVES, GENERAL PURPOSE

A. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**DynaQuip Controls**]
f. [**FNW; Ferguson Enterprises, Inc.**]
g. [**Hammond Valve**]
h. [**Jenkins Valves; a Crane Co. brand**]
i. [**Jomar Valve**]
j. [**KITZ Corporation**]
k. [**Lance Valves**]
l. [**Legend Valve & Fitting, Inc**]
m. [**Marwin Valve; Richards Industries**]
n. [**Milwaukee Valve Company**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.

10. Ball: Chrome-plated brass.
11. Port: Full.

B. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**DynaQuip Controls**]
   f. [**FNW; Ferguson Enterprises, Inc.**]
   g. [**Hammond Valve**]
   h. [**Jamesbury; a brand of Valmet**]
   i. [**Jenkins Valves; a Crane Co. brand**]
   j. [**Jomar Valve**]
   k. [**KITZ Corporation**]
   l. [**Lance Valves**]
   m. [**Legend Valve & Fitting, Inc**]
   n. [**Marwin Valve; Richards Industries**]
   o. [**Milwaukee Valve Company**]
   p. [**Red-White Valve Corp.**]
   q. [**RuB Inc**]
   r. [**Siemens Industry, Inc., Building Technologies Division**]
   s. [**Stockham; a Crane Co. brand**]
   t. [**Viega LLC**]
   u. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

C. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.

5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered ends. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.

D. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DynaQuip Controls**]
   b. [**Marwin Valve; Richards Industries**]
   c. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-110.
3. SWP Rating: **150 psig (1035 kPa)**.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

E. Ball Valves, Threaded Ends - Bronze, Two Piece, Safety Exhaust:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**DynaQuip Controls**]
   c. [**Lance Valves**]

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: **200 psig (1380 kPa)** or other pressure. See Part 3 ball valve schedule articles.
4. Body Design: Two piece.
5. Body Material: Bronze, ASTM B584, Alloy C844.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
10. Port: Full.

F. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jamesbury; a brand of Valmet**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **285 psig (1964 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

G. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jamesbury; a brand of Valmet**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **720 psig (4960 kPa)**.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

H. Ball Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-72.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

I. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jomar Valve**]

2. Standard: MSS SP-110.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

2.5 BUTTERFLY VALVES, LEAD FREE

A. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]

b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)**, or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]

o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)**, or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 12 (DN 300) and Smaller: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See

Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Center Line; a Crane Co. brand**]
   d. [**DeZURIK**]
   e. [**DynaQuip Controls**]
   f. [**Flo Fab Inc**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jamesbury; a brand of Valmet**]
   j. [**Jenkins Valves; a Crane Co. brand**]
   k. [**Jomar Valve**]
   l. [**Kennedy Valve Company; a division of McWane, Inc.**]
   m. [**KITZ Corporation**]
   n. [**Lance Valves**]
   o. [**Legend Valve & Fitting, Inc**]
   p. [**Milwaukee Valve Company**]
   q. [**NIBCO INC.**]
   r. [**Norriseal**]
   s. [**Red-White Valve Corp.**]
   t. [**Stockham; a Crane Co. brand**]
   u. [**Sure Flow Equipment Inc**]
   v. [**Viega LLC**]
   w. [**WATTS; A Watts Water Technologies Company**]
   x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]

m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Hammond Valve**]
c. [**Kennedy Valve Company; a division of McWane, Inc.**]
d. [**NIBCO INC.**]
e. [**Norriseal**]
f. [**Red-White Valve Corp.**]
g. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **175 psig (1200 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

H. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
k. [**Victaulic Company**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

I. Butterfly Valves, Lead Free, Grooved End - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
e. [**Victaulic Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. CWP Rating, NPS 10 (DN 250) and Larger: **200 psig (1380 kPa)**.
5. Body Material: Type 316 stainless steel, ASTM A743/A743M.
6. Ends: Grooved.
7. Stem: Type 416 stainless steel.
8. Disc: Type 316 stainless steel or ductile iron, encapsulated with Grade "EN" EPDM.
9. Seat: EDPM.

J. Butterfly Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Colonial Engineering, Inc.**]

c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**NIBCO INC.**]
f. [**Spears Manufacturing Company**]
g. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: CPVC.
8. Stem: Stainless steel.
9. Handle: Lever.

K. Butterfly Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**ASC Engineered Solutions**]
d. [**Colonial Engineering, Inc.**]
e. [**GF Piping Systems: Georg Fischer LLC**]
f. [**Hayward Flow Control; Hayward Industries, Inc.**]
g. [**IPEX USA LLC**]
h. [**Legend Valve & Fitting, Inc**]
i. [**NIBCO INC.**]
j. [**Spears Manufacturing Company**]
k. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: PVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: PVC.
8. Stem: Stainless steel.
9. Handle: Lever.

2.6 BUTTERFLY VALVES, GENERAL PURPOSE

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]

o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**WATTS; A Watts Water Technologies Company**]
y. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.

3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Center Line; a Crane Co. brand**]
   d. [**DeZURIK**]
   e. [**DynaQuip Controls**]
   f. [**Flo Fab Inc**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jamesbury; a brand of Valmet**]
   j. [**Jenkins Valves; a Crane Co. brand**]
   k. [**Jomar Valve**]
   l. [**Kennedy Valve Company; a division of McWane, Inc.**]
   m. [**KITZ Corporation**]
   n. [**Lance Valves**]
   o. [**Legend Valve & Fitting, Inc**]
   p. [**Milwaukee Valve Company**]
   q. [**NIBCO INC.**]
   r. [**Norriseal**]
   s. [**Red-White Valve Corp.**]
   t. [**Stockham; a Crane Co. brand**]
   u. [**Sure Flow Equipment Inc**]
   v. [**Viega LLC**]
   w. [**WATTS; A Watts Water Technologies Company**]
   x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DeZURIK**]
e. [**DynaQuip Controls**]
f. [**Flo Fab Inc**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**NIBCO INC.**]
r. [**Norriseal**]
s. [**Red-White Valve Corp.**]
t. [**Stockham; a Crane Co. brand**]
u. [**Sure Flow Equipment Inc**]
v. [**Viega LLC**]
w. [**WATTS; A Watts Water Technologies Company**]
x. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]

l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**WATTS; A Watts Water Technologies Company**]
z. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
k. [**Victaulic Company**]
l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating: **175 psig (1200 kPa)**.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: NBR.

H. Butterfly Valves, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
   c. [**Hammond Valve**]
   d. [**Kennedy Valve Company; a division of McWane, Inc.**]
   e. [**NIBCO INC.**]
   f. [**Norriseal**]
   g. [**Red-White Valve Corp.**]
   h. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   j. [**Victaulic Company**]
   k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Coated, ductile iron
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: NBR.

I. Butterfly Valves, Grooved End - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**ASC Engineered Solutions**]
   d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   e. [**Victaulic Company**]

2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: **300 psig (2070 kPa)**.
4. Body Material: Type 316 stainless steel, ASTM A743/A743M.
5. Ends: Grooved.
6. Stem: Type 416 stainless steel.
7. Disc: Type 316 stainless steel.
8. Seat: NBR.

2.7 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**Val-Matic Valve & Manufacturing Corp.**]
    m. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

C. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Crane Fluid Systems; Crane Co.**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Jomar Valve**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**NIBCO INC.**]
    j. [**Powell Valves**]
    k. [**Red-White Valve Corp.**]
    l. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**FNW; Ferguson Enterprises, Inc.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Lance Valves**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Lead Free, Swing Type, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]

2. Standards: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B584, bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
8. Disc: Brass or bronze.

F. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
e. [**Cooper Valves**]
f. [**Crane Fluid Systems; Crane Co.**]
g. [**DeZURIK**]
h. [**GA Industries, Inc**]
i. [**Hammond Valve**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Milwaukee Valve Company**]
p. [**Powell Valves**]
q. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

G. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ASC Engineered Solutions**]
b. [**Cooper Valves**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**DeZURIK**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**KITZ Corporation**]
g. [**Lance Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Composition.
8. Seat Ring: Bronze.
9. Disc Holder: Bronze.
10. Disc: PTFE.
11. Gasket: Asbestos free.

H. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**GA Industries, Inc**]
g. [**Hammond Valve**]
h. [**Jenkins Valves; a Crane Co. brand**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Milwaukee Valve Company**]
l. [**Powell Valves**]
m. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

I. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Spring-

Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crispin Valve**]
   e. [**DeZURIK**]
   f. [**GA Industries, Inc**]
   g. [**Kennedy Valve Company; a division of McWane, Inc.**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

J. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**ASC Engineered Solutions**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**Cooper Valves**]
   e. [**Crispin Valve**]
   f. [**DeZURIK**]
   g. [**GA Industries, Inc**]
   h. [**Kennedy Valve Company; a division of McWane, Inc.**]
   i. [**Milwaukee Valve Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

K. Check Valves, Lead Free, Swing Type, Grooved Ends - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**DeZURIK**]
d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
e. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. [**Victaulic Company**]

2. CWP Rating: **300 psig (2070 kPa)**.
3. Body Material: ASTM A536, ductile iron.
4. Seat: EPDM.
5. Disc: Spring operated, ductile iron or stainless steel.

L. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
n. [**Val-Matic Valve & Manufacturing Corp.**]
o. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

M. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]

e. [**KITZ Corporation**]
f. [**Metraflex Company (The)**]
g. [**Milwaukee Valve Company**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Val-Matic Valve & Manufacturing Corp.**]
j. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

N. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
m. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

O. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]
e. [**Hilton Valves**]
f. [**KITZ Corporation**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

P. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper Valves**]
   c. [**DeZURIK**]
   d. [**DFT Inc.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**Keckley Company**]
   g. [**Metraflex Company (The)**]
   h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   i. [**Val-Matic Valve & Manufacturing Corp.**]
   j. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

Q. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Metraflex Company (The)**]
   d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

R. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Cooper Valves**]
c. [**Crispin Valve**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Keckley Company**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

S. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

T. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.

6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

U. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

V. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

W. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.

5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

X. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]
   f. [**Victaulic Company**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Y. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: MSS SP-125.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Z. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**Victaulic Company**]

2. Standard: MSS SP-125.

3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

AA. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]

2. Standard: MSS SP-125.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

BB. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**DeZURIK**]
   d. [**Flo Fab Inc**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**Jomar Valve**]
   g. [**Keckley Company**]
   h. [**Lance Valves**]
   i. [**Metraflex Company (The)**]
   j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

CC. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**DeZURIK**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Metraflex Company (The)**]
h. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
i. [**Stockham; a Crane Co. brand**]
j. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

DD. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

EE. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Keckley Company**]
d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
e. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

FF. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flowserve Corporation**]
   b. [**GA Industries, Inc**]
   c. [**Jomar Valve**]
   d. [**Keckley Company**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

GG. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flomatic Valves; Flomatic Corporation**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

HH. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DeZURIK**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

II. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flowserve Corporation**]
   b. [**GA Industries, Inc**]
   c. [**Jomar Valve**]
   d. [**Keckley Company**]
   e. [**Victaulic Company**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

JJ. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jomar Valve**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating: **400 psig (2760 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

KK. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

LL. Check Valves, Lead Free - CPVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**NIBCO INC.**]
g. [**Spears Manufacturing Company**]
h. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
7. Ball: CPVC.
8. Seals: EPDM- or FKM-rubber O-rings.

MM. Check Valves, Lead Free - PVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**NIBCO INC.**]
g. [**Spears Manufacturing Company**]
h. [**Thermoplastic Valves, Inc**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
3. Body Material: PVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, [**socket**][**socket or threaded**][**threaded**][**flange**].
7. Ball: PVC.
8. Seals: EPDM- or FKM-rubber O-rings.

2.8 CHECK VALVES, GENERAL PURPOSE

A. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**American Valve, Inc**]
    c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Jomar Valve**]
    h. [**Keckley Company**]
    i. [**Metraflex Company (The)**]
    j. [**Milwaukee Valve Company**]
    k. [**NIBCO INC.**]
    l. [**Stockham; a Crane Co. brand**]
    m. [**Val-Matic Valve & Manufacturing Corp.**]
    n. [**Victaulic Company**]
    o. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**Jenkins Valves; a Crane Co. brand**]
    c. [**Jomar Valve**]
    d. [**Keckley Company**]
    e. [**Lance Valves**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Red-White Valve Corp.**]
    i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**Val-Matic Valve & Manufacturing Corp.**]
    l. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: NBR or PTFE.

C. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Red-White Valve Corp.**]
    j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
    k. [**Stockham; a Crane Co. brand**]
    l. [**Val-Matic Valve & Manufacturing Corp.**]
    m. [**Victaulic Company**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Jenkins Valves; a Crane Co. brand**]
    d. [**Jomar Valve**]
    e. [**Keckley Company**]
    f. [**Lance Valves**]
    g. [**Milwaukee Valve Company**]
    h. [**NIBCO INC.**]
    i. [**Powell Valves**]
    j. [**Red-White Valve Corp.**]
    k. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 3.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

F. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]

2. Standard: MSS SP-80, Type 4.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

G. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Cooper Valves**]
e. [**Crane Fluid Systems; Crane Co.**]
f. [**DeZURIK**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**GA Industries, Inc**]
i. [**Hammond Valve**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Milwaukee Valve Company**]
p. [**Powell Valves**]
q. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

H. Check Valves, Swing Type, Flanged Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Valves**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**DeZURIK**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
h. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Composition.
9. Seat Ring: Bronze.
10. Disc Holder: Bronze.
11. Disc: PTFE.
12. Gasket: Asbestos free.

I. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Cooper Valves**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**Crispin Valve**]
   e. [**DeZURIK**]
   f. [**FNW; Ferguson Enterprises, Inc.**]
   g. [**GA Industries, Inc**]
   h. [**Hammond Valve**]
   i. [**Jenkins Valves; a Crane Co. brand**]
   j. [**KITZ Corporation**]
   k. [**Lance Valves**]
   l. [**Milwaukee Valve Company**]
   m. [**Powell Valves**]
   n. [**Victaulic Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

J. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crispin Valve**]
   e. [**DeZURIK**]
   f. [**GA Industries, Inc**]
   g. [**Kennedy Valve Company; a division of McWane, Inc.**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and spring.

K. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crispin Valve**]
   e. [**DeZURIK**]
   f. [**GA Industries, Inc**]
   g. [**Kennedy Valve Company; a division of McWane, Inc.**]
   h. [**Milwaukee Valve Company**]

2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and weight.

L. Check Valves, Swing Type, Grooved Ends - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**DeZURIK**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   e. [**Victaulic Company**]

2. CWP Rating: **300 psig (2070 kPa)**.
3. Body Material: ASTM A536, ductile iron.
4. Seat: NBR.
5. Disc: Spring operated, ductile iron or stainless steel.

M. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**DeZURIK**]

d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

N. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**DeZURIK**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Legend Valve & Fitting, Inc**]
h. [**Metraflex Company (The)**]
i. [**Stockham; a Crane Co. brand**]
j. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

O. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

P. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Keckley Company**]
   d. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   e. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

Q. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

R. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flomatic Valves; Flomatic Corporation**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]

d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

S. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DeZURIK**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

T. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. [**Victaulic Company**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

U. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jomar Valve**]
   b. [**Keckley Company**]

c. [**Stockham; a Crane Co. brand**]
d. [**Sure Flow Equipment Inc**]
e. [**Val-Matic Valve & Manufacturing Corp.**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

V. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Keckley Company**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Sure Flow Equipment Inc**]

2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

2.9 GATE VALVES, LEAD FREE

A. Gate Valves, Lead Free, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or solder joint. See Part 3 gate valve schedule articles.

6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

B. Gate Valves, Lead Free, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**KITZ Corporation**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Powell Valves**]
   i. [**Stockham; a Crane Co. brand**]
   j. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or solder joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Lead Free, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**KITZ Corporation**]
   f. [**Lance Valves**]
   g. [**Milwaukee Valve Company**]
   h. [**Powell Valves**]
   i. [**Red-White Valve Corp.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.

7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

D. Gate Valves, Lead Free, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**KITZ Corporation**]
   f. [**Milwaukee Valve Company**]
   g. [**Powell Valves**]
   h. [**Stockham; a Crane Co. brand**]
   i. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

E. Gate Valves, Lead Free, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
   c. [**Hammond Valve**]
   d. [**Milwaukee Valve Company**]
   e. [**NIBCO INC.**]

2. Standards: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum **200 psig (1380 kPa)**.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Press.
6. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
7. Stem: Brass or bronze, RS or NRS. See Part 3 gate valve schedule articles.
8. Disc: Solid wedge, bronze.
9. Packing: Graphite.
10. Port: Full.
11. Handwheel: Malleable iron, bronze, or aluminum.

F. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**Jomar Valve**]
    h. [**Kennedy Valve Company; a division of McWane, Inc.**]
    i. [**KITZ Corporation**]
    j. [**Lance Valves**]
    k. [**Powell Valves**]
    l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

G. Gate Valves, Lead Free, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**Jomar Valve**]
    e. [**Kennedy Valve Company; a division of McWane, Inc.**]
    f. [**KITZ Corporation**]
    g. [**Lance Valves**]
    h. [**Milwaukee Valve Company**]
    i. [**Powell Valves**]
    j. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flange.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

H. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**Jenkins Valves; a Crane Co. brand**]
    g. [**KITZ Corporation**]
    h. [**Victaulic Company**]
    i. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flange.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

I. Gate Valves, Lead Free, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**Hammond Valve**]
    d. [**KITZ Corporation**]
    e. [**Milwaukee Valve Company**]
    f. [**Powell Valves**]
    g. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
    h. [**Victaulic Company**]
    i. [**WATTS; A Watts Water Technologies Company**]
    j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating: **500 psig (3450 kPa)**.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

J. Gate Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
3. Body Material: CPVC.
4. Body Design: NRS.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, flanged. See Part 3 gate valve schedule articles.
7. Gate and Stem: Plastic.
8. Seals: EPDM rubber.
9. Handle: Wheel.

K. Gate Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]

2. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
3. Body Material: PVC.
4. Body Design: NRS.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, or flanged.
7. Gate and Stem: Plastic.
8. Seals: EPDM rubber.
9. Handle: Wheel.

2.10 GATE VALVES, GENERAL PURPOSE

A. Gate Valves, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]

f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or soldered joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

B. Gate Valves, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **200 psig (1380 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
5. Ends: Threaded or soldered joint. See Part 3 gate valve schedule articles.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]

e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 1.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

D. Gate Valves, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]

2. Standard: MSS SP-80, Type 2.
3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge, bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron[bronze, or aluminum].

E. Gate Valves, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
c. [**Cooper Valves**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**FNW; Ferguson Enterprises, Inc.**]

g. [**Jenkins Valves; a Crane Co. brand**]
h. [**Jomar Valve**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**KITZ Corporation**]
k. [**Lance Valves**]
l. [**Legend Valve & Fitting, Inc**]
m. [**Powell Valves**]
n. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

F. Gate Valves, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jomar Valve**]
f. [**Kennedy Valve Company; a division of McWane, Inc.**]
g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Milwaukee Valve Company**]
k. [**Powell Valves**]
l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**WATTS; A Watts Water Technologies Company**]
n. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

G. Gate Valves, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
c. [**Cooper Valves**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**FNW; Ferguson Enterprises, Inc.**]
g. [**Jenkins Valves; a Crane Co. brand**]
h. [**KITZ Corporation**]
i. [**Victaulic Company**]
j. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

H. Gate Valves, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]

2. Standard: MSS SP-70, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Disc: Solid wedge.
9. Packing and Gasket: Asbestos free.

2.11 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Babbitt Steam Specialty Co**]
2. [**Roto Hammer Industries; Rotork**]
3. [**Trumbull Industries**]

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain[and attachment brackets for mounting chainwheels directly to handwheels].

1. Sprocket Rim with Chain Guides: [**Ductile iron**][**Ductile or cast iron**][**Cast iron**][**Aluminum**][**Bronze**], of type and size required for valve.[**Include zinc or epoxy coating.**]
2. Chain: [**Hot-dip, galvanized steel**][**Brass**][**Stainless steel**], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for [**butterfly**][**globe**][**and**][**gate**] valves [**NPS 4 (DN 100)**] and larger and more than [**96 inches (2400 mm)**] above floor. Extend chains to [**60 inches (1520 mm)**] above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves: [**Center-guided type**][**and**][**plate type**], in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

J. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Stainless Steel Piping, NPS 2 (DN 50) and Smaller: [**Threaded**][**Press**] ends.
8. For Stainless Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends.
9. For Grooved-End Copper Tubing: Valve ends may be grooved.
10. For Grooved-End Steel Piping: Valve ends may be grooved.
11. Wafer-Type Valves: Flanged connections.

3.5 LOW-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.

3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig (1380 kPa)**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

3.6 HIGH-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig (1380 kPa)**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

3.7 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, lead free, threaded ends - brass, one piece.
2. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
4. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
5. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and stainless

steel trim; [**threaded**][**soldered**] ends.
6. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, lead free, threaded ends - bronze, one piece with bronze trim.
9. Ball valves, lead free, threaded ends - bronze, one piece with stainless steel trim.
10. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
11. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
12. Ball valves, lead free, threaded ends - bronze, two piece with regular port and bronze or brass trim.
13. Ball valves, lead free, threaded ends - bronze, two piece with regular port and stainless steel trim.
14. Ball valves, lead free, threaded ends - bronze, three piece with full port and bronze or brass trim.
15. Ball valves, lead free, threaded ends - bronze, three piece with full port and stainless steel trim.
16. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
17. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
18. Ball valves, lead free, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.
19. Ball valves, lead free, press ends - brass, two piece with full port and brass trim.
20. Ball valves, lead free, press ends - brass, two piece with full port and stainless steel trim.
21. Ball valves, lead free, press ends - bronze, two piece with full port and bronze or brass trim.
22. Ball valves, lead free, press ends - stainless steel, two piece with full port.
23. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**threaded**][**flanged**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, lead free, flanged or threaded ends - iron, Class 125; [**flanged**][**threaded**] ends.
2. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**flanged**][**threaded**] ends.
3. Ball valves, lead free, flanged or threaded ends - steel, with regular port, Class 150; [**flanged**][**threaded**] ends.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**][**flanged**] ends.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**] at [**73 deg F (23 deg C)**].

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [Socket][threaded].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**] at [**73 deg F (23 deg C)**].

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [Socket][threaded].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.8 LOW-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.9 HIGH-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; 200 CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; 200 CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.10 DOMESTIC HOT- AND COLD-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, lead free, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, lead free, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, lead free, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, lead free, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, lead free, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, lead free, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, lead free, grooved end - ductile iron, 175 CWP; [**EPDM**][**NBR**] seat.
8. Butterfly valves, lead free, grooved end - ductile iron, 300 CWP; [**EPDM**][**NBR**] seat.

B. For CPVC Pipe: CPVC butterfly valve for [**NPS 2-1/2 (DN 65)**][**NPS 5 (DN 125)**] and larger.

C. For PVC Pipe: PVC butterfly valve for [**NPS 2-1/2 (DN 65)**][**NPS 5 (DN 125)**] and larger.

D. For Stainless Steel Pipe: Stainless steel, grooved-end butterfly valve for **NPS 2-1/2 (DN 65)** and larger.

3.11 LOW-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.

2. Horizontal and Vertical Applications:

a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.12 HIGH-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.

b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.

2. Horizontal and Vertical Applications:

a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.13 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.
2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.
5. Check valves, lead free, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 125; [**flanged**][**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with nonmetallic-to-metal Seats, Class 125; [**flanged**][**threaded**] ends.
3. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 250; [**flanged**][**threaded**] ends.
4. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-

closure control, Class 125; [**flanged**][**threaded**] ends.

5. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**][**threaded**] ends.
6. Check valves, lead free, swing type, grooved ends - iron, 300 CWP.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
11. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
12. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
13. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
14. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [EPDM][NBR] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [EPDM][NBR] seat.
17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [EPDM][NBR] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [EPDM][NBR] seat.
19. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [EPDM][NBR] seat.
20. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [EPDM][NBR] seat.
21. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [EPDM][NBR] seat.
22. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [EPDM][NBR] seat.
23. Check valves, lead free, dual-plate type - iron, with metal seat, Class 125.
24. Check valves, lead free, dual-plate type - iron, with metal seat, Class 150.
25. Check valves, lead free, dual-plate type - iron, with metal seat, Class 250.
26. Check valves, lead free, dual-plate type - iron, with metal seat, Class 300.
27. Check valves, lead free, single-plate type - iron, with resilient seat, Class 125; [EPDM][NBR] seat.
28. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 125; [EPDM][NBR] seat.
29. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 150; [EPDM][NBR] seat.
30. Check valves, lead free, single-plate type - iron, with resilient seat, Class 250; [EPDM][NBR] seat.
31. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 250; [EPDM][NBR] seat.
32. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 300; [EPDM][NBR] seat.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] ball valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] ball valve.

3.14 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**][**soldered**] ends.

2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**][**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**][**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger for Domestic Water Pumps:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-closure control, Class 125; [**flanged**][**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**][**threaded**] ends.
3. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
4. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
5. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
6. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
11. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [EPDM][NBR] seat.
12. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [EPDM][NBR] seat.
13. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [EPDM][NBR] seat.
14. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [EPDM][NBR] seat.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [EPDM][NBR] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [EPDM][NBR] seat.
17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [EPDM][NBR] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [EPDM][NBR] seat.

C. Pipe NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage:

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.15 LOW-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.16 HIGH-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [threaded][soldered] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [threaded][soldered] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.17 DOMESTIC HOT- AND COLD-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, lead free, threaded or soldered ends - bronze, NRS, Class 125; [threaded][soldered] ends.
2. Gate valves, lead free, threaded or soldered ends - bronze, RS, Class 125; [threaded][soldered] ends.
3. Gate valves, lead free, threaded ends - bronze, NRS, Class 150.
4. Gate valves, lead free, threaded ends - bronze, RS, Class 150.
5. Gate valves, lead free, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, lead free, flanged ends - iron, NRS, Class 125.
2. Gate valves, lead free, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, lead free, flanged ends - iron, NRS, Class 250.
4. Gate valves, lead free, flanged ends - iron, OS&Y, Class 250.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] gate valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**][**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**][**Non-union**] gate valve.

END OF SECTION 22 05 23 00

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Task	Specification	Specification Description
22 05 23 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 23 00	23 05 23 00	General-Duty Valves for HVAC Piping
22 05 23 00	23 05 00 00a	Coatings for HVAC

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SECTION 22 05 29 00 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - carbon steel.
2. Pipe hangers and supports - stainless steel.
3. Pipe/tube hangers and supports - copper.
4. Pipe hangers - metal, trapeze type.
5. Pipe hangers - FRP.
6. Strut support system - metal, rod type.
7. Strut support system - metal, cable type.
8. Strut support systems - FRP.
9. Thermal hanger shield insert - calcium silicate.
10. Thermal hanger shield insert - polyisocyanurate.
11. Thermal hanger shield insert - phenolic.
12. Thermal hanger shield insert - cellular glass.
13. Fastener systems.
14. Pipe-positioning systems.
15. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220500 "Common Work Results for Plumbing" for pipe guides and anchors.
3. [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**] for vibration isolation devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: [**Signed and sealed by a qualified professional engineer.**] Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Rooftop-mounted strut support systems.
4. FRP strut support systems.
5. Pipe stands.
6. Equipment supports.

C. Delegated Design Submittals: For [**trapeze hangers**][**and**][**strut support systems**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for [**trapeze hangers**][**strut support**

systems] .

2. Detail fabrication/assembly and design calculations for each type of strut support system, by manufacturer's technical representative.

D. Delegated Design Engineer Qualifications: For [**trapeze hangers**][**and**][**strut support systems**] .

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

3. Product Data for Cradle-to-Cradle Certification:

   a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

   b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

   c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

4. Product Data for Health Product Declaration Compliance:

   a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

   b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

5. Product Data for Declare Certification:

   a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

   b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

6. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For structural-steel and pipe welding.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2025 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**trapeze hangers**][**strut support systems,**][**and**] equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**] .

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment [**and obtain approval from authorities having jurisdiction**] .

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**][**stainless steel**].

B. Pipe Hangers and Supports - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Rocket Rack; Robroy Industries**]

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**stainless steel**].

C. Pipe/Tube Hangers and Supports - Copper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: MSS SP-58, Types 1 through 58, copper-plated-steel, factory-fabricated components.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-plated steel**][**stainless steel**].

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Pipe Hangers - Metal, Trapeze Type: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 PIPE HANGERS - FRP

A. Pipe Hangers - FRP, Clevis Type:

1. Description: Similar to MSS SP-58, Type 1 factory-fabricated steel pipe hanger, except hanger is made of FRP resin.

2. Hanger Rods: Continuous-thread [**stainless steel**] rod, washer, and nuts made of [**FRP**][**polyurethane**][**stainless steel**].

3. Flammability: ASTM D635, ASTM E84, UL 94.

B. Pipe Hangers - FRP, Strap Type:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of FRP resin.

a. Flammability: ASTM D635, ASTM E84, UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of [**stainless steel**].

2.5 STRUT SUPPORT SYSTEMS - METAL

A. Strut Support System - Metal, Rod Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Atkore Unistrut**]
d. [**CADDY; brand of nVent Electrical plc**]
e. [**Carpenter & Paterson, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Empire Industries, Inc.**]
h. [**Flex-Strut Inc.**]
i. [**G-Strut**]
j. [**Haydon Corp.**]
k. [**PHD Manufacturing, Inc**]
l. [**Rocket Rack; Robroy Industries**]
m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]

2. Description: Factory-fabricated pipe-support assembly, made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.

3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.

4. Struts: Continuous slotted [**carbon steel**][**stainless steel, Type 304**][**stainless steel, Type 316**][**extruded-aluminum**][**channel with inturned lips**][**angle**].
5. Strut Width: Selected for applicable load criteria.
6. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**][**stainless steel**] .

8. Metallic Coating: [**Plain**][**Pregalvanized G90 (Z275)**][**Electroplated zinc**][**Hot-dip galvanized**][**Gold (yellow zinc dichromate) galvanized**] .
9. Paint Coating: [**Green epoxy, acrylic, or urethane**].
10. Plastic Coating: [**PVC**].

B. Strut Support System - Metal, Cable Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Gripple Inc.**]

2. Description: Factory-fabricated pipe-support system, consisting of cable pipe clamps and associated vibration isolation rubber pads, slotted channel brackets, wire rope suspension components, and associated accessories for a complete piping suspension system; no tools required for manual assembly in the field to support multiple parallel pipe routing.
3. Standards:

   a. ICC-ES PMG Product Certificate.
   b. Brackets: Fire rated; tested to F120 in accordance with BS EN 1363-1.

4. Components:

   a. Pipe Clamps: Size-adjustable [**standard**][**compact**][**and**][**field-height-adjustable**] clamps with [**rubber pad, 14 dBa noise reduction**][**and**][**large rubber pad, 18 dBa noise reduction**][**acoustic rubber pad, 23 dBa noise reduction**] ; with sleeve to prevent galvanic corrosion.
   b. Brackets: Slotted channels furnished in pre-cut lengths to suit specific system application for Project.
   c. Suspension Components: Hanging cables with adjustable fastener; can be pre-installed on the brackets using pre-fitted washer/nuts or retention clips.

      1) Wire Rope: High tensile steel wire rope, complying with ASTM A1023/A1023M, ASTM A641/A641M Class A zinc coating; [**7 by 7**][**and**][**7 by 19**] cross-sectional construction; having a tensile strength of **256,000 psi (1770 N/sq mm)**; lengths, diameters, and wire construction [**to accommodate design loads**][**as indicated on Shop Drawings**] .

         a) Locking screw/release button.
         b) Foot attachment type to suit application.
         c) End Fix Type: [**Loop**][**strap hook**][**eyelet**].

   d. Adjustable Fastener: Mild steel (Type EN1A), bright zinc-plated, one-channel body; encasing a series of Type 302 stainless steel springs with serrated self-locking, Grade 40, chrome steel balls; adjustable by means of an integrated mechanism, and capable of accommodating load of [**100 lb (45 kg)**][**200 lb (90 kg)**][**500 lb (225 kg)**] .

2.6 STRUT SUPPORT SYSTEMS - FRP

A. Strut Support System - FRP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atkore Unistrut**]
b. [**Champion Fiberglass, Inc**]
c. [**G-Strut**]
d. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]

2. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

a. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
b. Struts: Continuous slotted FRP channel with inturned lips.
c. Strut Width: Selected for applicable load criteria.
d. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.

e. Fitting and Accessory Materials: Same as those for channels and angles [**except metal items may be stainless steel**] .
f. Rated Strength: Selected to suit applicable load criteria.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 THERMAL HANGER SHIELD INSERTS

A. Thermal Hanger Shield Insert - Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bergen Pre-Insulated Pipe Supports, Inc.**]
b. [**National Pipe Hanger Corporation**]
c. [**Pipe Shields Inc.**]
d. [**Rilco Manufacturing Co., Inc**]
e. [**Value Engineered Products, Inc.; an ASC Engineered**]

2. Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with **100 psig (688 kPa)** minimum compressive strength.

a. ASTM E84, Flame Spread/Smoke Developed: 5/5.

3. Application: For hot piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

B. Thermal Hanger Shield Insert - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Buckaroos, Inc.**]
b. [**KB Enterprise**]

c. [**National Pipe Hanger Corporation**]
d. [**Value Engineered Products, Inc.; an ASC Engineered**]

2. Insulation-Insert Material: ASTM C591, Type VI, Grade 1 polyisocyanurate with **125 psig (862 kPa)** minimum compressive strength and vapor barrier.

   a. ASTM E84, Flame Spread/Smoke Developed: 25/450.

3. Application: For insulated [**hot**][**and**][**cold**] piping not installed in return-air plenums.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

C. Thermal Hanger Shield Insert - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Buckaroos, Inc.**]

2. Insulation-Insert Material: Rigid phenolic foam insulation, ASTM C1126, Type III, with ASTM E96 zero perm vapor barrier.

   a. Minimum Compressive Strength, ASTM D1621: [**40 psi (276 kPa) minimum perpendicular to rise and 50 psi (345 kPa) minimum parallel to rise**][**70 psi (483 kPa) minimum perpendicular to rise and 90 psi (620 kPa) minimum parallel to rise**] .
   b. ASTM E84, Flame Spread/Smoke Developed: 25/50.

3. Application: For [**hot**][**and**][**cold**] piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

D. Thermal Hanger Shield Insert - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Rilco Manufacturing Co., Inc**]

2. Insulation-Insert Material: ASTM C552, Type II cellular glass with **100 psig (688 kPa)** minimum compressive strength and vapor barrier.

   a. ASTM E84, Flame Spread/Smoke Developed: 0/0.

3. Application: For insulated [**hot**][**and**][**cold**] piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hilti, Inc.**]
b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
c. [**MKT Fastening, LLC**]

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
b. [**Empire Industries, Inc.**]
c. [**Hilti, Inc.**]
d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
e. [**MKT Fastening, LLC**]

2. Indoor Applications: [**Zinc-coated**][**stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.9 PIPE-POSITIONING SYSTEMS

A. Pipe-Positioning System: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Holdrite; a division of Reliance Worldwide Corporation**]

2.10 EQUIPMENT SUPPORTS

A. Equipment Support: Welded, shop- or field-fabricated equipment support made from structural-carbon steel shapes.

2.11 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION OF HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus [**200 lb (90 kg)**].

3.2 INSTALLATION OF HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] and larger [**and at changes in direction of piping**] . Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum

pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Thermal hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

   a. Thermal hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): **12 inches (305 mm)** long and **0.048 inch (1.22 mm)** thick.
   b. NPS 4 (DN 100): **12 inches (305 mm)** long and **0.06 inch (1.52 mm)** thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): **18 inches (457 mm)** long and **0.06 inch (1.52 mm)** thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): **24 inches (610 mm)** long and **0.075 inch (1.91 mm)** thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): **24 inches (610 mm)** long and **0.105 inch (2.67 mm)** thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Pipe Hangers and Supports - Metal: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

H. Pipe Hangers - Metal, Trapeze Type: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M carbon steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. Pipe Hangers - FRP: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Strut Support Systems - Metal: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems. Install in accordance with manufacturer's written installation instructions.

K. Strut Support Systems - FRP: Arrange for grouping of parallel runs of piping, and support together on

field-assembled strut systems. Install in accordance with manufacturer's written installation instructions.

L. Thermal Hanger Shield Inserts: Install in pipe hanger or shield for insulated piping.

M. Fastener Systems:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches (100 mm)** thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Install lag screw wood fasteners in accordance with manufacturer's written instructions.
4. Install fasteners in accordance with manufacturer's written instructions.

N. Pipe-Positioning System: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

O. Hangers and Supports, General: Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

P. Equipment Supports:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [**trapeze pipe hangers**][**and**][**equipment supports**] .

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches (40 mm)**].

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.

2. Comply with requirements in [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**Section 099600 "High-Performance Coatings"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Comply with requirements in [**Section 099114 "Exterior Painting (MPI Standards)"**][**Section 099124 "Interior Painting (MPI Standards)"**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
4. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon steel [**pipe hangers and supports**][**metal trapeze pipe hangers**][**and**][**metal framing systems**] and attachments for general service applications.

F. Use [**stainless steel pipe hangers**][**FRP pipe hangers**][**and**][**FRP strut systems**] and [**stainless steel**][**corrosion-resistant**] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**][**stainless steel**] attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated,

stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F (566 deg C)** pipes **NPS 4 to NPS 24 (DN 100 to DN 600)**, requiring up to **4 inches (100 mm)** of insulation.
3. Carbon Steel or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36 (DN 20 to DN 900)**, requiring clamp flexibility and up to **4 inches (100 mm)** of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4 (DN 15 to DN 100)**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8 (DN 20 to DN 200)**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8 (DN 10 to DN 200)**.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3 (DN 10 to DN 80)**.
12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36 (DN 65 to DN 900)** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30 (DN 25 to DN 750)**, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24 (DN 65 to DN 600)**, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42 (DN 50 to DN 1050)** if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24 (DN 50 to DN 600)** if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30 (DN 50 to DN 750)** if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
2. Carbon Steel or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24 (DN 20 to DN 600)** if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to **6 inches (150 mm)** for heavy loads.
2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F (49 to 232 deg C)** piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): **750 lb (340 kg)**.
    b. Medium (MSS Type 32): **1500 lb (680 kg)**.
    c. Heavy (MSS Type 33): **3000 lb (1360 kg)**.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed **1-1/4 inches (32 mm)**.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use [**powder-actuated fasteners**][**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29 00

Task	Specification	Specification Description
22 05 29 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 05 33 00 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance electric heating cables.
2. Controls.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 230533 "Heat Tracing for HVAC Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

B. Sample Warranties: For specified special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Self-Regulating, Parallel-Resistance Heating Cables:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BriskHeat**]
   b. [**Chromalox, Inc.**]
   c. [**Delta-Therm Corporation**]
   d. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
   e. [**Nelson; Emerson Electric Co., Automation Solutions**]
   f. [**Raychem (a brand of Chemelex)**]
   g. [**Thermon, Inc.**]
   h. [**Trasor Corp.**]
   i. [**WarmlyYours Radiant, Inc.**]

2. Source Limitations: Obtain all heat tracing from one manufacturer.
3. Standard: IEEE 515.1.
4. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**] , stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
5. Electrical Insulating Jacket: Flame-retardant polyolefin.
6. Grounding Cover: [**Copper**][**Tinned-copper**] braid.

7. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.
8. Terminate cable with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
9. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].

10. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].
11. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.

12. Capacities and Characteristics:

    a. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**].
    b. Electrical Characteristics for Single-Circuit Connection:

       1) Volts: [**120**][**208**][**240**][**277**][**480**] V.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote Bulb Temperature Control Unit: Adjustable temperature range from [**30 to 50 deg F**

(minus 1 to plus 10 deg C)].
2. Single-Pole Switch: Snap action; open-on-rise; with minimum current rating adequate for connected cable.
3. Remote Temperature-Sensing Bulb: On capillary, resistance temperature device, or thermistor for directly sensing outside air or pipe-wall temperature.
4. Enclosure: Corrosion resistant, waterproof.

B. Control Panel:

1. Control Type: [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Remote Outside Air Temperature Sensor: Programmable to energize the freeze-protection cable when temperature falls below [**34 to 44 deg F (1 to 7 deg C)**].

3. Remote Domestic Hot Water Temperature Sensor: Programmable to control the domestic hot water temperature at [**110 to 120 deg F (47 to 53 deg C)**].
4. Enclosure: Corrosion proof and waterproof, suitable for outdoor mounting, for controls and temperature sensors.
5. Contactor: Minimum 30 A to energize cable or close other contactors.
6. Ground-fault protection.
7. Single-Point Control of Heat Tracing: For freeze protection [**and domestic hot-water-temperature maintenance**] .

8. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by central HVAC-control system. Coordinate type of connection ports with Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC-control system.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: See Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least **3 mils (0.08 mm)** thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): **3/4 inch (19 mm)** minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: **1-1/2 inches (38 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 220719 "Plumbing Piping Insulation."

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Warning Tape: Install warning tape on piping insulation where piping is equipped with electric heating cables.

3.3 INSTALLATION OF CONTROLS

A. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

B. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

C. Install and connect outside air and pipe temperature sensors.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit for freeze protection to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect temperature-control unit for domestic hot-water-temperature maintenance to interrupt power supply to electric heating cable when hot water is above set point.

E. Connect remote electronic temperature sensors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Test and Inspections: Perform the following [**with the assistance of a factory-authorized service representative**] :

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 22 05 33 00

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SECTION 22 05 48 00 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for non-structural components.
2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies devices for fire-suppression equipment and systems.
3. Section 230548 "Vibration and Seismic Controls for HVAC" specifies devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, mechanical, electrical, plumbing, or fire-protection system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professional: Engage qualified professional structural engineer to design, sign/seal, seismic and wind restraints.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
b. Include load rating for each seismic-[**and wind-**]restraint device.
c. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-**]restraint component.
d. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].
e. Annotate to indicate application of each product submitted and compliance with requirements.
f. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic [**and wind**] restraints for components with other systems and equipment in the vicinity, including other supports and other seismic restraints.

C. Delegated Design Submittal:

1. All delegated design and submittals for [**seismic**][**and**][**wind**] restraints must be signed and sealed by a qualified professional structural engineer responsible for their preparation. Structural engineer is to possess qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete attachments.
2. For each seismic-restraint device, including [**seismic-restrained mounting,**][**pipe-riser resilient support,**][**snubber,**][**seismic restraint,**][**seismic-restraint accessory,**][**and**][**concrete anchor and insert,**] that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraint, Vibration Isolator, and Vibration Isolation Base Selection: Select and submit seismic restraints [**and**] vibration isolators [**, and vibration isolation bases**] complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Post-Installed Concrete Anchors and Concrete Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for

reinforcement use.
d. Seismic Design Calculations: Submit all input data and loading calculations.

3. For each wind-restraint device, including [**restraint - rigid,**][**restraint - cable,**][**restraint accessory,**][**concrete anchor,**][**and**][**concrete insert**] that is required by this Section or is indicated on Drawings, submit the following:

   a. Wind Restraints: Select and submit wind restraints complying with performance requirements, design criteria, and analysis data.
   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing wind-restraint criteria. Include certification that device is approved by qualified testing laboratory for reinforcement use.
   c. Wind-Restraint Design Calculations: Submit all input data and loading calculations.

4. Seismic- and Wind-Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

5. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
6. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
7. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-**] and seismic-restraint devices for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**][**and**][**testing agency**].

C. Welding certificates.

D. Air-Spring Isolator Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports:

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring isolators**][**and**][**restrained-air-spring isolators**] to include in operation and maintenance manuals.

1.7 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and Shop Drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.8 QUALIFICATIONS

A. Professional Structural Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete foundations.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified professional structural engineer to prepare seismic- and wind-restraint calculations in accordance with criteria specified in Section 018123 "Facility Seismic and Wind Criteria."

B. Seismic- and Wind-Restraint-Device Load Ratings: Devices must be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices are must be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to authorities having jurisdiction**].

C. Consequential Damage: Provide additional seismic[**and wind**] restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a nonessential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals are to have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when

tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be labeled as such.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components are to be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
4. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
5. Size: Factory or field cut to match requirements of supported equipment.
6. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

7. Surface Pattern: Smooth, ribbed, or waffle pattern.
8. Infused nonwoven cotton or synthetic fibers.
9. Load-bearing metal plates adhered to pads.
10. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**]<**Insert compound**>.

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Mason Industries, Inc.**]
    h. [**NOVIA; a division of Carpenter & Paterson**]
    i. [**Vibration Eliminator Co., Inc**]
    j. [**Vibration Isolation**]
    k. [**Vibration Management Corp.**]
    l. [**VMC GROUP**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Mason Industries, Inc.**]
    h. [**NOVIA; a division of Carpenter & Paterson**]
    i. [**Vibration Eliminator Co., Inc**]
    j. [**Vibration Isolation**]
    k. [**Vibration Management Corp.**]
    l. [**VMC GROUP**]
    m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
4. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

5. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
4. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad

attached to the underside. Baseplates shall limit floor load to **500 psig (3447 kPa)**.

9. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, laterally stable, housed, open-spring isolators from single manufacturer.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psig (3447 kPa)**.
b. Top housing with [**attachment and leveling bolt**][**threaded mounting holes and internal leveling device**][**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
4. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psig (3447 kPa)**.
   b. Top plate with [**threaded mounting holes**][**elastomeric pad**].

c. Internal leveling bolt that acts as blocking during installation.

5. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
6. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
4. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with

[**adjustable**][**nonadjustable**] snubbers to limit vertical movement.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psig (3447 kPa)**.
b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**California Dynamics Corporation**]
b. [**Kinetics Noise Control, Inc**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Eliminator Co., Inc**]
e. [**Vibration Management Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**California Dynamics Corporation**]
b. [**Kinetics Noise Control, Inc**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Eliminator Co., Inc**]
e. [**Vibration Management Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain resilient pipe-riser supports from single manufacturer.
4. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum **1/2-inch- (13-mm-)** thick neoprene.
5. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
6. Maximum Load Per Support: **500 psig (3447 KPa)** on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain resilient pipe guides from single manufacturer.
4. Description: resilient pipe guide with telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum **1/2-inch- (13-mm-)** thick neoprene.
5. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air-spring isolators from single manufacturer.
4. Arrangement: [**Single**][**or**][**multiple**].
5. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
6. Maximum Natural Frequency: 3 Hz.
7. Operating Pressure Range: **25 to 100 psig (172 to 690 kPa)**.
8. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
9. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
4. Arrangement: [**Single**][**or**][**multiple**].
5. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psig (3447 kPa)**.
b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
c. Internal leveling bolt that acts as blocking during installation.

6. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
10. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
11. Maximum Natural Frequency: [**3 Hz**]<**Insert frequency**>.
12. Operating Pressure Range: **25 to 100 psig (172 to 690 kPa)**.
13. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
14. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Kinetics Noise Control, Inc**]
    e. [**Mason Industries, Inc.**]
    f. [**NOVIA; a division of Carpenter & Paterson**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Kinetics Noise Control, Inc**]
    e. [**Mason Industries, Inc.**]
    f. [**NOVIA; a division of Carpenter & Paterson**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
4. Description: Elastomeric hanger mounted in a steel frame with upper and lower steel hanger rods.
5. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
6. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain spring hangers from single manufacturer.
4. Description: Combination coil-spring and elastomeric-insert hanger.
5. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
6. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
10. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
11. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
12. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain snubbers from single manufacturer.

D. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14, Ch. 17 for 2015 or 2018 IBC**]. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
2. Anchors in Masonry: Design in accordance with TMS 402.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.16 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rigid-type restraints from single manufacturer.

D. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain cable-type restraints from single manufacturer.

D. Seismic- and Wind-Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

E. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain restraint accessories from single manufacturer.

D. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

E. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**][**and**][**restraint cables**].

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
4. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
4. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select

anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)**, which is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete inserts from single manufacturer.

D. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.

E. Comply with ANSI/MSS 58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]
8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]
8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. **<Insert manufacturer's name>**

C. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

D. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

F. Concrete Inertia Base: [**Factory-fabricated**][**or**][**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- [**and wind-**]restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support Assemblies: Where not specifically indicated otherwise, select sizes of components so strength is adequate to carry static[**, wind load,**] and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROLS AND SEISMIC RESTRAINTS FOR PLUMBING PIPING AND EQUIPMENT

A. Provide seismic-[**and wind-**]restraint devices and vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where

required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**, wind-restraints,**] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
3. Install seismic-restraint[**and wind-restraint**] devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.
3. Brace a change of direction longer than **12 feet (3.7 m)**.

H. Install seismic-[**and wind-**]restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-[**and wind-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Mechanical Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**][**and**][**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**][**constant**] air supply.
3. Inflate isolators to [**height**][**and**][**or**][**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test at least [**four**]<**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 22 05 48 00

Task	Specification	Specification Description
22 05 48 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 05 48 13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device [**and wind-load-restraint**]component.

4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

   a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
   b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
   c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
   d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

      1) Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

   e. Wind-Restraint Detail Drawings:

      1) Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
      2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
      3) Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

   f. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
   g. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).

2. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design

vibration isolation bases.

3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-load reinforcement**]device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**][**and**][**testing agency**].

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

F. Wind-Load Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
3. The following plumbing systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind load and impact damage must be provided by manufacturer.

   a. <**Insert list**>.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring mounts**][**and**][**restrained-air-spring mounts**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally

recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

1. Wind-Load Performance: Equipment and systems shall withstand the effects of high wind events determined in accordance with [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**]<**Insert requirement**>.

B. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**]<**Insert ASCE/SEI 7 edition or other wind-load calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

   a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
   b. Coordinate design wind-load calculations with vibration isolator calculations for equipment requiring both vibration isolation and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" less than **60 feet (18.3 m)**.
   d. PART 4: Buildings with "h" greater than **60 feet (18.3 m)** and less than **160 feet (48.8 m)**.
   e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

   a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. Kd = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**][**C**][**D**].
   f. Kzt = Topographic Factor: <**Insert factor**>.
   g. Ke = Ground Elevation Factor: <**Insert factor**>.

h. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
i. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
j. qz = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. qh = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
l. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.
m. Enclosure Classification: <**Insert classification**>.
n. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.

4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" greater than **60 feet (18.3 m)**.
d. PART 4: Buildings with "h" less than **160 feet (48.8 m)**.
e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. Kd = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**][**C**][**D**].
f. Kzt = Topographic Factor: <**Insert factor**>.
g. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
j. qh = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.
l. Enclosure Classification: <**Insert classification**>.
m. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.

6. Design wind load "F" for rooftop equipment and external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

a. I = Importance Factor: <**Insert factor**>.
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. Kd = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**][**C**][**D**].
f. Kzt = Topographic Factor: <**Insert factor**>.
g. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design

Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.

j. qh = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.
l. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.
m. GCp = External Pressure Coefficient: <**Insert coefficient**>.
n. Cf = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
o. Af = Projected Area Normal to the Wind: Except where Cf is specified for the actual surface area. Value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

C. Consequential Damage: Provide additional restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**] so that failure of a non-essential or essential fire-suppression system component will not cause failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of [**ASCE/SEI 7-05 Section 13.6**][**ASCE/SEI 7-10 Section 13.6**][**ASCE/SEI 7-16 Section 13.6**].

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]

m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Minimum deflection as indicated on Drawings.
6. Pad Material: Oil- and water-resistant rubber.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**]<**Insert compound**>.

a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

4. Minimum deflection as indicated on Drawings.
5. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

4. Minimum deflection as indicated on Drawings.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]

f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to **500 psi (3447 kPa)**.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
9. Minimum deflection as indicated on Drawings.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]

h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. **<Insert manufacturer's name>**

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.
8. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Top housing with [**attachment and leveling bolt**][**threaded mounting holes and internal leveling device**][**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]

h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Minimum deflection as indicated on Drawings.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]

d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**][**non-adjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum **1/2-inch- (13-mm-)** Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. <**Insert manufacturer's name**>

3. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in

both directions.
4. Maximum Load Per Support: **500 psi (3447 kPa)** on isolation material providing equal isolation in all directions.
5. Minimum deflection as indicated on Drawings.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum **1/2-inch- (13-mm-)** Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

3. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

3. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
4. Maximum Natural Frequency: 3 Hz.
5. Operating Pressure Range: **25 to 100 psi (172 to 690 kPa)**.
6. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
7. Minimum deflection as indicated on Drawings.
8. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Minimum deflection as indicated on Drawings.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
10. Maximum Natural Frequency: 3 Hz.
11. Operating Pressure Range: **25 to 100 psi (172 to 690 kPa)**.
12. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
13. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Kinetics Noise Control, Inc**]
    e. [**Mason Industries, Inc.**]
    f. [**NOVIA; a division of Carpenter & Paterson**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Kinetics Noise Control, Inc**]
    e. [**Mason Industries, Inc.**]
    f. [**NOVIA; a division of Carpenter & Paterson**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

3. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
4. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
5. Minimum deflection as indicated on Drawings.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Minimum deflection as indicated on Drawings.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
10. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
11. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14 Ch. 17 for 2015 or 2018 IBC**]
2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.16 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]

4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

C. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

C. Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

D. Restraint cable assembly and cable fittings must comply with [**ASCE/SEI 19-10**][**ASCE/SEI 19-16**]. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]

4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. **<Insert manufacturer's name>**

C. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod.

D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**][**and**][**restraint cables**].

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atkore Unistrut**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hilti, Inc.**]
d. [**Mason Industries, Inc.**]
e. [**Powers Fasteners**]
f. <**Insert manufacturer's name**>

3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)** that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. <**Insert manufacturer's name**>

C. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]
8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]

8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. <**Insert manufacturer's name**>

C. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Concrete Inertia Base: [**Factory-fabricated**][**or**][**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation [**and wind-load control**]devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static [**and wind-load**]forces within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND WIND-LOAD CONTROLDEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide wind-load control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**and wind-load restraints**] must not cause any stresses, misalignment or change of position of equipment or piping.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
3. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.

3. Brace a change of direction longer than **12 feet (3.7 m)**.

H. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**][**and**][**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**][**constant**] air supply.
3. Inflate isolators to [**height**][**and**][**or**][**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as

determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of base are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than [**four**]<**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 22 05 48 13

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Task	Specification	Specification Description
22 05 48 13	22 05 48 00	Vibration And Seismic Controls For Plumbing Piping And Equipment
22 05 48 13	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 05 53 00 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

B. Related Requirements:

1. Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities" for labeling requirements, complying with NFPA 99, for medical, compressed-air system piping and associated components in healthcare facilities.
2. Section 226213 "Vacuum Piping for Laboratory and Healthcare Facilities" for labeling requirements, complying with NFPA 99, for medical surgical, healthcare laboratory, and dental vacuum system piping, waste anesthetic gas and oral evacuation system piping, and associated components in healthcare facilities.
3. Section 226313 "Gas Piping for Laboratory and Healthcare Facilities" for labeling requirements, complying with NFPA 99, for medical carbon dioxide, laboratory carbon dioxide, medical helium, laboratory helium, medical nitrogen, laboratory nitrogen, medical nitrous oxide, laboratory nitrous oxide, medical oxygen, and laboratory oxygen.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-Numbering Scheme: For valve tags.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**Champion America**]
    d. [**Craftmark Pipe Markers**]
    e. [**emedco**]
    f. [**Kolbi Pipe Marker Co.**]
    g. [**LEM Products Inc.**]
    h. [**Marking Services Inc.**]
    i. [**Pipemarker.com; Brimar Industries, Inc.**]
    j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: [**Brass, 0.032-inch (0.8-mm)**][**Stainless steel, 0.025-inch (0.64-mm)**][**Aluminum, 0.032-inch (0.8-mm)**][**Anodized aluminum, 0.032-inch (0.8-mm)**] minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
5. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**Champion America**]
    d. [**Craftmark Pipe Markers**]
    e. [**emedco**]
    f. [**Kolbi Pipe Marker Co.**]
    g. [**LEM Products Inc.**]
    h. [**Marking Services Inc.**]
    i. [**Pipemarker.com; Brimar Industries, Inc.**]
    j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.
5. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.

6. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Carlton Industries, LP**]
3. [**Champion America**]
4. [**Craftmark Pipe Markers**]
5. [**emedco**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**National Marker Company**]
9. [**Pipemarker.com; Brimar Industries, Inc.**]
10. [**Seton Identification Products; a Brady Corporation company**]
11. [**Stranco, Inc.**]

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.

E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.

F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E [**and other applicable codes and standards**] .

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Craftmark Pipe Markers**]
3. [**National Marker Company**]
4. [**Pipemarker.com; Brimar Industries, Inc.**]
5. [**Seton Identification Products; a Brady Corporation company**]

B. Material: Vinyl.

C. Minimum Thickness: **0.005 inch (0.12 mm)**.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: **160 deg F (70 deg C)**.

G. Minimum Width: [**2 inches (50 mm)**][**4 inches (100 mm)**] .

2.4 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
2. [**Brady Corporation**]
3. [**Carlton Industries, LP**]
4. [**Champion America**]
5. [**Craftmark Pipe Markers**]
6. [**emedco**]
7. [**Kolbi Pipe Marker Co.**]
8. [**LEM Products Inc.**]
9. [**Marking Services Inc.**]
10. [**Pipemarker.com; Brimar Industries, Inc.**]
11. [**Seton Identification Products; a Brady Corporation company**]

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [**partially cover**][**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on [**main**] distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**] .

2.5 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Craftmark Pipe Markers**]
   b. [**Kolbi Pipe Marker Co.**]
   c. [**Marking Services Inc.**]
   d. [**Pipemarker.com; Brimar Industries, Inc.**]

2. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**] .
3. Stencil Material: Aluminum, brass, or fiberboard.

4. Stencil Paint: Exterior, gloss, [**alkyd enamel**][**acrylic enamel**]<**Insert paint type**> in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**][**acrylic enamel**]<**Insert paint type**> in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
2. [**Brady Corporation**]
3. [**Carlton Industries, LP**]
4. [**Champion America**]
5. [**Craftmark Pipe Markers**]
6. [**emedco**]
7. [**Kolbi Pipe Marker Co.**]
8. [**LEM Products Inc.**]
9. [**Marking Services Inc.**]

10. [**Pipemarker.com; Brimar Industries, Inc.**]
11. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** numbers.

1. Tag Material: [**Brass, 0.04-inch (1.0-mm)**][**stainless steel, 0.024-inch (0.61-mm)**][**aluminum, 0.031-inch (0.79-mm)**][**anodized aluminum, 0.031-inch (0.79-mm)**] minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass [**wire**][**link chain**][**beaded chain**][**S-hook**] .

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Champion America**]
3. [**Craftmark Pipe Markers**]
4. [**emedco**]
5. [**Kolbi Pipe Marker Co.**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**Pipemarker.com; Brimar Industries, Inc.**]
9. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Preprinted [**or partially preprinted**] accident-prevention tags of plasticized card stock [**with matte finish suitable for writing**] .

1. Size: [**3 by 5-1/4 inches (75 by 133 mm) minimum**][**Approximately 4 by 7 inches (100 by 178 mm)**].
2. Fasteners: [**Brass grommet and wire**][**Reinforced grommet and wire or string**] .
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Equipment Label Colors:

1. [**White letters on an ANSI Z535.1 safety-green background**].

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF WARNING SIGNS AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Warning Sign and Label Colors: In accordance with requirements of OSHA [**and other applicable codes and standards**] .

1. [**Black letters on an ANSI Z535.1 safety-yellow background**].

C. Locate warning signs and labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E [**and other applicable codes and standards**] .

3.5 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: [**Yellow background with black diagonal stripes**].

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than **6 ft. (2 m)** of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.6 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, [**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within **3 ft. (1 m)** of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within **3 ft. (1 m)** of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of [**25 ft. (8 m)**] along each run. Reduce intervals to [**10 ft. (3 m)**] in areas of congested piping and equipment.

E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of **125 deg F (52 deg C)** or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe-Label Color Schedule:

1. Low-Pressure Compressed-Air Piping: [**White letters on an ANSI Z535.1 safety-blue background**].
2. High-Pressure Compressed-Air Piping: [**White letters on an ANSI Z535.1 safety-blue background**].
3. Vacuum Piping: [**White letters on an ANSI Z535.1 Safety blue background**].
4. Domestic Cold-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**].
5. Domestic Hot-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**].
6. Domestic Hot-Water Return Piping [**White letters on an ANSI Z535.1 safety-green background**].
7. Sanitary Waste Piping: [**White letters on a black background**].
8. Storm Drainage Piping: [**White letters on a black background**].
9. Nonpotable Cold Water: [**Black letters on an ANSI Z535.1 safety-yellow background**].
10. Nonpotable Hot Water: [**Black letters on an ANSI Z535.1-yellow background**].
11. Nonpotable Hot-Water Recirculation: [**Black letters on an ANSI Z535.1 safety-yellow background**].
12. Reagent Water Piping: [**White letters on an ANSI Z535.1 safety-blue background**].
13. Deionized Water Piping: [**White letters on an ANSI Z535.1 safety-blue background**].
14. Distilled Water Piping: [**White letters on an ANSI Z535.1 safety-blue background**].

15. Reverse Osmosis Water Piping: [**White letters on an ANSI Z535.1 safety-blue background**].

3.7 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
b. Domestic Hot Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
c. Domestic Hot-Water Return: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
d. Low-Pressure Compressed Air: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
e. High-Pressure Compressed Air: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
f. Nonpotable Cold Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
g. Nonpotable Hot Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
h. Nonpotable Hot-Water Return: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
i. Reagent Water Piping: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
j. Deionized Water Piping: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
k. Distilled Water Piping: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
l. Reverse Osmosis Water Piping: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

3.8 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: [**Black letters on an ANSI Z535.1 safety-yellow background**].

B. Attach warning tags, with proper message, to equipment and other items where [**indicated on Drawings**][**scheduled**] .

END OF SECTION 22 05 53 00

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Task	Specification	Specification Description
22 05 53 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing
22 05 76 00	22 05 00 00a	Testing, Adjusting, and Balancing for Plumbing

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SECTION 22 07 16 00 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium silicate equipment insulation.
2. Cellular glass equipment insulation.
3. Flexible elastomeric equipment insulation.
4. Glass-fiber equipment insulation.
5. Mineral wool equipment insulation.
6. Polyolefin equipment insulation.
7. Insulating cements.
8. Insulation adhesives.
9. Insulation mastics and coatings.
10. Insulation sealants.
11. Field-applied insulation jackets.
12. Field-applied fabric-reinforcing mesh for insulation.
13. Field-applied cloths for insulation.
14. Vapor-retarder tapes.
15. Insulation securements.
16. Insulation corner angles.

B. Related Requirements:

1. Section 220719 "Plumbing Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Product Data: For adhesives, mastics, and sealants, indicating VOC content.

14. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
2. Sheet Jacket Materials: **12 inches (300 mm)** square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field Quality Control Reports: For specified tests and inspections.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

a. One tank or vessel.
b. One pump.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation, and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application. Before preparing equipment Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 EQUIPMENT INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Indoor Equipment Insulation Schedule" articles for where insulating materials are to be applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM SILICATE EQUIPMENT INSULATION

A. Equipment Insulation - Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
   c. <**Insert manufacturer's name**>

3. Description: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement.
4. Standard: ASTM C533, Type I or Type II.
5. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR GLASS EQUIPMENT INSULATION

A. Equipment Insulation - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Owens Corning**]

b. <**Insert manufacturer's name**>

3. Description: Cellular glass equipment insulation of inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Block Insulation: Type I.
6. Special-Shaped Insulation: Type III.
7. Board Insulation: Type IV.
8. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
9. Equipment insulation without facing.
10. Equipment Insulation With Factory-Applied Insulation Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
    c. FSK Facing: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
    d. FSP Facing: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type III.
    e. Vinyl Facing: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.5 FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Equipment Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric equipment insulation.
4. Standard ASTM C543/ASTMC534M, Type II for sheet materials.
5. Suitable for maximum use temperature between **70 deg F (minus 57 deg C)** and **220 deg F (104 deg C)**.

2.6 GLASS-FIBER EQUIPMENT INSULATION

A. Equipment Insulation - Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

3. Description: Glass-fiber blanket equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Suitable for maximum use temperature up to **450 deg F (232 deg C)** in accordance with ASTM C411.
5. Unfaced, Type I.
6. Factory-Applied Insulation Facing:

   a. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   b. Vinyl: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

B. Equipment Insulation - High-Temperature, Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: High-temperature glass-fiber equipment blanket insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C553, Type V.
5. Unfaced.
6. Suitable for maximum use temperature up to **1000 deg F (650 deg C)**.

C. Equipment Insulation - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass-fiber board equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type IA or Type IB.
5. Suitable for maximum use temperature between **35 deg F (1.7 deg C)** and **250 deg F (121 deg C)** for jacketed and between **35 deg F (1.7 deg C)** and **450 deg F (232 deg C)** for unfaced in accordance with ASTM C411.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

D. Equipment Insulation - High-Temperature, Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

3. Description: High-temperature, glass-fiber board insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1000 deg F (650 deg C)** in accordance with ASTM C411.

E. Equipment Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

3. Description: Glass-fiber, pipe and tank insulation consisting of glass fibers bonded with a

thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature between **35 deg F (1.7 deg C)** and **850 deg F (454 deg C)**, in accordance with ASTM C411.
6. Semirigid board material with factory-applied [**ASJ**][**FSK**] jacket.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.7 MINERAL WOOL EQUIPMENT INSULATION

A. Equipment Insulation - Mineral Wool Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

3. Description: Mineral wool equipment insulation blanket consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C553.
5. Unfaced.
6. Suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447.

B. Equipment Insulation - Mineral Wool Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool board equipment insulation consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1100 deg F (600 deg C)** in accordance with ASTM C411.

C. Equipment Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool, pipe and tank insulation consisting of fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facings:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.8 POLYOLEFIN EQUIPMENT INSULATION

A. Equipment Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

3. Description: Polyethylene type of polyolefin thermal plastic equipment insulation.
4. Standard: ASTM C1427, Type I, Grade I for tubular materials and Type II, Grade I for sheet materials.

2.9 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.10 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
6. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.

8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

3. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
4. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.
4. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

3. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
4. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
6. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
7. Color: [**Black**]<**Insert color**> .
8. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.

F. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

G. Insulation Adhesive for ASJ, FSK and PVDC Facings/Jackets: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Adhesive for bonding ASJ, FSK and PVDC facing/jacket lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

H. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

3. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.

I. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.11 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Knauf Insulation**]
    d. [**Mon-Eco Industries, Inc.**]
    e. [**Vimasco Corporation**]
    f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water-based, suitable for indoor and outdoor use on above-ambient surfaces.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perms)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .

2.12 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Owens Corning**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Owens Corning**]

e. **<Insert manufacturer's name>**

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Sealant shall have a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealants for ASJ, PVDC, and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.

5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.13 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Equipment Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Speedline Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Speedline Corporation**]
   e. <**Insert manufacturer's name**>

3. High-impact-resistant, UV-resistant PVC complying with ASTM 1784, Class 16354-C.
4. Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated tank heads and tank side panels.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]
   c. <**Insert manufacturer's name**>

3. Jacket Material: Aluminum.

   a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
   b. Standard: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
   d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
   e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
   f. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel Jacket.

   a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
   b. Standard: ASTM A240/A240M.
   c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles.
   d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
   e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
   f. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**MFM Building Products Corp.**]
    b. [**Polyguard Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**MFM Building Products Corp.**]
    b. [**Polyguard Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
4. Vapor Barrier/Waterproofing Membrane: **60-mil- (1.5-mm-)** thick.

F. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**3M**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**3M**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
    d. <**Insert manufacturer's name**>

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket to have five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive.
5. Outer aluminum surface is to be coated with UV-resistant coating for protection from environmental contaminants.
6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

G. Insulation Jacket, Field Applied - Indoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

3. Description: PVDC jacket for indoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **4 mil (0.10 mm)** thick.
5. Permeance: **0.02 perm (0.013 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

H. Insulation Jacket, Field Applied - Outdoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

3. Description: PVDC jacket for outdoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **6 mil (0.15 mm)** thick.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

I. Insulation Jacket, Field Applied - PVDC-SSL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. <**Insert manufacturer's name**>

3. Description: PVDC jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
4. Thickness: **6 mil (0.15 mm)**.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

2.14 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber mesh for covering equipment insulation.
4. Weight: Approximately **4 oz./sq. yd. (114 g/sq. m)**.
5. Thread Count: **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)**.

B. Woven Polyester Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]

b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.15 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alpha Associates, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Associates, Inc.**]
b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I, plain weave.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.16 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]

c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   c. <**Insert manufacturer's name**>

3. Description: White, vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: 500 percent.
9. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

E. Vapor-Retarder Tape - PVDC, for Indoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]

b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for indoor applications.
4. Width: [**3 inches (75 mm)**]**<Insert value>** .
5. Film Thickness: [**6 mils (0.15 mm)**]**<Insert value>** .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]**<Insert value>** .
7. Elongation at Break: [**145**]**<Insert value>** percent.
8. Tensile Strength: [**55 psi (138 kPa)**]**<Insert value>** in width.

F. Vapor-Retarder Tape -PVDC, for Outdoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for outdoor applications.
4. Width: [**3 inches (75 mm)**]**<Insert value>** .
5. Film Thickness: [**6 mils (0.15 mm)**]**<Insert value>** .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]**<Insert value>** .
7. Elongation at Break: [**145**]**<Insert number>** percent.
8. Tensile Strength: [**55 psi (379 kPa)**]**<Insert value>** in width.

2.17 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Pins and Hangers - Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding.
d. Shank: [**0.106-inch- (2.6-mm-)**][**0.135-inch- (3.5-mm-)**] diameter.
e. Length: To suit depth of insulation indicated.

2. Insulation Pins and Hangers - Cupped-Head, Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) **<Insert manufacturer's name>**

c. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding.
d. Shank: [**0.106-inch- (2.6-mm-)**][**0.135-inch- (3.5-mm-)**] diameter.
e. Length: To suit depth of insulation indicated, with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.

3. Insulation Pins and Hangers - Metal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) **<Insert manufacturer's name>**

c. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated.
f. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation Hangers - Nonmetal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Perforated, nylon sheet, **0.030 inch (0.76 mm)** thick by **1-1/2 inches (38 mm)** in diameter.
e. Spindle: Nylon, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated, up to **2-1/2 inches (63 mm)**.
f. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Insulation Hangers - Self-Sticking-Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

c. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed; **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.
f. Adhesive-backed base with a peel-off protective cover.

6. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

d. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Insulation Washers - Nonmetal, Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.18 INSULATION CORNER ANGLES

A. Insulation Corner Angles - PVC:

1. Thickness: Minimum [**30-mils (0.8-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Insulation Corner Angles - Aluminum:

1. Thickness: Minimum [**0.040-inch (1.0-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angles - Stainless Steel:

1. Thickness: [**0.024-inch (0.61-mm-)**]<**Insert dimension**> .
2. Dimensions: Minimum **1- by 1-inch (25- by 25-mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that equipment to be insulated has been tested and is free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF EQUIPMENT INSULATION, GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [**, unless otherwise approved by the engineer of record**] .

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or area of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

P. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on **6-inch (150-mm)** centers, starting at corners. Install **3/8-inch- (10-mm-)** diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from [**galvanized steel**][**aluminum**][**or**][**stainless steel**] , at least [**0.040 inch (1.0 mm)**][**0.050 inch (1.3 mm)**][**0.060 inch (1.6 mm)**] thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal

between flanges with replaceable gasket material to form a vapor barrier.

3.4 INSTALLATION OF MINERAL WOOL EQUIPMENT INSULATION

A. Secure mineral wool equipment insulation with adhesive and anchor pins and speed washers.

B. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.

C. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

D. Protect exposed corners with secured corner angles.

E. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

1. Do not weld anchor pins to ASME-labeled pressure vessels.
2. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
3. On tanks and vessels, maximum anchor-pin spacing is to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
4. Do not compress insulation during installation.
5. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
6. Impale insulation over anchor pins, and attach speed washers.
7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

F. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.

G. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.

H. Stagger joints between insulation layers at least **3 inches (75 mm)**.

I. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

J. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

K. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 INSTALLATION OF GLASS-FIBER EQUIPMENT INSULATION

A. Secure glass-fiber equipment insulation with adhesive and anchor pins and speed washers.

B. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.

C. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

D. Protect exposed corners with secured corner angles.

E. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

1. Do not weld anchor pins to ASME-labeled pressure vessels.
2. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
3. On tanks and vessels, maximum anchor-pin spacing is to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
4. Do not compress insulation during installation.
5. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
6. Impale insulation over anchor pins, and attach speed washers.
7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
8. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
9. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.
10. Stagger joints between insulation layers at least **3 inches (75 mm)**.
11. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
12. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
13. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.6 INSTALLATION OF CALCIUM SILICATE EQUIPMENT INSULATION

A. On Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive

and press on one layer of glass cloth. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Apply [**100**]<**Insert value**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.

C. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 INSTALLATION OF WOVEN GLASS-FIBER CLOTH

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.9 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
2. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

1. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.

4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

D. Insulation Jacket, Field-Applied - PVDC:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. A **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal.
2. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
3. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

E. Insulation Jacket, Field-Applied - PVDC-SSL:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**]<**Insert number**> location(s) for each type of equipment defined in the "Indoor Plumbing Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.12 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48-kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.

B. Round, concealed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu m)** nominal density.

C. Rectangular, exposed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.
5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

D. Rectangular, concealed breeching and connector insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**]<**Insert density**> nominal density.

5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

3.13 INDOOR PLUMBING EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-exchanger (water-to-water for domestic water-heating service) insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inch (50 mm)**]<**Insert dimension**> thick.

D. Steam-to-hot-water converter insulation is to be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inch (38 mm)**]<**Insert dimension**> thick.

E. Domestic water pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4**

lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.

F. Domestic chilled-water (potable) pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool Board: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.

G. Domestic hot-water pump insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation are to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

I. Domestic hot-water storage tank insulation is to be one of the following, of R-value indicated:

1. R-value: [**12.5**]<**Insert value**> .
2. Equipment Insulation - Cellular glass.
3. Equipment Insulation - Glass-Fiber Blanket: [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6

lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-fiber pipe and tank.
6. Equipment Insulation - Mineral Wool Blanket: [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank.

J. Domestic water storage tank insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

K. Domestic chilled-water (potable) storage tank insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [1 inch (25 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [1.5 inch (38 mm)]<**Insert dimension**> thick.
9. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

L. Domestic water filter-housing insulation is to be one of the following:

1. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Blanket: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber Board: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [2 inches (50 mm)]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Blanket: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool Board: [2 inch (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool, Pipe and Tank: [2 inch (50 mm)]<**Insert dimension**> thick.

3.14 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Equipment, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.15 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] :

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] thick.

D. Equipment, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**][**with Z-shaped locking seam**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

END OF SECTION 22 07 16 00

SECTION 22 07 19 00 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cellular glass pipe insulation.
2. Flexible elastomeric pipe insulation.
3. Glass-fiber pipe insulation.
4. Mineral wool pipe insulation.
5. Phenolic pipe insulation.
6. Polyolefin pipe insulation.
7. Insulating cements.
8. Insulation adhesives.
9. Insulation mastics and coatings.
10. Insulation sealants.
11. Field-applied insulation jackets.
12. Field-applied fabric-reinforcing mesh.
13. Field-applied cloths for insulation.
14. Vapor-retarder tapes.
15. Insulation securements.
16. Protective shielding guards.

B. Related Requirements:

1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.
11. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
12. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail attachment and covering of heat tracing inside insulation.
4. Detail insulation application at pipe expansion joints for each type of insulation.
5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
6. Detail removable insulation at piping specialties, equipment connections, and access panels.
7. Detail application of field-applied jackets.
8. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
2. Jacket Materials for Pipe: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
3. Sheet Jacket Materials: **12 inches (300 mm)** square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One **10-foot (3-m)** section of **NPS 2 (DN 50)** straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One **NPS 2 (DN 50)** or smaller valve and one **NPS 2-1/2 (DN 65)** or larger valve.

e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems [**and after installing and testing heat tracing**] . Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical

products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 PIPING INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CELLULAR GLASS PIPE INSULATION

A. Pipe Insulation - Cellular Glass, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

3. Description: Preformed pipe insulation of inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
6. Without Insulation Facing: Type II, Class 1.
7. Factory-Applied Insulation Facing: Type II, Class 2.

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.4 FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Pipe Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**K-Flex USA**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**K-Flex USA**]
d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric pipe insulation.
4. Standard: ASTM C534/C534M, Type I, for tubular materials; Type II for sheet materials.
5. Suitable for maximum use temperature between **minus 70 deg F (minus 57 deg C)** and **220 deg F (104 deg C)**.

2.5 GLASS-FIBER PIPE INSULATION

A. Pipe Insulation - Glass-Fiber, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Knauf Insulation**]
c. [**Manson Insulation Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Knauf Insulation**]
c. [**Manson Insulation Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to **850 deg F (454 deg C)** in accordance with ASTM C411. Comply with ASTM C547.
4. Preformed Pipe Insulation: Type I, Grade A.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature between **35 and 850 deg F (1.7 and 454 deg C)**, in

accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.6 MINERAL WOOL PIPE INSULATION

A. Pipe Insulation - Mineral Wool, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

3. Description: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447. Comply with ASTM C547.
4. Standard: ASTM C547.
5. Preformed Pipe Insulation: Type II, Grade A.
6. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

3. Description: Mineral wool fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 PHENOLIC PIPE INSULATION

A. Pipe Insulation - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Kingspan Tarec Industrial Insulation NV**]
   c. [**Polyguard Products, Inc.**]
   d. [**Resolco Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Kingspan Tarec Industrial Insulation NV**]
c. [**Polyguard Products, Inc.**]
d. [**Resolco Inc.**]
e. <**Insert manufacturer's name**>

3. Description: Prefabricated pipe insulation of rigid, expanded, closed-cell structure.
4. Standard: ASTM C1126.
5. Prefabricated Pipe Insulation: Type III.
6. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
c. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 POLYOLEFIN PIPE INSULATION

A. Pipe Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

3. Description: Polyethylene thermal plastic insulation.
4. Standard: ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials [**, self-seal**] .

2.9 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.10 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
6. Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.
8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Two-component, thermosetting urethane adhesive containing no flammable solvents,

with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.

4. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**Foster Brand; H. B. Fuller**]
   d. [**K-Flex USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**Foster Brand; H. B. Fuller**]
   d. [**K-Flex USA**]
   e. <**Insert manufacturer's name**>

3. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
4. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
6. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
7. Color: [**Black**]<**Insert color**> .
8. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.

E. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]

d. **<Insert manufacturer's name>**

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

F. Insulation Adhesive for Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

3. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.
4. Adhesive: As recommended by phenolic manufacturer and with a VOC content of 50 g/L or less.

G. Insulation Adhesive for ASJ and FSK Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. **<Insert manufacturer's name>**

3. Description: Pipe insulation adhesive for bonding ASJ and FSK facing/jacket insulation lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

H. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**P.I.C. Plastics, Inc.**]
   c. [**Proto Corporation**]
   d. [**Sekisui Voltek, LLC**]
   e. [**Speedline Corporation**]
   f. [**The Dow Chemical Company**]
   g. <**Insert manufacturer's name**>

3. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.
4. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.

2.11 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Knauf Insulation**]
d. [**Mon-Eco Industries, Inc.**]
e. [**Vimasco Corporation**]
f. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent-based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water-based, suitable for indoor and outdoor use on above-ambient surfaces.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .

2.12 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Sealant shall have a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.13 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Pipe Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Airex Manufacturing Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Airex Manufacturing Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. <**Insert manufacturer's name**>

3. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
4. Thickness: As indicated in "Outdoor, Field-Applied Jacket Schedule" Articles under Part 3.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Jacket Material - Aluminum:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
    d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
    e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
    f. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: ASTM A240/A240M.
c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**2.5-mil- (0.063-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Owens Corning**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Owens Corning**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Description: Underground direct-buried jacket of rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
4. Vapor Barrier and Waterproofing Membrane: **125 mils (3.2 mm)** thick.

F. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MFM Building Products Corp.**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
4. Vapor Barrier/Waterproofing Membrane: **60 mils (1.5 mm)** thick.

G. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
5. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.
6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

2.14 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **2 oz./sq. yd. (68 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.

B. Woven Polyester Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Foster Brand; H. B. Fuller**]
   b. [**Vimasco Corporation**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Foster Brand; H. B. Fuller**]
   b. [**Vimasco Corporation**]
   c. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.15 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.16 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]
   f. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Application: Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: [**500**]<**Insert value**> percent.
9. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**]<**Insert value**> in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]

d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

2.17 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Staples: Outward clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

C. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**C & F Wire Products**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**RPR Products, Inc.**]
    d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**C & F Wire Products**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**RPR Products, Inc.**]
    d. **<Insert manufacturer's name>**

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.18 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Buckaroos, Inc.**]
    b. [**McGuire Manufacturing**]
    c. [**MVG Molded Products**]
    d. [**Plumberex Specialty Products, Inc.**]
    e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    f. [**Truebro; IPS Corporation**]
    g. [**Zurn Industries, LLC**]
    h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Buckaroos, Inc.**]
    b. [**McGuire Manufacturing**]
    c. [**MVG Molded Products**]
    d. [**Plumberex Specialty Products, Inc.**]
    e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    f. [**Truebro; IPS Corporation**]
    g. [**Zurn Industries, LLC**]
    h. **<Insert manufacturer's name>**

3. Description: Manufactured plastic wraps for covering plumbing fixture [**hot-water supply**][**hot-**

and cold-water supplies] and trap and drain piping. Comply with Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines requirements.

B. Protective Shielding Piping Enclosures, :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   b. [**Truebro; IPS Corporation**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   b. [**Truebro; IPS Corporation**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA and ABA Accessibility Guidelines requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

   1. Verify that piping to be insulated has been tested and is free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range of between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF PIPING INSULATION, GENERAL

A. Requirements in this article apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

E. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [**, unless otherwise approved by the engineer-of-record**] .

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry

film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at **4 inches (100 mm)** o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least [**4 inches (100 mm)**]<**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

R. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [**preformed fitting insulation**][**or**][**mitered or routed fittings**] made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [**preformed fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the

insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

S. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

T. Install removable insulation covers [**at locations indicated on Drawings**] . Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF CELLULAR-GLASS PIPE INSULATION

A. Installation on:

1. Straight Pipes and Tubes:

a. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
b. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:

a. Install prefabricated sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation on:

1. Pipe Flanges:

a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Fittings and Elbows:

a. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Valves and Pipe Specialties:

a. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
b. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.7 INSTALLATION OF GLASS-FIBER PIPE INSULATION

A. Insulation on:

1. Straight Pipes and Tubes:

a. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
c. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
d. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

a. Install prefabricated pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

3. Pipe Fittings and Elbows:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
b. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

4. Valves and Pipe Specialties:

a. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
b. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
d. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF PHENOLIC PIPE INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.

B. Insulation on:

1. Straight Pipes and Tubes:

    a. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
    b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
    c. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
    d. For insulation with jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

2. Pipe Flanges:

    a. Install prefabricated pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

3. Pipe Fittings and Elbows:

    a. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

4. Valves and Pipe Specialties:

    a. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
    b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
    c. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF POLYOLEFIN PIPE INSULATION

A. Insulation on:

1. Straight Pipes and Tubes:

    a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive [**, or via self-seal mechanism**] to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Pipe Flanges:

    a. Install pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
    d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive

to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Pipe Fittings and Elbows:

   a. Install mitered sections of polyolefin pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

4. Valves and Pipe Specialties:

   a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 INSTALLATION OF WOVEN GLASS-FIBER CLOTH

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

   1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
   2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.11 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field-Applied - FSK:

   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field-Applied - PVC:

   1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   2. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field-Applied - Metal:

   1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
   2. Overlap longitudinal seams arranged to shed water.
   3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
   4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**]<**Insert number**> locations of straight pipe, [**three**]<**Insert number**> locations of threaded fittings, [**three**]<**Insert number**> locations of welded fittings, [**two**]<**Insert number**> locations of threaded strainers, [**two**]<**Insert number**> locations of welded strainers, [**three**]<**Insert number**> locations of threaded valves, and [**three**]<**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water Piping:

1. Insulation for pipe size NPS 1 (DN 25) and smaller is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

2. Insulation for pipe size NPS 1-1/4 (DN 32) and larger is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water Piping:

1. Insulation for pipe size NPS 1-1/4 (DN32) and smaller is to be one of the following:

a. Pipe Insulation - Cellular Glass Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

2. Insulation for pipe size NPS 1-1/2 (DN 40) and larger is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

C. Domestic Chilled Water (Potable) Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

D. Stormwater and Overflow Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

E. Roof Drain and Overflow Drain Bodies:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Flexible Elastomeric: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1/2 inch (13 mm)][1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Polyolefin: [1/2 inch (13 mm)][3/4 inch (19 mm)][1 inch (25 mm)]<**Insert dimension**> thick.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.

d. Pipe Insulation - Phenolic: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.

H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

I. Hot Service Drains and Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.

J. Hot Service Vent Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**2 inches (50 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**2 inches (50 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**2 inches (50 mm)**]<**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**2 inches (50 mm)**]<**Insert dimension**> thick.

c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**2 inches (50 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyolefin: [**2 inches (50 mm)**]<**Insert dimension**> thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Phenolic: [**2 inches (50 mm)**]<**Insert dimension**> thick.

D. Hot Service Drains and Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.

E. Hot Service Vent Piping:

1. Insulation for all pipe sizes is to be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Pipe insulation - cellular glass, preformed [**2 inches (50 mm)**]<**Insert dimension**> thick.

B. Chilled Water, All Sizes: Pipe insulation - cellular glass, preformed [**2 inches (50 mm)**]<**Insert dimension**> thick.

3.18 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.19 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.20 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19 00

Task	Specification	Specification Description
22 07 19 00	21 07 00 00	Fire-Suppression Systems Insulation

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SECTION 22 11 16 00 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube, drawn temper - domestic water.
2. Copper tube, annealed temper - domestic water.
3. Copper tube fittings, solder joint - domestic water.
4. Wrought-copper, solder-joint fittings - domestic water.
5. Copper tube fittings, mechanically formed tee - domestic water.
6. Copper tube appurtenances, grooved end, mechanical joint - domestic water.
7. Copper or bronze, pressure-seal-joint fittings - domestic water.
8. Copper tube, push-on-joint fittings - domestic water.
9. Ductile-iron pipe and fittings - domestic water.
10. Ductile-iron pipe appurtenances, grooved end - domestic water.
11. Stainless steel pipe and fittings - domestic water.
12. Stainless steel pipe appurtenances, grooved end, mechanical joint - domestic water.
13. Stainless steel pipe, pressure-seal-joint fittings - domestic water.
14. CPVC pipe and fittings - domestic water.
15. PVC pipe and fittings - domestic water.
16. PEX tube and fittings - domestic water.
17. PEX-AL-PEX tube and fittings - domestic water.
18. PEX-AL-HDPE tube and fittings - domestic water.
19. Polypropylene (PP-R and PP-RCT) pipe and fittings - domestic water.
20. Pipe joining materials - domestic water.
21. Encasement for piping.
22. Transition fittings - domestic water.
23. Dielectric fittings - domestic water.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for water-service piping [**and water meters**] outside the building from source to the point where water-service piping enters the building.

1.2 DEFINITIONS

A. DHWR: Domestic hot water return.

B. PP-RCT: Polypropylene random copolymer with modified crystallinity and temperature resistance.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment

completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field Quality -Control Reports: For specified tests and inspections.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.6 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**the Owner**] no fewer than [**two**] days in advance of proposed interruption of water service.
2. Do not interrupt water service without [**Architect's**][**Construction Manager's**][**the Owner's**] written permission.

1.7 WARRANTY

A. Polypropylene (PP-R and PP-RCT) Pipe and Fittings Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of piping system due to defects in materials or manufacturing.
2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372, or be certified in compliance with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372 by an ANSI-accredited third-party

certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF/ANSI 14, NSF/ANSI/CAN 61, and NSF/ANSI/CAN 372. [**Include marking "NSF-pw" on piping.**]

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Copper Tube, Drawn Temper - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

B. Copper Tube, Annealed Temper - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

C. Copper Tube Fittings, Solder Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
   b. [**Mueller Streamline Co.; a company of Mueller Industries**]
   c. [**NIBCO INC.**]

D. Cast-Copper, Solder-Joint Fittings - Domestic Water: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

E. Wrought-Copper, Solder-Joint Fittings - Domestic Water: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
b. [**Mueller Streamline Co.; a company of Mueller Industries**]
c. [**NIBCO INC.**]

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

G. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

H. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

I. Copper Tube Fittings, Mechanically Formed Tee - Domestic Water: For forming T-branch on copper water tube.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**T-DRILL Industries Inc**]

2. Description: Tee formed in copper tube in accordance with ASTM F2014.

J. Copper Tube Appurtenances, Grooved End, Mechanical Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
e. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, mechanical-joint copper tube from single manufacturer.
3. Grooved-End Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372, and rated for minimum [**180 deg F (80 deg C)**] , for use with ferrous housing

and steel bolts and nuts; **300 psig (2060 kPa)** minimum CWP pressure rating.

K. Copper or Bronze, Pressure-Seal-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**Conex Bänninger; a part of IBP Group LLC**]
   c. [**Copper Press Brand; Merit Brass Company**]
   d. [**Elkhart Brass Mfg. Co., Inc**]
   e. [**FNW; Ferguson Enterprises, Inc.**]
   f. [**Mueller Streamline Co.; a company of Mueller Industries**]
   g. [**NIBCO INC.**]
   h. [**Viega LLC**]

2. Source Limitations: Obtain copper or bronze pressure-seal-joint fittings from single manufacturer.
3. Housing: Copper.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Working-Pressure Rating: Minimum **200 psig (1370 kPa)** at **250 deg F (121 deg C)**.

L. Copper Tube, Push-on-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**NIBCO INC.**]
   c. [**SharkBite, A Division of Reliance Worldwide Corporation**]

2. Source Limitations: Obtain copper tube, push-on-joint fittings from single manufacturer.
3. Description:

   a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B16.22.
   b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.4 DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Ductile-Iron Pipe, Mechanical Joint:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron Fittings, Standard Pattern, Mechanical Joint:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Ductile-Iron Fittings, Compact Pattern, Mechanical Joint:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Ductile-Iron Pipe, Push-on Joint:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Ductile-Iron Fittings, Standard Pattern, Push-on Joint:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Ductile-Iron Fittings, Compact Pattern, Push-on Joint:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Ductile-Iron Pipe, Plain End: AWWA C151/A21.51.

H. Ductile-Iron Pipe Appurtenances, Grooved End - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**ASC Engineered Solutions**]
   c. [**SCI; an ASC Engineered Solution**]
   d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, ductile-iron pipe from single manufacturer.
3. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.

4. Mechanical Couplings for Grooved-End, Ductile-Iron-Pipe:

   a. AWWA C606 for ductile-iron-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating:

1) NPS 14 to NPS 18 (DN 350 to DN 450): [**250 psig (1725 kPa)**].
2) NPS 20 to NPS 46 (DN 500 to DN 1150): [**150 psig (1035 kPa)**].

2.5 STAINLESS STEEL PIPE AND FITTINGS - DOMESTIC WATER

A. Potable-Water Piping and Components: Comply with NSF/ANSI 61 and NSF/ANSI/CAN 372.

B. Stainless Steel Pipe: ASTM A312/A312M, seamless, stainless steel of types and schedules as indicated in "Domestic Water Piping Applications" Article.

C. Stainless Steel Pipe Fittings: ASTM A815/A815M.

D. Stainless Steel Pipe Appurtenances, Grooved End, Mechanical Joint - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**GroovJoint**]
e. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
f. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end, stainless steel pipe from single manufacturer.
3. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

a. AWWA C606 for stainless steel pipe dimensions.
b. Stainless steel housing sections.
c. Stainless steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: [**600 psig (4137 kPa)**] .
2) NPS 10 and NPS 12 (DN 250 to DN 300): [**400 psig (2758 kPa)**].
3) NPS 14 to NPS 24 (DN 350 to DN 600): [**250 psig (1725 kPa)**].

E. Stainless Steel Pipe, Pressure-Seal-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**GroovJoint**]
c. [**Merit Brass Company**]

d. [**Victaulic Company**]
e. [**Viega LLC**]

2. Source Limitations: Obtain stainless steel pipe, pressure-seal-joint fittings from single manufacturer.
3. Material: Type 316 stainless steel, ASTM A312/A312M, [**Schedule 5**][**Schedule 10**] .
4. Fittings: Type 316 stainless steel with EPDM O-ring seal in each end, and approved for potable-water applications.
5. Listing: ICC-ES LC1002 or UL classified in accordance with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372.
6. Working-Pressure Rating: Minimum **200 psig (1379 kPa)** at **250 deg F (121 deg C)**.

2.6 CPVC PIPE AND FITTINGS - DOMESTIC WATER

A. CPVC Pipe - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]
d. [**Uponor Inc.**]

2. Source Limitations: Obtain CPVC pipe from single manufacturer.

3. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Domestic Water Piping Applications" Article.

4. CPVC Socket Fittings: [**ASTM F438 for Schedule 40**][**and**][**ASTM F439 for Schedule 80**] .

5. CPVC Threaded Fittings: ASTM F437, Schedule 80.

B. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.7 PVC PIPE AND FITTINGS - DOMESTIC WATER

A. PVC Pipe - Domestic Water: ASTM D1785, with wall thickness as indicated in "Domestic Water Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC pipe from single manufacturer.

B. PVC Fittings - Domestic Water: ASTM D2466, schedule 40 PVC plastic pipe fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC fittings from single manufacturer.

3. PVC Socket Fittings: [**ASTM D2466 for Schedule 40**][**and**][**ASTM D2467 for Schedule 80**] .

4. PVC Schedule 80 Threaded Fittings: ASTM D2464.

2.8 PEX TUBE AND FITTINGS - DOMESTIC WATER

A. PEX Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**HeatLink Group Inc.**]
   b. [**IPEX USA LLC**]
   c. [**MrPex Systems Inc**]
   d. [**NIBCO INC.**]
   e. [**REHAU**]
   f. [**SharkBite, A Division of Reliance Worldwide Corporation**]
   g. [**Sioux Chief Manufacturing Company, Inc.**]
   h. [**Uponor Inc.**]
   i. [**Viega LLC**]
   j. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain PEX tube from single manufacturer.
3. Tube Material: PEX plastic in accordance with ASTM F876 [**and ASTM F877**] .

B. PEX Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**NIBCO INC.**]
   b. [**Oatey Co.**]
   c. [**SharkBite, A Division of Reliance Worldwide Corporation**]
   d. [**Uponor Inc.**]
   e. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain PEX tube fittings from single manufacturer.

3. Fittings: [**ASTM F1807, metal insert and copper crimp rings**][**ASTM F1960, cold expansion fittings and reinforcing rings**] .
4. Push-Fit Fittings: ASSE/ANSI 1061, push-fit fittings.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.9 PEX-AL-PEX TUBE AND FITTINGS - DOMESTIC WATER

A. PEX-AL-PEX Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Heat Innovations Inc**]

2. Source Limitations: Obtain PEX-AL-PEX tube and fittings from single manufacturer.
3. PEX-AL-PEX Tube: PEX plastic bonded to inside and outside of a welded aluminum tube in accordance with ASTM F1281.

B. PEX-AL-PEX Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Heat Innovations Inc**]

2. PEX-AL-PEX Tube Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

2.10 PEX-AL-HDPE TUBE AND FITTINGS - DOMESTIC WATER

A. PEX-AL-HDPE Tube - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Uponor Inc.**]
b. [**Viega LLC**]

2. Source Limitations: Obtain PEX-AL-HDPE tube and fittings from single manufacturer.

B. PEX-AL-HDPE Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Uponor Inc.**]
   b. [**Viega LLC**]

2. PEX-AL-HDPE Tube Fittings: Metal-insert type with copper or stainless steel crimp ring and matching PEX-AL-HDPE tube dimensions.

2.11 POLYPROPYLENE (PP-R AND PP-RCT) PIPE AND FITTINGS - DOMESTIC WATER

A. Polypropylene (PP-R and PP-RCT) Pipe - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**aquatherm**]
   b. [**IPEX USA LLC**]
   c. [**Nupi Americas**]
   d. [**Uponor Inc.**]

2. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe and fittings from single manufacturer.
3. Polypropylene (PP-R and PP-RCT) Pipe: ASTM F2389, [**SDR 7.4**][**SDR 11**] pipe pressure rating to comply with temperature and pressure ratings of code requirements for applicable service.

4. Smoke and Fire Ratings:

   a. Where indicated on Drawings that a plenum-rated piping system is required, pipe is to be wrapped and/or insulated with fiberglass or mineral-wool pipe insulation, and field installed.
   b. System is to have a flame-spread index of less than 25 and smoke-developed index of less than 50.
   c. Pipe, wrap, or insulate as a system to comply with requirements of CAN/ULC-S102.2, ASTM E84, or UL 2846.
   d. For insulation required for thermal and condensation reasons, see Section 220719 "Plumbing Piping Insulation."

5. Integration of PP-R and PP-RCT Piping Systems with Other Systems:

   a. When integrating PP-R and PP-RCT piping systems with other systems or with components not made of PP-R or PP-RCT (for example, valves, pumps, other piping, check valves, or strainers), ensure that operating parameters for PP-R and PP-RCT will not damage other materials in the system or vice versa.
   b. Verify that all parts of the system are compatible with the medium being carried before installation. PP-R and PP-RCT pipe do not require treatment to protect them from corrosion. Metals (ferrous and non-ferrous) in the system may be susceptible to corrosion. Provide water treatment to protect system metals.
   c. Do not mix PP-R and PP-RCT pipe with other piping systems in conditions that will cause the other system or components to fail.

d. For Domestic Hot Water Recirculation (DHWR) Systems:

1) When using copper piping in conjunction with PP-R and PP-RCT in a DHWR system, ensure that operating conditions will not cause degradation or erosion/corrosion of copper.
2) Follow CDA guidelines in CDA's "Copper Tube Handbook" for sizing, temperature, and flow velocity in the copper tubing.
3) Sustained high levels of copper in DHWR piping can damage components within the system, even PP-R and PP-RCT.
4) Ensure that maximum hot-water temperature within any part of the system/loop does not exceed **140 deg F (60 deg C)**. Some regulations and codes further restrict temperature at any fixture to maximum of **120 deg F (50 deg C)**. Do not exceed temperature rating of pipe for the operating pressure.
5) Maximum temperature used must not exceed rating of pipe for the operating pressure.
6) Flow rates in a DHWR system should not exceed **1.5 ft./sec (0.5 m/s)** anywhere in the system, except in some special cases where velocities up to **3 ft./sec (1 m/s)** are needed to achieve proper flow temperature.

7) When adding PP-R or PP-RCT to an existing copper system in a DHWR application, the level of copper in the water must be tested. Do not install PP-R or PP-RCT where dissolved copper levels exceed **0.1 ppm (0.1 mg/L)**.
8) Do not install PP-R or PP-RCT under the following conditions:

a) Excessive temperature above **140 deg F (60 deg C)**.
b) High flow velocity greater than **1.5 ft./s (0.5 m/s)** (or **3 ft./s (0.1 m/s)** in special cases).
c) Improper system chemistry, such as chemicals, additives, disinfectants, or corrosion products that can degrade the piping.
d) Turbulence at fittings, elbows, and abrupt direction changes.
e) Velocities greater than **8 ft./s (2 m/s)** in cold water, and **5 ft./s (2 m/s)** in hot water.
f) Transitions such as changes in direction, including bends, tees, and elbows; and at joints where fittings are improperly aligned or mismatched. These conditions are further aggravated by burrs left from improper cutting, which create micro-turbulence and concentrate stress within the piping system.

B. Polypropylene (PP-R and PP-RCT) Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**IPEX USA LLC**]
c. [**Nupi Americas**]
d. [**Uponor Inc.**]

2. Polypropylene Fittings: ASTM F2389, [**SDR 7.4**][**SDR 11**] socket-fusion, butt-fusion, electrofusion, or fusion-outlet fittings to be used for fusion-welded joints between pipe and fittings.
3. Polypropylene Mechanical Fittings and Transition Fittings: To be used where transitions are made to other piping materials or to valves and appurtenances.
4. Polypropylene Threaded Transition Fittings: Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is

required.

5. PP-R and PP-RCT Socket Fittings: ASTM F2389, [**SDR 7.4**][**SDR 11**] .

2.12 PIPE JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, **1/8 inch (3.2 mm)** thick or ASME B16.21, nonmetallic and asbestos free.
2. Full-face or ring type.

B. Metal Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

1. Product Data: Verify CPVC welding solvent cement has a VOC content of 490 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

1. Product Data:

a. Verify PVC welding solvent cement has a VOC content of 510 g/L or less.

b. Verify adhesive primer has a VOC content of 550 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

6. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

7. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

8. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Plastic Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended in writing by piping system manufacturer.

2.13 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

1. Form: [**Sheet**][**tube**] .
2. Color: [**Black**][**natural**].

2.14 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Pipeline Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Romac Industries, Inc.**]
f. [**Smith-Blair, a Xylem brand.**]
g. [**Viking Johnson**]

2. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Sioux Chief Manufacturing Company, Inc.**]
d. [**Spears Manufacturing Company**]
e. [**Uponor Inc.**]

2. Source Limitations: Obtain plastic-to-metal transition fittings from single manufacturer.
3. Description: [**CPVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

a. End Connections: One end with threaded brass insert and one solvent-cement-socket [**or threaded**] end.

E. Plastic-to-Metal Transition Unions - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
3. Description: [**CPVC**][**PVC**] four-part union.

a. Threaded End: Brass [**or stainless steel**] .
b. End Connections: Solvent-cement-joint [**or threaded**] plastic end.
c. Gasket: Rubber O-ring.
d. Union nut.

2.15 DIELECTRIC FITTINGS - DOMESTIC WATER

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**HART Industrial Unions, LLC**]
d. [**Jomar Valve**]
e. [**Matco-Norca**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Wilkins**]
h. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE/IAPMO/ANSI/CAN 1079.

4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**] .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ASC Engineered Solutions**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric flanges from single manufacturer.
3. Standard: ASSE/IAPMO/ANSI/CAN 1079.
4. Description: Factory-fabricated, bolted, companion-flange assembly.

5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 180 deg F (82 deg C)**].
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]

2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
3. Description: Nonconducting materials for field assembly of companion flanges.

4. Pressure Rating: [**150 psig (1035 kPa)**] .
5. Gasket: Phenolic.
6. Temperature Rating: [**225 deg F (108 deg C)**] .
7. Bolt Sleeves: Phenolic or polyethylene.
8. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**Matco-Norca**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Victaulic Company**]

2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Standard: IAPMO PS 66.
4. Description: Electroplated steel nipple complying with ASTM F1545.

5. Pressure Rating and Temperature: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**].
6. End Connections: Male threaded or grooved.
7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 DOMESTIC WATER PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications in paragraphs below.

B. Flanges and unions may be used for aboveground piping joints.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-Building-Slab, Domestic Water, Building-Service Piping, NPS 3 (DN 80) and Smaller: To be the following:

1. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**] ; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
2. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
3. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

E. Under-Building-Slab, Domestic Water, Building-Service Piping, NPS 4 to NPS 8 (DN 100 to DN 200) and Larger: To be the following:

1. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**] ; wrought-copper, solder-joint fittings; and brazed joints.

2. Mechanical-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, mechanical-joint fittings, and mechanical joints.
3. Push-on-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, push-on-joint fittings, and gasketed joints.
4. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.
5. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

F. Under-Building-Slab, Combined Domestic Water, Building-Service, and Fire-Service-Main Piping, NPS 6 to NPS 12 (DN 150 to DN 300): To be the following:

1. Mechanical-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, mechanical-joint fittings, and mechanical joints.
2. Push-on-Joint, Ductile-Iron Pipe: [**Standard**][**compact**] pattern, push-on-joint fittings, and gasketed joints.
3. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-Building-Slab, Domestic Water Piping, NPS 2 (DN 50) and Smaller: To be the following:

1. Drawn-Temper Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
2. Annealed-Temper Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**; [**wrought-copper, solder-joint fittings; and brazed**][**copper pressure-seal-joint fittings; and pressure-sealed**] joints.
3. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

H. Aboveground Domestic Water Piping, NPS 2 (DN 50) and Smaller: To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

   a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
   b. Copper pressure-seal-joint fittings and pressure-sealed joints.
   c. Copper push-on-joint fittings; and push-on joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**] , pressure-seal-joint fittings, and pressure-sealed joints.
3. CPVC Pipe: [**Schedule 40 socket fittings and solvent-cemented joints**][**Schedule 80 socket fittings and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded**

fittings; and threaded joints] .

4. CPVC Tubing System: CPVC tube, CPVC socket fittings, and solvent-cemented joints. [**NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.**]

5. PEX Tube - Domestic Water: **NPS 1 (DN 25)** and smaller.

   a. Fittings for PEX tube:

      1) ASTM F1807, metal insert and copper crimp rings.
      2) ASTM F1960, cold expansion fittings and reinforcing rings.
      3) ASSE/ANSI 1061, push-fit fittings.

6. PEX-AL-PEX Tube: **NPS 1 (DN 25)** and smaller, fittings for PEX-AL-PEX tube, and crimped joints.
7. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
8. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

I. Aboveground Domestic Water Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

   a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
   b. Copper pressure-seal-joint fittings and pressure-sealed joints.
   c. Grooved-end, copper-tube appurtenances; and grooved joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.
3. CPVC Pipe: [**Schedule 40, socket fittings, and solvent-cemented joints**][**Schedule 80, socket fittings, and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints**] .
4. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

J. Aboveground Domestic Water Piping, NPS 5 to NPS 8 (DN 125 to DN 200): To be the following:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] .

   a. [**Cast-copper**][**wrought-copper**] solder-joint fittings and [**brazed**][**soldered**] joints.
   b. Grooved-end, copper-tube appurtenances; and grooved joints.

2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

3. CPVC Pipe: [**Schedule 40, socket fittings, and solvent-cemented joints**][**Schedule 80, socket fittings, and solvent-cemented joints**][**Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints**] .
4. PVC Pipe: [**Schedule 40**][**Schedule 80**] , socket fittings, and solvent-cemented joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**SDR 7.4**][**SDR 11**] pipe and socket-fusion, butt-fusion, fusion-outlet, or electrofusion fittings and joints.

K. Aboveground, Combined Domestic Water-Service and Fire-Service-Main Piping, NPS 6 to NPS 12 (DN 150 to DN 300): To be the following:

1. Plain-End, Ductile-Iron Pipe: Grooved-end, ductile-iron-pipe appurtenances; and grooved joints.
2. Stainless Steel Pipe: [**Schedule 5**][**Schedule 10**][**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF DOMESTIC WATER PIPING, GENERAL

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

E. Install domestic water piping level [**with 0.25 percent slope downward toward drain**][**without pitch**] and plumb.

F. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

P. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic-Water Pumps."

Q. Install thermometers on [**inlet and**] outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

U. Joint Construction, General:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

4. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 INSTALLATION OF COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

B. Install underground copper tube in polyethylene encasement in accordance with ASTM A674 or AWWA C105/A21.5.

C. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

D. Joint Construction:

1. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
2. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
3. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended in writing by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

4. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gauge. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
5. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
6. Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

3.5 INSTALLATION OF DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

B. Install underground ductile-iron pipe in polyethylene encasement in accordance with ASTM A674 or AWWA C105/A21.5.

C. Joint Construction:

1. Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
2. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

3.6 INSTALLATION OF STAINLESS STEEL PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Grooved-End Steel Piping: Make joints in accordance with AWWA C606. [**Square cut**][**Roll**] groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

3.7 INSTALLATION OF CPVC PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. Join in accordance with ASTM D2846/D2846M.

3.8 INSTALLATION OF PVC PIPE AND FITTINGS - DOMESTIC WATER

A. Joint Construction of Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

2. Join in accordance with ASTM D2855.

3.9 INSTALLATION OF PEX TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX tube with loop at each change of direction of more than 90 degrees.

B. Joint Construction:

1. Joints for PEX Tubing, ASTM: Join in accordance with ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
2. Joints for PEX Tubing, ASSE: Join in accordance with ASSE/ANSI 1061 for push-fit fittings.

3.10 INSTALLATION OF PEX-AL-PEX TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX-AL-PEX tubing and fittings per manufacturer instructions.

B. Joint Connection:

1. Joints PEX-AL-PEX Tubing, ASTM: Join in accordance with using approved mechanical compression, press, or crimp fittings per ASTM F1281.

3.11 INSTALLATION OF PEX-AL-HDPE TUBE AND FITTINGS - DOMESTIC WATER

A. Install PEX-AL-HDPE tubing and fittings per manufacturer instructions.

B. Joint Connections:

1. Joints for PEX-AL-HDPE Tubing: Join in accordance with manufacturer's written instructions and standard ISO/EN.

3.12 INSTALLATION OF POLYPROPYLENE PIPING AND FITTINGS - DOMESTIC WATER

A. Install Polypropylene piping and fitting per manufacturer's instructions.

B. Joint Connections:

1. Jointing Polypropylene Piping and Fittings, ASTM and ISO: Join by the use of the thermal fusion method specifically approved by the manufacturer based on ASTM F2389 and ISO 15874.

3.13 INSTALLATION OF TRANSITION FITTINGS - DOMESTIC WATER

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal

transition [**fittings**][**unions**] .

3.14 INSTALLATION OF DIELECTRIC FITTINGS - DOMESTIC WATER

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**couplings**][**couplings or nipples**][**nipples**][**unions**] .

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**] .

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.15 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Metal Tube/Pipe:

1. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of metal tube/pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Plastic Pipe:

1. Install vinyl-coated hangers with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of plastic pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. PEX Tube:

1. Install vinyl-coated hangers for PEX tube, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of PEX tube to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches (300 mm)**] of each fitting.

3.16 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for **NPS 2-1/2 (DN 65)** and larger.

3.17 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.18 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system in accordance with either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least **50 ppm (50 mg/L)** of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least **200 ppm (200 mg/L)** of chlorine. Isolate and allow to stand for three hours.

   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.19 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.20 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Polypropylene (PP-R and PP-RCT) Pipe: Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 22 11 16 00

SECTION 22 11 16 00A - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. Stainless steel pipe and fittings.
3. Fiberglass pipe and fittings.
4. Joining materials.

B. Related Requirements:

1. Section 232216 "Steam and Condensate Heating Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show steam and steam condensate piping layouts, sizes, elevations, and piping slopes, including connecting equipment, valves, special-duty valves, fittings, strainers, air vents and vacuum breakers, flash tanks, steam pressure reducing valves, steam traps, steam meters, steam condensate meters, and expansion loops/expansion joints/anchors.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 foot (1:50)**]<**Insert value**>.

C. Sustainable Design Submittals:

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.

D. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the

same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fiberglass Pipe and Fitting Installers: Installers of fiberglass pipe and fittings to be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators in accordance with the following:

1. ASME Compliance: Comply with [**ASME B31.1, "Power Piping,"**][**and**][**ASME B31.9, "Building Services Piping,"**] for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. HP Steam Piping: <**Insert psig (kPa)**>.
2. LP Steam Piping: <**Insert psig (kPa)**>.
3. LP Clean Steam Piping: <**Insert psig (kPa)**>.

4. Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.
5. Clean Steam Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.
6. Makeup-Water Piping: [**80 psig (552 kPa)**][**150 psig (1034 kPa)**]<**Insert value**> at [**150 deg F (66 deg C)**]<**Insert temperature**>.
7. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
8. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
9. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe: ASTM A312/A312M, plain ends, seamless; stainless steel of types and schedules as indicated in piping application articles.

B. Stainless Steel Socket Weld Fittings: Stainless steel, wrought or forged, of types and classes as indicated in piping application articles.

C. Stainless Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, wrought, raised face weld neck, including gaskets, bolts, and nuts of material to match pipe.

2.4 FIBERGLASS PIPE AND FITTINGS

A. Reinforced Thermosetting Resin Pressure Pipe (RTRP): ASTM D2996, Type 1, Grade 1, Class F, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. Glass-Fiber-Reinforced Thermosetting-Resin: ASTM D5685, Type 2 or Type 5, Grade 1, Class F, compression or spray-up/contact molded fittings of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D4024, Type 1, Grade 1, full-face gaskets suitable for the service, minimum **1/8 inch (3.2 mm)** thick, 60-70 durometer. ASTM A307, Grade B, hex head bolts with washers.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face flanges.
b. Narrow-Face Type: For raised-face flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel of type to match pipe unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

E. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, [**NPS 2 (DN 50) and Smaller**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, [**NPS 2-1/2 through NPS 12 (DN 65 through DN 300)**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. LP Steam Piping, [**NPS 14 through NPS 18 (DN 350 through DN 450)**]<**Insert pipe size range**>: Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. LP Steam Piping, [**NPS 20 (DN 500) and Larger**]<**Insert pipe size range**>: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

F. Condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

G. Condensate piping below grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

H. Condensate piping below grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

I. LP Clean Steam Piping:

1. LP clean steam piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be the following:

   a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; [**wrought**][**or**][**forged**], [**Class 2000**][**Class 3000**]<**Insert class**>, same type stainless steel socket weld fittings.

2. LP clean steam piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be the following:

   a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; same type stainless steel flanges and wrought stainless steel flanged fittings.

J. Clean Steam Condensate Piping:

1. Clean steam condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be the following:

   a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; [**wrought**][**or**][**forged**][**Class 2000**][**Class 3000**]<**Insert class**> same type stainless steel socket weld fittings.

2. Clean steam condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be the following:

   a. [**Schedule 40**][**Schedule 80**], [**Type 304**][**Type 316**] stainless steel pipe; same type stainless steel flanges and wrought stainless steel flanged fittings.

3.2 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, [**NPS 2 (DN 50) and Smaller**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, [**NPS 2-1/2 through NPS 12 (DN 65 through DN 300)**]<**Insert pipe size range**>: [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. HP Steam Piping, [**NPS 14 through NPS 18 (DN 350 through DN 450)**]<**Insert pipe size range**>: Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

D. HP Steam Piping, [**NPS 20 (DN 500) and Larger**]<**Insert pipe size range**>: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping above grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

   1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
   2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

F. Condensate piping above grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

   1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

G. Condensate piping below grade, [**NPS 2 (DN 50)**]<**Insert pipe size range**> and smaller, to be[**either of**] the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

H. Condensate piping below grade, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size range**> and larger, to be[**either of**] the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and Glass-Fiber-Reinforced Thermosetting-Resin pipe with adhesive or flanged joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Vacuum-Breaker Piping: Outlet, same as service where installed.

C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, **NPS 3/4 (DN 20)** full port-ball valve, and short **NPS 3/4 (DN 20)** threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using[**mechanically formed**] tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves in accordance with Section 230523 "General-Duty Valves for HVAC Piping" or other Sections as needed.

Q. Install unions in piping, [**NPS 2 (DN 50)**]<**Insert pipe size**> and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**> and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install **NPS 3/4 (DN 20)** nipple and full port ball valve in blowdown connection of strainers **NPS 2 (DN 50)** and larger. Match size of strainer blowoff connection for strainers smaller than **NPS 2 (DN 50)**.

U. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding [**300 ft. (90 m)**]<**Insert distance**>.
2. Size drip legs same size as main. In steam mains **NPS 6 (DN 150)** and larger, drip leg size can be reduced, but to no less than **NPS 4 (DN 100)**.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF STEAM AND CONDENSATE PIPING SPECIALTIES

A. Comply with requirements in Section 232216 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than **20 ft. (6 m)** long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping **20 ft. (6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping and steel steam condensate piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

G. Support vertical runs of steel steam supply piping and steel steam condensate piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections to be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.9 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping in accordance with [**ASME B31.1, "Power Piping,"**][**and**][**ASME B31.9, "Building Services Piping,"**] and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure will not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Prepare test and inspection reports.

END OF SECTION 22 11 16 00A

Task	Specification	Specification Description
22 11 16 00	21 05 00 00	Common Work Results for Fire Suppression
22 11 16 00	22 05 00 00	Common Work Results for Plumbing
22 11 16 00	22 13 16 00	Sanitary Waste And Vent Piping
22 11 16 00	22 14 13 00	Storm Drainage Piping
22 11 16 00	22 15 13 00	General-Service Compressed-Air Piping
22 11 16 00	22 63 13 00	Gas Piping For Laboratory And Healthcare Facilities
22 11 16 00	23 05 00 00	Common Work Results for HVAC
22 11 16 00	23 21 13 00	Hydronic Piping
22 11 16 00	23 23 00 00	Refrigerant Piping

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SECTION 22 11 19 00 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valve systems.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.
7. Strainers for domestic water piping.
8. Outlet boxes.
9. Hose stations.
10. Hose bibbs.
11. Wall hydrants.
12. Ground hydrants.
13. Post hydrants.
14. Roof hydrants.
15. Drain valves.
16. Water-hammer arresters.
17. Trap-seal primer device.
18. Trap-seal primer systems.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing."
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
6. Section 224700 "Drinking Fountains and Water Coolers."
7. Section 230923.18 "Leak Detection Instruments" for leak detection devices related to HVAC applications.
8. Section 331415 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

1.2 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: [**125 psig (860 kPa)**]<**Insert value**> unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Cash Acme Plumbing Products; an RWC brand**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. **<Insert manufacturer's name>**

3. Standard: ASSE 1001.
4. Size: **NPS 1/4 to NPS 3 (DN 8 to DN 80)**, as required to match connected piping.
5. Body: Bronze.
6. Inlet and Outlet Connections: Threaded.
7. Finish: [**Rough bronze**][**Chrome plated**].

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Cash Acme Plumbing Products; an RWC brand**]
   c. [**Champion-Arrowhead**]
   d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   e. [**MIFAB, Inc**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Cash Acme Plumbing Products; an RWC brand**]
   c. [**Champion-Arrowhead**]
   d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   e. [**MIFAB, Inc**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. **<Insert manufacturer's name>**

3. Standard: ASSE 1011.
4. Body: Bronze, nonremovable, with manual drain.
5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
6. Finish: [**Chrome or nickel plated**][**Rough bronze**].

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**FEBCO; A WATTS Brand**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Standard: ASSE 1020.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [**5 psig (35 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
10. Accessories:

    a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**WATTS; A Watts Water Technologies Company**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

3. Standard: ASSE 1035.
4. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)** matching faucet size.

5. Body: Bronze.
6. End Connections: Threaded.
7. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Standard: ASSE 1056.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
6. Accessories:

   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Caleffi North America**]
   c. [**Cash Acme Plumbing Products; an RWC brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Caleffi North America**]
   c. [**Cash Acme Plumbing Products; an RWC brand**]

d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Standard: ASSE 1012.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**].
6. Body: Bronze.
7. End Connections: [**Union, solder**][**Solder**] joint.
8. Finish: [**Rough bronze**]<**Insert finish**>.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Caleffi North America**]
   d. [**FEBCO; A WATTS Brand**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Caleffi North America**]
   d. [**FEBCO; A WATTS Brand**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

3. Standard: ASSE 1013.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [**12 psig (83 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for sizes **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
10. Body: [**Bronze**][**cast silicon copper alloy**][**or**][**stainless steel**] for **NPS 2 (DN 50)** and smaller; [**ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved**][**or**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
12. Configuration: Designed for [**horizontal, straight-through**][**vertical-inlet, horizontal-center-section, and vertical-outlet**][**vertical**]<**Insert configuration**> flow.
13. Accessories:

a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Standard: ASSE 1015.
4. Operation: Continuous-pressure applications unless otherwise indicated.
5. Pressure Loss: [**5 psig (35 kPa)**]<**Insert value**> maximum, through middle third of flow range.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
9. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for sizes **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
10. Body: [**Bronze**][**cast silicon copper alloy**][**or**][**stainless steel**] for **NPS 2 (DN 50)** and smaller; [**ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved**][**or**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
12. Configuration: Designed for [**horizontal, straight-through**]<**Insert configuration**> flow.
13. Accessories:

    a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1022.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)**.
6. Body: [**Stainless steel or non-metallic**]<**Insert material**>.
7. End Connections: Threaded or flare.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE 1024.
4. Operation: Continuous-pressure applications.
5. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**][**NPS 1-1/4 (DN 32)**].
6. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**WATTS; A Watts Water Technologies Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**WATTS; A Watts Water Technologies Company**]
b. <**Insert manufacturer's name**>

3. Standard: ASSE 1032.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8 (DN 8 or DN 10)**.
6. Body: Stainless steel.
7. End Connections: Threaded or flare.

G. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Woodford Manufacturing Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Woodford Manufacturing Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1052.
4. Operation: Up to **10-ft. head of water (30-kPa)** back pressure.
5. Inlet Size: **NPS 3/4 (DN 20)**.
6. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
7. Capacity: At least **3-gpm (0.19-L/s)** flow.

H. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**FEBCO; A WATTS Brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Cash Acme Plumbing Products; an RWC brand**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Standard: ASSE 1003.
4. Pressure Rating: Initial working pressure of **150 psig (1035 kPa)**.
5. Size: <**Insert NPS (DN)**>.
6. Design Flow Rate: <**Insert gpm (L/s)**>.
7. Design Inlet Pressure: <**Insert psig (kPa)**>.
8. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

9. Body: Bronze[**with chrome-plated finish**] for **NPS 2 (DN 50)** and smaller; [**bronze**][**cast iron with interior lining that complies with AWWA C550 or that is FDA approved**] for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.
10. Valves for Booster Heater Water Supply: Include integral bypass.
11. End Connections: Threaded or solder for **NPS 2 (DN 50)** and smaller; flanged or solder for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.

B. Water-Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**CLA-VAL**]
   c. [**Flomatic Valves; Flomatic Corporation**]
   d. [**IMI Hydronic Engineering Inc**]
   e. [**OCV Control Valves**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**CLA-VAL**]
   c. [**Flomatic Valves; Flomatic Corporation**]
   d. [**IMI Hydronic Engineering Inc**]
   e. [**OCV Control Valves**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

3. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
4. Pressure Rating: Initial working pressure of **150 psig (1035 kPa)** minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
5. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless steel body.

   a. Size: <**Insert NPS (DN)**>.
   b. Pattern: [**Angle**][**Globe**]-valve design.
   c. Trim: Stainless steel.

6. Design Flow: <**Insert gpm (L/s)**>.
7. Design Inlet Pressure: <**Insert psig (kPa)**>.
8. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
9. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.

2.6 AUTOMATIC WATER SHUTOFF VALVE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**FloLogic, Inc.**]
2. [**OnSite PRO Inc**]
3. [**QMI Manufacturing Inc.**]
4. [**RectorSeal Plumbing; A CSW Industrials Company**]
5. [**Reliance Detection Technologies**]
6. [**WaterCop**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**FloLogic, Inc.**]
2. [**OnSite PRO Inc**]
3. [**QMI Manufacturing Inc.**]
4. [**RectorSeal Plumbing; A CSW Industrials Company**]
5. [**Reliance Detection Technologies**]
6. [**WaterCop**]
7. <**Insert manufacturer's name**>

C. Shutoff Control Ball Valves and Actuators <**Insert drawing designation if any**>:

1. Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**][**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**]<**Insert pipe size**>.
2. Design Flow Rate: <**Insert gpm (L/s)**>.
3. Design Inlet Pressure: <**Insert psig (kPa)**>.
4. Control Valve: Two-piece, full-port brass ball valve, MSS SP-110.

    a. End Connections: Threaded, female.
    b. Fittings: One **3/8-by-1/2-inch (9.5-by-12.7-mm)** male compression and one **3/8-by-1/2-inch (9.5-by-12.7-mm)** female compression.
    c. Seats: PTFE.
    d. O-Rings: FKM.
    e. Stem: Low-lead brass. Blowout proof.
    f. CWP Rating: [**600 psig (4140 kPa)**]<**Insert value**>.

5. Manual-override control turn-knob for emergency operation of valve.
6. Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.

    a. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
    b. Manual Intervention: Allowed.
    c. Position Indicator: Standard.

7. Actuator Enclosure: Suitable for ambient conditions encountered by application.
8. Wireless Leak Detection System:

    a. Sensor-Water Flow Type: Pipe-mounted to detect water flow.
    b. Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal

conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.

c. Wireless Signal Range: **100 ft. (30.5 m)** minimum between sensors and receiver.
d. Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
e. Onboard Battery Backup: 48 hours of protection.[**Valve to close prior to backup failure.**]
f. LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
g. FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
h. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
i. Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.

1) Push-button pairing and unpairing, into and out of the network.
2) Visual indication of wireless signal strength, low battery, and lost communication.
3) Standard wall outlet, 120 V ac, power.
4) Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.

j. Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
k. Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

9. Wired Leak Detection System:

a. Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
b. Power Cord Length: [**12 ft. (3.66 m)**]<**Insert dimension**>.
c. Control Panel: LED power and LED valves indicator.
d. Alarms: Audible alarm[**, with external output**].
e. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
f. Wired Sensors:

1) Quantity Per Receiver: [**One**][**Two**][**Three**][**Four**][**Five**][**Six**].

g. Cable Length: [**8 ft. (2.44 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**>.
h. Cable Adder: [**10 ft. (3 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**> in length.

D. Shutoff Control Butterfly Valve and Actuator <**Insert drawing designation if any**>:

1. Size: [**NPS 2-1/2 (DN 65)**][**NPS 3 (DN 80)**][**NPS 4 (DN 100)**]<**Insert pipe size**>.
2. Compliance: MSS SP-67.
3. Full-port, epoxy-coated, ductile-iron lug body.
4. Seat: EPDM, **minus 30 deg F to plus 250 deg F (minus 34 deg C to plus 121 deg C)**.
5. Face-to-Face Flange: ASME B16.5 flanges.
6. Disc Design: Floating stainless steel dual shaft.
7. Disc Material: Coated ductile iron.
8. Locating Pin: Carbon steel.
9. Bushings: PTFE.
10. O-Rings: EPDM.
11. Ten-position stop.

12. Manual-override control turn-knob for emergency operation of valve.
13. Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.

    a. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
    b. Manual Intervention: Allowed.
    c. Position Indicator: Standard.

14. Actuator Enclosure: Suitable for ambient conditions encountered by application.
15. Wireless Leak Detection System:

    a. Sensor-Water Flow Type: Pipe-mounted to detect water flow.
    b. Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.
    c. Wireless Signal Range: **100 ft. (30.5 m)** minimum between sensors and receiver.
    d. Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
    e. Onboard Battery Backup: 48 hours of protection.[**Valve to close prior to backup failure.**]
    f. LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
    g. FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
    h. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
    i. Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.

        1) Push-button pairing and unpairing, into and out of the network.
        2) Visual indication of wireless signal strength, low battery, and lost communication.
        3) Standard wall outlet, 120 V ac, power.
        4) Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.

    j. Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
    k. Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

16. Wired Leak Detection System:

    a. Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
    b. Power Cord Length: [**12 ft. (3.66 m)**]<**Insert dimension**>.
    c. Control Panel: LED power and LED valves indicator.
    d. Alarms: Audible alarm[**, with external output**].
    e. Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
    f. Wired Sensors:

        1) Quantity Per Receiver: [**One**][**Two**][**Three**][**Four**][**Five**][**Six**].

    g. Cable Length: [**8 ft. (2.44 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert dimension**>.
    h. Cable Adder: [**10 ft. (3 m)**][**25 ft. (7.62 m)**][**50 ft. (15.2 m)**][**100 ft. (30.5 m)**]<**Insert**

dimension> in length.

E. Clothes Washer Shutoff Control Valve and Actuator <**Insert drawing designation if any**>:

1. Brass or stainless steel ball valve.
2. End Connections: Male hose connections, **NPS 3/4 (DN 20)**.
3. Pressure Rating: **400 psi (2758 kPa)** at **32 to 150 deg F (0 to 65.6 deg C)**.
4. Valve Actuator:

   a. Enclosure: Suitable for ambient conditions encountered by application.
   b. Power Supply: [**Battery**][**120 V ac**][**120 V ac step-down transformer**][**with cord and plug**].
   c. Position Indicator: Standard.

5. Wired Leak Detection System:

   a. Water sensor with minimum **6-ft. (1.8-m)** length of wire.
   b. 120 V ac step-down transformer with cord and plug.
   c. LED operation and leak notification.
   d. Audible alarm.
   e. Power failure or manual disconnection of power causes valves to close.

F. Accessories:

1. Electrical Plug Interrupter: Plugs into standard 120 V ac wall outlet.
2. Gas Flow Interrupter: ECO connector with female spade connectors. Factory prewired, **8 ft. (2.44 m)**.
3. Gas Interface Cable: Interface cable with male and female connectors.
4. Step-Down Transformer: [**120**][**208**][**240**] V ac to 24 V ac with mounting plate, **12-ft. (3.66-m)** plenum wire to power, and **8-ft. (2.44-m)** plenum wire to sensor.
5. Liquid Level Sensors: Monitor fluid levels in addition to detecting plumbing leaks.
6. Auto Dialer: Send and receive automatic alerts when a fault condition occurs. Standard output contacts trigger up to nine predetermined telephone number calls.

   a. Prerecord message for future playback.
   b. 10-second recordable message.
   c. Built-in tamper switch.
   d. DC adaptor with battery backup.
   e. Programmable as a silent (dialer only) or audible (siren and dialer) alarm.
   f. Easy "Stop Call Sequence" - push "#" on phone to acknowledge the alarm and stop the dialing sequence.

7. Cellular Text Notification System:

   a. Event SMS text notification to up to three cell phones.
   b. Battery Backup: Four (4) AA batteries.
   c. **12-ft. (3.66-m)** interface cable to leak detection system.
   d. Customized messaging.
   e. <**Insert wireless network service provider**>.

2.7 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bell & Gossett; a Xylem brand**]
b. [**IMI Hydronic Engineering Inc**]
c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
d. [**NIBCO INC.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bell & Gossett; a Xylem brand**]
b. [**IMI Hydronic Engineering Inc**]
c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
d. [**NIBCO INC.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

3. Type: [**Ball**][**or**][**Y-pattern globe**] valve with two readout ports and memory-setting indicator.
4. Body: [**Brass**][**or**][**bronze**].
5. Size: Same as connected piping, but not larger than **NPS 2 (DN 50)**.
6. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Caleffi North America**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]

g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. **<Insert manufacturer's name>**

3. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
4. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
5. Size: **NPS 2 (DN 50)** or smaller.
6. Body: Copper alloy.
7. Port: Standard or full port.
8. Ball: Chrome-plated brass or stainless steel.
9. Seats and Seals: Replaceable.
10. End Connections: Solder joint or threaded.
11. Handle: Vinyl-covered steel with memory-setting device.

C. Automatic Flow Control Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Caleffi North America**]
c. [**IMI Hydronic Engineering Inc**]
d. [**ThermOmegaTech**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Caleffi North America**]
c. [**IMI Hydronic Engineering Inc**]
d. [**ThermOmegaTech**]
e. **<Insert manufacturer's name>**

3. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
4. Pressure Rating: **200 psig (1380 kPa)**.
5. Size: **NPS 2 (DN 50)** or smaller.
6. Body: Stainless steel or brass.
7. Flow Cartridge: Stainless steel or antiscale polymer.
8. End Connections: Threaded or solder joint.

2.8 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]

b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Cash Acme Plumbing Products; an RWC brand**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Symmons Industries, Inc**]
g. [**Taco Comfort Solutions**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Controls; a Division of Morris Group International**]
   b. [**Acorn Engineering Company; a Division of Morris Group International**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Cash Acme Plumbing Products; an RWC brand**]
   e. [**POWERS; A Watts Water Technologies Company**]
   f. [**Symmons Industries, Inc**]
   g. [**Taco Comfort Solutions**]
   h. [**WATTS; A Watts Water Technologies Company**]
   i. [**Zurn Industries, LLC**]
   j. <**Insert manufacturer's name**>

3. Standard: ASSE 1070.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Type: Thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[**union**] inlets and outlet.
8. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Valve Finish: [**Chrome plated**][**Rough bronze**].

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Controls; a Division of Morris Group International**]
   b. [**Acorn Engineering Company; a Division of Morris Group International**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Caleffi North America**]
   e. [**Cash Acme Plumbing Products; an RWC brand**]
   f. [**Lawler Manufacturing Company, Inc**]
   g. [**POWERS; A Watts Water Technologies Company**]
   h. [**Symmons Industries, Inc**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Controls; a Division of Morris Group International**]
   b. [**Acorn Engineering Company; a Division of Morris Group International**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Caleffi North America**]
   e. [**Cash Acme Plumbing Products; an RWC brand**]
   f. [**Lawler Manufacturing Company, Inc**]
   g. [**POWERS; A Watts Water Technologies Company**]
   h. [**Symmons Industries, Inc**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

3. Standard: ASSE 1017.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Type: [**Exposed-mounted**][**Cabinet-type**], thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[**union**] inlets and outlet.
8. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: <**Insert gpm (L/s)**>.
12. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
13. Valve Finish: [**Chrome plated**][**Polished, chrome plated**][**Rough bronze**].
14. Piping Finish: [**Chrome plated**][**Copper**].
15. Cabinet: Factory fabricated, stainless steel, for [**recessed**][**surface**] mounting and with hinged, stainless steel door.

C. Primary, Electronic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Controls; a Division of Morris Group International**]
   b. [**Acorn Engineering Company; a Division of Morris Group International**]
   c. [**Caleffi North America**]
   d. [**Leonard Valve Company**]
   e. [**POWERS; A Watts Water Technologies Company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Controls; a Division of Morris Group International**]
   b. [**Acorn Engineering Company; a Division of Morris Group International**]
   c. [**Caleffi North America**]
   d. [**Leonard Valve Company**]
   e. [**POWERS; A Watts Water Technologies Company**]
   f. <**Insert manufacturer's name**>

3. Standard: ASSE 1017.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Type: Exposed, electronically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded or solder joint inlets and outlet.
8. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: <**Insert gpm (L/s)**>.
12. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
13. Valve Finish: Bronze.
14. Digital temperature control and monitoring module.

    a. Controls temperature within plus or minus **2 deg F (1 deg C)**.
    b. User programmable at module or through BAS.
    c. ASHRAE 188 compliance.
    d. Local and remote monitoring.
    e. [**BACNet**][**Modbus**][**Metasys**][**Ethernet**] protocol language(s).
    f. [**115**][**230**] V ac, 60 Hz.
    g. Battery backup.

D. Manifold, Thermostatic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**POWERS; A Watts Water Technologies Company**]
    c. [**Symmons Industries, Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**POWERS; A Watts Water Technologies Company**]
    c. [**Symmons Industries, Inc**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, [**cabinet-type**][**exposed-mounted**], thermostatically controlled, water mixing valve assembly in [**two**][**three**]-valve parallel arrangement.
4. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
5. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
6. Small-Flow Parallel: Thermostatic, water mixing valve.
7. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
8. Water Regulator(s): Comply with ASSE 1003. Include pressure gauge on inlet and outlet.

9. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
10. Cabinet: Factory fabricated, stainless steel, for [**recessed**][**surface**] mounting and with hinged, stainless steel door.
11. Selected Large-Flow, Tempered-Water Valve Size: <**Insert size**>.
12. Tempered-Water Setting: <**Insert deg F (deg C)**>.
13. Unit Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
14. Unit Minimum Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
15. Selected Unit Flow Rate at **45-psig (310-kPa)** Pressure Drop: <**Insert gpm (L/s)**>.
16. Unit Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
17. Unit Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
18. Unit Hot- and Cold-Water Inlet Size: <**Insert NPS (DN)**> end connections.
19. Thermostatic Mixing Valve and Water Regulator Finish: [**Chrome plated**][**Polished, chrome plated**][**Rough bronze**].
20. Piping Finish: [**Chrome plated**][**Copper**].

E. Photographic-Process, Thermostatic, Water Mixing Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**POWERS; A Watts Water Technologies Company**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**POWERS; A Watts Water Technologies Company**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. <**Insert manufacturer's name**>

3. Standard: ASSE 1017, thermostatically controlled, water mixing valve made for precise, process-water temperature control.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
8. Cabinet: Factory fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
12. Hot- and Cold-Water Inlet Size: <**Insert NPS (DN)**> end connections.

F. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Controls; a Division of Morris Group International**]

b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Caleffi North America**]
d. [**Lawler Manufacturing Company, Inc**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Acorn Engineering Company; a Division of Morris Group International**]
c. [**Caleffi North America**]
d. [**Lawler Manufacturing Company, Inc**]
e. [**POWERS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body with corrosion-resistant interior components.
6. Temperature Control: Adjustable.
7. Connections: Threaded inlets and outlet.
8. Finish: Chrome plated.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.

G. Primary Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Heat-Timer Corporation**]
c. [**Holby Valve Inc.**]
d. [**WATTS; A Watts Water Technologies Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Controls; a Division of Morris Group International**]
b. [**Heat-Timer Corporation**]
c. [**Holby Valve Inc.**]
d. [**WATTS; A Watts Water Technologies Company**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
4. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
5. Material: Bronze body.

6. Temperature Control: Manual.
7. Connections: Threaded inlets and outlet.
8. Selected Primary Water Tempering Valve Size: <**Insert size**>.
9. Tempered-Water Setting: <**Insert deg F (deg C)**>.
10. Tempered-Water Design Flow Rate: <**Insert gpm (L/s)**>.
11. Pressure Drop at Design Flow Rate: <**Insert psig (kPa)**>.
12. Tempered-Water Outlet Size: <**Insert NPS (DN)**> end connection.
13. Cold-Water Inlet Size: <**Insert NPS (DN)**> end connection.
14. Hot-Water Inlet Size: <**Insert NPS (DN)**> end connection.
15. Valve Finish: [**Rough bronze**]<**Insert finish**>.

2.9 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Caleffi North America**]
   b. [**Keckley Company**]
   c. [**Titan Flow Control, Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Caleffi North America**]
   b. [**Keckley Company**]
   c. [**Titan Flow Control, Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
4. Body: Bronze for **NPS 2 (DN 50)** and smaller; cast iron[**with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and**] for **NPS 2-1/2 (DN 65)** and larger.
5. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 (DN 65)** and larger.
6. Screen: Stainless steel with round perforations unless otherwise indicated.
7. Perforation Size:

   a. Strainers NPS 2 (DN 50) and Smaller: [**0.020 inch (0.51 mm)**][**0.033 inch (0.84 mm)**][**0.062 inch (1.57 mm)**]<**Insert dimension**>.
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**0.045 inch (1.14 mm)**][**0.062 inch (1.57 mm)**][**0.125 inch (3.18 mm)**]<**Insert dimension**>.
   c. Strainers NPS 5 (DN 125) and Larger: [**0.10 inch (2.54 mm)**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.

8. Drain: [**Pipe plug**][**Factory-installed, hose-end drain valve**].

2.10 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**Guy Gray, IPS Corporation**]
   c. [**LSP Products Group**]
   d. [**Oatey Co.**]
   e. [**Sioux Chief Manufacturing Company, Inc.**]
   f. [**Symmons Industries, Inc**]
   g. [**Water-Tite, IPS Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**Guy Gray, IPS Corporation**]
   c. [**LSP Products Group**]
   d. [**Oatey Co.**]
   e. [**Sioux Chief Manufacturing Company, Inc.**]
   f. [**Symmons Industries, Inc**]
   g. [**Water-Tite, IPS Corporation**]
   h. <**Insert manufacturer's name**>

3. Mounting: Recessed.[**Fire rated.**]
4. Material and Finish: [**Enameled-steel or epoxy-painted-steel**][**Enameled-steel, epoxy-painted-steel, or plastic**][**Plastic**][**Stainless steel**] box and faceplate.
5. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
6. Drain Outlet Connection: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
7. Accessory: Water hammer arresters.
8. Supply Shutoff Fittings: **NPS 1/2 (DN 15)** gate, globe, or ball valves and **NPS 1/2 (DN 15)** copper, water tubing.
9. Drain: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] standpipe and P-trap for direct waste connection to drainage piping.
10. Inlet Hoses: Two **60-inch- (1500-mm-)** long, rubber, household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
11. Drain Hose: One **48-inch- (1200-mm-)** long, rubber, household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Guy Gray, IPS Corporation**]

b. [**LSP Products Group**]
c. [**Oatey Co.**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Water-Tite, IPS Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Guy Gray, IPS Corporation**]
b. [**LSP Products Group**]
c. [**Oatey Co.**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Water-Tite, IPS Corporation**]
f. <**Insert manufacturer's name**>

3. Mounting: Recessed.[**Fire rated.**]
4. Material and Finish: [**Enameled-steel or epoxy-painted-steel**][**Enameled-steel, epoxy-painted-steel, or plastic**][**Plastic**][**Stainless steel**] box and faceplate.
5. Faucet: Valved fitting complying with ASME A112.18.1. Include **NPS 1/2 (DN 15)** or smaller copper tube outlet.
6. Accessory: Water hammer arrestor.
7. Supply Shutoff Fitting: **NPS 1/2 (DN 15)** gate, globe, or ball valve and **NPS 1/2 (DN 15)** copper, water tubing.

2.11 HOSE STATIONS

A. Single-Temperature-Water Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARCHON Industries, Inc**]
b. [**Armstrong International, Inc**]
c. [**DynaFluid Ltd.**]
d. [**Strahman Valves, Inc**]
e. [**T&S Brass and Bronze Works, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARCHON Industries, Inc**]
b. [**Armstrong International, Inc**]
c. [**DynaFluid Ltd.**]
d. [**Strahman Valves, Inc**]
e. [**T&S Brass and Bronze Works, Inc.**]
f. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Cabinet: Stainless steel enclosure with exposed valve handle, hose connection, and hose rack.

Include thermometer in front.
5. Hose-Rack Material: Stainless steel.
6. Body Material: Bronze[**with stainless steel wetted parts**].
7. Body Finish: Rough bronze[**, chrome plated**].
8. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
9. Supply Fittings: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valve and check valve and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valve if check stop is included with fitting.
10. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
11. Nozzle: With hand-squeeze, on-off control.
12. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

B. Hot- and Cold-Water Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**Cooney Brothers, Inc**]
    d. [**DynaFluid Ltd.**]
    e. [**Strahman Valves, Inc**]
    f. [**T&S Brass and Bronze Works, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARCHON Industries, Inc**]
    b. [**Armstrong International, Inc**]
    c. [**Cooney Brothers, Inc**]
    d. [**DynaFluid Ltd.**]
    e. [**Strahman Valves, Inc**]
    f. [**T&S Brass and Bronze Works, Inc.**]
    g. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Faucet Type: [**Blending**][**Thermostatic mixing**] valve.
5. Cabinet: Stainless steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
6. Hose-Rack Material: Stainless steel.
7. Body Material: Bronze[**with stainless steel wetted parts**].
8. Body Finish: Rough bronze[**or chrome plated**].
9. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
10. Supply Fittings: Two [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valves and check valves and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valves if check stops are included with fitting.

11. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
12. Nozzle: With hand-squeeze, on-off control.
13. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Cold-Water and Steam Hose Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARCHON Industries, Inc**]
   b. [**Armstrong International, Inc**]
   c. [**DynaFluid Ltd.**]
   d. [**Strahman Valves, Inc**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARCHON Industries, Inc**]
   b. [**Armstrong International, Inc**]
   c. [**DynaFluid Ltd.**]
   d. [**Strahman Valves, Inc**]
   e. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1.
4. Faucet Type: [**Blending**][**Thermostatic mixing**] valve.
5. Cabinet: Stainless steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
6. Hose-Rack Material: Stainless steel.
7. Body Material: Bronze[**with stainless steel wetted parts**].
8. Body Finish: Rough bronze[**or chrome plated**].
9. Mounting: [**Wall, with reinforcement**][**Floor, with stainless steel pedestal**].
10. Supply Fittings: Two [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] gate, globe, or ball valves and check valves and [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper, water tubing. Omit check valves if check stops are included with fitting.
11. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [**25 ft. (7.6 m)**][**50 ft. (15 m)**]<**Insert dimension**> long.
12. Nozzle: With hand-squeeze, on-off control.
13. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Prier Products, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1 for sediment faucets.
4. Body Material: Bronze.
5. Seat: Bronze, replaceable.
6. Supply Connections: **NPS 1/2 or NPS 3/4 (DN 15 or DN 20)** threaded or solder-joint inlet.
7. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
8. Pressure Rating: **125 psig (860 kPa)**.
9. Vacuum Breaker: Integral[**or field-installation,**] nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
10. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
11. Finish for Service Areas: [**Rough bronze**][**Chrome or nickel plated**].
12. Finish for Finished Rooms: Chrome or nickel plated.
13. Operation for Equipment Rooms: Wheel handle or operating key.
14. Operation for Service Areas: [**Wheel handle**][**Operating key**].
15. Operation for Finished Rooms: [**Wheel handle**][**Operating key**].
16. Include operating key with each operating-key hose bibb.
17. Include[**integral**] wall flange with each chrome- or nickel-plated hose bibb.

2.13 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]

c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
8. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Box: Deep, flush mounted with cover.
10. Box and Cover Finish: [**Polished nickel bronze**][**Rough bronze**]<**Insert finish**>.
11. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
12. Nozzle and Wall-Plate Finish: [**Polished nickel bronze**][**Rough bronze**][**Chrome plated**]<**Insert finish**>.
13. Operating Keys(s): [**One**][**Two**] with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Murdock Manufacturing; A Division of Morris Group International**]
e. [**Prier Products, Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Woodford Manufacturing Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
7. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
8. Outlet: Concealed.
9. Box: Deep, flush mounted with cover.
10. Box and Cover Finish: [**Polished nickel bronze**][**Chrome plated**]<**Insert finish**>.
11. Vacuum Breaker:

    a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

12. Operating Key(s): [**One**][**Two**] with each wall hydrant.

C. Moderate-Climate Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**MIFAB, Inc**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Prier Products, Inc.**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Woodford Manufacturing Company**]
    g. [**Zurn Industries, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**MIFAB, Inc**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Prier Products, Inc.**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Woodford Manufacturing Company**]
    g. [**Zurn Industries, LLC**]

h. **<Insert manufacturer's name>**

3. Standard: ASME A112.21.3M for [**concealed**][**exposed**]-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig (860 kPa)**.
5. Operation: Loose key.
6. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)**.
7. Outlet, Concealed:

   a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: [**Polished nickel bronze**][**Chrome plated**]**<Insert finish>**.
10. Outlet, Exposed:

    a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7.

11. Nozzle and Wall-Plate Finish: [**Polished nickel bronze**][**Rough bronze**]**<Insert finish>**.
12. Operating Key(s): [**One**][**Two**] with each wall hydrant.

D. Nonfreeze Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Champion-Arrowhead**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Woodford Manufacturing Company**]
   g. [**Zurn Industries, LLC**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Champion-Arrowhead**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Woodford Manufacturing Company**]
   g. [**Zurn Industries, LLC**]
   h. **<Insert manufacturer's name>**

3. Standard: ASSE 1019, Type A or Type B.
4. Type: Automatic draining with integral air-inlet valve.
5. Classification: [**Type A, for automatic draining with hose removed or**]Type B, for automatic draining with hose removed or with hose attached and nozzle closed.

6. Pressure Rating: **125 psig (860 kPa)**.
7. Operation: [**Loose key**][**or**][**wheel handle**].
8. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
9. Inlet: **NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**.
10. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.14 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, concealed-outlet ground hydrant with box.
5. Operation: Loose key.
6. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
7. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Box: [**Standard**][**Deep**] pattern with cover.
11. Box and Cover Finish: [**Rough**][**Polished nickel**]<**Insert finish**> bronze.
12. Operating Key(s): [**One**][**Two**] with each ground hydrant.
13. Vacuum Breaker: ASSE 1011.

2.15 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Prier Products, Inc.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Woodford Manufacturing Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, exposed-outlet post hydrant.
5. Operation: Loose key.
6. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
7. Casing: Bronze with casing guard.
8. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
9. Outlet: Garden-hose thread complying with ASME B1.20.7.
10. Drain: Designed with hole to drain into ground when shut off.
11. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

12. Operating Key(s): [**One**][**Two**] with each loose-key-operation wall hydrant.

B. Nonfreeze Sanitary Yard Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hoeptner Products**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Woodford Manufacturing Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hoeptner Products**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. [**Murdock Manufacturing; A Division of Morris Group International**]
   d. [**Woodford Manufacturing Company**]
   e. <**Insert manufacturer's name**>

3. Standard: ASSE 1057.
4. Operation: Wheel handle or lever.
5. Head: Cast iron or brass, with pail hook.
6. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25)** threaded.
7. Length: As required for burial of valve and canister below frost line.
8. Canister: [**Stainless steel**]<**Insert material**>.
9. Vacuum Breaker:

   a. Removable hose-connection backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.16 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Roof Hydrants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**MIFAB, Inc**]
   c. [**Murdock Manufacturing; A Division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Woodford Manufacturing Company**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**MIFAB, Inc**]
   c. [**Murdock Manufacturing; A Division of Morris Group International**]
   d. [**Prier Products, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]

f. [**Woodford Manufacturing Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Standard: ASME A112.21.3M.
4. Type: Nonfreeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
5. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
6. Inlet: [**NPS 3/4 (DN 20)**]<**Insert pipe size**>.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Vacuum Breaker:

   a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.17 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: ASTM B62 bronze.
5. Inlet: **NPS 3/4 (DN 20)** threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: **200-psig (1380-kPa)** minimum CWP or Class 125.
3. Size: **NPS 3/4 (DN 20)**.
4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: **NPS 1/8 (DN 6)** side outlet with cap.

2.18 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMTROL, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Precision Plumbing Products**]
f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMTROL, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Precision Plumbing Products**]
f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: [**Metal bellows**][**Piston**][**Diaphragm**].
5. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.19 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Precision Plumbing Products**]
e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Precision Plumbing Products**]
e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Standard: ASSE 1018.
4. Pressure Rating: **125 psig (860 kPa)** minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: **NPS 1/2 (DN 15)** threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: **NPS 1/2 (DN 15)** threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Precision Plumbing Products**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**MIFAB, Inc**]
c. [**Precision Plumbing Products**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Standard: ASSE 1044, lavatory P-trap with **NPS 3/8 (DN 10)** minimum, trap makeup connection.
4. Size: **NPS 1-1/4 (DN 32)** minimum.
5. Material: Chrome-plated, cast brass.

2.20 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Precision Plumbing Products**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Precision Plumbing Products**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1044.
4. Inlet Size: **NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B)**; copper, water tubing.
5. Cabinet: [**Recessed**][**Surface**]-mounted steel box with stainless steel cover.
6. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

7. Vacuum Breaker: ASSE 1001.
8. Number Outlets: [**Four**][**Six**][**Eight**]<**Insert number**>.
9. Size Outlets: [**NPS 1/2 (DN 15)**][**NPS 5/8 (DN 18)**].

2.21 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Flex-Hose Co., Inc**]
2. [**Mason Industries, Inc.**]
3. [**Metraflex Company (The)**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Flex-Hose Co., Inc**]
2. [**Mason Industries, Inc.**]
3. [**Metraflex Company (The)**]
4. <**Insert manufacturer's name**>

C. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**].
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

D. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**].
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.22 WATER METERS

A. Displacement-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Master Meter, Inc**]
d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
e. [**Neptune Technology Group Inc.**]
f. [**Niagara Meters**]
g. [**Sensus; a Xylem brand**]
h. <**Insert manufacturer's name**>

3. Standard: AWWA C700.
4. Pressure Rating: **150-psig (1035-kPa)** working pressure.
5. Body Design: Nutating disc; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Stainless steel**].
8. End Connections: Threaded or flanged.

B. Turbine-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
d. [**Neptune Technology Group Inc.**]
e. [**Niagara Meters**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Carlon Meter**]
c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
d. [**Neptune Technology Group Inc.**]
e. [**Niagara Meters**]
f. <**Insert manufacturer's name**>

3. Standard: AWWA C701.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**> working pressure.
5. Body Design: Turbine; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Epoxy-coated cast iron**].
8. End Connections: Threaded or flanged.

C. Compound-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. [**Sensus; a Xylem brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]

c. [**Neptune Technology Group Inc.**]
d. [**Sensus; a Xylem brand**]
e. <**Insert manufacturer's name**>

3. Standard: AWWA C702.
4. Pressure Rating: **150-psig (1035-kPa)** working pressure.
5. Body Design: With integral mainline and bypass meters; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

   a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

      1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Coated ductile iron**].
8. End Connections: Flanged.

D. Ultrasonic-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**Master Meter, Inc**]
   c. [**Neptune Technology Group Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**Master Meter, Inc**]
   c. [**Neptune Technology Group Inc.**]
   d. <**Insert manufacturer's name**>

3. Standard: Applicable portions of AWWA C700.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**> working pressure.
5. Body Design: Ultrasonic open flow tube; totalization meter.
6. Registration: In **gallons (liters)** or **cubic feet (cubic meters)** as required by utility company.

   a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

      1) System to be capable of transmitting data using AMR/AMI technology.

7. Case: [**Bronze**][**Stainless steel**][**Engineered polymer**][**Epoxy-coated ductile iron**].
8. End Connections: Threaded or flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves[**and bypass with memory-stop balancing valve**]. Install pressure gauges on inlet and outlet.

C. Water Control Valves: Install with inlet and outlet shutoff valves[**and bypass with globe valve**]. Install pressure gauges on inlet and outlet.

D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.

E. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Y-Pattern Strainers: For water, install on supply side of each [**control valve**][**water pressure-reducing valve**][**solenoid valve**][**and**][**pump**].

H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install **1-1/2-by-3-1/2-inch (38-by-89-mm)** fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

I. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install **1-1/2-by-3-1/2-inch (38-by-89-mm)** fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

J. Ground Hydrants: Install with [**1 cu. yd. (0.75 cu. m)**]<**Insert dimension**> of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Nonfreeze, Draining-Type Post Hydrants: Install with [**1 cu. yd. (0.75 cu. m)**]<**Insert dimension**> of crushed gravel around drain hole. Set post hydrants in concrete paving or in [**1 cu. ft. (0.03 cu. m)**]<**Insert dimension**> of concrete block at grade.

L. Nonfreeze, Nondraining-Type Post Hydrants: Set in concrete or pavement.

M. Nonfreeze, Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.

N. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

O. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

P. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

Q. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

R. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valve systems.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.

7. Outlet boxes.
8. Hose stations.
9. Wall hydrants.
10. Ground hydrants.
11. Post hydrants.
12. Roof hydrants.
13. Trap-seal primer device.
14. Trap-seal primer systems.
15. Water meters.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each [**pressure vacuum breaker**][**reduced-pressure-principle backflow preventer**][**double-check, backflow-prevention assembly**][**and**][**double-check, detector-assembly backflow preventer**]<**Insert type**> in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Test each [**pressure vacuum breaker**][**reduced-pressure-principle backflow preventer**][**double-check, backflow-prevention assembly**][**and**][**double-check, detector-assembly backflow preventer**]<**Insert type**> according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 22 11 19 00

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Task	Specification	Specification Description
22 11 19 00	21 05 00 00	Common Work Results for Fire Suppression
22 11 19 00	22 05 00 00	Common Work Results for Plumbing
22 11 19 00	23 05 00 00	Common Work Results for HVAC
22 11 19 00	22 11 16 00a	Steam And Condensate Piping
22 11 19 00	23 43 00 00	Electronic Air Cleaners

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SECTION 22 11 23 13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Constant-speed packaged booster pump, simplex.
2. Constant-speed packaged booster pump, multiplex.
3. Variable-speed packaged booster pump, simplex.
4. Variable-speed packaged booster pump, multiplex.

B. Related Requirements:

1. Section 221123.21 "Inline, Domestic-Water Pumps" for domestic-water circulation pumps.
2. Section 221223.11 "Facility Indoor Potable-Water Storage Tanks" for separate hydropneumatic domestic-water tanks for multiplex booster pumps.

1.2 DEFINITIONS

A. Domestic-water packaged booster pump assembly: Factory fabricated, assembled, and tested assembly of booster pumps, connecting piping, valves, controls, and electrical components mounted on a base.

B. PID: Proportional Integral Derivative.

C. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Construction details, material descriptions, and dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For packaged booster pumps.

1. Shop Drawing Scale: [**1/4 inch per foot (1:50)**].
2. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Provide design calculations for selecting vibration isolators [**and seismic**

restraints] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which domestic-water packaged booster pump assembly is shown and coordinated with other installations, using input from installers of the items involved.

B. Seismic Qualification Certificates: For booster pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Limitation Reports: For factory testing of equipment.

D. Field Quality Control Reports: For specified tests and inspections.

E. Qualification Statements: For testing agency and factory-authorized service representative.

F. Delegated Design Engineer Qualifications: For domestic-water packaged booster pump assembly restraint and anchor design.

G. Sample Warranty: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged booster pumps.

1. Indicate the actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**, from the same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer to perform [**manufacturer's field services**][**and**][**startup services**][**and**][**demonstration services**] .

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type

indicated.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage and handling.

1.10 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace packaged booster pump components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**One**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic-water packaged booster pumps intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF/ANSI 61 and NSF/ANSI/CAN 372, or be certified in compliance with NSF/ANSI 61 and NSF/ANSI/CAN 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Seismic Performance: Domestic-water packaged booster pumps are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means that "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

C. Delegated Design: Design restraints and anchors for domestic-water packaged booster pump assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.2 CONSTANT-SPEED PACKAGED BOOSTER PUMP

A. Constant-Speed Packaged Booster Pump, Simplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advanced Mechanical Technologies**]
   b. [**Canariis Corporation**]
   c. [**Delta P Carver**]
   d. [**Metropolitan Industries, Inc**]
   e. [**Thrush Co. Inc.**]
   f. [**TIGERFLOW Systems, Inc.**]

2. Source Limitations: Obtain constant-speed packaged booster pumps from single manufacturer.
3. Description: Simplex, constant-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

   a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

   a. ASME Compliance: Comply with ASME B31.9 for piping.
   b. UL 508, "Industrial Control Equipment."
   c. UL 508A, "Industrial Control Panels."
   d. UL 778, "Motor-Operated Water Pumps."
   e. UL 1995, "Heating and Cooling Equipment."

5. Pump:

   a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
   c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   e. Seal: Mechanical.
   f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Motor: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
7. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
8. Valves:

   a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in pump suction and discharge piping.
   b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in pump suction and discharge piping.

c. Check Valve NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in pump discharge piping.
d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
e. Control Valve with Separate Check Valve: Adjustable, automatic, [**pilot-operated**][**direct-acting**] , pressure-reducing type in pump discharge piping.

f. Control Valve: Combination adjustable, automatic, [**pilot-operated**][**direct-acting**] pressure-reducing-and-check type in pump discharge piping.
g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

9. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
10. Hydropneumatic Tank: Precharged [**, ASME-construction,**] diaphragm or bladder tank made of materials complying with NSF/ANSI 61 and NSF/ANSI/CAN 372.
11. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for single-pump, constant-speed operation, with load control and protection functions.

a. Control Logic: [**Electromechanical system with switches, relays**][**Solid-state system with transducers, programmable microprocessor**] , and other devices in the controller.

b. Motor Controller, General Purpose: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

c. Motor Controller, Solid State: NEMA ICS 2, solid-state, reduced-voltage type.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

d. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Type 12**].
e. Motor Overload Protection: Overload relay in each phase.
f. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

g. Pump Operation: [**Current-**][**pressure-**] sensing method.

1) Time Delay: Controls pump on-off operation; adjustable from [**1 to 300**] seconds.

h. Instrumentation: Suction and discharge pressure gauges.
i. Light: Running light for pump.
j. Thermal-bleed cutoff.
k. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

l. High-suction-pressure cutout.
m. Low-discharge-pressure cutout.
n. High-discharge-pressure cutout.
o. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of pump.
2) Alarm status.

12. Base: Structural steel.

13. Capacities and Characteristics:

a. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**].
b. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**] V.
2) Phases: [**Single**][**Three**] .
3) Hertz: [**60**] Hz.

c. Hydropneumatic Tank:

1) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].

B. Constant-Speed Packaged Booster Pump, Multiplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advanced Mechanical Technologies**]
b. [**Canariis Corporation**]
c. [**Metropolitan Industries, Inc**]
d. [**SyncroFlo, Inc.**]
e. [**Thrush Co. Inc.**]
f. [**TIGERFLOW Systems, Inc.**]

2. Source Limitations: Obtain constant-speed packaged booster pumps from single manufacturer.
3. Description: Multiplex, constant-speed factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

a. ASME Compliance: Comply with ASME B31.9 for piping.
b. UL 508, "Industrial Control Equipment."
c. UL 508A, "Industrial Control Panels."
d. UL 778, "Motor-Operated Water Pumps."
e. UL 1995, "Heating and Cooling Equipment."

5. Pumps, End Suction, Close Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Pumps, End Suction, Frame Mounted, Separately Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction,

frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. [**Include back-pullout design.**]

b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.
g. Coupling: Flexible, with metal guard.

7. Pumps, In Line, Single Stage:

a. Type: In line, single stage as defined in ANSI/HI 14.1-14.2 and HI 14.3 for in-line, close-coupled, single-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.

8. Pumps, Vertical, Multistage:

a. Type: Vertical, multistage as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for in-line, separately coupled, multistage, overhung-impeller, centrifugal pump.
b. Casing: Cast-iron or steel base and stainless steel chamber.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft: Stainless steel.
e. Seal: Mechanical.
f. Bearing: Water-lubricated sleeve type.

9. Pumps, Vertical, Turbine, Can:

a. Type: Vertical turbine, can, as defined in ANSI/HI 14.1-14.2 for in-line, barrel or can, lineshaft, vertical turbine pump.
b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
c. Bowls: [**Epoxy-coated cast iron**][**Cast iron**].
d. Shaft: Stainless steel.
e. Seals: Mechanical and stuffing-box types.
f. Bearings: Water-lubricated bushing type.

10. Motors: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings. Select motors that will not overload through full range of pump performance curve.
11. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
12. Valves:

a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in each pump's suction and discharge piping.
b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in each pump's suction and discharge piping [**and in inlet and outlet headers**] .
c. Check Valves NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in each pump's discharge piping.
d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.

e. Control Valves with Separate Check Valve: Adjustable, automatic, [**pilot-operated**][**direct-acting**] , pressure-reducing type in each pump's discharge piping.

f. Control Valves: Combination adjustable, automatic, [**pilot-operated**][**direct-acting**] pressure-reducing-and-check type in each pump's discharge piping.
g. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

13. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
14. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, constant-speed operation, with load control and protection functions.

a. Control Logic: [**Electromechanical system with switches, relays**][**Solid-state system with transducers, programmable microprocessor**] , and other devices in the controller.

b. Motor Controller, General Purpose: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

c. Motor Controller, Solid State: NEMA ICS 2, solid-state, reduced-voltage type.

1) Control Voltage: [**24**][**120**] V ac, with integral control-power transformer.

d. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Type 12**].
e. Motor Overload Protection: Overload relay in each phase.
f. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
2) Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.

g. Pump Operation and Sequencing: [**Current-**][**pressure-**] sensing method.

1) Time Delay: Controls pump on-off operation; adjustable from [**1 to 300**] seconds.

h. Instrumentation: Suction and discharge pressure gauges.
i. Lights: Running light for each pump.
j. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from [**1 to 300**] seconds, with [**automatic**][**manual**] reset.

k. Thermal-bleed cutoff.
l. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

m. High-suction-pressure cutout.
n. Low-discharge-pressure cutout.
o. High-discharge-pressure cutout.
p. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct-Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

15. Base: Structural steel.

16. Capacities and Characteristics:

a. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

b. Lag Pumps: Each of [**two**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

2.3 VARIABLE-SPEED PACKAGED BOOSTER PUMP

A. Variable-Speed Packaged Booster Pump, Simplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advanced Mechanical Technologies**]
b. [**Canariis Corporation**]
c. [**Delta P Carver**]
d. [**QuantumFlo, Inc.**]
e. [**Taco Comfort Solutions**]
f. [**TIGERFLOW Systems, Inc.**]
g. [**Xylem**]

2. Source Limitations: Obtain variable-speed packaged booster pumps from single manufacturer.
3. Description: Simplex, variable-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

a. ASME Compliance: Comply with ASME B31.9 for piping.
b. UL 508, "Industrial Control Equipment."
c. UL 508A, "Industrial Control Panels."
d. UL 778, "Motor-Operated Water Pumps."

e. UL 1995, "Heating and Cooling Equipment."

5. Pump:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Motor: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
7. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and pump**][**Galvanized-steel pipe and cast-iron fittings**] .
8. Valves:

a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in pump suction and discharge piping.
b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in pump suction and discharge piping.
c. Check Valve NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in pump discharge piping.
d. Check Valve NPS 2-1/2 (DN 65) and Larger: Silent type in pump discharge piping.
e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

9. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
10. Hydropneumatic Tank: Precharged [**, ASME-construction,**] diaphragm or bladder tank made of materials complying with NSF/ANSI 61 and NSF/ANSI/CAN 372.

11. VFC Specified in Other Section: Comply with Section 262923 "Variable-Frequency Motor Controllers."
12. VFC: Serving each pump in pump array.

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**] for [**Design A and Design B**][**inverter-duty**] motors.
b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**] ; maximum voltage equals input voltage.
c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [**0.1 to 999.9**] seconds.
d) Deceleration: [**0.1 to 999.9**] seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.

b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) VFC and motor overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) PID control interface.
8) DDC System for HVAC Protocols for Network Communications: [**ASHRAE 135**].

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**] .
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors [**and isolating switch**] .
b) Three-contactor style, with bypass and input and output isolating contactors [**and isolating switch**] .

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**] type.

f. Instrumentation: Suction and discharge pressure gauges.
g. Light: Running light for pump.
h. Thermal-bleed cutoff.
i. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

j. High-suction-pressure cutout.
k. Low-discharge-pressure cutout.
l. High-discharge-pressure cutout.
m. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

13. Base: Structural steel.

14. Capacities and Characteristics:

    a. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**].
    b. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**] V.
        2) Phases: [**Single**][**Three**] .
        3) Hertz: [**60**] Hz.

    c. Hydropneumatic Tank:

        1) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].

B. Variable-Speed Packaged Booster Pump, Multiplex:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advanced Mechanical Technologies**]
    b. [**Armstrong Fluid Technology**]
    c. [**Canariis Corporation**]
    d. [**Delta P Carver**]
    e. [**Flo Fab Inc**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Patterson Pump Company; a Gorman-Rupp company**]
    h. [**QuantumFlo, Inc.**]
    i. [**SyncroFlo, Inc.**]
    j. [**Taco Comfort Solutions**]
    k. [**Thrush Co. Inc.**]
    l. [**TIGERFLOW Systems, Inc.**]
    m. [**Xylem**]

2. Source Limitations: Obtain variable-speed packaged booster pumps from single manufacturer.
3. Description: Multiplex, variable-speed factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

    a. Booster pump to be listed and labeled as a packaged pumping system by a testing agency acceptable to authorities having jurisdiction.

4. Standards:

    a. ASME Compliance: Comply with ASME B31.9 for piping.
    b. UL 508, "Industrial Control Equipment."
    c. UL 508A, "Industrial Control Panels."
    d. UL 778, "Motor-Operated Water Pumps."
    e. UL 1995, "Heating and Cooling Equipment."

5. Pumps, End Suction, Close Coupled:

    a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.

b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted [**horizontally**][**vertically**] .

6. Pumps, End Suction, Frame Mounted, Separately Coupled:

a. Type: End suction as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. [**Include back-pullout design.**]
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.
g. Coupling: Flexible, with metal guard.

7. Pumps, In Line, Single Stage:

a. Type: In line, single stage as defined in ANSI/HI 14.1-14.2 and ANSI/HI 14.3 for in-line, close-coupled, single stage overhung-impeller, centrifugal pump.
b. Casing: Radially split; [**bronze**][**cast iron**][**stainless steel**] .
c. Impeller: Closed, [**ASTM B584 cast bronze**][**stainless steel**]; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Stainless steel [**or steel**] shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.
f. Bearing: [**Grease-lubricated**][**pre-greased, permanently shielded**] ball type.

8. Pumps, Vertical, Multistage:

a. Type: Vertical, multistage as defined in ANSI/HI 14.1-14.2 and ANSIHI 14.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
b. Casing: Cast-iron or steel base and stainless steel chamber.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft: Stainless steel.
e. Seal: Mechanical.
f. Bearing: Water-lubricated sleeve type.

9. Pumps, Vertical, Turbine, Can:

a. Type: Vertical turbine, can, as defined in ANSI/HI 14.1-14.2 for in-line, barrel or can, lineshaft, vertical pump.
b. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
c. Bowls: [**Epoxy-coated cast iron**][**Cast iron**].
d. Shaft: Stainless steel.
e. Seals: Mechanical and stuffing-box types.
f. Bearings: Water-lubricated bushing type.

10. Motors: Single speed, with [**grease-lubricated**][**pre-greased, permanently shielded**] , ball-bearings. Select motors that will not overload through full range of pump performance curve.
11. Piping: [**Copper tube and copper fittings**][**Stainless steel pipe and fittings**][**Stainless steel pipe and fitting headers and copper tube and copper fittings between headers and**

pump][**Galvanized-steel pipe and cast-iron fittings**] .

12. Valves:

    a. Shutoff Valves NPS 2 (DN 50) and Smaller: [**Gate valve**][**two-piece, full-port ball valve**] , in each pump's suction and discharge piping.
    b. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: [**Gate valve**][**lug-type butterfly valve**] , in each pump's suction and discharge piping [**and in inlet and outlet headers**] .
    c. Check Valves NPS 2 (DN 50) and Smaller: [**Silent**][**swing**] type in each pump's discharge piping.
    d. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
    e. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

13. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

14. VFC Specified in Other Section: Comply with Section 262923 "Variable-Frequency Motor Controllers."
15. VFC: Serving each pump in pump array.

    a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**] for [**Design A and Design B**][**inverter-duty**] motors.
    b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**] ; maximum voltage equals input voltage.
    c. Unit Operating Requirements:

        1) Internal Adjustability:

            a) Minimum Speed: 5 to 25 percent of maximum rpm.
            b) Maximum Speed: 80 to 100 percent of maximum rpm.
            c) Acceleration: [**0.1 to 999.9**] seconds.
            d) Deceleration: [**0.1 to 999.9**] seconds.
            e) Current Limit: 30 to minimum of 150 percent of maximum rating.

        2) Self-Protection and Reliability Features:

            a) Surge suppression.
            b) Loss of input signal protection.
            c) Under- and overvoltage trips.
            d) VFC and motor overload/overtemperature protection.
            e) Critical frequency rejection.
            f) Loss-of-phase protection.
            g) Reverse-phase protection.
            h) Motor-overtemperature fault.

        3) Bidirectional autospeed search.
        4) Torque boost.
        5) Motor temperature compensation at slow speeds.

            a) Panel-mounted operator station.
            b) Historical logging information and displays.
            c) Digital indicating devices.

        6) Control Signal Interface: Electric.
        7) PID control interface.

8) DDC System for HVAC Protocols for Network Communications: [**ASHRAE 135**].

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**] .
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors [**and isolating switch**] .
b) Three-contactor style, with bypass and input and output isolating contactors [**and isolating switch**] .

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**] type.

f. Instrumentation: Suction and discharge pressure gauges.
g. Lights: Running light for each pump.
h. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from [**1 to 300**] seconds, with [**automatic**][**manual**] reset.

i. Thermal-bleed cutoff.
j. [**Low-suction-pressure**][**Water-storage-tank, low-level**] cutout.

k. High-suction-pressure cutout.
l. Low-discharge-pressure cutout.
m. High-discharge-pressure cutout.
n. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to [**BACnet**][**LonWorks**] DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

16. Base: Structural steel.

17. Capacities and Characteristics:

a. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
b. Lead Pump:

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

c. Lag Pumps: Each of [**two**].

1) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**] V.
b) Phases: [**Single**][**Three**] .
c) Hertz: [**60**] Hz.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of packaged booster pumps.

B. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DOMESTIC-WATER PACKAGED BOOSTER PUMPS

A. Install packaged booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

D. Support connected domestic-water piping so weight of piping is not supported by packaged booster pumps.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to packaged booster pumps. Install suction and discharge pipe equal to

or greater than size of system suction and discharge [**headers**][**piping**] .

1. Install shutoff valves on piping connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Install ball, butterfly, or gate valves same size as suction and discharge [**headers**][**piping**] . Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge [**headers**][**piping**] at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to packaged booster-pump suction and discharge [**headers**][**piping**] . Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
5. Where installing piping adjacent to packaged booster pumps, allow space for service and maintenance.

C. Install pressure gauges on feedwater-inlet and treated water outlet piping. Comply with requirements for pressure gauges specified in Section 220500 "Common Work Results for Plumbing."

1. Exception: Packaged booster pumps with factory-installed pressure gauges.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within [**12**] months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to [**two**] visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner’s maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23 13

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SECTION 22 11 23 23 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal pumps, in-line, sealless.
2. Centrifugal pumps, horizontally mounted, in-line, separately coupled.
3. Centrifugal pumps, horizontally mounted, in-line, close-coupled.
4. Centrifugal pumps, vertically mounted, in-line, close-coupled.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.
2. Section 331113 "Potable Water Supply Wells" for well pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For pump controls.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For testing agency and factory-authorized service representative.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer to perform [**manufacturer's field services**][**and**][**startup services**] .

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF/ANSI 61 and NSF/ANSI/CAN 372.

D. Seismic Performance: Inline, domestic-water pumps to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

2.2 CENTRIFUGAL PUMPS

A. Centrifugal Pumps, In-Line, Sealless:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flo Fab Inc**]
b. [**GRUNDFOS CBS Inc.**]
c. [**Taco Comfort Solutions**]
d. [**WILO USA LLC - WILO Canada Inc.**]

2. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**] V.
2) Phase: [**Single**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
b. Minimum Working Pressure: [**125 psig (860 kPa)**].
c. Maximum Continuous Operating Temperature: [**220 deg F (104 deg C)**].
d. Casing: [**Cast iron**][**Bronze**][**Stainless steel**] , with threaded or companion-flange connections.
e. Impeller: [**Plastic**][**composite**][**stainless steel**] .
f. Motor: [**Single**][**Three**] speed.

B. Centrifugal Pumps, Horizontally Mounted, In-Line, Separately Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bell & Gossett; a Xylem brand**]
b. [**MEPCO, LLC.**]
c. [**Taco Comfort Solutions**]
d. [**Thrush Co. Inc.**]

2. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Casing:

1) Radially split [**bronze**][**cast iron**][**stainless steel**] with threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections.
2) Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
3) Gauge port tappings at suction and discharge nozzles.

b. Impeller: [**Bronze**][**stainless steel**] , statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
d. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
e. Seal: Mechanical, with [**carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket**].
f. Bearings: [**Grease-lubricated**][**permanently lubricated**] ball type.
g. Minimum Working Pressure: [**125 psig (860 kPa)**][**175 psig (1200 kPa)**].
h. Continuous Operating Temperature: [**200 deg F (93 deg C)**].

5. Motor: Single speed, with permanently lubricated ball bearings; and [**resiliently**][**rigidly**] mounted to pump casing.

C. Centrifugal Pumps, Horizontally Mounted, In-Line, Close-Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alyan Pump Company**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**MEPCO, LLC.**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Taco Comfort Solutions**]
f. [**Thrush Co. Inc.**]

2. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

3. Capacities and Characteristics:

a. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
b. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

   a. Casing:

      1) Radially split [**bronze**][**brass**][**cast iron**] with threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections.
      2) Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
      3) Gauge port tappings at suction and discharge nozzles.

   b. Impeller: [**Bronze**][**brass**] , statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
   d. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
   e. Seal: Mechanical, with [**carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket**].
   f. Bearings: [**Grease-lubricated**][**permanently lubricated**] ball type.
   g. Minimum Working Pressure: [**175 psig (1200 kPa)**].
   h. Continuous Operating Temperature: [**225 deg F (107 deg C)**].

5. Motor: Single speed, with grease-lubricated ball bearings; [**resiliently**][**rigidly**] mounted to pump casing.

D. Centrifugal Pumps, Vertically Mounted, In-Line, Close-Coupled:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alyan Pump Company**]
   b. [**Armstrong Fluid Technology**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]
   e. [**GRUNDFOS CBS Inc.**]
   f. [**MEPCO, LLC.**]
   g. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
   h. [**Pentair Aurora; Pentair Pump Group**]
   i. [**Taco Comfort Solutions**]
   j. [**Thrush Co. Inc.**]
   k. [**Weinman Division**]

2. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertically.

3. Capacities and Characteristics:

   a. Casing Material: [**Bronze**][**Cast iron**] .
   b. Impeller Material: [**ASTM B584, cast bronze**][**ASTM B584, cast bronze or stainless steel**][**Stainless steel**] .
   c. Minimum Operating Pressure: **175 psig (1200 kPa)**.
   d. Maximum Continuous Operating Temperature: **225 deg F (107 deg C)**.
   e. Pump Control: [**Pressure switch**][**Thermostat**][**Timer**] .
   f. Electrical Characteristics:

1) Volts: [**120**][**240**] V.
2) Phases: [**Single**][**Three**] phase.
3) Hertz: [**60**] Hz.

4. Pump Construction:

a. Casing: Radially split [**bronze**][**cast or ductile iron**] , with wear rings and threaded companion-flange connections for pumps with **NPS 2 (DN 50)** pipe connections and flanged connections for pumps with **NPS 2-1/2 (DN 65)** pipe connections. [**Include pump manufacturer's base attachment for mounting pump on concrete base.**]
b. Impeller: [**Bronze**][**brass**][**stainless steel**] , statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: [**Steel**][**stainless-steel**] shaft, with copper-alloy shaft sleeve.
d. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
e. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
f. Bearings: Oil-lubricated; bronze-journal or ball type.
g. Minimum Working Pressure: [**175 psig (1200 kPa)**].
h. Continuous Operating Temperature: [**225 deg F (107 deg C)**].

5. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Pressure Switches: Electric, adjustable for control of [**water-supply**] pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, [**Type 4X**].
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [**24 V ac**][**120 V ac**].

B. Thermostats: Electric; adjustable for control of [**hot-water circulation**] pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: [**50 to 125 deg F (10 to 52 deg C)**][**65 to 200 deg F (18 to 93 deg C)**][**100 to 240 deg F (38 to 116 deg C)**].
3. Enclosure: NEMA 250, [**Type 4X**].
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: [**24 V ac**][**120 V ac**].
7. Settings: Start pump at [**105 deg F (41 deg C)**][**110 deg F (43 deg C)**][**115 deg F (46 deg C)**] and stop pump at [**120 deg F (49 deg C)**][**125 deg F (52 deg C)**].

C. Timers: Electric, for control of [**hot-water circulation**] pump.

1. Type: Programmable, [**seven-day**] clock with manual override on-off switch.
2. Enclosure: NEMA 250, [**Type 1**], suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [**24 V ac**][**120 V ac**].
6. Programmable Sequence of Operation: [**Up to two on-off cycles each day for seven days**].

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, [**Type 4X**].
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: [**24 V ac**][**120 V ac**].
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation, plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF CENTRIFUGAL PUMPS

A. Comply with ANSI/HI 14.1-14.2.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Fabricate brackets or supports as required.

2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install pressure switches in water-supply piping.

F. Install thermostats in hot-water return piping.

G. Install timers [**on wall in engineer's office**].

H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Install pressure gauge [**and snubber**] at suction of each pump and pressure gauge [**and snubber**] at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF CONTROLS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. the Owner will engage a qualified testing agency to perform tests and inspections.

2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation, as directed by the Owner.

1. Extent of inspection is limited to [**three**] locations of straight pipe, [**three**] locations of threaded fittings, [**three**] locations of welded fittings, [**two**] locations of threaded strainers, [**two**] locations of welded strainers, [**three**] locations of threaded valves, and [**three**] locations of flanged valves for each pipe service defined in "Piping Insulation Schedule, General" Article.

2. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set [**pressure switches,**][**thermostats,**][**timers,**][**and**][**time-delay relays**] for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23 23

Task	Specification	Specification Description
22 11 23 23	23 21 23 00	Hydronic Pumps

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SECTION 22 12 19 00 - FACILITY GROUND-MOUNTED, POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Potable-water tank, ground mounted - welded steel, reservoir type.
2. Potable-water tank, ground mounted - welded steel, standpipe type.
3. Potable-water tank, ground mounted - bolted steel, reservoir type.
4. Potable-water tank, ground mounted - bolted steel, standpipe type.
5. Potable-water tank, ground mounted - concrete, wire- or strand-wound.
6. Paint materials.
7. Shop painting.
8. Ground-mounted, potable-water storage tank appurtenances.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 221216 "Facility Elevated, Potable-Water Storage Tanks" for multiple-column, elevated water-storage tanks and for single-pedestal, elevated water-storage tanks.

1.2 DEFINITIONS

A. Bottom Capacity Level (BCL): Water level above which the specified capacity is provided. In a ground-supported tank (reservoir or standpipe), the BCL is the water level in the tank shell when the tank is emptied through the specified discharge fittings, unless otherwise specified.

B. Capacity: Net volume, in **gallons (liters)**, that may be removed from a tank filled to TCL and emptied to BCL.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. Minimum Capacity within Operating Range: Capacity when water level is at BCL.

E. NR: Natural rubber.

F. Range of Head: Vertical distance between TCL and BCL.

G. Reservoir: Flat-bottomed, cylindrical, steel ground-mounted water-storage tank with shell height equal to or less than its diameter.

H. SDWA: Safe Drinking Water Act.

I. Standpipe: Flat-bottomed, cylindrical, ground-mounted water-storage tank with shell height greater than its diameter.

J. Top Capacity Level (TCL): Water level defined by the lip of the overflow elevation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details for each facility ground-mounted, potable-water storage tank, including the following:

1. Tank, roof, and shell openings.
2. Safety railings and ladders.
3. Plans, elevations, sections, and attachment details.
4. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Diagram power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Seismic Qualification Certificates: For facility ground-mounted, potable-water storage tanks and components, from manufacturer.

1. Basis for Certification: Include calculation upon which withstand certification is based.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Bacteriological test results.

E. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:

1. Obstruction lighting.
2. Lightning protection.
3. Cathodic protection.
4. Tank heaters.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of ground-mounted, potable-water storage tanks.

1. Engineering Responsibility: Preparation of data for ground-mounted, potable-water tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in

assemblies similar to those indicated for this Project.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

C. Pipe Welding: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ground-mounted, potable-water tank, including structural reinforcement and foundation, is to withstand the effects of dead and live gravity loads and winds of [**100 mph (161 km/h)**]<**Insert value**>.

B. Seismic Performance: Ground-mounted, potable-water storage tank, including structural reinforcement and foundation, is to withstand the effects of earthquake motions. See Section 018123 "Facility Seismic and Wind Criteria" for seismic criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. Thermal Movements: Ground-mounted, potable-water tank, including structural reinforcement and foundation, is to allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Tanks for Potable-Water Storage and Fire-Suppression Water Supply: Comply with NFPA 22, "Water Tanks for Private Fire Protection,"

F. Comply with NSF 61 and NSF 372.

G. Comply with 29 CFR 1910.

2.2 POTABLE-WATER TANKS, GROUND MOUNTED

A. Potable-Water Tank, Ground Mounted - Welded Steel, Reservoir Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Tank and Construction Co**]
    b. [**Brown Tank, LLC**]
    c. [**Caldwell Tanks, Inc.**]
    d. [**Fisher Tank Company**]
    e. [**Maguire Iron, Inc.**]
    f. [**Pittsburg Tank & Tower Co., Inc.**]
    g. [**Superior Tank Co., Inc**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Tank and Construction Co**]
    b. [**Brown Tank, LLC**]
    c. [**Caldwell Tanks, Inc.**]
    d. [**Fisher Tank Company**]
    e. [**Maguire Iron, Inc.**]
    f. [**Pittsburg Tank & Tower Co., Inc.**]
    g. [**Superior Tank Co., Inc**]
    h. <**Insert manufacturer's name**>

3. Description: Manufactured, welded-steel tank with welded-steel plates, bolts, rods, and reinforcing steel.
4. Standard: Designed and fabricated in accordance with [**AWWA D100 and AWWA M42**][**AWWA D100, AWWA M42, and NFPA 22**]<**Insert standards**>.
5. Capacity: [**50,000 gal. (189 cu. m)**][**5,000,000 gal. (18 930 cu. m)**]<**Insert capacity**>.
6. Minimum Capacity within Operating Range: <**Insert capacity**>.
7. Shell Roof:

    a. [**Dome**][**Ellipsoidal**] welded steel and self-supporting.
    b. Conical with[**knuckle and**] column-rafter support.

8. Reservoir Shell Diameter: <**Insert feet (m)**>.
9. BCL: <**Insert height in feet (m) of level above foundation**>.
10. Pipe Connections: Comply with AWWA D100. Match size of water-distribution pipe.
11. Overflow Piping: ASTM A53/A53M, Grade B, Schedule 40, welded-steel pipe with ASTM A234/A234M, Grade WPB, Schedule 40, carbon-steel butt-weld fittings.
12. Roof Opening Hatch at Ladder: Comply with AWWA D100. Steel, hinged cover, [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**> minimum or as required by OSHA, with [**4-inch (100-mm)**]<**Insert dimension**> curb and [**2-inch (50-mm)**]<**Insert dimension**> downward overlap with hasp and lock, located over interior ladder and adjacent to exterior ladder.
13. Roof Center Opening: Comply with AWWA D100. Steel, removable, [**20-inch- (500-mm-)**]<**Insert dimension**> minimum-diameter cover with [**4-inch- (100-mm-)**]<**Insert dimension**> minimum-height neck and minimum [**2-inch (50-mm)**]<**Insert dimension**> downward overlap with hasp and lock. Construct opening with capability of supporting ventilation fan.
14. Shell Sidewall Manholes: Comply with AWWA D100. Provide two steel manholes. One circular, **30 inches (750 mm)** minimum in diameter. The second, [**circular, 24 inches (600 mm) in diameter**][**circular, 36 inches (900 mm) in diameter**][**elliptical, 18-by-22-inch- (450-by-560-mm-) minimum size**]<**Insert shape and dimensions**>.

15. Painter's Accessories: Include [**lugs**][**couplings**][**rail**] inside and outside tank for painting.
16. Tank Vent: Steel pipe with stainless steel screen, constructed to prevent entrance of rain,[**insects,**] birds, and animals.[**Include pressure-vacuum screened vent or separate pressure-vacuum relief mechanism to maintain clear screen.**]
17. Foundation: Reinforced concrete. See Section 033000 "Cast-in-Place Concrete."

B. Potable-Water Tank, Ground Mounted - Welded Steel, Standpipe Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Tank and Construction Co**]
    b. [**Brown Tank, LLC**]
    c. [**Caldwell Tanks, Inc.**]
    d. [**Fisher Tank Company**]
    e. [**Maguire Iron, Inc.**]
    f. [**Pittsburg Tank & Tower Co., Inc.**]
    g. [**Superior Tank Co., Inc**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Tank and Construction Co**]
    b. [**Brown Tank, LLC**]
    c. [**Caldwell Tanks, Inc.**]
    d. [**Fisher Tank Company**]
    e. [**Maguire Iron, Inc.**]
    f. [**Pittsburg Tank & Tower Co., Inc.**]
    g. [**Superior Tank Co., Inc**]
    h. <**Insert manufacturer's name**>

3. Description: Manufactured, welded-steel tank with welded-steel plates, bolts, rods, and reinforcing steel.
4. Standard: Designed and fabricated in accordance with [**AWWA D100 and AWWA M42**][**AWWA D100, AWWA M42, and NFPA 22**]<**Insert standards**>.
5. Capacity: [**50,000 gal. (189 cu. m)**][**5,000,000 gal. (18 930 cu. m)**]<**Insert capacity**>.
6. Minimum Capacity within Operating Range: <**Insert capacity**>.
7. Shell Roof:

    a. [**Dome**][**Ellipsoidal**] welded steel and self-supporting.
    b. Conical with[**knuckle and**] column-rafter support.

8. Standpipe Shell Height: <**Insert height in feet (m)**> from top of foundation to overflow level.
9. Standpipe Range of Head: <**Insert height in feet (m)**> from BCL to overflow level.
10. BCL: <**Insert height in feet (m) of level above foundation**>.
11. Pipe Connections: Comply with AWWA D100. Match size of water-distribution pipe.
12. Overflow Piping: ASTM A53/A53M, Grade B, Schedule 40, welded-steel pipe with ASTM A234/A234M, Grade WPB, Schedule 40, carbon-steel butt-weld fittings.
13. Roof Opening Hatch at Ladder: Comply with AWWA D100. Steel, hinged cover, [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**> minimum or as required by OSHA, with [**4-inch (100-mm)**]<**Insert dimension**> curb and [**2-inch (50-mm)**]<**Insert dimension**> downward overlap with hasp and lock, located over interior ladder and adjacent to exterior ladder.

14. Roof Center Opening: Comply with AWWA D100. Steel, removable, [**20-inch- (500-mm-)**]<**Insert dimension**> minimum-diameter cover with [**4-inch- (100-mm-)**]<**Insert dimension**> minimum-height neck and minimum [**2-inch (50-mm)**]<**Insert dimension**> downward overlap with hasp and lock. Construct opening with capability of supporting ventilation fan.
15. Shell Sidewall Manholes: Comply with AWWA D100. Provide two steel manholes. One circular, **30 inches (750 mm)** minimum in diameter. The second, [**circular, 24 inches (600 mm) in diameter**][**circular, 36 inches (900 mm) in diameter**][**elliptical, 18-by-22-inch- (450-by-560-mm-) minimum size**]<**Insert shape and dimensions**>.
16. Painter's Accessories: Include [**lugs**][**couplings**][**rail**] inside and outside tank for painting.
17. Tank Vent: Steel pipe with stainless steel screen, constructed to prevent entrance of rain,[**insects,**] birds, and animals.[**Include pressure-vacuum screened vent or separate pressure-vacuum relief mechanism to maintain clear screen.**]
18. Foundation: Reinforced concrete. See Section 033000 "Cast-in-Place Concrete."

C. Potable-Water Tank, Ground Mounted - Bolted Steel, Reservoir Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Tank Company, Inc.**]
    b. [**CST Industries**]
    c. [**Pittsburg Tank & Tower Co., Inc.**]
    d. [**Superior Tank Co., Inc**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Tank Company, Inc.**]
    b. [**CST Industries**]
    c. [**Pittsburg Tank & Tower Co., Inc.**]
    d. [**Superior Tank Co., Inc**]
    e. <**Insert manufacturer's name**>

3. Description: Manufactured tank with bolted-steel plates, bolts, rods, and reinforcing steel.
4. Standard: Designed and fabricated in accordance with [**AWWA D103 and AWWA M42**][**AWWA D103, AWWA M42, and NFPA 22**]<**Insert standards**>.
5. Capacity: [**4000 gal. (15 cu. m)**][**160,000 gal. (605 cu. m)**]<**Insert capacity**>.
6. Minimum Capacity within Operating Range: <**Insert capacity**>.
7. Shell Roof: Comply with AWWA D103.
8. Reservoir Shell Diameter: <**Insert feet (m)**>.
9. BCL: <**Insert height in feet (m) of level above foundation**>.
10. Pipe Connection: Comply with AWWA D103. Match size of water-distribution pipe.
11. Overflow Piping: ASTM A53/A53M, Grade B, Schedule 40, welded-steel pipe with ASTM A234/A234M, Grade W.B., Schedule 40, carbon-steel butt-weld fittings.
12. Roof Opening Hatch above TCL: Comply with AWWA D103. Steel, hinged cover, [**24 by 15 inches (600 by 600 mm)**]<**Insert dimensions**> minimum or as required by OSHA, with **4-inch (100-mm)** curb and **2-inch (50-mm)** downward overlap with hasp and lock, located over interior ladder and adjacent to exterior ladder.
13. Roof Center Opening: Comply with AWWA D103. steel, removable, [**20-inch- (500-mm-)**]<**Insert dimension**> minimum-diameter cover with **4-inch- (100-mm-)** minimum-height neck and minimum [**2-inch (50-mm)**]<**Insert dimension**> downward overlap with hasp and lock. Construct

opening with capability of supporting ventilation fan.

14. Shell Sidewall Manholes: Comply with AWWA D103. Provide two steel manholes, [**circular, minimum 24 inches (600 mm) in diameter**][**square, minimum 24 by 24 inches (610 by 610 mm) in diameter**][**elliptical, minimum 18 by 22 inches (450 by 560 mm)**][**flush rectangular, minimum length 24 inches (610 mm) in shortest direction and maximum length 48 inches (1220 mm) in the longest direction**]<**Insert shape and dimensions**>.
15. Painter's Accessories: Include [**lugs**][**couplings**][**rail**] inside and outside tank for painting.
16. Painting, Factory Applied, Internal: [**Epoxy powder coating, NSF and FDA compliant**]<**Insert coating type**>.
17. Painting, Factory Applied, External: [**Polyester powder coating**]<**Insert coating type**>.
18. Tank Vent: Steel pipe with stainless steel screen, constructed to prevent entrance of rain,[**insects,**] birds, and animals.[**Include pressure-vacuum screened vent or separate pressure-vacuum relief mechanism to maintain clear screen.**]
19. Foundation: Reinforced concrete. See Section 033000 "Cast-in-Place Concrete."

D. Potable-Water Tank, Ground Mounted - Bolted Steel, Standpipe Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Tank Company, Inc.**]
    b. [**CSI Industries Inc.**]
    c. [**Pittsburg Tank & Tower Co., Inc.**]
    d. [**Superior Tank Co., Inc**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Tank Company, Inc.**]
    b. [**CSI Industries Inc.**]
    c. [**Pittsburg Tank & Tower Co., Inc.**]
    d. [**Superior Tank Co., Inc**]
    e. <**Insert manufacturer's name**>

3. Description: Manufactured tank with bolted-steel plates, bolts, rods, and reinforcing steel.
4. Standard: Designed and fabricated in accordance with [**AWWA D103 and AWWA M42**][**AWWA D103, AWWA M42, and NFPA 22**]<**Insert standards**>.
5. Capacity: [**4000 gal. (15 cu. m)**][**160,000 gal. (605 cu. m)**]<**Insert capacity**>.
6. Minimum Capacity within Operating Range: <**Insert capacity**>.
7. Shell Roof: Comply with AWWA D103.
8. Standpipe Shell Height: <**Insert height in feet (m)**> from top of foundation to overflow level.
9. Standpipe Range of Head: <**Insert height in feet (m)**> from BCL to overflow level.
10. BCL: <**Insert height in feet (m) of level above foundation**>.
11. Pipe Connection: Comply with AWWA D103. Match size of water-distribution pipe.
12. Overflow Piping: ASTM A53/A53M, Grade B, Schedule 40, welded-steel pipe with ASTM A234/A234M, Grade W.B., Schedule 40, carbon-steel butt-weld fittings.
13. Roof Opening Hatch above TCL: Comply with AWWA D103. Steel, hinged cover, [**24 by 15 inches (600 by 600 mm)**]<**Insert dimensions**> minimum or as required by OSHA, with **4-inch (100-mm)** curb and **2-inch (50-mm)** downward overlap with hasp and lock, located over interior ladder and adjacent to exterior ladder.
14. Roof Center Opening: Comply with AWWA D103. steel, removable, [**20-inch- (500-mm-)**]<**Insert dimension**> minimum-diameter cover with **4-inch- (100-mm-)** minimum-height neck and

minimum [2-inch (50-mm)]<**Insert dimension**> downward overlap with hasp and lock. Construct opening with capability of supporting ventilation fan.

15. Shell Sidewall Manholes: Comply with AWWA D103. Provide two steel manholes, [**circular, minimum 24 inches (600 mm) in diameter**][**square, minimum 24 by 24 inches (610 by 610 mm) in diameter**][**elliptical, minimum 18 by 22 inches (450 by 560 mm)**][**flush rectangular, minimum length 24 inches (610 mm) in shortest direction and maximum length 48 inches (1220 mm) in the longest direction**]<**Insert shape and dimensions**>.
16. Painter's Accessories: Include [**lugs**][**couplings**][**rail**] inside and outside tank for painting.
17. Painting, Factory Applied, Internal: [**Epoxy powder coating, NSF and FDA compliant**]<**Insert coating type**>.
18. Painting, Factory Applied, External: [**Polyester powder coating**]<**Insert coating type**>.
19. Tank Vent: Steel pipe with stainless steel screen, constructed to prevent entrance of rain,[**insects,**] birds, and animals.[**Include pressure-vacuum screened vent or separate pressure-vacuum relief mechanism to maintain clear screen.**]
20. Foundation: Reinforced concrete. See Section 033000 "Cast-in-Place Concrete."

E. Potable-Water Tank, Ground Mounted - Concrete, Wire- or Strand-Wound:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crom Corporation (The)**]
    b. [**DN Tanks**]
    c. [**Preload Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crom Corporation (The)**]
    b. [**DN Tanks**]
    c. [**Preload Inc.**]
    d. <**Insert manufacturer's name**>

3. Description: Wire- and strand-wound, circular prestressed concrete tank with option of four types of core walls:

    a. Type I - cast-in-place concrete with vertical prestressed reinforcement
    b. Type II - shotcrete with steel diaphragm
    c. Type III - precast concrete with steel diaphragm; Type IV - cast-in-place concrete with steel diaphragm.

4. Standard: Designed and fabricated in accordance with [**AWWA D110**][**AWWA D110 and NFPA 22**]<**Insert standards**>.
5. Capacity: [**100,000 gal. (379 cu. m)**][**40,000,000 gal. (151 400 cu. m)**]<**Insert capacity**>.
6. Minimum Capacity within Operating Range: <**Insert capacity**>.
7. Tank Height: <**Insert height in feet (m)**> from top of foundation to overflow.
8. Tank Inside Diameter: <**Insert feet (m)**>.
9. Range of Head: <**Insert height in feet (m)**> from BCL to overflow level.
10. BCL: <**Insert height in feet (m) of level above foundation**>.
11. Tank Floor: Reinforced, cast-in-place concrete.
12. Tank Wall, Cast-in-Place Concrete Tank (AWWA D110 Type I): Mix proportions to meet minimum

28-day [**4000 psig (28 MPa)**]<**Insert pressure**> compressive strength

13. Tank Wall, Shotcrete with Steel Diaphragm Tank (AWWA D110 Type II): Mix proportions to meet minimum 28-day [**4500 psig (31 MPa)**]<**Insert pressure**> compressive strength. Include steel diaphragm.
14. Tank Wall, Precast Concrete with Steel Diaphragm Tank (AWWA D110 Type III): Comply with AWWA D110. [**4000 psig (28 MPa)**]<**Insert pressure**> compressive strength. Include steel diaphragm.
15. Tank Wall, Cast-in-Place Concrete with Steel Diaphragm Tank (AWWA D110 Type IV): Comply with AWWA D110. Mix proportions to meet minimum 28-day [**4000 psig (28 MPa)**]<**Insert pressure**> compressive strength. Include steel diaphragm.
16. Internal Baffling: [**Polypropylene curtain(s) supported by glass-fiber angles**][**Steel-reinforced concrete block masonry wall(s)**][**Cast-in-place concrete or shotcrete wall(s)**][**Precast concrete wall(s)**].
17. Baffles: Configured to comply with SDWA-mandated disinfectant contact times.
18. Domed Tank Roof: Reinforced, [**cast-in-place**][**precast**][**shotcrete**] concrete.
19. Flat Tank Roof: Reinforced, [**cast-in-place**][**precast**] concrete complying with applicable requirements of ACI 350, with special attention to crack control.
20. Reinforcing Steel: ASTM A767/A767M, **Grade 60 (Grade 240)**, zinc-coated billet steel bars.
21. Waterstops: Comply with AWWA D110.
22. Bearing Pads:

    a. Material: [**Comply with AWWA D110**][**NR**][**ASTM D2240, CR, with durometer hardness of 40 to 50**].
    b. Minimum Thickness: [**1/2 inch (13 mm)**]<**Insert dimension**> under walls and [**1/2 inch (13 mm)**]<**Insert dimension**> under roof.
    c. Minimum Width: [**3 inches (75 mm)**]<**Insert dimension**> under walls and [**2 inches (50 mm)**]<**Insert dimension**> under roof.

23. Bolts, Nuts, Washers, and Expansion Sleeve Inserts: Stainless steel.
24. Construction and Maintenance Hatch: [**Aluminum**][**Galvanized-steel**] frame and cover at least **3/16 inch (5 mm)** thick, **48-by-48-inch- (1200-by-1200-mm-)** minimum-size, hinged cover with a **4-inch (100-mm)** neck and **2-inch (50-mm)** downward overlap and having a hasp and lock.[**Locate top of hatch above grade.**]
25. Personnel Hatch: [**Aluminum**][**Galvanized-steel**] frame and cover at least **3/16 inch (5 mm)** thick, **30-inch- (760-mm-)** minimum, square hinged cover with a **4-inch (100-mm)** neck and **2-inch (50-mm)** downward overlap and having a hasp and lock. Construct opening with capability of supporting ventilation fan.[**Locate top of hatch above grade.**]
26. Tank Vents: [**Fiberglass**][**Galvanized-steel**] pipe with [**aluminum**][**stainless steel**] screen, constructed to prevent entrance of rain,[**insects,**] birds, and animals.[**Include pressure-vacuum screened vent or separate pressure-vacuum relief mechanism to maintain clear screen.**]
27. Tank Interior Surface Sealer: Cementitious coating modified with acrylic or styrene-acrylic based polymer.

2.3 PAINT MATERIALS

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's [**epoxy-polyamide**]<**Insert paint**> paint.

C. Tank Shell Interior Finish Paint: Tank fabricator's [**epoxy-polyamide paint**]<**Insert paint**> complying with NSF 61 and NSF 372, and compatible with prime coat.

D. Tank Shell Exterior Intermediate Paint: Tank fabricator's [**epoxy-polyamide**]<**Insert paint**> paint compatible with prime and finish paint. Intermediate coat is to have a slight color contrast with finish

coat.

E. Tank Shell Exterior Finish Paint: Tank fabricator's [**urethane**]<**Insert paint**> paint.

1. Color: [**As selected by Owner from tank manufacturer's paint chart**]<**Insert color**>.

2.4 SHOP PAINTING

A. Factory coating in accordance with AWWA D103.

B. Tank Shell Interior Finish Coat: Comply with NSF 61 and NSF 372.

C. Tank Shell Exterior Finish Coat: Factory coating in accordance with AWWA D103.

2.5 GROUND-MOUNTED, POTABLE-WATER STORAGE TANK APPURTENANCES

A. Water-Level Controls: Automatic controls for maintaining water level in tank, with valves, piping, and audible and visual alarms to indicate the following:

1. High- and low-water levels.
2. Tank overflowing or tank not filling.
3. <**Insert required alarms**>.

B. Obstruction Lighting: Comply with requirements of authorities having jurisdiction.

C. Lightning Protection: Comply with requirements in Section 264113 "Lightning Protection for Structures."

D. Cathodic Protection: Comply with requirements in Section 134713 "Cathodic Protection" and with AWWA D104.

E. Tank Heaters: Comply with NFPA 22 and with capacity to maintain **42 deg F (6 deg C)** water temperature inside surface water-storage tank.

F. Spiral Staircase:

1. Material: [**Galvanized steel**]<**Insert material**>.
2. Size: Custom sized to tank.
3. Accessories: Including step off platform.
4. Safety Devices: As required by 29 CFR 1910 (OSHA) safety and health regulations.
5. Standards: Comply with [**AWWA D100**][**AWWA D103**][**AWWA D110**].

G. Exterior Ladder: Straight, vertical ladder rungs.

1. Material: [**Powder-coated or galvanized**][**Stainless**] steel.
2. Size: Custom sized to tank.
3. Accessories: Including step off platform.
4. Safety Devices: As required by 29 CFR 1910 (OSHA) safety and health regulations.
5. Standards: Comply with [**AWWA D100**][**AWWA D103**][**AWWA D110**].

H. Interior Ladder: Straight, vertical ladder rungs.

1. Material: [**Powder-coated or galvanized**][**Stainless**] steel.

2. Size: Custom sized to tank.
3. Accessories: Including step off platform.
4. Safety Devices: As required by 29 CFR 1910 (OSHA) safety and health regulations.
5. Standards: Comply with [**AWWA D100**][**AWWA D103**][**AWWA D110**].

I. <**Insert accessories**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF POTABLE-WATER TANKS, GROUND MOUNTED

A. Welded-Steel Tanks:

1. Erect tank shell, accessories, and appurtenances in accordance with AWWA D100 and AWWA M42.
2. Fabricate steel plate sections in the shop. Erect tank shell by welding plate sections in the field.

B. Bolted-Steel Tanks:

1. Erect tank shell, accessories, and appurtenances in accordance with AWWA D103 and AWWA M42.
2. Fabricate tank sections and drill or punch bolt holes in the shop. Install bolts during field erection of tank.

C. Set top of reinforced-concrete foundation at least **6 inches (150 mm)** above finish grade.

D. Install roof hatch near exterior[**and interior**] ladder(s).

E. Install roof center opening near center of roof.

F. Install tank vent at center of roof.

G. Install two manholes in tank wall near grade.

H. Tank Wall: Construct tank wall and install accessories and appurtenances in accordance with AWWA D110.

I. Floor: Reinforced, cast-in-place concrete. Slope floor 1.0 to 1.5 percent from highest point to water outlet pipe. Pour monolithically without cold joints and provide mechanical float finish.

J. Dome Roof: Install reinforced, cast-in-place concrete with circumferential prestressing.[**Place 6-inch (150-mm) waterstop between roof and wall.**]

1. Install curb on roof perimeter with no fewer than 6 downspouts spaced [**60 degrees**]<**Insert number**> and no more than [**50 ft. (15 m)**]<**Insert dimension**> apart.

K. Flat Slab Roof: Install reinforced, cast-in-place concrete with drop panels and support having reinforced, cast-in-place concrete columns. Place solid neoprene bearing pads[**and 6-inch (150-mm) waterstop**] between roof and wall. If voids are present between wall and roof after use of solid bearing pads, fill voids with closed-cell CR pads and soft mastic.

1. Install curb on roof perimeter with no fewer than 6 downspouts spaced [**60 degrees**]<**Insert number**> and no more than [**50 ft. (15 m)**]<**Insert dimension**> apart.

L. Install construction and maintenance hatch near [**wall**][**ladder**].

M. Install ventilators at highest point of roof.[**Install additional units where indicated.**]

3.2 PIPING CONNECTIONS

A. Connect tanks to water-distribution piping.

B. Connect drains to storm-drainage piping.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 SURFACE PREPARATION OF STEEL TANKS

A. Surface preparation is specified in [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

B. Field Cleaning: After erecting tank shell, remove burrs, dirt, and construction debris and repair damaged finishes. Remove weld splatter, sharp edges on weld seams, and scabs and slivers by grinding. Remove weld flux, slag, fins, and laminations.

C. Field Surface Preparation: After field cleaning, prepare steel surfaces where shop prime coat has been damaged, in accordance with the Specifications listed above for shop cleaning, and remove dust or residue from cleaned surfaces.

D. If surface develops rust before prime coat is applied, repeat field surface preparation.

3.6 FIELD PAINTING

A. Surface preparation is specified in [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

B. Apply paint in accordance with AWWA D102.

C. Prime-Coat Touchup: Apply primer to cleaned areas and where shop finish has been damaged during shipping, handling, and erection. Apply prime coat to a dry film thickness of **3.0 to 5.0 mils (0.08 to 0.13 mm)** for tank interior and to a dry film thickness of **2.0 to 3.0 mils (0.05 to 0.08 mm)** for exterior tank and support surfaces.

D. Tank Shell Interior Finish Coats: Apply two coats of interior finish paint above bottom ring to a dry film thickness of **4.0 to 5.0 mils (0.1 to 0.13 mm)**. Apply interior finish paint to surfaces below bottom ring to a dry film thickness of **8.0 to 10.0 mils (0.2 to 0.25 mm)**.

E. Tank Shell and Steel Support Exterior Coats: Apply intermediate paint to a dry film thickness of **2.0 to 3.0 mils (0.05 to 0.08 mm)**. Apply finish paint to a dry film thickness of **2.0 to 3.0 mils (0.05 to 0.08 mm)**.

F. Concrete tanks do not require painting.

G. Paint concrete, surface water-storage tanks in accordance with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

H. Tank Exterior Lettering and Logo: Apply [**one coat**][**two coats**] of urethane paint to a dry film thickness of **2.0 to 3.0 mils (0.05 to 0.08 mm)**[**for each application**].

I. Overflow Pipe: Paint pipe exterior that is outside tank and structure as indicated for tank exterior.

J. Exterior Ladders: Paint as indicated for tank shell exterior.

K. Do not paint if ambient temperature is less than **50 deg F (10 deg C)** or is expected to drop below **40 deg F (5 deg C)** in the next 18 hours. Do not paint if temperature of steel surface is higher than **125 deg F (52 deg C)**. Do not apply paint if surfaces are wet or damp, if precipitation is expected, or if relative humidity will exceed 85 percent. Do not spray paint when wind velocity exceeds **15 mph (24 km/h)**. Maintain at least a 24-hour waiting period between coats. Provide adequate ventilation in tank during painting to maintain clear atmosphere and provide explosion-proof flood lighting and spot lighting.

L. Complete daily painting to allow time for paint to dry before condensation is expected.

3.7 INSTALLATION OF SURFACE WATER-STORAGE TANK APPURTENANCES

A. Install and adjust water-level control valves, piping, and alarms.

B. Install obstruction lighting in accordance with authorities having jurisdiction.

C. Install lightning protection in accordance with Section 264113 "Lightning Protection for Structures."

D. Install cathodic protection in accordance with Section 134713 "Cathodic Protection" and AWWA D104.

E. Install tank heaters in accordance with NFPA 22.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Tank Weld Test: Use radiographic method in accordance with AWWA D100. Repair failures and retest.
2. Leak Test for Welded Reservoirs or Standpipes: Comply with AWWA D100[**and NFPA 22**]. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

   a. Water will be furnished by Owner.

3. Leak Test for Bolted Reservoirs or Standpipes: Comply with AWWA D103[**and NFPA 22**]. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

   a. Water will be furnished by Owner.

4. Leak Test for Concrete Tanks: Comply with [**AWWA D110**][**and NFPA 22**]. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

   a. Water will be furnished by Owner.

5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 CLEANING

A. Clean interior and exterior of ground-mounted, potable-water storage tanks.

B. Disinfect surface water-storage tanks in accordance with [**AWWA C652**][**requirements of authorities having jurisdiction**].

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the following:

1. Obstruction lighting.
2. Water-level controls.
3. Tank heaters.

END OF SECTION 22 12 19 00

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Task	Specification	Specification Description
22 12 19 00	23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks

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SECTION 22 12 23 00 - FACILITY INDOOR POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, pressure, potable-water storage tanks.
2. Steel, nonpressure, potable-water storage tanks.
3. Steel, floating-wafer, potable-water storage tanks.
4. Steel, precharged, potable-water storage tanks.
5. Insulated, steel, potable-water storage tanks.
6. Plastic, pressure, potable-water storage tanks.
7. Plastic, nonpressure, potable-water storage tanks.

1.2 DEFINITIONS

A. HDPE: High-density polyethylene plastic.

B. LDPE: Low-density polyethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Steel water tanks to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

1.4 ACTION SUBMITTALS

A. Product Data:

1. Steel, pressure, potable-water storage tanks.
2. Steel, nonpressure, potable-water storage tanks.
3. Steel, floating-wafer, potable-water storage tanks.
4. Steel, precharged, potable-water storage tanks.
5. Insulated, steel, potable-water storage tanks.
6. Plastic, pressure, potable-water storage tanks.
7. Plastic, nonpressure, potable-water storage tanks.

B. Product Data Submittals: For each product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water storage tanks.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For steel water storage tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of potable-water storage tank, from manufacturer.

C. Source quality-control reports.

D. Purging and disinfecting reports.

1.6 QUALITY ASSURANCE

A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

B. ASME Compliance for FRP Tanks: Fabricate and label FRP, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic potable-water storage tanks and components. Include appropriate NSF marking.

D. Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 STEEL, PRESSURE, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]

6. [**Flo Fab Inc**]
7. [**GSW Water Heating**]
8. [**HESCO Bastion Ltd.**]
9. [**Lochinvar, LLC**]
10. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**GSW Water Heating**]
8. [**HESCO Bastion Ltd.**]
9. [**Lochinvar, LLC**]
10. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

K. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.2 STEEL, NONPRESSURE, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
4. [**RECO USA**]
5. [**Steel Tank and Fabricating Corporation (STAFCO)**]
6. [**Wood, John Co**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
4. [**RECO USA**]
5. [**Steel Tank and Fabricating Corporation (STAFCO)**]
6. [**Wood, John Co**]
7. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], nonpressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: Steel, constructed with nontoxic welded joints.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

G. Cover for Open Tank: [**Plastic**][**Steel, with lining same as or similar to tank lining and**] with shape that encloses top of tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in the tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

K. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

L. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

M. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.3 STEEL, FLOATING-WAFER, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cemline Corporation**]
2. [**State Industries**]
3. [**Wood, John Co**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cemline Corporation**]
2. [**State Industries**]
3. [**Wood, John Co**]
4. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls and with floating-wafer separator.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Floating Wafer: Nontoxic plastic, of diameter to match tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

K. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: [**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.4 STEEL, PRECHARGED, POTABLE-WATER STORAGE TANKS

A. Steel, Precharged, Diaphragm, Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMTROL, Inc.**]
b. [**Armstrong Fluid Technology**]
c. [**Flexcon Industries**]
d. [**Flo Fab Inc**]
e. [**Myers, F.E.; Pentair Ltd**]
f. [**State Industries**]
g. [**Taco Comfort Solutions**]
h. [**Wessels Company**]

i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**AMTROL, Inc.**]
   b. [**Armstrong Fluid Technology**]
   c. [**Flexcon Industries**]
   d. [**Flo Fab Inc**]
   e. [**Myers, F.E.; Pentair Ltd**]
   f. [**State Industries**]
   g. [**Taco Comfort Solutions**]
   h. [**Wessels Company**]
   i. **<Insert manufacturer's name>**

3. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.
4. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
5. Operation: Factory-installed, butyl-rubber diaphragm.

B. Steel, Precharged, Bladder, Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong Fluid Technology**]
   b. [**Flo Fab Inc**]
   c. [**Taco Comfort Solutions**]
   d. [**Wessels Company**]
   e. [**Wood, John Co**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Armstrong Fluid Technology**]
   b. [**Flo Fab Inc**]
   c. [**Taco Comfort Solutions**]
   d. [**Wessels Company**]
   e. [**Wood, John Co**]
   f. **<Insert manufacturer's name>**

3. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.
4. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
5. Operation: Factory-installed, butyl-rubber bladder.

C. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]**<Insert value>** working pressure.

D. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

E. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure gage.
2. <**Insert required specialties**>.

F. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

G. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

H. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.5 INSULATED, STEEL, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Bradford White Corporation**]
3. [**GSW Water Heating**]
4. [**HESCO Bastion Ltd.**]
5. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
6. [**Lochinvar, LLC**]
7. [**Precision Boilers**]
8. [**PVI; A WATTS Brand**]
9. [**RBI**]
10. [**State Industries**]
11. [**Vaughn Thermal Corporation**]
12. [**Wessels Company**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Bradford White Corporation**]
3. [**GSW Water Heating**]
4. [**HESCO Bastion Ltd.**]
5. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
6. [**Lochinvar, LLC**]
7. [**Precision Boilers**]
8. [**PVI; A WATTS Brand**]
9. [**RBI**]

10. [**State Industries**]
11. [**Vaughn Thermal Corporation**]
12. [**Wessels Company**]
13. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

J. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

K. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with ASHRAE/IESNA 90.1.

L. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.6 PLASTIC, PRESSURE, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

C. Description: FRP, vertical, pressure-rated tank with cylindrical sidewalls.

D. Construction: [**ASME code, composite FRP**][**Composite FRP**], [**contact-molded**][**or**][**filament-wound**], thermosetting-resin tank for [**100-psig (690-kPa)**][**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Tank Lining Material: Nontoxic [**HDPE**][**LDPE**]<**Insert material**> complying with NSF 61 Annex G barrier materials for potable-water tanks.

E. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated, FRP flanged-end nozzle.

1. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or FRP skirt attached by FRP brackets to tank sidewall.

I. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

2.7 PLASTIC, NONPRESSURE, POTABLE-WATER STORAGE TANKS

A. FRP Potable-Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMTROL, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**AMTROL, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

3. Description: FRP, vertical, nonpressure-rated water tank; complying with NSF 61 Annex G barrier materials for potable-water tanks.
4. Construction: [**ASTM D3299, filament-wound**][**or**][**ASTM D4097, contact-molded**] FRP.
5. Tappings: Factory-fabricated, FRP flanged-end nozzle.

a. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.

1) [**Exception: Tappings may be threaded FRP coupling integral with nozzle for connections for plastic piping.**]

b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting tank.

B. PE Potable-Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

3. Description: PE, vertical, flat-bottom, nonpressure-rated water tank; complying with NSF 61

Annex G barrier materials for potable-water tanks.
4. Construction: ASTM D1998, molded PE.
5. Tappings: Factory-fabricated bulkhead fittings attached to tank.

   a. NPS 2 (DN 50) and Smaller: With female thread.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting entire bottom of tank.

C. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

D. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.

E. Specialties and Accessories: Include tappings in the tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.
2. Pressure Testing for Non-ASME-Code, Pressure, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks at pressure of [**50 psig (345 kPa)**]<**Insert value**> above system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert value**>. Fill tanks with water, vent air, pressurize tanks, disconnect test equipment, hold pressure for two hours with no drop in pressure, and check for leaks.
3. Testing for Nonpressure, Potable-Water Storage Tanks: Fill tanks to water operating level to ensure structural integrity and freedom from leaks. Hold water level for two hours with no drop in water level.

B. Repair or replace tanks that fail test with new tanks, and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

1. Install horizontal tanks on [**concrete piers and factory-fabricated**][**fabricated steel supports and**] saddles.

B. Anchor tank supports and tanks to substrate.

1. Use steel or FRP straps over or around plastic tanks.

C. Install tank seismic restraints.

D. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220500 "Common Work Results for Plumbing."

E. Install the following devices on tanks where indicated:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

F. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

a. Valves NPS 2 (DN 50) and Smaller: Gate or ball.
b. Valves NPS 2-1/2 (DN 65) and Larger: Gate or butterfly.
c. Drain Valves: **NPS 3/4 (DN 20)** gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."
3. Connect air piping to hydropneumatic tanks with unions or flanges and gate or ball valves. Make connections to dissimilar metals with dielectric fittings, which are specified in Section 221513 "General-Service Compressed-Air Piping."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Verify that air precharge in precharged tanks is correct.

2. Test operation of tank accessories and devices.
3. Verify that pressure relief valves have correct setting.

    a. Manually operate pressure relief valves.
    b. Adjust pressure settings.

4. Verify that vacuum relief valves are correct size.

    a. Manually operate vacuum relief valves.
    b. Adjust vacuum settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tanks.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.
2. Disinfect tanks by one of the following methods:

    a. Fill tanks with water-chlorine solution containing at least **50 ppm (50 mg/L)** of chlorine. Isolate tanks and allow to stand for 24 hours.
    b. Fill tanks with water-chlorine solution containing at least **200 ppm (200 mg/L)** of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.
4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 12 23 00

Task	Specification	Specification Description
22 12 23 13	22 12 23 00	Facility Indoor Potable-Water Storage Tanks
22 12 23 13	22 33 00 00	Electric Domestic-Water Heaters
22 12 23 13	22 34 00 00	Fuel-Fired, Domestic-Water Heaters
22 12 23 26	22 12 23 00	Facility Indoor Potable-Water Storage Tanks

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SECTION 22 13 00 00 - FACILITY GRAY-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, pressure, water storage tank.
2. Steel, nonpressure, water storage tank.
3. Insulated, steel, water storage tanks.
4. Plastic, pressure, water storage tank.
5. Plastic, nonpressure, water storage tanks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for gray-water storage tanks.
2. Include rated capacities, operating characteristics, [**electrical characteristics,**]and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of <**Insert portion of Work**>.
4. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For facility gray-water storage tanks.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer**][**fabricator**].

B. Seismic Qualification Certificates: For gray-water storage tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gray-water storage tanks to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of surface water-storage tanks.

1. Engineering Responsibility: Preparation of data for surface water-storage tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforced Steel."

C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design facility gray-water storage tanks.

B. Structural Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of dead and live gravity loads and winds of [**100 mph (161 km/h)**]<**Insert value**>.

C. Seismic Performance: Surface water-storage tank, including structural reinforcement and foundation, withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: [**1.5**][**1.0**].

D. Thermal Movements: Surface water-storage tank, including structural reinforcement and foundation, shall allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

E. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks."

F. Comply with AWWA D110, "Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks."

G. Comply with AWWA D110, "Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks."

H. Comply with AWWA D115, "Tendon-Prestressed Concrete Water Tanks."

I. Comply with AWWA D120, "Thermosetting Fiberglass-Reinforced Plastic Tanks."

2.2 STEEL, PRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]

12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

K. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.3 STEEL, NONPRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], nonpressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: Steel, constructed with nontoxic welded joints.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

G. Cover for Open Tank: [**Plastic**][**Steel, with lining same as or similar to tank lining and**] with shape that encloses top of tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

K. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.4 INSULATED, STEEL, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]

4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with nontoxic welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

F. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

J. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with

ASHRAE/IES 90.1.

K. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.5 PLASTIC, PRESSURE, WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

C. Description: FRP, vertical, pressure-rated tank with cylindrical sidewalls.

D. Construction: [**ASME code, composite FRP**][**Composite FRP**], [**contact-molded**][**or**][**filament-wound**], thermosetting-resin tank for [**100-psig (690-kPa)**][**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

E. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated, FRP flanged-end nozzle.

1. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or FRP skirt attached by FRP brackets to tank sidewall.

2.6 PLASTIC, NONPRESSURE, WATER STORAGE TANKS

A. FRP Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

3. Description: FRP, vertical, nonpressure-rated water tank.
4. Construction: [**ASTM D3299, filament-wound**][**or**][**ASTM D4097, contact-molded**] FRP.
5. Tappings: Factory-fabricated, FRP flanged-end nozzle.

a. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.

1) [**Exception: Tappings may be threaded FRP coupling integral with nozzle for connections for plastic piping.**]

b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting tank.

B. PE Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]
e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Assmann Corporation of America**]
c. [**Chem-Tainer Industries**]
d. [**Poly Processing Company**]

e. [**Premier Plastics Inc.**]
f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

3. Description: PE, vertical, flat-bottom, nonpressure-rated water tank.
4. Construction: ASTM D1998, molded PE.
5. Tappings: Factory-fabricated bulkhead fittings attached to tank.

a. NPS 2 (DN 50) and Smaller: With female thread.
b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting entire bottom of tank.

C. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.

D. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.

E. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

2.7 PAINT MATERIALS

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's standard epoxy-polyamide paint.

C. Tank Shell Exterior Intermediate Paint: Tank fabricator's standard, two-component epoxy paint compatible with prime and finish paint. Intermediate coat shall have a slight color contrast with finish coat.

D. Tank Shell Exterior Finish Paint: Tank fabricator's standard urethane paint.

1. Color: [**As selected by Owner from tank manufacturer's paint chart**]<**Insert color**>.

2.8 SHOP PAINTING

A. Tank Shell Exterior Finish Coat: Factory coating according to AWWA D103.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices

needing servicing are accessible.

1. Install horizontal tanks on [**concrete piers and factory-fabricated**][**fabricated steel supports and**] saddles.

B. Vertical Water Storage Tanks:

1. Install on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Anchor tank supports and tanks to substrate.

1. Use steel or FRP straps over or around plastic tanks.

D. Install tank seismic restraints.

E. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220500 "Common Work Results for Plumbing."

F. Install the following devices on tanks:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

G. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Tank Weld Test: Use radiographic method according to AWWA D100. Repair failures and retest.
2. Leak Test, AWWA D100: Comply with AWWA D100[**and NFPA 22**]. Fill tanks with water and test for leaks after installation. Repair leaks and retest until no leaks exist.

   a. Water will be furnished by Owner.

3. Leak Test: Comply with [**AWWA D110**][**AWWA D115**][**and NFPA 22**]. Fill tanks with water and test for leaks after installation. Repair leaks and retest until no leaks exist.

   a. Water will be furnished by Owner.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water storage tanks will be considered defective if they do not pass test and inspections.

C. Prepare test and inspection reports.

END OF SECTION 22 13 00 00

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Task	Specification	Specification Description
22 13 13 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 13 16 00 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. ABS pipe and fittings.
8. PVC pipe and fittings.
9. Specialty pipe fittings.
10. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
2. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
3. Section 333115 "Site Sanitary Sewerage Piping" for sanitary sewerage piping and structures outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: [**10 ft. head of water (30 kPa head of water)**]<**Insert pressure**>.
2. Waste, Force-Main Piping: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].

C. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A74, [**service**][**and**][**extra-heavy**] cast iron.

D. Gaskets: ASTM C564, rubber.

E. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

D. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Conine Manufacturing Co., Inc**]
    b. [**SE Sovent**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Conine Manufacturing Co., Inc**]
    b. [**SE Sovent**]
    c. <**Insert manufacturer's name**>

E. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Standards: ASTM C1277 and CISPI 310.
4. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AB & I Foundry; a part of the McWane family of companies**]
   b. [**ANACO-Husky; a part of the McWane family of companies**]
   c. [**Charlotte Pipe and Foundry Company**]
   d. [**Clamp-All Corp**]
   e. [**Dallas Specialty & Mfg. Co.**]
   f. [**Ideal Tridon Group**]
   g. [**MIFAB, Inc**]
   h. [**Mission Rubber Company, LLC**]
   i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**AB & I Foundry; a part of the McWane family of companies**]
   b. [**ANACO-Husky; a part of the McWane family of companies**]
   c. [**Charlotte Pipe and Foundry Company**]
   d. [**Clamp-All Corp**]
   e. [**Dallas Specialty & Mfg. Co.**]
   f. [**Ideal Tridon Group**]
   g. [**MIFAB, Inc**]
   h. [**Mission Rubber Company, LLC**]
   i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   j. **<Insert manufacturer's name>**

3. Standards: ASTM C1277 and ASTM C1540. **<Insert standard>**.
4. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**U.S. Steel**]
   2. [**Wheatland Tube; Zekelman Industries**]
   3. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   1. [**U.S. Steel**]
   2. [**Wheatland Tube; Zekelman Industries**]
   3. **<Insert manufacturer's name>**

C. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight cast iron. Include square-cut-grooved or threaded ends matching joining method.

D. Cast-Iron Drainage Fittings: [**Galvanized;**]ASME B16.12, threaded.

E. Steel Pipe Pressure Fittings:

1. Steel Pipe Nipples: [**Galvanized;**]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [**Galvanized;**]ASME B16.4, Class 125, standard pattern.

F. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

3. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536, ductile-iron castings; ASTM A47/A47M, malleable-iron castings; ASTM A234/A234M, forged steel fittings; or ASTM A106/A106M, steel pipes with dimensions matching ASTM A53/A53M, steel pipe, and complying with AWWA C606 for grooved ends.
4. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.6 STAINLESS STEEL DRAINAGE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anvil; an ASC Engineered Solution**]
2. [**BLÜCHER; A Watts Water Technologies Company**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anvil; an ASC Engineered Solution**]
2. [**BLÜCHER; A Watts Water Technologies Company**]
3. <**Insert manufacturer's name**>

C. Description: Comply with requirements of ASME A112.3.1 drainage pattern.

D. Material: [**Type 304 stainless steel**][**Type 316L stainless steel**][**Type 304 or 316L stainless steel**].

E. Pipe Construction: Seamless.

F. Internal Sealing Rings: [**EPDM**][**NBR**]<**Insert material**>[**, marked or color-coded for the application**].

G. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
3. [**McWane Ductile; a part of the McWane family of companies**]
4. [**U.S. Pipe**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]
2. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
3. [**McWane Ductile; a part of the McWane family of companies**]
4. [**U.S. Pipe**]
5. <**Insert manufacturer's name**>

C. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

E. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends in accordance with AWWA C606.

F. Ductile-Iron, Grooved-End Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Smith-Cooper International**]
   d. [**Star Pipe Products**]
   e. [**Victaulic Company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Smith-Cooper International**]
   d. [**Star Pipe Products**]
   e. [**Victaulic Company**]
   f. <**Insert manufacturer's name**>

3. Grooved-End, Ductile-Iron Fittings: ASTM A536, ductile-iron castings, with dimensions matching AWWA C110/A 21.10, ductile-iron pipe or AWWA C153/A 21.53, ductile-iron fittings, and complying with AWWA C606 for grooved ends.
4. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Cambridge-Lee Industries, LLC**]
3. [**Cerro Flow Products, LLC**]
4. [**Wieland Copper Products, LLC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Cambridge-Lee Industries, LLC**]
3. [**Cerro Flow Products, LLC**]
4. [**Wieland Copper Products, LLC**]
5. <**Insert manufacturer's name**>

C. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

D. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

E. Hard Copper Tube: **ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C)**, water tube, drawn temper.

F. Soft Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**, water tube, annealed temper.

G. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

H. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

I. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.9 ABS PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. <**Insert manufacturer's name**>

C. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic

drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

E. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

F. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

G. Solvent Cement: ASTM D2235.

1. Product Data: Verify ABS solvent cement has a VOC content of 325 g/L or less.
2. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.10 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**GF Piping Systems**]
4. [**JM Eagle**]
5. [**National Pipe and Plastic, Inc. (Oldcastle)**]
6. [**North America Pipe Corporation**]
7. [**Rocky Mountain Colby Pipe Company**]
8. [**Silver-line Plastics**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**GF Piping Systems**]
4. [**JM Eagle**]
5. [**National Pipe and Plastic, Inc. (Oldcastle)**]
6. [**North America Pipe Corporation**]
7. [**Rocky Mountain Colby Pipe Company**]
8. [**Silver-line Plastics**]
9. <**Insert manufacturer's name**>

C. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

D. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

E. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

F. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

G. Adhesive Primer: ASTM F656.

1. Product Data: Verify adhesive primer has a VOC content of 550 g/L or less.
2. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Solvent Cement: ASTM D2564.

1. Product Data: Verify PVC welding solvent cement has a VOC content of 510 g/L or less.

2.11 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) [**Plastic Oddities**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) [**Plastic Oddities**]
5) **<Insert manufacturer's name>**

c. Standard: ASTM C1173.
d. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.
f. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**Mission Rubber Company, LLC**]
3) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**Mission Rubber Company, LLC**]
3) **<Insert manufacturer's name>**

c. Standard: ASTM C1460.
d. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**Cascade Waterworks Mfg. Co.**]
3) [**EBAA Iron Sales, Inc.**]
4) [**Ford Meter Box Company, Inc. (The)**]
5) [**JCM Industries, Inc**]
6) [**Romac Industries, Inc.**]
7) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**Cascade Waterworks Mfg. Co.**]
3) [**EBAA Iron Sales, Inc.**]
4) [**Ford Meter Box Company, Inc. (The)**]
5) [**JCM Industries, Inc**]
6) [**Romac Industries, Inc.**]
7) <**Insert manufacturer's name**>

c. Standard: AWWA C219.
d. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
e. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
f. Gasket Material: Natural or synthetic rubber.
g. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**Capitol Manufacturing Company**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**HART Industrial Unions, LLC**]
5) [**Jomar Valve**]
6) [**Matco-Norca**]
7) [**WATTS; A Watts Water Technologies Company**]
8) [**Wilkins**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**Capitol Manufacturing Company**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**HART Industrial Unions, LLC**]
5) [**Jomar Valve**]
6) [**Matco-Norca**]
7) [**WATTS; A Watts Water Technologies Company**]
8) [**Wilkins**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Capitol Manufacturing Company**]
2) [**GF Piping Systems: Georg Fischer LLC**]
3) [**Matco-Norca**]
4) [**WATTS; A Watts Water Technologies Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Capitol Manufacturing Company**]
2) [**GF Piping Systems: Georg Fischer LLC**]
3) [**Matco-Norca**]
4) [**WATTS; A Watts Water Technologies Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Products & Systems, LLC**]
2) [**CALPICO, Inc.**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**GPT; a division of EnPRO Industries**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Advance Products & Systems, LLC**]
2) [**CALPICO, Inc.**]
3) [**GF Piping Systems: Georg Fischer LLC**]
4) [**GPT; a division of EnPRO Industries**]
5) <**Insert manufacturer's name**>

c. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Elster Perfection; Honeywell**]
3) [**Matco-Norca**]
4) [**Precision Plumbing Products**]
5) [**Victaulic Company**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Elster Perfection; Honeywell**]
3) [**Matco-Norca**]
4) [**Precision Plumbing Products**]
5) [**Victaulic Company**]
6) <**Insert manufacturer's name**>

c. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.12 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping **NPS 3 (DN 80)** and smaller; [**1**][**2**]<**Insert number**> percent downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
2. Horizontal Sanitary Waste Piping: [**Two**]<**Insert number**> percent downward in direction of flow.
3. Vent Piping: [**One**]<**Insert number**> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install steel piping in accordance with applicable plumbing code.

P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**][**and**][**PVC**] piping in accordance with ASTM D2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   c. Do not use pipe sections that have cracked or open welds.

E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

   a. Provide axial restraint for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
   b. Provide rigid sway bracing for pipe and fittings [**4 inches (100 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
   c. Provide rigid sway bracing for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: [**Unshielded**][**Shielded**], nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**][**unions**].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install [**gate**][**full-port ball**] valve for piping **NPS 2 (DN 50)** and smaller.
3. Install [**gate**]<**Insert type**> valve for piping **NPS 2-1/2 (DN 65)** and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in [**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

1. Install [**carbon-steel**]<**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**][**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**]<**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for [**cast-iron**][**steel**][**stainless steel**][**and**][**copper**] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**and**][**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting[**, valve,**] and coupling.

F. Support vertical runs of [**cast-iron**][**steel**][**stainless steel**][**and**][**copper**] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**][**and**][**PVC**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [**with cleanout cover flush with floor**][**in pit with pit cover flush with floor**]<**Insert description**>.
6. Comply with requirements for [**backwater valves**][**cleanouts**][**and**][**drains**] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

   a. Provide shutoff valve if indicated and union for each connection.
   b. Use flanges instead of unions for connections **NPS 2-1/2 (DN 65)** and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

   a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

   a. Close openings in piping system and fill with water to point of overflow, but not less than **10 ft. head of water (30 kPa head of water)**.
   b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.

c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

   a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1 inch wg (250 Pa)**.
   b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
   c. Air pressure must remain constant without introducing additional air throughout period of inspection.
   d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials.

   a. Isolate test source and allow to stand for four hours.
   b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect [**ABS**][**PVC**] plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings[**and hubless, single-stack aerator fittings**]; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings [**and hubless, single-stack aerator fittings**]; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, **Type M (Type C)**; copper pressure fittings; and soldered joints.

6. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. [**Extra-heavy**][**Service**] cast-iron soil piping; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**][**cast-iron**] hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. [**Extra-heavy**][**Service**], cast-iron soil piping; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**][**heavy-duty**][**cast-iron**] hubless-piping couplings; coupled joints.
3. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Hard copper tube, **Type L (Type B)**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:

1. Hard copper tube, **Type L (Type B)**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. [**Hard**][**Soft**] copper tube, **Type L (Type B)**; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than **NPS 1-1/2 (DN 40)** and pressure transition coupling for **NPS 1-1/2 (DN 40)** and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, **Type L (Type B)**; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 13 16 00

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Task	Specification	Specification Description
22 13 16 00	21 05 00 00	Common Work Results for Fire Suppression
22 13 16 00	22 05 00 00	Common Work Results for Plumbing
22 13 16 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 16 00	22 14 13 00	Storm Drainage Piping
22 13 16 00	23 05 00 00	Common Work Results for HVAC

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SECTION 22 13 19 00 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves, horizontal, cast iron.
2. Backwater valves, drain-outlet type.
3. Backwater valves, horizontal, plastic.
4. Cleanouts, cast iron, exposed.
5. Cleanouts, stainless steel, exposed.
6. Cleanouts, cast iron, exposed, floor mounted.
7. Cleanouts, stainless steel, exposed, floor mounted.
8. Cleanouts, cast iron, wall mounted.
9. Cleanouts, plastic, floor mounted.
10. Air-admittance valves, at fixture.
11. Air-admittance valves, stack mounted.
12. Air-admittance valves, wall box.
13. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
6. Section 224300 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
7. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. EPDM: Ethylene propylene diene monomer.

C. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Frost-Resistant Vent Terminals: Show fabrication and installation details.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties.

PART 2 - PRODUCTS

2.1 ASSEMBLY REQUIREMENTS

A. Provide sanitary waste piping specialties bearing label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14 for plastic sanitary waste piping specialty components.

2.2 BACKWATER VALVES

A. Backwater Valves, Horizontal, Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with [**bolted**][**threaded**] access check valve.
6. End Connections: [**Hub and spigot**][**hubless**] .
7. Check Valve: Removable bronze swing check, factory assembled or field modified to hang [**closed**][**open for airflow unless subject to backflow condition**] .
8. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; in place of backwater valve cover.

B. Backwater Valves, Drain-Outlet Type :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

b. [**Josam Company**]
c. [**WATTS; A Watts Water Technologies Company**]
d. [**Zurn; Zurn Elkay**]

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

C. Backwater Valves, Horizontal, Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Endura; a Canplas Industries Company**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Oatey Co.**]
e. [**Plastic Oddities**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**Zurn; Zurn Elkay**]

2. Size: Same as connected piping.
3. Body: [**ABS**][**PVC**] .
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

2.3 CLEANOUTS

A. Cleanouts, Cast Iron, Exposed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a part of the McWane family of companies**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2.
3. Size: Same as connected drainage piping.
4. Body Material: [**Hub-and-spigot, cast-iron soil pipe T-branch**][**Hubless, cast-iron soil pipe test tee**] as required to match connected piping.
5. Closure: [**Countersunk**][**raised-head**] , [**brass**][**cast-iron**][**plastic**] plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cleanouts, Stainless Steel, Exposed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BLÜCHER; A Watts Water Technologies Company**]
   b. [**Josam Company**]
   c. [**Kusel Equipment Co**]
   d. [**Zurn Elkay Water Solutions**]

2. Standard: ASME A112.3.1.
3. Size: Same as connected drainage piping.
4. Body Material: Stainless steel tee with side cleanout as required to match connected piping.
5. Closure: Stainless steel plug with seal.

C. Cleanouts, Cast Iron, Exposed, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Sioux Chief Manufacturing Company, Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2 for [**adjustable housing**][**cast-iron soil pipe with cast-iron ferrule**][**heavy-duty, adjustable housing**][**threaded, adjustable housing**] cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron.
5. Clamping Device: [**Not required**][**Required**] .
6. Outlet Connection: [**Inside caulk**][**Spigot**][**Threaded**] .
7. Closure: [**Brass plug with straight threads and gasket**][**Brass plug with tapered threads**][**Cast-iron plug**][**Plastic plug**] .
8. Adjustable Housing Material: [**Cast iron**][**Plastic**] with [**threads**][**setscrews or other device**] .
9. Frame and Cover Material and Finish: [**Nickel-bronze, copper alloy**][**Painted cast iron**][**Polished bronze**][**Rough bronze**][**Stainless steel**].
10. Frame and Cover Shape: [**Round**][**Square**].
11. Top-Loading Classification: [**Extra-Heavy**][**Heavy**][**Light**][**Medium**] Duty.
12. Riser: ASTM A74, [**Extra-Heavy**][**Service**] Class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cleanouts, Stainless Steel, Exposed, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**BLÜCHER; A Watts Water Technologies Company**]
b. [**Josam Company**]
c. [**Kusel Equipment Co**]
d. [**Zurn; Zurn Elkay**]

2. Standards: ASME A112.3.1 [**; NSF listed**] .
3. Size: Same as connected branch.

4. Housing: [**Type 304**][**Type 316**] stainless steel.
5. Closure: [**Stainless steel with seal**][**Plastic plug**] .
6. Riser: ASTM A74, [**Extra-Heavy**][**Service**] Class, [**stainless steel**][**cast-iron**] drainage pipe fitting and riser to cleanout.
7. Body or Ferrule: Stainless steel.
8. Clamping Device: [**Not required**][**Required**] .
9. Outlet Connection: [**Inside caulk**][**Spigot**][**Threaded**][**Butt-weld**] .
10. Adjustable Housing Material: [**Cast iron**][**Plastic**] with [**threads**][**setscrews or other device**] .
11. Frame and Cover Material and Finish: Stainless steel.
12. Frame and Cover Shape: [**Round**][**Square**] .
13. Top-Loading Classification: [**Extra Heavy**][**Heavy**][**Light**][**Medium**] Duty.

E. Cleanouts, Cast Iron, Wall Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn; Zurn Elkay**]

2. Standard: ASME A112.36.2. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: [**Hub-and-spigot, cast-iron soil pipe T-branch**][**Hubless, cast-iron soil pipe test tee**] as required to match connected piping.
5. Closure Plug:

a. Material: [**Brass**][**Cast iron**] .
b. Closure Type: [**Countersunk**][**raised**] head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, [**deep, chrome-plated bronze**][**flat, chrome-plated brass or stainless steel**] cover plate with screw.
7. Wall Access, Frame and Cover: [**Round**][**Square**] , [**nickel-bronze, copper-alloy, or stainless steel**] wall-installation frame and cover.

F. Cleanouts, Plastic, Floor Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Endura; a Canplas Industries Company**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn; Zurn Elkay**]

2. Size: Same as connected branch.
3. Body: [**ABS**][**PVC**] .
4. Closure Plug: [**ABS**][**PVC**] .
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.4 AIR-ADMITTANCE VALVES

A. Air-Admittance Valves, at Fixture :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**ProVent Systems**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: [**ABS**][**PVC**] .
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Air-Admittance Valves, Stack Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Standard: ASSE 1050 for vent stacks.
3. Housing: [**ABS**][**PVC**] .
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Air-Admittance Valves, Wall Box :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Oatey Co.**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Studor, Inc.; a brand of IPS Corporation**]

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: Approximately **6 inches wide by 6 inches high by 4 inches deep (150 mm wide by 150 mm high by 100 mm deep)**.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains :

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping [**with increaser fitting of size indicated**] .

B. Deep-Seal Traps :

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2 (DN 50): **4-inch- (100-mm-)** minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: **5-inch- (125-mm-)** minimum water seal.

C. Floor Drain, Trap-Seal Primer Fittings :

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with **NPS 1/2 (DN 15)** side inlet.

D. Floor Drain, Inline Trap Seal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Green Drain, Inc.**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**RectorSeal Plumbing; A CSW Industrials Company**]
f. [**Sure Seal; a RectorSeal brand**]
g. [**Zurn; Zurn Elkay**]

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: [**Polypropylene**][**ABS**][**EPDM**][**Silicone rubber**] .
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: [**ICC-ES**][**IAPMO**] listed.
6. Size: Same as floor drain outlet or strainer throat.

E. Air-Gap Fittings :

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

F. Sleeve Flashing Device :

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [**1 inch (25 mm)**][**2 inches (51 mm)**] above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

G. Stack Flashing Fittings :

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Vent Caps :

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

I. Frost-Resistant Vent Terminals :

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide **1-inch (25-mm)** enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

J. Expansion Joints :

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION OF BACKWATER VALVES

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

3.2 INSTALLATION OF CLEANOUTS

A. Install cleanouts in aboveground piping and building drain piping in accordance with the following, unless otherwise indicated:

1. Size same as drainage piping up to **NPS 4 (DN 100)**. Use **NPS 4 (DN 100)** for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of **50 ft. (15 m)** for piping **NPS 4 (DN 100)** and smaller and **100 ft. (30 m)** for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.3 INSTALLATION OF AIR-ADMITTANCE VALVES

A. Install fixture air-admittance valves on fixture drain piping.

B. Install stack air-admittance valves at top of stack vent and vent stack piping.

C. Install air-admittance-valve wall boxes recessed in wall.

3.4 INSTALLATION OF MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains: Assemble open drain fittings and install with top of hub [**1 inch (25 mm)**][**2 inches (51 mm)**] above floor.

B. Deep-Seal Traps: Install deep-seal traps on floor drains and other waste outlets, as indicated [**in the floor drain schedule**][**on Drawings**] .

C. Floor Drain, Trap-Seal Primer Fittings: Install floor drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

D. Floor Drain, Inline Trap Seal: Install inline trap seal device in the outlet of the floor drain in accordance with manufacturer's written instructions.

1. Verify that the floor drain is clean and free of debris.
2. Insert the trap seal into the drain outlet so that it seats fully and forms a secure, watertight fit without distortion.
3. Ensure the device is oriented correctly to maintain proper one-way flow and prevent sewer gas backflow.
4. After installation, pour water through the drain to confirm unrestricted flow and proper operation of the trap seal.
5. Protect inline trap seals from construction debris and damage until Project completion.

E. Air-Gap Fittings: Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

F. Sleeve Flashing Device: Install sleeve and sleeve seals with each riser passing through floors with waterproof membrane.

1. Ensure the pipe is clean and free of debris.

G. Stack Flashing Fittings: Install stack flashing fittings and seals with each stack passing through floors with waterproof membrane.

1. Ensure the pipe is clean and free of debris.

H. Vent Caps: Install vent caps on each vent pipe passing through roof.

1. Ensure the pipe is clean and free of debris.
2. Use setscrews to fasten the cap to the pipe, making sure it is tight and vandal-proof.
3. Confirm that there is at least a **1-inch (25-mm)** gap between the pipe and the roof substrate.

I. Frost-Resistant Vent Terminals: Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch (25-mm)** clearance between vent pipe and roof substrate.

1. Ensure the pipe is clean and free of debris.

J. Expansion Joints: Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

K. Blocking: Install blocking reinforcement for wall-mounting-type specialties.

L. Traps, General: Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.5 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.6 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19 00

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Task	Specification	Specification Description
22 13 19 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 00	23 41 33 00	High-Efficiency Particulate Air Filtration

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SECTION 22 13 19 13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Concrete trench drain-forming system.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sanitary drains are to bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Floor Drain - Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Commercial Enameling Company**]
b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
c. [**Josam Company**]
d. [**MIFAB, Inc**]
e. [**Prier Products, Inc.**]
f. [**Sioux Chief Manufacturing Company, Inc.**]
g. [**Wade; a subsidiary of McWane Inc.**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Whitehall Manufacturing; a division of Morris Group International**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Commercial Enameling Company**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. [**Josam Company**]
   d. [**MIFAB, Inc**]
   e. [**Prier Products, Inc.**]
   f. [**Sioux Chief Manufacturing Company, Inc.**]
   g. [**Wade; a subsidiary of McWane Inc.**]
   h. [**WATTS; A Watts Water Technologies Company**]
   i. [**Whitehall Manufacturing; a division of Morris Group International**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron floor drains from single manufacturer.
4. Standard: ASME A112.6.3[**with backwater valve**].
5. Pattern: [**Area**][**Floor**][**Funnel floor**][**Sanitary**]<**Insert pattern**> drain.
6. Body Material: [**Gray iron**]<**Insert material**>.
7. Seepage Flange: [**Not required**][**Required**].
8. Anchor Flange: [**Not required**][**Required**].
9. Clamping Device: [**Not required**][**Required**].
10. Outlet: [**Bottom**][**Side**]<**Insert type**>.
11. Backwater Valve: [**Drain-outlet type**][**Integral, ASME A112.14.1, swing-check type**][**Not required**].
12. Coating on Interior and Exposed Exterior Surfaces: [**Acid-resistant enamel**][**Not required**]<**Insert material**>.
13. Sediment Bucket: [**Not required**]<**Insert description**>.
14. Top or Strainer Material: [**Bronze**][**Gray iron**][**Nickel bronze**][**Stainless steel**]<**Insert material**>.
15. Top of Body and Strainer Finish: [**Nickel bronze**][**Polished bronze**][**Rough bronze**][**Stainless steel**]<**Insert finish**>.
16. Top Shape: [**Round**][**Square**]<**Insert shape**>.
17. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
18. Top Loading Classification: [**Extra Heavy Duty**][**Heavy Duty**][**Light Duty**][**Medium Duty**].
19. Funnel: [**Not required**][**Required**]<**Insert description and dimensions**>.
20. Inlet Fitting: [**Not required**][**Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection**].
21. Trap Material: [**Bronze**][**Cast iron**][**Copper**][**Not required**]<**Insert material**>.
22. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.
23. Trap Features: [**Cleanout**][**Trap-seal primer valve drain connection**][**Cleanout and trap-seal primer valve drain connection**][**Not required**]<**Insert type**>.

B. Floor Drain - Stainless Steel, ASME A112.3.1 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Zurn Industries, LLC**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Zurn Industries, LLC**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor drains, ASME A112.3.1, from single manufacturer.
4. Standard: ASME A112.3.1.
5. Outlet: [**Bottom**][**Side**]<**Insert type**>.
6. Top or Strainer Material: [**Stainless steel**]<**Insert material**>.
7. Top Shape: [**Round**][**Square**]<**Insert shape**>.
8. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
9. Seepage Flange: [**Not required**][**Required**].
10. Anchor Flange: [**Not required**][**Required**].
11. Clamping Device: [**Not required**][**Required**].
12. Trap-Primer Connection: [**Not required**][**Required**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.

C. Floor Drain - Stainless Steel, ASME A112.6.3 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Josam Company**]
   e. [**Kusel Equipment Co**]
   f. [**Scherping Systems, Inc.**]
   g. [**Sioux Chief Manufacturing Company, Inc.**]
   h. [**Wade; a subsidiary of McWane Inc.**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

d. [**Josam Company**]
e. [**Kusel Equipment Co**]
f. [**Scherping Systems, Inc.**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**Wade; a subsidiary of McWane Inc.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor drains, ASME A112.6.3, from single manufacturer.
4. Standard: ASTM A112.6.3.
5. Outlet: [**Bottom**][**Side**]<**Insert type**>.
6. Top or Strainer Material: [**Stainless steel**]<**Insert material**>.
7. Top Shape: [**Round**][**Square**]<**Insert shape**>.
8. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
9. Seepage Flange: [**Not required**][**Required**].
10. Anchor Flange: [**Not required**][**Required**].
11. Clamping Device: [**Not required**][**Required**].
12. Trap-Primer Connection: [**Not required**][**Required**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Deep-seal P-trap**][**Standard P-trap**][**Not required**]<**Insert pattern**>.

D. Floor Drain - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Josam Company**]
   e. [**Oatey Co.**]
   f. [**Plastic Oddities**]
   g. [**Schluter Systems L.P.**]
   h. [**Sioux Chief Manufacturing Company, Inc.**]
   i. [**Zurn Industries, LLC**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**Josam Company**]
   e. [**Oatey Co.**]
   f. [**Plastic Oddities**]
   g. [**Schluter Systems L.P.**]
   h. [**Sioux Chief Manufacturing Company, Inc.**]
   i. [**Zurn Industries, LLC**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain plastic floor drains from single manufacturer.
4. Standard: ASME A112.6.3.
5. Material: [**ABS**][**or**][**PVC**]<**Insert material**>.
6. Seepage Flange: [**Not required**][**Required**].
7. Clamping Device: [**Not required**][**Required**].
8. Outlet: [**Bottom**][**Side**]<**Insert type**>.
9. Sediment Bucket: [**Not required**]<**Insert description**>.
10. Top or Strainer Material: [**Bronze**][**Plastic**][**Stainless steel**]<**Insert other**>.
11. Top of Body and Strainer Finish: [**Nickel bronze**][**Polished bronze**][**Rough bronze**][**Stainless steel**]<**Insert other**>.
12. Top Shape: [**Round**][**Square**]<**Insert shape**>.
13. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate if required**>.
14. Trap Material: [**Cast iron**][**Plastic drainage piping**][**Not required**]<**Insert material**>.
15. Trap Pattern: [**Standard P-trap**][**Not required**]<**Insert pattern**>.

2.3 FLOOR SINKS

A. Floor Sink - Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Commercial Enameling Company**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. [**Wade; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Commercial Enameling Company**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. [**Wade; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: Cast iron.
7. Anchor Flange: [**Not required**][**Required**][**, with seepage holes**].
8. Clamping Device: [**Not required**][**Required**].
9. Outlet: Bottom, [**no-hub**]<**Insert type**> connection.
10. Coating on Interior Surfaces: [**Not required**][**Acid-resistant enamel**]<**Insert coating**>.
11. Sediment Bucket: [**Not required**]<**Insert description**>.
12. Internal Strainer: [**Not required**][**Dome**][**Flat**].
13. Internal Strainer Material: [**Aluminum**]<**Insert material**>.
14. Top Grate Material: [**Cast iron**]<**Insert material**>[**, loose**][**, hinged**].

15. Top of Body and Grate Finish: [**Nickel bronze**][**Acid-resistant enamel**]<**Insert finish**>.
16. Top Shape: [**Round**][**Square**]<**Insert shape**>.
17. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
18. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
19. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
20. <**Insert additional options here**>.

B. Floor Sink - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Wade; a subsidiary of McWane Inc.**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Wade; a subsidiary of McWane Inc.**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: Stainless steel.
7. Anchor Flange: [**Not required**][**Required**][**, with seepage holes**].
8. Clamping Device: [**Not required**][**Required**].
9. Outlet: Bottom, [**no-hub**]<**Insert type**> connection.
10. Sediment Bucket: [**Not required**]<**Insert description**>.
11. Internal Strainer: [**Not required**][**Dome**][**Flat**].
12. Internal Strainer Material: [**Stainless steel**]<**Insert material**>.
13. Top Grate Material: [**Stainless steel**]<**Insert material**>[**, loose**][**, hinged**].
14. Top of Body and Grate Finish: [**Satin nickel**][**Stainless steel**]<**Insert finish**>.
15. Top Shape: [**Round**][**Square**]<**Insert shape**>.
16. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
17. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
18. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
19. <**Insert additional options here**>.

C. Floor Sink - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**Oatey Co.**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**Oatey Co.**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain plastic floor sinks from single manufacturer.
4. Standard: ASME A112.6.7.
5. Pattern: [**Floor**][**Funnel floor**]<**Insert pattern**> drain.
6. Body Material: PVC.
7. Outlet: Bottom, PVC primer and solvent cement connection.
8. Sediment Bucket: [**Not required**]<**Insert description**>.
9. Internal Strainer: [**Not required**][**Dome**][**Flat**].
10. Internal Strainer Material: [**PVC**]<**Insert material**>.
11. Top Grate Material: [**PVC**]<**Insert material**>.
12. Top Shape: [**Round**][**Square**]<**Insert shape**>.
13. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
14. Top Loading Classification: [**No traffic**]<**Insert traffic loading**>.
15. Funnel: [**Not required**][**Required**]. <**Insert material, shape and dimensions**>.
16. <**Insert additional options here**>.

2.4 TRENCH DRAINS

A. Trench Drain, Individual - Cast Iron or Ductile Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]

b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Sioux Chief Manufacturing Company, Inc.**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain trench drains from single manufacturer.
4. Standard: ASME A112.6.3 for trench drains.
5. Material: Cast iron or ductile iron body.
6. Flange: [**Anchor**][**Seepage**][**Not required**].
7. Clamping Device: [**Not required**][**Required**].
8. Outlet: [**Bottom**][**End**][**Side**]<**Insert location**>.
9. Grate Material: [**Ductile iron**][**Ductile iron or gray iron**][**Gray iron**][**Stainless steel**]<**Insert material**>.
10. Grate Finish: [**Painted**][**Not required**]<**Insert finish**>.
11. Dimensions of Frame and Grate: <**Insert dimensions and describe body, sump, and grate if required**>.
12. Top Loading Classification: [**Extra Heavy Duty**][**Heavy Duty**][**Light Duty**][**Medium Duty**].
13. Trap Material: [**Cast iron**][**Stainless steel**][**Not required**]<**Insert material**>.
14. Trap Pattern: [**Standard P-trap**][**Not required**]<**Insert pattern**>.

B. Trench Drain, Individual - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**WATTS; A Watts Water Technologies Company**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**WATTS; A Watts Water Technologies Company**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain stainless steel trench drain from single manufacturer.
4. Description: Stainless steel trench consisting of sloped trench body, grates, and appurtenances; designed so grates fit into trench body recesses without rocking or rattling.
5. Standard: ASME A112.6.3.
6. Dimensions: <**Insert dimensions**> wide by <**Insert dimensions long**>.
7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channels.

   a. Material: Stainless steel.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to body channel**][**Not required**].

8. Covers: Solid stainless steel of width and thickness that fit recesses in channel, and of length indicated.

9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.

C. Trench Drain, Modular Channel System - Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Eric'sons**]
   d. [**MultiDrain Systems, Inc.**]
   e. [**Vodaland**]
   f. [**Whitehall Manufacturing; a division of Morris Group International**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACO, Inc.**]
   b. [**BLÜCHER; A Watts Water Technologies Company**]
   c. [**Eric'sons**]
   d. [**MultiDrain Systems, Inc.**]
   e. [**Vodaland**]
   f. [**Whitehall Manufacturing; a division of Morris Group International**]
   g. [**Zurn Industries, LLC**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain modular stainless steel channel systems, from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of stainless steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking joint, stainless steel with level invert.

   a. Dimensions: [**6 inches (152 mm)**][**12 inches (305 mm)**] wide. Include number of units required to form total lengths indicated.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channels.

   a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**][**stainless steel**]<**Insert material**>, of width and thickness that fit recesses in channels, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Trench Drain, Modular Channel System - Polymer Concrete, Narrow, Sloped Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**MultiDrain Systems, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABT, Inc.**]
   b. [**ACO, Inc.**]
   c. [**Eric'sons**]
   d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   f. [**MultiDrain Systems, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, sloped-invert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

   a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
   b. Include extension sections necessary for required depth.
   c. Dimensions: [**4-inch (102-mm)**]<**Insert dimension**> inside width. Include number of units required to form total lengths indicated.
   d. Frame: [**Gray-iron, cast iron, or galvanized steel for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

   a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. Trench Drain, Modular Channel System - Polymer Concrete, Narrow, Level Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    e. [**Josam Company**]
    f. [**MultiDrain Systems, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    e. [**Josam Company**]
    f. [**MultiDrain Systems, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, level-insert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
    b. Dimensions: [**5-inch (127-mm)**]<**Insert dimension**> inside width and [**9-3/4 inches (248 mm)**]<**Insert dimension**> inside depth. Include number of units required to form total lengths indicated.
    c. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Cast iron or gray iron**][**Stainless steel**]<**Insert material**>.
    b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile, cast, or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

F. Trench Drain, Modular Channel System - Polymer Concrete, Wide, Level Invert :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wide, level-insert, polymer-concrete channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
b. Dimensions: [**8-inch (203-mm)**]<**Insert dimension**> inside width and [**13-3/4 inches (350 mm)**]<**Insert dimension**> inside depth. Include number of units required to form total lengths indicated.
c. Frame: [**Galvanized steel, gray iron, or cast iron for grates**][**Not required**]<**Insert material**>.

7. Grates: Manufacturer's designation "[**Heavy**][**Medium**] Duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

G. Trench Drain, Modular Channel System - FRP :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACO, Inc.**]
    b. [**Aquaduct, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACO, Inc.**]
    b. [**Aquaduct, Inc.**]
    c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

    a. Dimensions: [**4 inches (102 mm)**][**4 or 6 inches (102 or 152 mm)**][**6 inches (152 mm)**][**6 or 8 inches (152 or 203 mm)**][**8 inches (203 mm)**] wide. Include number of units required to form total lengths indicated.
    b. Frame: [**Galvanized steel**][**Stainless steel**][**Manufacturer's standard metal**]<**Insert material**> for grates.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

    a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
    b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

8. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
9. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
10. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

H. Trench Drain, Modular Channel System - HDPE or PE :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Sioux Chief Manufacturing Company, Inc.**]
    c. [**Tuf-Tite Corporation**]
    d. [**Zurn Industries, LLC**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Sioux Chief Manufacturing Company, Inc.**]
   c. [**Tuf-Tite Corporation**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

I. Trench Drain, Modular Channel System - PP :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Infinity Plastics, Inc.**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Infinity Plastics, Inc.**]
   b. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PP channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, PP modular units, with end caps. Include flat, rounded, or

inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

J. Trench Drain, Modular Channel System - PVC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MultiDrain Systems, Inc.**]
b. [**NDS Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MultiDrain Systems, Inc.**]
b. [**NDS Inc**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain PVC channel drainage systems from single manufacturer.
4. Standard: ASME A112.6.8.
5. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
6. Channel Sections: Interlocking-joint, PVC modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

7. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

8. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.5 CONCRETE TRENCH DRAIN-FORMING SYSTEM

A. Concrete Trench Drain-Forming System: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Eric'sons**]
    d. [**MultiDrain Systems, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABT, Inc.**]
    b. [**ACO, Inc.**]
    c. [**Eric'sons**]
    d. [**MultiDrain Systems, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain concrete trench drain-forming system from single manufacturer.
4. Description: Radius trench-drain-forming system, including a removable form that is customizable for width, depth, length, shape, slope, frame material, and grate material.
5. Form Bottom: [**Smooth radius**][**Vee**][**Flat**]<**Insert option**>.
6. Form Use: [**Single use**][**or**][**reusable**].
7. Form Covers: Plywood or metal to keep concrete out of trench form during installation.
8. Width: [**8-inch (203-mm)**][**10-inch (254-mm)**][**12-inch (305-mm)**][**18-inch (457-mm)**][**24-inch (610-mm)**]<**Insert width**> inside dimension.
9. Depth: [**See Drawings**]<**Insert dimension**>.
10. Length: [**See Drawings**]<**Insert dimension**>.
11. Bottom Shape: [**Smooth radius**][**Vee**]<**Insert shape**>.
12. Slope: [**Level - no slope**][**0.5 percent**][**0.6 percent**][**1.0 percent**]<**Insert slope**>.
13. Frame/Grate Seat:

    a. Load Bearing, <**Insert loading requirement**>.
    b. Material: [**Powder-coated steel**][**Galvanized steel**][**Iron**][**Aluminum**][**Plastic**][**FRP**][**Stainless steel**]<**Insert material**>.

14. Concrete Anchors: [**18 inches (457 mm) o.c.**]<**Insert spacing**>.
15. Grate:

    a. Manufacturer's Load Bearing Designation: "[**Heavy**][**Medium**] Duty".
    b. Material: [**Ductile iron**][**FRP**][**Galvanized steel**][**Cast iron**][**Stainless steel**]<**Insert material**>.
    c. Grate Type: [**ADA**][**Heel-proof**][**slotted**][**perforated**][**bar**]<**Insert grate type**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF SANITARY DRAINS

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than **1/4-inch (6.35-mm)** total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than **1-inch (25-mm)** total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub [**1 inch (25 mm)**][**2 inches (51 mm)**]<**Insert dimension**> above floor.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19 13

Task	Specification	Specification Description
22 13 19 13	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 13	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 13	23 41 33 00	High-Efficiency Particulate Air Filtration
22 13 19 26	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 26	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 26	23 41 33 00	High-Efficiency Particulate Air Filtration
22 13 19 33	22 05 23 00	General-Duty Valves for Plumbing Piping
22 13 19 33	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 33	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 33	23 05 23 00	General-Duty Valves for HVAC Piping
22 13 19 33	23 41 33 00	High-Efficiency Particulate Air Filtration
22 13 19 36	22 13 19 00	Sanitary Waste Piping Specialties
22 13 19 36	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 19 36	23 41 33 00	High-Efficiency Particulate Air Filtration

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SECTION 22 13 23 00 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interceptors, grease.
2. Grease-removal devices.
3. Interceptors, oil.
4. Interceptors, sand.
5. Interceptors, sand and oil.
6. Interceptors, solids.
7. Precast-concrete manhole risers.
8. Manhole risers, frames, and covers.
9. Sampling ports.

1.2 DEFINITIONS

A. FOGs: Fats, oils, greases.

B. FRP: Fiberglass-reinforced plastic.

C. PP: Polypropylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of sanitary waste interceptor.

1. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
2. Include diagrams of power wiring.

B. Shop Drawings: For each type and size of precast-concrete sanitary waste interceptor.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Piping connections. Include size, location, and elevation of each.
2. Interface with underground structures and utility services.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.6 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 INTERCEPTORS, GREASE

A. Interceptors, Grease - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

3. Standard:

   a. ASTM C913.
   b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping

or openings to retain grease and to permit wastewater flow.

6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

    a. Light-Traffic Load: Comply with ASTM C890, A-8.
    b. Medium-Traffic Load: Comply with ASTM C890, A-12.
    c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
    d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**GREASE INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
    c. Flow Rate: <**Insert gpm (L/s)**>.
    d. Retention Capacity: <**Insert lb (kg)**>.
    e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.
    k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

B. Interceptors, Grease - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]

c. [**MIFAB, Inc**]
d. [**ParkUSA; a Northwest Pipe Company**]
e. [**Rockford Separators**]
f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**ParkUSA; a Northwest Pipe Company**]
   e. [**Rockford Separators**]
   f. [**Wade; a subsidiary of McWane Inc.**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Standard:

   a. PDI G101.
   b. [**ASME A112.14.3**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
6. Body Material: Steel.
7. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
9. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
10. Body Extension: <**Insert inches (mm)**> height.
11. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
    c. Flow Rate: <**Insert gpm (L/s)**>.
    d. Retention Capacity: <**Insert lb (kg)**>.
    e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

       1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
       2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.
    k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

C. Interceptors, Grease - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ashland PolyTrap**]
    b. [**Bio-Microbics, Inc.**]
    c. [**Canplas Industries Ltd.**]
    d. [**MIFAB, Inc**]
    e. [**Rockford Separators**]
    f. [**Schier Products Company**]
    g. [**Town & Country Plastics, Inc**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ashland PolyTrap**]
    b. [**Bio-Microbics, Inc.**]
    c. [**Canplas Industries Ltd.**]
    d. [**MIFAB, Inc**]
    e. [**Rockford Separators**]
    f. [**Schier Products Company**]
    g. [**Town & Country Plastics, Inc**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

3. Standard:

    a. PDI G101.
    b. [**ASME A112.14.3**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease interceptor for intercepting and retaining FOG from food[**-preparation**][**or**][**-processing**] wastewater.
6. Body Material: Plastic.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Body Extension: <**Insert inches (mm)**> height.
9. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Number of Compartments: [**One**][**Two**]<**Insert number**>.
    c. Flow Rate: <**Insert gpm (L/s)**>.
    d. Retention Capacity: <**Insert lb (kg)**>.
    e. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.

j. Flow-Control Fitting: Required.
k. Operation: [**Manual cleaning**][**Semiautomatic, manual drawoff**]<**Insert operation**>.

2.2 GREASE-REMOVAL DEVICES

A. Grease-Removal Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**G K & L, Inc**]
   b. [**Grease Guardian**]
   c. [**Highland Tank & Manufacturing Company, Inc.**]
   d. [**International Grease Recovery Device**]
   e. [**Josam Company**]
   f. [**MIFAB, Inc**]
   g. [**Thermaco, Inc**]
   h. [**Wade; a subsidiary of McWane Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**G K & L, Inc**]
   b. [**Grease Guardian**]
   c. [**Highland Tank & Manufacturing Company, Inc.**]
   d. [**International Grease Recovery Device**]
   e. [**Josam Company**]
   f. [**MIFAB, Inc**]
   g. [**Thermaco, Inc**]
   h. [**Wade; a subsidiary of McWane Inc.**]
   i. <**Insert manufacturer's name**>

3. Standard:

   a. PDI G101.
   b. [**ASME A112.14.3**].
   c. [**ASME A112.14.4**].

4. PDI Seal: Required.
5. Description: Factory-fabricated grease-removal device for automatic intercepting and removal of FOG from food[**-preparation**][**or**][**-processing**]<**Insert application**> wastewater.
6. Body Material: [**Stainless steel**][**Steel**]<**Insert material**>.
7. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacture's acid-resistant coating.
9. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
10. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
11. Capacities and Characteristics:

    a. Heater: Required.
    b. Length by Width by Depth: <**Insert inches (mm)**>.

c. Flow Rate: <**Insert gpm (L/s)**>.
d. Basket Material: [**Stainless steel**]<**Insert material**>.
e. Inlet and Outlet Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Cleanout: Integral[**or field installed on outlet**].
g. Vent Pipe Size: <**Insert NPS (DN)**>.
h. Mounting: [**Above floor**]<**Insert mounting**>.
i. Flow-Control Fitting: Required.
j. Operation: [**Automatic recovery**]<**Insert operation**>.
k. Electrical Characteristics:

1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2) Power Requirement: [**120 V ac**]<**Insert power**>.
3) Full-Load Amperes: <**Insert number**> A.
4) Minimum Circuit Ampacity: <**Insert number**> A.
5) Maximum Overcurrent Protection: <**Insert number**> A.

l. Waste Grease Receptacle: [**Furnished by Owner**]<**Insert description**>.

2.3 INTERCEPTORS, OIL

A. Interceptors, Oil - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Concrete Products Co.**]
b. [**Copeland Precast, Inc.**]
c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
d. [**Wieser Concrete**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Concrete Products Co.**]
b. [**Copeland Precast, Inc.**]
c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
d. [**Wieser Concrete**]
e. <**Insert manufacturer's name**>

3. Standard:

a. ASTM C913.
b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles,

vents, and flow-control fitting on inlet.

5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain oil and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

    a. Light-Traffic Load: Comply with ASTM C890, A-8.
    b. Medium-Traffic Load: Comply with ASTM C890, A-12.
    c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
    d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser, with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
13. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.

B. Interceptors, Oil - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
10. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
11. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet Required: Integral.

g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

C. Interceptors, Oil - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**MIFAB, Inc**]
   b. [**Striem**]
   c. [**Town & Country Plastics, Inc**]
   d. [**Xerxes by Shawcor Ltd.**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MIFAB, Inc**]
   b. [**Striem**]
   c. [**Town & Country Plastics, Inc**]
   d. [**Xerxes by Shawcor Ltd.**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
9. Capacities and Characteristics:

   a. Length by Width by Depth: <**Insert inches (mm)**>.
   b. Flow Rate: <**Insert gpm (L/s)**>.
   c. Capacity: <**Insert gal. (L)**>.
   d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

      1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
      2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

   e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

      1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

   f. Trapped Outlet: Integral.

g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.4 INTERCEPTORS, SAND

A. Interceptors, Sand - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Concrete Products Co.**]
   b. [**Copeland Precast, Inc.**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Wieser Concrete**]
   e. <**Insert manufacturer's name**>

3. Standard:

   a. ASTM C913.
   b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated sand interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain sand and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

   a. Light-Traffic Load: Comply with ASTM C890, A-8.
   b. Medium-Traffic Load: Comply with ASTM C890, A-12.
   c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
   d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-**

inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [60 inches (1500 mm)]<**Insert dimension**>.

10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**SAND INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert** inches (mm)>.
    b. Flow Rate: <**Insert** gpm (L/s)>.
    c. Capacity: <**Insert** gal. (L)>.
    d. Inlet and Outlet Pipe Size: <**Insert** NPS (DN)>.

        1) Centerline of Inlet to Floor: <**Insert** inches (mm)>.
        2) Centerline of Outlet to Floor: <**Insert** inches (mm)>.

    e. Trapped Outlet: Integral.
    f. Cleanout: Integral[**or field installed on outlet**].
    g. Vent Pipe Size: <**Insert** NPS (DN)>.
    h. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    i. Flow-Control Fitting: Required.

B. Interceptors, Sand - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. [**Zurn Industries, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]

f. [**Wade; a subsidiary of McWane Inc.**]
g. [**WATTS; A Watts Water Technologies Company**]
h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand interceptor, steel body and inlet grate; with settlement chamber and removable basket or strainer made for removing and retaining sand from wastewater.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resisting coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resisting coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Grate: Cast iron or steel with reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
9. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Trapped Outlet: Integral.
f. Cleanout: Integral[**or field installed on outlet**].
g. Vent Pipe Size: <**Insert NPS (DN)**>.
h. Installation Position: [**Top flush with grade**]<**Insert position**>.

C. Interceptors, Sand - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.5 INTERCEPTORS, SAND AND OIL

A. Interceptors, Sand and Oil - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Copeland Precast, Inc.**]
b. [**Oldcastle Infrastructure Inc.; CRH Americas**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Copeland Precast, Inc.**]
b. [**Oldcastle Infrastructure Inc.; CRH Americas**]
c. <**Insert manufacturer's name**>

3. Standard:

a. ASTM C913.
b. [**Specific requirements of the Authority Having Jurisdiction**].

4. Description: Factory-fabricated sand and oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
5. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain sand and to permit wastewater flow.
6. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
7. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.

c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into interceptor walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
11. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**][**SAND & OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

12. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
13. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

        1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
        2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Trapped Outlet: Integral.
    f. Cleanout: Integral[**or field installed on outlet**].
    g. Vent Pipe Size: <**Insert NPS (DN)**>.
    h. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    i. Flow-Control Fitting: Required.

B. Interceptors, Sand and Oil - Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]
    d. [**ParkUSA; a Northwest Pipe Company**]
    e. [**Rockford Separators**]
    f. [**Wade; a subsidiary of McWane Inc.**]
    g. [**WATTS; A Watts Water Technologies Company**]

h. [**Zurn Industries, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**ParkUSA; a Northwest Pipe Company**]
   e. [**Rockford Separators**]
   f. [**Wade; a subsidiary of McWane Inc.**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand and oil interceptor with removable basket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Steel.
5. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
6. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
8. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
9. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C890 [**A-03, walkway**]<**Insert loading type**> load.
10. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
11. Capacities and Characteristics:

    a. Length by Width by Depth: <**Insert inches (mm)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Capacity: <**Insert gal. (L)**>.
    d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

       1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
       2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

       1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

    f. Trapped Outlet: Integral.
    g. Cleanout: Integral[**or field installed on outlet**].
    h. Vent Pipe Size: <**Insert NPS (DN)**>.
    i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
    j. Flow-Control Fitting: Required.

C. Interceptors, Sand and Oil - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. [**Town & Country Plastics, Inc**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Striem**]
c. [**Town & Country Plastics, Inc**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sand and oil interceptor with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
4. Body Material: Plastic.
5. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
6. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
7. Cover: Plastic[**with steel reinforcement to provide ASTM C890**][**A-03, walkway**]<**Insert loading type**> load.
8. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
9. Capacities and Characteristics:

a. Length by Width by Depth: <**Insert inches (mm)**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. Capacity: <**Insert gal. (L)**>.
d. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Inlet to Floor: <**Insert inches (mm)**>.
2) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

e. Waste-Oil-Outlet Pipe Size: <**Insert NPS (DN)**>.

1) Centerline of Outlet to Floor: <**Insert inches (mm)**>.

f. Trapped Outlet: Integral.
g. Cleanout: Integral[**or field installed on outlet**].
h. Vent Pipe Size: <**Insert NPS (DN)**>.
i. Mounting: [**Above floor**][**Recessed in acid-resistant, coated steel frame and cradle**][**Recessed, flush with floor**]<**Insert mounting**>.
j. Flow-Control Fitting: Required.

2.6 INTERCEPTORS, SOLIDS

A. Interceptors, Solids - Cast Iron, Cast Aluminum, or Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Rockford Separators**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Rockford Separators**]
e. [**Wade; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Description: Factory-fabricated solids interceptor made for removing and retaining [**lint**][**sediment**]<**Insert solid**> from wastewater.
4. Body Material: Cast iron, cast aluminum or steel.
5. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
6. Interior Lining: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
7. Exterior Coating: Factory-applied epoxy, polyurethane, or manufacturer's acid-resistant coating.
8. Inlet, and Outlet Piping Connections: Threaded unless otherwise indicated.
9. Body Dimensions: <**Insert dimensions**>.
10. Flow Rate: <**Insert gpm (L/s)**>.
11. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.
12. Mounting: [**Above floor**][**Inline**]<**Insert mounting**>.

B. Interceptors, Solids - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashland PolyTrap**]
b. [**MIFAB, Inc**]
c. [**Striem**]
d. [**Town & Country Plastics, Inc**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashland PolyTrap**]

b. [**MIFAB, Inc**]
c. [**Striem**]
d. [**Town & Country Plastics, Inc**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated interceptor made for removing and retaining [**lint**][**sediment**]<**Insert solid**> from wastewater.
4. Body Material: Plastic.
5. Interior Separation Device: [**Baffles**][**Screens**]<**Insert device**>.
6. Inlet, and Outlet Piping Connections: Threaded unless otherwise indicated.
7. Body Dimensions: <**Insert dimensions**>.
8. Flow Rate: <**Insert gpm (L/s)**>.
9. Inlet and Outlet Pipe Size: <**Insert NPS (DN)**>.
10. Mounting: [**Above floor**][**Inline**]<**Insert mounting**>.

2.7 MANHOLE RISERS, FRAMES, AND COVERS

A. Precast-Concrete Manhole Risers: [**ASTM C478 (ASTM C478M)**][**ASTM C913**], with rubber-gasket joints.

1. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.
c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

2. Length: From top of underground concrete structure to grade.
3. Riser Sections: **3-inch (75-mm)** minimum thickness and [**36-inch (915-mm)**]<**Insert dimension**> diameter.
4. Top Section: Eccentric cone unless otherwise indicated. Include top of cone to match grade ring size.
5. Gaskets: **ASTM C443 (ASTM C443M)**, rubber.
6. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals.

B. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover.

1. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
2. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
3. Include indented top design with lettering cast into cover, using wording equivalent to the following:

a. Grease Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**GREASE INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

b. Oil Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.
c. Sand Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**SAND INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.
d. Sand and Oil Interceptors in Sanitary Sewerage System: "[**INTERCEPTOR**][**SAND & OIL INTERCEPTOR**][**SANITARY SEWER**]" <**Insert lettering**>.

2.8 SAMPLING PORTS

A. Sampling Ports - Precast Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ParkUSA; a Northwest Pipe Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ParkUSA; a Northwest Pipe Company**]
   b. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Precast concrete or Class I/II concrete with design strength of **4500 psi (31,026 kPa)** at 28 days.
5. Location: Below grade.
6. Body Interior Diameter: [**15-inch (381-mm)**][**18-inch (458-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
7. Structural Design Loads:

   a. Light-Traffic Load: Comply with ASTM C890, A-8.
   b. Medium-Traffic Load: Comply with ASTM C890, A-12.
   c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
   d. Walkway Load: Comply with ASTM C890, A-03.

8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into walls, for each pipe connection.
9. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover.
10. Manhole Frames and Covers:

    a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

B. Sampling Ports - Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ParkUSA; a Northwest Pipe Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ParkUSA; a Northwest Pipe Company**]
b. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Type 304 stainless steel conforming with ASTM A480/A480M.
5. Body Diameter: [**15-inch (381-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
6. Location: [**Above grade**][**In accessible pit**].
7. Cover: Removable lid with securing bolts and gasket.

a. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

C. Sampling Ports - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MIFAB, Inc**]
b. [**Schier Products Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MIFAB, Inc**]
b. [**Schier Products Company**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated sampling port.
4. Body Material: Seamless rotationally molded polyethylene or molded HDPE.
5. Body Diameter: [**15-inch (381-mm)**][**18-inch (458-mm)**][**24-inch (610-mm)**]<**Insert dimension**> diameter.
6. Location: [**Above grade**][**In accessible pit**][**Below grade**].
7. Cover: Water and gas-tight seal.

a. Include indented top design with lettering cast into cover, using wording equivalent to "[**SAMPLING WELL/PORT**]" <**Insert lettering**>.

8. Body Extension: <**Insert inches (mm)**> height.
9. Structural Design Loads:

a. Light-Traffic Load: Comply with ASTM C890, A-8.
b. Medium-Traffic Load: Comply with ASTM C890, A-12.

c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
d. Walkway Load: Comply with ASTM C890, A-03.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF SANITARY WASTE INTERCEPTORS

A. Equipment Mounting:

1. Install [**grease interceptors**][**grease-removal devices**][**and**][**solids interceptors**] on cast-in-place concrete equipment base(s).
2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Install precast-concrete interceptors in accordance with ASTM C891.

C. Set interceptors level and plumb.

D. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

E. Set tops of manhole frames and covers flush with finished surface in pavements.

1. Set tops [**3 inches (75 mm)**]<**Insert dimension**> above finish surface elsewhere unless otherwise indicated.

F. Set tops of grating frames and grates flush with finished surface.

G. Set [**metal**][**and**][**plastic**] interceptors level and plumb.

H. Set tops of metal interceptor covers flush with finished surface in pavements.

1. Set tops [**3 inches (75 mm)**]<**Insert dimension**> above finish surface elsewhere unless otherwise indicated.

I. Install captured waste oil piping and waste oil storage tanks in accordance with the requirements of the Authority Having Jurisdiction.

J. Install grease interceptors, including trapping, venting, and flow-control fitting, in accordance with authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

K. Install grease-removal devices on floor. Install trap, vent, and flow-control fitting in accordance with authorities having jurisdiction.

1. Install control panel adjacent to unit unless otherwise indicated.

L. Install oil and sand & oil interceptors, including trapping, venting, and flow-control fitting, in accordance with authorities having jurisdiction and with clear space for servicing.

1. Coordinate captured waste oil storage tank and/or gravity drain with the Authority Having Jurisdiction.

M. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.

1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inches (13 mm)** high.

3.5 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving."

1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
2. Use warning tapes or detectable warning tape over ferrous piping.
3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or

near each of the following:

1. Grease interceptors.
2. Grease-removal devices.
3. Oil and sand, and oil interceptors.
4. Solids interceptors.
5. Sampling ports.

3.6 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23 00

Task	Specification	Specification Description
22 13 23 00	22 13 19 00	Sanitary Waste Piping Specialties
22 13 23 00	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 13 29 00 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Submersible sewage pumps.
3. Wet-pit-volute sewage pumps.
4. Sewage-pump, reverse-flow assemblies.
5. Sewage-pump basins and basin covers.
6. Progressing-cavity sewage pumps.
7. Packaged, submersible sewage-pump units.
8. Packaged wastewater-pump units.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for applications in storm-drainage systems.
2. Section 333200 "Site Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. [**Include construction details, material descriptions, dimensions of individual components and profiles.**][**Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**]

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE EFFLUENT PUMPS

A. Submersible, Fixed-Position, Single-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Barnes; a Crane Pumps & Systems brand**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]
   e. [**Goulds Water Technology; a Xylem brand**]
   f. [**GRUNDFOS CBS Inc.**]
   g. [**Liberty Pumps**]
   h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
   i. [**Pentair Aurora; Pentair Pump Group**]
   j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
   l. [**Stancor, Inc**]
   m. [**WILO-EMU USA LLC**]
   n. [**Zoeller Company**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Barnes; a Crane Pumps & Systems brand**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]

e. [**Goulds Water Technology; a Xylem brand**]
f. [**GRUNDFOS CBS Inc.**]
g. [**Liberty Pumps**]
h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
i. [**Pentair Aurora; Pentair Pump Group**]
j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Stancor, Inc**]
m. [**WILO-EMU USA LLC**]
n. [**Zoeller Company**]
o. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to

building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABS; Cardo Flow Solutions**]
   b. [**BJM Pumps, LLC**]
   c. [**Federal Pump Corp**]
   d. [**HOMA Pump Technology Inc.**]
   e. [**KSB Inc.**]
   f. [**Liberty Pumps**]
   g. [**Pentair Aurora; Pentair Pump Group**]
   h. [**PX Pumps USA**]
   i. [**Stancor, Inc**]
   j. [**Tsurumi America, Inc.**]
   k. [**WILO-EMU USA LLC**]
   l. [**Zoeller Company**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABS; Cardo Flow Solutions**]
   b. [**BJM Pumps, LLC**]
   c. [**Federal Pump Corp**]
   d. [**HOMA Pump Technology Inc.**]
   e. [**KSB Inc.**]
   f. [**Liberty Pumps**]
   g. [**Pentair Aurora; Pentair Pump Group**]
   h. [**PX Pumps USA**]
   i. [**Stancor, Inc**]
   j. [**Tsurumi America, Inc.**]
   k. [**WILO-EMU USA LLC**]
   l. [**Zoeller Company**]
   m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.

8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Liberty Pumps**]
    b. [**Pentair Aurora; Pentair Pump Group**]
    c. [**Stancor, Inc**]
    d. [**WILO-EMU USA LLC**]
    e. [**Zoeller Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Liberty Pumps**]
b. [**Pentair Aurora; Pentair Pump Group**]
c. [**Stancor, Inc**]
d. [**WILO-EMU USA LLC**]
e. [**Zoeller Company**]
f. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

   a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

       1) On-off status of pump.
       2) Alarm status.

13. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABS; Cardo Flow Solutions**]
    b. [**Chicago Pump Company; Grundfos Pumps Corporation**]
    c. [**Federal Pump Corp**]
    d. [**Flygt; a brand of Xylem Inc.**]
    e. [**HOMA Pump Technology Inc.**]
    f. [**Liberty Pumps**]
    g. [**Pentair Aurora; Pentair Pump Group**]
    h. [**PX Pumps USA**]
    i. [**Stancor, Inc**]
    j. [**Tsurumi America, Inc.**]
    k. [**WILO-EMU USA LLC**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABS; Cardo Flow Solutions**]
    b. [**Chicago Pump Company; Grundfos Pumps Corporation**]
    c. [**Federal Pump Corp**]
    d. [**Flygt; a brand of Xylem Inc.**]
    e. [**HOMA Pump Technology Inc.**]
    f. [**Liberty Pumps**]
    g. [**Pentair Aurora; Pentair Pump Group**]
    h. [**PX Pumps USA**]
    i. [**Stancor, Inc**]
    j. [**Tsurumi America, Inc.**]
    k. [**WILO-EMU USA LLC**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

14. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump

during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

a. Capacity: <**Insert value**> **gpm (L/min.)**.
b. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.
c. Total Dynamic Head: <**Insert value**>**feet (kPa)**.
d. Speed: <**Insert rpm**>.
e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
f. Motor Horsepower: <**Insert value**> hp.
g. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
2) Phases: [**Single**][**Three**].
3) Hertz: 60.

4. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**> A.
b. Minimum Circuit Ampacity: <**Insert value**> A.
c. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Fixed-Position, Single-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**EBARA Pumps Americas Corp.**]
d. [**Flo Fab Inc**]
e. [**Flygt; a brand of Xylem Inc.**]
f. [**Goulds Water Technology; a Xylem brand**]
g. [**GRUNDFOS CBS Inc.**]
h. [**Liberty Pumps**]
i. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
j. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
k. [**Peerless Pump Company**]
l. [**Pentair Aurora; Pentair Pump Group**]
m. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
n. [**Swaby Manufacturing Company**]
o. [**Weil Pump; a Wilo Company**]

p. [**Weinman; a Crane Pumps & Systems brand**]
q. [**WILO-EMU USA LLC**]
r. [**Zoeller Company**]
s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Bell & Gossett; a Xylem brand**]
   c. [**EBARA Pumps Americas Corp.**]
   d. [**Flo Fab Inc**]
   e. [**Flygt; a brand of Xylem Inc.**]
   f. [**Goulds Water Technology; a Xylem brand**]
   g. [**GRUNDFOS CBS Inc.**]
   h. [**Liberty Pumps**]
   i. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
   j. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
   k. [**Peerless Pump Company**]
   l. [**Pentair Aurora; Pentair Pump Group**]
   m. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   n. [**Swaby Manufacturing Company**]
   o. [**Weil Pump; a Wilo Company**]
   p. [**Weinman; a Crane Pumps & Systems brand**]
   q. [**WILO-EMU USA LLC**]
   r. [**Zoeller Company**]
   s. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

   a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.

e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Goulds Water Technology; a Xylem brand**]
k. [**HOMA Pump Technology Inc.**]
l. [**KSB Inc.**]
m. [**Liberty Pumps**]
n. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
o. [**Pentair Aurora; Pentair Pump Group**]
p. [**PX Pumps USA**]
q. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
r. [**Stancor, Inc**]
s. [**Swaby Manufacturing Company**]
t. [**Weil Pump; a Wilo Company**]
u. [**Weinman; a Crane Pumps & Systems brand**]
v. [**WILO-EMU USA LLC**]
w. [**Zoeller Company**]
x. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Goulds Water Technology; a Xylem brand**]
k. [**HOMA Pump Technology Inc.**]
l. [**KSB Inc.**]
m. [**Liberty Pumps**]
n. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
o. [**Pentair Aurora; Pentair Pump Group**]
p. [**PX Pumps USA**]
q. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
r. [**Stancor, Inc**]
s. [**Swaby Manufacturing Company**]
t. [**Weil Pump; a Wilo Company**]
u. [**Weinman; a Crane Pumps & Systems brand**]
v. [**WILO-EMU USA LLC**]
w. [**Zoeller Company**]
x. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.

e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBARA Pumps Americas Corp.**]
b. [**Flygt; a brand of Xylem Inc.**]
c. [**Gorman-Rupp Company (The)**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Liberty Pumps**]
f. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
g. [**Pentair Aurora; Pentair Pump Group**]
h. [**Swaby Manufacturing Company**]
i. [**Weil Pump; a Wilo Company**]
j. [**WILO-EMU USA LLC**]
k. [**Zoeller Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBARA Pumps Americas Corp.**]
b. [**Flygt; a brand of Xylem Inc.**]
c. [**Gorman-Rupp Company (The)**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Liberty Pumps**]
f. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
g. [**Pentair Aurora; Pentair Pump Group**]
h. [**Swaby Manufacturing Company**]
i. [**Weil Pump; a Wilo Company**]

j. [**WILO-EMU USA LLC**]
k. [**Zoeller Company**]
l. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]
g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Gorman-Rupp Company (The)**]
k. [**Goulds Water Technology; a Xylem brand**]
l. [**HOMA Pump Technology Inc.**]
m. [**KSB Inc.**]
n. [**Liberty Pumps**]
o. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
p. [**Pentair Aurora; Pentair Pump Group**]
q. [**PX Pumps USA**]
r. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
s. [**Stancor, Inc**]
t. [**Swaby Manufacturing Company**]
u. [**Tsurumi America, Inc.**]
v. [**Weil Pump; a Wilo Company**]
w. [**Weinman; a Crane Pumps & Systems brand**]
x. [**WILO-EMU USA LLC**]
y. [**Zoeller Company**]
z. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Barnes; a Crane Pumps & Systems brand**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**BJM Pumps, LLC**]
e. [**Chicago Pump Company; Grundfos Pumps Corporation**]
f. [**E.I.M. Electric Co., Ltd.**]

g. [**EBARA Pumps Americas Corp.**]
h. [**Federal Pump Corp**]
i. [**Flygt; a brand of Xylem Inc.**]
j. [**Gorman-Rupp Company (The)**]
k. [**Goulds Water Technology; a Xylem brand**]
l. [**HOMA Pump Technology Inc.**]
m. [**KSB Inc.**]
n. [**Liberty Pumps**]
o. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
p. [**Pentair Aurora; Pentair Pump Group**]
q. [**PX Pumps USA**]
r. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
s. [**Stancor, Inc**]
t. [**Swaby Manufacturing Company**]
u. [**Tsurumi America, Inc.**]
v. [**Weil Pump; a Wilo Company**]
w. [**Weinman; a Crane Pumps & Systems brand**]
x. [**WILO-EMU USA LLC**]
y. [**Zoeller Company**]
z. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
4. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
6. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**ASTM B584, cast bronze**][**and**][**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA

250, Type 6 enclosures with mounting rod and electric cables.

c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.

b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.

2) Alarm status.

14. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."

b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.

c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.

d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.

f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.

g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Submersible, Quick-Disconnect, Grinder Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABS; Cardo Flow Solutions**]

b. [**Alyan Pump Company**]

c. [**Barnes; a Crane Pumps & Systems brand**]

d. [**BJM Pumps, LLC**]

e. [**EBARA Pumps Americas Corp.**]

f. [**HOMA Pump Technology Inc.**]

g. [**Liberty Pumps**]

h. [**Pentair Aurora; Pentair Pump Group**]

i. [**Stancor, Inc**]

j. [**Tsurumi America, Inc.**]

k. [**Vaughan Co., Inc.**]

l. [**Weil Pump; a Wilo Company**]

m. [**WILO-EMU USA LLC**]

n. [**Zoeller Company**]

o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABS; Cardo Flow Solutions**]
b. [**Alyan Pump Company**]
c. [**Barnes; a Crane Pumps & Systems brand**]
d. [**BJM Pumps, LLC**]
e. [**EBARA Pumps Americas Corp.**]
f. [**HOMA Pump Technology Inc.**]
g. [**Liberty Pumps**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**Stancor, Inc**]
j. [**Tsurumi America, Inc.**]
k. [**Vaughan Co., Inc.**]
l. [**Weil Pump; a Wilo Company**]
m. [**WILO-EMU USA LLC**]
n. [**Zoeller Company**]
o. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
6. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

   a. Motor Housing Fluid: [**Air**][**Oil**].

10. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Controls, Float- and Pressure-Switch Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
    b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

F. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barnes; a Crane Pumps & Systems brand**]
b. [**Environment One Corporation**]
c. [**Pentair Aurora; Pentair Pump Group**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Barnes; a Crane Pumps & Systems brand**]
b. [**Environment One Corporation**]
c. [**Pentair Aurora; Pentair Pump Group**]
d. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, progressing-cavity, grinder sewage-pump unit with guide-rail supports.
4. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
5. Pump Body: [**Cast iron**]<**Insert material**>.
6. Pump Bearings: Radial and thrust types.
7. Pump Shaft: Steel.
8. Rotor: Stainless steel.
9. Stator: [**Buna-N**][**or**][**natural rubber**]<**Insert material**>.
10. Seal: Packing gland and mechanical types.
11. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
12. Controls, Rod-and-Float Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

14. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

15. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

G. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

a. Capacity: <**Insert value**> **gpm (L/min.)**.
b. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.
c. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
d. Speed: <**Insert rpm**>.
e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.

f. Motor Horsepower: <**Insert value**> hp.
g. Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
2) Phases: [**Single**][**Three**].
3) Hertz: 60.

4. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**> A.
b. Minimum Circuit Ampacity: <**Insert value**> A.
c. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 WET-PIT-VOLUTE SEWAGE PUMPS

A. Description: Factory-assembled and -tested sewage-pump unit.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alyan Pump Company**]
2. [**Armstrong Fluid Technology**]
3. [**Chicago Pump Company; Grundfos Pumps Corporation**]
4. [**Federal Pump Corp**]
5. [**Flo Fab Inc**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Peerless Pump Company**]
8. [**Pentair Aurora; Pentair Pump Group**]
9. [**Swaby Manufacturing Company**]
10. [**Tramco Pump Company**]
11. [**Vertiflo Pump Company**]
12. [**Weil Pump; a Wilo Company**]
13. [**Weinman; a Crane Pumps & Systems brand**]
14. [**Yeomans Chicago Corporation**]
15. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alyan Pump Company**]
2. [**Armstrong Fluid Technology**]
3. [**Chicago Pump Company; Grundfos Pumps Corporation**]
4. [**Federal Pump Corp**]
5. [**Flo Fab Inc**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Peerless Pump Company**]
8. [**Pentair Aurora; Pentair Pump Group**]
9. [**Swaby Manufacturing Company**]
10. [**Tramco Pump Company**]
11. [**Vertiflo Pump Company**]
12. [**Weil Pump; a Wilo Company**]
13. [**Weinman; a Crane Pumps & Systems brand**]
14. [**Yeomans Chicago Corporation**]
15. <**Insert manufacturer's name**>

D. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.

E. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.

F. Pump Shaft: [**Stainless steel**][**and**][**steel**].

G. Impeller: Statically and dynamically balanced, [**ASTM A48/A48M, Class No. 25 A cast iron**][**ASTM A532/A532M, abrasion-resistant cast iron**][**and**][**ASTM B584, cast bronze**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.

H. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at **48-inch- (1200-mm-)** maximum intervals if basin depth is more than **48 inches (1200 mm)**, and grease-lubricated, ball-type thrust bearings.

I. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

J. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.

1. Revise piping configuration to accommodate reverse-flow assembly.

K. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sewage-Pump Basins and Basin Covers" Article for requirements.

L. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

M. Motor: Single speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.

N. Controls, Rod-and-Float Type:

1. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

O. Controls, Float- and Pressure-Switch Type:

1. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
2. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

P. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

    a. On-off status of pump.
    b. Alarm status.

Q. Capacities and Characteristics:

1. Unit Capacity: <**Insert value**> **gpm (L/min.)**.
2. Number of Pumps: [**One**][**Two**]<**Insert value**>.
3. Each Pump:

    a. Capacity: <**Insert value**> **gpm (L/min.)**.
    b. Solids Handling Capability: [**2 inches (50 mm)**][**2-1/2 inches (65 mm)**][**3 inches (75 mm)**]<**Insert inches (mm)**> minimum.
    c. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
    d. Speed: <**Insert rpm**>.
    e. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
    f. Motor Horsepower: <**Insert value**> hp.
    g. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
        2) Phases: [**Single**][**Three**].
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**> A.
    b. Minimum Circuit Ampacity: <**Insert value**> A.
    c. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 SEWAGE-PUMP, REVERSE-FLOW ASSEMBLIES

A. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chicago Pump Company; Grundfos Pumps Corporation**]
2. [**Federal Pump Corp**]
3. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
4. [**Peerless Pump Company**]
5. [**Weil Pump; a Wilo Company**]
6. [**Yeomans Chicago Corporation**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Chicago Pump Company; Grundfos Pumps Corporation**]
2. [**Federal Pump Corp**]
3. [**PACO Pumps; Grundfos Pumps Corporation, USA**]

4. [**Peerless Pump Company**]
5. [**Weil Pump; a Wilo Company**]
6. [**Yeomans Chicago Corporation**]
7. <**Insert manufacturer's name**>

D. Components: Include the following corrosion-resistant-metal components:

1. Inlet Fitting: One combination inlet-overflow strainer fitting.
2. Valves: Two shutoff valves and two check valves.
3. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
4. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

2.6 SEWAGE-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: [**Cast iron**][**Fiberglass**][**Polyethylene**]<**Insert material**>.
2. Reinforcement: Mounting plates for pumps, fittings[**, guide-rail supports if used,**] and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: <**Insert value**> **gal. (L)**.
2. Diameter: <**Insert value**> **inches (mm)**.
3. Depth: <**Insert value**> **inches (mm)**.
4. Inlet No. 1:

   a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
   b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

5. Inlet No. 2:

   a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
   b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

6. Inlet No. 3:

   a. Drainage Pipe Size: <**Insert value**> **NPS (DN)**.
   b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

7. Sidewall Outlet:

a. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
b. Bottom of Sump to Centerline: <**Insert value**> **inches (mm)**.
c. Type: [**Hubbed inside**][**Hubbed outside**]<**Insert type**>.

8. Cover Material: [**Cast iron**][**Steel with bituminous coating**][**Cast iron or steel with bituminous coating**]<**Insert material**>.
9. Cover Diameter: <**Insert value**> **inches (mm)**, but not less than outside diameter of basin top flange.
10. Manhole Required in Cover: [**Yes**][**No**].
11. Vent Size: <**Insert value**> **NPS (DN)**.

2.7 PROGRESSING-CAVITY SEWAGE PUMPS

A. Description: Factory-assembled and -tested, progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Continental Pump Co.**]
2. [**Moyno, Inc.**]
3. [**Roper Pump Co.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Continental Pump Co.**]
2. [**Moyno, Inc.**]
3. [**Roper Pump Co.**]
4. <**Insert manufacturer's name**>

D. Pump Body: [**Cast iron**]<**Insert material**> with feet for base or floor installation.

E. Pump Bearings: Radial and thrust types.

F. Pump Shaft: Steel.

G. Rotor: [**Chrome-plated steel**]<**Insert material**>.

H. Stator: [**Buna-N**][**or**][**natural rubber**]<**Insert material**>.

I. Seals: Packing gland and mechanical types.

J. Coupling: Flexible.

K. Motor: Single speed; grease-lubricated ball bearings.

L. Capacities and Characteristics:

1. Capacity: <**Insert value**>**gal. (L/min.)**.
2. Solids Handling Capability: [**Not applicable**][**2 inches (50 mm) minimum**][**2-1/2 inches (65 mm) minimum**][**3 inches (75 mm) minimum**]<**Insert inches (mm) minimum**>.

3. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
4. Speed: <**Insert rpm**>.
5. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
6. Motor Horsepower: <**Insert value**> hp.
7. Electrical Characteristics:

    a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
    b. Phases: [**Single**][**Three**].
    c. Hertz: 60.

8. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**> A.
    b. Minimum Circuit Ampacity: <**Insert value**> A.
    c. Maximum Overcurrent Protection: <**Insert value**> A.

2.8 PACKAGED, SUBMERSIBLE SEWAGE-PUMP UNITS

A. Packaged, Submersible, Grinder, Sewage-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder sewage-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Environment One Corporation**]
    d. [**Goulds Water Technology; a Xylem brand**]
    e. [**Liberty Pumps**]
    f. [**Pentair Aurora; Pentair Pump Group**]
    g. [**SFA Saniflo USA**]
    h. [**Zoeller Company**]
    i. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Environment One Corporation**]
    d. [**Goulds Water Technology; a Xylem brand**]
    e. [**Liberty Pumps**]
    f. [**Pentair Aurora; Pentair Pump Group**]
    g. [**SFA Saniflo USA**]
    h. [**Zoeller Company**]
    i. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron.

6. Impeller: Stainless-steel grinder[**, cutter, or slicer**] type with shredding ring.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
8. Controls for Simplex Pump: Manufacturer's standard panel for one pump.
9. Controls for Duplex Pump: Automatic, with mechanical- or mercury-float switches and alternator.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight[**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

B. Packaged, Submersible, Nonclog, Sewage-Pump Units :

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Glentronics, Inc.**]
    e. [**Goulds Water Technology; a Xylem brand**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Liberty Pumps**]
    h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
    i. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
    j. [**Pentair Aurora; Pentair Pump Group**]
    k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A.Y. McDonald Mfg. Co.**]
    b. [**Barnes; a Crane Pumps & Systems brand**]
    c. [**Bell & Gossett; a Xylem brand**]
    d. [**Glentronics, Inc.**]
    e. [**Goulds Water Technology; a Xylem brand**]
    f. [**GRUNDFOS CBS Inc.**]
    g. [**Liberty Pumps**]
    h. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
    i. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
    j. [**Pentair Aurora; Pentair Pump Group**]
    k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
    l. [**Zoeller Company**]
    m. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Casing: Cast iron.

6. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling **2-inch- (50-mm-)** diameter solids.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
8. Controls for Simplex Pump: Manufacturer's standard panel for one pump.
9. Controls for Duplex Pump: Automatic, with mechanical- or mercury-float switches and alternator.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight[**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

C. Capacities and Characteristics:

1. System Capacity: <**Insert value**>**gal. (L/min.)**.
2. Number of Pumps: [**One**][**Two**].
3. Each Pump:

   a. Capacity: <**Insert value**>**gal. (L/min.)**.
   b. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
   c. Speed: <**Insert rpm**>.
   d. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
   e. Motor Horsepower: <**Insert value**> hp.
   f. Electrical Characteristics:

      1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V ac.
      2) Phases: [**Single**][**Three**].
      3) Hertz: 60.

4. Unit Electrical Characteristics:

   a. Full-Load Amperes: <**Insert value**> A.
   b. Minimum Circuit Ampacity: <**Insert value**> A.
   c. Maximum Overcurrent Protection: <**Insert value**> A.

5. Alternator Control Required: [**Yes**][**No**].
6. Basin:

   a. Dimensions: <**Insert values**>.
   b. Inlet Size: <**Insert value**> **NPS (DN)**.
   c. Bottom to Inlet Centerline: <**Insert value**> **inches (mm)**.
   d. Vent Size: <**Insert value**> **NPS (DN)**.

2.9 PACKAGED WASTEWATER-PUMP UNITS

A. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alyan Pump Company**]
b. [**Federal Pump Corp**]
c. [**Hartell Pumps; Milton Roy**]
d. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alyan Pump Company**]
b. [**Federal Pump Corp**]
c. [**Hartell Pumps; Milton Roy**]
d. <**Insert manufacturer's name**>

4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Body and Impeller: Corrosion-resistant materials.
6. Motor: With built-in overload protection and mounted vertically on basin cover.
7. Power Cord: Three-conductor, waterproof cable of length required, but not less than **72 inches (1830 mm)** and with grounding plug and cable-sealing assembly for connection at pump.
8. Control: Float switch.
9. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
10. Basin: Watertight, aluminum, plastic, or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.

B. Packaged, Submersible Wastewater-Pump Units:

1. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**ABS; Cardo Flow Solutions**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**GRUNDFOS CBS Inc.**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**SFA Saniflo USA**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**ABS; Cardo Flow Solutions**]
c. [**Bell & Gossett; a Xylem brand**]

d. [**Goulds Water Technology; a Xylem brand**]
e. [**GRUNDFOS CBS Inc.**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**SFA Saniflo USA**]
k. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

4. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
5. Pump Body and Impeller: Corrosion-resistant materials.
6. Pump Seals: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor, waterproof cable of length required, but not less than **72 inches (1830 mm)** and with grounding plug and cable-sealing assembly for connection at pump.
9. Control: Float switch.
10. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.

C. Capacities and Characteristics:

1. Pump Capacity: <**Insert value**> **gpm (L/min.)**.
2. Total Dynamic Head: <**Insert value**> **feet (kPa)**.
3. Speed: <**Insert rpm**>.
4. Discharge Pipe Size: <**Insert value**> **NPS (DN)**.
5. Motor Horsepower: <**Insert value**> hp.
6. Electrical Characteristics:

   a. Volts: [**120**][**240**]<**Insert value**> V ac.
   b. Phases: [**Single**][**Three**].
   c. Hertz: 60.

7. Unit Electrical Characteristics:

   a. Full-Load Amperes: <**Insert value**> A.
   b. Minimum Circuit Ampacity: <**Insert value**> A.
   c. Maximum Overcurrent Protection: <**Insert value**> A.

8. Basin:

   a. Capacity: [**2 gal. (7.6 L)**][**4 gal. (15.1 L)**]<**Insert value**> minimum.
   b. Inlet Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.
   c. Vent Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert startup steps**>.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain[**controls and**] pumps.

END OF SECTION 22 13 29 00

Task	Specification	Specification Description
22 13 29 00	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 13	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 13	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 16	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 16	22 13 00 00	Facility Gray-Water Storage Tanks
22 13 29 33	22 13 29 00	Sanitary Sewerage Pumps
22 13 29 33	22 13 00 00	Facility Gray-Water Storage Tanks

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SECTION 22 14 00 00 - FACILITY STORM-WATER RETENTION TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel, pressure, storm-water retention tanks.
2. Steel, nonpressure, storm-water retention tanks.
3. Insulated, steel, storm-water retention tanks.
4. Plastic, pressure, storm-water retention tanks.
5. Plastic, nonpressure, storm-water retention tanks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for storm-water retention tanks.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of storm-water retention tanks.
4. <**Insert list of products**>.

C. Delegated-Design Submittal: For storm-water retention tanks.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For facility storm-water retention tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design facility storm-water retention tanks.

B. Structural Performance: Facility storm-water retention tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of dead and live gravity loads and winds of [**100 mph (161 km/h)**]<**Insert value**>.

C. Seismic Performance: Facility storm-water retention tank, including structural reinforcement and foundation, shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."

D. Thermal Movements: Storm-water retention tank, including structural reinforcement and foundation, shall allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

2.2 STEEL, PRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]

12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Adamson Global Technology**]
3. [**Aldrich Company, Inc. (The)**]
4. [**Bradford White Corporation**]
5. [**Cemline Corporation**]
6. [**Flo Fab Inc**]
7. [**Green Boiler Technologies**]
8. [**GSW Water Heating**]
9. [**HESCO Bastion Ltd.**]
10. [**Lochinvar, LLC**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**RBI**]
14. [**RECO USA**]
15. [**State Industries**]
16. [**Weben-Jarco, Inc**]
17. [**Wendland Manufacturing Corp.**]
18. [**Wessels Company**]
19. [**Wood, John Co**]
20. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.

2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

J. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

K. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.3 STEEL, NONPRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adamson Global Technology**]
2. [**Highland Tank & Manufacturing Company, Inc.**]
3. [**RECO USA**]
4. [**Steel Tank and Fabricating Corporation (STAFCO)**]
5. [**Wood, John Co**]
6. <**Insert manufacturer's name**>

C. Description: Steel, [**horizontal**][**vertical**], nonpressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: Steel, constructed with welded joints.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter.

G. Cover for Open Tank: [**Plastic**][**Steel, with lining same as or similar to tank lining and**] with shape

that encloses top of tank.

H. Tappings: Factory-fabricated[**stainless**] steel, welded to tank.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

I. Specialties and Accessories: Include tappings in tank and the following:

1. Vacuum relief valve.
2. Free air vent with insect screen.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

J. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank[**before testing and labeling**].

K. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

L. Exterior Coating: [**Galvanized**][**Manufacturer's standard enamel paint**][**Primer paint**]<**Insert coating**>.

2.4 INSULATED, STEEL, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]
8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**GSW Water Heating**]
3. [**HESCO Bastion Ltd.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Precision Boilers**]
7. [**PVI; A WATTS Brand**]

8. [**RBI**]
9. [**State Industries**]
10. [**Vaughn Thermal Corporation**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

C. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

D. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

E. Construction: [**ASME code, steel**][**Steel**], constructed with welded joints, for [**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D100, "Welded Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for welded-steel, surface-water retention tanks.

F. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

G. Tappings: Factory-fabricated[**stainless**] steel, welded to tank[**before testing and labeling**].

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

H. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank[**before testing and labeling**].

1. Lining Material: [**Cement**][**Copper**]<**Insert material**>.
2. Coating: [**Epoxy resin**][**Galvanized**][**Glass**][**Nickel**]<**Insert coating**>.

J. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with ASHRAE/IES 90.1.

K. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.5 PLASTIC, PRESSURE, STORM-WATER RETENTION TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]

3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Pentair, Inc.**]
2. [**Tankinetics, Inc**]
3. <**Insert manufacturer's name**>

C. Description: Fiberglass-reinforced plastic (FRP), vertical, pressure-rated tank with cylindrical sidewalls.

D. Construction: [**ASME code, composite FRP**][**Composite FRP**], [**contact-molded**][**or**][**filament-wound**], thermosetting-resin tank for [**100-psig (690-kPa)**][**125-psig (860-kPa)**][**150-psig (1035-kPa)**]<**Insert value**> working pressure.

1. Comply with AWWA D120.

E. Manhole: Watertight, for tank more than [**36 inches (900 mm)**]<**Insert dimension**> in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated, FRP flanged-end nozzle.

1. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or FRP skirt attached by FRP brackets to tank sidewall.

2.6 PLASTIC, NONPRESSURE, STORM-WATER RETENTION TANKS

A. FRP Water Retention Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amprotec, Inc.**]
b. [**Belding Tank Technologies, Inc**]
c. [**L. F. Manufacturing, Inc**]
d. [**Palmer Manufacturing and Tank Company**]
e. <**Insert manufacturer's name**>

3. Description: FRP, vertical, nonpressure-rated water tank.
4. Construction: [**ASTM D3299, filament-wound**][**or**][**ASTM D4097, contact-molded**] FRP.
5. Tappings: Factory-fabricated, FRP flanged-end nozzle.

   a. NPS 2 (DN 50) and Smaller: Include plastic-to-steel transition fitting from tank nozzle flange to ASME B1.20.1, female thread.

      1) Exception: Tappings may be threaded FRP coupling integral with nozzle for connections for plastic piping.

   b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting tank.
7. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.
8. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.
9. Specialties and Accessories: Include tappings in tank and the following:

   a. Vacuum relief valve.
   b. Free air vent with insect screen.
   c. Thermometer.
   d. Gage glass, brass fittings, compression stops, and gage-glass guard.

B. PE Water Retention Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amprotec, Inc.**]
   b. [**Assmann Corporation of America**]
   c. [**Chem-Tainer Industries**]
   d. [**Poly Processing Company**]
   e. [**Premier Plastics Inc.**]
   f. [**Snyder Industries, Inc.**]
   g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
   h. [**TolPlast Company, Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amprotec, Inc.**]
   b. [**Assmann Corporation of America**]
   c. [**Chem-Tainer Industries**]
   d. [**Poly Processing Company**]
   e. [**Premier Plastics Inc.**]

f. [**Snyder Industries, Inc.**]
g. [**Steel Tank and Fabricating Corporation (STAFCO)**]
h. [**TolPlast Company, Inc.**]
i. <**Insert manufacturer's name**>

3. Description: PE, vertical, flat-bottom, nonpressure-rated water tank.
4. Construction: ASTM D1998, molded PE.
5. Tappings: Factory-fabricated bulkhead fittings attached to tank.

   a. NPS 2 (DN 50) and Smaller: With female thread.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged.

6. Vertical Tank Support: Separate factory-fabricated steel stand capable of supporting entire bottom of tank.
7. Manhole: Watertight, for tank more than [**36 inches (915 mm)**]<**Insert dimension**> in diameter.
8. Cover for Open Tank: Plastic, same as or similar to tank material and with shape that encloses top of tank.
9. Specialties and Accessories: Include tappings in tank and the following:

   a. Vacuum relief valve.
   b. Free air vent with insect screen.
   c. Thermometer.
   d. Gage glass, brass fittings, compression stops, and gage-glass guard.

2.7 PAINT MATERIALS

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's standard epoxy-polyamide paint.

C. Tank Shell Exterior Intermediate Paint: Tank fabricator's standard, two-component epoxy paint compatible with prime and finish paint. Intermediate coat shall have a slight color contrast with finish coat.

D. Tank Shell Exterior Finish Paint: Tank fabricator's standard urethane paint.

   1. Color: [**As selected by Owner from tank manufacturer's paint chart**]<**Insert color**>.

2.8 SHOP PAINTING

A. Tank Shell Exterior Finish Coat: Factory coating according to AWWA D103.

PART 3 - EXECUTION

3.1 INSTALLATION OF STORM-WATER RETENTION TANKS

A. Install storm-water retention tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

   1. Install horizontal tanks on [**concrete piers and factory-fabricated**][**fabricated steel supports and**] saddles.

B. Anchor tank supports and tanks to substrate.

1. Use steel or FRP straps over or around plastic tanks.

C. Install thermometers and pressure gages on water retention tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220500 "Common Work Results for Plumbing."

D. Install the following devices on tanks where indicated:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

E. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Where installing piping adjacent to storm-water retention tanks, allow space for service and maintenance.

B. Connect water piping to water retention tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. Valves NPS 2 (DN 50) and Smaller: Gate valves or ball valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Valves NPS 2-1/2 (DN 65) and Larger: Gate valves or butterfly valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."
3. Drain Valves: **NPS 3/4 (DN 20)** gate valves or ball valves complying with requirements in Section 220523 "General-Duty Valves for Plumbing Piping." Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.
4. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

END OF SECTION 22 14 00 00

SECTION 22 14 13 00 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.
8. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: [**10-foot head of water (30 kPa)**]<**Insert pressure**>.
2. Storm Drainage, Force-Main Piping: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

B. Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully functional after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A74.
3. Class: [**Service weight**][**and**][**Extra heavy**] cast iron.

D. Gaskets: ASTM C564, rubber.

E. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]

4. **<Insert manufacturer's name>**

C. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 and CISPI 301.

D. Standard, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Ideal Tridon Group**]
   f. [**Matco-Norca**]
   g. [**MIFAB, Inc**]
   h. [**Mission Rubber Company, LLC**]
   i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Ideal Tridon Group**]
   f. [**Matco-Norca**]
   g. [**MIFAB, Inc**]
   h. [**Mission Rubber Company, LLC**]
   i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   j. **<Insert manufacturer's name>**

3. Marked with CISPI collective trademark [**and NSF certification mark**].
4. Standards: ASTM C1277 and CISPI 310.
5. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]

d. [**Fernco Inc**]
e. [**Ideal Tridon Group**]
f. [**Matco-Norca**]
g. [**MIFAB, Inc**]
h. [**Mission Rubber Company, LLC**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Dallas Specialty & Mfg. Co.**]
d. [**Fernco Inc**]
e. [**Ideal Tridon Group**]
f. [**Matco-Norca**]
g. [**MIFAB, Inc**]
h. [**Mission Rubber Company, LLC**]
i. **<Insert manufacturer's name>**

3. Standard: ASTM C1277 or ASTM C1540.
4. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MG Coupling**]
b. [**MIFAB, Inc**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**MG Coupling**]
b. [**MIFAB, Inc**]
c. **<Insert manufacturer's name>**

3. Standard: ASTM A1056.
4. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight class. Include ends matching joining method.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**U.S. Steel**]
b. [**Wheatland Tube; Zekelman Industries**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**U.S. Steel**]
b. [**Wheatland Tube; Zekelman Industries**]
c. <**Insert manufacturer's name**>

B. Cast-Iron Drainage Fittings: [**Galvanized,**]ASME B16.12, threaded.

C. Steel-Pipe Pressure Fittings:

1. Steel Pipe Nipples: [**Galvanized,**]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [**Galvanized,**]ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Smith-Cooper International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Smith-Cooper International**]
d. <**Insert manufacturer's name**>

3. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping:

a. ASTM A536 ductile-iron castings.

b. ASTM A234/A234M forged-steel fittings.

2.6 COPPER TUBE AND FITTINGS

A. Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Wieland Copper Products, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cambridge-Lee Industries, LLC**]
   b. [**Cerro Flow Products, LLC**]
   c. [**Wieland Copper Products, LLC**]
   d. <**Insert manufacturer's name**>

3. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
4. Copper Tube, Drawn Temper: **ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C)**.
5. Copper Tube, Annealed Temper: **ASTM B88, Type L (ASTM B88M, Type B)**.

B. Copper Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

3. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
4. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
5. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.
b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.7 ABS PIPE AND FITTINGS

A. ABS Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

3. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
4. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.
5. Cellular-Core ABS Pipe: ASTM F1488, Schedule 40.

B. ABS Socket Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

3. Standard: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

4. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solvent Cement: ASTM D2235.

1. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.8 PVC PIPE AND FITTINGS

A. PVC Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**JM Eagle**]
   c. [**National Pipe and Plastic, Inc. (Oldcastle)**]
   d. [**North America Pipe Corporation**]
   e. [**Silver-line Plastics**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**JM Eagle**]
   c. [**National Pipe and Plastic, Inc. (Oldcastle)**]
   d. [**North America Pipe Corporation**]
   e. [**Silver-line Plastics**]
   f. <**Insert manufacturer's name**>

3. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
4. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
5. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

B. PVC Socket Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. [**North America Pipe Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Charlotte Pipe and Foundry Company**]
b. [**NIBCO INC.**]
c. [**North America Pipe Corporation**]
d. <**Insert manufacturer's name**>

3. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Adhesive Primer: ASTM F656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

c. Standard: ASTM C1173.
d. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564 rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Dallas Specialty & Mfg. Co.**]
2) [**Fernco Inc**]
3) [**Mission Rubber Company, LLC**]
4) <**Insert manufacturer's name**>

c. Standard: ASTM C1460.
d. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**EBAA Iron Sales, Inc.**]
3) [**Ford Meter Box Company, Inc. (The)**]
4) [**JCM Industries, Inc**]
5) [**Romac Industries, Inc.**]
6) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Cascade Waterworks Mfg. Co.**]
2) [**EBAA Iron Sales, Inc.**]
3) [**Ford Meter Box Company, Inc. (The)**]
4) [**JCM Industries, Inc**]
5) [**Romac Industries, Inc.**]
6) **<Insert manufacturer's name>**

c. Standard: AWWA C219.
d. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
e. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
f. Gasket Material: Natural or synthetic rubber.
g. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**HART Industrial Unions, LLC**]
3) [**Jomar Valve**]
4) [**Matco-Norca**]
5) [**WATTS; A Watts Water Technologies Company**]
6) [**Zurn Industries, LLC**]
7) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**A.Y. McDonald Mfg. Co.**]
2) [**HART Industrial Unions, LLC**]
3) [**Jomar Valve**]

4) [**Matco-Norca**]
5) [**WATTS; A Watts Water Technologies Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**WATTS; A Watts Water Technologies Company**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**WATTS; A Watts Water Technologies Company**]
2) <**Insert manufacturer's name**>

c. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure and temperature**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Products & Systems, LLC**]
2) [**GPT; a division of EnPRO Industries**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advance Products & Systems, LLC**]
2) [**GPT; a division of EnPRO Industries**]
3) <**Insert manufacturer's name**>

c. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Matco-Norca**]
3) [**Precision Plumbing Products**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Matco-Norca**]
3) [**Precision Plumbing Products**]
4) <**Insert manufacturer's name**>

c. Description: Electroplated steel nipple.
d. Standards: ASTM F492, ASME B1.20.1.
e. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
f. End Connections: Male threaded or grooved.
g. Lining: Inert and noncorrosive, propylene.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**High-density, crosslaminated polyethylene film of 0.004-inch (0.10-mm)**][**or**][**linear low-density polyethylene film of 0.008-inch (0.20-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

M. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: [**1/4 inch per foot (2 percent)**]<**Insert number**> downward in direction of

flow for piping NPS 3 (DN 80) and smaller; [1/8 inch per foot (2 percent)][1/4 inch per foot (2 percent)]<**Insert number**> downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Horizontal Storm Drainage Piping: [1/4 inch per foot (2 percent)]<**Insert number**> downward in direction of flow.

O. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Install steel piping in accordance with applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**][**and**][**PVC**] piping in accordance with ASTM D2321.

U. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

V. Install force mains at elevations indicated.

W. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings [**4 inches (100 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings [**5 inches (125 mm)**]<**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: [**Unshielded**][**Shielded**], nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**][**unions**].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**][**flange kits**][**nipples**].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install [**gate**][**full port ball valve**] for piping **NS 2 (DN 50)** and smaller.
3. Install [**gate**][**butterfly**]<**Insert type**> valve for piping **NPS 2-1/2 (DN 65)** and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install [**carbon-steel**]<**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**][**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**]<**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for [**cast-iron**][**galvanized-steel**][**and**][**copper**] soil [**tubing**][**and**][**piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**and**][**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting[**, valve,**] and coupling.

F. Support vertical [**cast-iron**][**galvanized steel**][**and**][**copper**][**tubing**][**and**][**piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

G. Support vertical [**ABS**][**and**][**PVC**] piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves [**with cleanout cover flush with floor**][**in pit with pit cover flush with floor**]<**Insert description**>.
3. Comply with requirements for [**backwater valves**][**cleanouts**][**and**][**drains**] specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

   a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

   a. Test storm drainage piping[**, except outside leaders,**] on completion of roughing-in.
   b. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water (30 kPa)**.
   c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
   d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials.

   a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.11 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping [**NPS 6 (DN 150) and smaller**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

C. Aboveground, storm drainage piping [**NPS 8 (DN 200) and larger**]<**Insert pipe size range**> is to be[

any of] the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

D. Underground storm drainage piping [**NPS 6 (DN 150) and smaller**]<**Insert pipe size range**> shall be[**any of**] the following:

1. [**Extra heavy**][**Service weight**], cast-iron soil pipe and fittings; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**][**cast-iron,**] hubless-piping couplings; and coupled joints.
3. [**Solid-wall**][**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

E. Underground, storm drainage piping [**NPS 8 (DN 200) and larger**]<**Insert pipe size range**> is to be[**any of**] the following:

1. [**Extra heavy**][**Service weight**], cast-iron soil pipe and fittings; [**gaskets; and gasketed**][**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI,**][**heavy-duty,**][**cast-iron,**] hubless-piping couplings; and coupled joints.
3. [**Solid-wall**][**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**][**Shielded**], nonpressure transition couplings.

F. Aboveground storm drainage force mains [**NPS 1-1/2 and NPS 2 (DN 40 and DN 50)**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Hard copper tube, **Type L (Type B)** copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains [**NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**]<**Insert pipe size range**> is to be[**any of**] the following:

1. Hard copper tube, **Type L (Type B)** copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 22 14 13 00

Task	Specification	Specification Description
22 14 13 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 13	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 16	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 26 19	22 14 00 00	Facility Storm-Water Retention Tanks

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SECTION 22 14 29 00 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sump pumps - submersible.
2. Sump pumps - wet-pit volute.
3. Oil-sensing sump pumps and controllers.
4. Sump pumps - pedestal.
5. Sump-pump basins and basin covers.
6. Packaged drainage-pump units - submersible.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Sump pumps - submersible.
2. Sump pumps - wet-pit volute.
3. Oil-sensing sump pumps and controllers.
4. Sump pumps - pedestal.
5. Sump-pump basins and basin covers.
6. Packaged drainage-pump units - submersible.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.5 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of <**Insert components**>.
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].
c. <**Insert conditions relating to specified products**>.
d. <**Insert failure modes**>.

2. Warranty Period: [**1**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of sump pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 SUMP PUMPS - SUBMERSIBLE

A. Sump Pumps - Submersible, Fixed Position, Single Seal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Crane Pumps & Systems**]
c. [**Glentronics, Inc.**]
d. [**GRUNDFOS CBS Inc.**]

e. [**Industrial Flow Solutions**]
f. [**Liberty Pumps**]
g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
h. [**Pentair Aurora; Pentair Pump Group**]
i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
j. [**Weil Pump; a Wilo Company**]
k. [**Xylem**]
l. [**Zoeller Company**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Crane Pumps & Systems**]
   c. [**Glentronics, Inc.**]
   d. [**GRUNDFOS CBS Inc.**]
   e. [**Industrial Flow Solutions**]
   f. [**Liberty Pumps**]
   g. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
   h. [**Pentair Aurora; Pentair Pump Group**]
   i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   j. [**Weil Pump; a Wilo Company**]
   k. [**Xylem**]
   l. [**Zoeller Company**]
   m. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seal: Mechanical.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

   a. Motor Housing Fluid: [**Air**][**Oil**].

10. Capacities and Characteristics:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

       1) Capacity: <**Insert gpm (L/min.)**>.
       2) Total Dynamic Head: <**Insert feet (kPa)**>.
       3) Speed: <**Insert rpm**>.
       4) Discharge Size: <**Insert NPS (DN)**>.
       5) Electrical Characteristics:

a) Motor Horsepower: <**Insert value**> hp.
b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
c) Phases: [**Single**][**Three**].
d) Hertz: 60.

d. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**> A.
2) Minimum Circuit Ampacity: <**Insert value**> A.
3) Maximum Overcurrent Protection: <**Insert value**> A.

11. Controls, Rod-and-Float Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

12. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Sump Pumps - Submersible, Fixed Position, Double Seal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBARA Pumps Americas Corp.**]
b. [**GRUNDFOS CBS Inc.**]
c. [**Industrial Flow Solutions**]
d. [**Xylem**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**EBARA Pumps Americas Corp.**]
    b. [**GRUNDFOS CBS Inc.**]
    c. [**Industrial Flow Solutions**]
    d. [**Xylem**]
    e. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
8. Seals: Mechanical.
9. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [**Air**][**Oil**].

11. Capacities and Characteristics:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

        1) Capacity: <**Insert gpm (L/min.)**>.
        2) Total Dynamic Head: <**Insert feet (kPa)**>.
        3) Speed: <**Insert rpm**>.
        4) Discharge Size: <**Insert NPS (DN)**>.
        5) Electrical Characteristics:

            a) Motor Horsepower: <**Insert value**> hp.
            b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
            c) Phases: [**Single**][**Three**].
            d) Hertz: 60.

    d. Unit Electrical Characteristics:

        1) Full-Load Amperes: <**Insert value**> A.
        2) Minimum Circuit Ampacity: <**Insert value**> A.
        3) Maximum Overcurrent Protection: <**Insert value**> A.

12. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

13. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

14. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

2.4 SUMP PUMPS - WET-PIT VOLUTE

A. Sump Pumps - Wet-Pit Volute: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Pumps & Systems**]
b. [**Federal Pump Corp**]
c. [**Peerless Pump Company**]
d. [**Swaby Manufacturing Company**]
e. [**Tramco Pump Company**]
f. [**Vertiflo Pump Company**]
g. [**Weil Pump; a Wilo Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Pumps & Systems**]
b. [**Federal Pump Corp**]
c. [**Peerless Pump Company**]
d. [**Swaby Manufacturing Company**]
e. [**Tramco Pump Company**]
f. [**Vertiflo Pump Company**]
g. [**Weil Pump; a Wilo Company**]

h. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit.
4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet and threaded connection for **NPS 2 (DN 50)** and smaller and flanged connection for **NPS 2-1/2 (DN 65)** and larger discharge piping.
6. Impeller: Statically and dynamically balanced, [**manufacturer's standard**]<**Insert material**> designed for clear wastewater handling, and keyed and secured to shaft.
7. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at **48-inch- (1200-mm-)** maximum intervals if basin depth is more than **48 inches (1200 mm)**, and grease-lubricated, ball-type thrust bearings.
8. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
9. Pump Discharge Piping: Factory- or field-fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
10. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sump-Pump Basins and Basin Covers" Article for requirements.
11. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
12. Motor: Single speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.
13. Capacities and Characteristics:

    a. Unit Capacity: <**Insert gpm (L/min.)**>.
    b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
    c. Each Pump:

        1) Capacity: <**Insert gpm (L/min.)**>.
        2) Total Dynamic Head: <**Insert feet (kPa)**>.
        3) Speed: <**Insert rpm**>.
        4) Discharge Size: <**Insert NPS (DN)**>.
        5) Electrical Characteristics:

            a) Motor Horsepower: <**Insert value**> hp.
            b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
            c) Phases: [**Single**][**Three**].
            d) Hertz: 60.

    d. Unit Electrical Characteristics:

        1) Full-Load Amperes: <**Insert value**> A.
        2) Minimum Circuit Ampacity: <**Insert value**> A.
        3) Maximum Overcurrent Protection: <**Insert value**> A.

14. Controls, Rod-and-Float Type:

    a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than **60 inches (1500 mm)**.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

15. Controls, Float- and Pressure-Switch Type:

a. Enclosure: NEMA 250, [**Type 1**][**Type 4X**]<**Insert type**>; [**pedestal**][**wall**] mounted.
b. Switch Type: [**Mechanical-float**][**Mercury-float**][**Pressure**]<**Insert type**> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**]<**Insert type**> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

16. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

2.5 OIL-SENSING SUMP PUMPS AND CONTROLLERS

A. Oil-Sensing Sump Pumps and Controllers: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flo Fab Inc**]
b. [**Industrial Flow Solutions**]
c. [**Liberty Pumps**]
d. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
e. [**Weil Pump; a Wilo Company**]
f. [**Xylem**]
g. [**Zoeller Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flo Fab Inc**]
b. [**Industrial Flow Solutions**]
c. [**Liberty Pumps**]
d. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
e. [**Weil Pump; a Wilo Company**]
f. [**Xylem**]
g. [**Zoeller Company**]
h. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested sump-pump unit. ASME A17.1 compliant.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.

6. Capacities and Characteristic:

   a. Unit Capacity: <**Insert gpm (L/min.)**>.
   b. Number of Pumps: [**One**][**Two**]<**Insert number**>.
   c. Each Pump:

      1) Capacity: <**Insert gpm (L/min.)**>.
      2) Total Dynamic Head: <**Insert feet (kPa)**>.
      3) Speed: <**Insert rpm**>.
      4) Discharge Size: <**Insert NPS (DN)**>.
      5) Electrical Characteristics:

         a) Motor Horsepower: <**Insert value**> hp.
         b) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
         c) Phases: [**Single**][**Three**].
         d) Hertz: 60.

   d. Unit Electrical Characteristics:

      1) Full-Load Amperes: <**Insert value**> A.
      2) Minimum Circuit Ampacity: <**Insert value**> A.
      3) Maximum Overcurrent Protection: <**Insert value**> A.

7. Controls:

   a. Industrial-grade switch(es) with internal [**20**]<**Insert number**> A relay and Type 304 stainless steel sensor probes.
   b. Liquid/oil sensor that differentiates and indicates the presence of oil and/or water under high-water conditions.
   c. Alarm Panel:

      1) High-oil-level alarm.
      2) High-water-level alarm.
      3) Audible and visual alarms for each alarm condition.
      4) Dry contacts for remote monitoring of oil, water, and high liquid conditions.

   d. Control Panel:

      1) [**Simplex**][**Duplex**].
      2) Enclosure: NEMA 250, Type 4X.
      3) HOA switch(es).
      4) Green pump run light; power on light.
      5) Pump circuit breaker(s).

2.6 SUMP PUMPS - PEDESTAL

A. Sump Pumps - Pedestal: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**AMT; a Gorman-Rupp company**]

c. [**Federal Pump Corp**]
d. [**Goulds Water Technology; a Xylem brand**]
e. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
f. [**Pentair Aurora; Pentair Pump Group**]
g. [**Tramco Pump Company**]
h. [**Zoeller Company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**AMT; a Gorman-Rupp company**]
   c. [**Federal Pump Corp**]
   d. [**Goulds Water Technology; a Xylem brand**]
   e. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
   f. [**Pentair Aurora; Pentair Pump Group**]
   g. [**Tramco Pump Company**]
   h. [**Zoeller Company**]
   i. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
4. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal sump pump, configured as a pedestal pump. Sump pump to be as defined in HI 14.1-14.2 and HI 14.3.
5. Pump Casing: Corrosion-resistant material, with strainer inlet; design that permits flow into impeller; and vertical discharge for piping connection.
6. Impeller: Aluminum, brass, or plastic.
7. Motor: With built-in overload protection and mounted vertically on sump-pump column.
8. Power Cord: Three-conductor waterproof cable of length required, but not less than **72 inches (1830 mm)**, with grounding plug and cable-sealing assembly for connection at pump.
9. Capacities and Characteristics:

   a. Capacity: <**Insert gpm (L/min.)**>.
   b. Total Dynamic Head: <**Insert feet (kPa)**>.
   c. Speed: <**Insert rpm**>.
   d. Discharge Size: <**Insert NPS (DN)**>.
   e. Electrical Characteristics:

      1) Motor Horsepower: <**Insert value**> hp.
      2) Volts: [**115**][**230**][**460**]<**Insert value**> V ac.
      3) Phases: [**Single**][**Three**].
      4) Hertz: 60.

10. Control: Float switch.

2.7 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins : Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

   1. Material: [**Cast iron**][**Fiberglass**][**Polyethylene**]<**Insert material**>.
   2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
   3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump,

and in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert inches (mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Inlet No. 1:

   a. Drainage Pipe Size: <**Insert NPS (DN)**>.
   b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

5. Inlet No. 2:

   a. Drainage Pipe Size: <**Insert NPS (DN)**>.
   b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

6. Inlet No. 3:

   a. Drainage Pipe Size: <**Insert NPS (DN)**>.
   b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
   c. Type: [**Flanged**][**Hubbed**][**Threaded**] outside.

7. Sidewall Outlet:

   a. Discharge Pipe Size: <**Insert NPS (DN)**>.
   b. Bottom of Sump to Centerline: <**Insert inches (mm)**>.
   c. Type: [**Hubbed inside**][**Hubbed outside**]<**Insert type**>.

8. Cover Material: [**Cast iron**][**Steel with bituminous coating**][**Cast iron or steel with bituminous coating**]<**Insert material**>.
9. Cover Diameter: <**Insert inches (mm)**>, but not less than OD of basin top flange.
10. Manhole Required in Cover: [**Yes**][**No**].
11. Vent Size: <**Insert NPS (DN)**>.

2.8 PACKAGED DRAINAGE-PUMP UNITS - SUBMERSIBLE

A. Packaged Drainage-Pump Units - Submersible: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Liberty Pumps**]

c. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Zoeller Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Liberty Pumps**]
   c. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
   d. [**Pentair Aurora; Pentair Pump Group**]
   e. [**Zoeller Company**]
   f. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
4. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 14.1-14.2 and HI 14.3.
5. Casing: [**Metal**]<**Insert material**>.
6. Impeller: [**Brass**]<**Insert material**>.
7. Pump Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
9. Power Cord: Three-conductor waterproof cable of length required, but not less than **72 inches (1830 mm)**, with grounding plug and cable-sealing assembly for connection at pump.
10. Pump Discharge Piping: Factory- or field-fabricated, [**galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**]<**Insert pipe material**>.
11. Control: Motor-mounted float switch.
12. Basin: Plastic.
13. Capacities and Characteristics:

    a. Capacity: <**Insert gpm (L/min.)**>.
    b. Total Dynamic Head: <**Insert feet (kPa)**>.
    c. Speed: <**Insert rpm**>.
    d. Discharge Pipe Size: <**Insert NPS (DN)**>.
    e. Electrical Characteristics:

       1) Motor Horsepower: <**Insert value**> hp.
       2) Volts: [**115**][**230**][**460**]<**Insert value**> V.
       3) Phases: [**Single**][**Three**].
       4) Hertz: 60.
       5) Full-Load Amperes: <**Insert value**> A.
       6) Minimum Circuit Ampacity: <**Insert value**> A.
       7) Maximum Overcurrent Protection: <**Insert value**> A.

    f. Basin:

       1) Capacity: [**2 gal. (7.6 L)**][**5 gal. (18.9 L)**]<**Insert value**> minimum.
       2) Inlet Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**> minimum.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump-pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 14.4 for installation of sump pumps.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. <**Insert startup steps if any**>.

3.6 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain[**controls and**] pumps.

END OF SECTION 22 14 29 00

Task	Specification	Specification Description
22 14 29 00	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 13	22 14 29 00	Sump Pumps
22 14 29 13	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 16	22 14 29 00	Sump Pumps
22 14 29 16	22 14 00 00	Facility Storm-Water Retention Tanks
22 14 29 19	22 14 29 00	Sump Pumps
22 14 29 19	22 14 00 00	Facility Storm-Water Retention Tanks

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SECTION 22 15 13 00 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Piping and related specialties for general-service compressed-air systems, as follows:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Valves.
4. Dielectric fittings.
5. Flexible pipe connectors.
6. Specialties.
7. Quick couplings.
8. Hose assemblies.

B. Related Requirements:

1. Section 221519 "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. HDPE: High-density polyethylene plastic.

D. High-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between **150 and 200 psig (1035 and 1380 kPa)**.

E. Low-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of **150 psig (1035 kPa)** or less.

F. NBR: Nitrile butadiene rubber.

G. PE: Polyethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Plastic pipes, fittings, and valves.
2. Dielectric fittings.
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators. Include rated capacities and operating characteristics.
6. Automatic drain valves.

7. Filters. Include rated capacities and operating characteristics.
8. Lubricators. Include rated capacities and operating characteristics.
9. Quick couplings.
10. Hose assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. [**Brazing**][**and**][**welding**] certificates.

B. Field quality-control reports.

C. Qualification Statements: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by respective manufacturer, for making branch outlets.
2. Press-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by respective manufacturer.
3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by respective manufacturer.
4. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by respective manufacturer.

B. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or with AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Welding: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping system to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the piping system will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure, compressed-air piping.
2. Comply with ASME B31.3, "Process Piping," for high- and low-pressure, compressed-air piping.
3. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.3 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded in accordance with ASME B1.20.1.

1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Flanges, Threaded: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel, Butt-Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
7. Grooved-End Fittings and Couplings, Steel:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**ASC Engineered Solutions**]
3) [**Star Pipe Products**]
4) [**Victaulic Company**]
5) [**Ward Manufacturing LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**ASC Engineered Solutions**]
3) [**Star Pipe Products**]
4) [**Victaulic Company**]
5) [**Ward Manufacturing LLC**]
6) **<Insert manufacturer's name>**

c. Grooved-End Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings; with grooves in accordance with AWWA C606 and dimensions matching steel pipe.

d. Grooved-End Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for **300 psig (2070 kPa)** minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.

B. Schedule 5, Steel Pipe: ASTM A135, carbon steel with plain ends and zinc-plated finish.

1. Press-Type, Schedule 5 Steel, Fittings: Listed and labeled by qualified testing agency and FM Global-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for **300 psig (2070 kPa)** minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Victaulic Company**]
3) [**Viega LLC**]
4) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Anvil; an ASC Engineered Solution**]
2) [**Victaulic Company**]
3) [**Viega LLC**]
4) **<Insert manufacturer's name>**

C. Copper Tube: [**ASTM B88, Type K or L (ASTM B88M, Type A or B)**] seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.
4. Press-Type, Copper Tube, Fittings, **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) [**Viega LLC**]
4) <**Insert manufacturer's name**>

5. Press-Type, Copper Tube, Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Bronze fitting with stainless steel grip ring and EPDM O-ring seal in each end.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**NIBCO INC.**]
2) [**Viega LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**NIBCO INC.**]
2) [**Viega LLC**]
3) <**Insert manufacturer's name**>

6. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube in accordance with ASTM F2014.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**T-DRILL Industries Inc**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**T-DRILL Industries Inc**]
2) <**Insert manufacturer's name**>

7. Grooved-End Fittings and Couplings, Copper:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Anvil; an ASC Engineered Solution**]
      2) [**ASC Engineered Solutions**]
      3) [**Victaulic Company**]
      4) **<Insert manufacturer's name>**

   b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

      1) [**Anvil; an ASC Engineered Solution**]
      2) [**ASC Engineered Solutions**]
      3) [**Victaulic Company**]
      4) **<Insert manufacturer's name>**

   c. Grooved-End Fittings: ASTM B75/B75M, copper tube or ASTM B584, bronze castings.
   d. Grooved-End Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

D. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

E. Aluminum Piping System: Aluminum pipe, Alloy Grade AA 6035-T5, for push-connect bite ring couplings, and roll-groove couplings.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Applied System Technologies**]
      b. [**Gardner Denver, an Ingersoll Rand business**]
      c. [**Ingersoll Rand**]
      d. [**SynergAir**]
      e. **<Insert manufacturer's name>**

   2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

      a. [**Applied System Technologies**]
      b. [**Gardner Denver, an Ingersoll Rand business**]
      c. [**Ingersoll Rand**]
      d. [**SynergAir**]
      e. **<Insert manufacturer's name>**

   3. Pressure and Temperature Range: Aluminum piping and related specialties for general-service

compressed-air systems operating at **220 psig (1517 kPa)** or less, across a temperature range of **minus 4 to plus 176 deg F (minus 20 to plus 80 deg C)**.

4. Tubing, 14 to 273 mm: Aluminum pipe, Alloy Grade AA 6063-T5.
5. Pipe Coating: Powder-coated paint that is certified nontoxic to AAMA 603 and AAMA 605, blue for compressed air.
6. Provide tubing that is quality controlled to comply with tolerances specified by roll-groove or push-to-connect coupling manufacturer. Tubing manufacturer follows ISO 9001:2000 quality standards.
7. Pipe Identification: Decal with maximum working pressure and temperature on each length of pipe.
8. Push-Connect Bite Ring Couplings, 14 to 63 mm: Solid-brass and nickel-plated body, NBR O-ring seal in excess of 36 percent, and AISI Type 304 stainless steel clamping washer.
9. Fittings: Solid brass and nickel plated.
10. Roll-Groove Couplings, 73 to 273 mm: Solid ductile-iron, galvanized, ASTM A536 Grade 65-45-12, NBR standard seals, and fluoroelastomer seals for high-temperature applications.
11. Ball Valves, 20 to 63 mm: NPT ends, or push-connect bite ring ends.
12. Butterfly Valves, 73 to 273 mm: Tube to tube, with two roll-groove end couplings.
13. Flanges, 73 to 273 mm: ASME B16.5, Class 150.

F. Blue ABS Piping System: Made of ASTM D3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**IPEX USA LLC**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**IPEX USA LLC**]
   b. <**Insert manufacturer's name**>

3. Transition Fittings, 20 to 63 mm: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107, transition union.
4. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
6. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.

G. Green ABS Piping System: Made of ASTM D3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A53/A53M, steel pipe.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**NIBCO INC.**]
   b. <**Insert manufacturer's name**>

3. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107, transition union.
4. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: ABS flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: Union ball valve with socket ends.
6. Valves, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Union ball valve with flanged ends. Include safety exhaust feature in "Valve Applications" Article if required.

H. HDPE Piping System: Made of ASTM D1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D3035, PE pipe.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Asahi/America**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Asahi/America**]
   b. <**Insert manufacturer's name**>

3. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: HDPE adapter with one socket end and one end with threaded brass insert.
4. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
5. Valves, **NPS 1/2 to NPS 3 (DN 15 to DN 80)**: HDPE union ball valve with socket ends.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system

manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.

2.5 VALVES

A. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**Jomar Valve**]
f. [**Matco-Norca**]
g. [**Viega LLC**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Wilkins**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Capitol Manufacturing Company**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**Jomar Valve**]
f. [**Matco-Norca**]
g. [**Viega LLC**]

h. [**WATTS; A Watts Water Technologies Company**]
i. [**Wilkins**]
j. <**Insert manufacturer's name**>

3. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**Matco-Norca**]
d. [**Viega LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**Matco-Norca**]
d. [**Viega LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Wilkins**]
g. <**Insert manufacturer's name**>

3. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**].
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]

b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

3. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**>.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.7 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASC Engineered Solutions**]
2. [**Flex-Hose Co., Inc**]
3. [**Flexicraft Industries**]
4. [**Hyspan Precision Products, Inc**]
5. [**Kadant Unaflex, LLC**]
6. [**Mercer Rubber Co**]
7. [**Metraflex Company (The)**]
8. [**Proco Products, Inc**]
9. [**Universal Metal Hose**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASC Engineered Solutions**]
2. [**Flex-Hose Co., Inc**]
3. [**Flexicraft Industries**]
4. [**Hyspan Precision Products, Inc**]
5. [**Kadant Unaflex, LLC**]
6. [**Mercer Rubber Co**]
7. [**Metraflex Company (The)**]
8. [**Proco Products, Inc**]
9. [**Universal Metal Hose**]
10. <**Insert manufacturer's name**>

C. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and

ends brazed to inner tubing.

1. Working-Pressure Rating: [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**] minimum.
2. End Connections, **NPS 2 (DN 50)** and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections, **NPS 2-1/2 (DN 65)** and Larger: Flanged copper alloy.

D. Stainless Steel-Hose Flexible Pipe Connectors: Corrugated, stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**] minimum.
2. End Connections, **NPS 2 (DN 50)** and Smaller: Threaded steel pipe nipple.
3. End Connections, **NPS 2-1/2 (DN 65)** and Larger: Flanged steel nipple.

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**250 psig (1725 kPa)**]<**Insert pressure**> inlet pressure, unless otherwise indicated.

1. Type: Pilot operated.

C. Air-Line Pressure Regulators, Bronze Body: [**Diaphragm**][**or**][**pilot**] operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**200 psig (1380 kPa)**]<**Insert pressure**> minimum inlet pressure, unless otherwise indicated.

D. Air-Line Pressure Regulators, Aluminum Alloy or Plastic Body: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**200 psig (1380 kPa)**]<**Insert pressure**> minimum inlet pressure, unless otherwise indicated.

E. Automatic Drain Valves: Stainless steel body and internal parts, rated for [**200 psig (1380 kPa)**]<**Insert pressure**> minimum working pressure, capable of automatic discharge of collected condensate.[**Include mounting bracket if wall mounting is indicated.**]

F. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.[**Include mounting bracket if wall mounting is indicated.**]

G. Mechanical Filters: Two-stage, mechanical-separation, air-line filters. Equip with deflector plates, resin-impregnated-ribbon filters with edge filtration, and drain cock.[**Include mounting bracket if wall mounting is indicated.**]

H. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering airstream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.[**Include mounting bracket if wall mounting is indicated.**]

1. Provide with automatic feed device for supplying oil to lubricator.

2.9 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aeroquip Performance Products; Eaton, Hydraulics Sector**]
2. [**Bowes Manufacturing Inc.**]
3. [**Foster Manufacturing, Inc.**]
4. [**Milton Industries, Inc**]
5. [**Parker (Parker Hannifin)**]
6. [**Rectus Corp**]
7. [**Schrader-Bridgeport/Standard Thomson**]
8. [**TOMCO Products Inc**]
9. [**Tuthill Corporation**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aeroquip Performance Products; Eaton, Hydraulics Sector**]
2. [**Bowes Manufacturing Inc.**]
3. [**Foster Manufacturing, Inc.**]
4. [**Milton Industries, Inc**]
5. [**Parker (Parker Hannifin)**]
6. [**Rectus Corp**]
7. [**Schrader-Bridgeport/Standard Thomson**]
8. [**TOMCO Products Inc**]
9. [**Tuthill Corporation**]
10. <**Insert manufacturer's name**>

C. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

D. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: [**Flow-sensor-bleeder, check-valve**][**Straight-through**] type with barbed outlet for attaching hose.

E. Valveless Quick Couplings: Straight-through brass body with stainless steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for [**300 psig (2070 kPa)**]<**Insert pressure**> minimum working

pressure, unless otherwise indicated.

1. Hose: Reinforced [**single-**][**or**][**double**]-wire-braid, CR-covered hose for compressed-air service.
2. Hose Clamps: Stainless steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller, Pressure-Sealed: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and press-seal joints.
3. NPS 2 (DN 50) and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
4. NPS 2 (DN 50) and Smaller, Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
5. 63 mm Outside Tube Diameter and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
6. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
7. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
8. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
10. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
11. 73 to 115 mm: Aluminum pipe; and roll-groove couplings.
12. NPS 5 (DN 125) and Larger, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
13. NPS 5 (DN 125) and Larger, Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
14. NPS 5 (DN 125) and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
15. NPS 5 (DN 125) and Larger, Grooved-End, Copper: Grooved-end, **ASTM B88, Type K or L (ASTM B88M, Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
16. 168 mm and Larger: Aluminum pipe; and roll-groove couplings.

B. Low-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 (DN 50) and Smaller, Pressure-Sealed, Steel: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
3. NPS 2 (DN 50) and Smaller, Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
4. NPS 2 (DN 50) and Smaller, Pressure-Sealed, Copper: **Type K or L (Type A or B)**, copper tube; press-type fittings; and pressure-sealed joints.
5. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bit ring couplings.
6. 63 mm and Smaller, Solvent-Fitted, Blue ABS: Pipe and fittings; transition fittings; valves; and solvent-cemented joints.
7. NPS 2 (DN 50) and Smaller, Solvent-Fitted, Green ABS: Pipe and fittings, transition fittings, and valves; and solvent-cemented joints.
8. NPS 2 (DN 50) and Smaller, Heat-Fused: HDPE pipe, fittings, and valves; and heat-fusion joints.
9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
10. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
11. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
12. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
13. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Pressure-Sealed: **Type K or L (Type A or B)**, copper tube; press-type fittings; and pressure-sealed joints.
14. 73 to 115 mm: Aluminum pipe; and roll-groove couplings.
15. 90 and 110 mm, Solvent-Fitted, Blue ABS: Pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.
16. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Solvent-Fitted, Green ABS: Green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.
17. NPS 2-1/2 to NPS 4 (DN 65 to DN 100), Heat-Fused: HDPE pipe and fittings; valves; and heat-fusion joints.
18. NPS 5 and NPS 6 (DN 125 and DN 150): Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
19. NPS 5 (DN 125) and Larger: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
20. NPS 5 to NPS 8 (DN 125 to DN 200): **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
21. 169 to 273 mm: Aluminum pipe; and roll-groove couplings.

C. High-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller, Pressure-Sealed: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
3. NPS 2 (DN 50) and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
4. NPS 2 (DN 50) and Smaller, Brazed or Soldered: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
5. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
6. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Threaded: Schedule 40, [**black**][**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
7. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Grooved-End: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
8. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Welded: Schedule 40, black-steel pipe; wrought-steel

fittings; and welded joints.
9. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
10. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Brazed: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
11. NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Grooved-End, Copper: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
12. 73 to 168 mm: Aluminum pipe; and roll-groove couplings.
13. NPS 8 (DN 200) and Larger, Grooved: Schedule 40, [**black**][**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.
14. NPS 8 (DN 200) and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
15. NPS 8 (DN 200), Grooved-End: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
16. 220 and 274 mm: Aluminum pipe; and roll-groove couplings.

D. Drain Piping: Use[**one of**] the following piping materials:

1. NPS 2 (DN 50) and Smaller: **Type M (Type C)** copper tube; wrought-copper fittings; and brazed or soldered joints.
2. 63 mm and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article in Section 220523 "General-Duty Valves for Plumbing Piping," according to the following:

1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
2. High-Pressure Compressed Air: Valve types specified for high-pressure compressed air.
3. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
4. Grooved-end valves may be used with grooved-end piping and grooved joints.

B. General-Duty Valves for Aluminum Piping System: Provide valves, made by piping system manufacturer, that are compatible with piping.

1. Ball Valves, 63 mm and Smaller: NPT ends, or push-connect bite ring ends.
2. Butterfly Valves, 73 mm and Larger: Tube to tube, with two roll-groove end couplings.

C. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.

1. Blue ABS Piping System: Ball and butterfly valves.
2. Green ABS Piping System: Ball valves.
3. HDPE Piping System: Ball valves.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless

deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Where installing piping adjacent to equipment and machines, allow space for service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed[**or soldered**] joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

L. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220500 "Common Work Results for Plumbing."

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF ALUMINUM PIPING SYSTEMS

A. Install aluminum piping systems in accordance with manufacturer's written instructions, using manufacturer's recommended tools, accessories, and methods.

B. Install branch connections [**NPS 2-1/2 (DN 65)**][**73 mm**] and larger, to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

C. Install branch connections [**NPS 2 (DN 50)**][**63 mm**] and smaller, to compressed-air mains using aluminum piping system reducing outlet tee with water trapping capabilities. Provide drain leg and drain trap at end of each main and branch and at low points.

D. Support aluminum pipe using manufacturer's hangers and supports, designed for use with the system.

E. Allow for expansion and contraction of aluminum piping system.

F. Do not use plastic components or plastic fittings of any kind within pressurized aluminum piping system. This limitation applies to main headers, branches, and drops.

3.5 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join in accordance with AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches in accordance with ASTM F2014, with tools recommended by procedure manufacturer, and using operators qualified in accordance with "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

I. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join in accordance with AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.

J. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper

towels. Join in accordance with ASTM D2657 for socket-fusion joints.

K. Press-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified in accordance with "Quality Assurance" Article.

L. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Join in accordance with ASME B31.9 for solvent-cemented joints and with ASTM D2235 Appendix.

M. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.6 INSTALLATION OF VALVES

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

3.7 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.8 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

A. Install flexible pipe connectors in discharge piping[**and in inlet air piping from remote air-inlet filter**] of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless steel-hose flexible pipe connectors in steel compressed-air piping.

3.9 INSTALLATION OF SPECIALTIES

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment[**and tools**].

D. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.[**Mount on wall at locations indicated.**]

E. Install air-line lubricators in branch piping to machine tools.[**Mount on wall at locations indicated.**]

F. Install quick couplings at piping terminals for hose connections.

G. Install hose assemblies at hose connections.

3.10 PIPING CONNECTIONS

A. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

B. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.11 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**copper tubing**][**and**][**steel piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**][**HDPE**][**aluminum**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

F. Support vertical runs of [**copper tubing**][**and**][**steel piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**][**HDPE**][**aluminum**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.

I. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

J. Base of Vertical Piping: MSS Type 52, spring hangers.

K. Install vinyl-coated hangers for [**ABS**][**HDPE**] piping.

3.12 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.13 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of **50 psig (345 kPa)** above system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert pressure**>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of **15 psig (105 kPa)**, hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed **220 psig (1515 kPa)**. Once desired operating pressure is met, let stand for one hour.
3. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of **110 deg F (43 deg C)** or less, to pressure of [**40 psig (275 kPa)**]<**Insert pressure**> above system operating pressure, but not less than [**80 psig (550 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> or more than **120 psig (825 kPa)**. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
4. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of **100 deg F (38 deg C)** or less, to pressure of [**40 psig (275 kPa)**]<**Insert pressure**> above system operating pressure, but not less than [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> or more than **180 psig (1240 kPa)**. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
5. Repair leaks and retest until no leaks exist.
6. Inspect [**filters**][**lubricators**][**and**][**pressure regulators**] for proper operation.

C. Prepare test and inspection reports.

END OF SECTION 22 15 13 00

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Task	Specification	Specification Description
22 15 13 00	22 15 19 00	General-Service Packaged Air Compressors and Receivers

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SECTION 22 15 19 00 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reciprocating air compressors - lubricated.
2. Reciprocating air compressors - oil free.
3. Reciprocating air compressors - oil less.
4. Rotary-screw air compressors - oil free.
5. Rotary-screw air compressors - oil flooded.
6. Rotary, sliding-vane air compressors - oil free.
7. Rotary, sliding-vane air compressors - oil sealed.
8. Air filters - inlet type.
9. Compressed-air aftercoolers - air cooled.
10. Compressed-air aftercoolers - water cooled.
11. Compressed-air dryers - refrigerant type.
12. Compressed-air dryers - desiccant type.
13. Computer interface cabinet.

1.2 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in **acfm (actual L/s)**.

B. Standard Air: Free air at **68 deg F (20 deg C)** and **1 atmosphere (29.92 in. Hg)** before compression or expansion and measured in **scfm (standard L/s)**.

1.3 ACTION SUBMITTALS

A. Product Data: For each product.

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include operating characteristics, electrical characteristics, and furnished accessories.
c. <**Insert requirements**>.

B. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations and size of each field connection.
3. Diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For compressed-air equipment mounting.

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases, indicated to comply with performance requirements and design criteria, including analysis data[**signed and sealed by the qualified professional engineer responsible for their preparation**].

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment.

1. Indicate actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Air Compressor, Inlet-Air-Filter Elements: Equal to <**Insert number**> percent of amount installed, but no fewer than <**Insert number**> units.
2. Belts: [**One**][**Two**]<**Insert number**> for each belt-driven compressor.

1.7 FIELD CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.10 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and installer agree**] to repair or replace equipment that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of <**Insert components**>.
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].
c. <**Insert conditions relating to specified products**>.
d. <**Insert failure modes**>.

2. Warranty Period: [**One**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of air compressor through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design compressed-air equipment mounting.

D. Seismic Performance: Compressed-air equipment to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.[**See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment.**]

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.3 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled;

continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to [**alternate lead-lag compressors for duplex**][**sequence lead-lag compressors for multiplex**] air compressors.
7. Instrumentation: Include discharge-air pressure gauge, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gauges, and control transformer.
8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

C. Receivers: Steel tank constructed in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gauge, drain, and pressure-reducing valve.

2.4 RECIPROCATING AIR COMPRESSORS - LUBRICATED

A. Reciprocating Air Compressors - Lubricated :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Copco**]
b. [**FS-Curtis**]
c. [**Gardner Denver, an Ingersoll Rand business**]
d. [**General Air Products, Inc**]
e. [**Ingersoll Rand**]
f. [**Kaeser Compressors, Inc**]
g. [**Powerex, Inc.**]
h. [**Quincy Compressor**]
i. [**Saylor-Beall Manufacturing Company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Copco**]
b. [**FS-Curtis**]

c. [**Gardner Denver, an Ingersoll Rand business**]
d. [**General Air Products, Inc**]
e. [**Ingersoll Rand**]
f. [**Kaeser Compressors, Inc**]
g. [**Powerex, Inc.**]
h. [**Quincy Compressor**]
i. [**Saylor-Beall Manufacturing Company**]
j. <**Insert manufacturer's name**>

B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.

1. Submerged gear-type oil pump.
2. Oil filter.
3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
4. Belt guard totally enclosing pulleys and belts.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**][**Three**]<**Insert number**>; [**single**][**single or two**][**two**] stage.

   a. Intercooler between stages of two-stage units.

2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Mounting: [**Freestanding**][**Tank mounted**].
8. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

9. Electrical Characteristics:

   a. Volts: [**120**][**208**][**240**]<**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 RECIPROCATING AIR COMPRESSORS - OIL FREE

A. Reciprocating Air Compressors - Oil Free: :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Gast Manufacturing Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Gast Manufacturing Inc**]
   b. <**Insert manufacturer's name**>

B. Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber, lubricated crankcase, and of construction that prohibits oil from entering compression chamber.

1. Submerged gear-type oil pump.
2. Oil filter.
3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
4. Belt guard totally enclosing pulleys and belts.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**][**Three**]<**Insert number**>; single stage.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Mounting: [**Freestanding**][**Tank mounted**].
8. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

9. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 RECIPROCATING AIR COMPRESSORS - OIL LESS

A. Reciprocating Air Compressors - Oil Less :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**FS-Curtis**]
   b. [**Gast Manufacturing Inc**]
   c. [**General Air Products, Inc**]
   d. [**JUN-AIR**]
   e. [**Powerex, Inc.**]
   f. [**Squire-Cogswell/Ohio Medical**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**FS-Curtis**]
   b. [**Gast Manufacturing Inc**]
   c. [**General Air Products, Inc**]
   d. [**JUN-AIR**]
   e. [**Powerex, Inc.**]
   f. [**Squire-Cogswell/Ohio Medical**]
   g. <**Insert manufacturer's name**>

B. Compressor(s): Oil-less (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that deliver air of quality equal to intake air.

1. High discharge-air temperature switch.
2. Belt guard totally enclosing pulleys and belts.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**][**Three**]<**Insert number**>; [**single**][**single or two**][**two**] stage.

   a. Intercooler between stages of two-stage units.

2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Mounting: [**Freestanding**][**Tank mounted**].
8. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

9. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.7 ROTARY-SCREW AIR COMPRESSORS - OIL FREE

A. Rotary-Screw Air Compressors - Oil Free :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Copco**]
   b. [**CompAir, Ltd**]
   c. [**Gardner Denver, an Ingersoll Rand business**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atlas Copco**]
   b. [**CompAir, Ltd**]
   c. [**Gardner Denver, an Ingersoll Rand business**]
   d. <**Insert manufacturer's name**>

B. Compressor(s): Oil-free, rotary-screw type with nonlubricated helical screws and lubricated gear box, and of construction that prohibits oil from entering compression chamber.

1. Coupling: Nonlubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
4. Air/Coolant Receiver and Separation System: **150 psig (1035 kPa)** rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between **50 and 100 psig (345 and 690 kPa)**. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Enclosure: Steel with sound-attenuating material lining.

E. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**]<**Insert number**>; single stage.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

8. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.8 ROTARY-SCREW AIR COMPRESSORS - OIL FLOODED

A. Rotary-Screw Air Compressors - Oil Flooded :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Copco**]
b. [**CompAir, Ltd**]
c. [**Gardner Denver, an Ingersoll Rand business**]
d. [**Ingersoll Rand**]
e. [**Kaeser Compressors, Inc**]
f. [**Quincy Compressor**]
g. [**Sullair Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Copco**]
b. [**CompAir, Ltd**]
c. [**Gardner Denver, an Ingersoll Rand business**]
d. [**Ingersoll Rand**]
e. [**Kaeser Compressors, Inc**]
f. [**Quincy Compressor**]
g. [**Sullair Corporation**]
h. <**Insert manufacturer's name**>

B. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.

1. Coupling: Nonlubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
4. Air/Coolant Receiver and Separation System: **150 psig (1035 kPa)** rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between **50 and 100 psig (345 and 690 kPa)**. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Enclosure: Steel with sound-attenuating material lining.

E. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**]<**Insert number**>; [**single**][**single or two**][**two**] stage.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**][**200 psig (1380 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

8. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 ROTARY, SLIDING-VANE AIR COMPRESSORS - OIL FREE

A. Rotary, Sliding-Vane Air Compressors - Oil Free :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Becker Pumps Corp**]
   b. [**Gast Manufacturing Inc**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Becker Pumps Corp**]
   b. [**Gast Manufacturing Inc**]
   c. <**Insert manufacturer's name**>

B. Compressor(s): Oil-free, nonpulsating, rotary, sliding-vane type with nonlubricated sliding vanes.

1. Cleanable inlet screens.
2. Outlet silencers on discharge connections.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**]<**Insert value**> minimum.

5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**]<**Insert number**>; single stage.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**15 psig (103 kPa)**][**20 psig (138 kPa)**][**25 psig (173 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Mounting: [**Freestanding**][**Tank mounted**].
8. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

9. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.10 ROTARY, SLIDING-VANE AIR COMPRESSORS - OIL SEALED

A. Rotary, Sliding-Vane Air Compressors - Oil Sealed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CompAir, Ltd**]
   b. [**Davey Compressor Company**]
   c. [**Gast Manufacturing Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CompAir, Ltd**]
   b. [**Davey Compressor Company**]
   c. [**Gast Manufacturing Inc**]
   d. <**Insert manufacturer's name**>

B. Compressor(s): Nonpulsating, rotary, sliding-vane type with oil-sealed sliding vanes.

1. Cleanable inlet screens.
2. Outlet silencers and oil-mist separators on discharge connections.

C. Receiver: ASME construction steel tank.

1. Arrangement: [**Horizontal**][**Vertical**].
2. Capacity: <**Insert gal. (L)**>.
3. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**> coating.
4. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
5. Pressure Regulator Setting: <**Insert psig (kPa)**>.
6. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
7. Drain: [**Automatic**][**Manual**] valve.

D. Capacities and Characteristics:

1. Air Compressor(s): [**One**][**Two**]<**Insert number**>; single stage.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**20 psig (138 kPa)**][**25 psig (173 kPa)**][**30 psig (207 kPa)**][**100 psig (690 kPa)**][**125 psig (860 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Mounting: [**Freestanding**][**Tank mounted**].
8. Motor (Each Air Compressor):

   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert value**> rpm.

9. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.11 AIR FILTERS - INLET TYPE

A. Description for Each Compressor: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

B. Description for Multiple Compressors: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.12 COMPRESSED-AIR AFTERCOOLERS - AIR COOLED

A. Compressed-Air Aftercoolers - Air Cooled :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aircel**]
   b. [**AKG Group**]
   c. [**IPAC, Inc.**]
   d. [**Kaeser Compressors, Inc**]
   e. [**Saylor-Beall Manufacturing Company**]
   f. [**Van Air Systems, Inc**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aircel**]
   b. [**AKG Group**]
   c. [**IPAC, Inc.**]
   d. [**Kaeser Compressors, Inc**]
   e. [**Saylor-Beall Manufacturing Company**]
   f. [**Van Air Systems, Inc**]
   g. <**Insert manufacturer's name**>

B. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at [**250 psig (1725 kPa)**]<**Insert value**> and leak tested at **350 psig (2415 kPa)** minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to [**10 deg F (6 deg C)**]<**Insert temperature**> above summertime maximum ambient temperature. Include moisture separator and automatic drain.

C. Capacities and Characteristics:

1. Standard-Air Capacity of Each Aftercooler: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering, Compressed-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving, Compressed-Air Temperature: <**Insert deg F (deg C)**>.
5. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
6. Maximum Compressed-Air-Pressure Drop: <**Insert psig (kPa)**>.
7. Motor Horsepower: <**Insert value**>.
8. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.13 COMPRESSED-AIR AFTERCOOLERS - WATER COOLED

A. Compressed-Air Aftercoolers - Water Cooled :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aircel**]
   b. [**IPAC, Inc.**]
   c. [**Kaeser Compressors, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aircel**]
   b. [**IPAC, Inc.**]
   c. [**Kaeser Compressors, Inc**]
   d. <**Insert manufacturer's name**>

B. Description: Shell-and-tube unit, rated at [**250 psig (1725 kPa)**]<**Insert value**> and leak tested at **350 psig (2415 kPa)** minimum air pressure, in capacities indicated. Include moisture separator and automatic drain.

C. Capacities and Characteristics:

1. Standard-Air Capacity of Each Aftercooler: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Water Flow: <**Insert gpm (L/s)**>.
5. Entering, Compressed-Air Temperature: <**Insert deg F (deg C)**>.
6. Leaving, Compressed-Air Temperature: <**Insert deg F (deg C)**>.

2.14 COMPRESSED-AIR DRYERS - REFRIGERANT TYPE

A. Compressed-Air Dryers - Refrigerant Type :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air/Tak, Inc**]
   b. [**Atlas Copco**]
   c. [**FS-Curtis**]
   d. [**Ingersoll Rand**]
   e. [**Kaeser Compressors, Inc**]
   f. [**McIntire Company**]
   g. [**Parker (Parker Hannifin)**]
   h. [**Pioneer Air Systems, Inc**]
   i. [**Pneumatech Inc**]
   j. [**SPXFLOW, Hankison**]

k. [**Wilkerson Operations**]
l. [**Zeks Compressed Air Solutions**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air/Tak, Inc**]
b. [**Atlas Copco**]
c. [**FS-Curtis**]
d. [**Ingersoll Rand**]
e. [**Kaeser Compressors, Inc**]
f. [**McIntire Company**]
g. [**Parker (Parker Hannifin)**]
h. [**Pioneer Air Systems, Inc**]
i. [**Pneumatech Inc**]
j. [**SPXFLOW, Hankison**]
k. [**Wilkerson Operations**]
l. [**Zeks Compressed Air Solutions**]
m. <**Insert manufacturer's name**>

B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver **35 deg F (2 deg C)**, **100 psig (690 kPa)** air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

C. Capacities and Characteristics:

1. Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Dew Point Temperature: <**Insert deg F (deg C)**>.
6. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7. Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8. Inlet Filter: [**5**]<**Insert number**> micrometers.
9. Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10. Motor Horsepower: <**Insert value**>.
11. Electrical Characteristics:

a. Volts: <**Insert value**>.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.15 COMPRESSED-AIR DRYERS - DESICCANT TYPE

A. Compressed-Air Dryers - Desiccant Type :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Air/Tak, Inc**]
b. [**Donaldson Company, Inc.**]
c. [**Ingersoll Rand**]
d. [**Kaeser Compressors, Inc**]
e. [**Numatics, Incorporated**]
f. [**Parker (Parker Hannifin)**]
g. [**Pioneer Air Systems, Inc**]
h. [**Pneumatech Inc**]
i. [**SPXFLOW, Air Treatment**]
j. [**SPXFLOW, Hankison**]
k. [**Van Air Systems, Inc**]
l. [**Wilkerson Operations**]
m. [**Zeks Compressed Air Solutions**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air/Tak, Inc**]
b. [**Donaldson Company, Inc.**]
c. [**Ingersoll Rand**]
d. [**Kaeser Compressors, Inc**]
e. [**Numatics, Incorporated**]
f. [**Parker (Parker Hannifin)**]
g. [**Pioneer Air Systems, Inc**]
h. [**Pneumatech Inc**]
i. [**SPXFLOW, Air Treatment**]
j. [**SPXFLOW, Hankison**]
k. [**Van Air Systems, Inc**]
l. [**Wilkerson Operations**]
m. [**Zeks Compressed Air Solutions**]
n. <**Insert manufacturer's name**>

B. Description: Twin-tower unit with purge system, mufflers, and capability to deliver [**plus 10 deg F (minus 12 deg C), 100 psig (690 kPa)**]<**Insert values**> air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

C. Capacities and Characteristics:

1. Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Dew Point Temperature: <**Insert deg F (deg C)**>.
6. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7. Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8. Inlet Filter: [**5**]<**Insert number**> micrometers.
9. Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10. Electrical Characteristics:

a. Volts: <**Insert value**>.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.16 COMPUTER INTERFACE CABINET

A. Description:

1. Wall mounting.
2. Welded steel with white enamel finish.
3. Gasketed door.
4. Grounding device.
5. Factory-installed, signal circuit boards.
6. Power transformer.
7. Circuit breaker.
8. Wiring terminal board.
9. Internal wiring capable of interfacing [**20**]<**Insert number**> alarm signals.

2.17 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

B. <**Insert unique motor characteristics**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of compressed air piping to verify actual location before air compressor installation.

3.2 INSTALLATION OF EQUIPMENT

A. Equipment Mounting:

1. Install air compressors[**and aftercoolers**][**and air dryers**][**, aftercoolers, and air dryers**] on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install [**water-cooled, compressed-air aftercoolers**][**and**][**desiccant compressed-air dryers**]

on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

3. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
4. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install compressed-air equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors[**and dryers**].
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221513 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

3.8 ADJUSTING

A. Adjust equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.9 FIELD QUALITY CONTROL

A. Test Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuity has been energized, start unit to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Air compressors, aftercoolers, air dryers, and controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air compressors[**and aftercoolers**][**and air dryers**][**, aftercoolers, and air dryers**].

END OF SECTION 22 15 19 00

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Task	Specification	Specification Description
22 15 19 13	22 15 19 00	General-Service Packaged Air Compressors and Receivers
22 15 19 19	22 15 19 00	General-Service Packaged Air Compressors and Receivers

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SECTION 22 31 00 00 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water softeners.
2. Chemicals.
3. Water-testing sets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water softeners.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for water softeners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Salt for Brine Tanks: Furnish in same form as and at least [**four**]<**Insert number**> times original load, but not less than [**200 (90.7)**][**1000 (453.6)**]<**Insert weight**> **lb (kg)**. Deliver on pallets according to the following:

a. Food-Grade Pellet Salt: In [**40- or 50- (18.1- or 22.7-)**][**80- (36.3-)**]<**Insert weight**> **lb (kg)** packages.
b. Plain Pellet Salt: In [**40- or 50- (18.1- or 22.7-)**][**80- (36.3-)**]<**Insert weight**> **lb (kg)** packages.
c. Crystallized Solar Salt: In [**40- or 50- (18.1- or 22.7-)**][**80- (36.3-)**]<**Insert weight**> **lb (kg)** packages.
d. Plain, Brine Block Salt: In [**50- (22.7-)**]<**Insert weight**> **lb (kg)** blocks.

2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of mineral and brine tanks.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
d. Attrition loss of resin exceeding 3 percent per year.
e. Mineral washed out of system during service run or backwashing period.
f. Effluent turbidity greater and color darker than incoming water.
g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.

2. Water Softeners, Warranty Period: From date of Substantial Completion.

a. Mineral Tanks: [**Five**][**10**]<**Insert number**> years.
b. Brine Tanks: [**10**]<**Insert number**> years.
c. Control Valve: [**One**]<**Insert number**> year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

B. Seismic Performance: Water softeners shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

C. Capacities and Characteristics:

1. Water Analysis:

a. Hardness: <**Insert number**> **grains/gal. or ppm (mg/L)**.
b. Iron: <**Insert number**> **ppm (mg/L)**.
c. Dissolved Solids: <**Insert number**> **ppm (mg/L)**.
d. Concentration: <**Insert pH**>.
e. Inlet Water Pressure: <**Insert number**> **psig (kPa)**.
f. Water Temperature: <**Insert number**> **deg F (deg C)**.

2. Continuous Service Flow Rate: <**Insert number**> **gpm at 15-psig (L/s at 104-kPa)** pressure drop.
3. Peak Service Flow Rate: <**Insert number**> **gpm at 25-psig (L/s at 173-kPa)** pressure drop.
4. Water Meter Size: <**Insert number**> **NPS (DN)**.
5. Manifold Pipe Size: <**Insert number**> **NPS (DN)**.
6. Backwash-to-Drain Pipe Size: <**Insert number**> **NPS (DN)**.
7. Water Consumption: <**Insert number**> **gal./day (cu. m/day)**.
8. Water Demand: <**Insert hours/day**>.
9. Number of Mineral Tanks: [**One**][**Two**][**Three**]<**Insert number**>.
10. Mineral Quantity, Each Tank: <**Insert number**> **cu. ft. (cu. m)**.
11. Mineral Exchange Capacity: <**Insert number**> **grains/cu. ft. per lb (kg/cu. m per kg)** of salt.
12. Electrical Characteristics:

a. Volts: <**Insert number**> V.
b. Phases: <**Insert number**>.
c. Hertz: <**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A.
f. Maximum Overcurrent Protection: <**Insert number**> A.

13. Salt Capacity: <**Insert number**> **lb (kg)**.
14. Minimum Number of Regenerations per Refill: <**Insert number**>.
15. Floor Area Required: <**Insert number**> **sq. ft. (sq. m)**.
16. Height Required: <**Insert number**> **inches (mm)**.

2.2 WATER SOFTENERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**3M**]
2. [**Aquion, Inc.**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Springsoft International, Inc.**]
11. [**Water King**]
12. [**WaterSoft**]
13. [**WATTS; A Watts Water Technologies Company**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**Aquion, Inc.**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Springsoft International, Inc.**]
11. [**Water King**]
12. [**WaterSoft**]
13. [**WATTS; A Watts Water Technologies Company**]
14. <**Insert manufacturer's name**>

C. Description: Factory-assembled, pressure-type water softener.

1. Configuration: [**Single unit with one mineral tank**][**Twin unit with two mineral tanks**][**Triple unit with three mineral tanks**]<**Insert configuration**> and one brine tank.
2. Mounting: On skids.
3. Wetted Components: Suitable for water temperatures from [**40 to at least 100 deg F (5 to at least 38 deg C)**][**40 to at least 120 deg F (5 to at least 49 deg C)**][**40 to at least 150 deg F (5 to at least 66 deg C)**]<**Insert temperature**>.
4. Mineral Tanks, FRP: Pressure-vessel quality.

    a. Construction: [**Non-ASME code.**][**Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."**]
    b. Pressure Rating: [**100 (690)**][**125 (860)**]<**Insert pressure**> **psig (kPa)** minimum.
    c. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
    d. Support Legs or Skirt: Constructed of structural steel, welded to tank[**before testing and labeling**].
    e. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
    f. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers, and

arranged for even flow distribution through resin bed.

g. Liner: PE, ABS, or other material suitable for potable water.

5. Mineral Tanks, [**Steel**][**Stainless Steel**]: Electric welded; pressure-vessel quality.

   a. Seismic Requirements: Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
   b. Construction: [**Non-ASME code.**][**Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.**]
   c. Pressure Rating: [**100 (690)**][**125 (860)**][**150 (1035)**]<**Insert pressure**> **psig (kPa)** minimum.
   d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
   e. Handholes: **4 inches (102 mm)** round or **4 by 6 inches (102 by 152 mm)** elliptical, in top head and lower sidewall of tanks [**30 (762)**]<**Insert dimension**> **inches (mm)** and smaller in diameter.
   f. Manhole: **11 by 15 inches (280 by 380 mm)** in top head of tanks larger than [**30 (762)**]<**Insert dimension**> **inches (mm)** in diameter.
   g. Support Legs or Skirt: Constructed of structural steel, welded to tank[**before testing and labeling**].
   h. Finish:

      1) Hot-dip galvanized on exterior and interior of tank after fabrication unless tank is stainless steel.
      2) Exterior of tank spray-painted with rust-resistant prime coat, **2- to 3-mil (0.051- to 0.076-mm)** dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, **8- to 10-mil (0.203- to 0.254-mm)** dry film thickness.

   i. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
   j. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers, and arranged for even flow distribution through resin bed.
   k. Liner: PE, ABS, or other material suitable for potable water.

6. Controls, Automatic: [**120**]<**Insert number**> V; factory wired and factory mounted on unit.

   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Electric time clock and switch for automatic operation except for manual return to service.
   d. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration.
   e. Pointer on pilot-control valve shall indicate cycle of operation.
   f. Includes means of manual operation of pilot-control valve if power fails.

7. Controls, Fully Automatic: [**120**]<**Insert number**> V; factory wired and factory mounted on unit.

   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
   d. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration and return to service.
   e. Pointer on pilot-control valve shall indicate cycle of operation.
   f. Includes means of manual operation of pilot-control valve if power fails.

8. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated, dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    e. Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
    f. Sampling cocks for soft water.
    g. Special tools are not required for service.

9. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.

    a. Meter Control: Each mineral tank is equipped with signal-register-head water meter that produces electrical signal indicating need for regeneration on reaching hand-set total in **gallons (liters)**. Signal will continue until reset.
    b. Demand-Initiated Control:

        1) Single mineral tank is equipped with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in **gallons (liters)**. Head automatically resets to preset total in **gallons (liters)** for next service run.
        2) Each mineral tank of twin mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to initiate regeneration at preset total in **gallons (liters)**. Head automatically resets to preset total in **gallons (liters)** for next service run. Electrical lockout prevents simultaneous regeneration of both tanks.
        3) Each twin mineral-tank unit is equipped with automatic-reset-head water meter, in common outlet header, that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in **gallons (liters)** and divert flow to other tank. Automatically repeats with other tank. Electrical lockout prevents simultaneous regeneration of both tanks.
        4) Each mineral tank of multiple mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to automatically regenerate at preset total in **gallons (liters)**. Head automatically resets to preset total in **gallons (liters)** for next service run. Electrical lockout prevents simultaneous regeneration of more than one tank.
        5) Each multiple mineral-tank unit is equipped with automatic-reset-head water meter, in common outlet header, that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in **gallons (liters)** and divert flow to other tanks. Automatically repeats with other tanks. Electrical lockout prevents simultaneous regeneration of more than one tank.

10. Brine Tank: Combination measuring and wet-salt storing system.

    a. Tank and Cover Material: Fiberglass, **3/16 inch (4.8 mm)** thick; or molded PE, **3/8 inch (9.5 mm)** thick.
    b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill.
    c. Size: Large enough for at least four regenerations at full salting.

11. Factory-Installed Accessories:

a. Piping, valves, tubing, and drains.
b. Sampling cocks.
c. Main-operating-valve position indicators.
d. Water meters.

2.3 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene, ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

1. Exchange Capacity: [**30,000 (69)**]<**Insert capacity**> **grains/cu. ft. (kg.cu. m)** of calcium carbonate of resin when regenerated with **15 lb (6.8 kg)** of salt.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

1. Form: Processed, [**food-grade salt pellets**][**plain salt pellets**][**crystallized solar salt collected from shallow ponds and milled into irregular particles**][**plain, brine block salt**].

2.4 WATER-TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

C. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

D. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

E. Hydrostatically test mineral tanks before shipment to a minimum of one and one-half times the pressure rating.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF WATER SOFTENERS

A. Equipment Mounting:

1. Install water softeners on cast-in-place concrete equipment base(s). Comply with requirements

for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer, but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water-testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank[**, and on inlet and outlet headers**].

1. Metal general-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Plastic valves are specified in Section 221116 "Domestic Water Piping."
3. Exception for water softeners with factory-installed shutoff valves at locations indicated.

D. Install pressure gauges on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gauges are specified in Section 220500 "Common Work Results for Plumbing."

1. Exception for water softeners with factory-installed pressure gauges at locations indicated.
2. Exception for household water softeners.
3. Exception for water softeners in hot-water service.

E. Install valved bypass in water piping around water softeners.

1. Metal general-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Plastic valves are specified in Section 221116 "Domestic Water Piping."
3. Water piping is specified in Section 221116 "Domestic Water Piping."
4. Exception for water softeners in hot-water service.

F. Install indirect wastes to spill into open drains or pit with drain.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Water softeners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Add water to brine tanks and fill with the following form of salt:

1. Water Softeners: Processed, [**plain salt pellets**][**crystallized solar salt collected from shallow ponds and milled into irregular particles**][**plain, brine block salt**]<**Insert salt form**>.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D859, "Test Method for Silica in Water."
2. ASTM D1067, "Test Methods for Acidity or Alkalinity of Water."

3. ASTM D1068, "Test Methods for Iron in Water."
4. ASTM D1126, "Test Method for Hardness in Water."
5. ASTM D1129, "Terminology Relating to Water."
6. ASTM D3370, "Practices for Sampling Water from Closed Conduits."

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by skilled employees of water softener Installer. Include [**monthly**][**quarterly**] preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain domestic water softeners.

END OF SECTION 22 31 00 00

Task	Specification	Specification Description
22 31 13 00	22 31 00 00	Domestic Water Softeners
22 31 16 00	22 31 00 00	Domestic Water Softeners

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SECTION 22 32 00 00 - DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Filters - bag type.
2. Filters - cartridge type, freestanding.
3. Filters - cartridge type, off floor.
4. Filters - carbon type.
5. Filters - sand type, circulating.
6. Filters - sand type, multimedia.
7. Filters - greensand type.
8. Separators.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for plumbing piping strainers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Filters - bag type.
2. Filters - cartridge type, freestanding.
3. Filters - cartridge type, off floor.
4. Filters - carbon type.
5. Filters - sand type, circulating.
6. Filters - sand type, multimedia.
7. Filters - greensand type.
8. Separators.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For water filtration equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For [**bag-type filters,**][**freestanding cartridge-type filters,**][**carbon-type filters,**][**circulating sand-type filters,**][**multimedia sand-type filters,**][**greensand-type filters,**][**separators,**] accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

C. Welding certificates.

D. Source quality-control reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water filtration equipment to include in emergency, operation, and maintenance manuals.

1. Indicate the actual installed items by marking the submittals with an arrow or box.

1.5 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bag-Type Filter Bags: Bags for bag-type filters equal to [**200**][**400**]<**Insert number**> percent of amount installed for each size and media indicated.
2. Cartridge-Filter Elements: Elements for cartridge filters equal to [**200**][**400**]<**Insert number**> percent of amount installed for each size and media indicated.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 PROJECT CONDITIONS

A. Feedwater Analysis:

1. Alkalinity: <**Insert ppm (mg/L)**>.
2. Arsenic: <**Insert ppm (mg/L)**>.
3. Calcium: <**Insert ppm (mg/L)**>.
4. Chlorine: <**Insert ppm (mg/L)**>.
5. Color: <**Insert nephelometric turbidity units**>.
6. Hydrogen-Ion Concentration: <**Insert pH**>.
7. Hardness: <**Insert ppm (mg/L)**>.
8. Hydrogen Sulfide: <**Insert ppm (mg/L)**>.
9. Iron: <**Insert ppm (mg/L)**>.
10. Lead: <**Insert ppm (mg/L)**>.
11. Magnesium: <**Insert ppm (mg/L)**>.
12. Manganese: <**Insert ppm (mg/L)**>.
13. Potassium: <**Insert ppm (mg/L)**>.
14. Sand: <**Insert ppm (mg/L)**>.
15. Silt: <**Insert ppm (mg/L)**>.
16. Sodium: <**Insert ppm (mg/L)**>.
17. Total Dissolved Solids: <**Insert ppm (mg/L)**>.
18. Turbidity: <**Insert ppm (mg/L)**>.
19. <**Insert characteristic**>: <**Insert value**>.

B. Feedwater Properties:

1. Inlet Water Pressure: <**Insert psig (kPa)**>.
2. Water Temperature: <**Insert deg F (deg C)**>.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace water filtration components that fail in materials or workmanship within specified warranty period.

B. Warranty Period: [**1**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of water filtration equipment through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Domestic water filtration equipment intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Seismic Performance: [**Bag-type filters,**][**Freestanding cartridge-type filters,**][**Carbon-type filters,**][**Circulating sand-type filters,**][**Multimedia sand-type filters,**][**Greensand-type filters,**][**and**][**separators**] is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means that "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.3 FILTERS - BAG TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Filtration Systems; Mechanical Mfg. Corporation**]
2. [**Hayward Flow Control; Hayward Industries, Inc.**]
3. [**Parker (Parker Hannifin)**]
4. [**PEP Filters, Inc.**]
5. [**Rosedale Products, Inc.**]
6. [**Shelco Filters**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Filtration Systems; Mechanical Mfg. Corporation**]
2. [**Hayward Flow Control; Hayward Industries, Inc.**]
3. [**Parker (Parker Hannifin)**]
4. [**PEP Filters, Inc.**]
5. [**Rosedale Products, Inc.**]
6. [**Shelco Filters**]
7. <**Insert manufacturer's name**>

C. Description: Simplex, floor-mounted housing with [**single-bag filter**][**multiple-bag filter**] for removing suspended particles from water.

1. Housing: Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through bag-type water filter(s); with bag support and base, feet, or skirt.

   a. Material: [**Carbon steel with NSF 61/NSF 372 lining material**][**Plastic**][**Stainless steel**].
   b. Seals: [**NBR**]<**Insert material**>.
   c. Bag Support: Top lock ring and perforated [**stainless steel**]<**Insert material**> basket.
   d. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
   e. Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if housing is stainless steel.
   f. Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150 psig (1035 kPa)** plastic flanges.

2. Bag: Replaceable, of shape to fit housing.

D. Capacity and Characteristics:

1. Filtrate Design Concentrations:

a. Alkalinity: <**Insert ppm (mg/L)**>.
b. Chlorine: <**Insert ppm (mg/L)**>.
c. Color: <**Insert nephelometric turbidity units**>.
d. Hydrogen Sulfide: <**Insert ppm (mg/L)**>.
e. Iron: <**Insert ppm (mg/L)**>.
f. Manganese: <**Insert ppm (mg/L)**>.
g. Sand: <**Insert ppm (mg/L)**>.
h. Silt: <**Insert ppm (mg/L)**>.
i. Turbidity: <**Insert ppm (mg/L)**>.
j. <**Insert characteristic**>: <**Insert value**>.

2. Filter Design:

a. Continuous Flow: <**Insert gpm (L/s)**>.
b. Peak Flow: <**Insert gpm (L/s)**>.
c. Filtration Efficiency: [**98**]<**Insert number**> percent retention of suspended particles [**10**][**20**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.
d. Pressure Drop, Clean: Not to exceed [**2 psig (14 kPa)**]<**Insert value**> at filter design flow rate when clean.
e. Pressure Drop, Dirty: Not to exceed <**Insert value**> when dirty.

3. Housing:

a. Pressure Rating: <**Insert psig (kPa)**>.
b. Diameter: <**Insert inches (mm)**>.
c. Height or Length: <**Insert inches (mm)**>.
d. Inlet and Outlet Size: <**Insert NPS (DN)**>.
e. Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.

4. Bag:

a. Nominal Diameter: <**Insert inches (mm)**>.
b. Nominal Length: <**Insert inches (mm)**>.
c. Media: [**Cotton**][**Polyester**][**PP**]<**Insert material**>; [**felt, filament, or mesh**][**felt**][**filament**][**mesh**] construction.

2.4 FILTERS - CARTRIDGE TYPE

A. Filters - Cartridge Type, Freestanding:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Campbell Manufacturing, Inc**]
b. [**Eden Equipment Company**]
c. [**Graver Technologies**]

d. [**Harmsco, Inc.**]
e. [**Parker (Parker Hannifin)**]
f. [**Porvair Filtration Group**]
g. [**Rosedale Products, Inc.**]
h. [**Serfilco, Ltd**]
i. [**Shelco Filters**]
j. [**Suez Water Technologies (Formerly GE Water)**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Campbell Manufacturing, Inc**]
   b. [**Eden Equipment Company**]
   c. [**Graver Technologies**]
   d. [**Harmsco, Inc.**]
   e. [**Parker (Parker Hannifin)**]
   f. [**Porvair Filtration Group**]
   g. [**Rosedale Products, Inc.**]
   h. [**Serfilco, Ltd**]
   i. [**Shelco Filters**]
   j. [**Suez Water Technologies (Formerly GE Water)**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. <**Insert manufacturer's name**>

3. Description: Simplex, floor-mounted housing with replaceable element(s) for removing suspended particles from water.

   a. Housing: Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element(s); with element support(s) and base, feet, or skirt.

      1) Fabricate supports and base, feet, or skirt and attachment to housing with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.
      2) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
      3) Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if housing is stainless steel.
      4) Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150 psig (1035 kPa)** plastic flanges.

   b. Element(s): Replaceable; of shape to fit housing.

4. Capacity and Characteristics:

   a. Filtrate Design Concentrations:

      1) Alkalinity: <**Insert ppm (mg/L)**>.
      2) Chlorine: <**Insert ppm (mg/L)**>.
      3) Color: <**Insert nephelometric turbidity units**>.
      4) Hydrogen Sulfide: <**Insert ppm (mg/L)**>.
      5) Iron: <**Insert ppm (mg/L)**>.

6) Manganese: <**Insert ppm (mg/L)**>.
7) Sand: <**Insert ppm (mg/L)**>.
8) Silt: <**Insert ppm (mg/L)**>.
9) Turbidity: <**Insert ppm (mg/L)**>.
10) <**Insert characteristic**>: <**Insert value**>.

b. Filter Design:

1) Continuous Flow: <**Insert gpm (L/s)**>.
2) Peak Flow: <**Insert gpm (L/s)**>.
3) Filtration Efficiency: [**98**]<**Insert number**> percent retention of suspended particles [**1**][**10**][**20**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.
4) Pressure Drop, Clean: Not to exceed [**2 psig (14 kPa)**]<**Insert value**> at filter design flow rate when clean.
5) Pressure Drop, Dirty: Not to exceed <**Insert value**> when dirty.

c. Housing:

1) Material: [**Plastic**][**Stainless steel**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Seals: [**NBR**]<**Insert material**>.
4) Diameter: <**Insert inches (mm)**>.
5) Height or Length: <**Insert inches (mm)**>.
6) Inlet and Outlet Size: <**Insert NPS (DN)**>.
7) Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.

d. Elements:

1) Number Required: [**One**][**Two**]<**Insert number**>.
2) Nominal Diameter: <**Insert inches (mm)**>.
3) Nominal Length: <**Insert inches (mm)**>.
4) Media:

a) [**Activated charcoal**][**or**][**ground charcoal**].
b) [**Pleated polyester**][**or**][**pleated PP**].
c) [**Wound polyester**][**or**][**wound PP**].
d) <**Insert material**>.

B. Filters - Cartridge Type, Off Floor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Campbell Manufacturing, Inc**]
b. [**Culligan International Company**]
c. [**Eagle Spring Filtration, Inc**]
d. [**Everpure; a brand of Pentair, Inc.**]
e. [**Filpro Corporation**]
f. [**Filtrete Home Filtration Products; a 3M brand**]
g. [**Graver Technologies**]
h. [**Harmsco, Inc.**]
i. [**Hydro Systems International**]
j. [**Matterhorn Filter Corp.**]

k. [**Omnipure Filter Company**]
l. [**Parker (Parker Hannifin)**]
m. [**Pentair Filtration, Inc.**]
n. [**Porvair Filtration Group**]
o. [**Shelco Filters**]
p. [**WATTS; A Watts Water Technologies Company**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Campbell Manufacturing, Inc**]
b. [**Culligan International Company**]
c. [**Eagle Spring Filtration, Inc**]
d. [**Everpure; a brand of Pentair, Inc.**]
e. [**Filpro Corporation**]
f. [**Filtrete Home Filtration Products; a 3M brand**]
g. [**Graver Technologies**]
h. [**Harmsco, Inc.**]
i. [**Hydro Systems International**]
j. [**Matterhorn Filter Corp.**]
k. [**Omnipure Filter Company**]
l. [**Parker (Parker Hannifin)**]
m. [**Pentair Filtration, Inc.**]
n. [**Porvair Filtration Group**]
o. [**Shelco Filters**]
p. [**WATTS; A Watts Water Technologies Company**]
q. <**Insert manufacturer's name**>

3. Description: Simplex, [**in-line**][**wall-mounted**] housing with replaceable element for removing suspended particles from water.

a. Housing: Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element; with element support.

1) Pipe Connections: Threaded in accordance with ASME B1.20.1.
2) Support: Wall bracket.

b. Element: Replaceable; of shape to fit housing.

4. Capacity and Characteristics:

a. Filtrate Design Concentrations:

1) Alkalinity: <**Insert ppm (mg/L)**>.
2) Chlorine: <**Insert ppm (mg/L)**>.
3) Color: <**Insert nephelometric turbidity units**>.
4) Hydrogen Sulfide: <**Insert ppm (mg/L)**>.
5) Iron: <**Insert ppm (mg/L)**>.
6) Manganese: <**Insert ppm (mg/L)**>.
7) Sand: <**Insert ppm (mg/L)**>.
8) Silt: <**Insert ppm (mg/L)**>.
9) Turbidity: <**Insert ppm (mg/L)**>.
10) <**Insert characteristic**>: <**Insert value**>.

b. Filter Design:

1) Continuous Flow: <**Insert gpm (L/s)**>.
2) Peak Flow: <**Insert gpm (L/s)**>.
3) Filtration Efficiency: [**98**]<**Insert number**> percent retention of suspended particles [**1**][**10**][**20**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.
4) Pressure Drop, Clean: Not to exceed [**2 psig (14 kPa)**]<**Insert value**> at filter design flow rate when clean.
5) Pressure Drop, Dirty: Not to exceed <**Insert value**> when dirty.

c. Housing:

1) Material: [**PE or PP**][**Plastic**][**Stainless steel**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Seals: [**NBR**]<**Insert material**>.
4) Diameter: <**Insert inches (mm)**>.
5) Height or Length: <**Insert inches (mm)**>.
6) Inlet and Outlet Size: <**Insert NPS (DN)**>.
7) Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.

d. Element:

1) Nominal Diameter: <**Insert inches (mm)**>.
2) Nominal Length: <**Insert inches (mm)**>.
3) Media:

a) [**Activated charcoal**][**or**][**ground charcoal**].
b) [**Pleated polyester**][**or**][**pleated PP**].
c) [**Wound polyester**][**or**][**wound PP**].
d) <**Insert material**>.

2.5 FILTERS - CARBON TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chandler Systems, Inc.**]
2. [**Diamond H2O**]
3. [**EcoWater Systems LLC**]
4. [**Marlo Incorporated**]
5. [**Water-Right, Inc.**]
6. [**WATTS; A Watts Water Technologies Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Chandler Systems, Inc.**]
2. [**Diamond H2O**]
3. [**EcoWater Systems LLC**]
4. [**Marlo Incorporated**]
5. [**Water-Right, Inc.**]
6. [**WATTS; A Watts Water Technologies Company**]

7. **<Insert manufacturer's name>**

C. Description: Simplex carbon-type filter, with media tank, media, and automatic backwash for [**removing chlorine from**][**and**][**improving color, odor, and taste of**]<**Insert application**> water.

1. Media Tank: Corrosion resistant with distribution system and media.

a. Construction:

1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section X, if indicated.
3) Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.
4) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
5) Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.
6) FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125 psig (0.862 MPa)**][**or**][**Designation F, 150 psig (1.034 MPa)**] pressure category flanges of grade same as tank material in accordance with ASTM D5421.
7) Support: Base, feet, or skirt.

2. Controls: Automatic for control of backwash; factory wired for single, external electrical connection.

a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure.
b. Backwash Initiation Device: [**Differential pressure gauges**][**Electric time clock**][**Water meter**].

D. Capacity and Characteristics:

1. Filtrate Design Concentrations:

a. Alkalinity: <**Insert ppm (mg/L)**>.
b. Chlorine: <**Insert ppm (mg/L)**>.
c. Color: <**Insert nephelometric turbidity units**>.
d. Hydrogen-Ion Concentration: <**Insert pH**>.
e. Hydrogen Sulfide: <**Insert ppm (mg/L)**>.
f. Iron: <**Insert ppm (mg/L)**>.
g. Manganese: <**Insert ppm (mg/L)**>.
h. Total Dissolved Solids: <**Insert ppm (mg/L)**>.
i. Turbidity: <**Insert ppm (mg/L)**>.
j. <**Insert characteristic**>: <**Insert value**>.

2. Filter Design:

a. Continuous Flow: <**Insert gpm (L/s)**>.
b. Flow Rate: <**Insert gpm/sq. ft. (L/s per sq. m)**> of media cross-sectional area.
c. Peak Flow: <**Insert gpm (L/s)**>.
d. Filtration Efficiency: [**98**]<**Insert number**> percent retention of suspended particles

[**20**][**40**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.

e. Pressure Drop, Clean: Not to exceed [**2 psig (14 kPa)**]<**Insert value**> at filter design flow rate when clean.
f. Pressure Drop, Dirty: Not to exceed <**Insert value**> when dirty.
g. Backwash Flow: <**Insert gpm (L/s)**>.

3. Filter Backwash Interval:

a. <**Insert psig (kPa)**> pressure drop measured by differential pressure gauges.
b. <**Insert number**> days measured by time clock.
c. <**Insert gal. (cu. m)**> measured by water meter.

4. Media Tank:

a. Material: [**Carbon steel with NSF 61/NSF 372 lining material**][**FRP**][**Stainless steel**].
b. Pressure Rating: <**Insert psig (kPa)**>.
c. Media: [**Activated charcoal**][**Ground charcoal**]<**Insert material**>.
d. Media Quantity: <**Insert cu. ft. (cu. m)**>.
e. Diameter: <**Insert inches (mm)**>.
f. Height: <**Insert inches (mm)**>.
g. Inlet and Outlet Size: <**Insert NPS (DN)**>.

5. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 FILTERS - SAND TYPE

A. Filters - Sand Type, Circulating:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond H2O**]
b. [**Everfilt**]
c. [**Miami Filter, Inc.**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**United Industries, Inc; Tower-flo Water Systems**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Diamond H2O**]
b. [**Everfilt**]

c. [**Miami Filter, Inc.**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**United Industries, Inc; Tower-flo Water Systems**]
g. **<Insert manufacturer's name>**

3. Description: Factory-fabricated and -tested, simplex, sand-filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing sediment particles from water.

a. Filter Tank: Corrosion resistant with distribution system and media.

1) Construction:

a) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
b) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section X, if indicated.
c) Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.

2) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
3) Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
4) FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125 psig (0.862 MPa)**][**or**][**Designation F, 150 psig (1.034 MPa)**] pressure category flanges of grade same as tank material in accordance with ASTM D5421.

b. Strainer: Basket type.

1) Pipe Connections:

a) Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
b) Connections NPS 2-1/2 (DN 65) and Larger: Cast-iron, Class 125 flanges in accordance with ASME B16.1.

c. Piping:

1) [**Galvanized steel pipe, galvanized cast-iron fittings**][**Stainless steel pipe, stainless steel fittings**], and flanged, grooved, or threaded joints.
2) **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

d. Safety Valves: Automatic and manual pressure relief.
e. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1) Pump Construction: Bronze fitted.

a) Casing: Radially split, cast iron.
b) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.

c) Impeller: ASTM B584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
d) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
e) Seal: Mechanical.

2) Motor: General requirements for motors are specified in Section 220500 "Common Work Results for Plumbing."

f. Controls: Automatic for control of circulating pump and tank backwash; factory wired for single, external electrical connection.

1) Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gauges.
2) Pump: Automatic and manual.
3) Backwash: Automatic; with [**time-clock**][**differential-pressure-switch**] initiation device.
4) Backwash Valve: Tank mounted.

g. Support: Skid mounting.

4. Capacity and Characteristics:

a. Filtrate Design Concentrations:

1) Sand: <**Insert ppm (mg/L)**>.
2) Silt: <**Insert ppm (mg/L)**>.
3) <**Insert characteristic**>: <**Insert value**>.

b. Filter Design:

1) Continuous Flow: <**Insert gpm (L/s)**> at [**5 psig (34.5 kPa)**]<**Insert value**> pressure drop.
2) Flow Rate: <**Insert gpm/sq. ft. (L/s per sq. m)**> of media cross-sectional area.
3) Peak Flow: <**Insert gpm (L/s)**>.
4) Filtration Efficiency: [**98**]<**Insert number**> percent removal of [**1.8**]<**Insert number**> minimum specific-gravity suspended particles [**5**][**10**][**20**][**45**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.

c. Filter Tank: With internal distribution piping.

1) Material: [**Carbon steel with NSF 61/NSF 372 lining material**][**FRP**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Diameter: <**Insert inches (mm)**>.
4) Height: <**Insert inches (mm)**>.
5) Inlet and Outlet Size: <**Insert NPS (DN)**>.
6) Purge Size: <**Insert NPS (DN)**>.

d. Filter Media: [**Graded silica sand**]<**Insert media**>.
e. Filter Backwash Interval:

1) <**Insert psig (kPa)**> pressure drop measured by differential pressure gauges.
2) <**Insert number**> days measured by time clock.

f. Circulating Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Inlet Size: <**Insert NPS (DN)**>.
5) Outlet Size: <**Insert NPS (DN)**>.

g. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert value**>.

h. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**> A.

B. Filters - Sand Type, Multimedia:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Culligan International Company**]
b. [**Diamond H2O**]
c. [**Everfilt**]
d. [**Hungerford & Terry, Inc**]
e. [**LAKOS Filtration Solutions**]
f. [**Marlo Incorporated**]
g. [**Mer-Made Filter, Inc.**]
h. [**Miami Filter, Inc.**]
i. [**PEP Filters, Inc.**]
j. [**Puroflux Corporation**]
k. [**Water King**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Culligan International Company**]
b. [**Diamond H2O**]
c. [**Everfilt**]
d. [**Hungerford & Terry, Inc**]
e. [**LAKOS Filtration Solutions**]
f. [**Marlo Incorporated**]
g. [**Mer-Made Filter, Inc.**]
h. [**Miami Filter, Inc.**]
i. [**PEP Filters, Inc.**]
j. [**Puroflux Corporation**]
k. [**Water King**]
l. <**Insert manufacturer's name**>

3. Description: Factory-fabricated and -tested, [**simplex**][**duplex**][**triplex**], multimedia, sand-filter system of filter tank(s), media, piping, and controls for removing sediment particles from water.

   a. Tank Construction:

      1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
      2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section X, if indicated.
      3) Fabricate supports and base and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.

   b. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
   c. Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
   d. FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125 psig (0.862 MPa)**][**or**][**Designation F, 150 psig (1.034 MPa)**] pressure category flanges of grade same as tank material in accordance with ASTM D5421.
   e. Service Valve(s): Diaphragm type [**hydraulically**][**pneumatically**] operated.
   f. Piping:

      1) [**Galvanized steel pipe, galvanized cast-iron fittings**][**Stainless steel pipe, stainless steel fittings**], and flanged, grooved, or threaded joints.
      2) **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
      3) Schedule 80 ABS or PVC pipe and fittings with solvent-cemented joints.

   g. Safety Valves: Automatic air vent.
   h. Controls for Simplex Tank System: Automatic, electric time clock for control of filter system flow and backwash cycles; factory wired for single, external electrical connection.
   i. Controls for Duplex and Triplex Tank Systems: Automatic, electric time clock for control of filter system flow and backwash cycles; factory wired for single, external electrical connection. System operation is to be continuous with bypass piping and not more than one tank in backwash cycle at same time.
   j. Support: Skid mounting.

4. Capacity and Characteristics:

   a. Filtrate Design Concentrations:

      1) Chlorine: <**Insert ppm (mg/L)**>.
      2) Color: <**Insert nephelometric turbidity units**>.
      3) Iron: <**Insert ppm (mg/L)**>.
      4) Manganese: <**Insert ppm (mg/L)**>.
      5) Total Dissolved Solids: <**Insert ppm (mg/L)**>.
      6) Turbidity: <**Insert ppm (mg/L)**>.
      7) <**Insert characteristic**>: <**Insert value**>.

   b. Filter Design:

      1) Continuous Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.
      2) Peak Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.
      3) Filtration Efficiency: [**98**]<**Insert number**> percent removal of suspended particles

[**10**][**20**][**40**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.

4) Backwash Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.

c. Media Tanks:

1) Single with controls.
2) [**Two**][**Three**] with manifolded inlet, outlet, and drain piping and controls.

d. Each Media Tank:

1) Material: [**Carbon steel with NSF 61 Annex lining material**][**FRP**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**> minimum.
3) Distribution System: Factory-installed plastic.
4) Temperature Rating: <**Insert deg F (deg C)**> minimum.
5) Diameter: <**Insert inches (mm)**>.
6) Height: <**Insert inches (mm)**>.
7) Service Valve Size: <**Insert NPS (DN)**>.
8) Inlet and Outlet Size: <**Insert NPS (DN)**>.
9) Drain Size: <**Insert NPS (DN)**>.

e. Filter Media: [**Graded silica sand**]<**Insert media**>.

C. Filters - Greensand Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond H2O**]
b. [**Hungerford & Terry, Inc**]
c. [**Marlo Incorporated**]
d. [**PEP Filters, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Diamond H2O**]
b. [**Hungerford & Terry, Inc**]
c. [**Marlo Incorporated**]
d. [**PEP Filters, Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. <**Insert manufacturer's name**>

3. Description: Greensand-type filter system of piping, and controls for removing [**iron**][**iron and manganese**][**manganese**] from water.

a. Tank Construction:

1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure

Vessel Code, Section VIII, Division 1.
2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section X.
3) Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.

b. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
c. Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
d. FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125 psig (0.862 MPa)**][**or**][**Designation F, 150 psig (1.034 MPa)**] pressure category flanges of grade same as tank material in accordance with ASTM D5421.
e. Service Valve(s): Diaphragm type [**hydraulically**][**pneumatically**] operated.
f. Piping:

1) [**Galvanized steel pipe, galvanized cast-iron fittings**][**Stainless steel pipe, stainless steel fittings**], and flanged, grooved, or threaded joints.
2) **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
3) Schedule 80 ABS or PVC pipe and fittings with solvent-cemented joints.

g. Safety Valves: Automatic air vent.
h. Controls for Simplex Tank System: Automatic, electric time clock for control of filter system flow and backwash cycles; factory wired for single, external electrical connection.
i. Controls for Tank System: [**Duplex**][**Triplex**]<**Insert type**>. Automatic, electric time clock controls filter system flow and backwash cycles; factory wired for single, external electrical connection. System operation is to be continuous with bypass piping and not more than one tank in backwash cycle at same time.
j. Support: Skid mounting.

4. Capacity and Characteristics:

a. Filtrate Design Concentrations:

1) Iron: <**Insert ppm (mg/L)**>.
2) Manganese: <**Insert ppm (mg/L)**>.
3) <**Insert characteristic**>: <**Insert value**>.

b. Filter Design:

1) Continuous Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.
2) Peak Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.
3) Filtration Efficiency: [**98**]<**Insert number**> percent removal of suspended particles [**10**][**20**][**40**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.
4) Backwash Flow: <**Insert gpm (L/s)**> at <**Insert psig (kPa)**> pressure drop.

c. Media Tanks:

1) Single with controls.
2) [**Two**][**Three**] with manifolded inlet, outlet, and drain piping and controls.

d. Each Media Tank:

1) Material: [**Carbon steel with NSF 61 Annex lining material**][**FRP**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**> minimum.
3) Distribution System: Factory-installed plastic.
4) Temperature Rating: <**Insert deg F (deg C)**> minimum.
5) Diameter: <**Insert inches (mm)**>.
6) Height: <**Insert inches (mm)**>.
7) Service Valve Size: <**Insert NPS (DN)**>.
8) Inlet and Outlet Size: <**Insert NPS (DN)**>.
9) Drain Size: <**Insert NPS (DN)**>.

e. Filter Media: [**Graded silica sand**]<**Insert media**>.

2.7 SEPARATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**LAKOS Filtration Solutions**]
2. [**PEP Filters, Inc.**]
3. [**Puroflux Corporation**]
4. [**Rosedale Products, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**LAKOS Filtration Solutions**]
2. [**PEP Filters, Inc.**]
3. [**Puroflux Corporation**]
4. [**Rosedale Products, Inc.**]
5. <**Insert manufacturer's name**>

C. Description:

1. Simplex separator housing with baffles and chambers for removing sediment particles from water by centrifugal action and gravity.
2. Factory-fabricated and -tested, simplex separator system of housing with baffles and chambers, strainer, circulating pump, piping, and controls for removing sediment particles from water by centrifugal action and gravity.

D. Housing: With manufacturer's proprietary system of baffles and chambers.

1. Construction:

a. Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
b. Fabricate supports, base, and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event when separator base is anchored to building structure.

2. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
3. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.

4. Collection Chamber: Designed to hold separated particles.
5. Outlet: Near top of unit.
6. Purge: At bottom of collection chamber.
7. Pipe Connections **NPS 2 (DN 50)** and Smaller: Threaded in accordance with ASME B1.20.1.
8. Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: ASME B16.1; steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.

E. Strainer: Basket type.

1. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
2. Pipe Connections NPS 2-1/2 (DN 65) and Larger: Cast-iron, Class 125 flanges in accordance with ASME B16.1.

F. Piping:

1. [**Galvanized steel pipe, galvanized cast-iron fittings**][**Stainless steel pipe, stainless steel fittings**], and flanged, grooved, or threaded joints.
2. **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

G. Safety Valves: Automatic and manual pressure relief.

H. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1. Pump Construction: Bronze fitted.

a. Casing: Radially split, cast iron.
b. Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
c. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
e. Seal: Mechanical.

2. Motor: General requirements for motors are specified in Section 220500 "Common Work Results for Plumbing."

I. Controls: Automatic for control of circulating pump and separator purge; factory wired for single, external electrical connection.

1. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure.
2. Pump: Automatic and manual.
3. Separator Purge: Automatic and manual.

J. Support: Skid mounting.

K. Capacity and Characteristics:

1. Filtrate Design Concentrations:

a. Sand: <**Insert ppm (mg/L)**>.
b. Silt: <**Insert ppm (mg/L)**>.
c. <**Insert characteristic**>: <**Insert value**>.

2. Separator Design:

a. Continuous Flow: <**Insert gpm (L/s)**> at [**5 psig (34.5 kPa)**]<**Insert value**> pressure drop.
b. Peak Flow: <**Insert gpm (L/s)**>.
c. Separator Efficiency: [**98**]<**Insert number**> percent removal of listed [**1.8**]<**Insert number**> minimum specific-gravity suspended particles [**5**][**10**][**20**][**45**]<**Insert size**> microns and larger from feedwater of listed filtrate design concentrations.

3. Housing:

a. Material: [**Carbon**][**Stainless**] steel.
b. Pressure Rating: <**Insert psig (kPa)**>.
c. Diameter: <**Insert inches (mm)**>.
d. Height: <**Insert inches (mm)**>.
e. Inlet and Outlet Size: <**Insert NPS (DN)**>.
f. Purge Size: <**Insert NPS (DN)**>.

4. Circulating Pump:

a. Capacity: <**Insert gpm (L/s)**>.
b. Total Dynamic Head: <**Insert feet (kPa)**>.
c. Speed: <**Insert rpm**>.
d. Inlet Size: <**Insert NPS (DN)**>.
e. Outlet Size: <**Insert NPS (DN)**>.

5. Pump Motor Size and Electrical Characteristics:

a. Horsepower: <**Insert value**>.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: [**60**]<**Insert value**>.

6. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**>.
b. Minimum Circuit Ampacity: <**Insert value**>.
c. Maximum Overcurrent Protection: <**Insert amperage**> A.

2.8 SOURCE QUALITY CONTROL

A. Before shipping, hydrostatically test [**carbon-type filters,**][**circulating sand-type filters,**][**multimedia sand-type filters,**][**greensand-type filters,**][**and**][**separators**] to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of [**filters**][**and**][**separators**].

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls and floors for suitable conditions where [**filters**][**and**][**separators**] will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT MOUNTING

A. Equipment Mounting: Install [**filters, except wall-mounted cartridge-type filters,**][**and**][**separators**] on concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 INSTALLATION OF BAG-TYPE FILTER

A. Install bag-type filters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install filters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

C. Install filter media bags.

D. Install seismic restraints for bag-type filter housings and anchor to building structure.

3.4 INSTALLATION OF CARTRIDGE-TYPE FILTER

A. Install cartridge-type filters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install freestanding cartridge-type filters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases if installation directly on floor is indicated.

C. Attach wall brackets for off-floor, wall-mounted, cartridge filter to vertical surface. Attach housing(s), and base if any, to wall bracket.

D. Install housings for off-floor, in-line, cartridge filters in piping.

E. Install filter elements in cartridges.

F. Install seismic restraints for freestanding cartridge-filter housings and anchor to building structure.

3.5 INSTALLATION OF CARBON-TYPE FILTER

A. Install carbon-type filters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install carbon-type filters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

C. Prepare carbon-filter tank distribution system and underbed, if any, for filter media, and place specified media into tanks.

D. Install seismic restraints for carbon-filter housings and anchor to building structure.

3.6 INSTALLATION OF SAND-TYPE FILTER

A. Install sand-type filters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install sand-filter tanks on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

C. Prepare sand-filter tank distribution system and underbed for filter media, and place specified sand and other media into tanks.

D. Install seismic restraints for sand-filter tanks and accessories and anchor to building structure.

3.7 INSTALLATION OF SEPARATOR

A. Install separators level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Equipment Mounting: Install separators on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

C. Install seismic restraints for separators and accessories and anchor to building structure.

3.8 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic

Water Piping."

D. Install shutoff valves on feedwater-inlet and filtrate-outlet piping of each water filtration equipment [**filter**][**and**][**separator**][**and on inlet and outlet headers**].

1. Comply with requirements for metal general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for plastic valves specified in Section 221116 "Domestic Water Piping."
3. Exception, Shutoff Valve Installation: Water filtration equipment with factory-installed shutoff valves at locations indicated.

E. Install pressure gauges on feedwater-inlet and filtrate-outlet piping of each water filtration equipment [**filter**][**and**][**separator**]. Comply with requirements for pressure gauges specified in Section 220500 "Common Work Results for Plumbing."

1. Exception, Pressure Gauge Installation:

   a. Water filtration equipment with factory-installed pressure gauges.
   b. Cartridge-type water filters.

F. Install valved bypass water piping around each water filtration equipment [**filter**][**and**][**separator**].

1. Comply with requirements for metal general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for plastic valves specified in Section 221116 "Domestic Water Piping."
3. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
4. Exception, Valved Bypass Water Piping Installation:

   a. Bag-type water filtration equipment.
   b. Cartridge-type water filtration equipment.

G. Install drains as indirect wastes to spill into open drains or over floor drains.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service for [**circulating sand-type filters,**][**multimedia sand-type filters,**][**greensand-type filters,**][**and**][**separators**].

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert additional startup steps if any**>.

B. Sample [**filter**][**and**][**separator**] filtrate after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service, Including Testing: Engage a factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water filtration equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**circulating sand-type filters,**][**multimedia sand-type filters,**][**greensand-type filters,**][**and**][**separators**].

END OF SECTION 22 32 00 00

Task	Specification	Specification Description
22 32 16 00	22 32 00 00	Domestic Water Filtration Equipment

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SECTION 22 33 00 00 - ELECTRIC DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Domestic-water booster heater, electric - commercial type.
2. Domestic-water heater, electric - commercial, storage type.
3. Domestic-water heater, electric - commercial, light-duty type.
4. Domestic-water heater, electric - commercial, hybrid heat pump type.
5. Domestic-water heater, electric - residential, small-capacity type.
6. Domestic-water heater, electric - residential, collector-to-tank, solar type.
7. Domestic-water heater, electric - residential, collector-to-tank-coil, solar type.
8. Domestic-water heater, electric - residential, storage type.
9. Domestic-water heater, electric - residential, tabletop type.
10. Domestic water heater, electric - residential, hybrid heat pump type.
11. Domestic-water heater, electric - flow-control, tankless type.
12. Domestic-water heater, electric - thermostat-control, tankless type.
13. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product Data: For energy efficiency.
2. Water Heaters: Product Data for water heater compliance with ASHRAE's "Advanced Energy Design Guides."

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and

describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of [**commercial**][**residential**][**and**][**tankless**], electric, domestic-water heater.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality control reports.

F. Field quality control reports.

G. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Electric, Domestic-Water Heaters:

1) Tank: [**Three**][**Five**]<**Insert number**> years.
2) Controls and Other Components: [**Three**][**Five**]<**Insert number**> years.

b. Residential, Electric, Storage, Domestic-Water Heaters:

1) Tank: [**Five**][**Six**][**10**]<**Insert number**> years.
2) Controls and Other Components: [**Two**][**Three**]<**Insert number**> years.

c. Electric, Tankless, Domestic-Water Heaters: [**One**][**Two**][**Five**]<**Insert number**> year(s).
d. Expansion Tanks: [**Five**]<**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electric domestic water heater equipment intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

C. Seismic Performance: Electric, domestic-water heaters to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Domestic-Water Booster Heater, Electric - Commercial Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**Coates Heater Company, Inc.**]
c. [**Electric Heater Company (The)**]
d. [**Hatco Corporation**]
e. [**HESco Industries, Inc**]
f. [**Lochinvar, LLC**]
g. [**Rheem Manufacturing Company**]
h. [**Ruud Water Heaters; a Rheem brand**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**Coates Heater Company, Inc.**]
c. [**Electric Heater Company (The)**]
d. [**Hatco Corporation**]
e. [**HESco Industries, Inc**]
f. [**Lochinvar, LLC**]
g. [**Rheem Manufacturing Company**]
h. [**Ruud Water Heaters; a Rheem brand**]
i. **<Insert manufacturer's name>**

3. Source Limitations: Obtain domestic-water booster heaters, electric - commercial type from single source from single manufacturer.
4. Standard: UL 1453.
5. Tank Construction: [**Corrosion-resistant metal**][**or**][**steel**].

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: **150 psig (1035 kPa)**.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal with hose-end connection.
   c. Insulation: Comply with ASHRAE/IES 90.1.
   d. Jacket: Rectangular shaped, with stainless steel front panel, unless otherwise indicated.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.

      1) Option: Booster heaters with total of 9 kW or less may have one, two, or three elements.

   f. Temperature Control: Adjustable thermostat, to setting of at least **180 deg F (82 deg C)**.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
   i. Gauges: Combination temperature-and-pressure type or separate thermometer and pressure gauge.

7. Special Requirements: NSF 5 construction with [**brackets for undercounter**][**legs for floor**] installation.

B. Domestic-Water Heater, Electric - Commercial, Storage Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**Cemline Corporation**]

e. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
f. [**Electric Heater Company (The)**]
g. [**HESco Industries, Inc**]
h. [**Lochinvar, LLC**]
i. [**Precision Boilers**]
j. [**PVI; A WATTS Brand**]
k. [**Rheem Manufacturing Company**]
l. [**State Water Heaters**]
m. [**Vaughn Thermal Corporation**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**Cemline Corporation**]
e. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
f. [**Electric Heater Company (The)**]
g. [**HESco Industries, Inc**]
h. [**Lochinvar, LLC**]
i. [**Precision Boilers**]
j. [**PVI; A WATTS Brand**]
k. [**Rheem Manufacturing Company**]
l. [**State Water Heaters**]
m. [**Vaughn Thermal Corporation**]
n. **<Insert manufacturer's name>**

3. Source Limitations: Obtain domestic-water heaters, electric - commercial, storage type from single source from single manufacturer.
4. Standard: UL 1453.
5. Tank Construction: [**Non-**]ASME-code, steel [**horizontal**][**vertical**] arrangement.

a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.

b. Pressure Rating: [**150 psig (1035 kPa)**]**<Insert value>**.
c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal with hose-end connection.
c. Insulation: Comply with ASHRAE/IES 90.1.
d. Jacket: Steel with enameled finish or high-impact composite material.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
f. Temperature Control: Adjustable thermostat.

g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Special Requirements: NSF 5 construction.

C. Domestic-Water Heater, Electric - Commercial, Light-Duty Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**Electric Heater Company (The)**]
e. [**Heat Transfer Products, Inc**]
f. [**Lochinvar, LLC**]
g. [**Rheem Manufacturing Company**]
h. [**Ruud Water Heaters; a Rheem brand**]
i. [**State Water Heaters**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**Electric Heater Company (The)**]
e. [**Heat Transfer Products, Inc**]
f. [**Lochinvar, LLC**]
g. [**Rheem Manufacturing Company**]
h. [**Ruud Water Heaters; a Rheem brand**]
i. [**State Water Heaters**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - commercial, light-duty type from single source from single manufacturer.
4. Standard: UL 174.
5. Tank Construction: Steel, vertical arrangement.

a. Tappings: ASME B1.20.1 pipe thread.
b. Pressure Rating: **150 psig (1035 kPa)**.
c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.

c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with ASHRAE/IES 90.1.
e. Jacket: Steel with enameled finish or high-impact composite material.
f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
g. Heating Elements: Electric, screw-in immersion type.
h. Temperature Control: Adjustable thermostat.
i. Safety Control: High-temperature-limit cutoff device or system.
j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

7. Special Requirements: NSF 5 construction with legs for off-floor installation.

D. Domestic-Water Heater, Electric - Commercial, Hybrid Heat Pump Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**Hubbell Heaters; a Nudyne Company**]
c. [**Lochinvar, LLC**]
d. [**State Water Heaters**]
e. [**Vaughn Thermal Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**Hubbell Heaters; a Nudyne Company**]
c. [**Lochinvar, LLC**]
d. [**State Water Heaters**]
e. [**Vaughn Thermal Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - commercial hybrid heat pumps from single source from single manufacturer.
4. Standards: **AHRI 1300 (AHRI 1301)**.
5. ENERGY STAR certified.
6. Tank Construction: [**Non-ASME-code**][**ASME-code**], steel [**horizontal**][**vertical**] arrangement.

a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.

b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> working pressure, [**300 psig (2070 kPa)**]<**Insert pressure**> test pressure.
c. Interior Material/Finish: [**Glass-lined**][**or**][**Hydrastone cement-lined**]<**Insert tank inner material**> tank. Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
d. Jacket: High-impact composite.

7. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: [**Replaceable magnesium**][**None required**].
    b. Drain Valve: Corrosion-resistant metal with hose-end connection.
    c. Insulation: Minimum [**3-inch- (75-mm-)**]<**Insert dimension**> thick CFC-free polyurethane foam insulation.
    d. Jacket: Steel with enameled finish or high-impact composite material.
    e. Backup Heating Elements: Electric, dual screw-in or bolt-on immersion type.
    f. Temperature Control: Adjustable thermostat.
    g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
    h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

8. Heat Pump Module:

    a. Air-to-air heat pump module including exhaust air outlet, intake air inlet, intake air filter, intake air fan, heat transfer coil, and condensate drain.
    b. Factory mounted on top of water storage tank.
    c. Heat pump operation down to minimum [**37 deg F (2.8 deg C)**]<**Insert minimum temperature**> ambient.
    d. Ducting kit.
    e. Washable inlet air filter.
    f. Refrigerant: [**R-134a**][**R-426A**]<**Insert refrigerant**>.

9. Controls:

    a. LCD display and local control panel, including display and control of the following:

        1) Water temperature setpoint.
        2) Water temperature setpoint up and down buttons.
        3) Degree F/Degree C toggle button.
        4) Operating mode selector buttons.
        5) Operating mode operation buttons.
        6) WiFi button.
        7) Bluetooth button.
        8) Alert indicator.
        9) Fault condition display code.
        10) "Control locked" indicator.
        11) <**Insert display features**>.

    b. Digital, "Smart" Connectivity: Via [**Bluetooth app**][**and**][**WiFi**].
    c. Leak-Detection Sensor: Digital, "smart" sensor provides automatic water shutoff upon actuation.
    d. Operating Modes:

        1) Hot Water-Plus Mode: Customizable amount of daily hot water.
        2) Hybrid (Default) Mode: Amount of hot water delivered is balanced with energy-saving performance. Heat pump switches to electric resistance heater mode only when required to meet high demand.
        3) Heat Pump Mode: Maximizes energy efficiency.
        4) Guest Mode: Provides maximum hot water for up to seven days' duration.
        5) Electric Mode: Provide hot water using only the electric backup heating elements.
        6) Vacation Mode: Prevents the heater from heating regardless of designated mode.

Unit is to resume previous mode of operation after the vacation mode period ends.

7) <**Insert special operating mode**>.

10. Special Requirements: NSF 5 construction.

E. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**40 deg F (22 deg C)**][**50 deg F (28 deg C)**][**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**][**180 deg F (82 deg C)**]<**Insert temperature**>.
4. Power Demand: <**Insert kilowatts**>.
5. Heating Elements:

   a. Number of Elements: [**Two**]<**Insert number**>.
   b. Kilowatts, Each Element: <**Insert kilowatts**>.
   c. Number of Stages: [**One**]<**Insert number**>.

6. Electrical Characteristics:

   a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
   b. Phases: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 RESIDENTIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Domestic-Water Heater, Electric - Residential, Small-Capacity Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bosch Thermotechnology Corp.**]
   d. [**Bradford White Corporation**]
   e. [**Eemax, Inc.; a Rheem brand**]
   f. [**Electric Heater Company (The)**]
   g. [**GSW Water Heaters**]
   h. [**Lochinvar, LLC**]
   i. [**Stiebel Eltron, Inc**]
   j. [**WaiWela**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]

c. [**Bosch Thermotechnology Corp.**]
d. [**Bradford White Corporation**]
e. [**Eemax, Inc.; a Rheem brand**]
f. [**Electric Heater Company (The)**]
g. [**GSW Water Heaters**]
h. [**Lochinvar, LLC**]
i. [**Stiebel Eltron, Inc**]
j. [**WaiWela**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, small-capacity type from single source from single manufacturer.
4. Standard: UL 174.
5. Tank Construction: Corrosion-resistant metal[**or steel with corrosion-resistant coating**].

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: **150 psig (1035 kPa)**.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Drain Valve: Corrosion-resistant metal with hose-end connection if tank has drain outlet. Provide hose-end drain valve in piping for domestic-water heaters without drain outlet. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
   b. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
   c. Jacket: Steel with enameled finish or high-impact composite material.
   d. Heating Element: One; electric, screw-in immersion type.
   e. Temperature Control: Adjustable thermostat.
   f. Safety Control: High-temperature-limit cutoff device or system.
   g. Power Supply Cord: **24 to 72 inches (610 to 1830 mm)** with plug.
   h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

B. Domestic-Water Heater, Electric - Residential, Collector-to-Tank, Solar Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alternate Energy Technologies, LLC**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**Lochinvar, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alternate Energy Technologies, LLC**]

b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**Lochinvar, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, collector-to-tank, solar type from single source from single manufacturer.
4. Standard: UL 174 with piping and electrical connections for UL 1279 solar collector system.
5. Tank Construction: Steel.

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: **150 psig (1035 kPa)**.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Sensor electrical connections and tank stud for sensor.
   b. Anode Rod: Replaceable magnesium.
   c. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   d. Drain Valve: Corrosion-resistant metal with hose-end connection.
   e. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
   f. Jacket: Steel with enameled finish.
   g. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   h. Heating Element: Electric, screw-in immersion type.
   i. Temperature Control: Adjustable thermostat.
   j. Safety Control: High-temperature-limit cutoff device or system.
   k. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

C. Domestic-Water Heater, Electric - Residential, Collector-to-Tank-Coil, Solar Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alternate Energy Technologies, LLC**]
   b. [**Electric Heater Company (The)**]
   c. [**Vaughn Thermal Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alternate Energy Technologies, LLC**]
   b. [**Electric Heater Company (The)**]
   c. [**Vaughn Thermal Corporation**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, collector-to-tank-coil, solar type from single source from single manufacturer.
4. Standard: UL 174 with integral coil-type heat exchanger.

5. Tank Construction: Steel.

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: **150 psig (1035 kPa)**.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
   e. Jacket: Steel with enameled finish or high-impact composite material.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Heat Exchanger: Corrosion-resistant-metal immersion coil.
   h. Heating Element: Electric, screw-in immersion type.
   i. Temperature Control: Adjustable thermostat.
   j. Safety Control: High-temperature-limit cutoff device or system.
   k. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

D. Domestic-Water Heater, Electric - Residential, Storage Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heaters**]
   e. [**Heat Transfer Products, Inc**]
   f. [**Lochinvar, LLC**]
   g. [**State Water Heaters**]
   h. [**Vaughn Thermal Corporation**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heaters**]
   e. [**Heat Transfer Products, Inc**]
   f. [**Lochinvar, LLC**]
   g. [**State Water Heaters**]
   h. [**Vaughn Thermal Corporation**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, storage type from single source from single manufacturer.
4. Standard: UL 174.
5. Tank Construction: Steel.

    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: **150 psig (1035 kPa)**.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal with hose-end connection.
    d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
    e. Jacket: Steel, cylindrical, with enameled finish or high-impact composite material.
    f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    g. Heating Elements: Electric, screw-in immersion type.
    h. Temperature Control: Adjustable thermostat.
    i. Safety Control: High-temperature-limit cutoff device or system.
    j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

E. Domestic-Water Heaters, Electric - Residential, Tabletop Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A. O. Smith Corporation**]
    b. [**American Water Heaters**]
    c. [**State Water Heaters**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A. O. Smith Corporation**]
    b. [**American Water Heaters**]
    c. [**State Water Heaters**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, tabletop type from single source from single manufacturer.
4. Standard: UL 174.
5. Tank Construction: Steel.

    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: **150 psig (1035 kPa)**.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
   e. Jacket: Steel, rectangular, with flat-top work surface, raised back, and enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Heating Elements: Electric, screw-in immersion type.
   h. Temperature Control: Adjustable thermostat.
   i. Safety Control: High-temperature-limit cutoff device or system.
   j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

F. Domestic-Water Heater, Electric - Residential, Hybrid Heat Pump Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heaters**]
   e. [**Heat Transfer Products, Inc**]
   f. [**Lochinvar, LLC**]
   g. [**State Water Heaters**]
   h. [**Vaughn Thermal Corporation**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heaters**]
   e. [**Heat Transfer Products, Inc**]
   f. [**Lochinvar, LLC**]
   g. [**State Water Heaters**]
   h. [**Vaughn Thermal Corporation**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - residential, hybrid heat pump type from single source from single manufacturer.
4. Standard: UL 60335-2-40.
5. ENERGY STAR certified.
6. Tank Construction: Non-ASME-code, steel [**horizontal**][**vertical**] arrangement.

   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.

b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> working pressure, [**300 psig (2070 kPa)**]<**Insert pressure**> test pressure.
c. Interior Material/Finish: [**Glass-lined**][**or**][**Hydrastone cement-lined**]<**Insert tank inner material**> tank. Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
d. Jacket: High-impact composite.

7. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rod: [**Replaceable magnesium**][**None required**].
b. Drain Valve: Corrosion-resistant metal with hose-end connection.
c. Insulation: Minimum [**3-inch- (75-mm-)**][**2-inch- (50-mm-)**]<**Insert dimension**> thick CFC-free polyurethane foam insulation.
d. Jacket: Steel with enameled finish or high-impact composite material.
e. Backup Heating Elements: Electric, dual screw-in or bolt-on immersion type.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

8. Heat Pump Module:

a. Air-to-air heat pump module including exhaust air outlet, intake air inlet, intake air filter, intake air fan, heat transfer coil and condensate drain.
b. Factory-mounted on top of water storage tank.
c. Heat pump operation down to minimum [**37 deg F (2.8 deg C)**]<**Insert minimum temperature**> ambient.
d. Ducting kit.
e. Washable inlet air filter.
f. Refrigerant: [**R-134a**][**R-426A**]<**Insert refrigerant**>.

9. Controls:

a. LCD display and local control panel, including display and control of the following:

1) Water temperature setpoint.
2) Water temperature setpoint up and down buttons.
3) Degree F/Degree C toggle button.
4) Operating mode selector buttons.
5) Operating mode operation buttons.
6) WiFi button.
7) Bluetooth button.
8) Alert indicator.
9) Fault condition display code.
10) "Control locked" indicator.
11) <**Insert display features**>.

b. Digital, "Smart" Connectivity: Via [**Bluetooth app**][**and**][**WiFi**].
c. Leak-Detection Sensor: Digital, "smart" sensor provides automatic water shutoff upon actuation.
d. Operating Modes:

1) Hot Water-Plus Mode: Customizable amount of daily hot water.
2) Hybrid (Default) Mode: Amount of hot water delivered is balanced with energy-saving performance. Heat pump switches to electric resistance heater mode only when required to meet high demand.
3) Heat Pump Mode: Maximizes energy efficiency.
4) Guest Mode: Provides maximum hot water for up to seven days' duration.
5) Electric Mode: Provide hot water using only the electric backup heating elements.
6) Vacation Mode: Prevents the heater from heating regardless of designated mode. Unit is to resume previous mode of operation after the vacation mode period ends.
7) <**Insert special operating mode**>.

G. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**]<**Insert temperature**>.
4. Power Demand: <**Insert kilowatts**>.
5. Heating Elements: <**Insert kilowatts**>.
6. Electrical Characteristics:

   a. Volts: [**120**][**240**]<**Insert value**> V.
   b. Phases: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Domestic-Water Heater, Electric - Flow-Control, Tankless Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Thermotechnology Corp.**]
   b. [**Bradley Corporation**]
   c. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
   d. [**Eemax, Inc.; a Rheem brand**]
   e. [**Stiebel Eltron, Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Thermotechnology Corp.**]
   b. [**Bradley Corporation**]
   c. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
   d. [**Eemax, Inc.; a Rheem brand**]
   e. [**Stiebel Eltron, Inc**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - flow-control, tankless type from single source from single manufacturer.
4. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliance.
5. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.

    a. Connections: ASME B1.20.1 pipe thread.
    b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
    c. Heating Element: Resistance heating system.
    d. Temperature Control: Flow-control fitting.
    e. Safety Control: High-temperature-limit cutoff device or system.
    f. Jacket: Aluminum or steel with enameled finish or plastic.

6. Support: Bracket for wall mounting.
7. Capacity and Characteristics:

    a. Flow Rate: <**Insert gpm (L/s)**>.
    b. Maximum Temperature Setting: <**Insert temperature**>.
    c. Power Demand: <**Insert kilowatts**>.
    d. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
        2) Phases: [**Single**][**Three**].
        3) Hertz: 60 Hz.
        4) Full-Load Amperes: <**Insert value**> A.
        5) Minimum Circuit Ampacity: <**Insert value**> A.
        6) Maximum Overcurrent Protection: <**Insert value**> A.

B. Domestic-Water Heater, Electric - Thermostat-Control, Tankless Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bosch Thermotechnology Corp.**]
    b. [**Bradley Corporation**]
    c. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
    d. [**Eemax, Inc.; a Rheem brand**]
    e. [**Niagara Industries, Inc.**]
    f. [**Stiebel Eltron, Inc**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bosch Thermotechnology Corp.**]
    b. [**Bradley Corporation**]
    c. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
    d. [**Eemax, Inc.; a Rheem brand**]
    e. [**Niagara Industries, Inc.**]
    f. [**Stiebel Eltron, Inc**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters, electric - thermostat-control, tankless type

from single source from single manufacturer.

4. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliance.
5. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.

    a. Connections: ASME B1.20.1 pipe thread.
    b. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
    c. Heating Element: Resistance heating system.
    d. Temperature Control: Thermostat.
    e. Safety Control: High-temperature-limit cutoff device or system.
    f. Jacket: Aluminum or steel with enameled finish or plastic.

6. Support: Bracket for wall mounting.
7. Capacity and Characteristics:

    a. Flow Rate: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
    b. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
    c. Power Demand: <**Insert kilowatts**>.
    d. Electrical Characteristics:

        1) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
        2) Phases: [**Single**][**Three**].
        3) Hertz: 60 Hz.
        4) Full-Load Amperes: <**Insert value**> A.
        5) Minimum Circuit Ampacity: <**Insert value**> A.
        6) Maximum Overcurrent Protection: <**Insert value**> A.

2.5 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A. O. Smith Corporation**]
    b. [**AMTROL, Inc.**]
    c. [**Flexcon Industries**]
    d. [**Honeywell International Inc.**]
    e. [**Pentair Aurora; Pentair Pump Group**]
    f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    g. [**State Water Heaters**]
    h. [**Taco Comfort Solutions**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A. O. Smith Corporation**]
    b. [**AMTROL, Inc.**]

c. [**Flexcon Industries**]
d. [**Honeywell International Inc.**]
e. [**Pentair Aurora; Pentair Pump Group**]
f. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
g. [**State Water Heaters**]
h. [**Taco Comfort Solutions**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
4. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
5. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

6. Capacity and Characteristics:

   a. Working-Pressure Rating: [**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert value**>.
   b. Capacity Acceptable: [**2 gal. (7.6 L)**][**4 gal. (15.1 L)**][**7 gal. (26.5 L)**][**10 gal. (37.9 L)**]<**Insert value**> minimum.
   c. Air Precharge Pressure: <**Insert system pressure**>.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than **NPS 3/4 (DN 20)** with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].

D. Heat-Trap Fittings: [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].

E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [**calibrated**][**memory-stop**] balancing valves to provide balanced flow through each domestic-water heater.

   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at **25-psig- (172.5-kPa-)** maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of [**18 inches (457 mm)**]<**Insert dimension**> above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test[**commercial**] domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Electric, Domestic-Water Heater Mounting: Install residential, electric, domestic-water heaters [**on floor**][**on water-heater stand on floor**][**on domestic-water heater mounting bracket**].

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters[**at least 18 inches (457 mm) above floor**] on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

D. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**][**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**]

F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install[**combination temperature-and-**] pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

I. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

J. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

K. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

L. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-

heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of [**25 psig (172 kPa)**]<**Insert value**>. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

M. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

N. Fill electric, domestic-water heaters with water.

O. Charge domestic-water expansion tanks with air to required system pressure.

P. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**commercial**][**and**][**tankless**], electric, domestic-water heaters. Training to be a minimum of [**one**][**two**]<**Insert duration**> hour(s).

END OF SECTION 22 33 00 00

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Task	Specification	Specification Description
22 33 30 16	22 33 00 00	Electric Domestic-Water Heaters
22 33 30 16	22 34 00 00	Fuel-Fired, Domestic-Water Heaters
22 33 33 00	22 33 00 00	Electric Domestic-Water Heaters

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SECTION 22 34 00 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
2. Commercial, power-burner, gas-fired, storage, domestic-water heaters.
3. Commercial, power-vent, gas-fired, storage, domestic-water heaters.
4. Commercial, direct-vent, gas-fired, storage, domestic-water heater.
5. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
6. Commercial, coil-type, finned-tube, gas-fired, domestic-water heaters.
7. Commercial, grid-type, finned-tube, gas-fired, domestic-water heaters.
8. Gas-fired, tankless, domestic-water heaters.
9. Residential, atmospheric, gas-fired, storage, domestic-water heaters.
10. Residential, direct-vent, gas-fired, storage, domestic-water heaters.
11. Residential, power-vent, gas-fired, storage, domestic-water heaters.
12. Commercial, oil-fired, storage, domestic-water heaters.
13. Commercial, large-volume, oil-fired, domestic-water heaters.
14. Residential, oil-fired, storage, domestic-water heaters.
15. Commercial, gas- and oil-fired, domestic-water heaters.
16. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.[**Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**]

B. Sustainable Design Submittals:

1. Product Data: For energy efficiency.
2. Water Heaters: Product Data for water heater compliance with ASHRAE's "Advanced Energy Design Guides."

C. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of [**commercial, gas-fired,**][**gas-fired, tankless,**][**residential, gas-fired,**][**commercial, oil-fired,**][**residential, oil-fired,**][**and**][**commercial, gas- and oil-fired,**] domestic-water heater.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: [**Three**][**Five**]<**Insert number**> years.
2) Controls and Other Components: [**One**][**Two**]<**Insert number**> year(s).

b. Commercial, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1) Heat Exchanger: [**Three**][**Five**]<**Insert number**> years.
2) Controls and Other Components: [**One**][**Two**]<**Insert number**> year(s).
3) Separate Hot-Water Storage Tanks: [**Three**][**Five**]<**Insert number**> years.

c. Gas-Fired, Tankless, Domestic-Water Heaters:

1) Heat Exchanger: [**Five**]<**Insert number**> years.
2) Controls and Other Components: [**Three**]<**Insert number**> years.

d. Residential, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: [**Five**][**Six**]<**Insert number**> years.
2) Controls and Other Components: [**Two**][**Three**]<**Insert number**> years.

e. Commercial, Oil-Fired, Domestic-Water Heaters:

1) Storage Tank: [**Three**][**Five**]<**Insert number**> years.
2) Burner: [**One**][**Two**]<**Insert number**> year(s).
3) Controls and Other Components: [**One**][**Two**][**Three**]<**Insert number**> year(s).

f. Residential, Oil-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: [**Five**][**Six**]<**Insert number**> years.
2) Burner: [**One**][**Two**]<**Insert number**> year(s).
3) Controls and Other Components: [**Two**][**Three**]<**Insert number**> years.

g. Commercial, Gas- and Oil-Fired, Domestic-Water Heaters:

1) Storage Tank: [**Three**][**Five**]<**Insert number**> years.
2) Burner: [**One**][**Two**]<**Insert number**> year(s).
3) Controls and Other Components: [**Two**][**Three**]<**Insert number**> years.

h. Expansion Tanks: [**Five**]<**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.

1. Comply with efficiency requirements in ASHRAE 189.1, which supersede requirements in ASHRAE/IESNA 90.1.

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bock Water Heaters, Inc**]
   d. [**Bradford White Corporation**]
   e. [**HESco Industries, Inc**]
   f. [**IBC Technologies; a Rheem brand**]
   g. [**Lochinvar, LLC**]
   h. [**PVI; A WATTS Brand**]
   i. [**Raypak; a Rheem brand**]
   j. [**Rheem Manufacturing Company**]
   k. [**Ruud Water Heaters; a Rheem brand**]
   l. [**State Industries**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bock Water Heaters, Inc**]
   d. [**Bradford White Corporation**]
   e. [**HESco Industries, Inc**]
   f. [**IBC Technologies; a Rheem brand**]
   g. [**Lochinvar, LLC**]
   h. [**PVI; A WATTS Brand**]
   i. [**Raypak; a Rheem brand**]
   j. [**Rheem Manufacturing Company**]
   k. [**Ruud Water Heaters; a Rheem brand**]
   l. [**State Industries**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.3/CSA 4.3.

5. Storage-Tank Construction: [**Non-**]ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
   g. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
   h. Temperature Control: Adjustable thermostat.
   i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Special Requirements: NSF 5 construction.
8. Draft Hood: Draft diverter, complying with ANSI Z21.12.
9. Automatic Damper: ANSI Z21.66/CSA 6.14, [**electrically operated**][**mechanically activated**][**thermally activated**], automatic-vent-damper device with size matching draft hood.

B. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**Aldrich Company, Inc. (The)**]
   c. [**Bock Water Heaters, Inc**]
   d. [**HESco Industries, Inc**]
   e. [**Precision Boilers**]
   f. [**PVI; A WATTS Brand**]
   g. [**State Industries**]

h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**Aldrich Company, Inc. (The)**]
   c. [**Bock Water Heaters, Inc**]
   d. [**HESco Industries, Inc**]
   e. [**Precision Boilers**]
   f. [**PVI; A WATTS Brand**]
   g. [**State Industries**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.3/CSA 4.3.
5. Storage-Tank Construction: [**Non-**]ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Burner: UL 795 for power-burner, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
   g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
   h. Temperature Control: Adjustable thermostat.
   i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Special Requirements: NSF 5 construction.

8. Draft Hood: [**Draft diverter, complying with ANSI Z21.12**]<**Insert different hood or other arrangement**>.

C. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**Raypak; a Rheem brand**]
   e. [**Rheem Manufacturing Company**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**Raypak; a Rheem brand**]
   e. [**Rheem Manufacturing Company**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.3/CSA 4.3.
5. Storage-Tank Construction: [**Non-**]ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.

e. Jacket: Steel with enameled finish.
f. Burner: For use with power-vent, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
h. Temperature Control: Adjustable thermostat.
i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Special Requirements: NSF 5 construction.
8. Power-Vent System: Exhaust fan, interlocked with burner.

D. Commercial, Direct-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Water Heaters**]
b. [**Bradford White Corporation**]
c. [**GSW Water Heating**]
d. [**Lochinvar, LLC**]
e. [**Rheem Manufacturing Company**]
f. [**State Industries**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Water Heaters**]
b. [**Bradford White Corporation**]
c. [**GSW Water Heating**]
d. [**Lochinvar, LLC**]
e. [**Rheem Manufacturing Company**]
f. [**State Industries**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.1/CSA 4.1.
5. Storage-Tank Construction: Steel.

a. Tappings: ASME B1.20.1 pipe thread.
b. Pressure Rating: **150 psig (1035 kPa)**.
c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with ASHRAE/IES 90.1.
e. Jacket: Steel with enameled finish.
f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
g. Burner: For use with direct-vent, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
i. Temperature Control: Adjustable thermostat.
j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

7. Direct-Vent System: Through-[**wall**][**roof**], coaxial- or double-channel vent assembly with domestic-water heater manufacturers' outside intake/exhaust screen.

E. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**AERCO; A WATTS Brand**]
c. [**American Water Heaters**]
d. [**Bock Water Heaters, Inc**]
e. [**Bradford White Corporation**]
f. [**Heat Transfer Products, Inc**]
g. [**PVI; A WATTS Brand**]
h. [**Raypak; a Rheem brand**]
i. [**Rheem Manufacturing Company**]
j. [**State Industries**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**AERCO; A WATTS Brand**]
c. [**American Water Heaters**]
d. [**Bock Water Heaters, Inc**]
e. [**Bradford White Corporation**]
f. [**Heat Transfer Products, Inc**]
g. [**PVI; A WATTS Brand**]
h. [**Raypak; a Rheem brand**]
i. [**Rheem Manufacturing Company**]
j. [**State Industries**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.3/CSA 4.3.
5. Description: Manufacturer's proprietary design to provide at least [**84**][**85**][**88**][**95**]<**Insert**

number> percent combustion efficiency at optimum operating conditions.

6. Storage-Tank Construction: ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> minimum working-pressure rating.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

7. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal with hose-end connection.
    d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
    g. Temperature Control: Adjustable thermostat.
    h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
    i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

8. Draft Hood: [**Draft diverter, complying with ANSI Z21.12**]<**Insert different hood or other arrangement**>.

F. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
4. Fuel Gas Demand: <**Insert cfh (L/s)**>.
5. Fuel Gas Input: <**Insert Btu/h (W)**>.
6. Gas Pressure Regulator:

    a. Capacity: <**Insert cfh (L/s)**>.
    b. Inlet Pressure: <**Insert psig (kPa) or inches (mm)**> water column.
    c. Gas Pressure Required at Burner: <**Insert psig (kPa) or inches (mm)**> water column.

7. Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

8. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.3 COMMERCIAL, FINNED-TUBE, GAS-FIRED, DOMESTIC-WATER HEATERS

A. Commercial, Coil-Type, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**CAMUS Hydronics Ltd.**]
c. [**IBC Technologies; a Rheem brand**]
d. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**CAMUS Hydronics Ltd.**]
c. [**IBC Technologies; a Rheem brand**]
d. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.13/CSA 4.9 for hot-water-supply boilers.
5. Description: Packaged unit with boiler, separate hot-water storage tank, pump, piping, and controls.
6. Boiler Construction: ASME code with [**160-psig (1100-kPa)**]<**Insert value**> working-pressure rating for hot-water-supply boiler, domestic-water heater.

a. Heat Exchanger: Helix or spiral, finned-copper-tube coils with bronze headers.
b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

7. Boiler Appurtenances:

a. Insulation: Comply with ASHRAE/IES 90.1. Surround entire boiler except connections and controls.
b. Jacket: Steel with enameled finish.

c. Burner: For use with coil-type, finned-tube, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 60730-2-5, intermittent electronic-ignition system.
e. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with circulator and burner.
f. Safety Control: Automatic, high-temperature-limit cutoff device or system.

8. Support: Steel base or skids.
9. Draft Hood: [**Draft diverter, complying with ANSI Z21.12**]<**Insert different hood or other arrangement**>.
10. Automatic Damper: ANSI Z21.66/CSA 6.14, [**electrically operated**][**mechanically activated**][**thermally activated**], automatic-vent-damper device with size matching draft hood.
11. Hot-Water Storage Tank: Connected with piping to circulating pump and domestic-water heater.

    a. Construction: In accordance with ASME Boiler and Pressure Vessel Code: Section VIII, steel with [**150-psig (1035-kPa)**][**125-psig (860-kPa)**]<**Insert value**> working-pressure rating.
    b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

12. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rods: Factory installed, magnesium.
    b. Drain Valve: Corrosion-resistant metal with hose-end connection.
    c. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
    d. Jacket: Steel with enameled finish.
    e. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

13. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [**125-psig (860-kPa)**]<**Insert value**> minimum working-pressure rating, and **225 deg F (107 deg C)** continuous-water-temperature rating.
14. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
15. Mounting: Domestic-water heater, tank, and accessories factory mounted on skids.

B. Commercial, Grid-Type, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**CAMUS Hydronics Ltd.**]
c. [**HESco Industries, Inc**]
d. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
e. [**Lochinvar, LLC**]
f. [**RBI**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**CAMUS Hydronics Ltd.**]
   c. [**HESco Industries, Inc**]
   d. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
   e. [**Lochinvar, LLC**]
   f. [**RBI**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.13/CSA 4.9 for hot-water-supply boilers.
5. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
6. Boiler Construction: ASME code with [**160-psig (1100-kPa)**]<**Insert value**> working-pressure rating for hot-water-boiler-type, domestic-water heater.

   a. Heat Exchanger: Horizontal, straight, finned-copper tubes with bronze headers.
   b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

7. Boiler Appurtenances:

   a. Insulation: Comply with ASHRAE/IES 90.1. Surround entire boiler except connections and controls.
   b. Jacket: Steel with enameled finish.
   c. Burner: For use with grid-type, finned-tube, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
   d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 60730-2-5, intermittent electronic-ignition system.
   e. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with circulator and burner.
   f. Safety Control: Automatic, high-temperature-limit cutoff device or system.

8. Support: Steel base or skids.
9. Draft Hood: [**Draft diverter, complying with ANSI Z21.12**]<**Insert different hood or other arrangement**>.
10. Automatic Damper: ANSI Z21.66/CSA 6.14, [**electrically operated**][**mechanically activated**][**thermally activated**], automatic-vent-damper device with size matching draft hood.
11. Hot-Water Storage Tank: Connected with piping to circulating pump and domestic-water heater.

    a. Construction: In accordance with ASME Boiler and Pressure Vessel Code: Section VIII,

steel with [**150-psig (1035-kPa)**][**125-psig (860-kPa)**]<**Insert value**> working-pressure rating.

b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

12. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rods: Factory installed, magnesium.
b. Drain Valve: Corrosion-resistant metal with hose-end connection.
c. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
d. Jacket: Steel with enameled finish.
e. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

13. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [**125-psig (860-kPa)**]<**Insert value**> minimum working-pressure rating, and **225 deg F (107 deg C)** continuous-water-temperature rating.
14. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
15. Mounting: Domestic-water heater, tank, and accessories factory mounted on skids.

C. Capacity and Characteristics:

1. Hot-Water Storage-Tank Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
4. Fuel Gas Demand: <**Insert cfh (L/s)**>.
5. Fuel Gas Input: <**Insert Btu/h (W)**>.
6. Gas Pressure Regulator:

a. Capacity: <**Insert cfh (L/s)**>.
b. Inlet Pressure: <**Insert psig (kPa) or inches (mm)**> water column.
c. Gas Pressure Required at Burner: <**Insert psig (kPa) or inches (mm)**> water column.

7. Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

8. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.4 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Bosch Thermotechnology Corp.**]
3. [**Bradford White Corporation**]
4. [**Intellihot**]
5. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
6. [**Navien Inc.**]
7. [**NORITZ America Corp.**]
8. [**Rheem Manufacturing Company**]
9. [**Rinnai Corporation**]
10. [**State Industries**]
11. [**Takagi**]
12. [**WaiWela**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Bosch Thermotechnology Corp.**]
3. [**Bradford White Corporation**]
4. [**Intellihot**]
5. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
6. [**Navien Inc.**]
7. [**NORITZ America Corp.**]
8. [**Rheem Manufacturing Company**]
9. [**Rinnai Corporation**]
10. [**State Industries**]
11. [**Takagi**]
12. [**WaiWela**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.

D. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.

E. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.

1. Tappings: ASME B1.20.1 pipe thread.
2. Pressure Rating: **150 psig (1035 kPa)**.
3. Heat Exchanger: [**Copper tubing**][**Stainless steel**].
4. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
5. Jacket: Metal, with enameled finish, or plastic.
6. Burner: For use with tankless, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
8. Temperature Control: Adjustable thermostat.

F. Support: Bracket for wall mounting.

G. Capacity and Characteristics:

1. Flow Rate: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
2. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
3. Fuel Gas Demand: <**Insert cfh (L/s)**>.
4. Fuel Gas Input: <**Insert Btu/h (W)**>.
5. Gas Pressure Regulator:

   a. Capacity: <**Insert cfh (L/s)**>.
   b. Inlet Pressure: <**Insert psig (kPa) or inches (mm)**> water column.
   c. Gas Pressure Required at Burner: <**Insert psig (kPa) or inches (mm)**> water column.

6. Electrical Characteristics:

   a. Volts: [**120**]<**Insert value**> V.
   b. Phase: Single.
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

7. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.5 RESIDENTIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Residential, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heating**]
   e. [**Lochinvar, LLC**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**American Water Heaters**]
   c. [**Bradford White Corporation**]
   d. [**GSW Water Heating**]
   e. [**Lochinvar, LLC**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.1/CSA 4.1.

5. Storage-Tank Construction: Steel.

    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: **150 psig (1035 kPa)**.
    c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal with hose-end connection.
    d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
    e. Jacket: Steel with enameled finish.
    f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    g. Burner: For use with atmospheric, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
    h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
    i. Temperature Control: Adjustable thermostat.
    j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

7. Draft Hood: Low-profile-type draft diverter, complying with ANSI Z21.12.
8. Automatic Damper: ANSI Z21.66/CSA 6.14, [**electrically operated**][**mechanically activated**][**thermally activated**], automatic-vent-damper device with size matching draft hood.

B. Residential, Direct-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A. O. Smith Corporation**]
    b. [**Bradford White Corporation**]
    c. [**Lochinvar, LLC**]
    d. [**State Industries**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A. O. Smith Corporation**]
    b. [**Bradford White Corporation**]
    c. [**Lochinvar, LLC**]
    d. [**State Industries**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.1/CSA 4.1.
5. Storage-Tank Construction: Steel.

a. Tappings: ASME B1.20.1 pipe thread.
b. Pressure Rating: **150 psig (1035 kPa)**.
c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
e. Jacket: Steel with enameled finish.
f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
g. Burner: For use with direct-vent, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
i. Temperature Control: Adjustable thermostat.
j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

7. Direct-Vent System: Through-[**wall**][**roof**], coaxial- or double-channel vent assembly with domestic-water heater manufacturers' outside intake/exhaust screen.

C. Residential, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A. O. Smith Corporation**]
b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**GSW Water Heating**]
e. [**Lochinvar, LLC**]
f. [**State Industries**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A. O. Smith Corporation**]
b. [**American Water Heaters**]
c. [**Bradford White Corporation**]
d. [**GSW Water Heating**]
e. [**Lochinvar, LLC**]
f. [**State Industries**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: ANSI Z21.10.1/CSA 4.1.

5. Storage-Tank Construction: Steel.

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: **150 psig (1035 kPa)**.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
   e. Jacket: Steel with enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Burner: For use with power-vent, gas-fired, domestic-water heaters and [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
   h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
   i. Temperature Control: Adjustable thermostat.
   j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

7. Power-Vent System: Exhaust fan, interlocked with burner.

D. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**]<**Insert temperature**>.
4. Fuel Gas Demand: <**Insert cfh (L/s)**>.
5. Fuel Gas Input: <**Insert Btu/h (W)**>.
6. Gas Pressure Regulator:

   a. Capacity: <**Insert cfh (L/s)**>.
   b. Inlet Pressure: <**Insert psig (kPa) or inches (mm)**> water column.
   c. Gas Pressure Required at Burner: <**Insert psig (kPa) or inches (mm)**> water column.

7. Electrical Characteristics:

   a. Volts: [**120**][**240**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

8. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.6 OIL-FIRED, DOMESTIC-WATER HEATERS

A. Commercial, Oil-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A. O. Smith Corporation**]
    b. [**Aldrich Company, Inc. (The)**]
    c. [**Bock Water Heaters, Inc**]
    d. [**Precision Boilers**]
    e. [**State Industries**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A. O. Smith Corporation**]
    b. [**Aldrich Company, Inc. (The)**]
    c. [**Bock Water Heaters, Inc**]
    d. [**Precision Boilers**]
    e. [**State Industries**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: UL 732 for storage, domestic-water heaters.
5. Storage-Tank Construction: [**Non-**]ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> minimum working-pressure rating.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal with hose-end connection.
    d. Insulation: Comply with ASHRAE/IES 90.1.
    e. Jacket: Steel with enameled finish.
    f. Temperature Control: Adjustable thermostat.
    g. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Oil Burners:

   a. Standard: UL 296 for use with No. 2 fuel oil.
   b. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   c. Draft Regulator: Barometric type or adjustable-damper device.

B. Commercial, Large-Volume, Oil-Fired, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A. O. Smith Corporation**]
   b. [**Aldrich Company, Inc. (The)**]
   c. [**Bock Water Heaters, Inc**]
   d. [**Precision Boilers**]
   e. [**PVI; A WATTS Brand**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A. O. Smith Corporation**]
   b. [**Aldrich Company, Inc. (The)**]
   c. [**Bock Water Heaters, Inc**]
   d. [**Precision Boilers**]
   e. [**PVI; A WATTS Brand**]
   f. [**State Industries**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: UL 732 for storage, domestic-water heaters except when capacity is greater than **120 gal. (454 L)**.
5. Storage-Tank Construction: ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> minimum working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.

b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with ASHRAE/IES 90.1.
e. Jacket: Steel with enameled finish.
f. Temperature Control: Adjustable thermostat.
g. Safety Control: Automatic, high-temperature-limit cutoff device or system.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Oil Burners:

a. Standard: UL 296 for use with No. 2 fuel oil.
b. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
c. Draft Regulator: Barometric type or adjustable-damper device.

C. Residential, Oil-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bock Water Heaters, Inc**]
b. [**Therma-Flow/Everhot**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bock Water Heaters, Inc**]
b. [**Therma-Flow/Everhot**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Standard: UL 732 for storage, domestic-water heaters.
5. Storage-Tank Construction: Steel.

a. Tappings: ASME B1.20.1 pipe thread.
b. Pressure Rating: **150 psig (1035 kPa)**.
c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

6. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with [**ASHRAE/IES 90.1**][**ASHRAE 90.2**].
e. Jacket: Steel with enameled finish.
f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
g. Temperature Control: Adjustable thermostat.

h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

7. Oil Burner: UL 296 for use with No. 2 fuel oil.
8. Draft Regulator: Barometric type or adjustable-damper device.

D. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
4. Fuel-Oil Demand: <**Insert gpm (kg/s)**>.
5. Fuel-Oil Input: <**Insert Btu/h (W)**>.
6. Electrical Characteristics:

a. Burner Horsepower: <**Insert value**>.
b. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
c. Phase: [**Single**][**Three**].
d. Hertz: 60 Hz.
e. Full-Load Amperes: <**Insert value**> A.
f. Minimum Circuit Ampacity: <**Insert value**> A.
g. Maximum Overcurrent Protection: <**Insert value**> A.

7. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.7 COMMERCIAL, GAS- AND OIL-FIRED, DOMESTIC-WATER HEATERS

A. Description: Comply with ANSI Z21.10.3/CSA 4.3 or UL 732 requirements appropriate for dual-fuel, gas- and oil-fired, domestic-water heaters.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Bock Water Heaters, Inc**]
3. [**HESco Industries, Inc**]
4. [**Precision Boilers**]
5. [**PVI; A WATTS Brand**]
6. [**State Industries**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Bock Water Heaters, Inc**]
3. [**HESco Industries, Inc**]
4. [**Precision Boilers**]
5. [**PVI; A WATTS Brand**]
6. [**State Industries**]
7. <**Insert manufacturer's name**>

D. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.

E. Storage-Tank Construction: ASME-code steel with [**150-psig (1035-kPa)**]<**Insert value**> minimum working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

   a. NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

2. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3. Lining: [**Cement**][**Glass**][**Nickel plate**][**Phenolic coating**][**Sheet copper**]<**Insert material**> complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

F. Factory-Installed, Storage-Tank Appurtenances:

1. Anode Rod: Replaceable magnesium.
2. Dip Tube: Required unless cold-water inlet is near bottom of tank.
3. Drain Valve: Corrosion-resistant metal with hose-end connection.
4. Insulation: Comply with ASHRAE/IES 90.1.
5. Jacket: Steel with enameled finish.
6. Temperature Control: Adjustable thermostat.
7. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

G. Fuel Burner:

1. Standards: Combination gas-and-oil burner assembly, complying with appropriate requirements of UL 795; or comply with UL 296 for oil burners for No. 2 fuel oil and UL 795 for [**natural-gas**][**LP-gas**]<**Insert fuel gas**> fuel.
2. Safety Control: Automatic, high-temperature-limit cutoff device or system.
3. Vent Connection: In accordance with standards of authorities having jurisdiction for dual-fuel, domestic-water heaters.

H. Capacity and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F (52 deg C)**][**140 deg F (60 deg C)**]<**Insert temperature**>.
4. Fuel Gas Demand: <**Insert cfh (L/s)**>.
5. Fuel Gas Input: <**Insert Btu/h (W)**>.
6. Gas Pressure Regulator:

   a. Capacity: <**Insert cfh (L/s)**>.
   b. Inlet Pressure: <**Insert psig (kPa) or inches (mm)**> water column.
   c. Gas Pressure Required at Burner: <**Insert psig (kPa) or inches (mm)**> water column.

7. Fuel-Oil Demand: <**Insert gpm (kg/s)**>.

8. Fuel-Oil Input: <**Insert Btu/h (W)**>.
9. Electrical Characteristics:

    a. Burner Horsepower: <**Insert value**>.
    b. Volts: [**120**][**240**]<**Insert value**> V.
    c. Phase: [**Single**][**Three**].
    d. Hertz: 60 Hz.
    e. Full-Load Amperes: <**Insert value**> A.
    f. Minimum Circuit Ampacity: <**Insert value**> A.
    g. Maximum Overcurrent Protection: <**Insert value**> A.

10. Minimum Vent Diameter: <**Insert inches (mm)**>.

2.8 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A. O. Smith Corporation**]
    b. [**AMTROL, Inc.**]
    c. [**Flexcon Industries**]
    d. [**Honeywell International Inc.**]
    e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    f. [**State Industries**]
    g. [**Taco Comfort Solutions**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A. O. Smith Corporation**]
    b. [**AMTROL, Inc.**]
    c. [**Flexcon Industries**]
    d. [**Honeywell International Inc.**]
    e. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
    f. [**State Industries**]
    g. [**Taco Comfort Solutions**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
5. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

6. Capacity and Characteristics:

   a. Working-Pressure Rating: [**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert value**>.
   b. Capacity Acceptable: [**2 gal. (7.6 L)**][**4 gal. (15.1 L)**][**7 gal. (26.5 L)**][**10 gal. (37.9 L)**]<**Insert value**> minimum.
   c. Air Precharge Pressure: <**Insert system pressure**>.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than **NPS 3/4 (DN 20)** with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [**calibrated**][**memory-stop**] balancing valves to provide balanced flow through each domestic-water heater.

F. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

   1. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.

H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include [**1/2-psig (3.5-kPa)**][**2-psig (13.8-kPa)**][**5-psig (34.5-kPa)**] pressure rating as required to match gas supply.

I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

J. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
   2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

K. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
   2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

M. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater minimum of [**18 inches (457 mm)**]<**Insert dimension**> above the floor.

N. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters[**and storage tanks**] specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test[**commercial**] domestic-water heaters[**and storage tanks**] to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DOMESTIC-WATER HEATER

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Domestic-Water Heater Mounting: Install residential domestic-water heaters on [**floor**][**water-heater stand on floor**][**domestic-water heater mounting bracket**].

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters[**at least 18 inches (457 mm) above floor**] on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

D. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and

referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Install gas-fired, domestic-water heaters in accordance with NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**]

F. Install oil-fired, domestic-water heaters in accordance with NFPA 31.

1. Install shutoff valves on fuel-oil supply piping to oil-fired water-heater burners without shutoff valves. Comply with requirements for shutoff valves specified in Section 231113 "Facility Fuel-Oil Piping."

G. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" and Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

H. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

I. Install [**combination temperature-and-**]pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

J. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

K. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

L. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

M. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without

integral or fitting-type heat traps.

N. Fill domestic-water heaters with water.

O. Charge domestic-water expansion tanks with air to required system pressure.

P. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for fuel-oil piping specified in Section 231113 "Facility Fuel-Oil Piping."

C. Comply with requirements for gas piping specified in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**]

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**commercial, gas-fired, storage,**][**gas-fired, tankless**][**commercial, oil-fired,**][**commercial, gas- and oil-fired,**] domestic-water heaters. Training shall be a minimum of [**one**][**two**]<**Insert duration**> hour(s).

END OF SECTION 22 34 00 00

Task	Specification	Specification Description
22 34 36 13	22 33 00 00	Electric Domestic-Water Heaters
22 34 36 23	23 52 16 00	Condensing Boilers
22 34 36 23	23 52 33 00	Water-Tube Boilers
22 34 46 11	22 34 00 00	Fuel-Fired, Domestic-Water Heaters

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SECTION 22 35 00 00 - DOMESTIC-WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shell-and-tube, domestic-water heat exchangers.
2. Instantaneous, domestic-water heaters.
3. Semi-instantaneous, domestic-water heaters.
4. Indirect-fired, storage, domestic-water heaters.
5. Plate, domestic-water heat exchangers.
6. Drainline heat exchangers.
7. Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.[**Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**]

B. Sustainable Design Submittals:

1. Product Data: For energy efficiency.
2. Water Heaters: Product Data for water heater compliance with ASHRAE's "Advanced Energy Design Guides."

C. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Also indicate the following:

1. Tube removal space, both vertical and/or horizontal as applicable.
2. Structural members to which heat exchangers will be attached.

B. Seismic Qualification Data: Certificates, for domestic-water heat exchangers, water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of [**shell-and-tube heat exchanger**][**instantaneous water**

heater][**semi-instantaneous water heater**][**and**][**plate heat exchanger**] from manufacturer.

1. Domestic-Water, Heat-Exchanger Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
2. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic-water heat exchangers and heaters to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of domestic-water heat exchangers and heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures, including domestic-water heat exchanger, water heater, storage tank, and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

   a. Shell-and-Tube, Domestic-Water Heat Exchangers:

      1) Tube Coil: [**One**]<**Insert number**> year(s).
      2) Controls and Other Components: [**One**]<**Insert number**> year(s).

   b. Instantaneous, Domestic-Water Heaters:

      1) Tank: [**Five**][**10**]<**Insert number**> years.
      2) Tube Coil: [**Five**][**10**]<**Insert number**> years.
      3) Controls and Other Components: [**Three**]<**Insert number**> years.

   c. Semi-Instantaneous, Domestic-Water Heaters:

      1) Tank: [**Five**]<**Insert number**> years.
      2) Tube Coil: [**Five**]<**Insert number**> years.

3) Controls and Other Components: [**Three**]<**Insert number**> years.

d. Indirect-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: [**Five**]<**Insert number**> years.
2) Tube Coil: [**Five**]<**Insert number**> years.
3) Controls and Other Components: [**Three**]<**Insert number**> years.

e. Plate, Domestic-Water Heat Exchangers:

1) Brazed-Plate Type: [**One**]<**Insert number**> year(s).
2) Plate-and-Frame Type: [**One**]<**Insert number**> year(s).

f. Drainline Heat Exchanger: [**One**]<**Insert number**> year(s).
g. Compression Tanks: [**One**]<**Insert number**> year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61and NSF 372.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Seismic Performance: Domestic-water heat exchangers and heaters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 SHELL-AND-TUBE, DOMESTIC-WATER HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Bell & Gossett; a Xylem brand**]
3. [**Maxi-Therm**]
4. [**Taco Comfort Solutions**]
5. [**Thrush Co. Inc.**]

6. [**Wessels Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Bell & Gossett; a Xylem brand**]
3. [**Maxi-Therm**]
4. [**Taco Comfort Solutions**]
5. [**Thrush Co. Inc.**]
6. [**Wessels Company**]
7. <**Insert manufacturer's name**>

C. Description: Factory-packaged assembly of shell, U-tube heat-exchanger coils, and specialties for heating domestic water with [**heating hot water**][**steam**] in shells.

D. Construction:

1. Fabricate and label heat exchanger to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

E. Configuration: U-tube with removable [**two-pass**][**four-pass**] bundle.

F. Shell Materials: Carbon-steel shell with [**150-psig (1035- kPa)**]<**Insert value**> minimum working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

a. **NPS 2 (DN 50)** and Smaller: Threaded ends according to ASME B1.20.1.
b. **NPS 2-1/2 (DN 65)** and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

G. Head: Cast iron, flanged and bolted to shell.

H. Heat-Exchanger Coil: [**Double**][**Single**]-wall, [**copper**][**copper-nickel**] coils for domestic water. Include pressure rating equal to or greater than heating-fluid-supply pressure.

I. Relief Valves: ASME rated and stamped for combination temperature- and pressure-relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting of less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

J. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping.[**Include components fitted for pneumatic control.**]

K. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometer, and piping.[**Include components fitted for pneumatic control.**]

1. Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.

L. Stand: Factory fabricated on skid for floor mounting.

M. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle, except connections and controls.

N. Required Connections: Domestic cold water in; domestic hot water out; [**heating hot-water-**][**steam**] supply in; [**heating hot water out**][**condensate return out**].

O. Capacity and Characteristics:

1. Domestic Water:

   a. Recovery: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
   b. Hot-Water Temperature Setting: <**Insert deg F (deg C)**>.
   c. Pipe Size: <**Insert NPS (DN)**>.

2. Heating Hot-Water Supply:

   a. Inlet Temperature: <**Insert deg F (deg C)**>.
   b. Outlet Temperature: <**Insert deg F (deg C)**>.
   c. Pipe Size: <**Insert NPS (DN)**>.

3. Steam Supply:

   a. Inlet Pressure: <**Insert psig (kPa)**>.
   b. Demand Rate: <**Insert lb/h (kg/s)**>.
   c. Input Rating: <**Insert Btu/h (kW)**>.
   d. Steam Pipe Size: <**Insert NPS (DN)**>.
   e. Condensate Pipe Size: <**Insert NPS (DN)**>.

2.3 INSTANTANEOUS, DOMESTIC-WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cemline Corporation**]
2. [**Circor Energy/Leslie Controls**]
3. [**Spirax Sarco Limited**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cemline Corporation**]
2. [**Circor Energy/Leslie Controls**]
3. [**Spirax Sarco Limited**]
4. <**Insert manufacturer's name**>

C. Description: Factory-packaged assembly of heat exchanger, blending valve, controls, and specialties for heating domestic water in coils with steam in shell utilizing feed forward principle design.

D. Construction: ASME code, with [**cast-iron**][**or**][**steel**] shell for steam.

1. Cast-Iron Shell Pressure Rating: [**50 psig (345 kPa)**][**75 psig (517 kPa)**].

2. Steel Shell Pressure Rating: **150 psig (1035 kPa)**.
3. Standard: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

E. Heat-Exchanger Coils: Spiral-wound, [**double**][**single**]-wall [**copper or copper-alloy**][**stainless steel**] coils for domestic water.

F. Temperature Control: Adjustable thermostat that operates blending valve and is capable of maintaining outlet water temperature within **4 deg F (2 deg C)** of setting.

G. Safety Control: Automatic feed forward blending valve actuated by differential pressure.

H. Miscellaneous Components: Strainers (main and drip), main trap, drip trap, outlet water temperature gauge, steam pressure gauge, and piping.

I. Stand: Factory-fabricated steel skid for floor mounting.

J. Insulation: Factory-fabricated and -installed cover placed over top of the exchanger.

K. Required Connections: Domestic cold water in; domestic hot water out; steam supply in; condensate return out.

L. Capacity and Characteristics:

1. Domestic Water:

a. Recovery: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
b. Hot-Water Temperature Setting: <**Insert deg F (deg C)**>.
c. Pipe Size: <**Insert NPS (DN)**>.

2. Steam Supply:

a. Inlet Pressure: <**Insert psig (kPa)**>.
b. Demand Rate: <**Insert lb/h (kg/s)**>.
c. Input Rating: <**Insert Btu/h (kW)**>.
d. Steam Pipe Size: <**Insert NPS (DN)**>.

3. Condensate Pipe Size: <**Insert NPS (DN)**>.

M. Recirculation Kit: Provide an integrally mounted recirculation package.

2.4 SEMI-INSTANTANEOUS, DOMESTIC-WATER HEATERS

A. Semi-Instantaneous, Heating-Fluid-in-Coil, Packaged, Compact, Less than 100-Gal. (378-L), Domestic-Water Heater:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AERCO; A WATTS Brand**]

b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AERCO; A WATTS Brand**]
   b. <**Insert manufacturer's name**>

3. Description: Factory-packaged assembly of shell, heat-exchanger coils, and specialties for heating domestic water with steam in coils.
4. Construction:

   a. Fabricate and label heat exchanger to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

5. Configuration: Vertical-stacked helically shaped coils.
6. Shell Materials: Carbon steel, copper-lined shell with [**250-psig (1725-kPa)**]<**Insert value**> minimum working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

      1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

7. Head: Cast iron, flanged and bolted to shell.
8. Heat-Exchanger Coil: [**Double**][**Single**]-wall, [**copper**][**copper-nickel**] coils for domestic water. Include pressure rating equal to or greater than heating-fluid supply pressure.
9. Relief Valves: ASME rated and stamped for combination temperature- and pressure-relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting of less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
10. Miscellaneous Components: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometer, and piping.[**Include components fitted for pneumatic control.**]

    a. Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.

11. Stand: Factory fabricated on skid for floor mounting.
12. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle, except connections and controls.
13. Required Connections: Domestic cold water in; domestic hot water out; steam supply in; condensate return out.
14. Capacity and Characteristics:

    a. Domestic Water:
    b. Recovery: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.

       1) Hot-Water Temperature Setting: <**Insert deg F (deg C)**>.
       2) Pipe Size: <**Insert NPS (DN)**>.

    c. Steam Supply:

1) Inlet Pressure: <**Insert psig (kPa)**>.
2) Demand Rate: <**Insert lb/h (kg/s)**>.
3) Input Rating: <**Insert Btu/h (kW)**>.
4) Steam Pipe Size: <**Insert NPS (DN)**>.

d. Condensate Pipe Size: <**Insert NPS (DN)**>.

B. Semi-Instantaneous, Heating-Fluid-in-Shell, Packaged, Compact, Less than 100-Gal. (378-L), Domestic-Water Heat Exchangers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adamson Global Technology**]
   b. [**AO Smith**]
   c. [**Cemline Corporation**]
   d. [**Electric Heater Company (The)**]
   e. [**Harsco Industrial, Patterson-Kelley**]
   f. [**Patterson-Kelley**]
   g. [**PVI; A WATTS Brand**]
   h. [**RECO USA**]
   i. [**Sellers Manufacturing Co**]
   j. [**Thrush Co. Inc.**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Adamson Global Technology**]
   b. [**AO Smith**]
   c. [**Cemline Corporation**]
   d. [**Electric Heater Company (The)**]
   e. [**Harsco Industrial, Patterson-Kelley**]
   f. [**Patterson-Kelley**]
   g. [**PVI; A WATTS Brand**]
   h. [**RECO USA**]
   i. [**Sellers Manufacturing Co**]
   j. [**Thrush Co. Inc.**]
   k. <**Insert manufacturer's name**>

3. Description: Factory packaged, less than **100-gal. (378-L)** storage-capacity hot-water storage tank with heat-exchanger coil, circulator, controls, and specialties for heating domestic water with [**heating hot water**][**steam**] in coil.
4. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.
5. Construction:

   a. Fabricate and label semi-instantaneous domestic-water heater to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

6. Configuration: Vertical or horizontal.

7. Shell Materials: ASME-code, copper-silicon or corrosion-resistant metal with **150-psig (1035-kPa)** working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.

        1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

8. Heat-Exchanger Coil: [**Double**][**Single**] copper or copper-alloy U tubes with tube sheet and supporting baffles. Include heat-exchanger pressure rating equal to or greater than heating-fluid supply pressure.
9. Temperature Control: Adjustable thermostat.
10. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.
11. Relief Valves: ASME rated and stamped for combination temperature- and pressure-relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting of less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
12. Gauges: Factory-mounted thermometer and pressure gauge.
13. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [**125- psig (860-kPa)**]<**Insert value**> minimum working-pressure rating, and **225 deg F (107 deg C)** continuous-water-temperature rating.

    a. Pump Control: Sensor for operating pump and control valve.

14. Miscellaneous Components for Heating Hot-Water Units: Control valve, valves, and piping.
15. Miscellaneous Components for Steam Units: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometer, and piping.
16. Support: Factory mounted on skid for floor mounting.
17. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.
18. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle, except connections and controls.
19. Required Connections: Domestic cold water in; domestic hot water out; [**heating hot-water**][**steam**] supply in; [**heating hot water**][**condensate return**] out.
20. Capacity and Characteristics:

    a. Domestic Water:
    b. Recovery: <**Insert gpm (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.

        1) Hot-Water Temperature Setting: <**Insert deg F (deg C)**>.
        2) Pipe Size: <**Insert NPS (DN)**>.

    c. Heating Hot-Water Supply:

        1) Inlet Temperature: <**Insert deg F (deg C)**>.
        2) Outlet Temperature: <**Insert deg F (deg C)**>.
        3) Pipe Size: <**Insert NPS (DN)**>.

    d. Steam Supply:

1) Inlet Pressure: <**Insert psig (kPa)**>.
2) Demand Rate: <**Insert lb/h (kg/s)**>.
3) Input Rating: <**Insert Btu/h (kW)**>.
4) Steam Pipe Size: <**Insert NPS (DN)**>.

e. Condensate Pipe Size: <**Insert NPS (DN)**>.

2.5 INDIRECT-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bradford White Corporation**]
2. [**Cemline Corporation**]
3. [**Electric Heater Company (The)**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
6. [**Patterson-Kelley**]
7. [**PVI; A WATTS Brand**]
8. [**RECO USA**]
9. [**Sellers Manufacturing Co**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bradford White Corporation**]
2. [**Cemline Corporation**]
3. [**Electric Heater Company (The)**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Niles Steel Tank: a subsidiary of Bradford White Corporation**]
6. [**Patterson-Kelley**]
7. [**PVI; A WATTS Brand**]
8. [**RECO USA**]
9. [**Sellers Manufacturing Co**]
10. <**Insert manufacturer's name**>

C. Description: Factory-packaged, hot-water storage tank with heat-exchanger coil, [**circulator**], controls, and specialties for heating domestic water with [**heating hot water**][**steam**] in coil.

D. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

E. Storage-Tank Construction: [**Non-**]ASME-code [**steel**]<**Insert material**> with [**125-psig (860- kPa)**][**150-psig (1035- kPa)**]<**Insert value**> working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

1. Configuration: [**Horizontal**][**Vertical**].
2. Manhole: **11 by 15 inches (280 by 380 mm)** in [**end head of horizontal**][**sidewall of vertical**] storage-tank shell.
3. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.

a. NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
b. NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

4. Lining: [**Cement**][**Glass**][**Nickel**][**Epoxy/Phenolic coating**][**Stainless steel**]<**Insert material**> complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
5. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle, except connections and controls.
6. Anode Rods: Factory installed, magnesium.

F. Heat-Exchanger Coil: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**]<**Insert pipe size**> diameter, [**single**][**double**]-wall copper or copper-alloy U tubes with tube sheet and supporting baffles. Include heat-exchanger pressure rating equal to or greater than heating-fluid supply pressure.

G. Temperature Control: Adjustable-temperature aquastat, mounted in storage-tank shell head unless otherwise indicated.

H. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.

I. Relief Valves: ASME rated and stamped for combination temperature- and pressure-relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting of less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

J. Gauges: Factory-mounted thermometer and pressure gauge.

K. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [**125-psig (860- kPa)**]<**Insert value**> minimum working-pressure rating, and **225 deg F (107 deg C)** continuous-water-temperature rating.

1. Pump Control: Sensor for operating pump and control valve.

L. Support: Factory mounted on skids.

M. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.

N. Required Connections: Domestic cold water in; domestic hot water out; [**heating hot-water**][**steam**] supply in; [**heating hot water**][**condensate return**] out.

O. Capacity and Characteristics:

1. Domestic Water:

a. Storage Capacity: <**Insert gal. (L)**>.
b. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 (deg C)**]<**Insert temperature**> temperature rise.
c. Pipe Size: <**Insert NPS (DN)**>.
d. Hot Water Temperature Setting: <**Insert deg F (deg C)**>.

2. Heating Hot-Water Supply:

a. Inlet Temperature: <**Insert deg F (deg C)**>.

b. Outlet Temperature: <**Insert deg F (deg C)**>.
c. Pipe Size: <**Insert NPS (DN)**>.

3. Steam Supply:

a. Inlet Pressure: <**Insert psig (kPa)**>.
b. Demand Rate: <**Insert lb/h (kg/s)**>.
c. Input Rating: <**Insert Btu/h (kW)**>.
d. Steam Pipe Size: <**Insert NPS (DN)**>.

4. Condensate Pipe Size: <**Insert NPS (DN)**>.
5. Electrical Characteristics:

a. Volts: <**Insert number**>.
b. Phases: <**Insert number**>.
c. Hertz: <**Insert number**>.
d. Full-Load Amperes: <**Insert number**>.
e. Minimum Circuit Ampacity: <**Insert number**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 PLATE, DOMESTIC-WATER HEAT EXCHANGERS

A. Brazed-Plate, Domestic-Water Heat Exchangers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alfa Laval Inc.**]
b. [**API Heat Transfer Inc.**]
c. [**Armstrong Fluid Technology**]
d. [**Bell & Gossett; a Xylem brand**]
e. [**Doucette Industries, Inc**]
f. [**Kelvion, Inc.**]
g. [**Patterson-Kelley**]
h. [**Paul Mueller Company**]
i. [**Polaris Heat Exchangers**]
j. [**Tranter, Inc**]
k. [**Triangle Tube**]
l. [**Wessels Company**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alfa Laval Inc.**]
b. [**API Heat Transfer Inc.**]
c. [**Armstrong Fluid Technology**]
d. [**Bell & Gossett; a Xylem brand**]
e. [**Doucette Industries, Inc**]
f. [**Kelvion, Inc.**]
g. [**Patterson-Kelley**]

h. [**Paul Mueller Company**]
i. [**Polaris Heat Exchangers**]
j. [**Tranter, Inc**]
k. [**Triangle Tube**]
l. [**Wessels Company**]
m. <**Insert manufacturer's name**>

3. Description: Factory-packaged assembly of heat-exchanger plates, permanently brazed together, for using [**heating hot water**][**steam**] to heat domestic water.
4. Working-Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum.
5. Plate Construction: [**Vented, double**][**Single**] wall.
6. Plate Material: Stainless steel.
7. Plate Thickness: Not less than [**0.0197 inch (0.5 mm)**][**0.024 inch (0.6 mm)**].
8. Connections: Stainless steel, threaded.
9. Brazing Filler Metal: [**Copper**][**or**][**nickel**].

B. Frame-and-Plate, Domestic-Water Heat Exchangers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alfa Laval Inc.**]
b. [**API Heat Transfer Inc.**]
c. [**APV; SPX Corporation**]
d. [**Armstrong Fluid Technology**]
e. [**Bell & Gossett; a Xylem brand**]
f. [**Flo Fab Inc**]
g. [**Kelvion, Inc.**]
h. [**Paul Mueller Company**]
i. [**Polaris Heat Exchangers**]
j. [**Tranter, Inc**]
k. [**Wessels Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alfa Laval Inc.**]
b. [**API Heat Transfer Inc.**]
c. [**APV; SPX Corporation**]
d. [**Armstrong Fluid Technology**]
e. [**Bell & Gossett; a Xylem brand**]
f. [**Flo Fab Inc**]
g. [**Kelvion, Inc.**]
h. [**Paul Mueller Company**]
i. [**Polaris Heat Exchangers**]
j. [**Tranter, Inc**]
k. [**Wessels Company**]
l. <**Insert manufacturer's name**>

3. Description: Factory-packaged assembly of nonfixed-position, heat-exchanger plates, with frame, for using [**heating hot water**][**steam**] to heat domestic water.
4. Working-Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**][**400**

psig (2760 kPa)]<**Insert value**> minimum.

5. Frame:

   a. Carrying and Guide Bars: [**Carbon steel**][**Stainless steel**]<**Insert material**>.
   b. Fixed, Frame Plate; Pressure Plate; Support Column; and Nuts and Bolts: Carbon steel.

6. Channel Plates:

   a. Type: [**Vented, double**][**Single**] wall.
   b. Material: Stainless steel.
   c. Plate Thickness: Not less than [**0.0197 inch (0.5 mm)**][**0.024 inch (0.6 mm)**][**0.031 inch (0.8 mm)**].
   d. Gasket Material: Butyl or acrylonitrile-butadiene rubber, suitable for potable water.

7. Connections: [**Stainless steel**]<**Insert material**>, suitable for potable water.

   a. NPS 2 (DN 50) and Smaller: Threaded.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged.

8. Protective Shroud: Steel, covering channel plates.
9. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire heat exchanger, except connections.

C. Required Connections: Domestic cold water in; domestic hot water out; [**heating hot water**][**steam**] supply in; [**heating hot water**][**condensate return**] out.

D. Capacity and Characteristics:

1. Heat-Exchanger Surface Area: <**Insert sq. ft. (sq. m)**>.
2. Number of Plates: <**Insert number**>.
3. Domestic Water:

   a. Recovery: <**Insert gph (L/s)**> at [**100 deg F (56 deg C)**]<**Insert temperature**> temperature rise.
   b. Pipe Size: <**Insert NPS (DN)**>.
   c. Hot-Water Temperature Setting: <**Insert deg F (deg C)**>.

4. Heating Hot-Water Supply:

   a. Inlet Temperature: <**Insert deg F (deg C)**>.
   b. Outlet Temperature: <**Insert deg F (deg C)**>.
   c. Pipe Size: <**Insert NPS (DN)**>.

5. Steam Supply:

   a. Inlet Pressure: <**Insert psig (kPa)**>.
   b. Demand Rate: <**Insert lb/h (kg/s)**>.
   c. Input Rating: <**Insert Btu/h (kW)**>.
   d. Steam Inlet Pipe Size: <**Insert NPS (DN)**>.

6. Condensate Outlet Pipe Size: <**Insert NPS (DN)**>.

2.7 DRAINLINE HEAT EXCHANGER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ecodrain**]
2. [**EcoInnovation Technologies**]
3. [**RenewABILITY Energy, Inc.**]
4. [**WaterFilm Energy, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ecodrain**]
2. [**EcoInnovation Technologies**]
3. [**RenewABILITY Energy, Inc.**]
4. [**WaterFilm Energy, Inc.**]
5. <**Insert manufacturer's name**>

C. Description: Drainline heat exchanger, full-size vertical or horizontal drainage tube with domestic-water preheat coil around drainage tube.

1. Drainage Tube: ASTM B306, Type DWV copper drainage tube of size indicated.
2. Domestic-Water Preheat Coil: **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube of connection size indicated attached to drainage tube.
3. Working-Pressure Rating: **150 psig (1035 kPa)** on domestic-water supply tubing.
4. Standards:

   a. All surfaces coming into contact with potable water must be NSF approved for potable water applications.
   b. Thermal effectiveness of heat exchanger shall be certified to CSA B55.1.
   c. Construction of heat exchanger shall be certified to CSA B55.2.

D. Capacities and Characteristics:

1. DWV Drainage Tube:

   a. Size: [**2 inch (DN 50)**][**3 inch (DN 80)**][**4 inch (DN 100)**].
   b. Unit Length: <**Insert inches (mm)**>.

2. Domestic-Water Preheat Coil Connection: [**1/2 inch (DN 15)**][**3/4 inch (DN 20)**][**1 inch (DN 25)**].

2.8 ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMTROL, Inc.**]
   b. [**AO Smith**]

c. [**Flexcon Industries**]
d. [**Honeywell International Inc.**]
e. [**State Industries**]
f. [**Taco Comfort Solutions**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMTROL, Inc.**]
b. [**AO Smith**]
c. [**Flexcon Industries**]
d. [**Honeywell International Inc.**]
e. [**State Industries**]
f. [**Taco Comfort Solutions**]
g. <**Insert manufacturer's name**>

3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system operating pressure at tank.
4. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:

a. Working Pressure Rating: [**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert value**>.
b. Capacity Acceptable: [**2 gal. (7.6 L)**][**4 gal. (15.1 L)**][**7 gal. (26.5 L)**][**10 gal. (37.9 L)**]<**Insert value**> minimum.
c. Air Precharge Pressure: <**Insert system pressure**>.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IES 90.1[**or ASHRAE 90.2**].

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Combination Temperature- and Pressure-Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than heat-exchanger working-pressure rating. Select relief valves with sensing element that extends into storage tank.

E. Pressure-Relief Valves: ASME rated and stamped. Include pressure setting less than heat-exchanger working pressure rating.

F. Vacuum-Relief Valves: ANSI Z21.22/CSA 4.4.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers and domestic-water heaters specified to ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers and domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heat exchangers and domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DOMESTIC-WATER HEAT EXCHANGERS AND DOMESTIC-WATER HEATERS

A. Domestic-Water Heat Exchangers and Domestic-Water Heaters Mounting: Install domestic-water heat exchangers and domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor heat exchangers and heaters to substrate.

B. Install domestic-water heat exchangers and domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic cold-water supply piping to domestic-water heat exchangers and domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install shutoff valves on heating hot-water piping to domestic-water heat exchangers and domestic-water heaters. Comply with requirements for shutoff valves specified in Section 2305023 "General-Duty Valves for HVAC Piping."
3. Install shutoff valves on steam and condensate piping to domestic-water heat exchangers and domestic-water heaters. Comply with requirements for shutoff valves specified in Section 2305023 "General-Duty Valves for HVAC Piping."

C. Install domestic-water heat exchangers and domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install temperature- and pressure-relief valves in top portion of domestic-water storage tank shells. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install [**combination temperature- and**]pressure-relief valves in water piping for domestic-water heat exchangers and domestic-water heaters without storage. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install domestic-water heat exchangers and domestic-water heaters drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in domestic-water piping for heat exchangers and heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Install thermometer on each domestic-water heat exchanger and domestic-water heater[**inlet and**] outlet piping, and install thermometer on each heat exchanger and heater heating-fluid[**inlet and**] outlet piping. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

H. Install pressure gauges on domestic-water heat exchanger and domestic-water heater heating-fluid piping. Comply with requirements for pressure gauges specified in Section 220500 "Common Work Results for Plumbing."

I. Fill domestic-water heat exchangers and domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for heating hot-water piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

C. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to domestic-water heat exchangers and heaters, allow space for service and maintenance. Arrange piping for easy removal of heat exchangers and heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Domestic-water heat exchangers and domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain domestic-water [**heat exchangers**][**and**][**instantaneous**][**semi-instantaneous**][**indirect-fired**] domestic-water heaters.

END OF SECTION 22 35 00 00

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Task	Specification	Specification Description
22 35 23 00	22 35 00 00	Domestic-Water Heat Exchangers
22 35 23 13	22 33 00 00	Electric Domestic-Water Heaters
22 35 23 13	22 35 00 00	Domestic-Water Heat Exchangers

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SECTION 22 41 00 00 - RESIDENTIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bathtubs with shower.
2. Bathtub faucets.
3. Hydromassage whirlpool baths.
4. Air massage whirlpool baths.
5. Walk-in baths.
6. Bidets.
7. Lavatories - counter mounted.
8. Lavatories - pedestal.
9. Lavatories - integral-bowl countertop.
10. Lavatories - countertop-mounted bowl.
11. Lavatory faucets.
12. Showers - standard.
13. Showers - accessible.
14. Showers - factory-fabricated cabinet.
15. Shower faucets.
16. Bar sinks.
17. Kitchen sinks.
18. Laundry trays.
19. Sink faucets.
20. Laminar-flow, faucet-spout outlets.
21. Disposers.
22. Hot-water dispensers.
23. Water closets.
24. Toilet seats.
25. Supply fittings.
26. Waste fittings.
27. Grout.

B. Related Requirements:

1. Section 224200 "Commercial Plumbing Fixtures."
2. Section 224300 "Healthcare Plumbing Fixtures."
3. Section 224500 "Emergency Plumbing Fixtures."
4. Section 224600 "Security Plumbing Fixtures."
5. Section 224700 "Drinking Fountains and Water Coolers."

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PMMA: Polymethyl methacrylate, also known as "acrylic."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For water consumption.
2. Plumbing Fixtures: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

3. Plumbing Fixtures: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of [**whirlpool baths**][**and**][**walk-in baths**].

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to [**10**]<**Insert number**> percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to [**5**]<**Insert number**> percent of amount of each type and size installed.

3. Flushometer-Tank Repair Kits: Equal to [**5**]<**Insert number**> percent of amount of each type installed, but no fewer than [**two**]<**Insert number**> of each type.
4. Toilet Seats: Equal to [**5**]<**Insert number**> percent of amount of each type installed.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of [**walk-in baths**][**and**][**whirlpool baths**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Residential Applications of Shells: [**Five**][**20**][**30**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Residential Applications of Pumps and Blowers: [**Five**][**20**]<**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Residential Applications of Electronic Controls: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Domestic water faucets intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 BATHTUBS WITH SHOWER

A. Enameled Cast-Iron Bathtubs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. <**Insert manufacturer's name**>

B. Enameled-Steel Bathtubs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Bootz**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Crane Plumbing, LLC; a division of American Standard**]
   e. [**Eljer, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Bootz**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Crane Plumbing, LLC; a division of American Standard**]
   e. [**Eljer, Inc.**]
   f. <**Insert manufacturer's name**>

C. FRP Bathtubs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Aquarius Bathware; a Praxis Company**]
   c. [**Clarion Bathware**]
   d. [**Florestone Products Co., Inc.**]
   e. [**Sterling**]
   f. [**Swan Surfaces LLC (Swanstone)**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Aquarius Bathware; a Praxis Company**]
   c. [**Clarion Bathware**]
   d. [**Florestone Products Co., Inc.**]
   e. [**Sterling**]
   f. [**Swan Surfaces LLC (Swanstone)**]
   g. <**Insert manufacturer's name**>

D. PMMA Bathtubs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acryline USA, Inc.**]
b. [**American Standard**]
c. [**Anzzi; a brand of SWCorp**]
d. [**Aqua Bath Company, Inc.**]
e. [**Aquarius Bathware; a Praxis Company**]
f. [**Aquatic**]
g. [**Clarion Bathware**]
h. [**Crane Plumbing, LLC; a division of American Standard**]
i. [**Florestone Products Co., Inc.**]
j. [**Lyons Industries, Inc**]
k. [**Mansfield Plumbing Products LLC**]
l. [**St. Thomas Creations**]
m. [**Swan Surfaces LLC (Swanstone)**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acryline USA, Inc.**]
b. [**American Standard**]
c. [**Anzzi; a brand of SWCorp**]
d. [**Aqua Bath Company, Inc.**]
e. [**Aquarius Bathware; a Praxis Company**]
f. [**Aquatic**]
g. [**Clarion Bathware**]
h. [**Crane Plumbing, LLC; a division of American Standard**]
i. [**Florestone Products Co., Inc.**]
j. [**Lyons Industries, Inc**]
k. [**Mansfield Plumbing Products LLC**]
l. [**St. Thomas Creations**]
m. [**Swan Surfaces LLC (Swanstone)**]
n. <**Insert manufacturer's name**>

E. Fixture:

1. Standard:

a. ASME A112.19.1/CSA B45.2 for enameled[**-steel**][**cast-iron**] bathtubs.
b. IAPMO Z124/CSA B45.5 for [**FRP**][**PMMA**] plastic bathtubs.

2. Bathing Surface: Slip resistant.
3. Size: [**48 by 30 inches (1219 by 762 mm)**][**60 by 30 inches (1525 by 762 mm)**][**66 by 30 inches (1680 by 762 mm)**]<**Insert dimensions**>[**with front apron**][**drop-in type**].
4. Color: [**White**]<**Insert color**>.
5. Drain Location: [**Left**][**Right**] end.
6. Drain: **NPS 1-1/2 (DN 40)**; chrome-plated brass, pop-up waste and overflow.

F. Faucet: <**Insert faucet designation from "Bathtub Faucets" Article**>.

G. Supply Fittings: Included in faucet.

H. Tub Filler: Chrome-plated-brass diverter spout.

I. Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Stainless steel or chrome-plated brass, removable strainer.
3. Overflow: Chrome-plated-brass escutcheon with toggle drain-plug device.
4. Drain Piping:

a. **NPS 1-1/2 (DN 40)** cast-brass overflow, P-trap, and waste.
b. Schedule 40 [**ABS**][**or**][**PVC**], **NPS 1-1/2 (DN 40)** P-trap, and waste.

2.3 BATHTUB FAUCETS

A. NSF Standard: Comply with NSF61 and NSF 372 for faucet materials that will be in contact with potable water.

B. Pressure-Balance Faucets, Single Handle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
d. [**Danze, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Lawler Manufacturing Company, Inc**]
g. [**Matco-Norca**]
h. [**Moen Incorporated**]
i. [**POWERS; A Watts Water Technologies Company**]
j. [**Speakman Company**]
k. [**St. Thomas Creations**]
l. [**Sterling**]
m. [**Symmons Industries, Inc**]
n. [**T&S Brass and Bronze Works, Inc.**]
o. [**Wolverine Brass, Inc**]
p. [**Zurn Industries, LLC**]
q. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
d. [**Danze, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Lawler Manufacturing Company, Inc**]
g. [**Matco-Norca**]
h. [**Moen Incorporated**]

i. [**POWERS; A Watts Water Technologies Company**]
j. [**Speakman Company**]
k. [**St. Thomas Creations**]
l. [**Sterling**]
m. [**Symmons Industries, Inc**]
n. [**T&S Brass and Bronze Works, Inc.**]
o. [**Wolverine Brass, Inc**]
p. [**Zurn Industries, LLC**]
q. **<Insert manufacturer's name>**

C. Thermostatic Faucets, Single Handle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Lawler Manufacturing Company, Inc**]
   c. [**POWERS; A Watts Water Technologies Company**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Lawler Manufacturing Company, Inc**]
   c. [**POWERS; A Watts Water Technologies Company**]
   d. **<Insert manufacturer's name>**

D. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.

E. Faucet:

1. Body Material: Solid brass.
2. Finish: Polished chrome plate.
3. Maximum Flow Rate: [**2.5 gpm (9.5 L/min.)**]**<Insert value>** unless otherwise indicated.
4. Mounting: [**Concealed**][**Exposed**].
5. Operation: Single handle, [**push-pull**][**or**][**twist-or-rotate**] control, with hot- and cold-water indicators.
6. Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
7. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
8. Diverter: In-tub filler spout.
9. Supply Connections: **NPS 1/2 (DN 15)**.

F. Shower Head:

1. Standard: ASME A112.18.1/CSA B125.1.
2. Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**][**Hand shower. Include wall-mounting device**]**<Insert type>**.
3. Backflow-Prevention Device: ASSE 1014.
4. Shower Head Material: Metallic with chrome-plated finish.
5. Spray Pattern: [**Adjustable**][**Fixed**].

6. Integral Volume Control: [**Not required**][**Required**].
7. Shower-Arm, Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**].
8. Temperature Indicator: [**Integral with faucet**][**Not required**].

G. Bathtub Filler Spout: Chrome-plated brass.

2.4 HYDROMASSAGE WHIRLPOOL BATHS

A. Enameled Cast-Iron Hydromassage Whirlpool Baths :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. <**Insert manufacturer's name**>

B. Enameled-Steel Hydromassage Whirlpool Baths :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Mansfield Plumbing Products LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Mansfield Plumbing Products LLC**]
   c. <**Insert manufacturer's name**>

C. FRP Hydromassage Whirlpool Baths :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aquarius Bathware; a Praxis Company**]
   b. [**Best Bath Systems**]

c. [**Clarion Bathware**]
d. [**MAAX**]
e. [**Sterling**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Aquarius Bathware; a Praxis Company**]
b. [**Best Bath Systems**]
c. [**Clarion Bathware**]
d. [**MAAX**]
e. [**Sterling**]
f. **<Insert manufacturer's name>**

D. PMMA Hydromassage Whirlpool Baths :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Whirlpool**]
b. [**Aquarius Bathware; a Praxis Company**]
c. [**Aquatic**]
d. [**BainUltra, Inc.**]
e. [**Benjamin Manufacturing Co., Inc.**]
f. [**Clarion Bathware**]
g. [**Clarke Products, Inc**]
h. [**Eljer, Inc.**]
i. [**Jacuzzi Inc.**]
j. [**Jason International, Inc**]
k. [**Jetta Corporation**]
l. [**Mansfield Plumbing Products LLC**]
m. [**Southland Spa & Sauna Inc.**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Whirlpool**]
b. [**Aquarius Bathware; a Praxis Company**]
c. [**Aquatic**]
d. [**BainUltra, Inc.**]
e. [**Benjamin Manufacturing Co., Inc.**]
f. [**Clarion Bathware**]
g. [**Clarke Products, Inc**]
h. [**Eljer, Inc.**]
i. [**Jacuzzi Inc.**]
j. [**Jason International, Inc**]
k. [**Jetta Corporation**]
l. [**Mansfield Plumbing Products LLC**]
m. [**Southland Spa & Sauna Inc.**]
n. **<Insert manufacturer's name>**

E. Description: Bathtub with water-jet nozzles and water circulation.

F. Standards:

1. ASME A112.19.1/CSA B45.2 and UL 1795 for enameled[**-steel**][**cast-iron**] hydromassage bathtubs.
2. ANSI Z124.1.2/CSA B45.5 and UL 1795 for [**FRP**][**PMMA**] hydromassage bathtubs.

G. Fixture:

1. Seating Capacity: [**One**][**Two**]<**Insert number**> person(s).
2. Bathing Surface: Slip resistant.
3. Size: [**60 by 30 inches (1525 by 762 mm)**][**66 by 30 inches (1680 by 762 mm)**][**60 by 42 inches (1525 by 1065 mm)**]<**Insert dimensions**>.
4. Nominal Water Capacity: <**Insert gal. (L)**>.
5. Apron: Matching unit, covering exposed front and sides, and with access panel.
6. Color: [**White**]<**Insert color**>.
7. Drain Location: [**Left**][**Right**] end.
8. Controls: For pump[**, timer,**][**and water heater**].

H. Faucet:

1. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
2. Description: Fixture manufacturer's chrome-plated, solid-brass [**individual valves**][**mixing valve**] with over-rim tub filler.
3. Faucet Standard: ASME A112.18.1/CSA B125.1.

I. Supplies: **NPS 1/2 (DN 15)** copper tubing with ball, gate, or globe valves.

J. Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Size: **NPS 1-1/2 (DN 40)**.
3. Drain: Chrome-plated exposed parts; brass pop-up waste and overflow.
4. Drain Piping:

   a. Cast- and tubular-brass overflow, P-trap, and waste.
   b. Schedule 40 [**ABS**][**or**][**PVC**], overflow, P-trap, and waste.

K. Water-Circulating System: Electric circulating pump complying with ASME A112.19.7/CAS B45.10 and with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and plastic piping.

L. Water Heater: Electric, inline complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

M. Unit Electrical Characteristics:

1. Volts: [**120**][**240**][**277**][**480**]<**Insert number**> V.
2. Phase(s): [**Single**][**Three**].
3. Hertz: [**60**]<**Insert number**> Hz.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 AIR MASSAGE WHIRLPOOL BATHS

A. PMMA Air Massage Whirlpool Baths :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acryline USA, Inc.**]
   b. [**American Whirlpool**]
   c. [**Aquatic**]
   d. [**BainUltra, Inc.**]
   e. [**Jacuzzi Inc.**]
   f. [**Jason International, Inc**]
   g. [**Jetta Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acryline USA, Inc.**]
   b. [**American Whirlpool**]
   c. [**Aquatic**]
   d. [**BainUltra, Inc.**]
   e. [**Jacuzzi Inc.**]
   f. [**Jason International, Inc**]
   g. [**Jetta Corporation**]
   h. <**Insert manufacturer's name**>

3. Description: Air massage bathtub with air-injection nozzles.
4. Standards: IAPMO Z124.1.2/ANSI Z124.1.2 and UL 1795.
5. Fixture:

   a. Seating Capacity: [**One**][**Two**]<**Insert number**> person(s).
   b. Bathing Surface: Slip resistant.
   c. Size: [**60 by 30 inches (1525 by 762 mm)**][**66 by 30 inches (1680 by 762 mm)**][**60 by 42 inches (1525 by 1065 mm)**]<**Insert dimensions**>.
   d. Nominal Water Capacity: <**Insert gal. (L)**>.
   e. Apron: Matching unit, covering exposed front and sides, and with access panel.
   f. Color: [**White**]<**Insert color**>.
   g. Drain Location: [**Left**][**Right**] end.

6. Controls: For blower[**, timer,**][**and water heater**].
7. Faucet:

   a. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
   b. Description: Fixture manufacturer's chrome-plated, solid-brass [**individual valves**][**mixing valve**] with over-rim tub filler.
   c. Faucet Standard: ASME A112.18.1/CSA B125.1.

8. Supplies: **NPS 1/2 (DN 15)** copper tubing with ball, gate, or globe valves.
9. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Size: **NPS 1-1/2 (DN 40)**.
c. Drain: Chrome-plated exposed parts; brass pop-up waste and overflow.
d. Drain Piping:

1) Cast- and tubular-brass overflow, P-trap, and waste.
2) Drain Piping: Schedule 40 [**ABS**][**or**][**PVC**], overflow, P-trap, and waste.

10. Water-Circulating System: Electric circulating pump, complying with ASME A112.19.7/CSA B45.10 and with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and plastic piping.
11. Water Heater: Electric, inline complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
12. Air-Injection System: Electric [**blower**][**combination blower/heater**] complying with ASME A112.19.7/CSA B45.10 and with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and plastic piping.
13. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**> Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.6 WALK-IN BATHS

A. Standard Walk-in Baths - Plastic, with Side-Entry Door, Seat, and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**BathEase Inc**]
c. [**Best Bath Systems**]
d. [**BOCA Walk In Tubs**]
e. [**Glamour Baths**]
f. [**Serenity Walk In Bathtubs**]
g. [**Walk In Bathtub Company (The)**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**BathEase Inc**]
c. [**Best Bath Systems**]
d. [**BOCA Walk In Tubs**]
e. [**Glamour Baths**]
f. [**Serenity Walk In Bathtubs**]
g. [**Walk In Bathtub Company (The)**]

h. <**Insert manufacturer's name**>

3. Fixture:

a. Standards: IAPMO Z124.1.2/ANSI Z124.1.2.
b. Material: [**Plastic**][**PMMA**]<**Insert material**>.
c. Nominal Size: Approximately **60 by 32 by 21 inches (1525 by 815 by 535 mm)**.
d. Skirt: [**Front only**][**On sides not against walls**].
e. Seat: Integral.
f. Grab Bar: Manufacturer's standard.
g. Door: Side opening with rubber sealing gasket.
h. Door Location: [**Left**][**Right**] side.
i. Drain Location: [**Left**][**Right**] end.

4. Faucet:

a. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
b. Description: Fixture manufacturer's chrome-plated, solid-brass [**individual valves**][**mixing valve**] with over-rim tub filler.[**Include diverter and hand shower.**]
c. Faucet Standard: ASME A112.18.1/CSA B125.1.
d. Mounting: Deck.

5. Supplies: **NPS 1/2 (DN 15)** copper tubing with ball, gate, or globe valves.
6. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Size: **NPS 1-1/2 (DN 40)**.
c. Drain: Chrome-plated exposed parts; brass pop-up waste and overflow.
d. Drain Piping:

1) Cast- and tubular-brass overflow, P-trap, and waste.
2) Schedule 40 [**ABS**][**or**][**PVC**], overflow, P-trap, and waste.

7. Water-Circulating System: Electric circulating pump complying with ASME A112.19.7/CSA B45.10 and with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and plastic piping.
8. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**> Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

B. Hydromassage Walk-in Baths - Plastic, with Side-Entry Door, Seat, and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**BathEase Inc**]
c. [**Glamour Baths**]

d. [**Safety Tubs LLC**]
e. [**Walk In Bathtub Company (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**BathEase Inc**]
   c. [**Glamour Baths**]
   d. [**Safety Tubs LLC**]
   e. [**Walk In Bathtub Company (The)**]
   f. <**Insert manufacturer's name**>

3. Fixture:

   a. Standards: IAPMO Z124.1.2/ANSI Z124.1.2 and UL 1795.
   b. Nominal Size: Approximately **60 by 32 by 21 inches (1525 by 815 by 535 mm)**.
   c. Skirt: [**Front only**][**On sides not against walls**].
   d. Seat: Integral.
   e. Grab Bar: Manufacturer's standard.
   f. Door: Side opening with rubber sealing gasket.
   g. Door Location: [**Left**][**Right**] side.
   h. Drain Location: [**Left**][**Right**] end.

4. Faucet:

   a. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
   b. Description: Fixture manufacturer's chrome-plated, solid-brass [**individual valves**][**mixing valve**] with over-rim tub filler.[**Include diverter and hand shower.**]
   c. Faucet Standard: ASME A112.18.1/CSA B125.1.
   d. Mounting: Deck.

5. Supplies: **NPS 1/2 (DN 15)** copper tubing with ball, gate, or globe valves.
6. Waste Fittings:

   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Size: **NPS 1-1/2 (DN 40)**.
   c. Drain: Chrome-plated exposed parts; brass pop-up waste and overflow.
   d. Drain Piping:

      1) Cast- and tubular-brass overflow, P-trap, and waste.
      2) Drain Piping: Schedule 40 [**ABS**][**or**][**PVC**], overflow, P-trap, and waste.

7. Water-Circulating System: Electric circulating pump complying with ASME A112.19.7/CSA B45.10 and with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and plastic piping.
8. Unit Electrical Characteristics:

   a. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**> Hz.
   d. Full-Load Amperes: <**Insert value**> A.

e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.7 BIDETS

A. Bidets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Anzzi; a brand of SWCorp**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Capizzi**]
   e. [**Crane Plumbing, LLC; a division of American Standard**]
   f. [**Danze, Inc.**]
   g. [**Duravit USA, Inc**]
   h. [**Eljer, Inc.**]
   i. [**Gerber Plumbing Fixtures LLC.**]
   j. [**Mansfield Plumbing Products LLC**]
   k. [**St. Thomas Creations**]
   l. [**TOTO USA, INC**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Anzzi; a brand of SWCorp**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Capizzi**]
   e. [**Crane Plumbing, LLC; a division of American Standard**]
   f. [**Danze, Inc.**]
   g. [**Duravit USA, Inc**]
   h. [**Eljer, Inc.**]
   i. [**Gerber Plumbing Fixtures LLC.**]
   j. [**Mansfield Plumbing Products LLC**]
   k. [**St. Thomas Creations**]
   l. [**TOTO USA, INC**]
   m. <**Insert manufacturer's name**>

3. Fixture:

   a. Standard: ASME A112.19.2/CSA B45.1 for vitreous-china bidets.
   b. Type: With [**spray**][**flushing rim**][**spray and flushing rim**][**no spray**].
   c. Hole Punching: Number and spacing to match faucet.
   d. Mounting: Floor.
   e. Overflow: [**Not required**][**Required**].
   f. Color: [**White**]<**Insert color**>.

4. Faucet:

a. Standard: ASME A112.18.3.
b. Type: Manufacturer's standard with [**vacuum breaker, diverter, and submerged spray**][**over-rim filling**], pop-up drain,[**NPS 1-1/4 (DN 32)**] tailpiece, and chrome-plated finish. Include [**manufacturer's standard**][**cross**][**lever**][**wrist-blade**]<**Insert type**> handles.

5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except faucet includes pop-up drain.

2.8 LAVATORIES - COUNTER MOUNTED

A. Enameled Cast-Iron Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Commercial Enameling Company**]
c. [**Eljer, Inc.**]
d. [**Sloan Valve Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Commercial Enameling Company**]
c. [**Eljer, Inc.**]
d. [**Sloan Valve Company**]
e. <**Insert manufacturer's name**>

B. Enameled-Steel Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Bootz**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Eljer, Inc.**]
f. [**Mansfield Plumbing Products LLC**]
g. [**Sloan Valve Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Bootz**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Eljer, Inc.**]
f. [**Mansfield Plumbing Products LLC**]
g. [**Sloan Valve Company**]
h. **<Insert manufacturer's name>**

C. PMMA Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Manufacturing Co., Inc.**]
b. [**Meganite Inc.**]
c. [**Royal Baths Manufacturing Co**]
d. [**Sloan Valve Company**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Benjamin Manufacturing Co., Inc.**]
b. [**Meganite Inc.**]
c. [**Royal Baths Manufacturing Co**]
d. [**Sloan Valve Company**]
e. **<Insert manufacturer's name>**

D. Solid-Surface Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Bradley Corporation**]
d. [**DuPont de Nemours, Inc.**]
e. [**Formica Corporation**]
f. [**Franke Consumer Products, Inc**]
g. [**inpro Corporation**]
h. [**Meganite Inc.**]
i. [**Rynone Manufacturing Corp.**]
j. [**Sloan Valve Company**]
k. [**Swan Surfaces LLC (Swanstone)**]
l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Bradley Corporation**]
d. [**DuPont de Nemours, Inc.**]
e. [**Formica Corporation**]
f. [**Franke Consumer Products, Inc**]
g. [**inpro Corporation**]
h. [**Meganite Inc.**]
i. [**Rynone Manufacturing Corp.**]
j. [**Sloan Valve Company**]
k. [**Swan Surfaces LLC (Swanstone)**]
l. **<Insert manufacturer's name>**

E. Stainless Steel Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Aqua Design Manufacturing**]
c. [**Elkay**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Aqua Design Manufacturing**]
c. [**Elkay**]
d. **<Insert manufacturer's name>**

F. Vitreous-China Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Barclay Products Limited**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Duravit USA, Inc**]
f. [**Eljer, Inc.**]
g. [**Gerber Plumbing Fixtures LLC.**]
h. [**Kohler Co**]
i. [**Mansfield Plumbing Products LLC**]
j. [**Pelican Int'l**]
k. [**Sloan Valve Company**]
l. [**St. Thomas Creations**]
m. [**Sterling**]
n. [**TOTO USA, INC**]

o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Barclay Products Limited**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Duravit USA, Inc**]
f. [**Eljer, Inc.**]
g. [**Gerber Plumbing Fixtures LLC.**]
h. [**Kohler Co**]
i. [**Mansfield Plumbing Products LLC**]
j. [**Pelican Int'l**]
k. [**Sloan Valve Company**]
l. [**St. Thomas Creations**]
m. [**Sterling**]
n. [**TOTO USA, INC**]
o. **<Insert manufacturer's name>**

G. Fixture:

1. Standard:

a. ASME A112.19.1/CSA B45.2 for enameled[**-steel**][**cast-iron**] lavatories.
b. IAPMO Z124.3/ANSI Z124.3 for PMMA lavatories.
c. ASME A112.19.3/CSA B45.4 for stainless steel lavatories.
d. ASME A112.19.2/CSA B45.1 for vitreous-china lavatories.

2. Type: [**Flat rim with ledge**][**Self-rimming**].
3. Oval Nominal Size: [**19 by 16 inches (483 by 406 mm)**][**20 by 17 inches (508 by 432 mm)**]**<Insert dimensions>**.
4. Rectangular Nominal Size: [**18 by 15 inches (457 by 381 mm)**][**19 by 16 inches (483 by 406 mm)**][**20 by 18 inches (508 by 457 mm)**][**24 by 20 inches (610 by 508 mm)**]**<Insert dimensions>**.
5. Round Nominal Size: [**18 inches (457 mm)**][**19 inches (483 mm)**]**<Insert dimensions>** in diameter.
6. Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
7. Faucet-Hole Location: [**None**][**Rim**].
8. Color: [**Not applicable**][**White**]**<Insert color>**.

H. Faucet: **<Insert lavatory-faucet designation from "Lavatory Faucets" Article>**.

I. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

J. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.9 LAVATORIES - PEDESTAL

A. Vitreous China, Pedestal Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Barclay Products Limited**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Eljer, Inc.**]
f. [**Gerber Plumbing Fixtures LLC.**]
g. [**Kohler Co**]
h. [**Mansfield Plumbing Products LLC**]
i. [**St. Thomas Creations**]
j. [**Sterling**]
k. [**TOTO USA, INC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Barclay Products Limited**]
c. [**Briggs Plumbing Products, Inc**]
d. [**Crane Plumbing, LLC; a division of American Standard**]
e. [**Eljer, Inc.**]
f. [**Gerber Plumbing Fixtures LLC.**]
g. [**Kohler Co**]
h. [**Mansfield Plumbing Products LLC**]
i. [**St. Thomas Creations**]
j. [**Sterling**]
k. [**TOTO USA, INC**]
l. <**Insert manufacturer's name**>

3. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1.
b. Oval Nominal Size: [**20 by 17 inches (508 by 432 mm)**][**24 by 18 inches (610 by 457 mm)**]<**Insert dimensions**>.
c. Rectangular Nominal Size: [**18 by 15 inches (457 by 381 mm)**][**19 by 16 inches (483 by 406 mm)**][**20 by 18 inches (508 by 457 mm)**][**24 by 20 inches (610 by 508 mm)**]<**Insert dimensions**>.
d. Rectangular Pedestal Nominal Size: [**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**>.
e. Oval Pedestal Nominal Size: [**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**>.
f. Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
g. Faucet-Hole Location: [**Top**][**Front wall**][**Inclined panel**].
h. Color: [**White**]<**Insert color**>.

4. Faucet: <**Insert sink-faucet designation from "Sink Faucets" Article**>.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.10 LAVATORIES - INTEGRAL-BOWL COUNTERTOP

A. Cultured-Marble Countertop Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Capital Marble Creations, Inc.**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Rynone Manufacturing Corp.**]
   d. [**Tri-City Marble, Inc.**]
   e. [**Virginia Marble Manufacturers, Inc.**]
   f. [**Waldorf Marble, Inc.**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Capital Marble Creations, Inc.**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Rynone Manufacturing Corp.**]
   d. [**Tri-City Marble, Inc.**]
   e. [**Virginia Marble Manufacturers, Inc.**]
   f. [**Waldorf Marble, Inc.**]
   g. **<Insert manufacturer's name>**

B. Solid-Surface Countertop Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aristech Surfaces**]
   b. [**DuPont de Nemours, Inc.**]
   c. [**Formica Corporation**]
   d. [**inpro Corporation**]
   e. [**Meganite Inc.**]
   f. [**Swan Surfaces LLC (Swanstone)**]
   g. [**Wilsonart LLC**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Aristech Surfaces**]
   b. [**DuPont de Nemours, Inc.**]
   c. [**Formica Corporation**]
   d. [**inpro Corporation**]
   e. [**Meganite Inc.**]
   f. [**Swan Surfaces LLC (Swanstone)**]
   g. [**Wilsonart LLC**]

h. **<Insert manufacturer's name>**

C. Fixture:

1. Description: Countertop lavatory with integral bowl(s) for mounting on base unit.
2. Backsplash: [**Integral with countertop**][**Separate, same material as countertop**][**Not required**].
3. Overall Rectangular Top Size: [**25 by 17 inches (635 by 432 mm)**][**31 by 19 inches (787 by 483 mm)**][**49 by 22 inches (1245 by 559 mm)**][**73 by 22 inches (1854 by 559 mm)**]<**Insert dimensions**> with [**one**][**two**][**three**][**four**] bowl(s).
4. Bowl Size: Oval, [**19 by 16 inches (483 by 406 mm)**][**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**>.
5. Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
6. Faucet-Hole Location: [**Countertop**]<**Insert location**>.
7. Color: [**White**]<**Insert color**>.

2.11 LAVATORIES - COUNTERTOP-MOUNTED BOWL

A. Glass Countertop Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
   b. [**Anzzi; a brand of SWCorp**]
   c. [**Vitraform, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
   b. [**Anzzi; a brand of SWCorp**]
   c. [**Vitraform, Inc.**]
   d. **<Insert manufacturer's name>**

B. Copper Countertop Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
   b. [**Copper and Brass Sinks Direct**]
   c. [**Signature Hardware**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
b. [**Copper and Brass Sinks Direct**]
c. [**Signature Hardware**]
d. **<Insert manufacturer's name>**

C. Bronze Countertop Lavatories :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
b. [**Signature Hardware**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
b. [**Signature Hardware**]
c. **<Insert manufacturer's name>**

D. Fixture:

1. General: Countertop lavatory bowl for mounting on base unit.
2. Overall Size: [**17-inch (142-mm) OD**]**<Insert dimensions>**.
3. Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
4. Faucet-Hole Location: [**Countertop**][**Wall**]**<Insert location>**.
5. Color: **<Insert color>**.

2.12 LAVATORY FAUCETS

A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.

B. General-Duty, Solid-Brass Lavatory Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Design Manufacturing**]
d. [**Bradley Corporation**]
e. [**BrassTech Inc**]
f. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
g. [**Chicago Faucets; Geberit Group**]
h. [**Danze, Inc.**]

i. [**Delta Faucet Company**]
j. [**Eljer, Inc.**]
k. [**Elkay**]
l. [**Franke Consumer Products, Inc**]
m. [**Gerber Plumbing Fixtures LLC.**]
n. [**Griffin Products, Inc.**]
o. [**GROHE America, Inc**]
p. [**Hansgrohe USA**]
q. [**Houzer, Inc.**]
r. [**Hydrotek International, Inc.**]
s. [**Matco-Norca**]
t. [**Moen Incorporated**]
u. [**Pelican Int'l**]
v. [**Price Pfister, Inc**]
w. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
x. [**Rohl LLC**]
y. [**Speakman Company**]
z. [**T&S Brass and Bronze Works, Inc.**]
aa. [**TOTO USA, INC**]
bb. [**Watermark Designs, Ltd.**]
cc. [**Wolverine Brass, Inc**]
dd. [**Zurn Industries, LLC**]
ee. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Design Manufacturing**]
d. [**Bradley Corporation**]
e. [**BrassTech Inc**]
f. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
g. [**Chicago Faucets; Geberit Group**]
h. [**Danze, Inc.**]
i. [**Delta Faucet Company**]
j. [**Eljer, Inc.**]
k. [**Elkay**]
l. [**Franke Consumer Products, Inc**]
m. [**Gerber Plumbing Fixtures LLC.**]
n. [**Griffin Products, Inc.**]
o. [**GROHE America, Inc**]
p. [**Hansgrohe USA**]
q. [**Houzer, Inc.**]
r. [**Hydrotek International, Inc.**]
s. [**Matco-Norca**]
t. [**Moen Incorporated**]
u. [**Pelican Int'l**]
v. [**Price Pfister, Inc**]
w. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
x. [**Rohl LLC**]
y. [**Speakman Company**]
z. [**T&S Brass and Bronze Works, Inc.**]
aa. [**TOTO USA, INC**]

bb. [**Watermark Designs, Ltd.**]
cc. [**Wolverine Brass, Inc**]
dd. [**Zurn Industries, LLC**]
ee. **<Insert manufacturer's name>**

C. General-Duty, Copper- or Brass-Underbody Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Delta Faucet Company**]
d. [**Eljer, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Moen Incorporated**]
g. [**Sterling**]
h. [**WhiteRock Corp**]
i. [**Wolverine Brass, Inc**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Delta Faucet Company**]
d. [**Eljer, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Moen Incorporated**]
g. [**Sterling**]
h. [**WhiteRock Corp**]
i. [**Wolverine Brass, Inc**]
j. **<Insert manufacturer's name>**

D. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

E. Standard: ASME A112.18.1/CSA B125.1.

F. Body Material: [**General duty, solid brass**][**General-duty, copper or brass underbody with brass cover plate**].

G. Finish: [**Polished chrome plate**][**Polished brass**].

H. Maximum Flow Rate: [**2.2 gpm (8.3 L/min.)**][**2.5 gpm (9.5 L/min.)**]**<Insert value>**.

I. Centers: [**3-3/8 inches (86 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**][**8 inches (203 mm)**][**Single hole**][**Adjustable**].

J. Mounting: [**Deck, exposed**][**Deck, concealed**][**Back/wall, exposed**][**Back/wall, concealed**].

K. Valve Handle(s): [**Lever**][**Knob**][**Knob, nonmetallic**][**Cross, four arm**][**Wrist blade, 4 inches (102**

mm)][**Elbow, 6 inches (152 mm)**][**Push button**][**Not applicable**].

L. Inlet(s): [**NPS 3/8 (DN 10) tubing, plain end**][**NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor**][**NPS 1/2 (DN 15) male shank**][**NPS 1/2 (DN 15) female shank**].

M. Spout: [**Rigid**][**Swing**][**Rigid, gooseneck**][**Swivel, gooseneck**].

N. Spout Outlet: [**Aerator**][**Spray**][**Laminar flow**][**Plain end**][**Spray, 0.5 gpm (1.5 L/min.)**].

O. Operation: [**Compression, manual**][**Noncompression, manual**][**Sensor**][**Self-closing, metering**].

P. Drain: [**Pop up**][**Stopper with chain**][**Grid**].

2.13 SHOWERS - STANDARD

A. FRP Shower, Standard, with Base and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aquarius Bathware; a Praxis Company**]
b. [**Clarion Bathware**]
c. [**Florestone Products Co., Inc.**]
d. [**MAAX**]
e. [**Sterling; a Kohler Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aquarius Bathware; a Praxis Company**]
b. [**Clarion Bathware**]
c. [**Florestone Products Co., Inc.**]
d. [**MAAX**]
e. [**Sterling; a Kohler Company**]
f. <**Insert manufacturer's name**>

B. PMMA Shower, Standard, with Base and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acryline USA, Inc.**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Bath Company, Inc.**]
d. [**Aquarius Bathware; a Praxis Company**]
e. [**Aquatic**]
f. [**Clarion Bathware**]
g. [**Comfort Designs Bathware**]

h. [**Jacuzzi Inc.**]
i. [**MAAX**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acryline USA, Inc.**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Bath Company, Inc.**]
d. [**Aquarius Bathware; a Praxis Company**]
e. [**Aquatic**]
f. [**Clarion Bathware**]
g. [**Comfort Designs Bathware**]
h. [**Jacuzzi Inc.**]
i. [**MAAX**]
j. <**Insert manufacturer's name**>

C. Standard: IAPMO Z124.1.2/ANSI Z124.1.2.

D. Nominal Size: [**36 by 34 inches (915 by 865 mm)**][**42 by 36 inches (1065 by 915 mm)**][**43 by 39 inches (1090 by 990 mm)**][**48 by 34 inches (1219 by 865 mm)**]<**Insert dimensions**>.

E. Surround:

1. One piece or sealed, multiple piece.
2. One piece.

F. Bathing Surface: Slip resistant.

G. Color: [**White**]<**Insert color**>.

H. Drain Location: [**Left side**][**Center**][**Right side**].

I. Faucet: <**Insert faucet designation from "Shower Faucets" Article**>.

2.14 SHOWERS - ACCESSIBLE

A. FRP Shower, Accessible, with Seat, Grab Bar, Base, and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Clarion Bathware**]
b. [**Florestone Products Co., Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Clarion Bathware**]
b. [**Florestone Products Co., Inc.**]
c. <**Insert manufacturer's name**>

B. PMMA Shower, Accessible, with Seat, Grab Bar, Base, and Faucet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aqua Bath Company, Inc.**]
b. [**Aquatic**]
c. [**Clarion Bathware**]
d. [**Comfort Designs Bathware**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aqua Bath Company, Inc.**]
b. [**Aquatic**]
c. [**Clarion Bathware**]
d. [**Comfort Designs Bathware**]
e. <**Insert manufacturer's name**>

C. Standards: IAPMO Z124.1.2/ANSI Z124.1.2 and ICC/ANSI A117.1 for roll-in shower compartments.

D. Nominal Size: [**60 by 36 inches (1525 by 915 mm)**][**72 by 36 inches (1830 by 915 mm)**]<**Insert dimensions**>.

E. Surround:

1. One piece or sealed, multiple piece.
2. One piece.

F. Bathing Surface: Slip resistant.

G. Color: [**White**]<**Insert color**>.

H. Drain Location: [**Left side**][**Center**][**Right side**].

I. Accessibility Options: Grab bar and bench.

J. Faucet: Shower <**Insert faucet designation from "Shower Faucets" Article**>.

K. Drain: Grid, **NPS 2 (DN 50)**.

2.15 SHOWERS - FACTORY-FABRICATED CABINET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Aquatic**]
2. [**Comfort Designs Bathware**]
3. [**E. L. Mustee & Sons, Inc**]
4. [**Stern-Williams Products, LLC.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aquatic**]
2. [**Comfort Designs Bathware**]
3. [**E. L. Mustee & Sons, Inc**]
4. [**Stern-Williams Products, LLC.**]
5. <**Insert manufacturer's name**>

C. Size: [**30 by 30 inches (762 by 762 mm)**][**32 by 32 inches (815 by 815 mm)**][**36 by 36 inches (915 by 915 mm)**][**36 by 39 inches (915 by 990 mm)**][**45 by 39 inches (1145 by 990 mm)**]<**Insert dimensions**>.

D. Material: [**Steel**][**Composite**][**Plastic**], [**front**][**corner**][**front and rear**] access.

E. Color: [**Not applicable**]<**Insert color**>.

F. Accessibility Options: Grab bar and bench.

G. Faucet: <**Insert faucet designation from "Shower Faucets" Article**>.

H. Supplies: **NPS 1/2 (DN 15)** copper tubing with shutoff valves.

I. Drain: Grid, **NPS 2 (DN 50)**.

2.16 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.

B. Single-Handle, Pressure-Balance Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
d. [**Danze, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Lawler Manufacturing Company, Inc**]
g. [**Matco-Norca**]
h. [**Moen Incorporated**]
i. [**POWERS; A Watts Water Technologies Company**]
j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]

k. [**Speakman Company**]
l. [**Swan Surfaces LLC (Swanstone)**]
m. [**Symmons Industries, Inc**]
n. [**T&S Brass and Bronze Works, Inc.**]
o. [**Wolverine Brass, Inc**]
p. [**Zurn Industries, LLC**]
q. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Briggs Plumbing Products, Inc**]
c. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
d. [**Danze, Inc.**]
e. [**Gerber Plumbing Fixtures LLC.**]
f. [**Lawler Manufacturing Company, Inc**]
g. [**Matco-Norca**]
h. [**Moen Incorporated**]
i. [**POWERS; A Watts Water Technologies Company**]
j. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
k. [**Speakman Company**]
l. [**Swan Surfaces LLC (Swanstone)**]
m. [**Symmons Industries, Inc**]
n. [**T&S Brass and Bronze Works, Inc.**]
o. [**Wolverine Brass, Inc**]
p. [**Zurn Industries, LLC**]
q. **<Insert manufacturer's name>**

C. Single-Handle, Thermostatic Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Lawler Manufacturing Company, Inc**]
c. [**POWERS; A Watts Water Technologies Company**]
d. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Lawler Manufacturing Company, Inc**]
c. [**POWERS; A Watts Water Technologies Company**]
d. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
e. **<Insert manufacturer's name>**

D. Two-Handle, Nonpressure-Balance and Nonthermostatic Mixing Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Barclay Products Limited**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Danze, Inc.**]
   e. [**E. L. Mustee & Sons, Inc**]
   f. [**Gerber Plumbing Fixtures LLC.**]
   g. [**Mansfield Plumbing Products LLC**]
   h. [**Matco-Norca**]
   i. [**Paul Decorative Products**]
   j. [**Price Pfister, Inc**]
   k. [**T&S Brass and Bronze Works, Inc.**]
   l. [**Wolverine Brass, Inc**]
   m. [**Zurn Industries, LLC**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Barclay Products Limited**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Danze, Inc.**]
   e. [**E. L. Mustee & Sons, Inc**]
   f. [**Gerber Plumbing Fixtures LLC.**]
   g. [**Mansfield Plumbing Products LLC**]
   h. [**Matco-Norca**]
   i. [**Paul Decorative Products**]
   j. [**Price Pfister, Inc**]
   k. [**T&S Brass and Bronze Works, Inc.**]
   l. [**Wolverine Brass, Inc**]
   m. [**Zurn Industries, LLC**]
   n. <**Insert manufacturer's name**>

E. Fixture:

1. Description: Include hot- and cold-water indicators, check stops, and [**fixed showerhead, arm, and flange**][**handheld head complying with ASSE 1014 with arm, flange, hose, and bracket**]. Coordinate faucet inlets with supplies.
2. Standard: ASME A112.18.1/CSA B125.1[**and ASSE 1016**].
3. Body Material: [**Solid brass**]<**Insert material**>[**with nonmetallic trim**].
4. Finish: [**Polished chrome plate**][**Polished brass**]<**Insert finish**>.
5. Maximum Flow Rate: [**2.5 gpm (9.5 L/min.)**]<**Insert value**> unless otherwise indicated.
6. Mounting: [**Exposed**][**Concealed**].
7. Backflow-Prevention Device for Handheld Shower: [**Required**][**Not required**].
8. Operation: [**Compression, manual**][**Noncompression, manual**].
9. Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

F. Supply Connections: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**].

G. Shower Head:

1. Type: [**Ball joint**][**Without ball joint**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**][**Handheld, slide-bar mounted**][**Handheld, hook mounted**].
2. Shower Head Material: [**Metallic**][**Nonmetallic**][**Combined, metallic and nonmetallic**] with chrome-plated finish.
3. Spray Pattern: [**Fixed**][**Adjustable**].
4. Integral Volume Control: [**Required**][**Not required**].
5. Shower-Arm, Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**].

2.17 BAR SINKS

A. Enameled Cast-Iron Bar Sink, Single Bowl, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Commercial Enameling Company**]
   c. [**Eljer, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Commercial Enameling Company**]
   c. [**Eljer, Inc.**]
   d. <**Insert manufacturer's name**>

B. Enameled-Steel Bar Sink, Single Bowl, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Bootz**]
   c. [**Commercial Enameling Company**]
   d. [**Eljer, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Bootz**]
   c. [**Commercial Enameling Company**]

d. [**Eljer, Inc.**]
e. **<Insert manufacturer's name>**

C. Solid-Surface Bar Sink, Single Bowl, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Franke Consumer Products, Inc**]
b. [**Meganite Inc.**]
c. [**Rynone Manufacturing Corp.**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Franke Consumer Products, Inc**]
b. [**Meganite Inc.**]
c. [**Rynone Manufacturing Corp.**]
d. **<Insert manufacturer's name>**

D. Stainless Steel Bar Sink, Single Bowl, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barclay Products Limited**]
b. [**Elkay**]
c. [**Franke Consumer Products, Inc**]
d. [**Griffin Products, Inc.**]
e. [**Houzer, Inc.**]
f. [**Moen Incorporated**]
g. [**Revere Sink**]
h. [**Sterling; a Kohler Company**]
i. [**WhiteRock Corp**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Barclay Products Limited**]
b. [**Elkay**]
c. [**Franke Consumer Products, Inc**]
d. [**Griffin Products, Inc.**]
e. [**Houzer, Inc.**]
f. [**Moen Incorporated**]
g. [**Revere Sink**]
h. [**Sterling; a Kohler Company**]
i. [**WhiteRock Corp**]
j. **<Insert manufacturer's name>**

E. Fixture:

1. Standard:

a. ASME A112.19.1/CSA B45.2 for enameled[**-steel**][**cast-iron**] lavatories.
b. IAMPO Z124.3/ANSI Z124.3 for PMMA lavatories.
c. IAMPO Z124.3/ANSI Z124.3 for solid-surface lavatories.
d. ASME A112.19.3/CSA B45.4 for stainless steel lavatories.
e. ASME A112.19.2/CSA B45.1 for vitreous-china lavatories.

2. Type: [**Flat rim with ledge**][**Self-rimming**].
3. Overall Dimensions: <**Insert dimensions**>.
4. Bowl Dimensions: <**Insert dimensions**>.

F. Faucet: <**Insert sink-faucet designation from "Sink Faucets" Article**>.

G. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

H. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.18 KITCHEN SINKS

A. Enameled Cast-Iron Kitchen Sink, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Commercial Enameling Company**]
c. [**Eljer, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Commercial Enameling Company**]
c. [**Eljer, Inc.**]
d. <**Insert manufacturer's name**>

B. Enameled-Steel Kitchen Sink, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Bootz**]
c. [**Commercial Enameling Company**]

d. [**Eljer, Inc.**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Standard**]
b. [**Bootz**]
c. [**Commercial Enameling Company**]
d. [**Eljer, Inc.**]
e. **<Insert manufacturer's name>**

C. PMMA Kitchen Sink, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gerber Plumbing Fixtures LLC.**]
b. [**Glacier Bay**]
c. [**Lyons Industries, Inc**]
d. [**Sterling; a Kohler Company**]
e. [**Thermocast; a division of ITC Industries**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Gerber Plumbing Fixtures LLC.**]
b. [**Glacier Bay**]
c. [**Lyons Industries, Inc**]
d. [**Sterling; a Kohler Company**]
e. [**Thermocast; a division of ITC Industries**]
f. **<Insert manufacturer's name>**

D. Solid-Surface Kitchen Sink, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anzzi; a brand of SWCorp**]
b. [**Franke Consumer Products, Inc**]
c. [**Swan Surfaces LLC (Swanstone)**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Anzzi; a brand of SWCorp**]
b. [**Franke Consumer Products, Inc**]

c. [**Swan Surfaces LLC (Swanstone)**]
d. <**Insert manufacturer's name**>

E. Stainless Steel Kitchen Sink, Counter Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
   b. [**American Standard**]
   c. [**Anzzi; a brand of SWCorp**]
   d. [**Elkay**]
   e. [**Franke Consumer Products, Inc**]
   f. [**Griffin Products, Inc.**]
   g. [**Houzer, Inc.**]
   h. [**Pelican Int'l**]
   i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   j. [**Revere Sink**]
   k. [**Sterling**]
   l. [**WhiteRock Corp**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Affinity Surfaces; a brand of Domain Industries, Inc.**]
   b. [**American Standard**]
   c. [**Anzzi; a brand of SWCorp**]
   d. [**Elkay**]
   e. [**Franke Consumer Products, Inc**]
   f. [**Griffin Products, Inc.**]
   g. [**Houzer, Inc.**]
   h. [**Pelican Int'l**]
   i. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   j. [**Revere Sink**]
   k. [**Sterling**]
   l. [**WhiteRock Corp**]
   m. <**Insert manufacturer's name**>

F. Fixture:

1. ASME A112.19.1/CSA B45.2 for enameled[**-steel**][**cast-iron**] kitchen sinks.
2. IAMPO Z124.3/ANSI Z124.3 for PMMA kitchen sinks.
3. IAMPO Z124.3/ANSI Z124.3 for solid-surface kitchen sinks.
4. ASME A112.19.3/CSA B45.4 for stainless steel kitchen sinks.
5. Overall Dimensions: <**Insert dimensions**>.
6. Metal Thickness: [**0.038 inch (1.0 mm)**][**0.050 inch (1.3 mm)**]<**Insert dimension**>.
7. Bowl:

   a. Dimensions: <**Insert dimensions**>.
   b. Drain: **3-1/2-inch (89-mm)** [**crumb cup**][**grid**][**outlet for disposer**].

1) Location: [**Centered in bowl**][**Near back of bowl**]<**Insert location**>.

8. Left Bowl:

a. Dimensions: <**Insert dimensions**>.
b. Drain: **3-1/2-inch (89-mm)** [**crumb cup**][**grid**][**grid with offset waste**][**outlet for disposer**].

1) Location: [**Centered in bowl**][**Near back of bowl**]<**Insert location**>.

9. Right Bowl:

a. Dimensions: <**Insert dimensions**>.
b. Drain: **3-1/2-inch (89-mm)** [**crumb cup**][**grid**][**grid with offset waste**][**outlet for disposer**].

1) Location: [**Centered in bowl**][**Near back of bowl**]<**Insert location**>.

10. Center Bowl:

a. Dimensions: <**Insert dimensions**>.
b. Drain: [**1-1/2-inch (38-mm)**][**3-1/2-inch (89-mm)**][**crumb cup**][**grid**][**grid with offset waste**].

1) Location: [**Centered in bowl**]<**Insert location**>.

G. Faucet: <**Insert sink-faucet designation from "Sink Faucets" Article**>.

H. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

I. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

1. Disposer: [**Not required**]<**Insert disposer designation from "Disposers" Article**>.
2. Hot-Water Dispenser: [**Not required**][**Comply with requirements in "Hot-Water Dispensers" Article**].

2.19 LAUNDRY TRAYS

A. Laundry Trays - Enameled Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Commercial Enameling Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Commercial Enameling Company**]

b. <**Insert manufacturer's name**>

3. Fixture:

a. Standard: ASME A112.19.1/CSA B45.2.
b. Nominal Size: [**24 by 21 inches (610 by 535 mm)**][**24 by 23 inches (610 by 584 mm)**]<**Insert dimensions**>.
c. Color: [**White**]<**Insert color**>.
d. Mounting: [**Freestanding on manufacturer's standard metal stand**][**Flush, counter mounted with stainless steel ring and sealant or on-counter mounted with sealant**].

4. Faucet: <**Insert sink-faucet designation from "Sink Faucets" Article**>.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

B. Laundry Trays - Plastic :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**E. L. Mustee & Sons, Inc**]
b. [**Fiat Products**]
c. [**Florestone Products Co., Inc.**]
d. [**Gerber Plumbing Fixtures LLC.**]
e. [**Swan Surfaces LLC (Swanstone)**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**E. L. Mustee & Sons, Inc**]
b. [**Fiat Products**]
c. [**Florestone Products Co., Inc.**]
d. [**Gerber Plumbing Fixtures LLC.**]
e. [**Swan Surfaces LLC (Swanstone)**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Fixture:

a. Standard: IAPMO Z124.6/ANSI Z124.6.
b. Style: Flat-rim ledge.
c. Material: [**Plastic**][**Cast polymer**][**FRP**][**PMMA**][**or**][**PP**].
d. Nominal Size: [**24 by 21 inches (610 by 535 mm)**][**25 by 22 inches (635 by 559 mm)**]<**Insert dimensions**>.
e. Color: [**White**]<**Insert color**>.
f. Mounting: Freestanding on manufacturer's standard legs or separate, painted-steel stand.

4. Faucet: <**Insert sink-faucet designation from "Sink Faucets" Article**>.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.20 SINK FAUCETS

A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.

B. General-Duty, Solid-Brass Sink Faucets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Design Manufacturing**]
d. [**Bradley Corporation**]
e. [**BrassTech Inc**]
f. [**Briggs Plumbing Products, Inc**]
g. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
h. [**Chicago Faucets; Geberit Group**]
i. [**Danze, Inc.**]
j. [**Delta Faucet Company**]
k. [**Eljer, Inc.**]
l. [**Elkay**]
m. [**Fisher Manufacturing Co**]
n. [**Franke Consumer Products, Inc**]
o. [**Gerber Plumbing Fixtures LLC.**]
p. [**GROHE America, Inc**]
q. [**Hansgrohe USA**]
r. [**Hydrotek International, Inc.**]
s. [**Moen Incorporated**]
t. [**Pelican Int'l**]
u. [**Price Pfister, Inc**]
v. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
w. [**Rohl LLC**]
x. [**Speakman Company**]
y. [**T&S Brass and Bronze Works, Inc.**]
z. [**Watermark Designs, Ltd.**]
aa. [**Wolverine Brass, Inc**]
bb. [**Zurn Industries, LLC**]
cc. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Anzzi; a brand of SWCorp**]
c. [**Aqua Design Manufacturing**]
d. [**Bradley Corporation**]
e. [**BrassTech Inc**]
f. [**Briggs Plumbing Products, Inc**]
g. [**Central Brass Company; a Pioneer Industries, Inc. brand**]
h. [**Chicago Faucets; Geberit Group**]
i. [**Danze, Inc.**]
j. [**Delta Faucet Company**]

k. [**Eljer, Inc.**]
l. [**Elkay**]
m. [**Fisher Manufacturing Co**]
n. [**Franke Consumer Products, Inc**]
o. [**Gerber Plumbing Fixtures LLC.**]
p. [**GROHE America, Inc**]
q. [**Hansgrohe USA**]
r. [**Hydrotek International, Inc.**]
s. [**Moen Incorporated**]
t. [**Pelican Int'l**]
u. [**Price Pfister, Inc**]
v. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
w. [**Rohl LLC**]
x. [**Speakman Company**]
y. [**T&S Brass and Bronze Works, Inc.**]
z. [**Watermark Designs, Ltd.**]
aa. [**Wolverine Brass, Inc**]
bb. [**Zurn Industries, LLC**]
cc. **<Insert manufacturer's name>**

2.21 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

A. NSF Standard: Comply with NSF 61 for faucet-spout outlet materials that will be in contact with potable water.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AM Conservation Group, Inc.**]
2. [**American Standard**]
3. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
4. [**Delta Faucet Company**]
5. [**NEOPERL, Inc.**]
6. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AM Conservation Group, Inc.**]
2. [**American Standard**]
3. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
4. [**Delta Faucet Company**]
5. [**NEOPERL, Inc.**]
6. **<Insert manufacturer's name>**

D. Description: Chrome-plated-brass, faucet-spout outlet that produces nonaerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.22 DISPOSERS

A. Batch-Feed Disposers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Franke Consumer Products, Inc**]
   b. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   c. [**KitchenAid; Whirlpool Corporation**]
   d. [**Maytag; Whirlpool Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Franke Consumer Products, Inc**]
   b. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   c. [**KitchenAid; Whirlpool Corporation**]
   d. [**Maytag; Whirlpool Corporation**]
   e. <**Insert manufacturer's name**>

B. Continuous-Feed Disposers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Franke Consumer Products, Inc**]
   c. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   d. [**KitchenAid; Whirlpool Corporation**]
   e. [**Maytag; Whirlpool Corporation**]
   f. [**WhiteRock Corp**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Franke Consumer Products, Inc**]
   c. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   d. [**KitchenAid; Whirlpool Corporation**]
   e. [**Maytag; Whirlpool Corporation**]
   f. [**WhiteRock Corp**]
   g. <**Insert manufacturer's name**>

C. Standards: ASSE 1008 and UL 430, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. General: Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless steel grinder or shredder; **NPS 1-1/2 (DN 40)** outlet; quick-mounting, stainless steel sink flange; antisplash guard; and combination cover/stopper.

E. Model: [**Not applicable**][**Sound-insulated chamber**][**Sound-insulated chamber and stainless-steel**

outer shell].

F. Motor: 115 V ac, 1725 rpm, [**1/3**][**1/2**][**3/4**][**1**] hp with overload protection.

2.23 HOT-WATER DISPENSERS

A. NSF Standard: Comply with NSF 61 for faucet materials that will be in contact with potable water.

B. Gooseneck Spout with Lever-Handle, Flow-Control, Hot-Water Dispensers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Elkay**]
   c. [**Franke Consumer Products, Inc**]
   d. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   e. [**KitchenAid; Whirlpool Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Elkay**]
   c. [**Franke Consumer Products, Inc**]
   d. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   e. [**KitchenAid; Whirlpool Corporation**]
   f. <**Insert manufacturer's name**>

C. Spout with Twist-Knob or Push-Button, Flow-Control, Hot-Water Dispensers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Elkay**]
   c. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   d. [**KitchenAid; Whirlpool Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anaheim Manufacturing, Inc.**]
   b. [**Elkay**]
   c. [**InSinkErator; Emerson Electric Co., Commercial and Residential Solutions**]
   d. [**KitchenAid; Whirlpool Corporation**]

e. **<Insert manufacturer's name>**

D. Standard: ASSE 1023.

E. General: Household-type dispenser with instant on-off control; insulated, corrosion-resistant-metal storage tank that is open to atmosphere; electric heating element; chrome-plated faucet or spout; removable strainer; thermostat control for water temperature up to **190 deg F (88 deg C)**; and thermal-overload protection.

F. Storage Tank Capacity: **0.5 gal. (1.5 L)**.

G. Heating Element: 750 W minimum, 115 V ac.

2.24 WATER CLOSETS

A. Water Closets : Floor mounted, floor outlet, close coupled (gravity tank), vitreous china, [**1.6 gal./flush (6 L)/flush)**][**1.28 gal./flush (5.8 L/flush)**][**1.0 gal./flush (4.5 L/flush)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Barclay Products Limited**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Capizzi**]
   e. [**Duravit USA, Inc**]
   f. [**Eljer, Inc.**]
   g. [**Gerber Plumbing Fixtures LLC.**]
   h. [**Kohler Co**]
   i. [**Lamosa Corp.**]
   j. [**Mansfield Plumbing Products LLC**]
   k. [**Pelican Int'l**]
   l. [**St. Thomas Creations**]
   m. [**TOTO USA, INC**]
   n. [**Zurn Industries, LLC**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Barclay Products Limited**]
   c. [**Briggs Plumbing Products, Inc**]
   d. [**Capizzi**]
   e. [**Duravit USA, Inc**]
   f. [**Eljer, Inc.**]
   g. [**Gerber Plumbing Fixtures LLC.**]
   h. [**Kohler Co**]
   i. [**Lamosa Corp.**]
   j. [**Mansfield Plumbing Products LLC**]
   k. [**Pelican Int'l**]
   l. [**St. Thomas Creations**]

m. [**TOTO USA, INC**]
n. [**Zurn Industries, LLC**]
o. <**Insert manufacturer's name**>

3. Bowl:

a. Standards: ASME A112.19.2/CSA B45.1, ASME A112.19.5/CSA B45.15, and ASSE 1037/ASME A112.1060/CSA B125.16.
b. Bowl Type: [**Siphon jet**]<**Insert type**>.
c. Height: [**Standard**][**Child**][**Handicapped/elderly**].
d. Rim Contour: [**Elongated**][**Regular**].
e. Water Consumption: [**Water saving**][**Low**].
f. Color: [**White**]<**Insert color**>.

4. Toilet Seat: <**Insert toilet-seat designation from "Toilet Seats" Article**>.
5. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
c. Stop: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.

1) Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.

d. Riser:

1) Size: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**].
2) Material: [**Chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA 125.6, braided- or corrugated-stainless steel flexible hose**] riser.

2.25 TOILET SEATS

A. Toilet Seats :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Bemis Manufacturing Company**]
c. [**Centoco Manufacturing Corporation**]
d. [**Church Seats; Bemis Manufacturing Company**]
e. [**Eljer, Inc.**]
f. [**Jones Stephens Corp.**]
g. [**Olsonite Seat Co.**]
h. [**Pressalit Inc.**]
i. [**Sanderson Plumbing Products, Inc**]
j. [**Sperzel of Lexington**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**American Standard**]
b. [**Bemis Manufacturing Company**]
c. [**Centoco Manufacturing Corporation**]
d. [**Church Seats; Bemis Manufacturing Company**]
e. [**Eljer, Inc.**]
f. [**Jones Stephens Corp.**]
g. [**Olsonite Seat Co.**]
h. [**Pressalit Inc.**]
i. [**Sanderson Plumbing Products, Inc**]
j. [**Sperzel of Lexington**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Standard: IAPMO Z124.5/ANSI Z124.5.
4. Material: Plastic.
5. Type: [**Residential**][**Commercial (Standard)**].
6. Shape: [**Regular rim (Open front)**][**Regular rim (Closed front)**][**Elongated rim (Open front)**][**Elongated rim (Closed front)**].
7. Configuration: [**Closed**][**Open**] front [**with**][**without**] cover.
8. Size: [**Elongated**][**Regular**].
9. Hinge Type: [**Check**][**Self-sustaining**][**Self-sustaining, check**][**Self-raising**].
10. Hinge Material: [**Noncorroding metal**][**Plastic**].
11. Seat Cover: [**Required**][**Not required**].
12. Color: [**White**][**Black**]<**Insert color**>.

2.26 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Bidet Lavatory Bar Sink Kitchen Sink and Laundry Tray Supply Fittings:

1. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
2. Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.

   a. Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.

3. Risers:

   a. Size:

      1) **NPS 3/8 (DN 10)** for [**bidets**][**and**][**lavatories**].
      2) [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**] for [**bar sinks**][**kitchen sinks**][**and**][**laundry trays**].

   b. Material: [**Chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless-steel flexible hose**] riser.

2.27 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain:

1. Grid type with **NPS 1-1/4 (DN 32)** offset tailpiece for accessible lavatories.
2. Pop-up type with **NPS 1-1/4 (DN 32)** straight tailpiece as part of faucet for standard lavatories.
3. Grid type with **NPS 1-1/2 (DN 40)** offset tailpiece for accessible [**bar sinks**][**and**][**kitchen sinks**].
4. Grid type with **NPS 1-1/2 (DN 40)** straight tailpiece for standard [**bar sinks**][**and**][**kitchen sinks**][**and for laundry trays**].

C. Trap:

1. Size:

a. [**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32)**][**NPS 1-1/2 (DN 40)**] for [**bidets**][**and**][**lavatories**].
b. **NPS 1-1/2 (DN 40)** for [**bar sinks**][**kitchen sinks**][**and**][**laundry trays**].

2. Material:

a. Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**one-piece, cast-brass trap with swivel 0.029-inch- (0.73-mm-) thick tubular brass wall bend**]<**Insert trap type**>; and chrome-plated-brass or -steel wall flange.
b. Stainless steel, two-piece trap and swivel elbow with **0.012-inch- (0.30-mm-)** thick stainless steel tube to wall; and stainless steel wall flange.
c. ASTM F409 [**ABS**][**or**][**PVC**][**one**][**two**]-piece trap and waste to wall and wall flange.

2.28 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF RESIDENTIAL PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb in accordance with roughing-in drawings.

B. Install floor-mounted water closets on closet flange attachments to drainage piping.

C. Install counter-mounting fixtures in and attached to casework.

D. Install pedestal lavatories on pedestals and secured to wood blocking in wall.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Use ball or gate valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

G. Install toilet seats on water closets.

H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

I. Install shower flow-control fittings with specified maximum flow rates in shower arms.

J. Install traps on fixture outlets.

1. Omit trap on fixtures with integral traps.
2. Omit trap on indirect wastes unless otherwise indicated.

K. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

L. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

M. Set [**bathtubs**][**baths**][**and**][**shower receptors**] in leveling bed of cement grout.

N. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible [**lavatories**][**and**][**sinks**]. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

O. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

P. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible [**lavatories**][**and**][**sinks**]. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 41 00 00

Task	Specification	Specification Description
22 41 26 00	22 41 00 00	Residential Plumbing Fixtures
22 41 39 00	22 41 00 00	Residential Plumbing Fixtures
22 41 39 00	22 42 00 00	Commercial Plumbing Fixtures
22 41 39 00	22 45 00 00	Emergency Plumbing Fixtures

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SECTION 22 42 00 00 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial lavatories.
2. Commercial showers.
3. Commercial sinks.
4. Commercial urinals.
5. Commercial water closets.
6. Commercial wash fountains.
7. Flushometer valves.
8. Toilet seats.
9. Fixture carriers.

B. Related Requirements:

1. Section 114000 "Foodservice Equipment" for NSF-compliant foodservice and handwash sinks.
2. Section 224100 "Residential Plumbing Fixtures" for residential plumbing fixtures.
3. Section 224300 "Healthcare Plumbing Fixtures" for healthcare plumbing fixtures.
4. Section 224500 "Emergency Plumbing Fixtures" for emergency plumbing fixtures.
5. Section 224600 "Security Plumbing Fixtures" for security plumbing fixtures.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. High-Efficiency Flush Volume: **1.28 gal.** **(4.8 L)** or less per flush.

C. PMMA: Polymethyl methacrylate; also known as "acrylic."

D. Standard-Efficiency Flush Volume: **1.6 gal.** **(6 L)** per flush.

E. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions and thicknesses, dimensions of individual components and profiles, and finishes for plumbing fixtures.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies, including accessories. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, location and size of each field connection, location and size of each cutout, and anchorage provisions and attachment methods. Indicate coordination requirements for adjacent and interfacing Work.
3. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product Data: For water consumption.
2. Plumbing Fixtures: Provide the following:

    a. Manufacturer cut sheet indicating water consumption.
    b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

3. Plumbing Fixtures: Provide the following:

    a. Manufacturer cut sheet indicating water consumption.
    b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories and/or counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For lavatories and faucets.

    a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

        1) Servicing and adjustments of automatic faucets.

2. For shower valves to include in maintenance manuals.
3. For sinks and faucets to include in operation and maintenance manuals.

    a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

        1) Servicing and adjustments of automatic faucets.

4. For flushometer valves[**and electronic sensors**] to include in operation and maintenance manuals.
5. For wash fountains and components to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to [**10**]<**Insert number**> percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to [**5**]<**Insert number**> percent of amount of each type and size installed.
3. Shower Valve Washers and O-Rings: Equal to [**10**]<**Insert number**> percent of amount of each type and size installed.
4. Shower Valve Cartridges and O-Rings: Equal to [**5**]<**Insert number**> percent of amount of each type and size installed.
5. Waterless Urinal Trap-Seal Cartridges: Equal to [**200**]<**Insert number**> percent of amount of each type installed, but no fewer than [**12**]<**Insert number**> of each type.
6. Waterless Urinal Trap-Seal Liquid: Equal to [**1 gal. (3.8 L)**]<**Insert volume**> for each urinal installed.
7. Flushometer-Valve Repair Kits: Equal to [**10**]<**Insert number**> percent of amount of each type installed, but no fewer than [**one**][**six**]<**Insert number**> of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lavatory faucets, sink faucets, shower valves, and wash fountain spray heads and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMMERCIAL LAVATORIES

A. Lavatories, Counter Mounted:

1. Lavatories, Counter Mounted - Enameled Cast Iron, Flat Rim, Flush Mount :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Commercial Enameling Company**]
2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Commercial Enameling Company**]

2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.1/CSA B45.2.
2) Type: For flush mounting with kit.
3) Nominal Size: Rectangular, [**18 by 15 inches (457 by 381 mm)**][**20 by 18 inches (508 by 457 mm)**].
4) Faucet-Hole Punching: [**Three holes, 2-inch (51-mm)**][**Three holes, 4-inch (102-mm)**] centers.
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting Materials: With stainless steel ring and sealant.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

2. Lavatories, Counter Mounted - Enameled Cast Iron, Self-Rimming :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Kohler Co**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Kohler Co**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.1/CSA B45.2.
2) Type: Self-rimming for above-counter mounting.
3) Nominal Size: Oval, [**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**> nominal.
4) Faucet-Hole Punching: [**Single center hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting Material: Sealant.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

3. Lavatories, Undercounter Mounted - Enameled Cast Iron :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Commercial Enameling Company**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Commercial Enameling Company**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.1/CSA B45.2.
2) Type: For undercounter mounting.
3) Nominal Size: Oval, [**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**> nominal.
4) Faucet-Hole Punching: No holes.
5) Faucet-Hole Location: On countertop.
6) Color: [**White**]<**Insert color**>.
7) Mounting Materials: Sealant and undercounter mounting kit.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

4. Lavatory, Counter Mounted - Vitreous China, Self-Rimming, Rectangular :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Mansfield Plumbing Products LLC**]
5) [**TOTO USA, INC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Mansfield Plumbing Products LLC**]
5) [**TOTO USA, INC**]
6) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.

2) Type: Self-rimming for above-counter mounting.
3) Nominal Size: Rectangular, [**21 by 19 inches (533 by 483 mm)**][**24 by 20 inches (610 by 508 mm)**]<**Insert dimensions**> nominal.
4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting Material: Sealant.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

5. Lavatory, Counter Mounted - Vitreous China, Self-Rimming, Oval or Round :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Gerber Plumbing Fixtures LLC.**]
4) [**Kohler Co**]
5) [**Mansfield Plumbing Products LLC**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Gerber Plumbing Fixtures LLC.**]
4) [**Kohler Co**]
5) [**Mansfield Plumbing Products LLC**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: Self-rimming for above-counter mounting.
3) Nominal Size:

a) Oval, [**19 by 17 inches (483 by 432 mm)**][**20 by 17 inches (508 by 432 mm)**]<**Insert dimensions**>.
b) Round, [**19 inches (483 mm)**]<**Insert dimension**>.

4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting Material: Sealant.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

6. Lavatories, Undercounter Mounted - Vitreous China, Oval :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Mansfield Plumbing Products LLC**]
5) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
6) [**Sloan Valve Company**]
7) [**TOTO USA, INC**]
8) [**Zurn Industries, LLC**]
9) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Mansfield Plumbing Products LLC**]
5) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
6) [**Sloan Valve Company**]
7) [**TOTO USA, INC**]
8) [**Zurn Industries, LLC**]
9) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: For undercounter mounting.
3) Nominal Size: Oval, [**19 by 16 inches (483 by 406 mm)**][**22 by 14 inches (559 by 356 mm)**][**23 by 15 inches (584 by 381 mm)**]<**Insert dimensions**>.
4) Faucet-Hole Punching: No holes.
5) Faucet-Hole Location: On countertop.
6) Color: [**White**]<**Insert color**>.
7) Mounting Material: Sealant and undercounter mounting kit.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

B. Lavatories, Wall Mounted:

1. Lavatory, Wall Mounted - Enameled Cast Iron, Rectangular :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**American Standard**]
      2) [**Kohler Co**]
      3) [**Zurn Industries, LLC**]
      4) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**American Standard**]
      2) [**Kohler Co**]
      3) [**Zurn Industries, LLC**]
      4) <**Insert manufacturer's name**>

   c. Fixture:

      1) Standard: ASME A112.19.1/CSA B45.2.
      2) Type: Straight-front apron with straight back.
      3) Nominal Size: Rectangular, [**19 by 17 inches (483 by 432 mm)**][**20 by 18 inches (508 by 457 mm)**].
      4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
      5) Faucet-Hole Location: Top.
      6) Color: [**White**]<**Insert color**>.
      7) Mounting Material: Wall bracket.

   d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.
   e. Support: [**Lavatory carrier, framing affixed**][**Lavatory carrier, floor affixed with steel uprights**]<**Insert carrier**>.
   f. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

2. Lavatories, Wall Mounted - Vitreous China, Rectangular with Back :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**American Standard**]
      2) [**Briggs Plumbing Products, Inc**]
      3) [**Gerber Plumbing Fixtures LLC.**]
      4) [**Kohler Co**]
      5) [**Mansfield Plumbing Products LLC**]
      6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
      7) [**Sloan Valve Company**]
      8) [**Zurn Industries, LLC**]

9) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Gerber Plumbing Fixtures LLC.**]
4) [**Kohler Co**]
5) [**Mansfield Plumbing Products LLC**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Sloan Valve Company**]
8) [**Zurn Industries, LLC**]
9) **<Insert manufacturer's name>**

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: For wall hanging.
3) Nominal Size: Rectangular, [**18 by 16 inches (457 by 406 mm)**][**20 by 18 inches (508 by 457 mm)**]**<Insert dimensions>**.
4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]**<Insert color>**.
7) Mounting Material: Chair carrier.

d. Faucet: **<Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph>**.
e. Support: [**Lavatory carrier, framing affixed**][**Lavatory carrier, floor affixed with steel uprights**][**,**][**exposed arm**][**concealed arm**]**<Insert carrier>**.
f. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

3. Lavatories, Wall Mounted - Vitreous China, Rectangular with Ledge Back :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Gerber Plumbing Fixtures LLC.**]
4) [**Kohler Co**]
5) [**Mansfield Plumbing Products LLC**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Gerber Plumbing Fixtures LLC.**]
4) [**Kohler Co**]
5) [**Mansfield Plumbing Products LLC**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: For wall hanging.
3) Nominal Size: Rectangular, [**19 by 17 inches (483 by 432 mm)**][**20 by 18 inches (508 by 457 mm)**]<**Insert dimensions**>.
4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting Material: Chair carrier.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

e. Support: [**Lavatory carrier, framing affixed**][**Lavatory carrier, floor affixed with steel uprights**][,][**exposed arm**][**concealed arm**]<**Insert carrier**>.

f. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

4. Lavatories, Wall Mounted - Vitreous China, Rectangular, Wheelchair :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Zurn Industries, LLC**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Gerber Plumbing Fixtures LLC.**]
3) [**Kohler Co**]
4) [**Zurn Industries, LLC**]
5) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.

2) Type: Wheelchair.
3) Nominal Size: Rectangular, **27 by 20 inches (686 by 508 mm)**.
4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102 mm) centers**][**Three holes, 5- to 6-inch (127- to 150-mm) centers**].
5) Faucet-Hole Location: Top.
6) Color: [**White**]<**Insert color**>.
7) Mounting: For concealed-arm carrier.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.
e. Support: [**Lavatory carrier, floor affixed with steel uprights**][,][**exposed-arm**][**concealed-arm**]<**Insert carrier**>.
f. Lavatory Mounting Height: [**Juvenile**][**Accessible in accordance with ICC A117.1**].

5. Lavatories, Wall Mounted - Vitreous China, Corner Type :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: Three-sided-front apron with three-sided back.
3) Nominal Size: Corner, **16 by 16 inches (406 by 406 mm)**.
4) Faucet-Hole Punching: [**One hole**][**Three holes, 2-inch (51-mm) centers**].
5) Faucet-Hole Location: Back wall.
6) Color: [**White**]<**Insert color**>.
7) Mounting Materials: Wall brackets.

d. Faucet: Manufacturer's standard; factory installed.
e. Support: [**Lavatory carrier, framing affixed**][**Lavatory carrier, floor affixed with steel uprights**]<**Insert carrier**>.
f. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

6. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Integral Ramp Basin(s) :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) **<Insert manufacturer's name>**

c. Basin(s) and Countertop:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Number of Stations: [**One**][**Two**][**Three**][**Four**].
4) Overall Countertop Size: [**30 by 21 by 5 inches (762 by 533 by 127 mm) (per station)**]**<Insert dimension>**.
5) Basin I.D.: [**20 by 13 by 5 inches (508 by 330 by 127mm)**][**18 by 12 by 5 inches (457 by 305 by 127 mm)**][**14 by 10 by 5 inches (356 by 254 by 127 mm)**].
6) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]**<Insert hole pattern>**.
7) Faucet-Hole Location: [**Top**][**Wall mount**].
8) Drain Type: Slot drain
9) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]**<Insert color>**.
10) Mounting: Concrete wall brackets.

d. Faucet: **<Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph>**.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Connection: **1-1/4-inch (32-mm)** fine thread tailpiece.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.

g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

7. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Integral Rectangular Basin(s) :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Basin(s) and Countertop:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Number of Stations: [**One**][**Two**][**Three**][**Four**].
4) Overall Countertop Size: [**30 by 21 by 5 inches (762 by 533 by 127 mm) (per station)**]<**Insert dimension**>.
5) Basin I.D.: **20 by 13 by 5 inches (508 by 330 by 127 mm)**.
6) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
7) Faucet-Hole Location: [**Top**][**Wall mount**].
8) Drain Type: **1-1/4-inch (32-mm)** grid drain assembly.
9) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
10) Mounting: Concrete wall brackets.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/4-inch (32-mm)** grid drain assembly.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.

g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

8. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Integral Half-Trough Basin(s) :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Number of Stations: [**One**][**Two**][**Three**][**Four**].
4) Overall Countertop Size: [**30 by 21 by 5 inches (762 by 533 by 127 mm) (per**

station)]<**Insert dimension**>.
5) Basin I.D.: [**20 by 13 by 5-1/2 inches (508 by 330 by 140 mm)**][**16 by 14 by 5-1/2 inches (406 by 356 by 140 mm)**].
6) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
7) Faucet-Hole Location: [**Top**][**Wall mount**].
8) Drain Type: **1-1/4-inch (32-mm)** grid drain assembly.
9) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
10) Mounting: Concrete wall brackets.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.
e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/4-inch (32-mm)** grid drain assembly.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.
g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

9. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Single Integral Ramp Basin, Two Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop Size: [**60 by 21 by 5 inches (1525 by 533 by 127 mm)**][**72 by 21 by 5 inches (1829 by 533 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**48 by 13 by 5 inches (1220 by 330 by 127 mm)**][**50 by 12 by 5 inches (1270 by 305 by 127 mm)**][**50 by 13 by 5 inches (1270 by 330 by 127 mm)**][**60 by 13 by 5 inches (1525 by 330 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].

7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete wall brackets.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.
e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.
g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

10. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Single Integral Ramp Basin, Three Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop Size: [**72 by 21 by 5 inches (1829 by 533 by 127 mm)**][**90 by 21 by 5 inches (2286 by 533 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**60 by 13 by 5 inches (1524 by 330 by 127 mm)**][**72 by 13 by 5 inches (1829 by 330 by 127 mm)**][**80 by 12 by 5 inches (2032 by 305 by 127 mm)**][**84 by 12 by 5 inches (2134 by 305 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].
7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete wall brackets.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually**

Operated" or "Lavatory Faucets, Automatically Operated" Paragraph>.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.

g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

11. Lavatories, Wall Mounted - Precast GFRC, Rectangular Countertop Deck with Single Integral Ramp Basin, Four Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop Size: [**106 by 21 by 5 inches (2692 by 533 by 127 mm)**][**120 by 21 by 5 inches (3048 by 533 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**96 by 12 by 5 inches (2438 by 305 by 127 mm)**][**110 by 12 by 5 inches (2794 by 305 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].
7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete wall brackets.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's standard product.
g. Lavatory Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

C. Lavatories, Freestanding:

1. Lavatories, Freestanding - Precast GFRC, Rectangular Countertop Deck with Integral Ramp Basin, Two Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop size: [**68 by 22 by 5 inches (1727 by 559 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**48 by 13 by 5 inches (1219 by 330 by 127 mm)**][**50 by 12 by 5 inches (1270 by 305 by 127 mm)**][**50 by 13 by 5 inches (1270 by 330 by 127 mm)**][**60 by 13 by 5 inches (1524 by 330 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].
7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete sink steel base.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.
e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Concrete sink steel base.
g. Lavatory Height: Accessible in accordance with ICC A117.1.

2. Lavatories, Freestanding - Precast GFRC, Rectangular Countertop Deck with Integral Ramp Basin, Three Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop Size: [**72 by 22 by 5 inches (1829 by 559 by 127 mm)**][**84 by 22 by 5 inches (2134 by 559 by 127 mm)**][**98 by 22 by 5 inches (2489 by 559 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**60 by 13 by 5 inches (1524 by 330 by 127 mm)**][**72 by 13 by 5 inches (1829 by 330 by 127 mm)**][**80 by 12 by 5 inches (2032 by 305 by 127 mm)**][**84 by 12 by 5 inches (2134 by 305 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].
7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete sink steel base.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's concrete sink steel base.

g. Lavatory Height: Accessible in accordance with ICC A117.1.

3. Lavatories, Freestanding - Precast GFRC, Rectangular Countertop Deck with Integral Ramp Basin, Four Station :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Trueform Concrete, LLC**]

2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Trueform Concrete, LLC**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards: CSA B45.8/IAPMO Z403 and ICC A117.1.
2) Type: Straight front and side aprons with straight back.
3) Overall Countertop Size: [**107 by 22 by 5 inches (2718 by 559 by 127 mm)**][**128 by 22 by 5 inches (3251 by 559 by 127 mm)**]<**Insert dimension**>.
4) Basin I.D.: [**96 by 12 by 5 inches (2438 by 305 by 127 mm)**][**110 by 12 by 5 inches (2794 by 305 by 127 mm)**].
5) Faucet-Hole Punching (per Station): [**Zero holes**][**One hole**][**Three holes, 2-inch (51-mm) centers**][**Three holes, 4-inch (102-mm) centers**]<**Insert hole pattern**>.
6) Faucet-Hole Location: [**Top**][**Wall mount**].
7) Drain Type: Slot drain.
8) Color: [**White linen**][**Concrete**][**Charcoal**][**Limestone**][**Graphite**][**Pewter**][**Dusk**][**Taupe**]<**Insert color**>.
9) Mounting Material: Concrete sink steel base.

d. Faucet: <**Insert lavatory faucet designation from "Lavatory Faucets, Manually Operated" or "Lavatory Faucets, Automatically Operated" Paragraph**>.

e. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Type: **1-1/2-inch (38-mm)** slip joint connection.
3) Finish: [**Polished chrome**][**Brushed nickel**][**Oil-rubbed bronze**].

f. Support: Manufacturer's concrete sink steel base.

g. Lavatory Height: Accessible in accordance with ICC A117.1.

D. Lavatory Systems:

1. Lavatory Systems - Single or Multiple Stations :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**D13 Group**]
4) [**Sloan Valve Company**]
5) [**Splash Lab (The)**]
6) [**Willoughby Industries, Inc.**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**D13 Group**]
4) [**Sloan Valve Company**]
5) [**Splash Lab (The)**]
6) [**Willoughby Industries, Inc.**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain lavatory systems from single source from single manufacturer.
d. Standards:

1) ASME A112.18.1/CSA B125.1.
2) CSA B45.5/IAPMO Z124.
3) NSF 61.
4) NSF 372.
5) Uniform Plumbing Code, International Plumbing Code, and GREENGUARD Certified.

e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
f. Bowl(s) and Counter:

1) Material: Solid-surface or natural quartz surface.
2) Height to Rim: [**Standard**][**Accessible in accordance with ICC A117.1**]<**Insert height**>.
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Access Panel: **16-1/8-inch (410-mm)** access panel.
5) Number of Bowls or User Stations: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
6) Bowl Shape: [**Trough**][**Oval**][**Round**][**Square**][**Rectangular**]<**Insert shape**>.
7) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece, each bowl.

g. Pedestal: [**Not required**][**Required, with access panel**].
h. Faucets:

1) Type: Manufacturer's standard, chrome-plated solid brass, each bowl/station.
2) Control: [**Manual, push-button**][**Hardwired, control-voltage, sensor-actuated**][**Battery-powered, sensor-actuated**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve with check stops for each bowl or user station.

i. Mixer Point-of-Use:

1) Material: Solid bimetal (bronze, brass, stainless steel).
2) Security: Hot limit stop set to a maximum of **109.4 deg F (43 deg C)**.
3) Set: Screwdriver adjustment temperature dial with scale: Cold-hot.
4) Operation: Electronic "no-touch" hardwired powered.
5) Power: 120 V ac.

j. High-Speed, Warm-Air Hand Dryer:

1) Dryer Mounting: [**Surface mounted**][**, with low-profile design**].
2) Operation: Electronic-sensor activated with operation time of [**10 to 20**]<**Insert**

number(s)> seconds.
3) Cover Material and Finish: [**Chrome-plated steel**]<**Insert material and finish**>.
4) Electrical Requirements: [**115 V, 13 A, 1500 W**][**115 V, 15 A, 1725 W**][**115 V, 20 A, 2300 W**][**208-240 V, 9-10 A, 1900-2300 W**]<**Insert electrical requirements**>.

k. Liquid-Soap Dispensers: [**Hardwired, sensor actuated**][**Battery powered, sensor actuated**][**Not required**], for each bowl or user station.
l. Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**commercial floor-mounted carrier**]<**Insert type**>.
m. Supply Fittings:

1) Piping: **NPS 1/2 (DN 15)** copper tubing, each bowl.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

n. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**, each bowl.

E. Lavatory Faucets, Manually Operated :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**CHG; Component Hardware Group, Inc.**]
c. [**Chicago Faucets; Geberit Group**]
d. [**Delta Faucet Company**]
e. [**Elkay**]
f. [**Gerber Plumbing Fixtures LLC.**]
g. [**Just Manufacturing**]
h. [**Kohler Co**]
i. [**Krowne**]
j. [**Moen Incorporated**]
k. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
l. [**Speakman Company**]
m. [**T&S Brass and Bronze Works, Inc.**]
n. [**Whitehall Manufacturing; a division of Morris Group International**]
o. [**Zurn Industries, LLC**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**CHG; Component Hardware Group, Inc.**]
c. [**Chicago Faucets; Geberit Group**]
d. [**Delta Faucet Company**]
e. [**Elkay**]
f. [**Gerber Plumbing Fixtures LLC.**]
g. [**Just Manufacturing**]
h. [**Kohler Co**]

i. [**Krowne**]
j. [**Moen Incorporated**]
k. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
l. [**Speakman Company**]
m. [**T&S Brass and Bronze Works, Inc.**]
n. [**Whitehall Manufacturing; a division of Morris Group International**]
o. [**Zurn Industries, LLC**]
p. <**Insert manufacturer's name**>

3. Standard: ASME A112.18.1/CSA B125.1.
4. Operation Type: [**Single control, mixing**][**Single control, nonmixing**][**Two handle, mixing**], [**Commercial**][**General duty**].
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: [**Centerset**][**Widespread**][**Single hole**]<**Insert type**>.
7. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: [**Polished chrome plate**]<**Insert finish**>.
9. Maximum Flow Rate: [**0.5 gpm (1.9 L/min.)**]<**Insert value**>.
10. Maximum Flow: [**0.25 gal. (0.95 L)**]<**Insert value**> per metering cycle.
11. Mounting Type: [**Deck, exposed**][**Deck, concealed**][**Back/wall, exposed**][**Back/wall, concealed**].
12. Valve Handle(s): [**Single lever**][**Knob**][**Knob, nonmetallic**][**Cross, three arm**][**Cross, four arm**][**Wrist blade, 4 inches (102 mm)**][**Elbow, 6 inches (150 mm)**][**Push button**]<**Insert type**>.
13. Spout: [**Rigid**][**Swing**][**Rigid, gooseneck**][**Swivel, gooseneck**] type.
14. Spout Outlet: [**Aerator**][**Laminar flow**][**Spray**]<**Insert type**>.
15. Operation: [**Compression, manual**][**Noncompression, manual**].
16. Drain: [**Not part of faucet**]<**Insert type**>.

F. Lavatory Faucets, Automatically Operated :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Modern Technologies Corporation - AMTC**]
b. [**American Standard**]
c. [**Bradley Corporation**]
d. [**Chicago Faucets; Geberit Group**]
e. [**Delta Faucet Company**]
f. [**Elkay**]
g. [**Hydrotek International, Inc.**]
h. [**Just Manufacturing**]
i. [**Kohler Co**]
j. [**Krowne**]
k. [**Moen Incorporated**]
l. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
m. [**Sloan Valve Company**]
n. [**Speakman Company**]
o. [**Stern Engineering Ltd.**]
p. [**T&S Brass and Bronze Works, Inc.**]
q. [**TOTO USA, INC**]
r. [**Whitehall Manufacturing; a division of Morris Group International**]
s. [**Zurn Industries, LLC**]

t. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Advanced Modern Technologies Corporation - AMTC**]
   b. [**American Standard**]
   c. [**Bradley Corporation**]
   d. [**Chicago Faucets; Geberit Group**]
   e. [**Delta Faucet Company**]
   f. [**Elkay**]
   g. [**Hydrotek International, Inc.**]
   h. [**Just Manufacturing**]
   i. [**Kohler Co**]
   j. [**Krowne**]
   k. [**Moen Incorporated**]
   l. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   m. [**Sloan Valve Company**]
   n. [**Speakman Company**]
   o. [**Stern Engineering Ltd.**]
   p. [**T&S Brass and Bronze Works, Inc.**]
   q. [**TOTO USA, INC**]
   r. [**Whitehall Manufacturing; a division of Morris Group International**]
   s. [**Zurn Industries, LLC**]
   t. **<Insert manufacturer's name>**

3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
4. Operation Type: [**Battery powered**][**Hardwired**] electronic sensor operated, [**mixing**][**nonmixing**].
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
7. Body Type: [**Single hole**]<**Insert type**>.
8. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
9. Finish: [**Polished chrome plate**]<**Insert finish**>.
10. Maximum Flow Rate: [**0.5 gpm (1.9 L/min.)**]<**Insert value**>.
11. Mounting Type: [**Deck, concealed**][**Back/wall, concealed**]<**Insert type**>.
12. Spout: [**Rigid**][**Swing**][**Rigid, gooseneck**][**Swivel, gooseneck**] type.
13. Spout Outlet: [**Aerator**][**Laminar flow**][**Spray**]<**Insert type**>.
14. Drain: [**Not part of faucet**]<**Insert type**>.

G. Lavatory Supply Fittings:

1. NSF Standards: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.

   a. Risers Size: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**].

b. Risers Material: [**Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces**][**Chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel, flexible hose**].

H. Lavatory Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with **NPS 1-1/4 (DN 32)** offset and straight tailpiece.
3. Trap:

a. Size: [**NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32)**][**NPS 1-1/4 (DN 32)**].
b. Material:

1) Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**one-piece, cast-brass trap with swivel 0.029-inch- (0.73-mm-) thick tubular brass wall bend**]<**Insert trap type**>; and chrome-plated, brass or steel wall flange.
2) Stainless steel, two-piece trap and swivel elbow with **0.012-inch (0.30-mm-)** thick stainless steel tube to wall, and stainless steel wall flange.

2.3 COMMERCIAL SHOWERS

A. Showers, Individual:

1. Showers, Individual - Cast Polymer :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**International Marble Industries**]
2) [**Mincey Marble**]
3) [**MPL Co.**]
4) [**WingIts**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**International Marble Industries**]
2) [**Mincey Marble**]
3) [**MPL Co.**]
4) [**WingIts**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain cast-polymer showers from single manufacturer.
d. Description: Molded and pre-cut cast-polymer (cultured marble) shower surround panels and accessories consisting of various choices of panel styles, textures, colors, and configurations, assembled in place in accordance with approved Shop Drawings.
e. Fire Hazard Classification:

1) Standard, non-Class A.
2) Class A, tested to ASTM E84[**; with ASTM E84 compliance certified by an NRTL**].

f. Accessories Material: Cast polymer, except where stainless steel is indicated in "Accessories" Subparagraph.

g. Accessories:

1) Ledge.
2) Panel trim strips.
3) Seam cover.
4) Soap dish[**- wall mount with drainage ridges**].
5) Corner soap dish[**- smooth**][**- drainage ridges**][**- stainless steel grid**][**- stainless steel slotted plate**].
6) Shampoo shelf.
7) Accessory shelf.
8) Footrest[**- chrome, wall mount**][**- chrome, corner mount**][**- black, corner mount**].
9) Threshold.
10) Door jamb.
11) Niche.
12) Nook.
13) Window sill.

h. Shower Basin:

1) Coordinating cast-polymer (cultured marble) shower basin.
2) Standard: CSA B45.5/IAPMO Z124.
3) Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
4) Nominal Size and Shape: See Drawings.
5) Color: [**White**]<**Insert color**>.

a) Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet[**; lip drain outside shower in accordance with ADA-ABA**].

i. See Drawings for specific panels[**, shower basin,**] and accessory configurations.

2. Showers, Individual - FRP, One Piece without Top :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Florestone Products Co., Inc.**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Florestone Products Co., Inc.**]
2) <**Insert manufacturer's name**>

c. Source Limitations: Obtain FRP showers without top from single source from single manufacturer.

d. Description: FRP shower enclosure with valve and receptor[**and appurtenances**].

e. Standard: CSA B45.5/IAPMO Z124.
f. Style: [**Standard**][**Accessible in accordance with ICC A117**].
g. Shower Head and Shower Valve: <**Insert shower head and shower valve designation from "Shower Valve Assemblies" Paragraph**>.
h. Shower Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**34 by 34 inches (865 by 865 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**48 by 36 inches (1219 by 914 mm) rectangular**][**60 by 36 inches (1524 by 914 mm) rectangular**][**36 inches (914 mm) neo-corner (two walls)**][**36 inches (914 mm) neo-corner (four walls)**][**38 inches (965 mm) neo-corner (two walls)**][**38 inches (965 mm) neo-corner (four walls)**][**42 inches (1067 mm) neo-corner (two walls)**][**42 inches (1067 mm) neo-corner (four walls)**]<**Insert dimensions**>.
i. Color: [**White**]<**Insert color**>.
j. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet.
k. Shower Rod and Curtain: [**Not required**][**Required**].
l. Grab Bar: [**ASTM F446, mounted on support area back wall**][**Not required**].

3. Showers, Individual - FRP, Sectional without Top :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**E. L. Mustee & Sons, Inc**]
2) [**Florestone Products Co., Inc.**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**E. L. Mustee & Sons, Inc**]
2) [**Florestone Products Co., Inc.**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain FRP showers without top from single source from single manufacturer.
d. Description: FRP shower enclosure with valve and receptor[**and appurtenances**].
e. Standard: CSA B45.5/IAPMO Z124.
f. Style: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Shower Head and Shower Valve: <**Insert shower head and shower valve designation from "Shower Valve Assemblies" Paragraph**>.
h. Shower Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**34 by 34 inches (865 by 865 mm) square**][**36 by 36 inches (915 by 915 mm) square**][**48 by 36 inches (1219 by 914 mm) rectangular**][**60 by 36 inches (1524 by 915 mm) rectangular**][**36 inches (915 mm) neo-corner (two walls)**][**36 inches (914 mm) neo-corner (four walls)**][**38 inches (965 mm) neo-corner (two walls)**][**38 inches (965 mm) neo-corner (four walls)**][**42 inches (1067 mm) neo-corner (two walls)**][**42 inches (1067 mm) neo-corner (four walls)**]<**Insert dimensions**>.
i. Color: [**White**]<**Insert color**>.
j. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet.
k. Shower Rod and Curtain: [**Not required**][**Required**].
l. Grab Bar: [**ASTM F446, mounted on support area back wall**][**Not required**].

4. Showers, Individual - PMMA :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Aqua Bath Company, Inc.**]
      2) [**Aquarius Bathware; a Praxis Company**]
      3) [**Clarion Bathware**]
      4) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**Aqua Bath Company, Inc.**]
      2) [**Aquarius Bathware; a Praxis Company**]
      3) [**Clarion Bathware**]
      4) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain PMMA showers from single source from single manufacturer.
   d. Description: PMMA shower enclosure with valve and receptor[**and appurtenances**].
   e. Type: [**One-piece**][**Sectional**].
   f. Standard: CSA B45.5/IAPMO Z124.
   g. Style: [**Standard**][**Accessible in accordance with ICC A117.1**].
   h. Shower Head and Shower Valve: <**Insert shower head and shower valve designation from "Shower Valve Assemblies" Paragraph**>.
   i. Shower Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**34 by 34 inches (865 by 865 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**48 by 36 inches (1219 by 914 mm) rectangular**][**60 by 36 inches (1524 by 914 mm) rectangular**][**36 inches (914 mm) neo-corner (two walls)**][**36 inches (914 mm) neo-corner (four walls)**][**38 inches (965 mm) neo-corner (two walls)**][**38 inches (965 mm) neo-corner (four walls)**][**42 inches (1067 mm) neo-corner (two walls)**][**42 inches (1067 mm) neo-corner (four walls)**]<**Insert dimensions**>..
   j. Color: [**White**]<**Insert color**>.
   k. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet.
   l. Shower Rod and Curtain: [**Not required**][**Required**].
   m. Grab Bar: [**ASTM F446, mounted on support area back wall**][**Not required**].

5. Showers, Individual - Cabinet :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Comfort Designs Bathware**]
      2) [**E. L. Mustee & Sons, Inc**]
      3) [**Stern-Williams Products, LLC.**]
      4) [**Willoughby Industries, Inc.**]
      5) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Comfort Designs Bathware**]
2) [**E. L. Mustee & Sons, Inc**]
3) [**Stern-Williams Products, LLC.**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain cabinet showers from single source from single manufacturer.
d. Description: Factory-fabricated[**, accessible**] cabinet shower, with valve and receptor.
e. Nominal Size: [**30 by 30 inches (762 by 762 mm)**][**32 by 32 inches (813 by 813 mm)**][**36 by 36 inches (914 by 914 mm)**][**36 by 39 inches (914 by 990 mm)**][**45 by 39 inches (1145 by 990 mm)**]<**Insert dimensions**>.
f. Material: [**Steel**][**Stainless steel**][**Composite**][**Plastic**].
g. Access: [**Front**][**Corner**][**Front and rear**] access.
h. Color: [**Not applicable**]<**Insert color**>.
i. Accessibility Options: Grab bar and bench.
j. Shower Head and Shower Valve: [**Manufacturer's standard fitting assembly**]<**Insert shower head and shower valve designation from "Shower Valve Assemblies" Paragraph**>.
k. Supplies: **NPS 1/2 (DN 15)** copper tubing[**with ball or gate valves**].
l. Drain: Grid, **NPS 2 (DN 50)**.

B. Shower Valve Assemblies:

1. Shower Valve Assemblies - Single-Handle, Pressure-Balanced Mixing Valve with Head :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Chicago Faucets; Geberit Group**]
3) [**Kohler Co**]
4) [**Moen Incorporated**]
5) [**POWERS; A Watts Water Technologies Company**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Speakman Company**]
8) [**Symmons Industries, Inc**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Chicago Faucets; Geberit Group**]
3) [**Kohler Co**]
4) [**Moen Incorporated**]
5) [**POWERS; A Watts Water Technologies Company**]
6) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7) [**Speakman Company**]
8) [**Symmons Industries, Inc**]

9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
d. Description: Single-handle, [**accessible,**]pressure-balance mixing valve with hot- and cold-water indicators; [**diverting valve**]check stops; and [**hose with handheld shower head**][**hose with handheld shower head on sliding rod**] shower head.
e. Shower Valve:

1) Standards:

a) ASME A112.18.1/CSA B125.1.
b) ASSE 1016/ASME A112.1016/CSA B125.16.

2) Body Material: Solid brass.
3) Finish: [**Polished chrome plate**]<**Insert finish**>.
4) Mounting: [**Concealed**][**Exposed**].
5) Operation: Single-handle, [**push-pull**][**or**][**twist or rotate**][**or**][**metering**] control.
6) Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
7) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

f. Supply Connections: **NPS 1/2 (DN 15)**.
g. Shower Head:

1) Standard: ASME A112.18.1/CSA B125.1.
2) Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**]<**Insert type**>.
3) EPA WaterSense: Required.
4) Shower Head Maximum Flow Rate: [**1.5 gpm (5.7 L/min.)**][**1.75 gpm (6.6 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**].
5) Shower Head Material: Metallic with chrome-plated finish.
6) Spray Pattern: [**Adjustable**][**Fixed**].
7) Integral Volume Control: [**Not required**][**Required**].
8) Temperature Indicator: [**Integral with shower valve**][**Not required**].

2. Shower Valve Assemblies - Single-Handle, Thermostatic Mixing Valve with Head :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Lawler Manufacturing Company, Inc**]
2) [**POWERS; A Watts Water Technologies Company**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Lawler Manufacturing Company, Inc**]
2) [**POWERS; A Watts Water Technologies Company**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
d. Description: Single-handle, [**accessible,**]thermostatic mixing valve with hot- and cold-water indicators; [**diverting valve**]check stops; and [**hose with handheld shower head**][**hose with handheld shower head on sliding rod**] shower head.
e. Shower Valve:

1) Standards:

a) ASME A112.18.1/CSA B125.1.
b) ASSE 1016/ASME A112.1016/CSA B125.16.

2) Body Material: Solid brass.
3) Finish: [**Polished chrome plate**]<**Insert finish**>.
4) Mounting: [**Concealed**][**Exposed**].
5) Operation: Single-handle, [**push-pull**][**or**][**twist or rotate**] control.
6) Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
7) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

f. Supply Connections: **NPS 1/2 (DN 15)**.
g. Shower Head:

1) Standard: ASME A112.18.1/CSA B125.1.
2) Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**]<**Insert type**>.
3) EPA WaterSense: Required.
4) Shower Head Maximum Flow Rate: [**1.5 gpm (5.7 L/min.)**][**1.75 gpm (6.6 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**].
5) Shower Head Material: Metallic with chrome-plated finish.
6) Spray Pattern: [**Adjustable**][**Fixed**].
7) Integral Volume Control: [**Not required**][**Required**].
8) Temperature Indicator: [**Integral with valve**][**Not required**].

3. Shower Valve Assemblies - Single-Handle, Thermostatic/Pressure-Balancing Mixing Valve with Head :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Chicago Faucets; Geberit Group**]
2) [**Lawler Manufacturing Company, Inc**]
3) [**POWERS; A Watts Water Technologies Company**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Chicago Faucets; Geberit Group**]
2) [**Lawler Manufacturing Company, Inc**]
3) [**POWERS; A Watts Water Technologies Company**]

4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.

d. Description: Single-handle, [**accessible,**]thermostatic/pressure-balancing mixing valve with hot- and cold-water indicators; [**diverting valve**]check stops; and [**hose with handheld shower head**][**hose with handheld shower head on sliding rod**]shower head.

e. Shower Valve:

1) Standards:

a) ASME A112.18.1/CSA B125.1.
b) ASSE 1016/ASME A112.1016/CSA B125.16.

2) Body Material: Solid brass.
3) Finish: [**Polished chrome plate**]<**Insert finish**>.
4) Mounting: [**Concealed**][**Exposed**].
5) Operation: Single-handle, [**push-pull**][**or**][**twist or rotate**] control.
6) Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
7) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

f. Supply Connections: **NPS 1/2 (DN 15)**.

g. Shower Head:

1) Standard: ASME A112.18.1/CSA B125.1.
2) Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**]<**Insert type**>.
3) EPA WaterSense: Required.
4) Shower Head Maximum Flow Rate: [**1.5 gpm (5.7 L/min.)**][**1.75 gpm (6.6 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**].
5) Shower Head Material: Metallic with chrome-plated finish.
6) Spray Pattern: [**Adjustable**][**Fixed**].
7) Integral Volume Control: [**Not required**][**Required**].
8) Temperature Indicator: [**Integral with valve**][**Not required**].

C. Shower Basins:

1. Shower Basins - Cast Polymer :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**International Marble Industries**]
2) [**Mincey Marble**]
3) [**MPL Co.**]
4) [**Winglts**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**International Marble Industries**]
2) [**Mincey Marble**]
3) [**MPL Co.**]
4) [**Winglts**]
5) **<Insert manufacturer's name>**

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: Cast-polymer base for built-up-type shower fixture.
e. Standard: CSA B45.5/IAPMO Z124.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**34 by 34 inches (865 by 865 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 865 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 865 to 914 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]**<Insert dimensions>**.
h. Color: [**White**]**<Insert color>**.
i. Outlet: Drain with [**NPS 2 (DN 50)**]**<Insert pipe size>** outlet[**; lip drain outside shower in accordance with ADA-ABA**].

2. Shower Basins - FRP :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**E. L. Mustee & Sons, Inc**]
2) [**Sterling; a Kohler Company**]
3) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**E. L. Mustee & Sons, Inc**]
2) [**Sterling; a Kohler Company**]
3) **<Insert manufacturer's name>**

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: FRP base for built-up-type shower fixture.
e. Standard: CSA B45.5/IAPMO Z124.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**34 by 34 inches (865 by 865 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 864 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 864 to 914 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]**<Insert dimensions>**.
h. Color: [**White**]**<Insert color>**.
i. Outlet: Drain with [**NPS 2 (DN 50)**]**<Insert pipe size>** outlet[**; lip drain outside shower in accordance with ADA-ABA**].

3. Shower Basins - PMMA :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Florestone Products Co., Inc.**]
2) [**Jason International, Inc**]
3) [**MAAX**]
4) [**Royal Baths Manufacturing Co**]
5) [**Sterling; a Kohler Company**]
6) [**Swan Surfaces LLC (Swanstone)**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Florestone Products Co., Inc.**]
2) [**Jason International, Inc**]
3) [**MAAX**]
4) [**Royal Baths Manufacturing Co**]
5) [**Sterling; a Kohler Company**]
6) [**Swan Surfaces LLC (Swanstone)**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: PMMA base for built-up-type shower fixture.
e. Standard: CSA B45.5/IAPMO Z124.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 865 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 865 to 914 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]<**Insert dimensions**>.
h. Color: [**White**]<**Insert color**>.
i. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet[**; lip drain outside shower in accordance with ADA-ABA**].

4. Shower Basins - Molded Stone :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Bath Factory**]
2) [**Fiat Products**]
3) [**International Marble Industries**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Bath Factory**]
2) [**Fiat Products**]
3) [**International Marble Industries**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: Molded-stone base for built-up-type shower fixture.
e. Standard: CSA B45.8/IAPMO Z403.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 865 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 864 to 915 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]<**Insert dimensions**>.
h. Color: [**White**]<**Insert color**>.
i. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet[**; lip drain outside shower in accordance with ADA-ABA**].

5. Shower Basins - Precast Terrazzo :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Fiat Products**]
2) [**Florestone Products Co., Inc.**]
3) [**Stern-Williams Products, LLC.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Fiat Products**]
2) [**Florestone Products Co., Inc.**]
3) [**Stern-Williams Products, LLC.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: Precast-terrazzo base for built-up-type shower fixture.
e. Standard: CSA B45.8/IAPMO Z403.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 865 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 865 to 914 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]<**Insert dimensions**>.
h. Color: [**White**]<**Insert color**>.
i. Outlet: Drain with [**NPS 2 (DN 50)**]<**Insert pipe size**> outlet[**; lip drain outside shower in accordance with ADA-ABA**].

6. Shower Basins - Solid Surface :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]

2) [**Comfort Designs Bathware**]
3) [**inpro Corporation**]
4) [**International Marble Industries**]
5) [**Swan Surfaces LLC (Swanstone)**]
6) [**Tower Industries, Inc.**]
7) [**Willoughby Industries, Inc.**]
8) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**American Standard**]
2) [**Comfort Designs Bathware**]
3) [**inpro Corporation**]
4) [**International Marble Industries**]
5) [**Swan Surfaces LLC (Swanstone)**]
6) [**Tower Industries, Inc.**]
7) [**Willoughby Industries, Inc.**]
8) **<Insert manufacturer's name>**

c. Source Limitations: Obtain shower basins from single source from single manufacturer.
d. Description: Solid-surface base for built-up-type shower fixture.
e. Standard: CSA B45.5/IAPMO Z124.
f. Type: [**Standard**][**Accessible in accordance with ICC A117.1**].
g. Nominal Size and Shape: [**30 by 30 inches (762 by 762 mm) square**][**32 by 32 inches (813 by 813 mm) square**][**36 by 36 inches (914 by 914 mm) square**][**42 by 34 to 36 inches (1067 by 865 to 914 mm) rectangular**][**48 by 34 to 36 inches (1219 by 865 to 914 mm) rectangular**][**36 inches (914 mm) neo-corner**][**42 inches (1067 mm) neo-corner**]**<Insert dimensions>**.
h. Color: [**White**]**<Insert color>**.
i. Outlet: Drain with [**NPS 2 (DN 50)**]**<Insert pipe size>** outlet[**; lip drain outside shower in accordance with ADA-ABA**].

D. Showers, Group:

1. Showers, Group - Column :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]
4) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]
4) **<Insert manufacturer's name>**

c. Source Limitations: Obtain showers from single source from single manufacturer.
d. Description: Stainless steel, column shower fixture with individual nozzles.
e. Standards:

1) ASME A112.18.1/CSA B125.1.
2) ASSE 1016/ASME A112.1016/CSA B125.16.

f. Metal Nominal Thickness: [**0.050 inch (1.3 mm) minimum**][**0.063 inch (1.6 mm)**].
g. Number of Shower Nozzles: [**Two**][**Three**][**Four**][**Five**][**Six**].
h. Height to Nozzles: [**66 inches (1675 mm)**][**72 inches (1829 mm)**][**78 inches (1981 mm)**]<**Insert dimension**>.
i. Control:

1) [**Thermostatic**][**Pressure-balance**] mixing valve with hot and cold-water operation.
2) Thermostatic mixing valve with individual, tempered-water supply and push-button operation.

j. Shower-Arm, Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**] for each shower head.
k. EPA WaterSense: Required.
l. Liquid Soap Dispenser: [**Not required**][**Required**] for each shower head.
m. Soap Dish: [**Not required**][**Required**] for each shower head.
n. Mounting: Floor flange.
o. Supplies: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] copper tubing with shutoff valve from [**bottom**][**top**].
p. Shroud: [**Not required**][**Stainless steel of size to cover supplies and vent piping**].
q. Drain Fitting: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**] outlet with **NPS 2 (DN 50)** vent, integral with base of column.

2. Showers, Group - Wall Mounted :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Bradley Corporation**]
2) [**Willoughby Industries, Inc.**]
3) [**Zurn Industries, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Bradley Corporation**]
2) [**Willoughby Industries, Inc.**]
3) [**Zurn Industries, LLC**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain showers from single source from single manufacturer.
d. Description: Stainless steel, wall-mounted, surface-enclosure shower fixture with individual nozzles.
e. Standards:

1) ASME A112.18.1/CSA B125.1.
2) ASSE 1016/ASME A112.1016/CSA B125.16.

f. Metal Nominal Thickness: [**0.050 inch (1.3 mm) minimum**][**0.063 inch (1.6 mm)**].
g. Number of Shower Nozzles: [**Two**][**Three**].
h. Height to Nozzles: [**66 inches (1675 mm)**][**72 inches (1830 mm)**]<**Insert dimension**>.
i. Control:

1) [**Thermostatic**][**Pressure-balance**] valve with individual hot- and cold-water mixing-valve operation.
2) Thermostatic valve with individual, tempered-water supply and push-button operation.

j. Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**] for each shower head.
k. EPA WaterSense: Required.
l. Liquid Soap Dispenser: [**Not required**][**Required**] for each shower head.
m. Soap Dish: [**Not required**][**Required**] for each shower head.
n. Mounting: Wall bracket.
o. Supplies: **NPS 3/4 (DN 20)** copper tubing with valves.

E. Showers, Outdoor:

1. Showers, Outdoor - Plastic :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ShowerTower Inc**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ShowerTower Inc**]
2) <**Insert manufacturer's name**>

c. Source Limitations: Obtain showers from single source from single manufacturer.
d. Description: Freestanding, plastic group-shower fixture.
e. Number of Shower Stations: [**One**][**Two**][**Three**][**Four**]<**Insert number up to six**> with individual, self-closing control valve(s).
f. Nozzles: With adjustable spray pattern; fixed, on column.
g. Control: Push button and timer.
h. Maximum Flow: **2.5 gpm (9.5 L/min.)** for each shower head.
i. Number of Foot-Wash Stations: [**One**][**Two**]<**Insert number**> with individual, self-closing control valve(s).
j. Hose Bibb: [**Not**][**One**] required.
k. Control-Valve Mounting Height: [**50 inches (1270 mm)**][**48 inches (1219 mm)**].
l. Material: Cast-filled-polymer plastic.
m. Color: [**Gray**]<**Insert color**>.
n. Internal Piping: Factory installed.
o. Mounting: Base flange with bolt holes.

2. Showers, Outdoor - Steel :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Bradley Corporation**]
      2) [**Most Dependable Fountains, Inc.**]
      3) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**Bradley Corporation**]
      2) [**Most Dependable Fountains, Inc.**]
      3) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain showers from single source from single manufacturer.
   d. Description: Freestanding, steel, group-shower fixture.
   e. Number of Shower Stations: [**Four or more**]<**Insert value**> with individual, self-closing control valve(s).
   f. Nozzles: Fixed, on column.
   g. Control: Push button and timer.
   h. Maximum Flow: **2.5 gpm (9.5 L/min.)** for each shower head.
   i. Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**][**2.5 gpm (9.5 L/min.)**] for each shower head.
   j. EPA WaterSense: Required.
   k. Number of Foot-Wash Stations: [**Not required**][**One**][**Two**] with individual, self-closing control valve(s).
   l. Material: [**Powder-coated steel**][**Stainless steel**].
   m. Color: [**Blue**]<**Insert color**>.
   n. Internal Piping: Factory installed.
   o. Mounting: Base flange with bolt holes.

F. Grout:

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.4 COMMERCIAL SINKS

A. Service Sinks, Floor Mounted:

1. Service Sinks, Floor Mounted - Terrazzo :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Fiat Products**]
3) [**Florestone Products Co., Inc.**]
4) [**Stern-Williams Products, LLC.**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Fiat Products**]
3) [**Florestone Products Co., Inc.**]
4) [**Stern-Williams Products, LLC.**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Material: Marble chips cast in portland cement to produce a compressive strength of not less than **3000 psi (20.7 MPa)**, seven days after casting.
2) Shape: [**Square**][**Rectangular**][**Five sided**][**Radial front**]<**Insert shape**>.
3) Nominal Size: [**24 by 24 inches (610 by 610 mm)**][**30 by 30 inches (762 by 762 mm)**][**24 by 36 inches (610 by 914 mm)**][**32 by 32 inches (813 by 813 mm)**][**36 by 36 inches (914 by 914 mm)**]<**Insert dimensions**>.
4) Height: [**6 inches (150 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**][**12 inches (305 mm) with dropped front**]<**Insert dimensions**>.
5) Tiling Flange: [**Not required**][**On one side**][**On two sides**][**On three sides**].
6) Rim Guard: On [**front**][**all**] top surfaces.
7) Color: [**Not applicable**]<**Insert color**>.
8) Drain: Grid with [**NPS 2 (DN 50)**][**NPS 3 (DN 80)**] outlet.

e. Mounting: On floor and flush to wall.
f. Faucet: <**Insert service sink faucet designation from "Sink Faucets, Manually Operated" Paragraph**>.

2. Service Sinks, Floor Mounted - Plastic :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.

d. Fixture:

1) Standard: CSA B45.5/IAPMO Z124.
2) Material: [**Molded polymer**]<**Insert material**>.
3) Nominal Size: [**24 by 36 by 10 inches (610 by 914 mm by 255 mm)**][**36 by 36 by 10 inches (914 by 914 by 255 mm)**]<**Insert dimensions**>.
4) Rim Guard: On [**front**][**all**] top surfaces.
5) Color: [**Not applicable**]<**Insert color**>.
6) Drain: Grid with [**NPS 2 (DN 50)**][**NPS 3 (DN 80)**] outlet.

e. Mounting: On floor and flush to wall.
f. Faucet: <**Insert service sink faucet designation from "Sink Faucets, Manually Operated" Paragraph**>.

3. Service Sinks, Floor Mounted - Molded Stone :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Fiat Products**]
2) [**Florestone Products Co., Inc.**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Fiat Products**]
2) [**Florestone Products Co., Inc.**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Shape: [**Square**][**Rectangular**]<**Insert shape**>.
3) Nominal Size: [**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**]<**Insert dimensions**>.
4) Height: [**10 inches (255 mm)**]<**Insert dimensions**>.
5) Rim Guard: On [**front**][**all**] top surfaces.
6) Color: [**Not applicable**]<**Insert color**>.
7) Drain: Grid with [**NPS 2 (DN 50)**][**NPS 3 (DN 80)**] outlet.

e. Mounting: On floor and flush to wall.
f. Faucet: <**Insert service sink faucet designation from "Sink Faucets, Manually Operated" Paragraph**>.

4. Service Sinks, Floor Mounted - Enameled Cast Iron :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Commercial Enameling Company**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Commercial Enameling Company**]
2) [**Zurn Industries, LLC**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.1/CSA B45.2.
2) Style: With front apron and raised back.
3) Nominal Size: **28 by 28 inches (710 by 710 mm)**.
4) Color: White.
5) Drain: Grid with [**NPS 2 (DN 50)**][**NPS 3 (DN 80)**] outlet.
6) Rim Guard: Coated wire.

e. Faucet: <**Insert service sink faucet designation from "Sink Faucets, Manually Operated" Subparagraph**>.

B. Service Sinks, Trap Standard Mounted:

1. Service Sinks, Trap Standard Mounted - Enameled Cast Iron :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Commercial Enameling Company**]
3) [**Kohler Co**]
4) [**Zurn Industries, LLC**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Commercial Enameling Company**]
3) [**Kohler Co**]
4) [**Zurn Industries, LLC**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.1/CSA B45.2.
2) Type: Service sink with back.
3) Back: [**Two faucet holes**][**Plain**].

4) Nominal Size: [**22 by 18 inches (559 by 457 mm)**][**24 by 20 inches (610 by 508 mm)**].
5) Color: White.
6) Mounting: [**NPS 2 (DN 50)**][**NPS 3 (DN 80)**] P-trap standard with grid strainer inlet, cleanout, and floor flange.
7) Rim Guard: On front and sides.

e. Faucet: <**Insert service sink faucet designation from "Sink Faucets, Manually Operated" Paragraph**>.
f. Support: [**Sink carrier**]<**Insert carrier**>.

C. Kitchen/Utility Sinks:

1. Kitchen/Utility Sinks, Counter Mounted - Stainless Steel :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Tabco**]
2) [**Amerisink Inc.**]
3) [**Eagle Group**]
4) [**Elkay**]
5) [**Just Manufacturing**]
6) [**Krowne**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advance Tabco**]
2) [**Amerisink Inc.**]
3) [**Eagle Group**]
4) [**Elkay**]
5) [**Just Manufacturing**]
6) [**Krowne**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.3/CSA B45.4.
2) Type: Stainless steel, self-rimming, sound-deadened unit [**less ledge back**][**with ledge back**].
3) Number of Compartments: [**One**][**Two**][**Three**].
4) Overall Dimensions: <**Insert dimensions**>.
5) Material: 18 gauge, Type 304 stainless steel.
6) Compartment:

a) Dimensions: <**Insert dimensions**>.
b) Drain: [**Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain**][**Grid with NPS 2 (DN 50) tailpiece and twist drain**][**NPS 1-1/2 (DN 40) tailpiece with stopper**]<**Insert drain**>.

c) Drain Location: [**Centered in compartment**][**Near back of compartment**][**Near left side of compartment**][**Near right side of compartment**]<**Insert location**>.
d) Depth: [**Standard**][**Accessible in accordance with ICC A117.1**].

7) Each Compartment:

a) Dimensions: <**Insert dimensions**>.
b) Drains: [**Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain**][**Grid with NPS 2 (DN 50) tailpiece and twist drain**][**NPS 1-1/2 (DN 40) tailpiece with stopper**]<**Insert drain**>.
c) Drain Location: [**Centered in compartment**][**Near back of compartment**]<**Insert location**>.
d) Depth: [**Standard**][**Accessible in accordance with ICC A117.1**].

e. Faucet(s): <**Insert sink faucet designation from "Sink Faucets, Manually Operated" or "Sink Faucets, Automatically Operated" Subparagraph**>.

1) Number Required: [**One**][**Two**].
2) Mounting: On ledge.

f. Supply Fittings:

1) Standard: ASME A112.18.1/CSA B125.1.
2) Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

a) Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.
b) Risers: **NPS 1/2 (DN 15)**, [**chrome-plated, rigid-copper pipe**][**chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose**].

g. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap(s) Size: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
3) Trap(s) Material:

a) Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall**]<**Insert trap type**>; and chrome-plated brass or steel wall flange.
b) Stainless steel, two-piece trap and swivel elbow with **0.012-inch- (0.30-mm-)** thick stainless steel tube to wall; and stainless steel wall flange.

4) Continuous Waste:

a) Size: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
b) Material: Chrome-plated, 17-gauge brass tube.

h. Mounting: On counter with sealant.

2. Kitchen/Utility Sinks, Freestanding - Stainless Steel :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Advance Tabco**]
2) [**AERO Manufacturing Company**]
3) [**Amtekco Industries, Inc; a Wasserstrom Company**]
4) [**Eagle Group**]
5) [**Elkay**]
6) [**Griffin Products, Inc.**]
7) [**Just Manufacturing**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advance Tabco**]
2) [**AERO Manufacturing Company**]
3) [**Amtekco Industries, Inc; a Wasserstrom Company**]
4) [**Eagle Group**]
5) [**Elkay**]
6) [**Griffin Products, Inc.**]
7) [**Just Manufacturing**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standards:

a) ASME A112.19.3/CSA B45.4.
b) NSF 2.

2) Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
3) Number of Compartments: [**One**][**Two**][**Three**][**Four**].
4) Overall Dimensions: <**Insert dimensions**>.
5) Material: [**14**][**16**] gauge, Type 304 stainless steel.
6) Compartment:

a) Dimensions: <**Insert dimensions**>.
b) Drain: [**Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain**][**Grid with NPS 2 (DN 50) tailpiece and twist drain**][**NPS 1-1/2 (DN 40) tailpiece with stopper**]<**Insert drain**>.
c) Drain Location: [**Centered in compartment**][**Near back of compartment**][**Near left side of compartment**][**Near right side of compartment**]<**Insert location**>.

7) Each Compartment:

a) Dimensions: <**Insert dimensions**>.
b) Drains: [**Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain**][**Grid with NPS 2 (DN 50) tailpiece and twist drain**][**NPS 1-1/2 (DN 40) tailpiece with stopper**]<**Insert drain**>.
c) Drain Location: [**Centered in compartment**][**Near back of compartment**]<**Insert location**>.

8) Integral Drainboard(s): [**Not required**][**Both**][**Left**][**Right**] side(s).

a) Dimensions Each: [**Not applicable**]<**Insert dimensions**>.

e. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.

f. Faucet(s): <**Insert sink faucet designation from "Sink Faucets, Manually Operated" or "Sink Faucets, Automatically Operated" Paragraph**>.

1) Number Required: [**One**][**Two**].
2) Mounting: On backsplash.

g. Supply Fittings:

1) Standard: ASME A112.18.1/CSA B125.1.
2) Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

a) Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.
b) Risers: **NPS 1/2 (DN 15)**, [**chrome-plated, rigid-copper pipe**][**chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose**].

h. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap(s) Size: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
3) Trap(s) Material:

a) Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall**]<**Insert trap type**>; and chrome-plated brass or steel wall flange.
b) Stainless steel, two-piece trap and swivel elbow with **0.012-inch- (0.30-mm-)** thick stainless steel tube to wall; and stainless steel wall flange.

4) Continuous Waste:

a) Size: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
b) Material: Chrome-plated, 17-gauge brass tube.

D. Handwash Sinks:

1. Handwash Sinks - Stainless Steel :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advance Tabco**]
2) [**AERO Manufacturing Company**]
3) [**Amtekco Industries, Inc; a Wasserstrom Company**]
4) [**Eagle Group**]
5) [**Elkay**]
6) [**Griffin Products, Inc.**]
7) [**Just Manufacturing**]

8) [**Krowne**]
9) [**Sloan Valve Company**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advance Tabco**]
2) [**AERO Manufacturing Company**]
3) [**Amtekco Industries, Inc; a Wasserstrom Company**]
4) [**Eagle Group**]
5) [**Elkay**]
6) [**Griffin Products, Inc.**]
7) [**Just Manufacturing**]
8) [**Krowne**]
9) [**Sloan Valve Company**]
10) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standards:

a) ASME A112.19.3/CSA B45.4.
b) NSF 61.

2) Type: [**Wall-mounted**][**Pedestal-base**] stainless steel basin with radius corners, back for faucet, and support brackets.
3) Overall Dimensions: [**17 by 16 by 5 inches (430 by 406 by 127 mm)**]<**Insert dimensions**>.
4) Material: [**18 gauge**][**20 gauge**]<**Insert gauge**>, Type 304 stainless steel.

e. Faucet: <**Insert sink faucet designation from "Sink Faucets, Manually Operated" or "Sink Faucets, Automatically Operated" Paragraph**>.
f. Supply Fittings: Comply with requirements in "Sink Supply Fittings" Paragraph.
g. Waste Fittings: Comply with requirements in "Sink Waste Fittings" Paragraph.
h. Support: [**Sink carrier, framing affixed**][**Sink carrier, floor affixed with steel uprights**]<**Insert carrier**>.
i. Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

E. Sacristy Sinks:

1. Sacristy Sinks - Stainless Steel, Wall Hung :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Just Manufacturing**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Just Manufacturing**]
2) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.3/CSA B45.4.
2) Type: [**Single**][**Double**] bowl.
3) Material: Bowl and hinged cover, 18 gauge, Type 304, 18-8 stainless steel.
4) Nominal Size: Approximately [**20 by 23 inches (508 by 584 mm)**][**21 by 42 inches (533 by 1067 mm)**]<**Insert dimensions**>.
5) Cover: Hinged with lock on [**left**][**right**] bowl.

e. Faucet: <**Insert sink faucet designation from "Sink Faucets, Manually Operated" or "Sink Faucets, Automatically Operated" Paragraph**>.

1) Location: On [**left**][**right**] bowl.

f. Supply Fittings: Comply with requirements in "Sink Supply Fittings" Paragraph.
g. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Bowl:

a) Orientation: [**Left**][**Right**].
b) Drain: Cup with stopper and **NPS 1-1/2 (DN 40)** tailpiece.

3) Opposite Bowl:

a) Drain: Grid with stopper and **NPS 1-1/2 (DN 40)** tailpiece.

4) Trap Size: **NPS 1-1/2 (DN 40)**.
5) Trap Material: Comply with requirements in "Waste Fittings" Article.
6) Drain Piping: **NPS 1-1/2 (DN 40)** chrome-plated, tubular-brass direct waste without trap, separate waste piping, and wall flange.

2. Sacristy Sinks - Stainless Steel, Drop In, Two Bowl :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Just Manufacturing**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Just Manufacturing**]
2) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sinks from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.3/CSA B45.4.
2) Type: Self-rimming.
3) Material: Bowl and hinged cover, 18 gauge, Type 304, 18-8 stainless steel.
4) Nominal Size: Approximately [**17-1/2 by 37 inches (445 by 940 mm)**][**18 by 29 inches (460 by 740 mm)**][**22 by 28 inches (560 by 712 mm)**][**22 by 33 inches (560 by 0 mm)**][**22 by 42 inches (560 by 1070 mm)**]<**Insert dimensions**>.
5) Cover: Hinged with lock on [**left**][**right**] bowl.

e. Faucet: <**Insert sink faucet designation from "Sink Faucets, Manually Operated" or "Sink Faucets, Automatically Operated" Paragraph**>.

1) Location: On [**left**][**right**] bowl.

f. Supply Fittings: Comply with requirements in "Sink Supply Fittings" Paragraph.
g. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Bowl:

a) Orientation: [**Left**][**Right**].
b) Drain: Cup with stopper and **NPS 1-1/2 (DN 40)** tailpiece.

3) Opposite Bowl:

a) Drain: Grid with stopper and **NPS 1-1/2 (DN 40)** tailpiece.

4) Trap Size: **NPS 1-1/2 (DN 40)**.
5) Trap Material: Comply with requirements in "Waste Fittings" Article.
6) Drain Piping: **NPS 1-1/2 (DN 40)** chrome-plated, tubular-brass direct waste without trap, separate waste piping, and wall flange.

F. Shampoo Bowls:

1. Shampoo Bowls - Enameled Cast Iron :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Belvedere, LLC**]
2) [**Takara Belmont**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Belvedere, LLC**]
2) [**Takara Belmont**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain bowls from single source from single manufacturer.
d. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Bowl: Shaped for head rest.
3) Nominal Size: [**19 by 19 by 10 inches (480 by 480 by 254 mm)**]<**Insert dimensions**>.
4) Color: [**White**]<**Insert color**>.

e. Faucet: Manufacturer's standard with vacuum breaker complying with ASME A112.18.3 and with hose spray head.
f. Waste Fittings: Comply with requirements in "Sink Waste Fittings" Paragraph except as follows:

1) Drain: Cup type with hair basket and **NPS 1-1/2 (DN 40)** tailpiece.
2) Trap Size: **NPS 1-1/2 (DN 40)**.

g. Mounting Material: [**Bracket or devices for attaching to counter**][**Wall bracket**].

2. Shampoo Bowls - Plastic :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Buy-Rite Beauty**]
2) [**Collins**]
3) [**Pibbs Industries**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Buy-Rite Beauty**]
2) [**Collins**]
3) [**Pibbs Industries**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain bowls from single source from single manufacturer.
d. Fixture:

1) Standard: CSA B45.5/IAPMO Z124.
2) Material: [**ABS**][**FRP**][**PMMA**]<**Insert material**>.
3) Bowl: Shaped for head rest.
4) Nominal Size: [**19 by 19 by 10 inches (483 by 483 by 250 mm)**]<**Insert dimensions**>.
5) Color: [**White**]<**Insert color**>.
6) Mounting Material: [**Bracket or devices for attaching to counter**][**Wall bracket**].

e. Faucet: Manufacturer's standard with vacuum breaker complying with ASME A112.18.3 and with hose spray head.
f. Waste Fittings: Comply with requirements in "Sink Waste Fittings" Paragraph except as follows:

1) Drain: Cup type with hair basket and **NPS 1-1/2 (DN 40)** tailpiece.
2) Trap Size: **NPS 1-1/2 (DN 40)**.

3. Shampoo Bowls - Solid-Surface Material :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Willoughby Industries, Inc.**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Willoughby Industries, Inc.**]
2) <**Insert manufacturer's name**>

c. Source Limitations: Obtain bowls from single source from single manufacturer.
d. Fixture:

1) Material: Molded, cast polymer.
2) Bowl: Shaped for head rest.
3) Nominal Size: [**19 by 19 by 9 inches (483 by 483 by 230 mm)**][**22 by 18 by 9 inches (560 by 469 by 230 mm)**]<**Insert dimensions**>.
4) Color: [**Gray granite**][**Sandstone**][**White granite**]<**Insert color**>.
5) Mounting Material: [**Bracket or devices for attaching to counter**][**Wall bracket**].

e. Faucet: Manufacturer's standard with vacuum breaker complying with ASME A112.18.3 and with hose spray head.
f. Waste Fittings: Comply with requirements in "Sink Waste Fittings" Paragraph except as follows:

1) Drain: Cup type with hair basket and **NPS 1-1/2 (DN 40)** tailpiece.
2) Trap Size: **NPS 1-1/2 (DN 40)**.

G. Sink Faucets, Manually Operated:

1. Sink Faucets, Manually Operated : [**Single control, mixing**][**Single control, nonmixing**][**Two handle, mixing**][**Pre-rinse**]<**Insert type**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Central Brass Company; a Pioneer Industries, Inc. brand**]
3) [**Chicago Faucets; Geberit Group**]
4) [**Elkay**]
5) [**Gerber Plumbing Fixtures LLC.**]
6) [**Just Manufacturing**]

7) [**Kohler Co**]
8) [**Krowne**]
9) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
10) [**Speakman Company**]
11) [**T&S Brass and Bronze Works, Inc.**]
12) [**Wolverine Brass, Inc**]
13) [**Zurn Industries, LLC**]
14) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**American Standard**]
2) [**Central Brass Company; a Pioneer Industries, Inc. brand**]
3) [**Chicago Faucets; Geberit Group**]
4) [**Elkay**]
5) [**Gerber Plumbing Fixtures LLC.**]
6) [**Just Manufacturing**]
7) [**Kohler Co**]
8) [**Krowne**]
9) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
10) [**Speakman Company**]
11) [**T&S Brass and Bronze Works, Inc.**]
12) [**Wolverine Brass, Inc**]
13) [**Zurn Industries, LLC**]
14) **<Insert manufacturer's name>**

c. Source Limitations: Obtain sink faucets from single source from single manufacturer.
d. Standards:

1) ASME A112.18.1/CSA B125.1.
2) NSF 61.
3) NSF 372.

e. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
f. Body Type: [**Centerset**][**Widespread**][**Single hole**]**<Insert type>**.
g. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
h. Finish: [**Chrome plated**][**Polished chrome plate**]**<Insert finish>**.
i. Maximum Flow Rate: [**1.0 to 1.28 gpm (3.8 to 4.8 L/min)**][**1.5 gpm (5.7 L/min)**]**<Insert value>**.
j. Mounting Type: [**Deck, concealed**][**Deck, exposed**][**Back/wall, exposed**].
k. Valve Handle(s): [**Lever**][**Cross, four arm**][**4-inch (102-mm) wrist blade**][**6-inch (150-mm) wrist blade**][**Not applicable**]**<Insert handles>**.
l. Spout Type: [**Rigid**][**Rigid with wall brace**][**Swing**][**Rigid, gooseneck**][**Swivel, gooseneck**]**<Insert type>**.
m. Vacuum Breaker: [**Required**][**Not required**] for hose outlet.
n. Spout Outlet: [**Aerator**][**Laminar flow**][**Hose thread in accordance with ASME B1.20.7**][**Plain end**][**Spray**]**<Insert type>**.
o. Pre-Rinse Unit:

1) Style: [**Flexible hose**][**Rigid**][**Combination rigid/flexible**]**<Insert type>**.
2) Riser: [**18-inch (457-mm) rigid riser**]**<Insert type>**.
3) Hose: [**44-inch (1117-mm) flexible stainless steel with heat-resistant**

handle]<**Insert type**>.
4) Spray valve: <**Insert type**>.
5) Wall bracket.

2. Sink Faucets, Manually Operated - Service Sink :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Central Brass Company; a Pioneer Industries, Inc. brand**]
3) [**Chicago Faucets; Geberit Group**]
4) [**Fiat Products**]
5) [**Just Manufacturing**]
6) [**Kohler Co**]
7) [**Krowne**]
8) [**Speakman Company**]
9) [**Stern-Williams Products, LLC.**]
10) [**T&S Brass and Bronze Works, Inc.**]
11) [**Zurn Industries, LLC**]
12) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Central Brass Company; a Pioneer Industries, Inc. brand**]
3) [**Chicago Faucets; Geberit Group**]
4) [**Fiat Products**]
5) [**Just Manufacturing**]
6) [**Kohler Co**]
7) [**Krowne**]
8) [**Speakman Company**]
9) [**Stern-Williams Products, LLC.**]
10) [**T&S Brass and Bronze Works, Inc.**]
11) [**Zurn Industries, LLC**]
12) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sink faucets from single source from single manufacturer.
d. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, **3/4-inch (20-mm)** hose thread end, integral vacuum breaker, inlets **8 inches (203 mm)** o.c., and two-handle mixing.
e. Faucet:

1) Standards:

a) ASME A112.18.1/CSA B125.1.
b) NSF 61 and NSF 372.
c) ICC A117.1.
d) ASSE 1001 (VB).

2) Finish: [**Rough chrome plated**][**Polished chrome plated**]<**Insert finish**>.

3) Handles: [**Lever**][**6-inch (152-mm) wrist blade**][**4-inch (102-mm) wrist blade**][**four arms**]<**Insert type**>.
4) Cartridges: [**One-fourth turn compression**][**Ceramic**]<**Insert type**>.
5) Brace: [**Adjustable top brace**][**Adjustable bottom brace**]<**Insert type**>.

f. Vacuum Breaker: [**Required**][**Not required**] for hose outlet.
g. Spout Outlet: [**Aerator**][**Laminar flow**][**Hose thread in accordance with ASME B1.20.7**][**Plain end**][**Spray**]<**Insert type**>.

H. Sink Faucets, Automatically Operated:

1. Sink Faucets, Automatically Operated : [**Battery powered,**][**Hardwired,**] electronic sensor operated, [**mixing**][**nonmixing**].

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Chicago Faucets; Geberit Group**]
2) [**Hydrotek International, Inc.**]
3) [**Kohler Co**]
4) [**Krowne**]
5) [**Moen Incorporated**]
6) [**Sloan Valve Company**]
7) [**Speakman Company**]
8) [**T&S Brass and Bronze Works, Inc.**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Chicago Faucets; Geberit Group**]
2) [**Hydrotek International, Inc.**]
3) [**Kohler Co**]
4) [**Krowne**]
5) [**Moen Incorporated**]
6) [**Sloan Valve Company**]
7) [**Speakman Company**]
8) [**T&S Brass and Bronze Works, Inc.**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Source Limitations: Obtain sink faucets from single source from single manufacturer.
d. Standards:

1) ASME A112.18.1/CSA B125.1.
2) UL 1951.

e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
f. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
g. Body Type: [**Centerset**][**Single hole**]<**Insert type**>.

h. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
i. Finish: [**Chrome plated**][**Polished chrome1 plate**]<**Insert finish**>.
j. Maximum Flow Rate: [**0.5 gpm (1.9 L/min)**]<**Insert value**>.
k. Mounting Type: [**Deck**][**Back/wall**].
l. Spout Type: [**Rigid**][**Swing**][**Rigid, gooseneck**][**Swivel, gooseneck**]<**Insert type**>.
m. Spout Outlet: [**Aerator**][**Laminar flow**][**Spray**]<**Insert type**>.
n. Thermostatic Mixing Valve: [**Above deck,**][**Below deck,**][**Single temperature**][**adjustable temperature manual side handle, with hot/cold water indicators**], with check valves.
o. Control Module: [**Above deck,**][**Below deck,**] water-resistant module with internal flow setting switches.
p. Drain: [**Not part of faucet**]<**Insert type**>.

I. Sink Supply Fittings:

1. NSF Standards: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.

a. Risers Sizes: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**].
b. Risers Material: [**Chrome-plated, rigid-copper pipe**][**Chrome-plated, soft-copper flexible tube**][**ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose**].

J. Sink Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with **NPS 1-1/2 (DN 40)** offset and straight tailpiece.
3. Trap:

a. Size: **NPS 1-1/2 (DN 40)**.
b. Material: Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall**][**one-piece, cast-brass trap with swivel 17-gauge tubular brass wall bend**]<**Insert trap type**>; and chrome-plated brass or steel wall flange.

K. Grout:

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.5 COMMERCIAL URINALS

A. Urinals, Stall:

1. Urinals, Stall - Washout Type :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Type: [**Straight or sloped**]<**Insert type**> front.
4) Seam Covers: For [**21-inch (533-mm)**][**24-inch (610-mm)**] urinal centers.
5) Strainer: Separate; removable.
6) Water Consumption: [**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].
7) Spud Size and Location: **NPS 3/4 (DN 20)**; [**top**][**back**].
8) Outlet Size and Location: **NPS 2 (DN 50)**; bottom for separate trap.
9) Color: [**White**]<**Insert color**>.

d. Flushometer Valve: <**Insert urinal flushometer-valve designation from "Flushometer Valves" Article**>.

B. Urinals, Wall Hung:

1. Urinals, Wall Hung - Back Outlet, Blowout :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Strainer or Trapway: [**Manufacturer's standard strainer**][**Open trapway**] with integral trap.
4) Water Consumption: [**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].
5) Spud Size and Location: **NPS 1-1/4 (DN 32)**; [**back**][**top**].
6) Outlet Size and Location: **NPS 2 (DN 50)**; back.
7) Color: [**White**]<**Insert color**>.

d. Flushometer Valve: <**Insert urinal-flushometer-valve designation from "Flushometer Valves" Article**>.
e. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
2) Size: **NPS 2 (DN 50)**.

f. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
g. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

2. Urinals, Wall Hung - Back Outlet, Siphon Jet :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Duravit USA, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
8) [**Zurn Industries, LLC**]
9) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Duravit USA, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]

8) [**Zurn Industries, LLC**]
9) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Type: Siphon jet[**with extended shields**].
4) Strainer or Trapway: [**Manufacturer's standard strainer**]<**Insert strainer**> with integral trap.
5) Water Consumption: [**0.125 gpf (0.5 Lpf)**][**0.25 gpf (1.0 Lpf)**][**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].
6) Spud Size and Location: **NPS 3/4 (DN 20)**; [**back**][**top**].
7) Outlet Size and Location: **NPS 2 (DN 50)**; back.
8) Color: [**White**]<**Insert color**>.

d. Flushometer Valve: <**Insert urinal flushometer-valve designation from "Flushometer Valves" Article**>.
e. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
2) Size: **NPS 2 (DN 50)**.

f. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
g. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

3. Urinals, Wall Hung - Back Outlet, Washout :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]

3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Type: Washout with extended shields.
4) Strainer or Trapway: [**Manufacturer's standard strainer**]<**Insert strainer**> with integral trap.
5) Water Consumption: [**0.125 gpf (0.5 Lpf)**][**0.25 gpf (1.0 Lpf)**][**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].
6) Spud Size and Location: **NPS 3/4 (DN 20)**, [**back**][**top**].
7) Outlet Size and Location: **NPS 2 (DN 50)**, back.
8) Color: [**White**]<**Insert color**>.

d. Flushometer Valve: <**Insert urinal flushometer-valve designation from "Flushometer Valves" Article**>.
e. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
2) Size: **NPS 2 (DN 50)**.

f. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
g. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

4. Urinals, Wall Hung - Bottom Outlet, Washout :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**ProFlo; a Ferguson Enterprises, Inc. brand**]

3) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Drain: Separate removable chrome-plated dome strainer with chrome-plated, **NPS 1-1/2 (DN 40)** tailpiece.
4) Strainer or Trapway: Manufacturer's standard strainer and **NPS 1-1/2 (DN 40)** tailpiece.
5) Inlet Spud Size and Location: **NPS 3/4 (DN 20)**; top.
6) Outlet Size and Location: **NPS 1-1/2 (DN 40)**; bottom.
7) Color: [**White**]<**Insert color**>.
8) Water Consumption: [**0.125 gpf (0.5 Lpf)**][**0.25 gpf (1.0 Lpf)**][**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].

d. Flushometer Valve: <**Insert urinal flushometer-valve designation from "Flushometer Valves" Article**>.
e. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap:

a) Size: **NPS 1-1/2 (DN 50)**.
b) Material, Chrome Plated: [**Two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**][**one-piece, cast-brass trap with swivel 0.029-inch- (73-mm-) thick tubular brass wall bend**]<**Insert trap type**>; and chrome-plated brass or steel wall flange.
c) Material, Stainless Steel: Two-piece trap and swivel elbow with **0.012-inch- (0.30-mm-)** thick, stainless steel tube to wall; and stainless steel wall flange.

f. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with hanger and bearing plates.
g. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

5. Urinals, Wall Hung - Back Outlet, Washdown :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Sloan Valve Company**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Sloan Valve Company**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standards:

a) ASME A112.19.2/CSA B45.1.
b) ASME A112.19.5/CSA B45.15.

2) Material: Vitreous china.
3) Type: Washdown with extended shields.
4) Strainer or Trapway: [**Manufacturer's standard strainer**]<**Insert strainer**> with integral trap.
5) Water Consumption: [**0.125 gpf (0.5 Lpf)**][**0.25 gpf (1.0 Lpf)**][**0.5 gpf (1.9 Lpf)**][**1.0 gpf (3.8 Lpf)**].
6) Spud Size and Location: **NPS 3/4 (DN 20)**, [**back**][**top**].
7) Outlet Size and Location: **NPS 2 (DN 50)**, back.
8) Color: [**White**]<**Insert color**>.

d. Flushometer Valve: <**Insert urinal flushometer-valve designation from "Flushometer Valves" Article**>.
e. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
2) Size: **NPS 2 (DN 50)**.

f. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
g. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

C. Urinals, Waterless:

1. Urinals, Waterless - Vitreous China, Wall Hung, Back Outlet :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Duravit USA, Inc**]
2) [**Falcon Waterfree Technologies**]
3) [**Kohler Co**]
4) [**Sloan Valve Company**]
5) [**Waterless Co**]
6) [**Zero Flush**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Duravit USA, Inc**]

2) [**Falcon Waterfree Technologies**]
3) [**Kohler Co**]
4) [**Sloan Valve Company**]
5) [**Waterless Co**]
6) [**Zero Flush**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1, except without water supply.
2) Designed for liquid-trap-seal operation.
3) Trap-Seal Method: Proprietary cartridge with liquid seal.
4) Outlet Size and Location: [**NPS 2 (DN 50)**]<**Insert pipe size**> flange; back.
5) Trap-Sealing Liquid: Proprietary.
6) Color: [**White**]<**Insert color**>.

d. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for transition coupling, trap, and waste pipe.
2) Size: [**NPS 2 (DN 50)**]<**Insert pipe size**>.

e. Support: [**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

f. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

2. Urinals, Waterless - Plastic, Wall Hung, Back Outlet :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Waterless Co**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Waterless Co**]
2) <**Insert manufacturer's name**>

c. Fixture:

1) Standard: CSA B45.5/IAPMO Z124, except without water supply.
2) Designed for liquid-trap-seal operation.
3) Material: [**FRP**]<**Insert material**>.
4) Trap-Seal Method: Proprietary cartridge or trap system.
5) Outlet Size and Location: **NPS 2 (DN 50)**; back. Include transition coupling.
6) Trap-Sealing Liquid: Proprietary.
7) Color: [**White**]<**Insert color**>.

d. Waste Fitting:

1) Standard: ASME A112.18.2/CSA B125.2 for transition coupling, trap, and waste pipe.
2) Size: [**NPS 2 (DN 50)**]<**Insert pipe size**>.

e. Support: [**Metal plate in wall**][**Wood blocking in wall**][**Urinal carrier, floor affixed with steel uprights**]<**Insert carrier**>[**with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture**].
f. Urinal Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

2.6 COMMERCIAL WATER CLOSETS

A. Water Closets, Floor Mounted:

1. Water Closets, Floor Mounted - Bottom Outlet, Top Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**Sloan Valve Company**]
8) [**TOTO USA, INC**]
9) [**Zurn Industries, LLC**]
10) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.

4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; top.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.

2. Water Closets, Floor Mounted - Bottom Outlet, Back Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
5) [**Sloan Valve Company**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
5) [**Sloan Valve Company**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.
4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; back.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.

3. Water Closets, Floor Mounted - Bottom Outlet, Close-Coupled Flushometer Tank :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Kohler Co**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Briggs Plumbing Products, Inc**]
3) [**Kohler Co**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer tank, [**gravity**][**pressure assisted**].
4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Color: [**White**]<**Insert color**>.

f. Toilet Seat: <**Insert toilet-seat designation**>.

4. Water Closets, Floor Mounted - Bottom Outlet, Juvenile :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]

2) [**Kohler Co**]
3) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.
4) Height: [**10 inches (254 mm)**][**14 inches (356 mm)**]<**Insert height**>.
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; top.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.

5. Water Closets, Floor Mounted - Back Outlet, Top Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
5) [**Sloan Valve Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
5) [**Sloan Valve Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.

4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; top.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.
h. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

6. Water Closets, Floor Mounted - Back Outlet, Back Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Kohler Co**]
2) [**Sloan Valve Company**]
3) [**Zurn Industries, LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Kohler Co**]
2) [**Sloan Valve Company**]
3) [**Zurn Industries, LLC**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.
4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; back.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.
h. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

7. Water Closets, Floor Mounted - Back Outlet, Close-Coupled Flushometer Tank :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**Mansfield Plumbing Products LLC**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer tank, [**gravity**][**pressure assisted**].
4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**] per flush.
7) Color: [**White**]<**Insert color**>.

f. Toilet Seat: <**Insert toilet-seat designation**>.
g. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

B. Water Closets, Wall Mounted:

1. Water Closets, Wall Mounted - Top Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
8) [**Sloan Valve Company**]
9) [**TOTO USA, INC**]
10) [**Zurn Industries, LLC**]
11) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Briggs Plumbing Products, Inc**]
4) [**Gerber Plumbing Fixtures LLC.**]
5) [**Kohler Co**]
6) [**Mansfield Plumbing Products LLC**]
7) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
8) [**Sloan Valve Company**]
9) [**TOTO USA, INC**]
10) [**Zurn Industries, LLC**]
11) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.
4) Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; top.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.
h. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

2. Water Closets, Wall Mounted - Back Spud :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
4) [**Sloan Valve Company**]
5) [**TOTO USA, INC**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Kohler Co**]
3) [**ProFlo; a Ferguson Enterprises, Inc. brand**]
4) [**Sloan Valve Company**]
5) [**TOTO USA, INC**]

6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer valve.
4) Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**] per flush.
7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; back.
8) Color: [**White**]<**Insert color**>.

f. Flushometer Valve: <**Insert flushometer-valve designation**>.
g. Toilet Seat: <**Insert toilet-seat designation**>.
h. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

3. Water Closets, Wall Mounted - Back Outlet, Close-Coupled Flushometer Tank :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Mansfield Plumbing Products LLC**]
3) [**TOTO USA, INC**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Mansfield Plumbing Products LLC**]
3) [**TOTO USA, INC**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain water closets from single source from single manufacturer.
d. Standard: ASME A112.19.2/CSA B45.1.
e. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.
3) Style: Flushometer tank, [**gravity**][**pressure assisted**].
4) Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
5) Rim Contour: Elongated.
6) Water Consumption: [**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**] per flush.
7) Color: [**White**]<**Insert color**>.

f. Toilet Seat: <**Insert toilet-seat designation**>.

g. Support: [**Water-closet carrier, floor affixed**]<**Insert carrier**>.

2.7 COMMERCIAL WASH FOUNTAINS

A. Wash Fountains, Circular Receptor:

1. Wash Fountains, Circular Receptor - Solid Surface :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Aqua Design Manufacturing**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Aqua Design Manufacturing**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) CSA B45.5/IAPMO Z124.
3) ASME A112.18.1/CSA B125.1.

e. Receptor:

1) Nominal Diameter: [**36 inches (914 mm)**][**or**][**39 inches (990 mm)**][**54 inches (1370 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with [**NPS 2 (DN 50)**]<**Insert pipe size**> tailpiece.

f. Spray Head:

1) Material: Stainless steel.
2) Number of User Stations: <**Insert number**>.
3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**] actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.
h. Pedestal: [**Manufacturer's standard**][**Painted or coated steel**][**Stainless steel**] with access panel.

i. Supply Fittings:

1) Piping: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From [**bottom**][**top**].

j. Waste Fittings:

1) Trap and Drain Piping: [**NPS 2 (DN 50)**]<**Insert size**>.
2) Vent Piping: [**Not required**][**NPS 1-1/2 (DN 40) to ceiling**].

k. Shroud: [**Not required**][**Stainless steel of size to cover supply and vent piping**].
l. Mounting: Manufacturer's standard floor bracket.

2. Wash Fountains, Circular Receptor - Stainless Steel :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1
3) ASME A112.19.3/CSA B45.4.

e. Receptor:

1) Nominal Diameter: [**36 inches (914 mm)**][**or**][**39 inches (990 mm)**][**42 inches (1067 mm)**][**54 inches (1372 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with [**NPS 2 (DN 50)**]<**Insert pipe size**> tailpiece.

f. Spray Head:

1) Material: Stainless steel.
2) Number of User Stations: <**Insert number**>.

3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**] actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**> for each user station.
h. Pedestal: Stainless steel with access panel.
i. Supply Fittings:

1) Piping: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From [**bottom**][**top**].

j. Waste Fittings:

1) Trap and Drain Piping: [**NPS 2 (DN 50)**]<**Insert size**>.
2) Vent Piping: [**Not required**][**NPS 1-1/2 (DN 40) to ceiling**].

k. Shroud: [**Not required**][**Stainless steel of size to cover supply and vent piping**].
l. Mounting: Manufacturer's standard floor bracket.

B. Wash Fountains, Semicircular Receptor:

1. Wash Fountains, Semicircular Receptor - Solid Surface, Floor or Wall Mounted :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Sloan Valve Company**]
5) [**Willoughby Industries, Inc.**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Sloan Valve Company**]
5) [**Willoughby Industries, Inc.**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1.
3) CSA B45.5/IAPMO Z124.

e. Receptor:

1) Nominal Diameter: [**36 inches (914 mm)**][**or**][**39 inches (990 mm)**][**46 inches (1168 mm)**][**54 inches (1372 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] tailpiece.

f. Spray Head:

1) Material: Stainless steel or integral part of receptor back.
2) Number of User Stations: <**Insert number**>.
3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.

h. Supply Fittings:

1) Piping: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From [**bottom**][**top**][**wall**].

i. Waste Fittings:

1) Trap and Drain Piping: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
2) Vent Piping: [**Not required**][**NPS 1-1/2 (DN 40) to ceiling**].

j. Shroud: [**Not required**][**Stainless steel of size to cover supply and vent piping**].

k. Wall Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**wash fountain carrier**]<**Insert type**>.

l. Floor Mounting: Manufacturer's floor bracket and wall bracket attached to [**reinforcement in**][**concrete or block**] wall.

2. Wash Fountains, Semicircular Receptor - Stainless Steel, Floor or Wall Mounted :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]

5) **<Insert manufacturer's name>**

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1.
3) ASME A112.19.3/CSA B45.4.

e. Receptor:

1) Nominal Diameter: [**36 inches (914 mm)**][**or**][**39 inches (990 mm)**][**42 inches (1067 mm)**][**54 inches (1372 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] tailpiece.

f. Spray Head:

1) Material: Stainless steel or integral part of receptor back.
2) Number of User Stations: <**Insert number**>.
3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.
h. Supply Fittings:

1) Piping: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From [**bottom**][**top**][**wall**].

i. Waste Fittings:

1) Trap and Drain Piping: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**].
2) Vent Piping: [**Not required**][**NPS 1-1/2 (DN 40) to ceiling**].

j. Shroud: [**Not required**][**Stainless steel of size to cover supply and vent piping**].
k. Wall Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**wash fountain carrier**]<**Insert type**>.
l. Floor Mounting: Manufacturer's floor bracket and wall bracket attached to [**reinforcement in**][**concrete or block**] wall.

C. Wash Fountains, Corner Receptor:

1. Wash Fountains, Corner Receptor - Precast Terrazzo :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]

3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1.
3) CSA B45.8/IAPMO Z403.

e. Receptor:

1) Nominal Side Width: [**27 inches (685 mm)**][**37 inches (940 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece.

f. Spray Head:

1) Material: Stainless steel or integral part of receptor back.
2) Number of User Stations: <**Insert number**>.
3) Control: [**Foot-control**][**Pneumatic push-button**][**Infrared sensor**][**Low-voltage, mechanical metering**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.
h. Supply Fittings:

1) Piping: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

i. Waste Fittings:

1) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**.

j. Mounting: Manufacturer's standard floor and wall bracket.

2. Wash Fountains, Corner Receptor - Solid Surface, Floor or Wall Mounted :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]

4) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) [**Willoughby Industries, Inc.**]
4) **<Insert manufacturer's name>**

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1.
3) CSA B45.5/IAPMO Z124.

e. Receptor:

1) Nominal Side Width: [**27 inches (685 mm)**][**37 inches (940 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece.

f. Spray Head:

1) Material: Stainless steel or integral part of receptor back.
2) Number of User Stations: **<Insert number>**.
3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.
h. Supply Fittings:

1) Piping: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

i. Waste Fittings:

1) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**.

j. Wall Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**wash fountain carrier**]<**Insert type**>.
k. Floor Mounting: Manufacturer's floor bracket and wall bracket attached to [**reinforcement in**][**concrete or block**] wall.

3. Wash Fountains, Corner Receptor - Stainless Steel, Floor or Wall Mounted :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Bradley Corporation**]
3) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) IAPMO IGC 156.
2) ASME A112.18.1/CSA B125.1
3) ASME A112.19.3/CSA 45.4.

e. Receptor:

1) Nominal Side Width: [**37 inches (940 mm)**][**38 inches (965 mm)**][**44 inches (1118 mm)**].
2) Height to Rim: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece.

f. Spray Head:

1) Material: Stainless steel or integral part of receptor back.
2) Number of User Stations: <**Insert number**>.
3) Control: [**Collective,**][**Individual,**][**foot-control**][**pneumatic push-button**][**infrared sensor**][**low-voltage, mechanical metering**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops.

g. Soap Dispensers: [**Not required**][**Bracket only**][**Foam**][**Powdered**][**Liquid**]<**Insert type**>, for each user station.
h. Supply Fittings:

1) Piping: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**] copper tubing.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

i. Waste Fittings:

1) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**.

j. Wall Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**wash fountain carrier**]<**Insert type**>.
k. Floor Mounting: Manufacturer's floor bracket and wall bracket attached to [**reinforcement in**][**concrete or block**] wall.

D. Wash Fountains, Linear Receptor:

1. Wash Fountains, Linear Receptor - Solid Surface :

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Acorn Engineering Company; a Division of Morris Group International**]
      2) [**Aqua Design Manufacturing**]
      3) [**Bradley Corporation**]
      4) [**Sloan Valve Company**]
      5) [**Willoughby Industries, Inc.**]
      6) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**Acorn Engineering Company; a Division of Morris Group International**]
      2) [**Aqua Design Manufacturing**]
      3) [**Bradley Corporation**]
      4) [**Sloan Valve Company**]
      5) [**Willoughby Industries, Inc.**]
      6) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
   d. Standards:

      1) ASME A112.18.1/CSA B125.1.
      2) CSA B45.5/IAPMO Z124.
      3) NSF 61.
      4) NSF 372.
      5) Uniform Plumbing Code, International Plumbing Code, and UL GREENGUARD certified.

   e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   f. Bowl(s) and Counter:

      1) Material: Solid-surface or natural quartz surface.
      2) Height to Rim: [**Standard**][**Accessible in accordance with ICC A117.1**]<**Insert height**>.
      3) Color or Finish: [**Not applicable**]<**Insert if required**>.
      4) Number of Bowls or User Stations: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
      5) Bowl Shape: [**Trough**][**Edge**][**Oval**][**Round**][**Square**][**Rectangular**]<**Insert shape**>.
      6) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece, each bowl.

   g. Apron: [**Not required**][**Required, with access panel**].
   h. Faucets:

      1) Type: Manufacturer's standard, chrome-plated solid brass, each bowl/station.
      2) Control: [**Manual, push-button**][**Hardwired, control-voltage, sensor-actuated**][**Battery-powered, sensor-actuated**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops for each bowl or user station.

i. Soap Dispensers: [**Not required**][**Bracket only**][**Manual**][**Hardwired, control-voltage, sensor-actuated**][**Battery-powered, sensor-actuated**][**, liquid**][**, foam**][**, powdered**]<**Insert type**> dispenser for each user station.
j. Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**commercial floor-mounted carrier**]<**Insert type**>.
k. Supply Fittings:

1) Piping: **NPS 1/2 (DN 15)** copper tubing, each bowl.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

l. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**, each bowl.

2. Wash Fountains, Linear Receptor - Stainless Steel :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Acorn Engineering Company; a Division of Morris Group International**]
2) [**Aqua Design Manufacturing**]
3) [**Bradley Corporation**]
4) [**Willoughby Industries, Inc.**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain wash fountains from single source from single manufacturer.
d. Standards:

1) ASME A112.18.1/CSA B125.1.
2) ASME A112.19.3/CSA B45.4.
3) NSF 61.
4) NSF 372.
5) Uniform Plumbing Code, International Plumbing Code, and UL GREENGUARD certified.

e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
f. Bowl(s) and Counter:

1) Material: Stainless steel.
2) Height to Rim: [**Standard**][**Accessible in accordance with ICC A117.1**]<**Insert height**>.

3) Color or Finish: [**Not applicable**]<**Insert if required**>.
4) Number of Bowls or User Stations: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
5) Bowl Shape: [**Trough**][**Oval**][**Round**]<**Insert shape**>.
6) Drain: Grid with **NPS 1-1/2 (DN 40)** tailpiece, each bowl.

g. Apron: [**Not required**][**Required, with access panel**].
h. Faucets:

1) Type: Manufacturer's standard, chrome-plated solid brass, each bowl/station.
2) Control: [**Manual, push-button**][**Hardwired, control-voltage, sensor-actuated**][**Battery-powered, sensor-actuated**]<**Insert type**> actuation with [**pressure-balancing**][**thermostatic**] mixing valve, and having check stops for each bowl or user station.

i. Soap Dispensers: [**Not required**][**Bracket only**][**Manual**][**Hardwired, control-voltage, sensor-actuated**][**Battery-powered, sensor-actuated**][**, liquid**][**, foam**][**, powered**]<**Insert type**> dispenser for each user station.
j. Mounting: [**Manufacturer's wall-mounting bracket**][**and/or**][**commercial floor-mounted carrier**]<**Insert type**>.
k. Supply Fittings:

1) Piping: **NPS 1/2 (DN 15)** copper tubing, each bowl.
2) Valves: Shutoff valve on each supply.
3) Supply Piping: From wall.

l. Waste Fittings:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Trap and Drain Piping: **NPS 1-1/2 (DN 40)**, each bowl.

2.8 FLUSHOMETER VALVES

A. Flushometer Valves, Manually Operated:

1. Flushometer Valves, Manually Operated - Diaphragm, Lever Handle :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**American Standard**]
3) [**Delany Products**]
4) [**I-Con Systems, Inc.**]
5) [**Sloan Valve Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Modern Technologies Corporation - AMTC**]

2) [**American Standard**]
3) [**Delany Products**]
4) [**I-Con Systems, Inc.**]
5) [**Sloan Valve Company**]
6) [**Zurn Industries, LLC**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
d. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
e. Minimum Pressure Rating: **125 psig (860 kPa)**.
f. Features: Include integral check stop and backflow-prevention device.
g. Material: Brass body with corrosion-resistant components.
h. Style: Exposed.
i. Flushometer-Valve Finish: Chrome-plated.
j. Handle Finish: [**Chrome plated**][**Antimicrobial**].
k. Consumption: [**0.125 gal. (0.5 L)**][**0.5 gal. (1.9 L)**][**1.0 gal. (3.8 L)**][**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**]<**Insert value**> per flush.
l. Minimum Inlet: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
m. Minimum Outlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

2. Flushometer Valves, Manually Operated - Piston, Lever Handle :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Delany Products**]
3) [**I-Con Systems, Inc.**]
4) [**Kohler Co**]
5) [**Sloan Valve Company**]
6) [**TOTO USA, INC**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Delany Products**]
3) [**I-Con Systems, Inc.**]
4) [**Kohler Co**]
5) [**Sloan Valve Company**]
6) [**TOTO USA, INC**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
d. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
e. Minimum Pressure Rating: **125 psig (860 kPa)**.
f. Features: Include integral check stop and backflow-prevention device.
g. Material: Brass body with corrosion-resistant components.
h. Style: Exposed.

i. Flushometer-Valve Finish: Chrome-plated.
j. Handle Finish: [**Chrome-plated**][**Antimicrobial**].
k. Consumption: [**0.125 gal. (0.5 L)**][**0.5 gal. (1.9 L)**][**1.0 gal. (3.8 L)**][**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**]<**Insert value**> per flush.
l. Minimum Inlet: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
m. Minimum Outlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

B. Flushometer Valves, Sensor Operated:

1. Flushometer Valves, Sensor Operated - Diaphragm :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**Delany Products**]
3) [**I-Con Systems, Inc.**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Modern Technologies Corporation - AMTC**]
2) [**Delany Products**]
3) [**I-Con Systems, Inc.**]
4) [**Sloan Valve Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
d. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
e. Minimum Pressure Rating: **125 psig (860 kPa)**.
f. Features: Include integral check stop and backflow-prevention device.
g. Material: Brass body with corrosion-resistant components.
h. Style: [**Exposed**][**Concealed**].
i. Exposed Flushometer-Valve Finish: Chrome-plated.
j. Panel Finish: Chrome-plated or stainless steel.
k. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
l. Trip Mechanism: [**Battery-powered**][**Hardwired, control-voltage**] electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
m. Consumption: [**0.125 gal. (0.5 L)**][**0.5 gal. (1.9 L)**][**1.0 gal. (3.8 L)**][**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**]<**Insert value**> per flush.
n. Minimum Inlet: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
o. Minimum Outlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

2. Flushometer Valves, Sensor Operated - Piston, Hardwired :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**American Standard**]
2) [**Hydrotek International, Inc.**]
3) [**I-Con Systems, Inc.**]
4) [**Moen Incorporated**]
5) [**Sloan Valve Company**]
6) [**Stern Engineering Ltd.**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**American Standard**]
2) [**Hydrotek International, Inc.**]
3) [**I-Con Systems, Inc.**]
4) [**Moen Incorporated**]
5) [**Sloan Valve Company**]
6) [**Stern Engineering Ltd.**]
7) [**Zurn Industries, LLC**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
d. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
e. Minimum Pressure Rating: **125 psig (860 kPa)**.
f. Features: Include integral check stop and backflow-prevention device.
g. Material: Brass body with corrosion-resistant components.
h. Style: [**Exposed**][**Concealed**].
i. Exposed Flushometer-Valve Finish: Chrome-plated.
j. Panel Finish: Chrome-plated or stainless steel.
k. Trip Mechanism: Hardwired, control-voltage electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
l. Consumption: [**0.125 gal. (0.5 L)**][**0.5 gal. (1.9 L)**][**1.0 gal. (3.8 L)**][**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**]<**Insert value**> per flush.
m. Minimum Inlet: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
n. Minimum Outlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

C. Flushometer Valves, Sensor Operated - Piston, Battery Powered :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Hydrotek International, Inc.**]
c. [**I-Con Systems, Inc.**]
d. [**Kohler Co**]
e. [**Moen Incorporated**]
f. [**Sloan Valve Company**]

g. [**Stern Engineering Ltd.**]
h. [**TOTO USA, INC**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Hydrotek International, Inc.**]
c. [**I-Con Systems, Inc.**]
d. [**Kohler Co**]
e. [**Moen Incorporated**]
f. [**Sloan Valve Company**]
g. [**Stern Engineering Ltd.**]
h. [**TOTO USA, INC**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
4. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
5. Minimum Pressure Rating: **125 psig (860 kPa)**.
6. Features: Include integral check stop and backflow-prevention device.
7. Material: Brass body with corrosion-resistant components.
8. Style: [**Exposed**][**Concealed**].
9. Exposed Flushometer-Valve Finish: Chrome plated.
10. Panel Finish: Chrome-plated or stainless steel.
11. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
12. Consumption: [**0.125 gal. (0.5 L)**][**0.5 gal. (1.9 L)**][**1.0 gal. (3.8 L)**][**1.1 gal. (4.2 L)**][**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)**][**Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)**]<**Insert value**> per flush.
13. Minimum Inlet: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].
14. Minimum Outlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

2.9 TOILET SEATS

A. Toilet Seats - Commercial :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Bemis Manufacturing Company**]
c. [**Centoco Manufacturing Corporation**]
d. [**Church Seats; Bemis Manufacturing Company**]
e. [**Jones Stephens Corp.**]
f. [**Kohler Co**]
g. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
h. [**TOTO USA, INC**]
i. [**Zurn Industries, LLC**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Bemis Manufacturing Company**]
   c. [**Centoco Manufacturing Corporation**]
   d. [**Church Seats; Bemis Manufacturing Company**]
   e. [**Jones Stephens Corp.**]
   f. [**Kohler Co**]
   g. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
   h. [**TOTO USA, INC**]
   i. [**Zurn Industries, LLC**]
   j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain toilet seat from single source from single manufacturer.
4. Standard: IAPMO/ANSI Z124.5.
5. Material: Plastic.
6. Type: Commercial (heavy duty).
7. Shape: [**Elongated rim, open front**][**Elongated rim, closed front**]**<Insert shape>**.
8. Hinge: [**Check**][**Self-sustaining, check**].
9. Hinge Material: Noncorroding metal.
10. Seat Cover: [**Required**][**Not required**].
11. Color: [**White**]**<Insert color>**.
12. Surface Treatment: [**Antimicrobial**][**Not required**].

2.10 FIXTURE CARRIERS

A. Fixture Carriers - Lavatory :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]

g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain lavatory carriers from single source from single manufacturer.
4. Standards:

   a. ASME A112.6.1M.
   b. ASME A112.6.2.

B. Fixture Carriers - Sink :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain sink carriers from single source from single manufacturer.
4. Standards:

   a. ASME A112.6.1M.
   b. ASME A112.6.2.

C. Fixture Carriers - Urinal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain urinal carriers from single source from single manufacturer.
4. Standard: ASME A112.6.1M.
5. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture.[**Include additional extension coupling, faceplate, and feet for installation in wide pipe space.**]

D. Fixture Carriers - Water Closet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**MIFAB, Inc**]
   c. [**Wade; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**MIFAB, Inc**]
   c. [**Wade; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water closet carriers from single source from single manufacturer.
4. Standard: ASME A112.6.1M.
5. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture.[**Include additional extension coupling, faceplate, and feet for installation in wide pipe space.**]

E. Fixture Carriers - Wash Fountain :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wash fountain carriers from single source from single manufacturer.
4. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.

C. Examine counters for suitable conditions where lavatories and sinks will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMMERCIAL PLUMBING FIXTURES

A. Lavatory Installation:

1. Install lavatories level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible, wall-mounted lavatories at mounting height in accordance with ICC A117.1.
4. Install water-supply piping with stop on each supply to each lavatory faucet. Install stops in locations that are accessible for ease of operation.
5. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon

requirements specified in Section 220500 "Common Work Results for Plumbing."
7. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

B. Shower Installation:

1. Assemble shower components in accordance with manufacturers' written instructions.
2. Install showers level and plumb in accordance with roughing-in drawings.
3. Install ball[**or gate**] valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with ball[**or gate**] valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping." Install valves in locations that are accessible for ease of operation.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Set [**shower receptors**][**and**][**shower basins**] in leveling bed of cement grout.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
7. Showers, except Cast-Polymer Showers: Seal joints between showers, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
8. Cast-Polymer Showers: Adhere panels to drywall using shower manufacturer's recommended adhesive. Seal joints, between panels and between panels and adjacent drywall, using shower manufacturer's recommended caulking specific for each application. Match sealant to fixture color.

C. Sink Installation:

1. Install sinks level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted sinks.
3. Install accessible, wall-mounted sinks at mounting height in accordance with ICC A117.1.
4. Set floor-mounted sinks in leveling bed of cement grout.
5. Install water-supply piping with stop on each supply to each sink faucet.

   a. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping."
   b. Install stops/valves in locations that are accessible for ease of operation.

6. Install trap and waste piping on each drain outlet of each sink to be connected to sanitary drainage system.
7. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
8. Seal joints between sinks, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
9. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

D. Urinal Installation:

1. Install urinals level and plumb in accordance with roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste-fitting seals and attached to supports.

3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height in accordance with ICC A117.1.
5. Install trap-seal liquid in waterless urinals.
6. Install supports, affixed to building substrate, for wall-hung urinals.
7. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
8. Use carriers without waste fitting for urinals with tubular waste piping.
9. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
10. Measure support height installation from finished floor, not structural floor.
11. Install flushometer-valve, water-supply fitting on each supply to each urinal.
12. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
13. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
14. Install actuators in locations easily reachable for people with disabilities.
15. Install new batteries in battery-powered, electronic-sensor mechanisms.
16. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
17. Seal joints between urinals, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to urinal color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

E. Water Closet Installation:

1. Install water closets level and plumb in accordance with roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
4. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
5. Use carrier supports with waste-fitting assembly and seal.
6. Install floor-mounted, back-outlet water closets, attached to building floor substrate, onto waste-fitting seals; and attach to support.
7. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals, and affix to building substrate.
8. Measure support height installation from finished floor, not structural floor.
9. Install flushometer-valve, water-supply fitting on each supply to each water closet.
10. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
11. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
12. Install actuators in locations easily reachable for people with disabilities.
13. Install new batteries in battery-powered, electronic-sensor mechanisms.
14. Install toilet seats on water closets.
15. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
16. Seal joints between water closets, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Wash Fountain Installation:

1. Install wash fountains level and plumb in accordance with roughing-in drawings.
2. Set freestanding wash fountains on floor.
3. Install off-floor carrier supports, affixed to building substrate, for wall-mounted wash fountains.
4. Install accessible, wall-mounted wash fountains at mounting height in accordance with ICC A117.1.

5. Install water-supply piping with shutoff valve on each supply to each wash fountain faucet. Use ball or gate valves if supply stops are not specified with wash fountain. Comply with valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping." Install stops/valves in locations that are accessible for ease of operation.
6. Install trap and waste piping on each drain outlet of each wash fountain to be connected to sanitary drainage system.
7. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
8. Seal joints between wash fountains, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
9. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 INSTALLATION OF PIPING CONNECTIONS

A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil, waste, and vent piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.4 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimensions**> high.

3.5 INSTALLATION OF CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Adjust water pressure at shower valves to produce proper flow.

D. Adjust water pressure at flushometer valves to produce proper flow.

E. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damage to finishes. Replace any fixtures unable to be repaired to the satisfaction of the [**Architect**][**Owner**].

B. Clean plumbing fixtures and associated faucets, valves, flushometer valves, and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and associated faucets, valves, flushometer valves, and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00 00

Task	Specification	Specification Description
22 42 13 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 13 13	22 42 00 00	Commercial Plumbing Fixtures
22 42 13 13	22 45 00 00	Emergency Plumbing Fixtures
22 42 13 16	22 42 00 00	Commercial Plumbing Fixtures
22 42 13 16	22 45 00 00	Emergency Plumbing Fixtures
22 42 16 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 16 13	22 42 00 00	Commercial Plumbing Fixtures
22 42 16 13	22 45 00 00	Emergency Plumbing Fixtures
22 42 16 16	22 42 00 00	Commercial Plumbing Fixtures
22 42 16 16	22 45 00 00	Emergency Plumbing Fixtures
22 42 19 00	10 28 19 00	Tub and Shower Enclosures
22 42 19 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 19 00	22 45 00 00	Emergency Plumbing Fixtures
22 42 23 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 23 00	22 45 00 00	Emergency Plumbing Fixtures
22 42 26 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 33 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 33 00	22 45 00 00	Emergency Plumbing Fixtures
22 42 39 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 39 00	22 45 00 00	Emergency Plumbing Fixtures
22 42 43 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 43 00	22 45 00 00	Emergency Plumbing Fixtures
22 42 46 00	22 42 00 00	Commercial Plumbing Fixtures
22 42 46 00	22 45 00 00	Emergency Plumbing Fixtures

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SECTION 22 43 00 00 - HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Healthcare water closets.
2. Flushometer valves.
3. Toilet seats.
4. Patient care units.
5. Healthcare showers.
6. Healthcare shower valves.
7. Healthcare bathing units.
8. Bedpan washers.
9. Bedpan washing equipment.
10. Clinic sinks.
11. Plaster sinks.
12. Scrub sinks.
13. Sink faucets.
14. Laminar-flow, faucet-spout outlets.
15. Hydrotherapy whirlpools.
16. Outlet boxes.
17. Morgue equipment.
18. Supports.
19. Supply fittings.
20. Waste fittings.
21. Grout.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for residential plumbing fixtures for use in healthcare facilities, but not requiring special healthcare fixture attributes.
2. Section 224213.13 "Commercial Water Closets" for conventional water closets, flushometer valves, carriers, and seats for use healthcare facilities, but not requiring special healthcare fixture attributes.
3. Section 224213.16 "Commercial Urinals" for urinals for use in healthcare facilities.
4. Section 224216.13 "Commercial Lavatories" for lavatories for use in healthcare facilities, but not requiring special healthcare fixture attributes.
5. Section 224216.16 "Commercial Sinks" for sinks for use in healthcare facilities, but not requiring special healthcare fixture attributes.
6. Section 224200 "Commercial Plumbing Fixtures" for showers for use in healthcare facilities, but not requiring special healthcare fixture attributes.
7. Section 224500 "Emergency Plumbing Fixtures" for emergency showers and eye-wash units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.

2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product Data: For water consumption.
2. Plumbing Fixtures: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

3. Plumbing Fixtures: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of [**flushometer valves**][**electronic sensors**][**healthcare bathing units**][**bedpan washer/sanitizers**][**hydrotherapy whirlpools**][**and**][**morgue equipment**].

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to [**10**]<**Insert number**> percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to [**5**]<**Insert number**> percent of amount of each type and size installed.
3. Flushometer-Valve Repair Kits: Equal to [**10**]<**Insert number**> percent of amount of each type installed, but no fewer than [**one**][**six**]<**Insert number**> of each type.
4. Toilet Seats: Equal to [**5**]<**Insert number**> percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with ASME A112.19.2/CSA B45.1 for vitreous-china plumbing fixtures.

B. Comply with ASME A112.19.3/CSA B45.4 for stainless steel plumbing fixtures.

C. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.

D. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets.

E. Comply with ASME A112.18.1/CSA B125.1 for plumbing supply fittings.

F. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

G. Comply with IAPMO Z124.5 for water-closet (toilet) seats.

H. Comply with ASME A112.6.1M for plumbing fixture supports.

I. Comply with ASSE 1016/ASME A112.1016/CSA B125.16 for shower valves.

J. Comply with ICC A117.1 for ADA-compliant, accessible plumbing fixtures and installation.

K. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous-china water closets to sanitary drainage systems.

L. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous-china water closets to sanitary drainage systems.

M. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

N. Faucets and bubblers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.3 HEALTHCARE WATER CLOSETS

A. Healthcare Water Closets, Wall Mounted - Vitreous China: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Crane Plumbing, LLC; a division of American Standard**]
c. [**Kohler Co**]
d. [**Sloan Valve Company**]
e. [**TOTO USA, INC**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Standard**]
    b. [**Crane Plumbing, LLC; a division of American Standard**]
    c. [**Kohler Co**]
    d. [**Sloan Valve Company**]
    e. [**TOTO USA, INC**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

3. Bowl:

    a. Material: Vitreous china.
    b. Type: Siphon jet.
    c. Style: [**Flushometer valve**][**Tank type**].
    d. Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
    e. Rim Contour: Elongated with bedpan lugs or slots.
    f. Water Consumption: [**1.28 gal. (4.8 L)**][**1.6 gal. (6.0 L)**][**1.6/1.1 gpm (7.2/5.0 L) dual flush**] per flush.
    g. Spud: **NPS 1-1/2 (DN 40)**, [**top**][**back**].

4. Flushometer Valve: <**Insert flushometer-valve designation**>.
5. Toilet Seat: <**Insert toilet-seat designation**>.
6. Water-Closet Support: [**Water-closet carrier**]<**Insert carrier**>.
7. Water-Closet Mounting Height: [**Standard**][**Child**][**ADA compliant**].

B. Healthcare Water Closets, Floor Mounted - Vitreous China: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Standard**]
    b. [**Crane Plumbing, LLC; a division of American Standard**]
    c. [**Kohler Co**]
    d. [**Sloan Valve Company**]
    e. [**TOTO USA, INC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Standard**]
    b. [**Crane Plumbing, LLC; a division of American Standard**]
    c. [**Kohler Co**]
    d. [**Sloan Valve Company**]
    e. [**TOTO USA, INC**]
    f. <**Insert manufacturer's name**>

3. Bowl:

a. Material: Vitreous china.
b. Type: Siphon jet.
c. Style: [**Flushometer valve**][**Tank type**].
d. Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
e. Rim Contour: Elongated with bedpan lugs or slots.
f. Water Consumption: [**1.28 gal. (4.8 L)**][**1.6 gal. (6.0 L)**][**1.6/1.1 gpm (7.2/5.0 L/min.) dual flush**] per flush.
g. Outlet: [**Floor**][**Back**].
h. Spud: **NPS 1-1/2 (DN 40)**, [**top**][**back**].

4. Flushometer Valve: <**Insert flushometer-valve designation**>.
5. Toilet Seat: <**Insert toilet-seat designation**>.

C. Healthcare Water Closets, Bariatric - Vitreous China: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Crane Plumbing, LLC; a division of American Standard**]
c. [**Sloan Valve Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Crane Plumbing, LLC; a division of American Standard**]
c. [**Sloan Valve Company**]
d. <**Insert manufacturer's name**>

3. Bowl:

a. Material: Vitreous china.
b. Type: Siphon jet.
c. Style: [**Flushometer valve**][**Tank type**][**Dual flush**].
d. Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
e. Mounting: [**Floor**][**Wall**].
f. Outlet: [**Bottom**][**Back**].
g. Rim Contour: Elongated with bedpan lugs or slots.
h. Water Consumption: [**1.28 gal. (4.8 L)**][**Dual flush**][**1.6/1.1 gpm (7.2/5.0 L/min.) dual flush**]<**Insert drawing designation**> per flush.
i. Spud: **NPS 1-1/2 (DN 40)**, [**top**][**back**].

4. Flushometer Valve: <**Insert flushometer-valve designation**>.
5. Toilet Seat: <**Insert toilet-seat designation**>.

D. Healthcare Water Closets, Bariatric - Stainless Steel: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. [**Willoughby Industries, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. [**Willoughby Industries, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Bowl:

a. Material: Stainless steel.
b. Finish: [**Satin**][**Powder coated**].
c. Type: Siphon jet.
d. Style: [**Flushometer valve**][**Tank type**].
e. Height: [**Standard**][**Accessible in accordance with ICC A117.1**].
f. Mounting: [**Floor**][**Wall**].
g. Outlet: [**Bottom**][**Back**].
h. Rim Contour: Elongated with bedpan lugs or slots.
i. Water Consumption: [**1.28 gal. (4.8 L)**][**1.6/1.1 gpm (7.2/5.0 L/min.) dual flush**] per flush.
j. Spud: **NPS 1-1/2 (DN 40)**, [**top**][**back**].

4. Flushometer Valve: <**Insert flushometer-valve designation**>.
5. Toilet Seat: <**Insert toilet-seat designation**>.

2.4 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Delany Products**]
c. [**Sloan Valve Company**]
d. [**Wolverine Brass, Inc**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Delany Products**]
c. [**Sloan Valve Company**]
d. [**Wolverine Brass, Inc**]

e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Minimum Pressure Rating: **125 psig (860 kPa)**.
4. Features: Integral check stop, backflow-prevention device, and outlet-tube-mounted bedpan washer.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Consumption: [**1.28 gal. (4.8 L)**][**1.6 gal. (6 L)**][**3.5 gal. (13.2 L)**][**1.6/1.1 gpm (7.2/5.0 L/min.) dual flush**]<**Insert value**> per flush.
9. Minimum Inlet: **NPS 1 (DN 25)**.
10. Minimum Outlet: **NPS 1-1/4 (DN 32)**, extended length.

2.5 TOILET SEATS

A. Toilet Seats: <**Insert designation**>.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Bemis Manufacturing Company**]
   c. [**Centoco Manufacturing Corporation**]
   d. [**Church Seats; Bemis Manufacturing Company**]
   e. [**Kohler Co**]
   f. [**Olsonite; Bemis Manufacturing Company**]
   g. [**TOTO USA, INC**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Bemis Manufacturing Company**]
   c. [**Centoco Manufacturing Corporation**]
   d. [**Church Seats; Bemis Manufacturing Company**]
   e. [**Kohler Co**]
   f. [**Olsonite; Bemis Manufacturing Company**]
   g. [**TOTO USA, INC**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Material: Plastic with antimicrobial agent.
4. Type: Commercial [**(standard)**][**(heavy duty)**].
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Color: White.

2.6 PATIENT CARE UNITS

A. Patient Care Units, Factory Fabricated, Combination, Swing-Away, Water Closet and Lavatory Healthcare Plumbing Fixture: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Krowne**]
   b. [**Metcraft Industries, Inc.**]
   c. [**Whitehall Manufacturing; a division of Morris Group International**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Krowne**]
   b. [**Metcraft Industries, Inc.**]
   c. [**Whitehall Manufacturing; a division of Morris Group International**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Cabinet: Fixed installation with storage space and toilet paper holder.

   a. Material: [**Stainless steel**][**Stainless steel, plastic laminate, or fiberglass**] with [**laminated-wood or -plastic**][**solid-plastic**][**stainless steel**] top surface.
   b. Color: [**Not applicable**]<**Insert color**>.
   c. Mounting: Wall bracket.

4. Water Closet: Swivel, floor mounted, [**back**][**floor**] outlet.

   a. Material: Stainless steel.
   b. Orientation: [**Left**][**Right**] hand.
   c. Seal: For outlet.
   d. Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
   e. Toilet Seat: White, solid plastic.
   f. Support: Floor plate.

5. Lavatory: Counter mounted.

   a. Material: [**Stainless steel**][**Cultured marble**][**Solid-surface material**]<**Insert material**>.
   b. Color: [**Not applicable**]<**Insert color**>.
   c. Faucet: [**Gooseneck type with wrist-blade handles**][**Swing-spout type with single lever**]<**Insert type**>, laminar flow.
   d. Waste Fittings: Grid drain, with **NPS 1-1/4 (DN 32)** tailpiece and [**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32)**] chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

B. Patient Care Units, Factory Fabricated, Combination, Fixed Position, Water Closet and Lavatory Healthcare Fixture: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Krowne**]
   b. [**Metcraft Industries, Inc.**]
   c. [**Whitehall Manufacturing; a division of Morris Group International**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Krowne**]
   b. [**Metcraft Industries, Inc.**]
   c. [**Whitehall Manufacturing; a division of Morris Group International**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Cabinet: Fixed installation; swing-away cabinet or retractable, water-closet cover design with storage space and toilet paper holder.

   a. Material: [**Stainless steel**][**Stainless steel, plastic laminate, or fiberglass**] with [**laminated-wood or -plastic**][**solid-plastic**][**stainless steel**] top surface.
   b. Color: [**Not applicable**]<**Insert color**>.
   c. Support: Wall bracket.

4. Water Closet: Floor mounted, floor outlet.

   a. Material: Stainless steel or vitreous china.
   b. Orientation: [**Left**][**Right**] hand.
   c. Seal: For outlet.
   d. Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
   e. Toilet Seat: White, solid plastic.

5. Lavatory: Counter mounted.

   a. Material: [**Stainless steel**][**Cultured marble**][**Solid-surface material**]<**Insert material**>.
   b. Color: [**Not applicable**]<**Insert color**>.
   c. Faucet: [**Gooseneck type with wrist-blade handles**][**Swing-spout type with single lever**]<**Insert type**>, laminar flow spout outlet.
   d. Waste Fittings: Grid drain, with **NPS 1-1/4 (DN 32)** tailpiece and [**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32)**] chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

2.7 HEALTHCARE SHOWERS

A. Healthcare Showers: Accessible, [**glass-fiber-reinforced plastic**][**acrylic**]. .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Aqua Bath Company, Inc.**]
b. [**Clarion Bathware**]
c. [**Florestone Products Co., Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aqua Bath Company, Inc.**]
b. [**Clarion Bathware**]
c. [**Florestone Products Co., Inc.**]
d. <**Insert manufacturer's name**>

3. Nominal Size: [**60 by 36 inches (1524 by 915 mm)**]<**Insert dimensions**>.
4. Surround:

a. One piece[**or sealed, multiple piece**].

5. Bathing Surface: Slip resistant.
6. Color: [**White**]<**Insert color**>.
7. Drain Location: [**Left side**][**Center**][**Right side**].
8. Accessibility Options: Include grab bar and bench.
9. Shower Valves: <**Insert healthcare shower-valve designation**>.
10. Drain: Grid, **NPS 2 (DN 50)**.

2.8 HEALTHCARE SHOWER VALVES

A. Healthcare Shower Valves, Pressure-Balance Mixing Valve: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**American Standard**]
c. [**Chicago Faucets; Geberit Group**]
d. [**Kohler Co**]
e. [**Lawler Manufacturing Company, Inc**]
f. [**Matco-Norca**]
g. [**Moen Incorporated**]
h. [**POWERS; A Watts Water Technologies Company**]
i. [**Speakman Company**]
j. [**Symmons Industries, Inc**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**American Standard**]
c. [**Chicago Faucets; Geberit Group**]
d. [**Kohler Co**]
e. [**Lawler Manufacturing Company, Inc**]
f. [**Matco-Norca**]
g. [**Moen Incorporated**]
h. [**POWERS; A Watts Water Technologies Company**]
i. [**Speakman Company**]
j. [**Symmons Industries, Inc**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Valve:

a. Body Material: Solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: [**1.25 gpm (4.7 L/min.)**][**1.5 gpm (6.8 L/min.)**][**2.0 gpm (9.1 L/min.)**][**2.5 gpm (9.5 L/min.)**]<**Insert value**> unless otherwise indicated.
d. Mounting: [**Concealed**][**Exposed**].
e. Operation: Single-handle, [**push-pull**][**or**][**twist or rotate**] control.
f. Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water-supply connections.
h. Indicators: For hot and cold water.

4. Shower Head:

a. Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**][**Handheld, slide bar mounted**][**Handheld, hook mounted**]<**Insert type**>.
b. Shower Head Material: Metallic with chrome-plated finish.
c. Spray Pattern: [**Adjustable**][**Fixed**].
d. Integral Volume Control: [**Not required**][**Required**].
e. Shower-Arm, Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**].
f. Temperature Indicator: [**Integral with faucet**][**Not required**].

B. Healthcare Shower Valves, Thermostatic Mixing Valve: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Chicago Faucets; Geberit Group**]
c. [**Lawler Manufacturing Company, Inc**]
d. [**POWERS; A Watts Water Technologies Company**]
e. [**Symmons Industries, Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Chicago Faucets; Geberit Group**]
c. [**Lawler Manufacturing Company, Inc**]
d. [**POWERS; A Watts Water Technologies Company**]
e. [**Symmons Industries, Inc**]
f. <**Insert manufacturer's name**>

3. Valve:

a. Body Material: Solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: [**1.25 gpm (4.7 L/min.)**][**1.5 gpm (6.8 L/min.)**][**2.0 gpm (9.1 L/min.)**][**2.5 gpm (9.5 L/min.)**]<**Insert value**> unless otherwise indicated.
d. Mounting: [**Concealed**][**Exposed**].
e. Operation: Single-handle, [**push-pull**][**or**][**twist or rotate**] control.
f. Antiscald Device: [**Integral with mixing valve**][**Separate unit**][**Not required**].
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water-supply connections.
h. Indicators: For hot and cold water.

4. Shower Head:

a. Type: [**Ball joint with arm and flange**][**Without ball joint, but with arm and flange**][**Ball joint and head integral with mounting flange**][**Integral with mounting flange**][**Handheld, slide bar mounted**][**Handheld, hook mounted**]<**Insert type**>.
b. Material: Metallic with chrome-plated finish.
c. Spray Pattern: [**Adjustable**][**Fixed**].
d. Integral Volume Control: [**Not required**][**Required**].
e. Shower-Arm, Flow-Control Fitting: [**Not required**][**1.5 gpm (5.7 L/min.)**][**2.0 gpm (7.6 L/min.)**].
f. Temperature Indicator: [**Integral with faucet**][**Not required**].

2.9 HEALTHCARE BATHING UNITS

A. Healthcare Bathing Units, Side Entry, Whirlpool: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. [**Invacare Continuing Care Group**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. [**Invacare Continuing Care Group**]
c. <**Insert manufacturer's name**>

3. Fixture: Plastic-tub, institutional bath fixture with whirlpool and integral controls.

a. Standard: UL 1795.
b. Tub Size: [**60 by 30 inches (1524 by 762 mm)**]<**Insert dimensions**>.
c. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and handheld shower head.

4. Supply Connections: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] with shutoff valve.
5. Drain: Manufacturer's standard [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] with tailpiece.
6. Drain Piping: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] cast-brass P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include combined drain piping if two drains.
7. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
b. Phase(s): [**One**][**Three**].
c. Hertz: [**60**]<**Insert number**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

B. Healthcare Bathing Units: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. [**Clarion Bathware**]
c. [**Comfort Designs Bathware**]
d. [**Invacare Continuing Care Group**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. [**Clarion Bathware**]
c. [**Comfort Designs Bathware**]
d. [**Invacare Continuing Care Group**]
e. <**Insert manufacturer's name**>

3. Fixture: Plastic-tub, institutional bath fixture with integral controls.

a. Tub Size: [**60 by 30 inches (1524 by 762 mm)**]<**Insert dimensions**>.
b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and handheld shower head.
c. Entry: [**Side**][**Transfer lift**][**Slide on**].
d. Height: [**Adjustable**][**Fixed**].

4. Supply Connections: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] with shutoff valve.
5. Drain: Manufacturer's standard [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] with tailpiece.
6. Drain Piping: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] cast-brass P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include combined drain piping if two drains.
7. Lift System: [**Not required**]<**Insert description**>.
8. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
b. Phase(s): [**One**][**Three**].
c. Hertz: [**60**]<**Insert number**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

C. Healthcare Bathing Units, Front-Entry Shower: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. [**Comfort Designs Bathware**]
c. [**Invacare Continuing Care Group**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. [**Comfort Designs Bathware**]
c. [**Invacare Continuing Care Group**]
d. <**Insert manufacturer's name**>

3. Fixture: Plastic-tub, institutional fixture with integral controls.

a. Cabinet Size: [**35 by 41 inches (889 by 1041 mm)**]<**Insert dimensions**>.
b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and handheld shower head.

4. Supply Connections: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**] with shutoff valve.
5. Drain: Manufacturer's standard **NPS 2 (DN 50)** with tailpiece.
6. Drain Piping: **NPS 2 (DN 50)** P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include combined drain piping if two drains.
7. Unit Electrical Characteristics:

a. Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
b. Phase(s): [**One**][**Three**].
c. Hertz: [**60**]<**Insert number**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.10 BEDPAN WASHERS

A. Bedpan Washers, Wall Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**American Standard**]
b. [**Kohler Co**]
c. [**T&S Brass and Bronze Works, Inc.**]
d. [**Whitehall Manufacturing; a division of Morris Group International**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Kohler Co**]
c. [**T&S Brass and Bronze Works, Inc.**]
d. [**Whitehall Manufacturing; a division of Morris Group International**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Hose Assembly: [**48-inch- (1220-mm-)**]<**Insert dimension**> long, rubber or vinyl hose with self-closing, handheld spray nozzle, wall bracket, and hook.
4. Vacuum Breaker: ASSE 1001, atmospheric, wall mounted.
5. Shutoff Valve: Wall-mounted, [**cross-handle**][**foot pedal valve**]<**Insert type**> supply stop upstream of vacuum breaker.
6. Connecting Piping: Concealed.
7. Finish: Polished chrome-plated finish on exposed metal parts.
8. Supply Connection: [**NPS 1/2 (DN 15)**]<**Insert size**>.

B. Bedpan Washers, Wall-Mounted Assembly with Foot Control: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kohler Co**]
b. [**T&S Brass and Bronze Works, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Kohler Co**]
b. [**T&S Brass and Bronze Works, Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Hose: [**48-inch- (1220-mm-)**]<**Insert dimension**> long, rubber or vinyl hose with self-closing, handheld spray nozzle, wall bracket, and hook.
4. Vacuum Breaker: ASSE 1001, atmospheric, wall mounted.
5. Shutoff Valve: Wall-mounted, [**cross-handle**]<**Insert type**> supply stop between foot control and vacuum breaker.
6. Connecting Piping: Concealed.

7. Finish: Polished chrome-plated finish on exposed metal parts.
8. Control Mounting: [**Floor**][**Wall**].
9. Supply Connection(s): [**NPS 1/2 (DN 15)**]<**Insert size**>.
10. Foot Control: [**Floor**][**Wall**] mounted.
11. Foot Control Type: [**Single pedal**][**Double pedal, hot and cold water**],

2.11 BEDPAN WASHING EQUIPMENT

A. Bedpan Washers/Sanitizers: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**MEIKO**]
   b. [**Rhima**]
   c. [**Steelco S.p.A.**]
   d. [**STERIS Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MEIKO**]
   b. [**Rhima**]
   c. [**Steelco S.p.A.**]
   d. [**STERIS Corporation**]
   e. <**Insert manufacturer's name**>

3. Fixture:

   a. Construction: Cast-iron chamber and P-trap waste assembly with spray nozzles and [**enameled-steel**][**stainless steel**] front panel and cover box.
   b. Controls: Electric, 120 V ac, automatic operation with timer, solenoid valves, and circuit breaker.
   c. Door Mechanism: Foot-pedal operation.

4. Supply Connections: **NPS 1 (DN 25)** cold water and **NPS 3/8 (DN 10)** [**hot water**][**steam**].
5. Drain Piping: **NPS 3 (DN 80)** P-trap and soil pipe.
6. Atmospheric Vent Connection: **NPS 2 (DN 50)**.
7. Mounting: [**Recessed**][**Wall**].
8. Mounting Hardware: Matching fixture-mounting arrangement.
9. Accessories:

   a. Bedpan Rack(s): [**One**][**Two**]<**Insert number**>.
   b. Urinal Rack(s): [**One**][**Two**]<**Insert number**>.
   c. Drain Tray(s): [**One**][**Two**]<**Insert number**>.

B. Bedpan Washers/Disinfectors: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Arjo Inc.**]
b. [**MEIKO**]
c. [**Rhima**]
d. [**Steelco S.p.A.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. [**MEIKO**]
c. [**Rhima**]
d. [**Steelco S.p.A.**]
e. <**Insert manufacturer's name**>

3. Fixture:

a. Controls: Electric, automatic operation.
b. Cabinet: Stainless steel.
c. Wash Chamber: Stainless steel.

4. Supply Connections: **NPS 1/2 (DN 15)** cold water and **NPS 1/2 (DN 15)** hot water.
5. Drain Piping: **NPS 4 (DN 100)** P-trap and soil pipe.
6. Mounting: [**Freestanding**][**Wall mounted**][**Undercounter mounted**].
7. Mounting Hardware: Matching fixture-mounting arrangement.
8. Unit Electrical Characteristics:

a. Volts: [**208**][**240**]<**Insert number**>.
b. Phase(s): [**One**][**Three**].
c. Hertz: [**60**]<**Insert number**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.12 CLINIC SINKS

A. Clinic Sinks, Wall Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Crane Plumbing, LLC; a division of American Standard**]
c. [**Kohler Co**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Standard**]
b. [**Crane Plumbing, LLC; a division of American Standard**]
c. [**Kohler Co**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Fixture: Back-outlet, vitreous-china, blowout-type, flushing-rim, service sink.

   a. Nominal Size: [**25 by 20 inches (635 by 510 mm)**]<**Insert dimensions**>.
   b. Outlet Size: [**NPS 4 (DN 100)**][**or**][**NPS 3 (DN 80)**].
   c. Color: White.
   d. Rim Guard: Stainless steel, on front.

4. Flushometer Valve: <**Insert flushometer-valve designation**>.
5. Faucet: [**Not required**]<**Insert sink-faucet designation**>.
6. Support: [**Type IV sink carrier**]<**Insert carrier**>.
7. Sink Mounting Height: [**Standard**][**ADA compliant**].

B. Clinic Sinks, Floor Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Kohler Co**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Kohler Co**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Fixture: Bottom-outlet, vitreous-china, siphon-jet, flushing-rim, service sink.

   a. Nominal Size: [**27 by 20 inches (685 by 510 mm)**]<**Insert dimensions**>.
   b. Color: White.
   c. Rim Guards: Stainless steel on front.

4. Sink Base: [**10 inches (254 mm)**]<**Insert dimension**> high; cast terrazzo if required.
5. Flushometer Valve: <**Insert flushometer-valve designation**>.
6. Faucet: <**Insert sink-faucet designation**>.
7. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

2.13 PLASTER SINKS

A. Plaster Sinks, Wall Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Franke**]
   d. [**Kohler Co**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Crane Plumbing, LLC; a division of American Standard**]
   c. [**Franke**]
   d. [**Kohler Co**]
   e. <**Insert manufacturer's name**>

3. Fixture:

   a. Type: Utility sink.
   b. Material: [**Vitreous china**][**or**][**stainless steel**].
   c. Nominal Size: [**24 by 22 inches (610 by 560 mm)**][**30 by 22 inches (762 by 560 mm)**]<**Insert dimensions**> with back.
   d. Color: White.
   e. Faucet Holes: [**One**][**Two**] in back.
   f. Drain: Grid, **NPS 1-1/2 (DN 40)**[**with NPS 1-1/2 (DN 40) to NPS 2 (DN 50) adaptor**].

4. Faucet: <**Insert sink-faucet designation**>.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Drain Piping: [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] chrome-plated brass; **0.045-inch- (1.1-mm-)** thick waste to interceptor; interceptor to wall; and wall flange complying with ASME A112.18.2/CSA B125.2.
7. Plaster Interceptor:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Jay R. Smith Mfg Co; a division of Morris Group International**]
      2) [**Josam Company**]
      3) [**MIFAB, Inc**]
      4) [**WATTS; A Watts Water Technologies Company**]
      5) [**Zurn Industries, LLC**]
      6) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Jay R. Smith Mfg Co; a division of Morris Group International**]
2) [**Josam Company**]
3) [**MIFAB, Inc**]
4) [**WATTS; A Watts Water Technologies Company**]
5) [**Zurn Industries, LLC**]
6) <**Insert manufacturer's name**>

c. Description: [**Cast iron**][**or**][**steel body**][**or**][**ABS plastic**][**PE resin**] and removable cover with acid-resistant-enameled interior lining and outside coating; removable, corrosion-resistant metal screens or strainer; and [**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**] inlet and outlet.

8. Support: [**Type III sink carrier with white-enameled-steel brackets**]<**Insert carrier**>.
9. Sink Mounting Height: [**Standard**][**ADA compliant**].

2.14 SCRUB SINKS

A. Scrub Sinks, Stainless Steel, Wall Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CSI Industries Inc.**]
b. [**Elkay**]
c. [**Franke**]
d. [**Sloan Valve Company**]
e. [**Whitehall Manufacturing; a division of Morris Group International**]
f. [**Willoughby Industries, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CSI Industries Inc.**]
b. [**Elkay**]
c. [**Franke**]
d. [**Sloan Valve Company**]
e. [**Whitehall Manufacturing; a division of Morris Group International**]
f. [**Willoughby Industries, Inc.**]
g. <**Insert manufacturer's name**>

3. Fixture:

a. Nominal Size: [**Single**][**Dual**][**Triple**]<**Insert number**> Station <**Insert width x depth dimensions**> with back and faucet hole.
b. Drain: [**Grid**]<**Insert type**>, **NPS 1-1/2 (DN 40)**.

4. Valve: Adjustable thermostatic controlled pressure mixing valve, one per station.
5. Faucet: Gooseneck-spout, [**knee-action**][**or**][**sensor-operated**][**or**][**foot-operated**] water and

soap dispenser; laminar-flow spout outlet. <**Insert sink-faucet designation**>.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
7. Support: [**Type I sink carrier**][**Type II sink carrier**]<**Insert carrier**>.
8. Sink Mounting Height: [**Standard**][**ADA compliant**].

B. Scrub Sinks, Vitreous China, Wall Mounted: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Kohler Co**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Kohler Co**]
   b. [**Whitehall Manufacturing; a division of Morris Group International**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Fixture:

   a. Nominal Size: [**28 by 22 inches (710 by 560 mm)**][**30 by 22 inches (762 by 560 mm)**]<**Insert dimensions**> with back or ledge with one faucet hole.
   b. Color: White.
   c. Drain: [**Grid**]<**Insert type**>, **NPS 1-1/2 (DN 40)**.

4. Faucet: Gooseneck-spout, [**knee-action**][**or**][**sensor-operated**][**or**][**foot-operated**] water and soap dispenser; laminar-flow spout outlet. <**Insert sink-faucet designation**>.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
7. Support: [**Type I sink carrier**][**Type II sink carrier**][**Type III sink carrier**]<**Insert carrier**>.
8. Sink Mounting Height: [**Standard**][**ADA compliant**].

2.15 SINK FAUCETS

A. Sink Faucets, Manual-Operation Mixing Valve: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Bradley Corporation**]
   c. [**Chicago Faucets; Geberit Group**]
   d. [**Delta Faucet Company**]
   e. [**Elkay**]
   f. [**Fisher Manufacturing Co**]

g. [**GROHE America, Inc**]
h. [**Kohler Co**]
i. [**Krowne**]
j. [**Moen Incorporated**]
k. [**Speakman Company**]
l. [**T&S Brass and Bronze Works, Inc.**]
m. [**Zurn Industries, LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Standard**]
   b. [**Bradley Corporation**]
   c. [**Chicago Faucets; Geberit Group**]
   d. [**Delta Faucet Company**]
   e. [**Elkay**]
   f. [**Fisher Manufacturing Co**]
   g. [**GROHE America, Inc**]
   h. [**Kohler Co**]
   i. [**Krowne**]
   j. [**Moen Incorporated**]
   k. [**Speakman Company**]
   l. [**T&S Brass and Bronze Works, Inc.**]
   m. [**Zurn Industries, LLC**]
   n. <**Insert manufacturer's name**>

3. Configuration: Hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: [**Centerset**][**Widespread**][**Single hole**]<**Insert type**>.
5. Body Material: Solid brass.
6. Finish: [**Chrome plated**][**Polished chrome plate**]<**Insert finish**>.
7. Maximum Flow Rate: [**2.2 gpm (8.3 L/min.)**][**2.5 gpm (9.5 L/min.)**]<**Insert value**>.
8. Control:

   a. [**Lever**][**Cross, four-arm**][**Wrist-blade, 4-inch (102-mm)**][**Elbow, 6-inch (152-mm)**]<**Insert type**> handle(s).
   b. [**Foot pedal**][**Knee action**]<**Insert type**>.

9. Mounting Type: [**Deck, concealed**][**Deck, exposed**][**Back/wall, exposed**]<**Insert type**>.
10. Spout Type: [**Rigid**][**Swivel**], [**low profile**][**gooseneck**]<**Insert type**>.
11. Vacuum Breaker: [**Required**][**Not required**] for hose outlet.
12. Spout Outlet: [**Laminar flow**][**Hose thread**][**Plain end**][**Spray**]<**Insert type**>.

B. Sink Faucets, Automatic, Electronic-Sensor-Operated Mixing Valve: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Standard**]
   b. [**Chicago Faucets; Geberit Group**]
   c. [**Hydrotek International, Inc.**]

d. [**Kohler Co**]
e. [**Moen Incorporated**]
f. [**Sloan Valve Company**]
g. [**Speakman Company**]
h. [**T&S Brass and Bronze Works, Inc.**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Standard**]
b. [**Chicago Faucets; Geberit Group**]
c. [**Hydrotek International, Inc.**]
d. [**Kohler Co**]
e. [**Moen Incorporated**]
f. [**Sloan Valve Company**]
g. [**Speakman Company**]
h. [**T&S Brass and Bronze Works, Inc.**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Configuration: Hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: [**Centerset**][**Widespread**][**Single hole**]<**Insert type**>.
5. Body Material: Solid brass.
6. Finish: [**Polished chrome plate**]<**Insert finish**>.
7. Maximum Flow Rate: [**2.2 gpm (8.3 L/min.)**][**2.5 gpm (9.5 L/min.)**]<**Insert value**> unless otherwise indicated.
8. Mounting Type: [**Deck, concealed**][**Deck, exposed**][**Back/wall, exposed**].
9. Power Supply: [**Battery powered**][**Hard wired**].
10. Spout Type: [**Rigid**][**Swivel**], [**low profile**][**gooseneck**]<**Insert type**>.
11. Vacuum Breaker: [**Required**][**Not required**] for hose outlet.
12. Spout Outlet: [**Laminar flow**][**Hose thread**][**Plain end**][**Spray**]<**Insert type**>.

2.16 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Standard**]
2. [**Chicago Faucets; Geberit Group**]
3. [**Delta Faucet Company.**]
4. [**Elkay**]
5. [**GROHE America, Inc**]
6. [**Kohler Co**]
7. [**Moen Incorporated**]
8. [**Speakman Company**]
9. [**T&S Brass and Bronze Works, Inc.**]
10. [**Zurn Industries, LLC**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**American Standard**]
2. [**Chicago Faucets; Geberit Group**]
3. [**Delta Faucet Company.**]
4. [**Elkay**]
5. [**GROHE America, Inc**]
6. [**Kohler Co**]
7. [**Moen Incorporated**]
8. [**Speakman Company**]
9. [**T&S Brass and Bronze Works, Inc.**]
10. [**Zurn Industries, LLC**]
11. <**Insert manufacturer's name**>

C. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes faucet flow.

2.17 HYDROTHERAPY WHIRLPOOLS

A. Hydrotherapy Whirlpools, Podiatry: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

3. Description: Stationary stainless steel tank for feet and ankles.

   a. Water Capacity: **15 gal. (57 L)**.
   b. Drain: Waste connection.
   c. Controls.
   d. Thermometer: Control panel or tank mounted.
   e. One electric turbine ejector.
   f. Unit Electrical Characteristics:

      1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
      2) Phase(s): [**One**][**Three**].
      3) Hertz: [**60**]<**Insert number**>.
      4) Full-Load Amperes: <**Insert value**>.
      5) Minimum Circuit Ampacity: <**Insert value**>.
      6) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Hydrotherapy Whirlpools, Upper Extremity: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

3. Description: Stationary, pedestal-mounted, stainless steel tank for arms, hands, and elbows.

   a. Water Capacity: **25 gal. (95 L)**.
   b. Drain: Waste connection.
   c. One arm support.
   d. Controls.
   e. Thermometer: Control panel or tank mounted.
   f. One electric turbine ejector.
   g. Unit Electrical Characteristics:

      1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
      2) Phase(s): [**One**][**Three**].
      3) Hertz: [**60**]<**Insert number**>.
      4) Full-Load Amperes: <**Insert value**>.
      5) Minimum Circuit Ampacity: <**Insert value**>.
      6) Maximum Overcurrent Protection: <**Insert amperage**>.

C. Hydrotherapy Whirlpools, High Tank, Body: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Whitehall Manufacturing; a division of Morris Group International**]
   b. <**Insert manufacturer's name**>

3. Description: Stationary, stainless steel tank for legs, hips, and back.

   a. Water Capacity: **105 gal. (397 L)**.
   b. Drain: Waste connection.
   c. Controls.
   d. Thermometer: Control panel or tank mounted.
   e. One electric turbine ejector.

f. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phases: [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

D. Hydrotherapy Whirlpools, Low Tank, Body: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

3. Description: Stationary, extended-length, stainless steel tank for legs, hips, and lower back.

a. Water Capacity: **105 gal. (397 L)**.
b. Drain: Waste connection.
c. Controls.
d. Thermometer: Control panel or tank mounted.
e. Head rest.
f. One electric turbine ejector.
g. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

E. Hydrotherapy Whirlpools, Small Hubbard Immersion Tank: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

3. Description: Stationary, butterfly-shaped tank for full-body massage.

a. Tank Dimensions: [**93 by 64 by 22 inches (2362 by 1626 by 560 mm)**]<**Insert dimensions**>.
b. Overall Height: [**34 to 38 inches (864 to 965 mm)**]<**Insert dimensions**>.
c. Water Capacity: [**268 gal. (1014 L)**]<**Insert value**>.
d. Material: Stainless steel.
e. Supports: Legs or base.
f. Controls.
g. Thermometer: Control panel or tank rim mounted.
h. Supply: Over-the-rim fill spout.
i. Drains: Two waste connections.
j. Electric Turbine Ejectors: Two; one rail mounted on each side.
k. Thermostatic, mixing-valve assembly.
l. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

m. Hose and handheld shower.
n. Wash-out-hose assembly.
o. Stretcher lift.
p. Overhead[**electric**] hoist.
q. <**Insert option**>.

F. Hydrotherapy Whirlpools, Medium Hubbard Immersion Tank: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. <**Insert manufacturer's name**>

3. Description: Stationary, butterfly-shaped tank for full-body massage.

a. Tank Dimensions: [**100 by 73 by 24 inches (2540 by 1854 by 610 mm)**]<**Insert dimensions**>.
b. Overall Height: [**34 to 38 inches (864 to 965 mm)**]<**Insert dimensions**>.

c. Water Capacity: [377 gal. (1468 L)]<**Insert value**>.
d. Material: Stainless steel.
e. Supports: Legs or base.
f. Controls.
g. Thermometer: Control panel or tank rim mounted.
h. Supply: Over-the-rim fill spout.
i. Drain: One waste connection.
j. Electric Turbine Ejector: One; panel mounted.
k. Thermostatic, mixing-valve assembly.
l. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

m. Hose and handheld shower.
n. Wash-out-hose assembly.
o. Stretcher lift.
p. Overhead[**electric**] hoist.
q. <**Insert option**>.

G. Hydrotherapy Whirlpools, Large Hubbard Immersion Tank: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Whitehall Manufacturing; a division of Morris Group International**]
b. <**Insert manufacturer's name**>

3. Description: Stationary, butterfly-shaped tank for full-body massage.

a. Tank Dimensions: [106 by 77 by 22 inches (2692 by 1956 by 560 mm)]<**Insert dimensions**>.
b. Overall Height: [34 inches (864 mm)]<**Insert dimension**>.
c. Water Capacity: [425 gal. (1609 L)]<**Insert value**>.
d. Material: Stainless steel.
e. Supports: Legs or base.
f. Controls.
g. Thermometer: Control panel or tank rim mounted.
h. Supply: Over-the-rim fill spout.
i. Drain(s): One or two waste connections.
j. Electric Turbine Ejectors: Two; one rail mounted on each side.
k. Thermostatic mixing-valve assembly.

l. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

m. Hose and handheld shower.
n. Wash-out-hose assembly.
o. Stretcher lift.
p. Overhead[**electric**] hoist.
q. <**Insert option**>.

H. Hydrotherapy Whirlpools, Full-Body Immersion Tank: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arjo Inc.**]
b. [**Whitehall Manufacturing; a division of Morris Group International**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arjo Inc.**]
b. [**Whitehall Manufacturing; a division of Morris Group International**]
c. <**Insert manufacturer's name**>

3. Description: Stationary rectangular tank for full-body massage.

a. Tank Dimensions: [**90 by 32 by 19 inches (2286 by 813 by 483 mm)**][**95 by 41 by 22 inches (2413 by 1041 by 560 mm)**]<**Insert dimensions**>.
b. Overall Height: **32 or 34 inches (813 or 860 mm)**.
c. Water Capacity: [**195 gal. (738 L)**][**260 gal. (984 L)**]<**Insert value**>.
d. Material: Stainless steel.
e. Supports: Legs or base.
f. Controls.
g. Thermometer: Control panel or tank rim mounted.
h. Supply: Over-the-rim fill spout.
i. Drain(s): One or two waste connections.
j. Electric Turbine Ejector: One, tank mounted [**at end**][**on rail**][**on side**].
k. Thermostatic mixing-valve assembly.
l. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

m. Hose and handheld shower.
n. Wash-out-hose assembly.
o. Stretcher lift.
p. Overhead[**electric**] hoist.
q. <**Insert option**>.

2.18 OUTLET BOXES

A. Outlet Boxes, for Dialysis Equipment: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Metcraft Industries, Inc.**]
c. [**Whitehall Manufacturing; a division of Morris Group International**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Metcraft Industries, Inc.**]
c. [**Whitehall Manufacturing; a division of Morris Group International**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Description: Recessed-mounted outlet box with water-supply and drain connections.

a. Box and Faceplate: Stainless steel.
b. Supply Fitting(s): [**One**][**Two**] **NPS 1/2 (DN 15)** PVC ball valve(s) and adapter with male hose-thread outlet.
c. Drain: **NPS 2 (DN 50)** standpipe, P-trap, and direct waste connection to drainage piping.

4. Reinforcement: Fire-retardant-treated wood blocking between studs. Comply with fire-retardant-treated wood requirements specified in Section 061000 "Rough Carpentry."

2.19 MORGUE EQUIPMENT

A. Autopsy Table: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CSI Industries Inc.**]
b. [**LEEC**]
c. [**Mopec**]

d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**CSI Industries Inc.**]
   b. [**LEEC**]
   c. [**Mopec**]
   d. **<Insert manufacturer's name>**

3. Description: Pedestal, stainless steel table with sink; designed for downdraft ventilation.

   a. Material: Stainless steel.
   b. Nominal Size: [**88 by 30 inches (2250 by 762 mm)**]<**Insert dimensions**> with deck faucet holes.
   c. Faucet: Manufacturer's standard, deck mounted with wrist- or elbow-blade handles.
   d. Aspirator: Deck mounted.
   e. Removable body supports.
   f. Rinse Assembly: Deck-mounted faucet with hose.
   g. Disposer: [**Not required**][**Required, in accordance with UL 430**].
   h. Receptacle: Duplex, hospital grade with ground-fault interruption.
   i. Supplies: With atmospheric vacuum breakers, in accordance with ASSE 1001, and stops.
   j. Drain: [**Grid**]<**Insert type**> with **NPS 1-1/2 (DN 40)** tailpiece.
   k. Waste piping.
   l. Unit Electrical Characteristics:

      1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
      2) Phase(s): [**One**][**Three**].
      3) Hertz: [**60**]<**Insert number**>.
      4) Full-Load Amperes: <**Insert value**>.
      5) Minimum Circuit Ampacity: <**Insert value**>.
      6) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Dissecting Sink: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CSI Industries Inc.**]
   b. [**LEEC**]
   c. [**Mopec**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**CSI Industries Inc.**]
   b. [**LEEC**]
   c. [**Mopec**]
   d. **<Insert manufacturer's name>**

3. Description: Wall-mounted sink with backsplash.

a. Material: Stainless steel.
b. Nominal Size:

1) [**84 by 28 inches (2130 by 710 mm)**]<**Insert dimensions**> with back faucet holes.
2) Approximately **30 inches (760 mm)** wide.

c. Equipment drawer.
d. Faucet: <**Insert faucet designation**>.
e. Aspirator: Back mounted.
f. Rinse Assembly: One back-mounted faucet with hose.
g. Disposer: [**Not required**][**Required, in accordance with UL 430**].
h. Support: ASME A112.6.1M, [**Type I sink carrier**][**Type III sink carrier**]<**Insert carrier**>.
i. Supplies: With atmospheric vacuum breakers, in accordance with ASSE 1001, and stops.
j. Drain: [**Grid**]<**Insert type**> with **NPS 1-1/2 (DN 40)** tailpiece.
k. Waste Piping: Comply with requirements in "Waste Fittings" Article.
l. Back-mounted, handheld eye wash.
m. Unit Electrical Characteristics:

1) Volts: [**120**][**240**][**277**][**480**]<**Insert number**>.
2) Phase(s): [**One**][**Three**].
3) Hertz: [**60**]<**Insert number**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

2.20 SUPPORTS

A. Water-Closet Carrier: <**Insert carrier type**>.

1. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.[**Include additional extension coupling, faceplate, and feet for installation in wide pipe space.**]
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]

e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

B. Type I Sink Carrier: **<Insert sink designation>**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

C. Type II Sink Carrier: **<Insert sink designation>**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]

g. **<Insert manufacturer's name>**

D. Type III Sink Carrier: **<Insert sink designation>**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

3. Support Brackets: [**White-enameled**]steel.

E. Type IV Sink Carrier: **<Insert sink designation>**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Wade; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]

f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2.21 SUPPLY FITTINGS

A. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.

B. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

C. Operation: [**Loose key**][**Wheel handle**]<**Insert type**>.

D. Risers: **NPS 1/2 (DN 15)** [**chrome-plated, rigid-copper pipe and brass straight or offset tailpieces**][**chrome-plated, soft-copper flexible tube**][**ASME A112.18.6, braided or corrugated stainless steel, flexible hose**].

2.22 WASTE FITTINGS

A. Drain: [**Grid**]<**Insert type**> with **NPS 1-1/2 (DN 40)** tailpiece.

B. Trap:

1. Size: **NPS 1-1/2 (DN 40)**.
2. Material:

a. Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick, brass tube to wall**][**two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick, brass tube to wall**][**one-piece, cast-brass trap with swivel 0.029-inch- (73-mm-) thick, tubular brass wall bend**]<**Insert trap type**>; and chrome-plated brass or steel wall flange.
b. Stainless steel, two-piece trap and swivel elbow with **0.012-inch- (0.30-mm-)** thick, stainless steel tube to wall; and stainless steel wall flange.

2.23 GROUT

A. Characteristics: Nonshrink; recommended for interior and exterior applications.

B. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

C. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HEALTHCARE PLUMBING FIXTURES

A. Install healthcare plumbing fixtures level and plumb in accordance with rough-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install floor-mounted healthcare water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.

D. Install counter-mounted fixtures in, and attached to, casework.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception for use of ball or gate valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install flushometer valves on healthcare water closets.

G. Install flushometer valves for accessible healthcare water closets, with lever handle mounted on wide side of compartment.

H. Install toilet seats on healthcare water closets.

I. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts, if faucets are not available with required rates and patterns. Include adapters if required.

J. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.

K. Install shower flow-control fittings with specified maximum flow rates in shower arms.

L. Install traps on fixture outlets.

1. Exception for omission of trap on fixtures with integral traps.

M. Set healthcare showers in leveling bed of cement grout.

N. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

O. Seal joints between healthcare plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

P. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-

pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."

C. Comply with requirements for soil and waste drainage piping[**and vent piping**] specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Comply with requirements for atmospheric vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."

E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning healthcare plumbing fixtures, fittings, and controls.

B. Adjust water pressure at [**faucets**][**and**][**flushometer valves**] to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After installing healthcare plumbing fixtures, inspect and repair damaged finishes.

B. Clean healthcare plumbing fixtures, faucets, and other fittings with manufacturers' recommended

cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of healthcare plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 43 00 00

Task	Specification	Specification Description
22 43 13 00	22 45 00 00	Emergency Plumbing Fixtures
22 43 16 00	22 45 00 00	Emergency Plumbing Fixtures
22 43 39 00	22 43 00 00	Healthcare Plumbing Fixtures
22 43 39 00	22 45 00 00	Emergency Plumbing Fixtures

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SECTION 22 45 00 00 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency showers.
2. Emergency eyewashes.
3. Emergency eye/face washes.
4. Emergency combination showers with eyewashes.
5. Emergency combination showers with eye/face washes.
6. Emergency recessed safety stations.
7. Supplemental equipment.
8. Water-tempering equipment.

1.2 DEFINITIONS

A. Barrier-Free Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between **60 and 100 deg F (16 and 38 deg C)**.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution: Separate lot and equal to at least [**200**]<**Insert number**> percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Plumbing fixtures intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Comply with requirements in ICC A117.1 for installation of barrier-free emergency fixtures.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 EMERGENCY SHOWERS

A. Emergency Shower - Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]

c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, freestanding, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1
   b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: [**NPS 1-1/4 (DN 32)**]<**Insert size**>.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**]<**Insert material**>.
8. Control Valve:

   a. Type: Stay-open type with flow regulator.
   b. Actuator: Pull rod[**, 60-inch (1524-mm)**].

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: Pedestal[**, barrier-free**].
11. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

B. Emergency Shower - Off Floor, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Sellstrom Manufacturing Company**]
   g. [**Speakman Company**]
   h. [**Stingray Systems LLC**]
   i. [**WaterSaver Faucet Co**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Sellstrom Manufacturing Company**]
g. [**Speakman Company**]
h. [**Stingray Systems LLC**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, off floor, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

   a. Type: Stay-open type with flow regulator.
   b. Actuator: Pull rod[**, 60-inch (1524-mm)**].

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: [**Horizontal from wall**][**Vertical from ceiling**][**, barrier-free**] and supported from structure.
11. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

C. Emergency Shower - Wall Mounted, Fully Recessed, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Guardian Equipment Co**]
   d. [**Haws Corporation**]
   e. [**Speakman Company**]
   f. [**WaterSaver Faucet Co**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Guardian Equipment Co**]
    d. [**Haws Corporation**]
    e. [**Speakman Company**]
    f. [**WaterSaver Faucet Co**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, wall mounted, fully recessed, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**]<**Insert material**>.
8. Control Valve: Stay-open type with flow regulator.
9. Enclosure: Wall-mounted, fully recessed, stainless steel enclosure with vandal-resistant access panel.
10. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, stainless steel <**Insert material**>.
11. Mounting: [**Horizontal from wall**][**Vertical from ceiling**][**, barrier-free**] and supported from structure.
12. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

D. Emergency Shower - Freeze Resistant, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Guardian Equipment Co**]
    c. [**Haws Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]
c. [**Haws Corporation**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency showers, freeze resistant, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1 (DN 25)**.
7. Integral Supply Pipe Material: Galvanized steel.
8. Control Valve:

   a. Type: Stay-open type with flow regulator.
   b. Actuator: Wall-mounted push handle.

9. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum-diameter, [**stainless steel**][**plastic**]<**Insert material**>.
10. Mounting: Horizontal from wall[**, barrier-free**]. Concealed piping within heated space.
11. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

2.3 EMERGENCY EYEWASHES

A. Emergency Eyewash - Standard, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bradley Corporation**]
   b. [**Guardian Equipment Co**]
   c. [**Speakman Company**]
   d. [**Stingray Systems LLC**]
   e. [**WaterSaver Faucet Co**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, freestanding, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**]<**Insert material**>.
8. Control Valve:

   a. Type: Stay-open type valve with flow regulator.
   b. Actuator: [**Paddle**][**Treadle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Pedestal.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

B. Emergency Eyewash - Barrier-Free, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bradley Corporation**]
   b. [**Stingray Systems LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Stingray Systems LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, barrier free, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Stainless steel**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Offset pedestal.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

C. Emergency Eyewash - Standard, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. [**WaterSaver Faucet Co**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bradley Corporation**]
   b. [**Speakman Company**]
   c. [**Stingray Systems LLC**]
   d. [**WaterSaver Faucet Co**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, wall mounted, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**]<**Insert material**>.
8. Control Valve:

   a. Type: Stay-open with flow regulator.
   b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

D. Emergency Eyewash - Barrier Free, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Speakman Company**]
c. [**Stingray Systems LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, barrier free, wall mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**]<**Insert material**>.
8. Control Valve:

a. Type: Stay-open with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

a. Size: **NPS 1-1/4 (DN 32)** minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

E. Emergency Eyewash - Deck or Wall Mounted, Swivel Type, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Guardian Equipment Co**]
c. [**Speakman Company**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, [**deck**][**wall**] mounted, swivel type, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Rotation of spray-head assembly**][**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two spray heads with offset piping.
10. Mounting: [**Deck mounted next to sink**][**Deck mounted on sink**][**Wall mounted**]<**Insert mounting**>.

F. Emergency Eyewash - Portable, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, portable, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Pressure Tank: [**10 gal. (38 L)**]<**Insert value**>, stainless steel, cylindrical, with pressure gauge, and suitable for on-floor installation.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Spray-Head Assembly: [**Chrome-plated copper alloy**][**Stainless steel**] piping with flow regulator; control valve; and two spray heads mounted on tank.
9. Control Valve:

   a. Type: Stay-open type with flow regulator.
   b. Actuator: Paddle.

10. Drench Hose: Handheld spray head with squeeze-handle actuation and hose attached to tank.

G. Emergency Eyewashes - Standard, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Honeywell Industrial Safety; Honeywell International, Inc.**]
   g. [**Sellstrom Manufacturing Company**]
   h. [**Speakman Company**]
   i. [**WaterSaver Faucet Co**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]

f. [**Honeywell Industrial Safety; Honeywell International, Inc.**]
g. [**Sellstrom Manufacturing Company**]
h. [**Speakman Company**]
i. [**WaterSaver Faucet Co**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, standard, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Gravity Tank: [**7 gal. (27 L) minimum**]<**Insert value**>, plastic, and suitable for shelf mounting.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Actuator: Pull-down front panel or pull strap.
9. Spray Heads: Protected, two mounted on tank.

H. Emergency Eyewash - Freeze Resistant, Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bradley Corporation**]
b. [**Encon Safety Products**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eyewashes, freeze resistant, self-contained, from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Gravity Tank: [**7 gal. (27 L) minimum**][**14 gal. (53 L) minimum**][**20 gal. (76 L) minimum**]<**Insert value**>, plastic, and suitable for shelf mounting.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Actuator: Pull-down front panel or pull strap.
9. Spray Heads: Protected, two mounted on tank.
10. Heating System: Electric, 120 V ac; insulation enclosed in a protective jacket.

2.4 EMERGENCY EYE/FACE WASHES

A. Emergency Eye/Face Wash - Standard, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Speakman Company**]
   g. [**Stingray Systems LLC**]
   h. [**WaterSaver Faucet Co**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Speakman Company**]
   g. [**Stingray Systems LLC**]
   h. [**WaterSaver Faucet Co**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, standard, freestanding, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**][**PVC**].
8. Control Valve:

   a. Type: Stay-open type with flow regulator.
   b. Actuator: [**Paddle**][**Treadle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.

c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Pedestal.
13. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Dust covers.
e. Magnetically actuated proximity switch.
f. Scald protection valve.
g. <**Insert size**> stainless steel ball valve.
h. <**Insert accessory**>.

B. Emergency Eye/Face Wash - Barrier Free, Freestanding, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Stingray Systems LLC**]
e. [**WaterSaver Faucet Co**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, barrier free, freestanding, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Galvanized steel**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open type with flow regulator.
b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**] bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

12. Mounting: Offset pedestal.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

C. Emergency Eye/Face Wash - Standard, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Encon Safety Products**]
    d. [**Guardian Equipment Co**]
    e. [**Haws Corporation**]
    f. [**Speakman Company**]
    g. [**Stingray Systems LLC**]
    h. [**WaterSaver Faucet Co**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, standard, wall mounted, plumbed, from single manufacturer.

4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**][**PVC**]<**Insert material**>.
8. Control Valve:

    a. Type: Stay-open type with flow regulator.
    b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

D. Emergency Eye/Face Wash - Barrier Free, Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Safety; a Division of Morris Group International**]
    b. [**Bradley Corporation**]
    c. [**Guardian Equipment Co**]
    d. [**Haws Corporation**]
    e. [**Speakman Company**]
    f. [**Stingray Systems LLC**]
    g. [**WaterSaver Faucet Co**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Safety; a Division of Morris Group International**]

b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Speakman Company**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, accessible, wall mounted, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

   a. Type: Stay-open with flow regulator.
   b. Actuator: [**Paddle**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four receptor-mounted spray heads.
10. Receptor: [**Stainless steel**][**Plastic**]<**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Wall bracket.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

E. Emergency Eye/Face Wash - Deck or Wall Mounted, Swivel Type, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Guardian Equipment Co**]

d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Guardian Equipment Co**]
d. [**Haws Corporation**]
e. [**Stingray Systems LLC**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, [**deck**][**wall**] mounted, swivel type, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: [**Chrome-plated brass**][**Stainless steel**].
8. Control Valve:

a. Type: Stay-open with flow regulator.
b. Actuator: Movement of spray-head assembly.

9. Spray-Head Assembly: Two or four spray heads with offset piping.
10. Mounting: [**Deck mounted**][**Wall mounted**]<**Insert mounting**>.

a. Location: [**Deck mounted next to sink**][**Deck mounted on sink**][**Wall mounted behind sink**]<**Insert mounting**>

F. Emergency Eye/Face Wash - Deck Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Guardian Equipment Co**]

c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency eye/face washes, deck mounted, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
6. Supply Connection Size: **NPS 1/2 (DN 15)**.
7. Integral Supply Pipe Material: Chrome-plated brass.
8. Control Valve:

   a. Type: Stay-open type valve with flow regulator.
   b. Actuator: [**Paddle**][**Push down**]<**Insert actuator**>.

9. Spray-Head Assembly: Two or four spray heads.
10. Receptor: Stainless steel <**Insert material**> bowl.
11. Drain Piping:

    a. Size: **NPS 1-1/4 (DN 32)** minimum.
    b. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

12. Mounting: Deck.
13. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Dust covers.
    e. Magnetically actuated proximity switch.
    f. Scald protection valve.
    g. <**Insert size**> stainless steel ball valve.
    h. <**Insert accessory**>.

2.5 EMERGENCY COMBINATION SHOWERS WITH EYEWASHES

A. Emergency Combination Shower with Eyewash, Standard, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Speakman Company**]

g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Speakman Company**]
   g. [**Stingray Systems LLC**]
   h. [**WaterSaver Faucet Co**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eyewashes, standard, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

   a. Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**][**PVC**].
   b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
   c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

   a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1 (DN 25)**.
   c. Control Valve:

      1) Stay-open type with flow regulator.
      2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**][**Treadle**]<**Insert actuator**>.

   d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
   e. Mounting: Pedestal.

7. Eyewash:

   a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
   b. Supply Piping Size: **NPS 1/2 (DN 15)**.
   c. Control Valve:

      1) Stay-open with flow regulator.
      2) Actuator: Paddle.

   d. Spray-Head Assembly: Two receptor-mounted spray heads.
   e. Receptor: [**Stainless steel**][**Plastic**] bowl.

f. Mounting: Attached to shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.

1) Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

8. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

B. Emergency Combination Shower with Eyewash, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eyewashes, barrier free, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

   a. Material: [**Galvanized steel**][**Stainless steel**].
   b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
   c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

   a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
   c. Control Valve:

      1) Type: Stay-open type with flow regulator.
      2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

   d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
   e. Mounting: Pedestal.

7. Eyewash:

   a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
   c. Control Valve:

      1) Type: Stay-open type with flow regulator.
      2) Actuator: Paddle.

   d. Spray-Head Assembly: Two receptor-mounted spray heads.
   e. Receptor: [**Stainless steel**][**Plastic**] bowl.
   f. Mounting: Attached shower pedestal.
   g. Drench-Hose Option: May be provided instead of eyewash unit.

      1) Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
      2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
      3) Mounting: Bracket on shower pedestal.

8. Accessories:

   a. Electric alarm with flashing light and horn.
   b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
   c. Flow switch; single pole.
   d. Modesty curtain.
   e. Magnetically actuated proximity switch.
   f. <**Insert size**> stainless steel ball valve.
   g. <**Insert accessory**>.

2.6 EMERGENCY COMBINATION SHOWERS WITH EYE/FACE WASHES

A. Emergency Combination Shower with Eye/Face Wash, Standard, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]
g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Speakman Company**]
g. [**Stingray Systems LLC**]
h. [**WaterSaver Faucet Co**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eye/face washes, standard, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

a. Material: [**Galvanized steel**][**Chrome-plated brass**][**Stainless steel**][**PVC**].
b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open with flow regulator.
2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**][**Treadle**]<**Insert actuator**>.

d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
e. Mounting: Pedestal.

7. Eye/Face Wash:

a. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open type with flow regulator.
2) Actuator: Paddle.

d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor: [**Stainless steel**][**Plastic**] bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eye/face wash unit.

1) Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

8. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

B. Emergency Combination Shower with Eye/Face Wash, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Haws Corporation**]
f. [**Stingray Systems LLC**]
g. [**WaterSaver Faucet Co**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with eye/face washes, barrier free, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.

5. Integral Supply/Drain Pipe:

    a. Material: [**Galvanized steel**][**Stainless steel**].
    b. Supply Connection Size: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].
    c. Drain Connection Size: Outlet at back or side near bottom. **NPS 1-1/4 (DN 32)** minimum.

6. Shower:

    a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
    c. Control Valve:

        1) Type: Stay-open type with flow regulator.
        2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

    d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless steel**][**plastic**].
    e. Mounting: Pedestal.

7. Eye/Face Wash:

    a. Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
    c. Control Valve:

        1) Type: Stay-open type with flow regulator.
        2) Actuator: Paddle.

    d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
    e. Receptor: [**Stainless steel**][**Plastic**] bowl.
    f. Mounting: Attached to shower pedestal.
    g. Drench-Hose Option: May be provided instead of eye/face wash unit.

        1) Capacity: Not less than **3.0 gpm (11.4 L/min.)** for at least 15 minutes.
        2) Drench Hose: Handheld spray head with squeeze-handle actuator and hose.
        3) Mounting: Bracket on shower pedestal.

8. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge. ASSE 1071 compliant.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

C. Emergency Combination Shower with Eyewash or Eye/Face Wash, Freeze Resistant, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**B-L-S Industries, Inc**]
   c. [**Bradley Corporation**]
   d. [**Encon Safety Products**]
   e. [**Guardian Equipment Co**]
   f. [**Haws Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**B-L-S Industries, Inc**]
   c. [**Bradley Corporation**]
   d. [**Encon Safety Products**]
   e. [**Guardian Equipment Co**]
   f. [**Haws Corporation**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency combination showers with [**eyewashes**][**eye/face washes**], freeze resistant, plumbed, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.

5. Integral Supply Pipe Material: Galvanized steel.

   a. Supply Connection: [**NPS 1-1/4 (DN 32) minimum**][**NPS 1-1/2 (DN 40)**].

6. Heating System: Electric, [**120**][**240**] V ac; insulation enclosed in a protective jacket with thermometer.

   a. Heating Capacity: [**10 deg F (6 deg C)**]<**Insert temperature**> minimum above ambient temperature.
   b. Design Ambient Temperature: <**Insert temperature**>.

7. Shower:

   a. Shower Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
   b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
   c. Control Valve:

      1) Type: Stay-open type with flow regulator.
      2) Actuator: [**Pull rod**][**, 60-inch (1524-mm)**]<**Insert actuator**>.

   d. Shower Head: [**3-inch- (76-mm-)**][**8-inch- (200-mm-)**] minimum diameter, [**stainless**

steel][**plastic**].
e. Mounting: Pedestal.

8. Eyewash:

a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
c. Control Valve:

1) Type: Stay-open with flow regulator.
2) Actuator: [**Paddle**]<**Insert actuator**>.

9. Eye/Face Wash:

a. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
b. Control Valve:

1) Type: Stay-open type with flow regulator.
2) Actuator: [**Paddle**]<**Insert actuator**>.

10. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. <**Insert size**> stainless steel ball valve.
g. <**Insert accessory**>.

2.7 EMERGENCY RECESSED SAFETY STATIONS

A. Emergency Recessed Safety Station - Emergency Eye/Face Wash with Shower, Barrier Free, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Guardian Equipment Co**]
b. [**Haws Corporation**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Guardian Equipment Co**]
b. [**Haws Corporation**]
c. [**WaterSaver Faucet Co**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain emergency recessed safety stations, emergency eye/face wash with shower, barrier free, plumbed, from single manufacturer.
4. Standards:

    a. ANSI/ISEA Z358.1.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.
    d. Barrier-free installation.

5. Cabinet:

    a. Mounting: Wall-mounted, fully recessed, stainless steel enclosure with vandal-resistant access panel.
    b. Fire Rated: [**1-hour**][**2-hour**].

        1) UL-listed as "Through Penetration Firestop System No. W-L-7167."

    c. Contents:

        1) Supply valves, flow regulator(s), strainers.
        2) Eye/face wash with daylight or no drain.
        3) Pull-down handle for shower valve activation.
        4) Combination cover and internal drain pan. Pull handle on face of unit down from vertical to horizontal position to activate eye/face wash.
        5) Internal Drain Connection: Outlet at bottom. **NPS 2 (DN 50)** minimum.

6. Eye/Face Wash:

    a. Capacity: Not less than **3 gpm (11.4 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull handle on face of unit down from vertical to horizontal position.
    d. Spray-Head Assembly: Two or four receptor-mounted spray heads.

7. Shower:

    a. Shower Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
    b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull handle on face of unit from up to down position.
    d. Shower Head: **8-inch- (200-mm-)** minimum diameter, [**chrome-plated brass**][**stainless steel**][**plastic**].
    e. Mounting: [**Horizontal from wall, exposed**][**Vertical from ceiling, exposed**][**Vertical from ceiling, recessed**].

8. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. <**Insert size**> stainless steel ball valve.
    g. <**Insert accessory**>.

2.8 SUPPLEMENTAL EQUIPMENT

A. Personal Eyewash - Self-Contained :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bradley Corporation**]
   b. [**Encon Safety Products**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bradley Corporation**]
   b. [**Encon Safety Products**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain self-contained, personal eyewashes from single manufacturer.
4. Standard: ANSI/ISEA Z358.1.
5. Capacity: Not less than **0.4 gpm (1.5 L/min.)**.
6. Pressure Tank: [**5 gal. (19 L)**]<**Insert value**>, stainless steel, cylindrical, with pressure gauge and base suitable for on-floor installation.
7. Flushing Fluid: Medically acceptable solution manufactured and labeled in accordance with applicable regulations.
8. Spray-Head Assembly: Chrome-plated copper alloy or stainless steel piping with flow regulator; paddle-actuated, stay-open control valve; and two spray heads mounted on tank.

B. Drench Hose - Deck Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Speakman Company**]
   f. [**WaterSaver Faucet Co**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Bradley Corporation**]
   c. [**Encon Safety Products**]
   d. [**Guardian Equipment Co**]
   e. [**Speakman Company**]

f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain drench hoses, deck mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Fitting: **NPS 1/2 (DN 15)** brass with flow regulator.
7. Drench Hose: Handheld spray head with [**squeeze-handle**][**push handle ball valve**] actuation and hose.
8. Mounting: In hole on deck.

C. Drench Hose - Wall Mounted, Plumbed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Safety; a Division of Morris Group International**]
b. [**Bradley Corporation**]
c. [**Encon Safety Products**]
d. [**Guardian Equipment Co**]
e. [**Speakman Company**]
f. [**WaterSaver Faucet Co**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain drench hoses, wall mounted, plumbed, from single manufacturer.
4. Standards:

a. ANSI/ISEA Z358.1.
b. ASME A112.18.1/CSA B125.1.

5. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
6. Supply Fitting: **NPS 1/2 (DN 15)** brass with flow regulator.
7. Drench Hose: Handheld spray head with [**squeeze-handle**][**push handle ball valve**] actuation and hose.
8. Mounting: Wall bracket.

2.9 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Armstrong International, Inc**]
   c. [**Bradley Corporation**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Lawler Manufacturing Company, Inc**]
   g. [**Leonard Valve Company**]
   h. [**Speakman Company**]
   i. [**Stingray Systems LLC**]
   j. [**WaterSaver Faucet Co**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Safety; a Division of Morris Group International**]
   b. [**Armstrong International, Inc**]
   c. [**Bradley Corporation**]
   d. [**Guardian Equipment Co**]
   e. [**Haws Corporation**]
   f. [**Lawler Manufacturing Company, Inc**]
   g. [**Leonard Valve Company**]
   h. [**Speakman Company**]
   i. [**Stingray Systems LLC**]
   j. [**WaterSaver Faucet Co**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.

5. Description: Factory-fabricated equipment with thermostatic mixing valve.

   a. Thermostatic Mixing Valve: Designed to provide [**85 deg F (29 deg C)**]<**Insert temperature**> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [**5 deg F (3 deg C)**]<**Insert temperature**> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, **and corrosion-resistant** enclosure. ASSE 1071 compliant.
   b. Supply Connections: For hot and cold water.

c. Cabinet: [**Surface**][**Recess**] mounted.

B. Water-Tempering Equipment - Electric, Tankless :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bradley Corporation**]
   b. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
   c. [**Encon Safety Products**]
   d. [**Haws Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bradley Corporation**]
   b. [**Chronomite Laboratories, Inc; a division of Morris Group International**]
   c. [**Encon Safety Products**]
   d. [**Haws Corporation**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water-tempering equipment, electric, tankless from single manufacturer.
4. Standards:

   a. ANSI/ISEA Z358.1.
   b. ASME A112.18.1/CSA B125.1.

5. Description: Factory-fabricated equipment with electric heating.

   a. Heating System: Electric, designed to provide [**85 deg F (29 deg C)**]<**Insert temperature**> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [**5 deg F (3 deg C)**]<**Insert temperature**> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.

      1) Electrical Characteristics: [**208 V ac, single phase**][**240 V ac, single phase**][**277 V ac, single phase**][**208 V ac, 3 phase**][**240 V ac, 3 phase**][**480 V ac, 3 phase**], 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water[**and waste**] piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURES

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of fixture. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exceptions:

a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency fixture.
b. Omit shutoff valve on supply to emergency fixture if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency fixture if piping and fixture connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install trap and waste piping on drain outlet of emergency fixture receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**]

H. Install indirect waste piping on drain outlet of emergency fixture receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**]

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with

requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in [**Section 221316 "Sanitary Waste and Vent Piping."**][**Section 221316 "Sanitary Waste and Vent Piping" and Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities."**] Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to [**sanitary waste**][**chemical waste**][**storm drainage**] piping.

E. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Emergency plumbing fixtures[**and water-tempering equipment**] will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.8 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 45 00 00

Task	Specification	Specification Description
22 45 13 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 16 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 23 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 26 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 29 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 33 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 36 00	22 45 00 00	Emergency Plumbing Fixtures
22 45 39 00	22 45 00 00	Emergency Plumbing Fixtures

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SECTION 22 46 00 00 - SECURITY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Security combination water closet/lavatory fixtures.
2. Security water closets.
3. Security urinals.
4. Security lavatories.
5. Security drinking fountains.
6. Security showers.
7. Security service sinks.
8. Flushometer valves.
9. Toilet seats.

B. Related Requirements:

1. Section 224200 "Commercial Plumbing Fixtures."
2. Section 224300 "Healthcare Plumbing Fixtures."
3. Section 224500 "Emergency Plumbing Fixtures."
4. Section 224700 "Drinking Fountains and Water Coolers."

1.2 DEFINITIONS

A. Accessible Service Space: Service area in secure space behind wall-mounted fixtures.

B. Back-Access Fixture: Security plumbing fixture designed to mount on wall sleeve built into wall or on wall, so installation and removal of fixture, piping, and other components are accessible only from service space behind wall.

C. Front-Access Fixture: Security plumbing fixture designed to mount on wall with installation and removal from fixture side of wall, and with piping and other components accessible only from access panel in fixture.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for security plumbing fixtures.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For water consumption.
2. WaterSense Fixtures: Provide WaterSense label for toilets, urinals, lavatories, and showerheads.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For security plumbing fixtures and components.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to [**10**]<**Insert number**> percent of quantity of each type installed, but no fewer than [**one**][**six**]<**Insert number**> of each type.
2. Toilet Seats: Equal to [**five**]<**Insert number**> percent of quantity of each type installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Faucets and bubblers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 SECURITY COMBINATION WATER CLOSET/LAVATORY FIXTURES

A. Security Combination Water Closet/Lavatory Fixture - Stainless Steel, Back Access, On or Off Floor, Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security combination water closet/lavatory fixtures from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.19.5/CSA B45.15.
c. ASME A112.18.1/CSA B125.1.
d. ASME A112.18.2/CSA B125.2.
e. ICC A117.1.
f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction, with fire-resistant sound-deadening material in cabinet interior. Toilet to be able to withstand a **5000 lb (22 kN)** load without deflection and/or damage.
6. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
7. Configuration: [**On**][**Off**] floor.
8. Cabinet: [**Rectangular apron**][**Five-sided apron with two angled sides**][**Four-sided apron with angled left side**][**Four-sided apron with angled right side**]<**Insert configuration**>, with backsplash.

a. Water-Closet Bowl Location: [**Centered on front**][**Left of center on front**][**Right of center on front**][**On angled left side**][**On angled right side**]<**Insert location**> of apron.
b. Toilet-Paper Holder: Recessed; stainless steel located [**above water closet and centered in front**][**in front**][**right of center in front**][**left of center in front**][**in angled right side**][**in angled left side**][**in right side**][**in left side**]<**Insert location**> of apron.

9. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.
10. Accessories:

a. Toothbrush Holder: One on [**each**][**left**][**right**] side of backsplash.
b. Towel Hook: [**One**][**Two**] on [**each**][**left**][**right**] side of fixture.
c. Bubbler: On [**backsplash**][**deck**].

11. Mounting: Bolts through wall sleeve into accessible service space.
12. Water Closet:

a. Bowl:

1) Type: Elongated, with back inlet, integral trap, and [**blowout**][**siphon-jet**] design with back outlet and integral contoured seat.
2) Seat Surface: Satin polished finish.
3) Punching: Two holes for installation of separate toilet seat.
4) Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], horizontal with cleanout and slip joint.

13. Flushometer Valve: <**Insert flushometer valve designation**>.
14. Toilet Seat: <**Insert toilet seat designation**>.
15. Lavatory:

a. Location: In top of cabinet.
b. Receptor: [**Oval**][**or**][**rectangular**] bowl with integral soap depression.
c. Hot- and Cold-Water and Bubbler Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual

check stops. Non-hold-open valve.
d. Filler Spout: [**Backsplash**][**or**][**deck**] mounted.
e. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** minimum waste and trap.

16. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.

B. Security Combination Water Closet/Lavatory Fixture - Stainless Steel, Front Access, On Floor, Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security combination water closet/lavatory fixtures from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.19.5/CSA B45.15.
   c. ASME A112.18.1/CSA B125.1.
   d. ASME A112.18.2/CSA B125.2.
   e. ICC A117.1.
   f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction, with fire-resistant sound-deadening material in cabinet interior. Toilet to be able to withstand a **5000 lb (22 kN)** load without deflection and/or damage.
6. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
7. Cabinet: [**Rectangular apron**][**Five-sided apron with two angled sides**][**Four-sided apron with angled left side**][**Four-sided apron with angled right side**]<**Insert configuration**>, with backsplash and access panel.

   a. Water-Closet Bowl Location: [**Centered on front**][**Left of center on front**][**Right of center on front**][**On angled left side**][**On angled right side**]<**Insert location**> of apron.
   b. Toilet-Paper Holder: Recessed; stainless steel located [**above water closet and centered**

in front][**in front**][**right of center in front**][**left of center in front**][**in angled right side**][**in angled left side**][**in right side**][**in left side**]<**Insert location**> of apron.

8. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.
9. Accessories:

    a. Toothbrush Holder: One on [**each**][**left**][**right**] side of backsplash.
    b. Towel Hook: [**One**][**Two**] on [**each**][**left**][**right**] side of fixture.
    c. Bubbler: On [**backsplash**][**deck**].

10. Mounting: Bolts through wall sleeve into accessible service space.
11. Water Closet:

    a. Bowl:

        1) Type: Elongated, with back inlet, integral trap, and [**blowout**][**siphon-jet**] design with back outlet and integral contoured seat.
        2) Seat Surface: Satin polished finish.
        3) Punching: Two holes for installation of separate toilet seat.
        4) Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], horizontal with cleanout and slip joint.

12. Flushometer Valve: <**Insert flushometer valve designation**>.
13. Toilet Seat: <**Insert toilet seat designation**>.
14. Lavatory:

    a. Location: In top of cabinet.
    b. Receptor: [**Oval**][**or**][**rectangular**] bowl with integral soap depression.
    c. Hot- and Cold-Water and Bubbler Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops. Non-hold-open valve.
    d. Filler Spout: [**Backsplash**][**or**][**deck**] mounted.
    e. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** minimum waste and trap.

15. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.

2.3 SECURITY WATER CLOSETS

A. Security Water Closet - Stainless Steel, Back Access, Off Floor, Back Outlet, Compact :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security water closets from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.19.5/CSA B45.15.
c. ASME A112.6.1M.
d. ICC A117.1.
e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction. Toilet to be able to withstand a minimum of **1500 lb (7 kN)** load without deflection and/or damage.
6. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
7. Features: [**ADA compliant**]<**Insert feature**>.
8. Bowl:

a. Type: Elongated, with back inlet, integral trap, and blowout design with integral contoured seat.
b. Length to Wall: Approximately **19 inches (483 mm)**.
c. Seat Surface: Satin polished finish.
d. Punching: Two holes for installation of separate toilet seat.

9. Mounting: Bolts through wall sleeve into accessible service space.
10. Mounting Height: [**Standard**][**Accessible**].
11. Flushometer Valve: <**Insert flushometer valve designation**>.
12. Toilet Seat: <**Insert toilet seat designation**>.
13. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.

a. Configuration for Accessible Fixtures: Modify wall sleeve for accessible water-closet mounting height.

B. Security Water Closet - Stainless Steel, Back Access, On or Off Floor, Back or Floor Outlet, Extended Bowl :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]

d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security water closets from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.19.5/CSA B45.15.
   c. ASME A112.6.1M.
   d. ICC A117.1.
   e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction. Toilet to be able to withstand a **5000 lb (22 kN)** load without deflection and/or damage.
6. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
7. Configuration: [**On**][**Off**] floor, [**back**][**floor**] outlet.
8. Features: [**ADA compliant**]<**Insert feature**>.
9. Bowl:

   a. Type, for Back-Outlet Water Closet: Elongated, with back inlet, integral trap, and [**blowout**][**siphon-jet**] design with back outlet and integral contoured seat.
   b. Type, for Bottom-Outlet Water Closet: Elongated, with back inlet, integral trap, and siphon-jet design with bottom outlet and contoured seat.
   c. Length to Wall: Minimum of **25 inches (635 mm)**.
   d. Back-Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], horizontal with cleanout and slip joint.
   e. Bottom-Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], vertical.
   f. Seat Surface: Satin polished finish.
   g. Punching: Two holes for installation of separate toilet seat.

10. Mounting: Bolts through wall sleeve into accessible pipe space.
11. Mounting Height: [**Standard**][**Accessible**].
12. Flushometer Valve: <**Insert flushometer valve designation**>.
13. Toilet Seat: <**Insert toilet seat designation**>.
14. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.

    a. Configuration for Accessible Fixtures: Modify wall sleeve for accessible water-closet mounting height.

C. Security Water Closet - Stainless Steel, Front Access, On or Off Floor, Back or Floor Outlet, Extended Bowl :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations:

    a. Obtain security water closets from single manufacturer.

4. Standards:

    a. ASME A112.19.3/CSA B45.4.
    b. ASME A112.19.5/CSA B45.15.
    c. ICC A117.1.
    d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction. Toilet to be able to withstand a **5000 lb (22 kN)** load without deflection and/or damage.
6. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
7. Configuration: [**On**][**Off**] floor, [**back**][**floor**] outlet.
8. Features: [**ADA compliant**]<**Insert feature**>.
9. Bowl:

    a. Type, for Back-Outlet Water Closet: Elongated, with back inlet, integral trap, and [**blowout**][**siphon-jet**] design with back outlet, integral contoured seat, and access panel.
    b. Type, for Bottom-Outlet Water Closet: Elongated, with back inlet, integral trap, and siphon-jet design with bottom outlet, contoured seat, and access panel.
    c. Length to Wall: Minimum of **25 inches (635 mm)**.
    d. Back-Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], horizontal with cleanout and slip joint.
    e. Bottom-Outlet Connection: [**NPS 3 (DN 80)**][**NPS 4 (DN 100)**], vertical.
    f. Seat Surface: Satin polished finish.
    g. Punching: Two holes for installation of separate toilet seat.

10. Mounting: Bolts from fixture-mounted flanges into wall.
11. Mounting Height: [**Standard**][**Accessible**].
12. Flushometer Valve: <**Insert flushometer valve designation**>.
13. Toilet Seat: <**Insert toilet seat designation**>.

14. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture. Include steel bars or other design to prevent escape if fixture is removed.

    a. Configuration for Accessible Fixtures: Modify wall sleeve for accessible water-closet mounting height.

D. Security Water Closet - Vitreous China, Floor Mounted, Back Outlet, Siphon Jet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Standard**]
    b. [**Kohler Co**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Standard**]
    b. [**Kohler Co**]
    c. <**Insert manufacturer's name**>

3. Source Limitations:

    a. Obtain security water closets from single manufacturer.

4. Standards:

    a. ASME A112.19.5/CSA B45.15.
    b. ICC A117.1.
    c. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

    a. Bowl: Elongated, vitreous china, with integral trap and integral contoured seat. [**ADA-compliant height.**]
    b. Spud Location and Size: Back, **NPS 1-1/2 (DN 40)**.

6. Flushometer Valve: <**Insert flushometer valve designation**>.
7. Toilet Seat: <**Insert toilet seat designation**>.
8. Support:

    a. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware match fixture.[**Include additional extension coupling, faceplate, and feet for installation in wide pipe space.**]

2.4 SECURITY URINALS

A. Security Urinal - Stainless Steel, Back Access, Back Outlet, Single :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations:

    a. Obtain security urinals from single manufacturer.

4. Standards:

    a. ASME A112.19.3/CSA B45.4.
    b. ASME A112.19.5/CSA B45.15.
    c. ASME A112.6.1M.
    d. ICC A117.1.
    e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

    a. Material: Minimum 18-gauge housing with 16-gauge bowl, Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in interior.
    b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
    c. Type and Configuration: [**Blowout**][**Washout**], with back inlet.
    d. Drain: Strainer with **NPS 2 (DN 50)** tailpiece and trap.
    e. Features: [**ADA compliant**]<**Insert feature**>.

6. Mounting: Bolts through wall sleeve into accessible service space.
7. Mounting Height: [**Standard**][**Accessible**].
8. Flushometer Valve: <**Insert designation**>.
9. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

B. Security Urinal - Stainless Steel, Front Access, Back Outlet, Single :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security urinals from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.19.5/CSA B45.15.
c. ASME A112.6.1M.
d. ICC A117.1.
e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: Minimum 18-gauge housing with 16-gauge bowl, Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in interior.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Type and Configuration: [**Blowout**][**Washout**], with back inlet and access panel.
d. Drain: Strainer with **NPS 2 (DN 50)** tailpiece and trap.
e. Features: [**ADA compliant**]<**Insert feature**>.

6. Mounting: Bolts from fixture-mounted flanges into wall.
7. Mounting Height: [**Standard**][**Accessible**].
8. Flushometer Valve: <**Insert designation**>.
9. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

C. Security Urinal - Stainless Steel, Back Access, Back Outlet, Trough :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security urinals from single manufacturer.

4. Standards:

   a. A112.19.3/CSA B45.4.
   b. ASME A112.19.5/CSA B45.15.
   c. ASME A112.6.1M.
   d. ICC A117.1.
   e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

   a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction.
   b. Finish: Satin polished finish on exposed surfaces.
   c. Type and Configuration: Washout, with back inlet, and [**36 inches (915 mm)**][**48 inches (1220 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] wide.
   d. Drain: Strainer with **NPS 2 (DN 50)** tailpiece and trap.
   e. Features: [**ADA compliant**]<**Insert feature**>.

6. Mounting: Bolts through wall sleeve into accessible service space.
7. Mounting Height: [**Standard**][**Accessible**].
8. Flushometer Valve: <**Insert designation**>.
9. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

D. Security Urinal - Stainless Steel, Bottom Outlet, Stall :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]

b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security urinals from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.19.5/CSA B45.15.
c. ASME A112.6.1M.
d. ICC A117.1.
e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Type and Configuration: Washout, with back inlet.
d. Drain: Strainer with **NPS 2 (DN 50)** outlet.

6. Mounting: Bolts through wall into accessible service space.
7. Flushometer Valve: <**Insert designation**>.

2.5 SECURITY LAVATORIES

A. Security Lavatory - Stainless Steel, Back Access :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security lavatories from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.
d. ASME A112.6.1M.
e. ICC A117.1.
f. NSF 61.
g. NSF 372.
h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in cabinet interior.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Size: <**Insert dimensions**>.
d. Receptor: [**Oval**][**or**][**rectangular**] bowl with integral soap depression and backsplash.
e. Hot- and Cold-Water and Bubbler Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops, and [**backsplash-**][**or**][**deck-**]mounted filler spouts. Non-hold-open valve.
f. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** minimum horizontal waste and trap.
g. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Accessories:

a. Toothbrush Holder: One on [**each**][**left**][**right**] side of backsplash.
b. Towel Hook: [**One**][**Two**] on [**each**][**left**][**right**] side of fixture.
c. Bubbler: Location on [**backsplash**][**deck**].

7. Mounting: Bolts through wall into accessible service space.
8. Mounting Height: [**Standard**][**Accessible**].

B. Security Lavatory - Stainless Steel, Front Access :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security lavatories from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.
d. ASME A112.6.1M.
e. ICC A117.1.
f. NSF 61.
g. NSF 372.
h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in cabinet interior.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Size: <**Insert dimensions**>.
d. Receptor: [**Oval**][**or**][**rectangular**] bowl with integral soap depression, backsplash, and access panel.
e. Hot- and Cold-Water and Bubbler Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops, and [**backsplash-**][**or**][**deck-**]mounted filler spouts. Non-hold-open valve.
f. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** minimum horizontal waste and trap.
g. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Accessories:

a. Toothbrush Holder: One on [**each**][**left**][**right**] side of backsplash.
b. Towel Hook: [**One**][**Two**] on [**each**][**left**][**right**] side of fixture.
c. Bubbler: Location on [**backsplash**][**deck**].

7. Mounting: Bolts from fixture-mounted flanges into wall.
8. Mounting Height: [**Standard**][**Accessible**].

2.6 SECURITY DRINKING FOUNTAINS

A. Security Drinking Fountain - Stainless Steel, Back Access :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Metcraft Industries, Inc.**]
c. [**Willoughby Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Metcraft Industries, Inc.**]
c. [**Willoughby Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security drinking fountains from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.
d. ASME A112.6.1M.
e. ICC A117.1.
f. NSF 61.
g. NSF 372.
h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in interior.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Receptor: Bowl with backsplash.
d. Bubbler Supply Valve: Push-button actuation and [**backsplash-**][**or**][**deck-**]mounted filler spouts.
e. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** tailpiece.
f. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Waste Fitting: **NPS 1-1/4 (DN 32)** minimum waste and trap.
7. Mounting: Bolts through wall into accessible service space.
8. Mounting Height: [**Standard**][**Accessible**].
9. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

B. Security Drinking Fountain - Stainless Steel, Front Access :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]

b. [**Metcraft Industries, Inc.**]
c. [**Willoughby Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**Metcraft Industries, Inc.**]
c. [**Willoughby Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security drinking fountains from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.18.1/CSA B125.1.
c. ASME A112.18.2/CSA B125.2.
d. ASME A112.6.1M.
e. ICC A117.1.
f. NSF 61.
g. NSF 372.
h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction with fire-resistant sound-deadening material in interior.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Receptor: Bowl with backsplash.
d. Bubbler Supply Valve: Push-button actuation and [**backsplash-**][**or**][**deck-**]mounted filler spouts.
e. Drain: Integral punched grid with **NPS 1-1/4 (DN 32)** tailpiece.
f. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Waste Fitting: **NPS 1-1/4 (DN 32)** minimum waste and trap.
7. Mounting: Bolts from fixture-mounted flanges into wall.
8. Mounting Height: [**Standard**][**Accessible**].

2.7 SECURITY SHOWERS

A. Security Shower - Stainless Steel, Back Access, Recessed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]

b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security showers from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.18.1/CSA B125.1.
   c. ASSE 1016.
   d. ICC A117.1.
   e. NSF 61.
   f. NSF 372.
   g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

   a. Material: 14-gauge, Type 304 stainless steel, seamless welded construction.
   b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
   c. Type and Configuration: Wall, with showerhead and soap dish.
   d. Tempered Hot- and Cold-Water Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops. Non-hold-open valve.[**ADA compliant.**]
   e. Shower: [**Hose with vandal-resistant, handheld**][**Vandal-resistant, fixed-type**][**Vandal-resistant, swivel-type**] head.
   f. Soap Dish: Recessed, stainless steel.
   g. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Mounting: Bolts through wall sleeve into accessible service space.
7. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

B. Security Shower - Stainless Steel, Front Access, Recessed :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acorn Engineering Company; a Division of Morris Group International**]
b. [**I-Con Systems, Inc.**]
c. [**Metcraft Industries, Inc.**]
d. [**Willoughby Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain security showers from single manufacturer.

4. Standards:

a. ASME A112.19.3/CSA B45.4.
b. ASME A112.18.1/CSA B125.1.
c. ASSE 1016.
d. ICC A117.1.
e. NSF 61.
f. NSF 372.
g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

a. Material: 14-gauge, Type 304 stainless steel, seamless welded construction.
b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
c. Type and Configuration: Wall, with showerhead and soap dish.
d. Tempered Hot- and Cold-Water Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops. Non-hold-open valve.[**ADA compliant.**]
e. Shower: [**Hose with vandal-resistant, handheld**][**Vandal-resistant, fixed-type**][**Vandal-resistant, swivel-type**] head.
f. Soap Dish: Recessed, stainless steel.
g. Access to Internal Components: Vandal-resistant access panels.
h. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Mounting: Bolts from fixture-mounted flanges into wall.

C. Security Shower - Stainless Steel, Front Access, Surface Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**I-Con Systems, Inc.**]
b. [**Metcraft Industries, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**I-Con Systems, Inc.**]
   b. [**Metcraft Industries, Inc.**]
   c. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security showers from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.18.1/CSA B125.1.
   c. ASSE 1016.
   d. ICC A117.1.
   e. NSF 61.
   f. NSF 372.
   g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

   a. Material: 14-gauge, Type 304 stainless steel, seamless welded construction.
   b. Finish: [**Satin polished finish on exposed surfaces**]<**Insert finish**>.
   c. Type and Configuration: Wall, with showerhead and soap dish.
   d. Tempered Hot- and Cold-Water-Water Supply Valves: [**Pneumatic, push-button, single-temperature, metering**][**Pneumatic, push-button, hot and cold, metering**][**Electronic, single-temperature, metering**][**Electronic, hot and cold, metering**] type with individual check stops. Non-hold-open valve.[**ADA compliant.**]
   e. Soap Dish: Recessed, stainless steel.
   f. Access to Internal Components: Vandal-resistant access panels.
   g. Features: [**ADA compliant**][**Ligature resistant**][**ADA compliant and ligature resistant**]<**Insert feature**>.

6. Mounting: Bolts from fixture-mounted flanges into wall.

D. Security Shower - Stainless Steel, Back or Front Access, Accessible, Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain security showers from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.
   d. ASSE 1016.
   e. ICC A117.1.
   f. NSF 61.
   g. NSF 372.
   h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

   a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction.
   b. Finish: Satin polished finish on exposed surfaces. Slip-resistant shower floor.
   c. Configuration: [**Back**][**Front**] access.
   d. Type and Configuration: Cabinet [**36 by 36 inches (915 by 915 mm)**][**36 by 60 inches (915 by 1524 mm)**]<**Insert dimensions**> with floor[**and top**], and with stainless steel soap dish, towel hook, drain, seat, and grab bar.
   e. Tempered Hot- and Cold-Water-Water Supply Valves: Mechanical-metering type with individual check stops.
   f. Shower: Hose with vandal-resistant, handheld head.
   g. Drain: Grid with **NPS 2 (DN 50)** outlet.
   h. Features: [**Ligature resistant**]<**Insert feature**>.

6. Waste Fitting: **NPS 2 (DN 50)** waste to wall; trap.
7. Mounting: Bolts through wall into accessible service space.

E. Security Shower - Stainless Steel, Back or Front Access, Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**I-Con Systems, Inc.**]
   c. [**Metcraft Industries, Inc.**]
   d. [**Willoughby Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**I-Con Systems, Inc.**]
    c. [**Metcraft Industries, Inc.**]
    d. [**Willoughby Industries, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations:

    a. Obtain security showers from single manufacturer.

4. Standards:

    a. ASME A112.19.3/CSA B45.4.
    b. ASME A112.18.1/CSA B125.1.
    c. ASME A112.18.2/CSA B125.2.
    d. ASSE 1016.
    e. NSF 61.
    f. NSF 372.
    g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

    a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction.
    b. Finish: Satin polished finish on exposed surfaces. Slip-resistant shower floor.
    c. Configuration: [**Back**][**Front**] access.
    d. Cabinet: [**30 by 30 inches (760 by 760 mm)**][**32 by 32 inches (815 by 815 mm)**][**36 by 36 inches (915 by 915 mm)**]<**Insert dimensions**> with floor[**and top**], and with stainless steel soap dish, towel hook, and drain.
    e. Tempered Hot- and Cold-Water Supply Valves: Mechanical-metering type with individual check stops.
    f. Shower: [**Vandal-resistant, fixed**][**Fixed**][**Swivel**]-type head.
    g. Drain: Grid with **NPS 2 (DN 50)** outlet.
    h. Features: [**Ligature resistant**]<**Insert feature**>.

6. Waste Fitting: **NPS 2 (DN 50)** elbow waste.
7. Mounting: Bolts through wall into accessible service space.

2.8 SECURITY SERVICE SINKS

A. Security Service Sink - Stainless Steel, Back or Front Access, On or Off Floor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Acorn Engineering Company; a Division of Morris Group International**]
    b. [**Metcraft Industries, Inc.**]
    c. [**Willoughby Industries, Inc.**]

d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Acorn Engineering Company; a Division of Morris Group International**]
   b. [**Metcraft Industries, Inc.**]
   c. [**Willoughby Industries, Inc.**]
   d. **<Insert manufacturer's name>**

3. Source Limitations:

   a. Obtain security service sinks from single manufacturer.

4. Standards:

   a. ASME A112.19.3/CSA B45.4.
   b. ASME A112.18.1/CSA B125.1.
   c. ASME A112.18.2/CSA B125.2.
   d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Fixture:

   a. Material: [**14-gauge**][**12-gauge**], Type 304 stainless steel, seamless welded construction.
   b. Finish: Satin polished finish on exposed surfaces.
   c. Configuration: [**Back**][**Front**] access, [**on**][**off**] floor.
   d. Receptor: Rectangular bowl with high backsplash.
   e. Nominal Size: [**20 by 19 inches (508 by 483 mm)**][**24 by 19 inches (610 by 483 mm)**]**<Insert dimensions>**.
   f. Hot- and Cold-Water Supply Valves: Push-button actuation and backsplash-mounted filler spout with [**hose**][**plain**] end.
   g. Drain: Grid with **NPS 2 (DN 50)** outlet.

6. Waste Fitting: **NPS 2 (DN 50)** elbow waste.
7. Mounting: Bolts through wall into accessible service space.
8. Wall Sleeve: Galvanized-steel frame of dimensions required to match fixture.

2.9 FLUSHOMETER VALVES

A. Flushometer Valve - Diaphragm :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Modern Technologies Corporation - AMTC**]
   b. [**Delany Products**]
   c. [**Sloan Valve Company**]
   d. [**Zurn Industries, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Advanced Modern Technologies Corporation - AMTC**]
b. [**Delany Products**]
c. [**Sloan Valve Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain flushometer valves from single manufacturer.

4. Standards:

a. ASSE 1037/ASME A112.1037/CSA B125.37
b. ASME A112.19.5/CSA B45.15.
c. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

5. Minimum Pressure Rating: **125 psig (860 kPa)**.
6. Features: Integral check stops and backflow-prevention device.
7. Material: Brass body with corrosion-resistant components.
8. Actuator: [**Lever handle**][**Hydraulic, push button**][**Solenoid, battery powered**][**Solenoid, hard wired**].
9. Trip Mechanism: [**Battery-powered**][**Hard-wired**] electronic sensor, listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
10. Style: Concealed.
11. Finish: Panel and exposed surfaces, chrome plated or stainless steel.
12. Consumption: [**1.6 gal. (6 L)**][**1.28 gal. (4.8 L)**][**1.1 gal. (4.2 L)**][**1.0 gal. (3.8 L)**][**0.5 gal. (1.9 L)**][**0.125 gal. (0.5 L)**] per flush.
13. Minimum Inlet: [**NPS 1 (DN 25)**][**NPS 3/4 (DN 20)**].
14. Minimum Outlet: [**NPS 1-1/4 (DN 32)**][**NPS 3/4 (DN 20)**].

2.10 TOILET SEATS

A. Toilet Seat :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Standard**]
b. [**Bemis Manufacturing Company**]
c. [**Centoco Manufacturing Corporation**]
d. [**Church Seats; Bemis Manufacturing Company**]
e. [**Jones Stephens Corp.**]
f. [**Kohler Co**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Standard**]
b. [**Bemis Manufacturing Company**]
c. [**Centoco Manufacturing Corporation**]
d. [**Church Seats; Bemis Manufacturing Company**]
e. [**Jones Stephens Corp.**]
f. [**Kohler Co**]
g. [**Zurn Industries, LLC**]
h. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain toilet seats from single manufacturer.

4. Material: Plastic.
5. Type: Commercial, heavy duty.

a. Shape: Elongated rim, [**open**][**closed**] front.
b. Hinge: [**Check**][**Self-sustaining check**].
c. Hinge Material: Noncorroding metal.
d. Seat Cover: [**Required**][**Not required**].
e. Color: [**White**][**Black**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECURITY PLUMBING FIXTURES

A. Install security plumbing fixtures level and plumb.

B. Install back-access, stainless steel fixtures as follows:

1. Install wall sleeve in wall if indicated.
2. Install fixture on wall sleeve or wall, as indicated, with access from accessible service space.
3. Extend supply piping from service space to fixture.
4. Install soil and waste piping from fixture and extend into service space.
5. Install fixture trap in service space instead of below fixture drain.

C. Install front-access, stainless steel fixtures as follows:

1. Install fixture support or mounting bracket.
2. Install fixture on support; mount components inside of or attached to fixture.
3. Extend supply piping from pipe space to fixture.

4. Install trap below fixture and extend soil and waste piping into pipe space.

D. Install fixture outlets with gasket seals.

E. Install fixtures designated "accessible" in accordance with ICC A117.1 for heights, dimensions, and clearances.

F. Install toilet seats on [**water closets**][**and**][**combination units**] if seats are indicated.

G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

H. Seal joints between fixtures, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

I. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."

C. Comply with requirements for soil and waste drainage piping specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 ADJUSTING

A. Operate and adjust flushometer valves and flow-control valves on fixtures. Replace damaged and

malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at fixtures to produce proper flow.

C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After installing fixtures, inspect and replace damaged finishes.

B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 46 00 00

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Task	Specification	Specification Description
22 46 13 00	22 46 00 00	Security Plumbing Fixtures
22 46 13 13	22 46 00 00	Security Plumbing Fixtures
22 46 13 16	22 46 00 00	Security Plumbing Fixtures
22 46 13 19	22 46 00 00	Security Plumbing Fixtures
22 46 16 00	22 46 00 00	Security Plumbing Fixtures
22 46 16 13	22 46 00 00	Security Plumbing Fixtures
22 46 16 16	22 46 00 00	Security Plumbing Fixtures
22 46 19 00	22 46 00 00	Security Plumbing Fixtures
22 46 56 00	22 46 00 00	Security Plumbing Fixtures

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SECTION 22 47 00 00 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Drinking fountains.
2. Water coolers.
3. Bottle filling stations.
4. Remote water coolers.
5. Fixture carriers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of fixture assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power wiring.

C. Delegated Design Submittals: For vibration isolation[**and supports,**][**, and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data [**signed and sealed by the qualified professional engineer responsible for their preparation**].

D. Sustainable Design Submittals:

1. Product Data: For water consumption.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For remote water coolers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**drinking fountains,**][**water coolers,**][**bottle filling stations,**][**and**][**remote water coolers**] to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include servicing and adjustment of electronic-sensor fixtures.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to <**Insert number**> percent of quantity installed for each type and size indicated, but no fewer than <**Insert number**> of each.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.7 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace [**drinking fountains**][**water coolers**][**bottle filling stations**][**remote water coolers**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of <**Insert type of failure**>.
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**][**use**].

B. Warranty Period: [**One**]<**number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains, water coolers, bottle filling stations, and remote water coolers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Delegated Design:

1. [**Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to**] design vibration isolation[**, supports,**][**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. [**Product manufacturer's qualified staff**][**Qualified professional engineer employed by the product manufacturer**] to select and size products to achieve specified performance requirements.

C. Seismic Performance: Remote water coolers are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**]<**Insert Section**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 DRINKING FOUNTAINS

A. Drinking Fountains - Surface Wall Mounted, Bronze :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Filtrine Manufacturing Company**]
   b. [**Murdock Manufacturing; A Division of Morris Group International**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Filtrine Manufacturing Company**]
   b. [**Murdock Manufacturing; A Division of Morris Group International**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, bronze drinking fountains from single source from single manufacturer.
4. Standards:

   a. NSF 61.
   b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

   a. Type: [**Slab**][**With back**][**On horizontal support**].
   b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
   c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
   d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
   e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

13. Support: Provide manufacturer's mounting plate.
14. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

B. Drinking Fountains - Surface Wall Mounted, Enameled Cast Iron :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Murdock Manufacturing; A Division of Morris Group International**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Murdock Manufacturing; A Division of Morris Group International**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, enameled cast iron drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

    a. Type: [**Slab**][**With back**][**On horizontal support**].
    b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.

c. Color: White.
d. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
e. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
f. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: Push button.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

C. Drinking Fountains - Surface Wall Mounted, Composite/Granite :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, composite/granite drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

    a. Type: [**Slab**][**With back**][**On horizontal support**].
    b. Shape: Rectangular.
    c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
    d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
    e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: Push button.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

D. Drinking Fountains - Surface Wall Mounted, Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Petersen Manufacturing Co. Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Petersen Manufacturing Co. Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, concrete drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

    a. Type: [**Slab**][**With back**][**On horizontal support**].
    b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
    c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
    d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
    e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: Push button.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

E. Drinking Fountains - Surface Wall Mounted, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Halsey Taylor**]
    b. [**Haws Corporation**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Oasis International**]
    e. [**Stern-Williams Products, LLC.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Halsey Taylor**]
    b. [**Haws Corporation**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Oasis International**]
    e. [**Stern-Williams Products, LLC.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, powder-coated-metal drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

    a. Type: [**Slab**][**With back**][**On horizontal support**].
    b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
    c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.

d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: Push button.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

F. Drinking Fountains - Surface Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Haws Corporation**]
    d. [**Most Dependable Fountains, Inc.**]
    e. [**Murdock Manufacturing; A Division of Morris Group International**]
    f. [**Oasis International**]
    g. [**Stern-Williams Products, LLC.**]
    h. [**Willoughby Industries, Inc.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Haws Corporation**]
    d. [**Most Dependable Fountains, Inc.**]
    e. [**Murdock Manufacturing; A Division of Morris Group International**]
    f. [**Oasis International**]
    g. [**Stern-Williams Products, LLC.**]
    h. [**Willoughby Industries, Inc.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

a. Type: [**Slab**][**With back**][**On horizontal support**].
b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

12. Electrical Characteristics:

a. Standard: Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
b. Volts: 120 V ac.
c. Phase: Single.
d. Hertz: 60 Hz.

13. Support: Provide manufacturer's mounting plate.
14. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

G. Drinking Fountains - Surface Wall Mounted, Stone Aggregate/Terrazzo :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elkay**]
b. [**Stern-Williams Products, LLC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elkay**]

b. [**Stern-Williams Products, LLC.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, stone aggregate/terrazzo drinking fountains from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Receptor(s):

a. Type: [**Slab**][**With back**][**On horizontal support**].
b. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
c. Back Panel: [**Stainless steel**]<**Insert material**> wall plate behind drinking fountain.
d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
e. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: Push button.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** chrome-plated brass P-trap and waste.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

H. Drinking Fountains - Semi-Recessed, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elkay**]
b. [**Filtrine Manufacturing Company**]
c. [**Oasis International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elkay**]
b. [**Filtrine Manufacturing Company**]

c. [**Oasis International**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain semi-recessed, wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4.

5. Receptor Shape: Concave with projecting bowl.
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: [**Push button**][**Push bar**]<**Insert control**>.
9. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

13. Support: Manufacturer-provided support frame for attaching to substrate.
14. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

I. Drinking Fountains - Recessed, Wall Mounted, Bronze :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Filtrine Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Filtrine Manufacturing Company**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, bronze drinking fountains from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.

5. Receptor Shape: Concave with flush wall flange.
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.

8. Control: Push button.
9. Drain: Grid with **NPS 1-1/4 (DN 32)** minimum horizontal waste and trap, complying with ASME A112.18.2/CSA B125.2.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Support: Provide manufacturer's support frame attached to substrate.
14. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

J. Drinking Fountains - Recessed, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Oasis International**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Oasis International**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.

5. Receptor Shape: Concave with flush wall flange.
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
8. Control: [**Push button**][**or**][**Push bar**]<**Insert control**>.
9. Drain: Grid with **NPS 1-1/4 (DN 32)** minimum horizontal waste and trap, complying with ASME A112.18.2/CSA B125.2.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.

12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Support: Provide manufacturer's support frame attached to substrate.
14. Drinking Fountain Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

K. Drinking Fountains - Pedestal, Concrete :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Petersen Manufacturing Co. Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Petersen Manufacturing Co. Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pedestal, concrete drinking fountains rom single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Pedestal: [**Rectangular**][**Round**]<**Insert shape**>.
7. Receptor(s):

    a. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
    b. Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
    c. Bottle Filler: Push-button activation.
    d. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

8. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
9. Control: Push button.
10. Access to Internal Components: Panel in pedestal.
11. Supply: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**] with shutoff valve.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

1) NSF 42.
2) NSF 53.

13. Drain Piping: [**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 (DN 40)**] minimum trap and waste.
14. Drinking Fountain Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
16. Bury Depth, Grade to Valve Components: [**36 inches (915 mm)**][**48 inches (1220 mm)**][**60 inches (1525 mm)**]<**Insert dimension**>.

L. Drinking Fountains - Pedestal, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Halsey Taylor**]
   b. [**Haws Corporation**]
   c. [**Most Dependable Fountains, Inc.**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Stern-Williams Products, LLC.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Halsey Taylor**]
   b. [**Haws Corporation**]
   c. [**Most Dependable Fountains, Inc.**]
   d. [**Murdock Manufacturing; A Division of Morris Group International**]
   e. [**Stern-Williams Products, LLC.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pedestal, powder-coated-metal drinking fountains from single source from single manufacturer.
4. Standards:

   a. NSF 61.
   b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Pedestal: [**Rectangular**][**Round**]<**Insert shape**>.
7. Receptor(s):

   a. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
   b. Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
   c. Bottle Filler: Push-button activation.
   d. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

8. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
9. Controls: Push button.
10. Access to Internal Components: Panel in pedestal.

11. Supply: [NPS 3/8 (DN 10)][NPS 1/2 (DN 15)] with shutoff valve.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Drain Piping: [NPS 1-1/4 (DN 32)][NPS 1-1/2 (DN 40)] minimum trap and waste.
14. Drinking Fountain Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
16. Bury Depth, Grade to Valve Components: [36 inches (915 mm)][48 inches (1220 mm)][60 inches (1525 mm)]<**Insert dimension**>.

M. Drinking Fountains - Pedestal, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Haws Corporation**]
    b. [**Most Dependable Fountains, Inc.**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Stern-Williams Products, LLC.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Haws Corporation**]
    b. [**Most Dependable Fountains, Inc.**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Stern-Williams Products, LLC.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pedestal, stainless steel drinking fountains from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Pedestal: [**Rectangular**][**Round**]<**Insert shape**>.
7. Receptor(s):

    a. Shape: [**Rectangular**][**Round**]<**Insert shape**>.
    b. Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
    c. Bottle Filler: Push-button activation.
    d. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.

8. Maximum Water Flow: [**0.15 gpm (0.0095 L/s)**][**0.5 gpm (0.0316 L/s)**]<**Insert value**>.
9. Controls: Push button.
10. Access to Internal Components: Panel in pedestal.
11. Supply: [**NPS 3/8 (DN 10)**][**NPS 1/2 (DN 15)**] with shutoff valve.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Drain Piping: [**NPS 1-1/4 (DN 32)**][**NPS 1-1/2 (DN 40)**] minimum trap and waste.
14. Drinking Fountain Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
16. Bury Depth, Grade to Valve Components: [**36 inches (915 mm)**][**48 inches (1220 mm)**][**60 inches (1525 mm)**]<**Insert dimension**>.

2.3 WATER COOLERS

A. Water Coolers - Freestanding, Floor Mounted, Single Station, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Oasis International**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. [**Oasis International**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, floor-mounted, single-station, stainless steel water coolers from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.
    d. ASHRAE 18.
    e. UL 399.
    f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Bubbler: One, with adjustable stream regulator, located on deck.
6. Control: [**Push button**][**Foot pedal**]<**Insert control**>.
7. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
8. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
10. Cooling System: Electric, with[**precooler,**] hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
11. Glass filler.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Capacities and Characteristics:

    a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**][**10 gph (0.0105 L/s)**][**14 gph (0.0147 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert gal. (L)**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**][**1/4**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

B. Water Coolers - Freestanding, Floor Mounted, Single Station, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Murdock Manufacturing; A Division of Morris Group International**]
    b. [**Oasis International**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Murdock Manufacturing; A Division of Morris Group International**]
    b. [**Oasis International**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, floor-mounted, single-station, powder-coated-metal water coolers from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASHRAE 18.
d. UL 399.
e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Bubbler: One, with adjustable stream regulator, located on deck.
6. Control: [**Push button**][**Foot pedal**]<**Insert control**>.
7. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
8. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
10. Cooling System: Electric, with[**precooler,**] hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
11. Glass filler.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Capacities and Characteristics:

    a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**][**10 gph (0.0105 L/s)**][**14 gph (0.0147 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert gal. (L)**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**][**1/4**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

C. Water Coolers - Surface Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Oasis International**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Elkay**]
b. [**Halsey Taylor**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Oasis International**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, stainless steel, water coolers from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4.
d. ASHRAE 18.
e. UL 399.
f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
7. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
8. Glass filler.
9. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]: Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
10. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
11. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
12. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
13. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

14. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
15. Support: Fixture carrier.
16. Water-Cooler Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
17. Capacities and Characteristics:

a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**]<**Insert value**>.
b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
e. Cooled-Water Storage: <**Insert value**>.
f. Electrical Characteristics:

1) Motor Horsepower: [**1/6**][**1/5**][**1/4**][**1/3**]<**Insert value**>.
2) Volts: 120 V ac.
3) Phase: Single.
4) Hertz: 60 Hz.

5) Full-Load Amperes: <**Insert value**> A.
6) Minimum Circuit Ampacity: <**Insert value**> A.
7) Maximum Overcurrent Protection: <**Insert value**> A.

D. Water Coolers - Surface Wall Mounted, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Elkay**]
   b. [**Murdock Manufacturing; A Division of Morris Group International**]
   c. [**Oasis International**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Elkay**]
   b. [**Murdock Manufacturing; A Division of Morris Group International**]
   c. [**Oasis International**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, powder-coated-metal, water coolers from single source from single manufacturer.
4. Standards:

   a. NSF 61.
   b. NSF 372.
   c. ASHRAE 18.
   d. UL 399.
   e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Color: Gray.
6. Type: [**Vandal resistant**][**and**][**freeze resistant**].
7. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
8. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
9. Glass filler.
10. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]: Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
11. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
12. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
13. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
14. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

       1) NSF 42.
       2) NSF 53.

15. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank,

and adjustable thermostat.

16. Support: Fixture carrier.
17. Water-Cooler Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
18. Capacities and Characteristics:

    a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**][**1/4**][**1/3**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

E. Water Coolers - Surface Wall Mounted, Vinyl-Covered Metal with Stainless Steel Top :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, vinyl-covered metal water coolers with stainless steel top from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.
    d. ASHRAE 18.
    e. UL 399.
    f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
7. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
8. Glass filler.

9. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]: Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
10. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
11. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
12. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
13. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

14. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
15. Support: Fixture carrier.
16. Water-Cooler Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
17. Capacities and Characteristics:

    a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**][**1/4**][**1/3**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

F. Water Coolers - Inwall Frame/Plate, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Oasis International**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]

d. [**Oasis International**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain inwall frame/plate, wall-mounted, stainless steel, water coolers from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4.
d. ASHRAE 18.
e. UL 399.
f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
7. Control: [**Push button**][**Push bar**][**Sensor**]<**Insert control**>.
8. Glass filler.
9. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
10. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
11. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
12. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
13. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

14. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
15. Support: Provide manufacturer's support frame for attachment to substrate.
16. Water-Cooler Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**][**High/low - standard/accessible in accordance with ICC A117.1**].
17. Capacities and Characteristics:

a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**]<**Insert value**>.
b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
e. Cooled-Water Storage: <**Insert value**>.
f. Electrical Characteristics:

1) Motor Horsepower: [**1/6**][**1/5**][**1/4**][**1/3**]<**Insert value**>.
2) Volts: 120 V ac.
3) Phase: Single.
4) Hertz: 60 Hz.
5) Full-Load Amperes: <**Insert value**> A.
6) Minimum Circuit Ampacity: <**Insert value**> A.
7) Maximum Overcurrent Protection: <**Insert value**> A.

G. Water Coolers - Semi-Recessed, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Halsey Taylor**]
    b. [**Oasis International**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Halsey Taylor**]
    b. [**Oasis International**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain semi-recessed, wall-mounted, stainless steel, water coolers from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.
    d. ASHRAE 18.
    e. UL 399.
    f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. [**Type: Vandal resistant.**]
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Control: [**Push button**][**Push bar**]<**Insert control**>.
8. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Cooling System: Electric, with [**precooler,**]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
13. Support: Provide manufacturer's support frame attachment to substrate.
14. Water-Cooler Mounting Height: [**Standard**][**Juvenile**].
15. Capacities and Characteristics:

    a. Cooled Water: [**8 gph (0.0084 L/s)**][**12 gph (0.0126 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

1) Motor Horsepower: [**1/6**][**1/5**]<**Insert value**>.
2) Volts: 120 V ac.
3) Phase: Single.
4) Hertz: 60 Hz.
5) Full-Load Amperes: <**Insert value**> A.
6) Minimum Circuit Ampacity: <**Insert value**> A.
7) Maximum Overcurrent Protection: <**Insert value**> A.

H. Water Coolers - Semi-Recessed, Wall Mounted, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Oasis International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Oasis International**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain semi-recessed, wall-mounted, powder-coated-metal, water coolers from single source from single manufacturer.
4. Standards:

   a. NSF 61.
   b. NSF 372.
   c. ASHRAE 18.
   d. UL 399.
   e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. [**Type: Vandal resistant**].
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Control: [**Push button**][**Push bar**]<**Insert control**>.
8. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

       1) NSF 42.
       2) NSF 53.

12. Cooling System: Electric, with [**precooler,**]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
13. Support: Provide manufacturer's support frame attachment to substrate.
14. Water-Cooler Mounting Height: [**Standard**][**Juvenile**].
15. Capacities and Characteristics:

a. Cooled Water: [**8 gph (0.0084 L/s)**][**12 gph (0.0126 L/s)**]<**Insert value**>.
b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
c. Inlet-Water Temperature: **80 deg F (27 deg C)**.
d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
e. Cooled-Water Storage: <**Insert value**>.
f. Electrical Characteristics:

1) Motor Horsepower: [**1/6**][**1/5**]<**Insert value**>.
2) Volts: 120 V ac.
3) Phase: Single.
4) Hertz: 60 Hz.
5) Full-Load Amperes: <**Insert value**> A.
6) Minimum Circuit Ampacity: <**Insert value**> A.
7) Maximum Overcurrent Protection: <**Insert value**> A.

I. Water Coolers - Recessed, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elkay**]
b. [**Halsey Taylor**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Oasis International**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elkay**]
b. [**Halsey Taylor**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. [**Oasis International**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, stainless steel, water coolers from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4.
d. ASHRAE 18.
e. UL 399.
f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. [**Type: Vandal resistant.**]
6. Bubbler: One, with adjustable stream regulator, located on deck.
7. Control: [**Push button**][**Push bar**]<**Insert control**>.
8. Glass filler.
9. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.

10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Cooling System: Electric, with [**precooler,**]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
14. Ventilation Grille: Stainless steel, located [**above**][**below**] water cooler.
15. Support: Provide manufacturer's support frame attachment to substrate.
16. Water-Cooler Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
17. Capacities and Characteristics:

    a. Cooled Water: [**8 gph (0.0084 L/s)**][**12 gph (0.0126 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C.)**
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

2.4 BOTTLE FILLING STATIONS

A. Bottle Filling Station - Surface Wall Mounted, ABS/Stainless Steel Combination :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Haws Corporation**]
    b. [**Murdock Manufacturing; A Division of Morris Group International**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, ABS/stainless steel combination, bottle filling

stations from single source from single manufacturer.

4. Standards:

   a. NSF 61.
   b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: ABS/stainless steel combination.
7. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
8. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Filter: One or more water filters complying with capacity sized for unit peak flow rate.

    a. Standards:

       1) NSF 42.
       2) NSF 53.

12. Support: Provide manufacturer's mounting plate.
13. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
14. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

B. Bottle Filling Station - Surface Wall Mounted, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Most Dependable Fountains, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Most Dependable Fountains, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, powder-coated-metal, bottle filling stations from single source from single manufacturer.
4. Standards:

   a. NSF 61.
   b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: Powder-coated metal.
7. Finish Color: <**Insert color**>.
8. Bottle Filler: Push-button activation.
9. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Support: Provide manufacturer's mounting plate.
14. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].

C. Bottle Filling Station - Surface Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain surface wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: Stainless steel.
7. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
8. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.

9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Cooling System: Electric, with [**precooler,**]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    a. Standards:

        1) ASHRAE 18.
        2) UL 399.
        3) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

12. Ventilation Grille: Stainless steel, located [**above**][**below**] bottle filler.
13. Cooling System Capacities and Characteristics:

    a. Cooled Water: [**8 gph (0.0084 L/s)**][**12 gph (0.0126 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C.)**
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

14. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

15. Support: Provide manufacturer's mounting plate.
16. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
17. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

D. Bottle Filling Station - Recessed, Wall Mounted, ABS/Stainless Steel Combination :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Haws Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Haws Corporation**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, ABS/stainless steel combination, bottle filling stations from single source from single manufacturer.
4. Standards:

a. NSF 61.
b. NSF 372.
c. ASME A112.19.3/CSA B45.4

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: ABS/stainless steel combination.
7. Bottle Filler: Sensor activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
8. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

a. Standards:

1) NSF 42.
2) NSF 53.

12. Support: Provide manufacturer's frame attached to substrate.
13. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
14. Electrical Characteristics:

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
b. Volts: 120 V ac.
c. Phase: Single.
d. Hertz: 60 Hz.

E. Bottle Filling Station - Recessed, Wall Mounted, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elkay**]
b. [**Most Dependable Fountains, Inc.**]
c. [**Murdock Manufacturing; A Division of Morris Group International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Most Dependable Fountains, Inc.**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, powder-coated-metal, bottle filling stations from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: Powder-coated metal.
7. Finish Color: <**Insert color**>.
8. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
9. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Support: Provide manufacturer's frame attached to substrate.
14. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
15. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

F. Bottle Filling Station - Recessed, Wall Mounted, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Most Dependable Fountains, Inc.**]
    d. [**Murdock Manufacturing; A Division of Morris Group International**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain recessed, wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Cabinet: Stainless steel.
7. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
8. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
9. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
11. Cooling System: Electric, with [**precooler,**]hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    a. Standards:

        1) ASHRAE 18.
        2) UL 399.
        3) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

12. Ventilation Grille: Stainless steel, located [**above**][**below**] bottle filler.
13. Cooling System Capacities and Characteristics:

    a. Cooled Water: [**8 gph (0.0084 L/s)**][**12 gph (0.0126 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C.)**
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert value**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/6**][**1/5**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60 Hz.
        5) Full-Load Amperes: <**Insert value**> A.
        6) Minimum Circuit Ampacity: <**Insert value**> A.
        7) Maximum Overcurrent Protection: <**Insert value**> A.

14. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

15. Support: Provide manufacturer's frame attached to substrate.
16. Bottle Filling Station Mounting Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
17. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

G. Bottle Filling Station - Pedestal, Powder-Coated Metal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Haws Corporation**]
    d. [**Most Dependable Fountains, Inc.**]
    e. [**Murdock Manufacturing; A Division of Morris Group International**]
    f. [**Stern-Williams Products, LLC.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Halsey Taylor**]
    c. [**Haws Corporation**]
    d. [**Most Dependable Fountains, Inc.**]
    e. [**Murdock Manufacturing; A Division of Morris Group International**]
    f. [**Stern-Williams Products, LLC.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pedestal, powder-coated-metal, bottle filling stations from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Pedestal: [**Rectangular**][**Round**]<**Insert shape**>.
7. Finish Color: <**Insert color**>

8. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
9. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
10. Access to Internal Components: Panel in pedestal.
11. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
12. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

13. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
14. Bottle Filling Station Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
15. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
16. Bury Depth, Grade to Valve Components: [**36 inches (915 mm)**][**48 inches (1220 mm)**][**60 inches (1525 mm)**]<**Insert dimension**>.
17. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

H. Bottle Filling Station - Pedestal, Stainless Steel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Haws Corporation**]
    b. [**Most Dependable Fountains, Inc.**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Stern-Williams Products, LLC.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Haws Corporation**]
    b. [**Most Dependable Fountains, Inc.**]
    c. [**Murdock Manufacturing; A Division of Morris Group International**]
    d. [**Stern-Williams Products, LLC.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pedestal, stainless steel, bottle filling stations from single source from single manufacturer.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.

5. Type: [**Vandal resistant**][**and**][**freeze resistant**].
6. Pedestal: [**Rectangular**][**Round**]<**Insert shape**>.
7. Bottle Filler: [**Sensor**][**Push-button**] activation[**, with**][**20-second**]<**Insert value**>[**automatic shutoff timer**]. Fill rate is [**0.5 to 1.5 gpm (0.03155 to 0.09464 L/s)**]<**Insert value**>.
8. Drain: Grid type with **NPS 1-1/4 (DN 32)** tailpiece.
9. Access to Internal Components: Panel in pedestal.
10. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
13. Bottle Filling Station Height: [**Standard**][**Juvenile**][**Accessible in accordance with ICC A117.1**].
14. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
15. Bury Depth, Grade to Valve Components: [**36 inches (915 mm)**][**48 inches (1220 mm)**][**60 inches (1525 mm)**]<**Insert dimension**>.
16. Electrical Characteristics:

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    b. Volts: 120 V ac.
    c. Phase: Single.
    d. Hertz: 60 Hz.

2.5 REMOTE WATER COOLERS

A. Remote Water Coolers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Halsey Taylor**]
    d. [**Haws Corporation**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elkay**]
    b. [**Filtrine Manufacturing Company**]
    c. [**Halsey Taylor**]
    d. [**Haws Corporation**]
    e. [**Oasis International**]
    f. <**Insert manufacturer's name**>

3. Description: Remote water-cooling chiller unit serving cooled water to drinking water fountains or bottle filling stations.
4. Standards:

    a. NSF 61.
    b. NSF 372.
    c. UL 399.
    d. ASHRAE 18.
    e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Refrigerant: [**R134a**][**or**][**R513A**]<**Insert refrigerant type**>.
6. Chassis: Galvanized or corrosion-resistant coated steel.
7. Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
8. Storage Tank: [**0.5 gal. (1.9 L)**][**4 gal. (15.1 L)**]<**Insert value**>, stainless steel.
9. Controls: Adjustable thermostat.
10. Ventilation Grille: Stainless steel, <**Insert size**>.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. Capacities and Characteristics:

    a. Cooled Water: [**5 gph (0.0053 L/s)**][**8 gph (0.0084 L/s)**][**14 gph (0.0147 L/s)**]<**Insert value**>.
    b. Ambient-Air Temperature: **90 deg F (32 deg C)**.
    c. Inlet-Water Temperature: **80 deg F (27 deg C.)**
    d. Cooled-Water Temperature: **50 deg F (10 deg C)**.
    e. Cooled-Water Storage: <**Insert gal. (L)**>.
    f. Electrical Characteristics:

        1) Motor Horsepower: [**1/5**][**1/4**][**1/3**]<**Insert value**>.
        2) Volts: 120 V ac.
        3) Phase: Single.
        4) Hertz: 60.
        5) Full-Load Amperes: <**Insert value**>.
        6) Minimum Circuit Ampacity: <**Insert value**>.
        7) Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 FIXTURE CARRIERS

A. Fixture Carriers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Josam Company**]
    c. [**MIFAB, Inc**]

d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Wade; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains and bottle filling stations on flat surface in accordance with manufacturer's written installation instructions.

C. Set freestanding water coolers on floor.

D. Install recessed drinking fountains and bottle filling stations secured to wood blocking in wall construction.

E. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

F. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.

G. Set remote water coolers on floor unless otherwise indicated.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section

220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

H. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball[**or gate**] valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

I. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

J. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

K. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball[**or gate**] shutoff valve on water supply to each fixture. [**Install ball or gate valves with valved bypass on water connections to remote water coolers**]. [**Install valve upstream from filter for drinking fountain, water cooler, and bottle filling station.**] Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

C. Adjust electronic-sensor settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 00 00

Task	Specification	Specification Description
22 47 13 00	22 47 00 00	Drinking Fountains And Water Coolers
22 47 16 00	22 45 00 00	Emergency Plumbing Fixtures
22 47 16 00	22 47 00 00	Drinking Fountains And Water Coolers
22 47 19 00	22 47 00 00	Drinking Fountains And Water Coolers
22 47 23 00	22 47 00 00	Drinking Fountains And Water Coolers
22 47 26 00	22 47 00 00	Drinking Fountains And Water Coolers

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SECTION 22 63 13 00 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Shape-memory-metal couplings.
3. Corrugated medical tubing (CMT) - copper.
4. Joining materials.
5. Zone valve box assemblies.
6. Ball valves.
7. Check valves.
8. Emergency oxygen connections.
9. Gas safety valves.
10. Pressure regulators.
11. Gas-service connections.
12. Patient-service consoles.
13. Nitrogen pressure-control panels.
14. Ceiling columns.
15. Gas manifolds.
16. Simplex specialty gas manifolds.
17. Duplex specialty gas manifolds.
18. Bulk medical gas storage tanks.
19. Gas cylinder storage racks.

B. Owner-Furnished Material:

1. Patient-service consoles.
2. Ceiling columns.
3. Gas manifolds.
4. Bulk medical gas storage tanks.
5. <**Insert product**>.
6. Owner will furnish gases for [**medical**][**laboratory**] gas concentration testing specified in this Section.

C. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for building seismic criteria.
2. Section 115313 "Laboratory Fume Hoods" for gas outlets in laboratory fume hoods.
3. Section 123553.13 "Metal Laboratory Casework" for gas outlets in laboratory fume hoods.
4. Section 123553.16 "Plastic-Laminate-Clad Laboratory Casework" for gas outlets in plastic-laminate-clad laboratory casework.
5. Section 123553.19 "Wood Laboratory Casework" for gas outlets in laboratory casework.
6. Section 123570 "Healthcare Casework" for gas outlets in medical casework.
7. Section 220963 "Medical Gas Alarms" for combined medical air, vacuum, and gas alarms.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-Index Safety System.

C. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen <**Insert other medical and combination gases**> for healthcare facility patient care.

D. Laboratory gas piping systems include carbon dioxide, helium, nitrogen, nitrous oxide, and oxygen <**Insert other medical and combination gases**> for laboratories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for [**gas manifolds**][**and**][**bulk gas storage tanks**], from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Material Certificates: Signed by Installer, certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

D. Brazing certificates.

E. Field quality control reports.

F. Source Quality Control Reports:

1. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**medical**][**and**][**specialty**] gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas-pressure outlets and suction inlets.

    a. Medical Carbon Dioxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    b. Medical Nitrous Oxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    c. Medical Oxygen: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    d. <**Insert medical gas**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    e. Laboratory Carbon Dioxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    f. Laboratory Nitrous Oxide: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    g. Laboratory Oxygen: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    h. <**Insert laboratory gas**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.

2. D.I.S.S. Service Connections: Furnish complete medical gas pressure outlets and suction inlets complying with CGA V-5.

    a. Medical Carbon Dioxide D.I.S.S. No. 1080: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    b. Medical Helium D.I.S.S. No. 1060: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    c. Medical Nitrogen D.I.S.S. No. 1120: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    d. Medical Nitrous Oxide D.I.S.S. No. 1040: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    e. Medical Oxygen D.I.S.S. No. 1240: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    f. <**Insert medical gas and D.I.S.S. No.**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    g. Laboratory Carbon Dioxide D.I.S.S. No. 1080: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    h. Laboratory Helium D.I.S.S. No. 1060: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    i. Laboratory Nitrogen D.I.S.S. No. 1120: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    j. Laboratory Nitrous Oxide D.I.S.S. No. 1040: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    k. Laboratory Oxygen D.I.S.S. No. 1240: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
    l. <**Insert laboratory gas and D.I.S.S. No.**>. Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: In accordance with ASSE Standard #6010[**and NFPA 99**] for medical-gas-system installers.
2. Bulk Medical Gas Systems for Healthcare Facilities: In accordance with ASSE Standard #6015[

and NFPA 99] for bulk-medical-gas-system installers.

3. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is[**a member of the Medical Gas Professional Healthcare Organization or is**] an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel in accordance with ASSE Standard #6020[**and NFPA 99**] for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications," or AWS B2.2/B2.2M.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. [**Medical**][**and**][**laboratory**] carbon dioxide operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

B. [**Medical**][**and**][**laboratory**] helium operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

C. [**Medical**][**and**][**laboratory**] nitrogen operating at [**160 to 185 psig (1100 to 1275 kPa)**][**higher than 200 psig (1380 kPa)**]<**Insert values**>.

D. [**Medical**][**and**][**laboratory**] nitrous oxide operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

E. [**Medical**][**and**][**laboratory**] oxygen operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

F. Specialty <**Insert designation**> operating at [**50 to 55 psig (345 to 380 kPa)**]<**Insert values**>.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: [**Gas manifolds**][**and**][**bulk gas storage tanks**] are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the [**gas manifolds**][**and**][**bulk gas storage tanks**] will remain in place without separation of any parts when subjected to the seismic forces specified[**and the manifolds and tanks will be fully operational after the seismic event**]."
2. Component Importance Factor is [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Comply with NFPA 55

C. Comply with NFPA 99.

2.3 PIPES, TUBES, AND FITTINGS

A. For all [**medical**][**and**][**laboratory**] gases, all positive-pressure [**medical**][**and**][**laboratory**] gas piping, tubing, and fittings are to have been manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.

1. Each length of tubing is to be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.
2. Fittings and other components are to be delivered manufacturer sealed and labeled, and kept sealed until prepared for installation.

B. Copper Medical and Laboratory Gas Tube: ASTM B819, [**Type K**][**and**][**Type L**], seamless, drawn temper. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch (3.2-mm)** maximum thickness, full-face type.
2. Flange Bolts and Nuts: ASME B18.2.1 carbon steel.

F. Shape-Memory-Metal Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aerofit, Inc**]
b. [**CAMERON; A Schlumber Co.**]
c. [**Motion Industries**]
d. [**Smart Tap; Smart Technology, Inc.**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Aerofit, Inc**]
b. [**CAMERON; A Schlumber Co.**]
c. [**Motion Industries**]
d. [**Smart Tap; Smart Technology, Inc.**]
e. **<Insert manufacturer's name>**

3. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy.

G. Corrugated Medical Tubing (CMT) - Copper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**MediTrac; OmegaFlex Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MediTrac; OmegaFlex Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Corrugated medical tubing system including corrugated copper-alloy tubing and brass fittings equipped for direct connection to medical gas piping system components.
4. Standards:

   a. UL Through-Penetration Ratings: W-L-1604 and C-AJ-1751.
   b. UL Listed: MH64301 UL 1365.
   c. Seismically qualified in accordance with ICC-ES AC156; testing protocol in accordance with ICC-ESR-4565.
   d. NFPA 99.

5. Quality Certification: Certified to ISO 9001 and 13485:2016 Medical Device Standard.
6. Tubing: ASTM B103/B103M, copper alloy UNS C51000, seamless, corrugated flexible medical tubing.
7. Jacket: Low-density polyethylene.
8. Jacket Flame Spread/Smoke Developed Rating: 25/50, in accordance with ASTM E84.
9. Maximum Operating Pressure, Continuous Use: **185 psig (1275 kPa)**.
10. Test Pressure: **647.4 psig (4464 kPa)**, maximum.
11. Safety Factor: 3.5 times maximum operating pressure, in accordance with NFPA 99.
12. Maximum Operating Temperature, Continuous Use: **250 deg F (121 deg C)**.
13. Maximum Exposure Temperature: **1000 deg F (538 deg C)**, in accordance with NFPA 99.
14. Minimum Bend Radius:

    a. **6 inches for 1/2-inch tubing (180 mm for 15-mm tubing)**.
    b. **8 inches for 3/4-inch tubing (264 mm for 22-mm tubing)**.
    c. **10 inches for 1-inch tubing (336 mm for 28-mm tubing)**.
    d. **24 inches for 1-1/2-inch tubing (600 mm for 50-mm tubing)**.

15. Fitting: Brass axial swage fittings, NFPA 99 compliant, and cleaned in accordance with CGA G-4.1, including the following components:

    a. Adaptor Material: CA360 brass.
    b. Anti-Tamper Sleeve Material: 300 series stainless steel.
    c. Non-Removable Threaded Axial Swaging Tool Material: CA360 brass.
    d. Split Ring Material: Brass, stainless steel.
    e. Jacket Lock Material: CA360 brass.
    f. Rear Swage Sleeve Material: CA360 brass.
    g. Treaded Driver Material: 300 series stainless steel.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.5 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged in accordance with CGA G-4.1 for oxygen service.

B. Zone Valve Box Assemblies: Box with medical gas valves, tube extensions, and gauges.

1. Steel Zone Valve Box with Aluminum Cover:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**CONCOA**]
4) [**Ohio Medical Corporation**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**CONCOA**]
4) [**Ohio Medical Corporation**]
5) <**Insert manufacturer's name**>

c. Description: Formed-steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.[**Medical air and medical vacuum tubing, valves, and gauges may be incorporated in zone valve boxes for medical gases.**]

1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Aluminum with frangible or removable windows.
3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, in accordance with NFPA 99.

d. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

1) Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
2) Delivered sealed and labeled and kept sealed until prepared for installation.

2. Steel Zone Valve Box with Stainless Steel Cover:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]

3) [**Ohio Medical Corporation**]
4) [**Tri-Tech Medical**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amico Corporation**]
2) [**BeaconMedaes**]
3) [**Ohio Medical Corporation**]
4) [**Tri-Tech Medical**]
5) <**Insert manufacturer's name**>

c. Description: Formed-steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.[**Medical air and medical vacuum tubing, valves, and gauges may be incorporated in zone valve boxes for medical gases.**]

1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Stainless steel with frangible or removable windows.
3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, in accordance with NFPA 99.

d. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

1) Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
2) Delivered sealed and labeled and kept sealed until prepared for installation.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**BeaconMedaes**]
d. [**Marwin Valve; Richards Industries**]
e. [**NIBCO INC.**]
f. [**Ohio Medical Corporation**]
g. [**Tri-Tech Medical**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**BeaconMedaes**]
d. [**Marwin Valve; Richards Industries**]

e. [**NIBCO INC.**]
f. [**Ohio Medical Corporation**]
g. [**Tri-Tech Medical**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. Description: Three-piece body, brass or bronze.
5. Pressure Rating: **300 psig (2070 kPa)** minimum.
6. Ball: Full-port, chrome-plated brass.
7. Seats: PTFE or TFE.
8. Handle: Lever[**type with locking device**].
9. Stem: Blowout proof with PTFE or TFE seal.
10. Ends: [**Manufacturer-installed ASTM B819, copper-tube extensions**][**and**][**manufacturer-installed ASTM B819, copper-tube extensions with pressure gauge on one copper-tube extension**].
11. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

    a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
    b. Delivered sealed and labeled and kept sealed until prepared for installation.

D. Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Amico Corporation**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BeaconMedaes**]
    d. [**Marwin Valve; Richards Industries**]
    e. [**NIBCO INC.**]
    f. [**Ohio Medical Corporation**]
    g. [**Tri-Tech Medical**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Amico Corporation**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**BeaconMedaes**]
    d. [**Marwin Valve; Richards Industries**]
    e. [**NIBCO INC.**]
    f. [**Ohio Medical Corporation**]
    g. [**Tri-Tech Medical**]
    h. <**Insert manufacturer's name**>

3. Description: In-line pattern, bronze.
4. Pressure Rating: **300 psig (2070 kPa)** minimum.
5. Operation: Spring loaded.
6. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
7. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Delivered sealed and labeled and kept sealed until prepared for installation.

E. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Ohio Medical Corporation**]
   d. [**Tri-Tech Medical**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Ohio Medical Corporation**]
   d. [**Tri-Tech Medical**]
   e. <**Insert manufacturer's name**>

3. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
4. Inlet: Manufacturer-installed, **NPS 1 or NPS 1-1/4 (DN 25 or DN 32)**, ASTM B819, copper tubing with **NPS 1 (DN 25)** minimum ball valve.
5. Safety Valve: Bronze-body pressure-relief valve set at **75 or 80 psig (520 or 550 kPa)**.
6. Instrumentation: Pressure gauge.
7. Positive-Pressure Medical Gas Valves, for All Medical Gas Types:

   a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
   b. Delivered sealed and labeled and kept sealed until prepared for installation.

F. Gas Safety Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amico Corporation**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**CEODEUX Meditec**]
   d. [**UCSF Health Environment of Care**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Amico Corporation**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**CEODEUX Meditec**]
d. [**UCSF Health Environment of Care**]
e. <**Insert manufacturer's name**>

3. Bronze body.
4. ASME-construction, poppet, pressure-relief type.
5. Settings to match system requirements.
6. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Delivered sealed and labeled and kept sealed until prepared for installation.

G. Pressure Regulators:

1. [**Bronze**][**Stainless steel**] body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
3. Manual pressure-setting adjustment.
4. Rated for [**250-psig (1725-kPa)**]<**Insert value**> minimum inlet pressure.
5. Capable of controlling delivered gas pressure within **0.5 psig for each 10-psig (5.0 kPa for each 100-kPa)** inlet pressure.
6. Positive-Pressure Medical Gas Valves, for All Gas Types:

a. Valves are to be manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
b. Valves are to be delivered sealed and labeled and kept sealed until prepared for installation.

2.6 GAS-SERVICE CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amico Corporation**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Tri-Tech Medical**]
5. [**Western Enterprises**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Amico Corporation**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Tri-Tech Medical**]
5. [**Western Enterprises**]
6. <**Insert manufacturer's name**>

C. General Requirements for Medical and Laboratory Gas-Service Connections:

1. All positive-pressure gas-service connections, for all gas types, are to be manufacturer cleaned, purged, and sealed as for oxygen service in accordance with CGA G-4.1.
2. Suitable for specific gas pressure and suction service listed.
3. Include roughing-in assemblies, finishing assemblies, and cover plates.
4. Recessed-type units made for concealed piping unless otherwise indicated.

D. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.
2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
3. Double seals that will prevent gas leakage.
4. ASTM B819, **NPS 3/8 (DN 10)** copper outlet tube brazed to valve with service marking and tube-end dust cap.

E. Finishing Assembly:

1. Brass housing with primary check valve.
2. Double seals that will prevent gas leakage.
3. Cover plate with gas-service label.

F. Quick-Coupler Pressure Service Connections: Outlets for [**carbon dioxide**][**nitrous oxide**][**and**][**oxygen**]<**Insert type of gas**> with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

G. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

1. Medical Carbon Dioxide: D.I.S.S. No. 1080.
2. Medical Helium: D.I.S.S. No. 1060.
3. Medical Nitrogen: D.I.S.S. No. 1120.
4. Medical Nitrous Oxide: D.I.S.S. No. 1040.
5. Medical Oxygen: D.I.S.S. No. 1240.
6. <**Insert medical gas**>. <**Insert D.I.S.S. No.**>.

H. Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent, color-coded, identifying label matching corresponding service.

2.7 PATIENT-SERVICE CONSOLES

A. Patient-Service Consoles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amico Corporation**]
b. [**BeaconMedaes**]
c. [**Tri-Tech Medical**]

d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Tri-Tech Medical**]
   d. <**Insert manufacturer's name**>

3. Manufacturer cleaned, purged, and sealed, for all medical gas types, for oxygen service in accordance with CGA G-4.1.
4. Standard: UL 60601.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Mounting: [**Recessed**][**Semirecessed**][**Surface**].
7. General Requirements for Patient-Service Consoles: Wall units with service connections. Include labels indicating services as well as the following:

   a. Steel console box or mounting bracket.
   b. Concealed supplies.
   c. Cover: One piece, [**aluminum**][**plastic**][**or**][**stainless steel**] and permanent identifying label.
   d. Medical gas-service connections, as specified in "Gas-Service Connections" Article.

      1) Medical Oxygen: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1240**] pressure outlet(s).
      2) Medical Air: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1160**] quick-coupler pressure outlet(s).
      3) Medical Vacuum: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1220**] suction inlet(s).
      4) Medical Vacuum Bottle Bracket(s): [**One**]<**Insert number**>.

   e. Electrical Service Connections:

      1) General Requirements for Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      2) Power Outlets: UL 498, Hospital Grade, 125 V ac, [**single**][**duplex**] receptacle(s)[**; in color selected by Architect**]. Include the following configurations in accordance with NEMA WD 1:

         a) [**One**]<**Insert number**> L5-20R, locking type, 20 A, single or duplex.
         b) [**One**]<**Insert number**> L5-20R, isolated ground, locking type, 20 A, single or duplex.
         c) <**Insert outlet type**>.

      3) Electrical Accessory Outlets: Provide the following configured receptacles in color selected by Architect:

         a) Patient Equipment Ground Jack: [**One**]<**Insert number**>, single pole, 30 A.
         b) Patient Monitoring: [**One**]<**Insert number**>, single, [**five**][**and**][**37**]<**Insert number**> pin.
         c) <**Insert outlet type**>.

4) Outlet Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent identifying label.

2.8 NITROGEN PRESSURE-CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

C. Description: Steel box and support brackets for recessed roughing-in, with stainless steel or anodized-aluminum cover plate with printed operating instructions.

D. Manifold: Assembly consisting of inlet supply valve, inlet supply pressure gauge, line-pressure control regulator, outlet supply pressure gauge, D.I.S.S. service connection, and piping outlet for remote service connection.

E. Minimum Working Pressure: [**200 psig (1380 kPa)**]<**Insert value**>.

F. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.

G. Pressure Gauges: **0 to 300 psig (0 to 2070 kPa)**.

H. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.

I. Before final assembly, provide temporary dust shield and U-tube for testing.

J. Label cover plate "Nitrogen Pressure Control."

K. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA G-4.1.

2.9 CEILING COLUMNS

A. Ceiling Columns : [**Retractable**][**Stationary**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Ohio Medical Corporation**]
   d. [**Tri-Tech Medical**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amico Corporation**]
   b. [**BeaconMedaes**]
   c. [**Ohio Medical Corporation**]
   d. [**Tri-Tech Medical**]
   e. <**Insert manufacturer's name**>

3. Description:

   a. Manually adjustable, using release and lock handles capable of locking column in all positions from fully retracted to fully extended; [**15-inch- (380-mm-)**]<**Insert dimension**> long, rectangular, counterbalanced, telescoping section with [**two**][**four**]<**Insert number**> double intravenous medication hooks; and [**36-inch- (915-mm-)**]<**Insert dimension**> long fixed column section. Include **0.078-inch- (2.0-mm-)** thick, stainless steel bottom plate with medical gas and electrical service connections as required.
   b. [**44-inch- (1120-mm-)**]<**Insert dimension**> long, rectangular stationary column section with [**two**][**four**]<**Insert number**> double intravenous medication hooks. Include **0.078-inch- (2.0-mm-)** thick, stainless steel bottom plate with medical gas and electrical service connections as required.
   c. Medical Gas-Service Connections: As specified in "Gas-Service Connections" Article. Include labels indicating services.

      1) Medical Carbon Dioxide: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1080**] pressure outlet(s).
      2) Medical Helium: [**One**]<**Insert number**> D.I.S.S. No. 1060 pressure outlet(s).
      3) Medical Nitrogen: [**One**]<**Insert number**> D.I.S.S. No. 1120 pressure outlet(s).
      4) Medical Nitrous Oxide: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1040**] pressure outlet(s).
      5) Medical Oxygen: [**Two**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1240**] pressure outlets.
      6) Instrument Air: [**One**]<**Insert number**> D.I.S.S. No. 1160 pressure outlet(s).
      7) Medical Air: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1160**] pressure outlet(s).
      8) Medical Vacuum: [**Two**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 1220**] suction inlets.
      9) Medical Vacuum Bottle Brackets: [**Two**]<**Insert number**>.
      10) WAGD: [**One**]<**Insert number**>[**quick-coupler**][**D.I.S.S. No. 2220**] suction inlet(s).
      11) <**Insert medical gas**>: <**Insert number and type**>.

   d. Standard: UL 60601.
   e. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
g. Mounting: Ceiling-mounted units.
h. Ceiling-Mounted Plate: Manufacturer's standard plate or roughing-in assembly.
i. Exposed Surfaces: Minimum **0.0375-inch- (0.95-mm-)** thick stainless steel.
j. Servicing: Include access panels or means of removing shroud.
k. Blank cover plates for cutouts not having service connections.
l. ASTM B819, **NPS 3/8 (DN 10)** copper-tube extensions for connection to medical gas systems.
m. Service Connections: Type and number indicated.
n. Dust Covers: For medical gas-service connections.
o. Electrical Service Connections:

1) Power Outlets: UL 498, Hospital Grade, 125 V ac, [**single**][**duplex**] receptacle(s)[**; in color selected by Architect**]. Include the following configurations in accordance with NEMA WD 1:

a) [**One**][**Two**]<**Insert number**> L5-20R, locking type, 20 A, single or duplex.
b) [**One**][**Two**]<**Insert number**> L5-20R, isolated ground, locking type, 20 A, single or duplex.
c) [**One**][**Two**]<**Insert number**> explosion proof, 20 A, two pole, three wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
d) [**One**][**Two**]<**Insert number**> 5-20R, straight blade, 20 A, duplex.
e) [**One**][**Two**]<**Insert number**> 5-20R, isolated ground, straight blade, 20 A, duplex.
f) <**Insert outlet type**>.

2) Electrical Accessory Outlets: Provide the following configured receptacles[**in color selected by Architect**]:

a) Patient Equipment Ground Jack: [**One**]<**Insert number**>, single pole, 30 A.
b) Patient Monitoring: [**One**]<**Insert number**>, single, [**five**][**and**][**37**]<**Insert number**> pin.
c) <**Insert outlet type**>.

3) Outlet Cover Plates: One piece, [**aluminum**][**or**][**stainless steel**] and permanent identifying label.

2.10 GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Amico Corporation**]
3. [**BeaconMedaes**]
4. [**Ohio Medical Corporation**]
5. [**Tri-Tech Medical**]
6. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

D. Comply with NFPA 99 for high-pressure medical gas cylinders.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Central Control-Panel Unit:

1. Weatherproof cabinet.
2. Supply and delivery pressure gauges.
3. Electrical alarm-system connections and transformer.
4. Indicator lights or devices.
5. Manifold connection.
6. Pressure changeover switch.
7. Line-pressure regulator.
8. Shutoff valves.
9. Safety valve.

G. Manifold and Headers:

1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
2. Designed for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, except nitrous oxide manifolds may be designed for [**800 psig (5520 kPa)**]<**Insert value**>, and carbon dioxide manifolds may be designed for [**1500 psig (10.35 MPa)**]<**Insert value**>.
3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

H. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

I. Mounting: [**Wall with mounting brackets for manifold control cabinet and headers**][**Floor with support legs for manifold control cabinet**].

J. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

K. Laboratory and Medical Carbon Dioxide Manifolds: For [**two**][**four**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

L. Laboratory and Medical Helium Manifolds: For [**two**][**four**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

M. Laboratory and Medical Nitrogen Manifolds: For [**eight**][**12**]<**Insert number**> cylinders and [**180-psig (1240-kPa)**][**higher than 200-psig (1380-kPa)**]<**Insert value**> line pressure.

N. Laboratory and Medical Nitrous Oxide Manifolds: For [**eight**][**12**]<**Insert number**> cylinders and [**55-**

psig (380-kPa)]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

O. Laboratory and Medical Oxygen Manifolds: For [**12**][**20**]<**Insert number**> cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure.

P. Laboratory and Medical Gas Cylinders: [**Furnished by Owner**][**Number and type of medical gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.11 SIMPLEX SPECIALTY GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Air Products and Chemicals, Inc.**]
3. [**Airgas; an Air Liquide company**]
4. [**BeaconMedaes**]
5. [**BOC Group, Inc.**]
6. [**CONCOA**]
7. [**GTS-Welco**]
8. [**Linde North America Inc**]
9. [**Matheson Tri-Gas, Inc.**]
10. [**Praxair Technology, Inc.**]
11. [**Spectra Gases, Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Air Products and Chemicals, Inc.**]
3. [**Airgas; an Air Liquide company**]
4. [**BeaconMedaes**]
5. [**BOC Group, Inc.**]
6. [**CONCOA**]
7. [**GTS-Welco**]
8. [**Linde North America Inc**]
9. [**Matheson Tri-Gas, Inc.**]
10. [**Praxair Technology, Inc.**]
11. [**Spectra Gases, Inc.**]
12. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all medical gas type, for oxygen service in accordance with CGA G-4.1.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gauges, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

F. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, cylinder-bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

G. Mounting: [**Wall with mounting brackets for manifold control cabinet and header**][**Floor with support legs for manifold control cabinet**].

H. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

I. Manifold: For <**Insert specialty gas**>; one cylinder and [**55-psig (380-kPa)**]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

J. Specialty Gas Cylinders: [**Furnished by Owner**][**Number and type of specialty gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.12 DUPLEX SPECIALTY GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Air Liquide America Specialty Gases LLC**]
3. [**Air Products and Chemicals, Inc.**]
4. [**Airgas; an Air Liquide company**]
5. [**BeaconMedaes**]
6. [**BOC Group, Inc.**]
7. [**CONCOA**]
8. [**GTS-Welco**]
9. [**Linde North America Inc**]
10. [**Matheson Tri-Gas, Inc.**]
11. [**Praxair Technology, Inc.**]
12. [**Spectra Gases, Inc.**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Air Liquide America Specialty Gases LLC**]
3. [**Air Products and Chemicals, Inc.**]
4. [**Airgas; an Air Liquide company**]
5. [**BeaconMedaes**]
6. [**BOC Group, Inc.**]
7. [**CONCOA**]
8. [**GTS-Welco**]
9. [**Linde North America Inc**]
10. [**Matheson Tri-Gas, Inc.**]
11. [**Praxair Technology, Inc.**]
12. [**Spectra Gases, Inc.**]
13. <**Insert manufacturer's name**>

C. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA

G-4.1.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Central Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gauges, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.

F. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for [**2000-psig (13.8-MPa)**]<**Insert value**> minimum inlet pressure, cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.

G. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

H. Mounting: [**Wall with mounting brackets for manifold control cabinet and headers**][**Floor with support legs for manifold control cabinet**].

I. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.

J. Manifold: For <**Insert specialty gas**>; two cylinders and [**55-psig (380-kPa)**]<**Insert value**> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

K. Specialty Gas Cylinders: [**Furnished by Owner**][**Number and type of specialty gas cylinders required for complete manifold systems**]<**Insert requirement**>.

2.13 BULK MEDICAL GAS STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Cryogenics**]
2. [**Chart Industries**]
3. [**Taylor-Wharton**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Cryogenics**]
2. [**Chart Industries**]
3. [**Taylor-Wharton**]
4. <**Insert manufacturer's name**>

C. General Requirements for Bulk Medical Gas Storage Tanks:

1. Manufacturer cleaned, purged, and sealed, for all gas types, for oxygen service in accordance with CGA G-4.1.

2. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1; and NFPA 99.
3. Include bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies.
4. Controls: Include actuating switch for alarm-system connection and means for automatic actuating of reserve supply.
5. Bulk Gas Storage Tanks: Vertical mounted, double-wall construction with inner vessel fabricated in accordance with ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:

    a. Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
    b. Pressure Gauges: For tank pressure and facility service-line pressure.
    c. Contents Gauge: High- and low-level indicator with electric signal circuit connection.
    d. Drain Valves: For piping, inner vessel, and outer shell.
    e. Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
    f. Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
    g. Permanent label showing medical gas type, storage-tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.

D. Liquid Oxygen Storage Tank:

1. Comply with NFPA 55 for bulk oxygen storage tanks.
2. Construction: Nickel-steel or stainless steel inner vessel with [**250-psig (1725-kPa)**]<**Insert value**> minimum working pressure.
3. Vaporizer Type: [**Electric**][**Steam**][**Ambient**].
4. Storage-Tank Capacity: [**As indicated**]<**Insert value**>.
5. Vaporizer Capacity: [**As indicated**]<**Insert value**>.

E. Oxygen Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures of up to [**4000 psig (27.6 MPa)**]<**Insert value**>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gauge, and inlet connections for <**Insert number**> cylinders indicated.

F. Liquid Nitrous Oxide Storage Tank:

1. Comply with CGA G-8.1 for bulk nitrous oxide storage tanks.
2. Construction: Steel-alloy inner vessel with [**300-psig (2070-kPa)**]<**Insert value**> minimum working pressure.
3. Vaporizer Type: [**Electric**][**Steam**].
4. Storage Tank Capacity: [**As indicated**]<**Insert value**>.
5. Vaporizer Capacity: [**As indicated**]<**Insert value**>.

G. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures of up to [**4000 psig (27.6 MPa)**]<**Insert value**>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gauge, inlet connections for <**Insert number**> cylinders indicated, and electric heater.

2.14 GAS CYLINDER STORAGE RACKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airgas; an Air Liquide company**]
2. [**RT Racking Systems**]
3. [**USA Safety**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Airgas; an Air Liquide company**]
2. [**RT Racking Systems**]
3. [**USA Safety**]
4. <**Insert manufacturer's name**>

C. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders, as indicated, or provide equivalent manufactured wall racks.

D. Freestanding Storage Racks: Fabricate racks as indicated, or provide equivalent manufactured storage racks.

E. Anchor holes in base to permit securing to the floor with anchor bolts supplied by the manufacturer.

F. Rack Support Tubing: Minimum **2-inch by 2-inch by 1/8-inch (50-mm by 50-mm by 3-mm)** tube steel finished with baked-on exterior grade polyurethane powder paint. All joints wrap-welded and polished.

G. Tank Restraints: Dual minimum **5/16-inch (8-mm)** steel welded link chain, electrically zinc-plated rated for **1900 lb (860 kg)** with minimum **5/16-inch (8-mm)** zinc-plated carabineer hooks rated for minimum **520 lb (235 kg)**.

H. Comply with NFPA 55.

I. Comply with NFPA 99.

J. Comply with OSHPD #OPA-2878-10.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gauges, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service in accordance with CGA G-4.1.
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of **1 lb (0.453 kg)** of chemical to **3 gal. (11.3 L)** of

water.

a. Scrub to ensure complete cleaning.
b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 INSTALLATION OF PIPING

A. General Location and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of medical gas piping.

C. Comply with NFPA 55 for installation of laboratory gas piping.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment and specialties to allow service and maintenance.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

I. Install piping to permit valve servicing.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and for branch connections.

L. Install medical gas piping to medical gas-service connections specified in this Section, to medical gas-service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

M. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

N. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

O. Install medical gas-service connections recessed in walls. Attach roughing-in assembly to substrate;

attach finishing assembly to roughing-in assembly.

P. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

Q. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

U. Prepare tubing and install fittings using tools by product manufacturer.

3.4 INSTALLATION OF VALVES

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

F. Install emergency oxygen connection with pressure-relief valve and full-size discharge piping to outside, with check valve downstream from pressure-relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings in accordance with CDA's "Copper Tube Handbook," Ch. "Brazed Joints." Do not use flux. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube in accordance with procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

F. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings in

accordance with ASTM B828.

G. Extruded-Tee Outlets: Form branches in copper tube in accordance with ASTM F2014, with tools recommended by tube manufacturer.

H. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.
2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

3.6 INSTALLATION OF GAS-SERVICE COMPONENTS

A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

E. Install gas manifolds[**on concrete base**] anchored to substrate.

F. Install gas cylinders and connect to manifold piping.

G. Install gas manifolds with seismic restraints.

H. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks[**in accordance with applicable requirements in NFPA 55 for bulk oxygen storage systems**]. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 55 and tank manufacturer's recommended clearances. Orient tanks, so controls and devices are accessible for servicing.

I. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Vertical Piping: MSS Type 8 or Type 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52 spring hangers.

G. Install hangers for copper tubing with maximum horizontal spacing and minimum rod diameters to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

I. Support vertical runs of copper tubing to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems in accordance with NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Carbon Dioxide: Black or white letters on gray background.
2. Helium: White letters on brown background.
3. Nitrogen: White letters on black background.
4. Nitrous Oxide: White letters on blue background.
5. Oxygen: White letters on green background or green letters on white background.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of [**medical compressed-air piping**][**and**][**medical vacuum piping**] systems.
2. Preparation: Perform the following Installer tests in accordance with requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blowdown.
b. Initial pressure test.
c. Cross-connection test.
d. Piping purge test.
e. Standing pressure test for positive-pressure medical gas piping.
f. Standing pressure test for vacuum systems.
g. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections in accordance with NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

a. Standing pressure test.
b. [**Individual-pressurization**][**or**][**pressure-differential**] cross-connection test.
c. Valve test.
d. Master and area alarm tests.
e. Piping purge test.
f. Piping particulate test.
g. Piping purity test.
h. Final tie-in test.
i. Operational pressure test.
j. Gas concentration test.
k. Air-purity test.
l. Verify correct labeling of equipment and components.
m. Verify medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed, and certify report results. Include the following:

a. Inspections performed.
b. Procedures, materials, and gases used.
c. Test methods used.
d. Results of tests.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of **50 psig (345 kPa)** above system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert value**>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test

pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect specialty gas regulators for proper operation.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, in accordance with "Preparation" Article.

3.12 DEMONSTRATION

A. [**Engage factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.13 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Gas Piping except Medical Nitrogen Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

C. Medical Nitrogen Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

D. Specialty Gas Piping except Specialty Gas Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

E. Specialty Gas Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

F. Laboratory Gas Piping except Laboratory Nitrogen Piping NPS 3 (DN 80) and Smaller Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

G. Laboratory Nitrogen Piping NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

H. <**Insert specialty gas**>. Piping except Specialty Gas NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

I. <**Insert specialty gas**>. Piping NPS 3 (DN 80) and Smaller to Operate at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

3.14 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions with pressure gauge on one copper-tube extension.

END OF SECTION 22 63 13 00

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Task	Specification	Specification Description
22 63 13 53	22 63 13 00	Gas Piping For Laboratory And Healthcare Facilities

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SECTION 22 66 00 00 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall pipe and fittings.
2. Double-wall containment pipe and fittings.
3. Field-fabrication containment piping.
4. Joining materials.
5. Piping specialties.
6. Neutralization tanks.
7. Neutralization systems.
8. Manholes - holding tanks.
9. Leak-detection systems.
10. pH monitoring systems.
11. High-level alarm stations.
12. Combination high-level and leak-detection alarm stations.

1.2 DEFINITIONS

A. FPM: Vinylidene fluoride (hexafluoropropylene copolymer rubber).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For neutralization system, leak-detection systems, and pH monitoring systems and level alarms.

1. Include plans, elevations, sections, and attachment details.
2. Include details of neutralization-system assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of leak-detection-system assemblies. Indicate required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For seismic restraints of aboveground piping.

1. Include design calculations for selecting seismic restraints. See Section 018123 "Facility Seismic and Wind Criteria" for building seismic and wind criteria.

D. Sustainable Design Submittals:

1. Product Data: For solvents and adhesives, indicating VOC content.
2. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements

for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Profile Drawings for Outdoor Underground Piping: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and vertical scale of not less than **1 inch equals 5 feet (1:50)**. Indicate underground structures and pipes. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Coordination Drawings: Plans and other details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

C. Seismic Qualification Certificates: For tanks and tank systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For chemical-waste specialties and [**neutralization tanks**][**neutralization systems**][**and**][**leak-detection systems**] to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Neutralization-Tank Limestone: Equal to [**200**]<**Insert number**> percent of amount required for each tank sump initial charge. Furnish limestone in **50 lb (22.7 kg)** bags.
2. Neutralization-System Limestone and Chemicals: For each neutralization system.

a. Limestone: Equal to [**500**]<**Insert number**> percent of amount required for tank sump initial charge. Furnish limestone in **50 lb (22.7 kg)** bags.
b. Chemicals: Equal to [**500**][**1000**]<**Insert number**> percent of neutralizing chemicals required for filling tanks.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, fittings, and seals from dirt and damage.

1.8 FIELD CONDITIONS

A. Interruption of Existing Chemical-Waste Service: Do not interrupt chemical-waste service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary chemical-waste service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of chemical-waste service.
2. Do not proceed with interruption of chemical-waste service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Single-Wall Piping Pressure Rating: [**5 psig (34.5 kPa)**]<**Insert value**>[**air test pressure**][**10 feet head (3.05 m)of water for 30 minutes**]<**Insert value and time**>.

B. Double-Containment Piping Pressure Rating:

1. Carrier Piping: [**5 psig (34.5 kPa)**]<**Insert value**>[**air test pressure**][**10 feet head (3.05 m) of water for 30 minutes**]<**Insert value and time**>.
2. Containment Piping: [**5 psig (34.5 kPa)**]<**Insert value**>[**air test pressure**]<**Insert test method**>.

C. Field-Fabrication Containment-Piping Pressure Rating: [**5 psig (34.5 kPa)**]<**Insert value**>[**air test pressure**]<**Insert test method**>.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. NFPA Compliance: Comply with NFPA 70.

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for aboveground piping. See Section 018123 "Facility Seismic and Wind Criteria," which specifies basis-of-design seismic and wind criteria for non-structural components.

G. Seismic Performance: Piping, piping specialties, tanks, and tank systems are to withstand the effects of earthquake motions. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 SINGLE-WALL PIPE AND FITTINGS

A. PP Drainage Pipe and Fittings: ASTM F1412, extruded pipe and drainage-pattern fittings molded, with Schedule 40 dimensions and with fire-retardant additive complying with ASTM D4101; with [**fusion-**][**and**][**mechanical-**]joint ends.

1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Town & Country Plastics, Inc**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Town & Country Plastics, Inc**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

4. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

B. CPVC Drainage Pipe and Fittings: ASTM F2618, pipe and drainage-pattern fittings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**Spears Manufacturing Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Charlotte Pipe and Foundry Company**]
   b. [**Spears Manufacturing Company**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

C. PVDF Drainage Pipe and Fittings: ASTM F1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with [**fusion-**][**and**][**mechanical-**]joint ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

D. Fiberglass Pipe and Fittings, Centrifugally Cast: ASTM D2997, Type II, [**Grade 1**][**Grade 2**]<**Insert grade**>, [**Class A**][**Class B**][**Class C**], RTRP pipe; with ASTM D5685, Type 4, fiberglass thermosetting resin fittings matching pipe; and [**adhesive-bonding**][**and**][**butt-and-wrap-joint**] materials. Include wall thickness that will provide [**160 psig (1105 kPa)**]<**Insert value**> minimum, sustained water test pressure rating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Smith Fiberglass; a National Oilwell Varco brand**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Smith Fiberglass; a National Oilwell Varco brand**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

E. Fiberglass Pipe and Fittings, Filament Wound: ASTM D2996, Type I, [**Grade 1**][**Grade 2**]<**Insert grade**>, [**Class A**][**Class B**][**Class C**][**Class E**][**Class F**]<**Insert class**>, RTRP pipe; ASTM D5685, Type 1, reinforced thermosetting resin fittings matching pipe; and [**adhesive-bonding**][**and**][**butt-and-wrap-joint**] materials. Include wall thickness that will provide [**160 psig (1105 kPa)**]<**Insert value**> minimum, sustained water test pressure rating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ameron International**]
    b. [**Fibrex**]
    c. [**Smith Fiberglass; a National Oilwell Varco brand**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ameron International**]
    b. [**Fibrex**]
    c. [**Smith Fiberglass; a National Oilwell Varco brand**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

F. Stainless Steel Drainage Pipe and Fittings: ASME A112.3.1, ASTM A666, Type 316L, stainless steel pipe and drainage-pattern fittings; with socket-and-spigot ends for gasket joints; and having piping manufacturer's FPM lip-seal rubber gaskets shaped to fit socket groove, with plastic backup ring.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Josam Company**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Josam Company**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

G. Borosilicate Glass Pipe and Fittings: ASTM C1053, pipe and drainage-pattern fittings; with manufacturer's standard couplings.

1. Covering: Factory-applied polystyrene for pipe installed underground.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Schott North America, Inc.**]
    b. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Schott North America, Inc.**]
   b. <**Insert manufacturer's name**>

4. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.

H. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.3 DOUBLE-WALL CONTAINMENT PIPE AND FITTINGS

A. Double-Wall Containment Pipe and Fittings - Factory Fabricated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Asahi/America**]
   b. [**Flo Safe, Inc**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**Insul-Tek Piping Systems, Inc**]
   e. [**IPEX USA LLC**]
   f. [**Orion Fittings; A Watts Water Technologies Company**]
   g. [**Performance Pipe**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Asahi/America**]
   b. [**Flo Safe, Inc**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**Insul-Tek Piping Systems, Inc**]
   e. [**IPEX USA LLC**]
   f. [**Orion Fittings; A Watts Water Technologies Company**]
   g. [**Performance Pipe**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
4. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners.
5. Piping Materials:

   a. PP Double-Containment Drainage Pipe and Fittings: Made of ASTM D4101 PP resin.

      1) Carrier and Containment Pipes: ASTM F1412, Schedule 40.
      2) Fittings: ASTM F1412, Schedule 40 drainage pattern complying with ASTM D3311.

b. PVDF Double-Containment Drainage Pipe and Fittings: Made of ASTM D3222 PVDF resin.

1) Carrier and Containment Pipes: ASTM F1673, Schedule 40.
2) Fittings: ASTM F1673, Schedule 40 drainage pattern complying with ASTM D3311.

6. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.4 FIELD-FABRICATION CONTAINMENT PIPING

A. Containment Piping - Field Fabricated: Containment split pipe and split fittings with carrier-pipe centralizers. Include manufacturer's fastening devices and materials.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flo Safe, Inc**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flo Safe, Inc**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain containment piping from single source from single manufacturer.
4. Material: [**HDPE**][**PP**] pipe and fittings.
5. Fastening System: FPM gaskets, clamps, and pins.

2.5 JOINING MATERIALS

A. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

D. Solvent Cement for Joining CPVC Piping: ASTM F493. Include primer in accordance with ASTM F656.

1. Product Data: Verify PVC welding solvent cement has a VOC content of 510 g/L or less.
2. Verify solvent cement complies with testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify solvent cement complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. Fiberglass-Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
2. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.6 PIPING SPECIALTIES

A. Plastic Dilution Traps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Town & Country Plastics, Inc**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Town & Country Plastics, Inc**]
   e. [**Zurn Industries, LLC**]

f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain traps from single source from single manufacturer.
4. Material: Corrosion-resistant PP, with removable base.
5. End Connections: Mechanical joint.
6. Dilution Tanks: **1 gal. (3.8 L)** capacity, with clear base unless colored base is indicated; with two **NPS 1-1/2 (DN 40)** top inlets and one **NPS 1-1/2 (DN 40)** side outlet.
7. Small Dilution Jars: **1-pint (0.5-L)** capacity, with clear base unless colored base is indicated; with **NPS 1-1/2 (DN 40)** top inlet and **NPS 1-1/2 (DN 40)** side outlet.
8. Large Dilution Jars: **1-quart (1-L)** capacity; with **NPS 1-1/2 (DN 40)** top inlet and **NPS 1-1/2 (DN 40)** side outlet.

B. Glass, Drain-Line, Interceptor Traps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Schott North America, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Schott North America, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain traps from single source from single manufacturer.
4. Standard: ASTM C1053.
5. Type: Drum trap.
6. Size: **NPS 1-1/2 (DN 40)**, **NPS 2 by NPS 1-1/2 (DN 50 by DN 40)**, or **NPS 2 (DN 50)**, as required to match connecting piping.

C. Corrosion-Resistant Traps:

1. Type: P-trap or drum trap.
2. Size: **NPS 1-1/2 or NPS 2 (DN 40 or DN 50)**, as required to match connected piping.
3. High-Silicon Iron: ASTM A861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
4. PP: ASTM D4101, with mechanical-joint pipe connections.
5. PVDF: ASTM D3222, with mechanical-joint pipe connections.
6. Glass: ASTM C1053, with coupling pipe connections.

D. Stainless Steel Floor Drains :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Josam Company**]
   b. [**Sioux Chief Manufacturing Company, Inc.**]

c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Josam Company**]
   b. [**Sioux Chief Manufacturing Company, Inc.**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain floor drains from single source from single manufacturer.
4. Standard: ASME A112.3.1; ASTM A666, Type 316L.
5. Body: With [**8.5-by-8.5-inch (215-by-215-mm)**][**12.4-by-12.4-inch (315-by-315-mm)**] top with grate.
6. Outlet: Bottom, of size indicated.

E. PP Floor Drains :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Schier Products Company**]
   e. [**Town & Country Plastics, Inc**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Zurn Industries, LLC**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**GF Piping Systems: Georg Fischer LLC**]
   b. [**IPEX USA LLC**]
   c. [**Orion Fittings; A Watts Water Technologies Company**]
   d. [**Schier Products Company**]
   e. [**Town & Country Plastics, Inc**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. [**Zurn Industries, LLC**]
   h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain floor drains from single source from single manufacturer.
4. Body: With **7- to 9-inch (178- to 230-mm)** top diameter, with flashing flange and weep holes; and with [**flashing clamp**][**basket strainer**][**funnel attachment**][**and**][**trap-primer connection**].
5. Outlet: Bottom, to match connecting pipe, with **NPS 2, NPS 3, NPS 4, or NPS 6 (DN 50, DN 80, DN 100, or DN 150)** outlet as indicated.

F. Stainless Steel Cleanouts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Josam Company**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Josam Company**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cleanouts from single source from single manufacturer.
4. Standard: ASME A112.3.1; ASTM A666, Type 316L.
5. Aboveground Piping: Cleanout tee of size matching piping.
6. Underground and Underslab Piping: Floor access cleanout of size matching piping.

G. Plastic Backwater Valves:

1. Description: Full-port **NPS 3 (DN 80)** check valve, PP or PVDF, matching or compatible with system piping and compatible with system liquid, with EPDM seals and flanged ends.

a. Exception: PVC material for use with PVC piping systems.

H. PP Sink Outlets:

1. Description: **NPS 1-1/2 (DN 40)**, with clamping device, stopper, and **7-inch- (178-mm-)** high overflow fitting.

I. Glass Sink Outlets:

1. **NPS 1-1/2 (DN 40)**; with sink assembly of outlet, strainer, gasket, and locknut; overflow fitting of length indicated; and tailpiece assembly of borosilicate glass and locknut.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Schott North America, Inc.**]
b. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Schott North America, Inc.**]
b. <**Insert manufacturer's name**>

4. Source Limitations: Obtain sink outlets from single source from single manufacturer.
5. Standard: ASTM C1053 components for field assembly.

2.7 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks :

1. Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Chem-Tainer Industries**]
   b. [**GF Piping Systems: Georg Fischer LLC**]
   c. [**IPEX USA LLC**]
   d. [**Orion Fittings; A Watts Water Technologies Company**]
   e. [**Schier Products Company**]
   f. [**Town & Country Plastics, Inc**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Chem-Tainer Industries**]
   b. [**GF Piping Systems: Georg Fischer LLC**]
   c. [**IPEX USA LLC**]
   d. [**Orion Fittings; A Watts Water Technologies Company**]
   e. [**Schier Products Company**]
   f. [**Town & Country Plastics, Inc**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Zurn Industries, LLC**]
   i. <**Insert manufacturer's name**>

4. Source Limitations: Obtain tanks from single source from single manufacturer.
5. Material: [**HDPE**][**HDPE or ASTM D4101 PP**][**ASTM D4101 PP**].
6. Tank Capacity: <**Insert capacity**>.
7. Dip Tube: On outlet pipe instead of inlet pipe.
8. Extension: HDPE, PE, or PP.
9. Traffic Cover: [**Light-duty**][**Heavy-duty pedestrian or light-duty vehicular, steel plate over**] plastic, bolted.
10. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.
11. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.

B. Ceramic Neutralization Tanks :

1. Corrosion-resistant, cast-ceramic shell; with removable, reinforced-plastic, gastight cover; inlet; interior, sidewall, dip-tube outlet; vent; and bell, sidewall pipe connections.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Koch Knight LLC**]
b. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Koch Knight LLC**]
   b. <**Insert manufacturer's name**>

4. Source Limitations: Obtain tanks from single source from single manufacturer.
5. Tank Capacity: <**Insert capacity**>.
6. Extension, Ceramic: Of size and length indicated, and with cast-iron manhole frame and cover.
7. Extension, Steel: With protective coating, **28-inch (710-mm)** diameter, and cast-iron manhole frame and cover.
8. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.
9. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.

C. Collection Tanks: Corrosion-resistant, cast-ceramic shell. Include removable, reinforced-plastic, gastight cover; inlet; vent; and bell, sidewall pipe connections.

1. Extension: [**Ceramic**][**Steel with protective coating**], **28-inch (710-mm)** minimum diameter, and cast-iron manhole frame and cover.

2.8 NEUTRALIZATION SYSTEMS

A. Plastic-Tank Neutralization Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Orion Fittings; A Watts Water Technologies Company**]
   b. [**Town & Country Plastics, Inc**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Orion Fittings; A Watts Water Technologies Company**]
   b. [**Town & Country Plastics, Inc**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain neutralization systems from single source from single manufacturer.
4. Description: Automatic system for neutralizing chemical waste.
5. Controls: Factory wired and tested, 120 V ac, to operate probes, control valves, and metering

pumps and to monitor pH of effluent; with wiring and electrical-power terminals.

6. Panel: NEMA 250, Type 4X enclosure unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, but not less than the following:

    a. Power light and on/off switch.
    b. pH analyzer with meter and high- and low-pH indicators.
    c. Low caustic- and acid-solution level indicators.
    d. Alarm horn with silencer and reset switch.
    e. Agitator running light with on/off switch.
    f. Running lights with on/off switches for caustic- and acid-solution pumps.

7. Strip chart recorder with capacity for 30-day record.
8. Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
9. Interceptor Tank: Same material as mixing tank; with removable, gastight cover and sidewall inlet and outlet piping connections.
10. Neutralization Tank: Same material as mixing tank; with removable, gastight cover, sidewall inlet and outlet piping connections, and vent connection in sidewall or top.

    a. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.
    b. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.

11. Mixing Tank: With removable, gastight cover, sidewall inlet and outlet piping connections, vent connection in sidewall or top, neutralizing-solution piping connections, and openings in top for probe and agitator.

    a. Material: [**HDPE**][**HDPE or ASTM D4101 PP**][**ASTM D4101 PP**].
    b. pH Probe: Type and length suitable for mixing-tank size.
    c. Agitator: Electric, with stainless steel shaft and propeller.

12. Caustic-Solution Storage Tank: PP.

    a. Caustic Chemical: Sodium hydroxide solution.

13. Acid Storage Tank: PP.

    a. Acid Chemical: Sulfuric acid solution.

14. Metering Pumps: Types suitable for neutralizing solutions.
15. Sampling Tank: Same material as mixing tank; with removable, gastight cover, sidewall inlet and outlet piping connections, and opening in top for probe.

    a. pH probe: Type and length suitable for sampling-tank size.

B. Ceramic-Tank Neutralization Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Koch Knight LLC**]

b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Koch Knight LLC**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain neutralization systems from single source from single manufacturer.
4. Description: Automatic system for neutralizing chemical waste.
5. Controls: Factory wired and tested, 120 V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.
6. Panel: NEMA 250, Type 4X enclosure unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, but not less than the following:

   a. Power light and on/off switch.
   b. pH analyzer with meter and high- and low-pH indicators.
   c. Low caustic- and acid-solution level indicators.
   d. Alarm horn with silencer and reset switch.
   e. Agitator running light with on/off switch.
   f. Running lights with on/off switches for caustic- and acid-solution pumps.

7. Strip chart recorder with capacity for 30-day record.
8. Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
9. Interceptor Tank: Same material as mixing tank; with removable, gastight cover and sidewall inlet and outlet piping connections.
10. Neutralization Tank: Same material as mixing tank; with removable, gastight cover, sidewall inlet and outlet piping connections, and vent connection in sidewall or top.

    a. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.
    b. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and **1- to 3-inch (25- to 75-mm)** diameter.

11. Mixing Tank: With removable, gastight cover, sidewall inlet and outlet piping connections, vent connection in sidewall or top, neutralizing-solution piping connections. and openings in top for probe and agitator.

    a. Material: Clay, vitrified into ceramic unit.
    b. pH Probe: Type and length suitable for mixing tank size.
    c. Agitator: Electric, with stainless steel shaft and propeller.

12. Caustic-Solution Storage Tank: PP.

    a. Caustic Chemical: Sodium hydroxide solution.

13. Acid Storage Tank: PP.

    a. Acid Chemical: Sulfuric acid solution.

14. Metering Pumps: Types suitable for neutralizing solutions.

15. Sampling Tank: Same material as mixing tank; with removable, gastight cover, sidewall inlet and outlet piping connections, and opening in top for probe.

    a. pH Probe: Type and length suitable for sampling-tank size.

2.9 MANHOLES - HOLDING TANKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ayer Sales, Inc.**]
2. [**ISCO Industries, LLC**]
3. [**Performance Pipe**]
4. [**Plastic Fusion Fabricators, Inc**]
5. [**PolyPipe Brand; Dura-Line**]
6. [**Zurn Industries, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ayer Sales, Inc.**]
2. [**ISCO Industries, LLC**]
3. [**Performance Pipe**]
4. [**Plastic Fusion Fabricators, Inc**]
5. [**PolyPipe Brand; Dura-Line**]
6. [**Zurn Industries, LLC**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain holding tanks from single source from single manufacturer.

D. Description: ASTM F1759, fabricated from PE components. Include bottom, sidewalls, and top sections; corrosion-resistant, tanks frame and cover; fusion or other watertight joints; and design to prohibit flotation.

E. Construction: [**Single wall**][**Double wall with interstitial space**].

F. Bottom: Channeled.

G. Connections: Inlets and outlet matching or suitable for piping.

H. Steps: Manufacturer's standard, fusion welded to sidewall. Omit steps for manholes less than [**60 inches (1500 mm)**]<**Insert dimension**> deep.

I. Top: Include **24-inch (610-mm)** nominal-diameter frame and cover.

2.10 LEAK-DETECTION SYSTEMS

A. Leak-Detection Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**Flo Safe, Inc**]
c. [**IPEX USA LLC**]
d. [**Pentair Thermal Management**]
e. [**PermAlert**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Asahi/America**]
b. [**Flo Safe, Inc**]
c. [**IPEX USA LLC**]
d. [**Pentair Thermal Management**]
e. [**PermAlert**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain leak-detection systems from single source from single manufacturer.
4. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.
5. Annunciator Panel: Enclosure with visual and audible alarms and leak-location indicator.
6. Sensors: Electric cable, suitable for insertion in double-containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.

2.11 pH MONITORING SYSTEMS

A. pH Monitoring System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IPEX USA LLC**]
b. [**Orion Fittings; A Watts Water Technologies Company**]
c. [**Process and Water**]
d. [**Sensorex USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**IPEX USA LLC**]
b. [**Orion Fittings; A Watts Water Technologies Company**]
c. [**Process and Water**]
d. [**Sensorex USA**]
e. <**Insert manufacturer's name**>

3. Description: pH monitoring system, including monitoring panel, pH probe, and interconnecting cable.
4. Monitoring Panel:

    a. Enclosure: UL 508 listed and labeled, <**Insert enclosure type**>.
    b. pH analyzer.
    c. Power-on LED.
    d. Alarms:

        1) User-selectable high and low pH setpoints.
        2) Analyzer/sensor fault alarm.
        3) Red visible alarm indicator lights.
        4) Audible alarm horn.
        5) Audible alarm silence button.

    e. Digital pH Chart Recorder Module:

        1) Fully connected and installed in monitoring panel.
        2) Paperless chart recorder.
        3) 30-day record.
        4) User-selectable high and low alarm set points.
        5) Enclosure: <**Insert enclosure type**>.

5. pH Probe and Cable:

    a. Industrial-quality pH probe.
    b. Airtight insertion fixture.
    c. Factory-calibrated.

2.12 HIGH-LEVEL ALARM STATIONS

A. High-Level Alarm Station:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Icon Process Controls**]
    b. [**MIFAB, Inc**]
    c. [**Orion Fittings; A Watts Water Technologies Company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Icon Process Controls**]
    b. [**MIFAB, Inc**]
    c. [**Orion Fittings; A Watts Water Technologies Company**]
    d. <**Insert manufacturer's name**>

3. Description: High-level alarm stations for tanks.

4. Alarm Panel:

    a. Enclosure: UL-listed, <**Insert enclosure type**>.
    b. 120 V ac, 60 Hz.
    c. Integral Alarm Horn: <**Insert decibels at distance**>.
    d. Integral red-light beacon that remains active until alarm state is resolved.
    e. Horn silence switch.
    f. Alarm test switch.

5. High-Level Alarm Sensor:

    a. Polypropylene NO float sensor with solid polypropylene exposed float.
    b. Maximum Operating Temperature: [**194 deg F (90 deg C)**]<**Insert maximum operating temperature**>.

B. Combination High-Level and Leak-Detection Alarm Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Icon Process Controls**]
    b. [**Orion Fittings; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Icon Process Controls**]
    b. [**Orion Fittings; A Watts Water Technologies Company**]
    c. <**Insert manufacturer's name**>

3. Description: Combination high level alarm and leak detection station for tanks.
4. Alarm Panel:

    a. Enclosure: UL-listed, <**Insert enclosure type**>.
    b. 120 V ac, 60 Hz.
    c. Green, power-on LED.
    d. Two red, alarm LEDs that remain active until alarm state is resolved.
    e. Integral alarm horn, <**Insert decibels at distance**>
    f. Horn silence switch.
    g. Alarm test switch.
    h. System Operating Temperature Range: [**Minus 22 deg F to plus 150 deg F (Minus 30 deg C to plus 65 deg C)**]<**Insert range**>.

5. High-Level Alarm Sensor:

    a. Polypropylene normally open float sensor with solid polypropylene exposed float.

6. Leak-Detection Sensor:

a. For sensing leaks on floor around outside perimeter of tank.
b. 12 V dc flat leak detection sensor.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 CONCRETE BASES

A. Equipment Mounting:

1. Install [**neutralization tanks**][**and**][**neutralization system tanks**] on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Anchor [**neutralization tanks**][**and**][**neutralization system tanks**] to concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **19-inch (480-mm)** centers around full perimeter of base.
2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 INSTALLATION OF PIPING

A. Chemical-Waste Sewerage Outside the Building:

1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
5. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

6. Install drainage piping pitched down in direction of flow, at minimum slope of [**1**][**2**]<**Insert number**> percent unless otherwise indicated.
7. Install drainage piping with [**36-inch (900-mm)**][**48-inch (1200-mm)**][**60-inch (1500-mm)**][**72-inch (1800-mm)**]<**Insert dimension**> minimum cover.
8. Install CPVC drainage piping in accordance with ASTM D2321 and ASTM F1668.
9. Install PVDF drainage piping in accordance with ASTM D2321 and ASTM F1668.
10. Install field-fabrication containment piping over[**new and**] existing carrier piping. Use containment piping manufacturer's fastening system.
11. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain a swab or drag inside piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

B. Chemical-Waste Piping Inside the Building:

1. Install piping adjacent to equipment, accessories, and specialties, to allow space for service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
12. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
13. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF PIPING SPECIALTY

A. Embed floor drains in **4-inch- (100-mm-)** minimum depth of concrete around bottom and sides. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete.

B. Fasten grates to drains if indicated.

C. Set floor drains with tops flush with pavement surface.

D. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

1. Set cleanout bodies in earth in cast-in-place concrete block, **18 by 18 by 12 inches (450 by 450 by 300 mm)** deep. Set with tops **1 inch (25 mm)** above surrounding grade. Set cleanout plugs in concrete pavement, with tops flush with pavement surface. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for formwork, reinforcement, and

concrete requirements.

E. Install backwater valves in horizontal position. Include riser to cleanout at grade.

3.5 JOINT CONSTRUCTION

A. Chemical-Waste Sewerage Outside the Building:

1. Plastic-Piping Fusion Joints: Make PP drainage-piping joints in accordance with ASTM F1290.
2. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.

B. Chemical-Waste Piping Inside the Building:

1. Plastic-Piping Fusion Joints: Make PP drainage-piping joints in accordance with ASTM F1290.
2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.6 INSTALLATION OF HANGER AND SUPPORT

A. Pipe sizes in this article refer to aboveground single-wall piping[**and carrier piping of containment piping**].

B. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

C. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or MSS Type 42 riser clamps.
2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52 spring hangers.

D. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.

E. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting and coupling.

F. Support vertical piping and tubing at base and at each floor.

G. Rod diameter may be reduced one size for double-rod hangers, to minimum of **3/8 inch (10 mm)**.

H. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): **33 inches (840 mm)** with **3/8-inch (10-mm)** rod.

2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): **42 inches (1067 mm)** with **1/2-inch (13-mm)** rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): **48 inches (1220 mm)** with **5/8-inch (16-mm)** rod.
4. NPS 6 (DN 150): **48 inches (1220 mm)** with **3/4-inch (19-mm)** rod.
5. NPS 8 (DN 200): **48 inches (1220 mm)** with **7/8-inch (22-mm)** rod.

I. Install supports for vertical PP piping every **72 inches (1830 mm)**.

J. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): **36 inches (910 mm)** with **3/8-inch (10-mm)** rod.
2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): **42 inches (1070 mm)** with **1/2-inch (13-mm)** rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): **48 inches (1220 mm)** with **5/8-inch (16-mm)** rod.
4. NPS 6 (DN 150): **48 inches (1220 mm)** with **3/4-inch (19-mm)** rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): **48 inches (1220 mm)** with **7/8-inch (22-mm)** rod.

K. Install supports for vertical CPVC piping every **48 inches (1220 mm)**.

L. Install vinyl-coated hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with liquid waste at temperatures above **140 deg F (60 deg C)**.
2. NPS 1/2 (DN 15) and Smaller: **30 inches (760 mm)** with **3/8-inch (10-mm)** rod.
3. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): **36 inches (910 mm)** with **3/8-inch (10-mm)** rod.
4. NPS 2 (DN 50): **36 inches (910 mm)** with **3/8-inch (10-mm)** rod.
5. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): **42 inches (1070 mm)** with **1/2-inch (13-mm)** rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): **48 inches (1220 mm)** with **5/8-inch (16-mm)** rod.
7. NPS 6 (DN 150): **48 inches (1220 mm)** with **3/4-inch (19-mm)** rod.

M. Install supports for vertical PVDF piping **NPS 1-1/2 (DN 40)** every **48 inches (1220 mm)** and **NPS 2 (DN 50)** and larger every **72 inches (1830 mm)**.

N. Install hangers for stainless steel drainage piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): **10 feet (3 m)** with **3/8-inch (10-mm)** rod.
2. NPS 2-1/2 (DN 65): **11 feet (3.4 m)** with **1/2-inch (13-mm)** rod.
3. NPS 3 (DN 80): **12 feet (3.6 m)** with **1/2-inch (13-mm)** rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): **12 feet (3.6 m)** with **5/8-inch (16-mm)** rod.
5. NPS 6 (DN 150): **12 feet (3.6 m)** with **3/4-inch (19-mm)** rod.

O. Install supports for vertical, stainless steel drainage piping every **15 feet (4.5 m)**.

P. Install vinyl-coated hangers for glass piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): **72 inches (1830 mm)** with **3/8-inch (10-mm)** rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): **96 inches (2440 mm)** with **3/8-inch (10-mm)** rod.
3. NPS 3 (DN 80): **96 inches (2440 mm)** with **1/2-inch (13-mm)** rod.
4. NPS 4 and NPS 6 (DN 100 and DN 150): **96 inches (2440 mm)** with **5/8-inch (16-mm)** rod.

Q. Install supports for vertical glass piping every **96 inches (2440 mm)**.

R. Support piping and tubing not listed above in accordance with MSS SP-58.

3.7 INSTALLATION OF NEUTRALIZATION TANK

A. Install exterior [**collection**][**and**][**neutralization**] tanks, complete with appurtenances indicated.

1. Set tops of tank covers flush with finished surface where covers occur in pavements. Set covers **3 inches (75 mm)** above finished surface elsewhere unless otherwise indicated.
2. Include initial fill of limestone for neutralization tanks.

B. Install interior neutralization tanks on smooth and level [**concrete base**][**floor surface**]. Include full initial charge of limestone.

3.8 INSTALLATION OF NEUTRALIZATION SYSTEM

A. Install neutralization systems on smooth and level [**concrete base**][**floor surface**]. Include neutralizing solutions and full initial charge of limestone.

3.9 INSTALLATION OF MANHOLE - HOLDING TANK

A. General: Install tanks, complete with appurtenances and accessories indicated. Comply with requirements in Section 333115 "Site Sanitary Sewerage Piping."

B. Set tops of tank frames and covers flush with finished surface where tanks occur in pavements. Set tops **3 inches (76 mm)** above finished surface elsewhere unless otherwise indicated.

3.10 INSTALLATION OF LEAK-DETECTION SYSTEM

A. Single-Pipe, Chemical-Waste Sewerage Piping: Install leak-detection system below piping.

B. Double-Containment Piping: Install leak-detection system in piping annular space.

C. Tanks: Install leak-detection system around bottom of exterior.

D. Install panel in location indicated.

3.11 CONCRETE PLACEMENT

A. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete supports.

B. Place cast-in-place concrete in accordance with ACI 318/318R.

3.12 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make connections to existing piping, so finished Work complies as nearly as practical with requirements specified for new Work.

C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus **6-inch (150-mm)** overlap, with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of [**3000 psi (20.7 MPa)**]<**Insert value**>.

D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

E. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.13 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.14 ADJUSTING

A. Adjust neutralization-system set points.

B. Adjust leak-detection-system control and device settings.

3.15 CLEANING

A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Clean piping by flushing with potable water.

3.16 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service for [**neutralization systems**][**and**][**leak-detection systems**].

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Neutralization Systems:

a. Verify that neutralization system is installed and connected according to the Contract Documents.
b. Verify that electrical wiring installation complies with manufacturer's submittal.
c. Install neutralizing solutions and limestone.
d. Energize circuits.
e. Start and run systems through complete sequence of operations.
f. Adjust operating controls.
g. <**Insert startup steps if any**>.

3. Leak-Detection Systems:

   a. Verify that electrical wiring installation complies with manufacturer's submittal.
   b. Energize circuits.
   c. Adjust operating controls.
   d. <**Insert startup steps if any**>.

3.17 FIELD QUALITY CONTROL

A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (610 mm)** of backfill is in place and again at completion of Project.

1. Defects requiring correction include the following:

   a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Hydrostatic Tests for Drainage Piping:

      1) Allowable leakage is a maximum of [**50 gal./inch of nominal pipe size per mile (4.6 L/mm of nominal pipe size per kilometer)**]<**Insert value**> of pipe during 24-hour period.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.

   e. Air Tests for Drainage Piping: Comply with UNI-B-6.

2. Leaks and loss in test pressure constitute defects that must be repaired.
3. Submit separate reports for each test.

B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.

C. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

E. Perform tests and inspections with the assistance of a factory-authorized service representative.

F. Tests and Inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled [**neutralization systems**][**and**][**leak-detection systems**] and their installation, including piping and electrical connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and

equipment.

G. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

3.18 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**neutralization systems**][**and**][**leak-detection systems**].

3.19 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.

B. Single-Wall, Chemical-Waste Sewerage Piping: Use[**any of**] the following piping materials for each size range:

1. NPS 2 to NPS 4 (DN 50 to DN 100) Stainless Steel: Drainage pipe and fittings and gasketed joints.
2. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) PP: Drainage pipe and fittings and fusion joints.
3. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) CPVC: Drainage pipe and fittings and solvent-cemented joints.
4. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) PVDF: Drainage pipe and fittings and fusion joints.
5. NPS 2 to NPS 4 (DN 50 to DN 100) Fiberglass: [**Centrifugally cast**][**Filament-wound**] fiberglass pipe and fittings and [**butt-and-wrap**][**bonded**] joints.
6. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) Glass: Glass pipe and fittings and coupled joints.
7. NPS 6 (DN 150) Stainless Steel: Drainage pipe and fittings and gasketed joints.
8. NPS 6 (DN 150) PP: Drainage pipe and fittings and fusion joints.
9. NPS 6 (DN 150) PVDF: Drainage pipe and fittings and fusion joints.
10. NPS 6 (DN 150) Fiberglass: [**Centrifugally cast**][**Filament-wound**] fiberglass pipe and fittings and [**butt-and-wrap**][**bonded**] joints.
11. NPS 6 (DN 150) Glass: Pipe and fittings and coupled joints.
12. NPS 8 to NPS 12 (DN 200 to DN 300) PP: Drainage pipe and fittings and fusion joints.
13. NPS 8 to NPS 12 (DN 200 to DN 300) PVDF: Drainage pipe and fittings and fusion joints.
14. NPS 8 to NPS 12 (DN 200 to DN 300) Fiberglass: [**Centrifugally cast**][**Filament-wound**] fiberglass pipe and fittings and [**butt-and-wrap**][**bonded**] joints.

C. Underground, Double-Containment, Chemical-Waste Sewerage Piping: Use[**any of**] the following piping materials for each size range:

1. NPS 2 to NPS 12 (DN 50 to DN 300) PP: Double-containment drainage pipe and fittings.
2. NPS 2 to NPS 12 (DN 50 to DN 300) CPVC: Double-containment drainage pipe and fittings.
3. NPS 2 to NPS 12 (DN 50 to DN 300) PVDF: Double-containment drainage pipe and fittings.
4. NPS 2 to NPS 12 (DN 50 to DN 300) PVDF/CPVC: Double-containment drainage pipe and fittings.

D. Aboveground Chemical-Waste Piping: Use[**any of**] the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) PP: Drainage piping and [**fusion**][**mechanical**] joints.

2. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) CPVC: Drainage piping and solvent-cemented joints.
3. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) PVDF: Drainage piping and [**fusion**][**mechanical**] joints.
4. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) Stainless Steel: Use **NPS 2 to NPS 4 (DN 50 to DN 100)** stainless steel drainage piping with socket-and-spigot ends and gasketed joints.
5. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) Borosilicate Glass: Pipe and fittings, couplings, and coupled joints.

E. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use[**any of**] the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) PP: Drainage piping and fusion joints.
2. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) PVDF: Drainage piping and fusion joints.
3. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) Stainless Steel: Drainage piping with socket-and-spigot ends and gasketed joints.
4. NPS 1-1/2 to NPS 6 (DN 40 to DN 150) Borosilicate Glass: Piping with covering, couplings, and coupled joints.
5. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): [**PP**][**PVDF**] double-containment drainage piping and manufacturer's standard joints.
6. NPS 8 (DN 200): [**PP**][**PVDF**] double-containment drainage piping and manufacturer's standard joints.

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Task	Specification	Specification Description
22 66 53 00	21 05 00 00	Common Work Results for Fire Suppression
22 66 53 00	22 05 00 00	Common Work Results for Plumbing
22 66 53 00	22 13 16 00	Sanitary Waste And Vent Piping
22 66 53 00	22 15 13 00	General-Service Compressed-Air Piping
22 66 53 00	22 66 00 00	Chemical-Waste Systems for Laboratory and Healthcare Facilities
22 66 53 00	23 05 00 00	Common Work Results for HVAC
22 66 83 00	22 66 00 00	Chemical-Waste Systems for Laboratory and Healthcare Facilities
22 66 83 16	22 66 00 00	Chemical-Waste Systems for Laboratory and Healthcare Facilities

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Task	Specification	Specification Description
23 01 10 91	23 05 93 00	Testing, Adjusting, and Balancing for HVAC
23 01 20 91	23 05 93 00	Testing, Adjusting, and Balancing for HVAC

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SECTION 23 01 30 51 - EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

B. Related Requirements:

1. Section 233113.00 "Metal Ducts" for cleaning newly installed metal ducts.
2. Section 233116.00 "Nonmetal Ducts" for cleaning newly installed nonmetal ducts.
3. Section 230593.00 "Testing, Adjusting, Balancing for HVAC" for system flow documentation before cleaning and balancing and following cleaning and restoration.
4. Section 233300.00 "Air Duct Accessories" for restoration of opened ducts and plenums with access doors.

1.2 DEFINITIONS

A. ACAC: American Council for Accredited Certification.

B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program

C. ASCS: Air systems cleaning specialist.

D. CESB: Council of Engineering and Scientific Specialty Boards.

E. CMI: Certified Microbial Investigator.

F. CMC: Certified Microbial Consultant.

G. CMR: Certified Microbial Remediator.

H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.

L. NADCA: National Air Duct Cleaners Association.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Cleaning agents
2. Antimicrobial surface treatments [**("sealant" for sustainable design submittal purposes)**].

B. Sustainable Design Submittals:

1. Product Data: For adhesives and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For an ASCS.
2. For an IEP.
3. For a CMR and a CMRS.

B. Field Quality-Control Reports:

1. Project's existing conditions.
2. Evaluations and recommendations, including cleanliness verification.
3. Strategies and procedures plan.

1.5 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.6 QUALITY ASSURANCE

A. ASCS Qualifications: [**A certified member of NADCA**]<**Insert objective qualifications**>.

1. Certification: Employ [**an ASCS certified by NADCA on a full-time basis**]<**Insert objective qualifications**>.
2. Supervisor Qualifications: Certified [**as an ASCS by NADCA**]<**Insert objective qualifications**>.

B. IEP Qualifications: [**CMI who is certified by ACAC and accredited by CESB**][**CMC who is certified by ACAC and accredited by CESB**].

C. CMR Qualifications: Certified by ACAC and accredited by CESB.

D. CMRS Qualifications: Certified by ACAC and accredited by CESB.

E. <**Insert objective qualifications for microbial remediation specialist**>.

F. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

G. Cleaning Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

A. Manufacturers: Subject to compliance with requirements [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include but are not limited to, the following**]:

1. Apex Engineering Products Corporation.
2. BBJ Environmental Solutions.
3. Goodway Technologies Corporation.
4. Nu-Calgon.
5. QuestVapco Corporation.
6. <**Insert manufacturer's name**>.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

C. Description:

1. Formulated for each specific soiled coil condition that needs remedy.
2. Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bio-Cide International, Inc.**]
2. [**Contec, Inc.**]
3. [**Ecolab, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bio-Cide International, Inc.**]
2. [**Contec, Inc.**]
3. [**Ecolab, Inc.**]
4. <**Insert manufacturer's name**>

C. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.

1. Formulated to kill and inhibit growth of microorganisms.
2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
3. Have no residual action after drying, with zero VOC off-gassing.
4. OSHA compliant.
5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.

C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule, including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.

1. Prepare written report listing conditions detrimental to performance of the Work.

E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.

E. Systems and Components to Be Cleaned:

1. All air-moving and -distribution equipment.
2. Air devices for supply and return air.
3. Air-terminal units and connections.

a. VAV boxes.

b. Chilled beams.
c. Fan coil units.
d. Unit ventilators.
e. Flexible connectors.

4. Ductwork:

a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
b. Return-air ducts to the air-handling unit.
c. Exhaust-air ducts.
d. Transfer ducts.

5. Casings.
6. Duct-mounted coils.
7. Air-Handling Units:

a. Interior surfaces of the unit casing.
b. Coil surfaces compartment.
c. Condensate drain pans.
d. Fans, fan blades, and fan housings.

8. Exhaust fans and power ventilators.
9. Filters and filter housings.
10. Gravity ventilators.
11. Air-to-air heat exchangers.

F. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

G. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

H. Control odors and mist vapors during the cleaning and restoration process.

I. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

J. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

K. Clean all air-distribution devices, registers, grilles, and diffusers.

L. Clean non-adhered substance deposits according to NADCA ACR and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

M. Air-Distribution Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

N. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

O. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.

2. Cleaning Mineral-Fiber Insulation Components:

    a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
    b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
    c. Fibrous materials that become wet shall be discarded and replaced.

P. Coil Cleaning:

1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
3. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
4. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
5. Rinse thoroughly with clean water to remove any latent residues.

Q. Application of Antimicrobial Treatment:

1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory [**accredited by AIHA-LAP with an EMLAP certificate**]<**Insert alternative accreditation**>, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. Apply antimicrobial treatments and coatings after the system is rendered clean.

3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Microbial remediation shall be performed by a [**qualified CMR and CMRS**]<**Insert alternate qualification**>.

3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Verification of Coil Cleaning, Known Design Pressure Loss:

1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of <**Insert inches wg (Pa)**>, the differential measured when the coil was first installed.

E. Verification of Coil Cleaning, Unknown Design Pressure Loss: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

G. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

H. Photographic Documentation: Comply with requirements in Section 013233 "Photographic Documentation."

3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in [**Section 233113 "Metal Ducts**][**Section 233116 "Nonmetal Ducts**]."

C. Reseal fibrous-glass ducts. Comply with requirements in Section 233116 "Nonmetal Ducts."

D. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

E. Replace damaged insulation according to Section 230713 "Duct Insulation."

F. Ensure that closures do not hinder or alter airflow.

G. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

H. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

I. Measure air flows through air-distribution system.

J. Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

A. Post-Project Report:

1. Post-cleaning laboratory results if any.
2. Post-cleaning photo images.
3. Post-cleaning verification summary.

B. Drawings:

1. Deviations of existing system from Owner's record drawings.
2. Location of service openings.

END OF SECTION 23 01 30 51

Task	Specification	Specification Description
23 01 30 51	23 05 93 00	Testing, Adjusting, and Balancing for HVAC
23 01 30 61	23 31 13 00	Metal Ducts
23 01 50 61	23 21 13 00	Hydronic Piping
23 01 50 61	23 52 23 00	Cast-Iron Boilers
23 01 60 71	23 05 93 00	Testing, Adjusting, and Balancing for HVAC
23 01 60 71	23 62 00 00	Packaged Compressor and Condenser Units

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SECTION 23 05 00 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packed expansion joints.
3. Packless expansion joints.
4. Grooved-joint expansion joints.
5. Alignment guides and anchors.
6. Sleeves without waterstop.
7. Sleeves with waterstop.
8. Stack-sleeve fittings.
9. Sleeve-seal systems.
10. Grout.
11. Silicone sealants.
12. Escutcheons.
13. Thermometers, bimetallic actuated.
14. Thermometers, filled system.
15. Thermometers, liquid in glass.
16. Thermometers, light activated.
17. Duct-thermometer mounting brackets.
18. Thermowells.
19. Pressure gauges, dial type.
20. Gauge attachments.
21. Test plugs.
22. Test-plug kits.
23. Sight flow indicators.
24. Flowmeters.
25. Thermal-energy meters.

B. Related Requirements:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
2. Section 232216 "Steam and Condensate Piping Specialties" for steam and condensate meters.
3. Section 230923.13 "Energy Meters" for thermal-energy meters connecting with the DDC system.
4. Section 230923.14 "Flow Instruments" for primary flow instruments connecting with the DDC system.

1.2 DEFINITIONS

A. Existing Piping To Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**][**meter,**][**and**][**gauge**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

   a. For motors with 2:1 speed ratio, consequent pole, single winding.
   b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**]<**Insert class**>.
10. Code Letter Designation:

    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**]<**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**]<**Insert number**>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

   a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
   b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

   a. Permanent-split capacitor.
   b. Split phase.
   c. Capacitor start, inductor run.
   d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [**120 V**][**or**][**240 V**] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [**Circuit board**][**or**][**digital speed controller/LED display**].
4. Building Automation System Interface: Via [**AC voltage signal**][**DC voltage signal**][**or**][**Digital Serial Interface (DSI)**].

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packed Expansion Joints:

1. Flexible, Ball-Joint Packed Expansion Joints: [**FBJ-01**]<**Insert drawing designation**>.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
d. Standards: 2021 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9 for materials and design of pressure-containing parts and bolting.
e. Material: Carbon-steel assembly with asbestos-free composition packing.
f. Design: Provide 360-degree rotation and angular deflection.
g. Minimum Pressure Rating: [**250 psig at 400 deg F (1725 kPa at 204 deg C)**]<**Insert value**>.
h. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degrees minimum.
i. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degrees minimum.
j. Seal Type: Two carbon-steel and graphite seals suitable for continuous operation at temperature up to **650 deg F (343 deg C)**.
k. Internal Ball: Plated with minimum 1-mil chrome cover.
l. Ball Socket: One- or two-piece design with integral socket/retainer.

1) Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
2) Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.

m. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
n. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2. Slip-Joint Packed Expansion Joints: [**SJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain slip-joint packed expansion joints from single manufacturer.
d. Standard: ASTM F1007.
e. Material: Carbon steel with asbestos-free PTFE packing.
f. Design: With internal guide and injection ports for repacking under full system pressure. Housing is to be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
g. Configuration: [**Single joint**][**single joint with base**][**and**][**double joint with base**] class(es) unless otherwise indicated.
h. Slip Tube for Sizes NPS 1-1/2 (DN 40) through NPS 16 (DN 400): Schedule 80.
i. Slip Tube for Sizes NPS 18 (DN 450) through NPS 24 (DN 600): Schedule 60.
j. Sliding Surface: 2-mil-thick chrome finish.
k. End Connections: Flanged or welded ends to match piping system.

C. Packless Expansion Joints:

1. Metal, Compensator Packless Expansion Joints: [**MCEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain metal compensator packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid

flow by an internal pipe sleeve and external housing.

f. Joint Axial Movement: **2 inches (50 mm)** of compression and **1/2 inch (12 mm)** of extension.

g. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

h. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Flanged**][**Threaded**][**Welded**].

2. Rubber Union Connector Expansion Joints: [**RUEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.

d. Material: Twin reinforced-rubber spheres[**with external restraining cables**].

e. Minimum Pressure Rating: [**150 psig at 170 deg F (1035 kPa at 77 deg C)**]<**Insert value**> unless otherwise indicated.

f. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

g. End Connections for Greater than NPS 2 (DN 50): Flanged.

3. Flexible-Hose Packless Expansion Joints: [**FHEJ-01**]<**Insert drawing designation**>.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
   d. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
   e. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
   f. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with [**solder-joint**]<**Insert type**> end connections.

      1) Bronze hoses and single-braid bronze sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **340 psig at 450 deg F (2340 kPa at 232 deg C)** ratings.
      2) Bronze hoses and double-braid bronze sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **500 psig at 450 deg F (3450 kPa at 232 deg C)** ratings.

   g. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with [**threaded**]<**Insert type**> end connections.

      1) Stainless steel hoses and single-braid, stainless steel sheaths with

300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

h. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.

i. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.

j. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

k. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

4. Metal-Bellows Packless Expansion Joints: [**MBEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]

7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]
7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) **<Insert manufacturer's name>**

c. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
d. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
e. Type: Circular, corrugated bellows[**with external tie rods**].
f. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1379 kPa)**]**<Insert value>** unless otherwise indicated.
g. Configuration: [**Single joint**][**Single joint with base**][**and**][**double joint with base**] class(es), unless otherwise indicated.
h. Expansion Joints for Copper Tubing: [**Single-**][**or**][**multi-**]ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Solder joint**][**or**][**threaded**].
3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

i. Expansion Joints for Steel Piping: [**Single-**][**or**][**multi-**]ply stainless steel bellows, steel pipe

ends, and carbon steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: [**Flanged**][**Welded**].

5. Externally Pressurized Metal-Bellows Packless Expansion Joints: [**EPEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

c. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description:

1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
2) Carbon-steel housing.
3) Drain plugs and lifting lug for **NPS 3 (DN 80)** and larger.
4) Bellows: With operating clearance between internal pipe sleeves and external

shrouds.

5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.

6) Joint Axial Movement: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert compression limit**> of compression and [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert extension limit**> of extension.

f. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.

g. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

6. Rubber Packless Expansion Joints: [**REJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
d. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
e. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
f. Arch Type: [**Single**][**or**][**multiple**] arches[**with external control rods**].
g. Spherical Type: [**Single**][**or**][**multiple**] spheres[**with external control rods**].
h. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): [**225 psig (1551 kPa) at 170 deg F (77 deg C)**]<**Insert pressure and temperature values**>.
i. Material for Fluids Containing Acids, Alkalis, or Chemicals: [**Butyl rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**]<**Insert material**>.
j. Material for Fluids Containing Gas, Hydrocarbons, or Oil: [**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**]<**Insert material**>.
k. Material for Water: [**Butyl rubber**][**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**][**Natural rubber**].
l. End Connections: Full-faced, integral steel flanges with steel retaining rings.

D. Grooved-Joint Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
4. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
5. Standard: AWWA C606, for grooved joints.
6. Materials: [**Galvanized,**]ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
7. Couplings: [**Five**][**Seven**][**10**][**12**]<**Insert number**>, flexible type for steel-pipe dimensions. Include ferrous housing sections [**, Buna-N gasket,**][**, EPDM rubber gasket,**] and bolts and nuts.

E. Alignment Guides and Anchors:

1. Alignment Guides: [**AG-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]

3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]
3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) **<Insert manufacturer's name>**

c. Source Limitations: Obtain alignment guides from single manufacturer.
d. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [**zinc-coated carbon**][**stainless**] steel.
2) Expansion Plug: [**Zinc-coated carbon**][**Stainless**] steel.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [**zinc-coated carbon**][**stainless**] steel with continuous thread on stud, unless otherwise indicated.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

3. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized-steel**], sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Wade; a subsidiary of McWane Inc.**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Wade; a subsidiary of McWane Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

3. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic seal: **20 psig (137 kPa) minimum)**.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating. ASTM B633**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-

cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) **<Insert manufacturer's name>**

   b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) **<Insert manufacturer's name>**

   c. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Pecora Corporation**]
      2) [**Sika Corporation**]
      3) [**The Dow Chemical Company**]
      4) [**Tremco Incorporated**]
      5) **<Insert manufacturer's name>**

   b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]
5) **<Insert manufacturer's name>**

c. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]
2) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Smooth-On**]
2) **<Insert manufacturer's name>**

4. Sealant shall have a VOC content of [**250**]**<Insert value>** g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]

2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

C. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

D. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

2.5 METERS AND GAUGES FOR HVAC PIPING

A. Thermometers, Bimetallic Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]

l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide bimetallic-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Liquid-filled**][**and**][**sealed**] type(s); stainless steel with [**3-inch (75-mm)**][**5-inch (125-mm)**]<**Insert dimension**> nominal diameter.
6. Dial: [**Nonreflective aluminum**]<**Insert material**> with permanently etched scale markings and scales in [**deg F (deg C)**][**deg F and deg C**].
7. Connector Type(s): Union joint, [**adjustable angle**][**rigid, back**][**and**][**rigid, bottom**]<**Insert type**>, with unified-inch screw threads.
8. Connector Size: [**1/2 inch (12 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
9. Stem: **0.25 or 0.375 inch (6.4 or 9.5 mm)** in diameter; stainless steel.
10. Window: [**Plain glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: Stainless steel.
12. Element: Bimetal coil.
13. Pointer: Dark-colored metal.
14. Accuracy: Plus or minus [**1**][**1.5**]<**Insert number**> percent of scale range.

B. Thermometers, Filled System - Direct-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]

f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]
f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

C. Thermometers, Filled System - Direct-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

D. Thermometers, Filled-System - Remote-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]
    e. [**Miljoco Corporation**]
    f. [**Palmer Wahl Instrumentation Group**]
    g. [**REOTEMP Instrument Corporation**]
    h. [**Trerice, H. O. Co**]
    i. [**Weiss Instruments, Inc**]
    j. [**WIKA Instrument Corporation**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]

e. [**Miljoco Corporation**]
f. [**Palmer Wahl Instrumentation Group**]
g. [**REOTEMP Instrument Corporation**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

E. Thermometers, Filled System - Remote-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, plastic-case, vapor-actuated

thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, threaded, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

F. Thermometers, Liquid-in-Glass - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, compact-style thermometers by single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.

12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

G. Thermometers, Liquid in Glass - Plastic Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ribbon Corp.**]
   b. [**Flo Fab Inc**]
   c. [**Miljoco Corporation**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Weiss Instruments, Inc**]
   f. [**Weksler Glass Thermometer Corp.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Blue Ribbon Corp.**]
   b. [**Flo Fab Inc**]
   c. [**Miljoco Corporation**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Weiss Instruments, Inc**]
   f. [**Weksler Glass Thermometer Corp.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, compact-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

H. Thermometers, Liquid in Glass - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ribbon Corp.**]

b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Blue Ribbon Corp.**]
   b. [**Flo Fab Inc**]
   c. [**Miljoco Corporation**]
   d. [**Palmer Wahl Instrumentation Group**]
   e. [**Trerice, H. O. Co**]
   f. [**Weiss Instruments, Inc**]
   g. [**Weksler Glass Thermometer Corp.**]
   h. [**Winters Instruments - U.S.**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

I. Thermometers, Liquid in Glass - Plastic Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ernst Flow Industries**]
   b. [**Marsh Bellofram**]
   c. [**Miljoco Corporation**]
   d. [**Palmer Wahl Instrumentation Group**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Weiss Instruments, Inc**]

g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ernst Flow Industries**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**][**Brass**][**Stainless steel**][**Aluminum, brass, or stainless steel**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

J. Thermometers, Light Activated - Direct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, direct-mounted thermometers from single manufacturer.
4. Case: [**Plastic**][**Metal**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Case Form: [**Adjustable angle**]<**Insert form**>.
7. Connector: [**1-1/4 inches (32 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
8. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermowell Installation: Bare stem.

9. Display: Digital.
10. Accuracy: Plus or minus **2 deg F (1 deg C)**.

K. Thermometers, Light Activated - Remote Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Miljoco Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Miljoco Corporation**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, remote-mounted thermometers from single manufacturer.
4. Case: Plastic, for wall mounting.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Sensor: Bulb and thermister wire.

   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus **2 deg F (1 deg C)**.

L. Duct-Thermometer Mounting Brackets:

1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

M. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: [**CNR**][**or**][**CUNI**]<**Insert material**>.
4. Material for Use with Steel Piping: [**CRES**][**CSA**]<**Insert material**>.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,)** ASME B1.20.1 pipe threads.
7. Internal Threads: **1/2, 3/4, and 1 inch (13, 19, and 25 mm)**, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [**Mixture of graphite and glycerin**]<**Insert material**>.

N. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]
    j. [**REOTEMP Instrument Corporation**]
    k. [**Tel-Tru Manufacturing Company**]
    l. [**Trerice, H. O. Co**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Weiss Instruments, Inc**]
    o. [**Weksler Glass Thermometer Corp.**]
    p. [**WIKA Instrument Corporation**]
    q. [**Winters Instruments - U.S.**]
    r. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]

j. [**REOTEMP Instrument Corporation**]
k. [**Tel-Tru Manufacturing Company**]
l. [**Trerice, H. O. Co**]
m. [**WATTS; A Watts Water Technologies Company**]
n. [**Weiss Instruments, Inc**]
o. [**Weksler Glass Thermometer Corp.**]
p. [**WIKA Instrument Corporation**]
q. [**Winters Instruments - U.S.**]
r. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**][**Open-front, pressure-relief**][**Solid-front, pressure-relief**]<**Insert type**> type(s); [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**|**START_SI**|**(kPa)**][|**END_SI**|**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Brass**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

O. Pressure Gauges, Dial Type - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Flo Fab Inc**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**Weiss Instruments, Inc**]
l. [**Weksler Glass Thermometer Corp.**]
m. [**WIKA Instrument Corporation**]
n. [**Winters Instruments - U.S.**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Flo Fab Inc**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**Weiss Instruments, Inc**]
l. [**Weksler Glass Thermometer Corp.**]
m. [**WIKA Instrument Corporation**]
n. [**Winters Instruments - U.S.**]
o. **<Insert manufacturer's name>**

3. Source Limitations: Provide dial-type, direct-mounted, plastic-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

P. Pressure Gauges, Dial Type - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]

n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, metal-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**]<**Insert type**> type; [**cast aluminum or drawn steel**][**metal**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

Q. Pressure Gauges, Dial Type - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]

d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, plastic-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

R. Gauge Attachments:

1. Snubbers: ASME B40.100, brass; with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and [**piston**][**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of [**brass**][**stainless steel**][**steel**] pipe with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**] pipe threads.
3. Valves: [**Brass ball**][**Brass or stainless steel needle**], with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads.

S. Test Plugs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Provide test plugs from single manufacturer.
4. Description: Test-station fitting made for insertion in piping tee fitting.
5. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
6. Thread Size: [**NPS 1/4 (DN 8)**][**or**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe thread.
7. Minimum Pressure and Temperature Rating: [**500 psig at 200 deg F (3450 kPa at 93 deg C)**]<**Insert ratings**>.
8. Core Inserts: [**Chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber.

T. Test-Plug Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]

c. **<Insert manufacturer's name>**

3. Source Limitations: Provide test-plug kits from single manufacturer.
4. Furnish [**one**]<**Insert number**> test-plug kit(s) containing [**one**][**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
5. Low-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.
6. High-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**0 to 220 deg F (minus 18 to plus 104 deg C)**]<**Insert temperature range**>.
7. Pressure Gauge: Small, Bourdon-tube insertion type with [**2- to 3-inch- (50- to 75-mm-)**]<**Insert dimension**> diameter dial and probe. Dial range shall be at least [**0 to 200 psig (0 to 1380 kPa)**]<**Insert range**>.
8. Carrying Case: Metal or plastic, with formed instrument padding.

U. Sight Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Provide sight flow indicators from single manufacturer.
4. Description: Piping inline-installation device for visual verification of flow.
5. Construction: Bronze or stainless steel body, with sight glass and [**ball, flapper, or paddle wheel**]<**Insert device**> indicator, and threaded or flanged ends.
6. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1034 kPa)**]<**Insert value**>.
7. Minimum Temperature Rating: [**200 deg F (93 deg C)**]<**Insert temperature**>.
8. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
9. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

V. Flowmeters:

1. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
2. Flowmeters - Orifice:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    c. Source Limitations: Provide orifice flowmeters from single manufacturer.
    d. Description: Flowmeter with orifice plate and flanges, differential pressure sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
    e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
    f. Orifice Plate: Wafer-orifice-type, calibrated, flow-measuring element; for installation between orifice plate pipe flanges.

        1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
        2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
        3) Minimum Pressure Rating: [**300 psig (2070 kPa)**]<**Insert value**>.
        4) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

    g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

    h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected sensor and having two **12 ft. (3.7 m)** hoses, with carrying case.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**2 percent between 20 and 80 percent of scale**

range]<**Insert accuracy**>.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor and indicator.
k. Operating Instructions: Include complete instructions with each flowmeter.

3. Flowmeters - Pitot Tube:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Provide pitot-tube flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Differential-pressure-type measurement for [**oil**][**water**]<**Insert fluid**>.
2) Construction: Stainless steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Integral Transformer: For low-voltage power connection.
i. Accuracy: Plus or minus [**3**]<**Insert number**> percent.
j. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
k. Operating Instructions: Include complete instructions with each flowmeter.

4. Flowmeters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**1-1/2**]<**Insert number**> percent.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

5. Flowmeters - Venturi:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]

4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]
4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide venture flowmeters from single manufacturer.
d. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Flow-Measuring Element:

1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Venturi type with [**in-line**][**or**][**insertion**] element.
3) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
4) Minimum Pressure Rating: [**250 psig (1725 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.
6) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
7) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
8) Flow Range: Flow-measuring element and flowmeter are to cover operating range of equipment or system served.

g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected flowmeter element and has two **12 ft. (3.7 m)** hoses, with carrying case.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor.
k. Operating Instructions: Include complete instructions with each flowmeter.

6. Flowmeters - Vortex Shedding:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide vortex-shedding flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in **gpm (Lps)**.

1) Design: Flow-obstruction device, vortex-measurement type for [**gas**][**steam**][**and**][**liquids**].
2) Construction: Stainless steel body, with integral transmitter and direct-reading scale.
3) Minimum Pressure Rating: [**1000 psig (6900 kPa)**]<**Insert value**>.
4) Minimum Temperature Rating: [**500 deg F (260 deg C)**]<**Insert temperature**>.
5) Integral Transformer: For low-voltage power operation.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**0.25**]<**Insert number**> percent for liquids and [**0.75**]<**Insert number**> percent for gases.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

7. Thermal-Energy Meters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: System with[**strainer,**] flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Turbine type; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**].
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provision to remove probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Temperature Sensors: Insertion-type sensor-transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**]; for wall mounting.

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Strainer: Full size of main line piping.
l. Operating Instructions: Include complete instructions with each thermal-energy meter system.

8. Thermal-Energy Meters - Ultrasonic:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide ultrasonic thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: Meter with flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Transit-time ultrasonic type with transmitter.
g. Temperature Sensors: Insertion-type or strap-on transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**].

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKED EXPANSION JOINTS

A. Install packed expansion joints with packing suitable for fluid service.

3.3 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows packless expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.4 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.5 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [**one**][**two**] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [**four**]<**Insert number**> pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.6 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [**five**]<**Insert number**> pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in main.

3.7 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**]<**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

3. Using [**grout**][**or**][**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.8 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [**grout**][**or**][**silicone sealant**], seal space around outside of sleeves.

3.9 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (76 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.10 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.11 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.12 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending [**a minimum of 2 inches (50 mm) into fluid**][**one-third of pipe diameter**][**to center of pipe**] and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.

R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

U. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

V. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.
8. <**Insert location**>.

W. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. <**Insert location**>.

3.13 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.14 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.15 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.16 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**][**or**][**stack-sleeve fittings**].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.17 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**][**cast brass**][**or split-plate steel**] with polished, chrome-plated finish.

3. Insulated Piping:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

   a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
   b. One piece, stainless steel with polished stainless steel finish.
   c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
   d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

   a. One piece, steel with polished, chrome-plated finish.
   b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
   c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

   a. One piece, steel with polished, chrome-plated finish.
   b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
   c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.18 THERMOMETER APPLICATION

A. Thermometers at inlet and outlet of each hydronic zone are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

G. Thermometers at inlet and outlet of each thermal-storage tank are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

I. Thermometer stems are to be of length to match thermowell insertion length.

3.19 THERMOMETER SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)**][**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
2. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
3. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
4. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].

B. Scale Range for Condenser-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
4. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
5. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**] .
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].
5. [**50 to 550 deg F (10 to 300 deg C)**][**50 to 550 deg F and 10 to 300 deg C**].

D. Scale Range for Steam and Steam-Condensate Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].

E. Scale Range for Air Ducts:

1. [**Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C)**][**Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C**].
2. [**Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)**][**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
3. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
4. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
5. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
6. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
7. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
8. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].

3.20 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each pressure-reducing valve are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each pump are to be the following:

1. [**Liquid-filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

3.21 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

B. Scale Range for Condenser-Water Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].

6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

D. Scale Range for Steam Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

3.22 FLOWMETER APPLICATION

A. Flowmeters for Chilled-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

B. Flowmeters for Condenser-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

C. Flowmeters for Heating, Hot-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

D. Flowmeters for Steam and Steam-Condensate Piping: [**Orifice**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

3.23 THERMAL-ENERGY METER APPLICATION

A. Thermal-Energy Meters for Chilled-Water Piping: [**Turbine**][**Ultrasonic**] type.

B. Thermal-Energy Meters for Condenser-Water Piping: [**Turbine**][**Ultrasonic**] type.

C. Thermal-Energy Meters for Heating, Hot-Water Piping: [**Turbine**][**Ultrasonic**] type.

D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: [**Turbine**][**Ultrasonic**] type.

END OF SECTION 23 05 00 00

SECTION 23 05 00 00A - COATINGS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:

1. Bake-cured corrosion-resistant coating systems.
2. Air-dried corrosion-resistant coating systems.

1.2 DEFINITIONS

A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports:

1. Certification of coating material testing.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: [**1**]<**Insert number**>[**container**][**spray can**] of each material and color applied [**, including base coat and top coat products**].

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between **50 and 75 deg F (10 and 24 deg C)**.

1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
2. Maintain containers in clean condition, free of foreign materials and residue.
3. Remove rags and waste from storage areas daily.

1.7 CONDITIONS FOR COATING APPLICATION

A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

PART 2 - PRODUCTS

2.1 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

A. Material Compatibility:

1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.
3. Products shall be of same manufacturer for each coat in a coating system.

B. Colors: [**Manufacturer's standard**]<**Insert requirements**>.

C. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. VOC Content, LEED v4: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.

5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

F. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Nonflat - High-Gloss Coatings: 150 g/L.
   d. Dry-Fog Coatings: 150 g/L.
   e. Industrial Maintenance Coatings: 250 g/L.
   f. Pretreatment Wash Primers: 420 g/L.
   g. Primers, Sealers, and Undercoaters: 100 g/L.
   h. Recycled Coatings: 250 g/L.
   i. Rust-Preventive Coatings: 250 g/L.

H. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Primers, Sealers, and Undercoats: 100 g/L.
   d. Shellacs, Clear: 730 g/L.
   e. Shellacs, Pigmented: 550 g/L.

I. VOC Content: For field applications inside the building, wall paints shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Interior Flat Latex Wall Paint: 50 g/L.
2. Interior Nonflat Latex Wall Paint: 150 g/L.

J. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.2 BAKE-CURED CORROSION-RESISTANT COATING SYSTEMS

A. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3500**][**6000**]<**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
3. SWAAT: ASTM G85: [**1000**][**Insert number**] hours.
4. Cyclic Weathering: ISO 12944-9, [**4200**]<**Insert number**> hours.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1100 psi (7.6 MPa)**]<**Insert value**>.
7. Impact: ASTM D2794.

   a. Direct Hit: [**70 lb.-in. (7.9 N-m)**][**80 lb.-in. (9.0 N-m)**][**90 lb.-in. (10.2 N-m)**][**100 lb.-in. (11.3 N-m)**]<**Insert value**>.
   b. Reverse Hit: [**20 lb.-in. (2.2 N-m)**][**30 lb.-in. (3.4 N-m)**][**40 lb.-in. (4.5 N-m)**][**50 lb.-in. (5.6 N-m)**]<**Insert value**>.

8. pH Range, 14-Day Liquid Spot Test: [**2.4 to 12.6**][**or**][**3 to 12**][**Insert value**].
9. Dry Heat Resistance: ASTM D2485: [**320 deg F (160 deg C)**][**392 deg F (200 deg C)**]<**Insert value**> maximum.
10. Dry Film Thickness: [**0.5 to 1.2 mils (0.013 to 0.030 mm)**][**0.6 to 1.5 mils (0.015 to 0.038 mm)**]<**Insert thickness range**>.
11. Heat-Transfer Reduction: [**1 percent maximum**]<**Insert value**>.
12. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**5H-6H**]<**Insert value**>.

B. Bake-Cured Coating for Equipment Serving Food-Preparation Areas: In accordance with NSF 51.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. [**Modine Manufacturing Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. [**Modine Manufacturing Company**]
   c. <**Insert manufacturer's name**>

C. Bake-Cured Top Coat:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. [**Modine Manufacturing Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. [**Modine Manufacturing Company**]
   c. <**Insert manufacturer's name**>

3. Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

D. Bake-Cured, Immersion-Applied Phenolic Epoxy System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

E. Baked-Cured, Immersion-Applied Epoxy Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2.3 AIR-DRIED CORROSION-RESISTANT COATING SYSTEMS

A. Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3500**]<**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
3. Cyclic Weathering: ISO 12944-9, Offshore Standard: [**4200**]<**Insert number**> hours.
4. Mandrel Flexibility: ASTM D522/D522M: [**1/2 inch (13 mm)**][**1/8 inch (3 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
5. Impact: ASTM D2794.

a. Direct Hit: [**100 in-lb (11.3 N-m)**]<**Insert value**>.

6. Dry Heat Resistance: ASTM D2485: [**356 deg F (180 deg C)**]<**Insert value**> maximum.
7. Dry Film Thickness: [**2 to 3 mils (0.050 to 0.075 mm)**]<**Insert thickness range**>.
8. Heat-Transfer Reduction: [**1 percent**]<**Insert value**> maximum.
9. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**2H**][**HBF**]<**Insert value**>.

B. Air-Dried, Spray-Applied Principle Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blygold America**]
   b. [**Heresite Protective Coatings**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Blygold America**]
   b. [**Heresite Protective Coatings**]
   c. <**Insert manufacturer's name**>

C. Air-Dried Phenolic System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

D. Air-Dried, Spray-Applied Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Modine Manufacturing Company**]
b. <**Insert manufacturer's name**>

E. Air-Dried, Spray-Applied, Polyurethane Mixed with Aluminum Flakes System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blygold America**]
b. [**Energy Guard USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blygold America**]
b. [**Energy Guard USA**]
c. <**Insert manufacturer's name**>

F. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3000**][**4000**][**5000**][**6000**][**10,000**]<**Insert number**> hours.
2. SWAAT: ASTM G85: [**1000**][**Insert number**] hours.
3. Cyclic Weathering: ISO 12944-9: [**4200**]<**Insert number**> hours.
4. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1,100 psi (7.6 MPa)**]<**Insert value**>
7. Impact: ASTM D2794.

a. Direct Hit: [**100 lb.-in. (11.3 N-m)**][**160 lb.-in. (18.0 N-m)**]<**Insert value**>.

8. Dry Heat Resistance: ASTM D2485: [**250 deg F (121 deg C)**]<**Insert value**> maximum.
9. Dry Film Thickness: [**0.5 to 1.2 mils (0.013 to 0.030 mm)**][**0.6 to 1.5 mils (0.015 to 0.038 mm)**]<**Insert thickness range**>.
10. Heat-Transfer Reduction: [**1 percent**]<**Insert value**> maximum.
11. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**HB-F**]<**Insert value**>.

G. Air-Dried Coating for Equipment Serving Food-Preparation Areas: In accordance with 21 CFR 175.300.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

H. Spray-Can Application System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

3. Spray-Can Application System Air-Dried Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

a. Type: Air dry, phenolic.

2.4 SOURCE QUALITY CONTROL

A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.

B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.3 APPLICATION

A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.

B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.

1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.

C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION 23 05 00 00A

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Task	Specification	Specification Description
23 05 13 00	23 05 00 00a	Coatings for HVAC
23 05 16 00	23 05 00 00a	Coatings for HVAC
23 05 17 00	21 05 00 00	Common Work Results for Fire Suppression
23 05 17 00	22 05 00 00	Common Work Results for Plumbing
23 05 17 00	23 05 00 00	Common Work Results for HVAC
23 05 17 00	23 05 00 00a	Coatings for HVAC
23 05 19 00	21 05 00 00	Common Work Results for Fire Suppression
23 05 19 00	22 05 00 00	Common Work Results for Plumbing
23 05 19 00	23 05 00 00	Common Work Results for HVAC
23 05 19 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 23 00 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Angle valves.
2. Globe valves.
3. Ball valves.
4. Butterfly valves.
5. Check valves.
6. Gate valves.
7. Plug valves.
8. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as "Buna-N").

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

J. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and dimensions of individual components.
2. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.
7. Set plug valves to open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper-alloy solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.1 for power piping valves.
10. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Wrench: Furnish Owner with one wrench for every [**five**][**10**]<**Insert number**> plug valves, for each size square plug-valve head.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves [**NPS 4 (DN 100)**]<**Insert pipe size**> and larger.
2. Hand Lever: For quarter-turn ball valves smaller than [**NPS 4 (DN 100)**]<**Insert pipe size**>.

I. Valves in Insulated Piping:

1. Provide **2-inch (50-mm)** extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 ANGLE VALVES

A. Angle Valves, Threaded Ends - Bronze, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Milwaukee Valve Company**]
   e. [**NIBCO INC.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Milwaukee Valve Company**]
   e. [**NIBCO INC.**]
   f. [**WATTS; A Watts Water Technologies Company**]
   g. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Angle Valves, Threaded Ends - Bronze, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**KITZ Corporation**]
    c. [**Milwaukee Valve Company**]
    d. [**Stockham; a Crane Co. brand**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**KITZ Corporation**]
    c. [**Milwaukee Valve Company**]
    d. [**Stockham; a Crane Co. brand**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE or stainless steel. See Part 3 angle valve schedule articles.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

2.4 GLOBE VALVES

A. Globe Valves, Threaded or Soldered Ends - Bronze, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**FNW; Ferguson Enterprises, Inc.**]
    d. [**Hammond Valve**]
    e. [**KITZ Corporation**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]
    h. [**Powell Valves**]
    i. [**Red-White Valve Corp.**]
    j. [**Stockham; a Crane Co. brand**]
    k. [**WATTS; A Watts Water Technologies Company**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**KITZ Corporation**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Powell Valves**]
   i. [**Red-White Valve Corp.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 globe valve schedule articles.
7. Stem: Bronze.
8. Disc: PTFE.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Globe Valves, Threaded Ends - Bronze, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**KITZ Corporation**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]
   g. [**Powell Valves**]
   h. [**Red-White Valve Corp.**]
   i. [**Siemens Industry, Inc., Building Technologies Division**]
   j. [**Valve Solutions, Inc.**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**KITZ Corporation**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]

g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Siemens Industry, Inc., Building Technologies Division**]
j. [**Valve Solutions, Inc.**]
k. [**WATTS; A Watts Water Technologies Company**]
l. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: PTFE or stainless steel. See Part 3 globe valve schedule articles.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

C. Globe Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**KITZ Corporation**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Powell Valves**]
j. [**Red-White Valve Corp.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Stockham; a Crane Co. brand**]
m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**KITZ Corporation**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Powell Valves**]
j. [**Red-White Valve Corp.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Stockham; a Crane Co. brand**]
m. **<Insert manufacturer's name>**

3. Standard: MSS SP-85, Type I.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Packing and Gasket: Asbestos free.
9. Operator: Handwheel or chainwheel.

D. Globe Valves, Flanged Ends - Iron, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. [**Stockham; a Crane Co. brand**]
   i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. [**Stockham; a Crane Co. brand**]
   i. **<Insert manufacturer's name>**

3. Standard: MSS SP-85, Type I.
4. CWP Rating: **500 psig (3450 kPa)**.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged.
7. Trim: Bronze.
8. Packing and Gasket: Asbestos free.
9. Operator: Handwheel or chainwheel.

2.5 BALL VALVES

A. Ball Valves, Threaded Ends - Brass, One Piece:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**KITZ Corporation**]
b. [**WATTS; A Watts Water Technologies Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**KITZ Corporation**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. CWP Rating: **400 psig (2760 kPa)**.
5. Body Design: One piece.
6. Body Material: Forged brass.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Reduced.

B. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Bray International, Inc.**]
   e. [**Center Line; a Crane Co. brand**]
   f. [**DynaQuip Controls**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jenkins Valves; a Crane Co. brand**]
   j. [**Jomar Valve**]
   k. [**KITZ Corporation**]
   l. [**Lance Valves**]
   m. [**Legend Valve & Fitting, Inc**]
   n. [**Marwin Valve; Richards Industries**]
   o. [**Milwaukee Valve Company**]
   p. [**Red-White Valve Corp.**]
   q. [**Siemens Industry, Inc., Building Technologies Division**]
   r. [**Stockham; a Crane Co. brand**]
   s. [**Viega LLC**]
   t. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]

b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Bray International, Inc.**]
e. [**Center Line; a Crane Co. brand**]
f. [**DynaQuip Controls**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jenkins Valves; a Crane Co. brand**]
j. [**Jomar Valve**]
k. [**KITZ Corporation**]
l. [**Lance Valves**]
m. [**Legend Valve & Fitting, Inc**]
n. [**Marwin Valve; Richards Industries**]
o. [**Milwaukee Valve Company**]
p. [**Red-White Valve Corp.**]
q. [**Siemens Industry, Inc., Building Technologies Division**]
r. [**Stockham; a Crane Co. brand**]
s. [**Viega LLC**]
t. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Full.

C. Ball Valves, Press Ends - Brass, Two Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Milwaukee Valve Company**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Milwaukee Valve Company**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. **<Insert manufacturer's name>**

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Press.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

D. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**DynaQuip Controls**]
f. [**Flow-Tek; a subsidiary of Bray International**]
g. [**FNW; Ferguson Enterprises, Inc.**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**KITZ Corporation**]
m. [**Lance Valves**]
n. [**Legend Valve & Fitting, Inc**]
o. [**Marwin Valve; Richards Industries**]
p. [**Milwaukee Valve Company**]
q. [**Red-White Valve Corp.**]
r. [**RuB Inc**]
s. [**Siemens Industry, Inc., Building Technologies Division**]
t. [**Stockham; a Crane Co. brand**]
u. [**Viega LLC**]
v. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**DynaQuip Controls**]
   f. [**Flow-Tek; a subsidiary of Bray International**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**Hammond Valve**]
   i. [**Jamesbury; a brand of Valmet**]
   j. [**Jenkins Valves; a Crane Co. brand**]
   k. [**Jomar Valve**]
   l. [**KITZ Corporation**]
   m. [**Lance Valves**]
   n. [**Legend Valve & Fitting, Inc**]
   o. [**Marwin Valve; Richards Industries**]
   p. [**Milwaukee Valve Company**]
   q. [**Red-White Valve Corp.**]
   r. [**RuB Inc**]
   s. [**Siemens Industry, Inc., Building Technologies Division**]
   t. [**Stockham; a Crane Co. brand**]
   u. [**Viega LLC**]
   v. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

E. Ball Valves, Press Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Hammond Valve**]
   f. [**Jomar Valve**]
   g. [**KITZ Corporation**]
   h. [**Lance Valves**]
   i. [**Legend Valve & Fitting, Inc**]
   j. [**Milwaukee Valve Company**]
   k. [**NIBCO INC.**]

l. [**Red-White Valve Corp.**]
m. [**RuB Inc**]
n. [**Stockham; a Crane Co. brand**]
o. [**Viega LLC**]
p. [**WATTS; A Watts Water Technologies Company**]
q. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jomar Valve**]
g. [**KITZ Corporation**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Red-White Valve Corp.**]
m. [**RuB Inc**]
n. [**Stockham; a Crane Co. brand**]
o. [**Viega LLC**]
p. [**WATTS; A Watts Water Technologies Company**]
q. **<Insert manufacturer's name>**

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Press.
8. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
9. Seats: PTFE or RPTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.
13. O-Ring Seal: NBR or EPDM.

F. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]

h. [**Jomar Valve**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Legend Valve & Fitting, Inc**]
l. [**Marwin Valve; Richards Industries**]
m. [**Milwaukee Valve Company**]
n. [**NIBCO INC.**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]
t. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Jomar Valve**]
i. [**KITZ Corporation**]
j. [**Lance Valves**]
k. [**Legend Valve & Fitting, Inc**]
l. [**Marwin Valve; Richards Industries**]
m. [**Milwaukee Valve Company**]
n. [**NIBCO INC.**]
o. [**Red-White Valve Corp.**]
p. [**Siemens Industry, Inc., Building Technologies Division**]
q. [**Stockham; a Crane Co. brand**]
r. [**Viega LLC**]
s. [**WATTS; A Watts Water Technologies Company**]
t. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Regular.

G. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Marwin Valve; Richards Industries**]
l. [**Milwaukee Valve Company**]
m. [**Red-White Valve Corp.**]
n. [**Siemens Industry, Inc., Building Technologies Division**]
o. [**Stockham; a Crane Co. brand**]
p. [**Viega LLC**]
q. [**WATTS; A Watts Water Technologies Company**]
r. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Center Line; a Crane Co. brand**]
e. [**FNW; Ferguson Enterprises, Inc.**]
f. [**Hammond Valve**]
g. [**Jomar Valve**]
h. [**KITZ Corporation**]
i. [**Lance Valves**]
j. [**Legend Valve & Fitting, Inc**]
k. [**Marwin Valve; Richards Industries**]
l. [**Milwaukee Valve Company**]
m. [**Red-White Valve Corp.**]
n. [**Siemens Industry, Inc., Building Technologies Division**]
o. [**Stockham; a Crane Co. brand**]
p. [**Viega LLC**]
q. [**WATTS; A Watts Water Technologies Company**]
r. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Brass or bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

H. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Bray International, Inc.**]
   b. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Brass.
11. Ball: Chrome-plated brass.
12. Port: Full.

I. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. [**DynaQuip Controls**]
   c. [**Marwin Valve; Richards Industries**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Bray International, Inc.**]
   b. [**DynaQuip Controls**]
   c. [**Marwin Valve; Richards Industries**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Forged brass.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.

10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

J. Ball Valves, Threaded Ends - Bronze, One Piece with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. CWP Rating: **400 psig (2760 kPa)**.
5. Body Design: One piece.
6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.
11. Port: Reduced.

K. Ball Valves, Threaded Ends - Bronze, One Piece with Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**NIBCO INC.**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: One piece.

6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Reduced.

L. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**DynaQuip Controls**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Hammond Valve**]
   f. [**Jenkins Valves; a Crane Co. brand**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Red-White Valve Corp.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**Zurn Industries, LLC**]
   l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**DynaQuip Controls**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Hammond Valve**]
   f. [**Jenkins Valves; a Crane Co. brand**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Red-White Valve Corp.**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**Zurn Industries, LLC**]
   l. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Full.

M. Ball Valves, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Center Line; a Crane Co. brand**]
    c. [**Hammond Valve**]
    d. [**Milwaukee Valve Company**]
    e. [**NIBCO INC.**]
    f. [**Red-White Valve Corp.**]
    g. [**Stockham; a Crane Co. brand**]
    h. [**Viega LLC**]
    i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Center Line; a Crane Co. brand**]
    c. [**Hammond Valve**]
    d. [**Milwaukee Valve Company**]
    e. [**NIBCO INC.**]
    f. [**Red-White Valve Corp.**]
    g. [**Stockham; a Crane Co. brand**]
    h. [**Viega LLC**]
    i. **<Insert manufacturer's name>**

3. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Press.
8. Press-End Connections Rating: Minimum **200 psig (1380 kPa)**.
9. Seats: PTFE or RPTFE.
10. Stem: Bronze or brass.
11. Ball: Chrome-plated brass.
12. Port: Full.
13. O-Ring Seal: EPDM or NBR.

N. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Crane Fluid Systems; Crane Co.**]
    c. [**DynaQuip Controls**]
    d. [**Hammond Valve**]
    e. [**Jenkins Valves; a Crane Co. brand**]
    f. [**Milwaukee Valve Company**]
    g. [**NIBCO INC.**]

h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. [**Viega LLC**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

O. Ball Valves, Threaded Ends - Bronze, Two Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Center Line; a Crane Co. brand**]
d. [**DynaQuip Controls**]
e. [**Hammond Valve**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Regular.

P. Ball Valves, Threaded Ends - Bronze, Two Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Center Line; a Crane Co. brand**]
c. [**DynaQuip Controls**]

d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**Viega LLC**]
l. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Two piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

Q. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. **<Insert manufacturer's name>**

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Bronze.
11. Ball: Chrome-plated brass.
12. Port: Full.

R. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**DynaQuip Controls**]
c. [**NIBCO INC.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Full.

S. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**NIBCO INC.**]
c. <**Insert manufacturer's name**>

3. Standards: MSS SP-110 and MSS SP-145.
4. CWP Rating: **600 psig (4140 kPa)**.
5. Body Design: Three piece.
6. Body Material: Bronze.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.

11. Port: Regular.

T. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**NIBCO INC.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**NIBCO INC.**]
   c. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating: **150 psig (1035 kPa)**.
5. CWP Rating: **600 psig (4140 kPa)**.
6. Body Design: Three piece.
7. Body Material: Bronze.
8. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Stainless steel.
11. Ball: Stainless steel, vented.
12. Port: Regular.

U. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Bray International, Inc.**]
   c. [**DynaQuip Controls**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Hammond Valve**]
   f. [**Jamesbury; a brand of Valmet**]
   g. [**Jomar Valve**]
   h. [**Lance Valves**]
   i. [**Max-Air Technology Inc.**]
   j. [**Milwaukee Valve Company**]
   k. [**NIBCO INC.**]
   l. [**Stockham; a Crane Co. brand**]
   m. [**Viega LLC**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Max-Air Technology Inc.**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Viega LLC**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **285 psig (1964 kPa)**.
5. Body Design: Split body.
6. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

V. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]

b. [**Bray International, Inc.**]
c. [**DynaQuip Controls**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Hammond Valve**]
f. [**Jamesbury; a brand of Valmet**]
g. [**Jomar Valve**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Stockham; a Crane Co. brand**]
l. [**Viega LLC**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **720 psig (4960 kPa)**.
5. Body Design: Split body.
6. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

W. Ball Valves, Flanged Ends - Iron, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. <**Insert manufacturer's name**>

3. Standard: MSS SP-72.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Split body.
6. Body Material: ASTM A126, gray iron.
7. Ends: Flanged.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel.
11. Port: Full.

X. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Bray International, Inc.**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Guardian Worldwide LLC.**]
   f. [**Hammond Valve**]
   g. [**Jomar Valve**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Bray International, Inc.**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Guardian Worldwide LLC.**]
   f. [**Hammond Valve**]
   g. [**Jomar Valve**]
   h. <**Insert manufacturer's name**>

3. Standard: MSS SP-110.
4. SWP Rating:**150 psig (1030 kPa)**.
5. WOG Rating: **1000 psig (6895 kPa)**.
6. Body Design: Split body.
7. Body Material: Type 316 stainless steel.
8. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
9. Seats: PTFE.
10. Stem: Type 316 stainless steel.
11. Ball: Type 316 stainless steel.
12. Port: Full.

Y. Ball Valves - CPVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**Red-White Valve Corp.**]

i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**Red-White Valve Corp.**]
   i. [**Spears Manufacturing Company**]
   j. [**Thermoplastic Valves, Inc**]
   k. **<Insert manufacturer's name>**

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: CPVC.
6. Body Design: Union type.
7. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
8. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
9. Ball: CPVC; full port.
10. Seals: PTFE or EPDM-rubber O-rings.
11. Handle: Tee shaped.

Z. Ball Valves - CPVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**IPEX USA LLC**]
   e. [**Jomar Valve**]
   f. [**Red-White Valve Corp.**]
   g. [**Spears Manufacturing Company**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]

d. [**IPEX USA LLC**]
e. [**Jomar Valve**]
f. [**Red-White Valve Corp.**]
g. [**Spears Manufacturing Company**]
h. **<Insert manufacturer's name>**

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: CPVC.
6. Body Design: Non-union type.
7. End Connections: Socket or threaded.
8. Ball: CPVC; full or reduced port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

AA. Ball Valves - PVC, Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**Colonial Engineering, Inc.**]
d. [**GF Piping Systems: Georg Fischer LLC**]
e. [**Hayward Flow Control; Hayward Industries, Inc.**]
f. [**IPEX USA LLC**]
g. [**Jomar Valve**]
h. [**Red-White Valve Corp.**]
i. [**Spears Manufacturing Company**]
j. [**Thermoplastic Valves, Inc**]
k. **<Insert manufacturer's name>**

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: PVC.

6. Body Design: Union type.
7. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
8. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable union with socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
9. Ball: PVC; full port.
10. Seals: PTFE or EPDM-rubber O-rings.
11. Handle: Tee shaped.

BB. Ball Valves - PVC, Non-Union Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**IPEX USA LLC**]
   e. [**Jomar Valve**]
   f. [**Red-White Valve Corp.**]
   g. [**Spears Manufacturing Company**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**IPEX USA LLC**]
   e. [**Jomar Valve**]
   f. [**Red-White Valve Corp.**]
   g. [**Spears Manufacturing Company**]
   h. <**Insert manufacturer's name**>

3. Standard: MSS SP-122.
4. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 ball valve schedule articles.
5. Body Material: PVC.
6. Body Design: Non-union type.
7. End Connections: Socket or threaded.
8. Ball: PVC; full or reduced port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

2.6 BUTTERFLY VALVES

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**Hammond Valve**]
i. [**Jamesbury; a brand of Valmet**]
j. [**Jenkins Valves; a Crane Co. brand**]
k. [**Jomar Valve**]
l. [**Kennedy Valve Company; a division of McWane, Inc.**]
m. [**KITZ Corporation**]
n. [**Lance Valves**]
o. [**Legend Valve & Fitting, Inc**]
p. [**Milwaukee Valve Company**]
q. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]

x. [**Zurn Industries, LLC**]
y. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Aluminum bronze.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**Zurn Industries, LLC**]
z. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]

f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
s. [**NIBCO INC.**]
t. [**Norriseal**]
u. [**Red-White Valve Corp.**]
v. [**Stockham; a Crane Co. brand**]
w. [**Sure Flow Equipment Inc**]
x. [**Viega LLC**]
y. [**Zurn Industries, LLC**]
z. **<Insert manufacturer's name>**

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]

q. [**Max-Air Technology Inc.**]
r. [**Milwaukee Valve Company**]
s. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
t. [**NIBCO INC.**]
u. [**Norriseal**]
v. [**Red-White Valve Corp.**]
w. [**Stockham; a Crane Co. brand**]
x. [**Sure Flow Equipment Inc**]
y. [**Viega LLC**]
z. [**Zurn Industries, LLC**]
aa. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Max-Air Technology Inc.**]
r. [**Milwaukee Valve Company**]
s. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
t. [**NIBCO INC.**]
u. [**Norriseal**]
v. [**Red-White Valve Corp.**]
w. [**Stockham; a Crane Co. brand**]
x. [**Sure Flow Equipment Inc**]
y. [**Viega LLC**]
z. [**Zurn Industries, LLC**]
aa. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Stainless steel.

D. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**DeZURIK**]
    f. [**DynaQuip Controls**]
    g. [**Flo Fab Inc**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**Hammond Valve**]
    j. [**Jamesbury; a brand of Valmet**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Legend Valve & Fitting, Inc**]
    q. [**Milwaukee Valve Company**]
    r. [**NIBCO INC.**]
    s. [**Norriseal**]
    t. [**Red-White Valve Corp.**]
    u. [**Stockham; a Crane Co. brand**]
    v. [**Sure Flow Equipment Inc**]
    w. [**Viega LLC**]
    x. [**Zurn Industries, LLC**]
    y. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**ABZ Valve; an ASC Engineered Solution**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**Bray International, Inc.**]
    d. [**Center Line; a Crane Co. brand**]
    e. [**DeZURIK**]
    f. [**DynaQuip Controls**]
    g. [**Flo Fab Inc**]
    h. [**FNW; Ferguson Enterprises, Inc.**]
    i. [**Hammond Valve**]
    j. [**Jamesbury; a brand of Valmet**]
    k. [**Jenkins Valves; a Crane Co. brand**]
    l. [**Jomar Valve**]
    m. [**Kennedy Valve Company; a division of McWane, Inc.**]
    n. [**KITZ Corporation**]
    o. [**Lance Valves**]
    p. [**Legend Valve & Fitting, Inc**]
    q. [**Milwaukee Valve Company**]
    r. [**NIBCO INC.**]
    s. [**Norriseal**]
    t. [**Red-White Valve Corp.**]

u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. **<Insert manufacturer's name>**

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Aluminum bronze.

E. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]

d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. **<Insert manufacturer's name>**

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]

p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Center Line; a Crane Co. brand**]
e. [**DeZURIK**]
f. [**DynaQuip Controls**]
g. [**Flo Fab Inc**]
h. [**FNW; Ferguson Enterprises, Inc.**]
i. [**Hammond Valve**]
j. [**Jamesbury; a brand of Valmet**]
k. [**Jenkins Valves; a Crane Co. brand**]
l. [**Jomar Valve**]
m. [**Kennedy Valve Company; a division of McWane, Inc.**]
n. [**KITZ Corporation**]
o. [**Lance Valves**]
p. [**Legend Valve & Fitting, Inc**]
q. [**Milwaukee Valve Company**]
r. [**NIBCO INC.**]
s. [**Norriseal**]
t. [**Red-White Valve Corp.**]
u. [**Stockham; a Crane Co. brand**]
v. [**Sure Flow Equipment Inc**]
w. [**Viega LLC**]
x. [**Zurn Industries, LLC**]
y. **<Insert manufacturer's name>**

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **150 psig (1035 kPa)** or **200 psig (1380 kPa)**. See Part 3 butterfly valve schedule articles.
5. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
6. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
7. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
8. Stem: One- or two-piece stainless steel.
9. Disc: Stainless steel.

G. Butterfly Valves, Grooved End - Ductile Iron, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-67, Type I.
4. CWP Rating: **175 psig (1200 kPa)**.
5. Body Material: Coated, ductile iron.
6. Ends: Grooved.
7. Stem: Two-piece stainless steel.
8. Disc: Coated, ductile iron.
9. Seat: EPDM.

H. Butterfly Valves, Grooved End - Ductile Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]

d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**WATTS; A Watts Water Technologies Company**]
l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Grinnell G-Fire; brand of Johnson Controls International plc, Building Solutions North America**]
d. [**Hammond Valve**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**NIBCO INC.**]
g. [**Norriseal**]
h. [**Red-White Valve Corp.**]
i. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
j. [**Victaulic Company**]
k. [**WATTS; A Watts Water Technologies Company**]
l. **<Insert manufacturer's name>**

3. Standard: MSS SP-67, Type I.
4. NPS 8 (DN 50) and Smaller CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: Coated, ductile iron
6. Ends: Grooved.
7. Stem: Two-piece stainless steel.
8. Disc: Coated, ductile iron.
9. Seat: EPDM.

I. Butterfly Valves, Single Flange (Lug Type) - High Performance, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Lance Valves**]
i. [**Milwaukee Valve Company**]
j. [**Stockham; a Crane Co. brand**]
k. [**XOMOX; Crane ChemPharma & Energy**]

l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**ASC Engineered Solutions**]
   c. [**Bray International, Inc.**]
   d. [**DeZURIK**]
   e. [**Flowseal; Crane Energy Flow Solutions**]
   f. [**Hammond Valve**]
   g. [**Jamesbury; a brand of Valmet**]
   h. [**Lance Valves**]
   i. [**Milwaukee Valve Company**]
   j. [**Stockham; a Crane Co. brand**]
   k. [**XOMOX; Crane ChemPharma & Energy**]
   l. **<Insert manufacturer's name>**

3. Standard: MSS SP-68.
4. CWP Rating: **285 psig (1965 kPa)** at **100 deg F (38 deg C)**.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: Carbon or stainless steel. See Part 3 butterfly valve schedule articles.
7. Seat: Reinforced PTFE or metal.
8. Stem: Stainless steel; offset from seat plane.
9. Disc: Type 316 stainless steel.
10. Service: Bidirectional.

J. Butterfly Valves, Single Flange (Lug Type) - High Performance, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Bray International, Inc.**]
   d. [**DeZURIK**]
   e. [**Flowseal; Crane Energy Flow Solutions**]
   f. [**Hammond Valve**]
   g. [**Jamesbury; a brand of Valmet**]
   h. [**Milwaukee Valve Company**]
   i. [**NIBCO INC.**]
   j. [**Process Development & Control, Inc.**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**XOMOX; Crane ChemPharma & Energy**]
   m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABZ Valve; an ASC Engineered Solution**]

b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flowseal; Crane Energy Flow Solutions**]
f. [**Hammond Valve**]
g. [**Jamesbury; a brand of Valmet**]
h. [**Milwaukee Valve Company**]
i. [**NIBCO INC.**]
j. [**Process Development & Control, Inc.**]
k. [**Stockham; a Crane Co. brand**]
l. [**XOMOX; Crane ChemPharma & Energy**]
m. **<Insert manufacturer's name>**

3. Standard: MSS SP-68.
4. CWP Rating: **720 psig (4965 kPa)** at **100 deg F (38 deg C)**.
5. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
6. Body Material: Carbon or stainless steel. See Part 3 butterfly valve schedule articles.
7. Seat: Reinforced PTFE or metal.
8. Stem: Stainless steel; offset from seat plane.
9. Disc: Type 316 stainless steel.
10. Service: Bidirectional.

2.7 CHECK VALVES

A. Check Valves, Lift Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]
c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Keckley Company**]
i. [**Metraflex Company (The)**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. [**WATTS; A Watts Water Technologies Company**]
p. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**American Valve, Inc**]

c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
d. [**Crane Fluid Systems; Crane Co.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jenkins Valves; a Crane Co. brand**]
g. [**Jomar Valve**]
h. [**Keckley Company**]
i. [**Metraflex Company (The)**]
j. [**Milwaukee Valve Company**]
k. [**NIBCO INC.**]
l. [**Stockham; a Crane Co. brand**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. [**WATTS; A Watts Water Technologies Company**]
p. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Vertical flow.
6. Body Material: ASTM B61 or ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

B. Check Valves, Lift Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Keckley Company**]
e. [**Lance Valves**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Stockham; a Crane Co. brand**]
k. [**Val-Matic Valve & Manufacturing Corp.**]
l. [**Victaulic Company**]
m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Keckley Company**]
e. [**Lance Valves**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]

i. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
j. [**Stockham; a Crane Co. brand**]
k. [**Val-Matic Valve & Manufacturing Corp.**]
l. [**Victaulic Company**]
m. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Vertical flow.
6. Body Material: ASTM B61 or ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: NBR or PTFE.

C. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Val-Matic Valve & Manufacturing Corp.**]
m. [**Victaulic Company**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves; a Crane Co. brand**]
d. [**Jomar Valve**]
e. [**Keckley Company**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**NIBCO INC.**]
i. [**Red-White Valve Corp.**]
j. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
k. [**Stockham; a Crane Co. brand**]
l. [**Val-Matic Valve & Manufacturing Corp.**]
m. [**Victaulic Company**]
n. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 3.
4. CWP Rating: **200 psig (1380 kPa)**.

5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

D. Check Valves, Swing Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Jenkins Valves; a Crane Co. brand**]
   d. [**Jomar Valve**]
   e. [**Keckley Company**]
   f. [**Lance Valves**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Jenkins Valves; a Crane Co. brand**]
   d. [**Jomar Valve**]
   e. [**Keckley Company**]
   f. [**Lance Valves**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 4.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: PTFE.

E. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Jenkins Valves; a Crane Co. brand**]
f. [**Jomar Valve**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Milwaukee Valve Company**]
j. [**NIBCO INC.**]
k. [**Powell Valves**]
l. [**Red-White Valve Corp.**]
m. [**Stockham; a Crane Co. brand**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 3.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: Bronze.

F. Check Valves, Swing Type, Threaded Ends - Bronze, with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]

i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Jenkins Valves; a Crane Co. brand**]
c. [**Jomar Valve**]
d. [**Lance Valves**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**Stockham; a Crane Co. brand**]
j. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 4.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B62, bronze.
7. Ends: Threaded.
8. Disc: PTFE.

G. Check Valves, Swing Type, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Legend Valve & Fitting, Inc**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**Hammond Valve**]
e. [**Legend Valve & Fitting, Inc**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-80.

4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Design: Horizontal flow.
6. Body Material: ASTM B584, bronze.
7. Ends: Press.
8. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
9. Disc: Brass or bronze.

H. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Bray International, Inc.**]
   d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   e. [**Cooper Valves**]
   f. [**Crane Fluid Systems; Crane Co.**]
   g. [**DeZURIK**]
   h. [**FNW; Ferguson Enterprises, Inc.**]
   i. [**GA Industries, Inc**]
   j. [**Hammond Valve**]
   k. [**Jenkins Valves; a Crane Co. brand**]
   l. [**Jomar Valve**]
   m. [**Kennedy Valve Company; a division of McWane, Inc.**]
   n. [**KITZ Corporation**]
   o. [**Lance Valves**]
   p. [**Milwaukee Valve Company**]
   q. [**Powell Valves**]
   r. [**Victaulic Company**]
   s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Bray International, Inc.**]
   d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   e. [**Cooper Valves**]
   f. [**Crane Fluid Systems; Crane Co.**]
   g. [**DeZURIK**]
   h. [**FNW; Ferguson Enterprises, Inc.**]
   i. [**GA Industries, Inc**]
   j. [**Hammond Valve**]
   k. [**Jenkins Valves; a Crane Co. brand**]
   l. [**Jomar Valve**]
   m. [**Kennedy Valve Company; a division of McWane, Inc.**]
   n. [**KITZ Corporation**]
   o. [**Lance Valves**]
   p. [**Milwaukee Valve Company**]
   q. [**Powell Valves**]
   r. [**Victaulic Company**]

s. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.

I. Check Valves, Swing Type, Flanged Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. [**Cooper Valves**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**DeZURIK**]
   e. [**Kennedy Valve Company; a division of McWane, Inc.**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   i. [**Victaulic Company**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Bray International, Inc.**]
   b. [**Cooper Valves**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**DeZURIK**]
   e. [**Kennedy Valve Company; a division of McWane, Inc.**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   i. [**Victaulic Company**]
   j. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Composition.
10. Seat Ring: Bronze.
11. Disc Holder: Bronze.

12. Disc: PTFE.
13. Gasket: Asbestos free.

J. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Bray International, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**Crispin Valve**]
   f. [**DeZURIK**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**GA Industries, Inc**]
   i. [**Hammond Valve**]
   j. [**Jenkins Valves; a Crane Co. brand**]
   k. [**KITZ Corporation**]
   l. [**Lance Valves**]
   m. [**Milwaukee Valve Company**]
   n. [**Powell Valves**]
   o. [**Victaulic Company**]
   p. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Bray International, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**Crispin Valve**]
   f. [**DeZURIK**]
   g. [**FNW; Ferguson Enterprises, Inc.**]
   h. [**GA Industries, Inc**]
   i. [**Hammond Valve**]
   j. [**Jenkins Valves; a Crane Co. brand**]
   k. [**KITZ Corporation**]
   l. [**Lance Valves**]
   m. [**Milwaukee Valve Company**]
   n. [**Powell Valves**]
   o. [**Victaulic Company**]
   p. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.

K. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Bray International, Inc.**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**Cooper Valves**]
   e. [**Crispin Valve**]
   f. [**DeZURIK**]
   g. [**GA Industries, Inc**]
   h. [**Kennedy Valve Company; a division of McWane, Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Bray International, Inc.**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**Cooper Valves**]
   e. [**Crispin Valve**]
   f. [**DeZURIK**]
   g. [**GA Industries, Inc**]
   h. [**Kennedy Valve Company; a division of McWane, Inc.**]
   i. <**Insert manufacturer's name**>

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.
11. Closure Control: Factory-installed, exterior lever and spring.

L. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**ASC Engineered Solutions**]
   c. [**Bray International, Inc.**]
   d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   e. [**Cooper Valves**]
   f. [**Crispin Valve**]
   g. [**DeZURIK**]

h. [**GA Industries, Inc**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**Milwaukee Valve Company**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**ASC Engineered Solutions**]
c. [**Bray International, Inc.**]
d. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
e. [**Cooper Valves**]
f. [**Crispin Valve**]
g. [**DeZURIK**]
h. [**GA Industries, Inc**]
i. [**Kennedy Valve Company; a division of McWane, Inc.**]
j. [**Milwaukee Valve Company**]
k. **<Insert manufacturer's name>**

3. Standard: MSS SP-71, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Clear or full waterway.
7. Body Material: ASTM A126, gray iron with bolted bonnet.
8. Ends: Flanged.
9. Trim: Bronze.
10. Gasket: Asbestos free.
11. Closure Control: Factory-installed, exterior lever and weight.

M. Check Valves, Swing Type, Grooved End - Iron, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**DeZURIK**]
e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
g. [**Victaulic Company**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**ASC Engineered Solutions**]
d. [**DeZURIK**]

e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
g. [**Victaulic Company**]
h. **<Insert manufacturer's name>**

3. CWP Rating: **300 psig (2070 kPa)**.
4. Body Material: ASTM A536, ductile iron.
5. Seat: EPDM.
6. Disc: Spring operated, ductile iron or stainless steel.

N. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Milwaukee Valve Company**]
m. [**Val-Matic Valve & Manufacturing Corp.**]
n. [**Victaulic Company**]
o. **<Insert manufacturer's name>**

3. Standard: MSS SP-125.

4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer.
8. Seat: Bronze.

O. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASC Engineered Solutions**]
   b. [**Crispin Valve**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**KITZ Corporation**]
   g. [**Metraflex Company (The)**]
   h. [**Milwaukee Valve Company**]
   i. [**Val-Matic Valve & Manufacturing Corp.**]
   j. [**WATTS; A Watts Water Technologies Company**]
   k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ASC Engineered Solutions**]
   b. [**Crispin Valve**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**KITZ Corporation**]
   g. [**Metraflex Company (The)**]
   h. [**Milwaukee Valve Company**]
   i. [**Val-Matic Valve & Manufacturing Corp.**]
   j. [**WATTS; A Watts Water Technologies Company**]
   k. **<Insert manufacturer's name>**

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

P. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Victaulic Company**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Cooper Valves**]
d. [**Crispin Valve**]
e. [**DeZURIK**]
f. [**DFT Inc.**]
g. [**Flomatic Valves; Flomatic Corporation**]
h. [**GA Industries, Inc**]
i. [**Keckley Company**]
j. [**KITZ Corporation**]
k. [**Metraflex Company (The)**]
l. [**Victaulic Company**]
m. [**WATTS; A Watts Water Technologies Company**]
n. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer.
8. Seat: Bronze.

Q. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**GA Industries, Inc**]
e. [**KITZ Corporation**]
f. [**Metraflex Company (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crispin Valve**]
   b. [**DFT Inc.**]
   c. [**Flomatic Valves; Flomatic Corporation**]
   d. [**GA Industries, Inc**]
   e. [**KITZ Corporation**]
   f. [**Metraflex Company (The)**]
   g. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

R. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper Valves**]
   c. [**DeZURIK**]
   d. [**DFT Inc.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**Keckley Company**]
   g. [**Metraflex Company (The)**]
   h. [**Val-Matic Valve & Manufacturing Corp.**]
   i. [**Victaulic Company**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper Valves**]
   c. [**DeZURIK**]
   d. [**DFT Inc.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**Keckley Company**]
   g. [**Metraflex Company (The)**]
   h. [**Val-Matic Valve & Manufacturing Corp.**]
   i. [**Victaulic Company**]
   j. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.

6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer, spring loaded.
8. Seat: Bronze.

S. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Metraflex Company (The)**]
   d. [**Val-Matic Valve & Manufacturing Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Metraflex Company (The)**]
   d. [**Val-Matic Valve & Manufacturing Corp.**]
   e. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

T. Check Valves, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper Valves**]
   c. [**Crispin Valve**]
   d. [**DFT Inc.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**Keckley Company**]
   g. [**Metraflex Company (The)**]
   h. [**Victaulic Company**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anvil; an ASC Engineered Solution**]
b. [**Cooper Valves**]
c. [**Crispin Valve**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Keckley Company**]
g. [**Metraflex Company (The)**]
h. [**Victaulic Company**]
i. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer, spring loaded.
8. Seat: Bronze.

U. Check Valves, Center Guided - Iron, Globe, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**DFT Inc.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: Bronze.

V. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]

d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cooper Valves**]
c. [**DeZURIK**]
d. [**DFT Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Val-Matic Valve & Manufacturing Corp.**]
g. [**Victaulic Company**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

W. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

X. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Val-Matic Valve & Manufacturing Corp.**]
   g. [**Victaulic Company**]
   h. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Y. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]
   d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Z. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Valves**]
   b. [**DeZURIK**]
   c. [**DFT Inc.**]
   d. [**Flomatic Valves; Flomatic Corporation**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Compact wafer, spring loaded.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

AA. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DFT Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Val-Matic Valve & Manufacturing Corp.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Val-Matic Valve & Manufacturing Corp.**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

BB. Check Valves, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Valves**]
b. [**DeZURIK**]
c. [**DFT Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Victaulic Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Valves**]
b. [**DeZURIK**]
c. [**DFT Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**Victaulic Company**]
f. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Compact wafer, spring loaded.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

CC. Check Valves, Center Guided - Iron, Globe, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DFT Inc.**]

b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DFT Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-125.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Style: Globe, spring loaded.
8. Ends: Flanged.
9. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

DD. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jomar Valve**]
g. [**Keckley Company**]
h. [**Lance Valves**]
i. [**Legend Valve & Fitting, Inc**]
j. [**Metraflex Company (The)**]
k. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
l. [**Stockham; a Crane Co. brand**]
m. [**Sure Flow Equipment Inc**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**Jomar Valve**]
g. [**Keckley Company**]
h. [**Lance Valves**]

i. [**Legend Valve & Fitting, Inc**]
j. [**Metraflex Company (The)**]
k. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
l. [**Stockham; a Crane Co. brand**]
m. [**Sure Flow Equipment Inc**]
n. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: Bronze.

EE. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Stockham; a Crane Co. brand**]
k. [**Sure Flow Equipment Inc**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**DeZURIK**]
e. [**Jomar Valve**]
f. [**Keckley Company**]
g. [**Lance Valves**]
h. [**Legend Valve & Fitting, Inc**]
i. [**Metraflex Company (The)**]
j. [**Stockham; a Crane Co. brand**]
k. [**Sure Flow Equipment Inc**]
l. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.

8. Seat: Bronze.

FF. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Stockham; a Crane Co. brand**]
   f. [**Sure Flow Equipment Inc**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Stockham; a Crane Co. brand**]
   f. [**Sure Flow Equipment Inc**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: Bronze.

GG. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABZ Valve; an ASC Engineered Solution**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Bray International, Inc.**]
   d. [**Keckley Company**]
   e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   f. [**Sure Flow Equipment Inc**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**ABZ Valve; an ASC Engineered Solution**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Bray International, Inc.**]
d. [**Keckley Company**]
e. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
f. [**Sure Flow Equipment Inc**]
g. **<Insert manufacturer's name>**

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: Bronze.

HH. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. **<Insert manufacturer's name>**

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, single spring-loaded plate.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

II. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bray International, Inc.**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Keckley Company**]
   d. [**Stockham; a Crane Co. brand**]

e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bray International, Inc.**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

JJ. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bray International, Inc.**]
b. [**DeZURIK**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bray International, Inc.**]
b. [**DeZURIK**]
c. [**Keckley Company**]
d. [**Stockham; a Crane Co. brand**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **300 psig (2070 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **250 psig (1725 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

KK. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. [**Victaulic Company**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GA Industries, Inc**]
   b. [**Jomar Valve**]
   c. [**Keckley Company**]
   d. [**Victaulic Company**]
   e. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Design: Wafer, single spring-loaded plate.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

LL. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jomar Valve**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jomar Valve**]
   b. [**Keckley Company**]
   c. [**Stockham; a Crane Co. brand**]
   d. [**Sure Flow Equipment Inc**]
   e. [**Val-Matic Valve & Manufacturing Corp.**]
   f. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.

6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A126, gray iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

MM. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Keckley Company**]
   b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   c. [**Sure Flow Equipment Inc**]
   d. <**Insert manufacturer's name**>

3. Standard: API 594.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **400 psig (2760 kPa)**.
6. Body Design: Wafer, spring-loaded plates.
7. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
8. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

NN. Check Valves - CPVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**Hayward Flow Control; Hayward Industries, Inc.**]
   e. [**IPEX USA LLC**]
   f. [**Legend Valve & Fitting, Inc**]
   g. [**NIBCO INC.**]
   h. [**Spears Manufacturing Company**]
   i. [**Thermoplastic Valves, Inc**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]

b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. **<Insert manufacturer's name>**

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Union-type ball check.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
8. Ball: CPVC.
9. Seals: EPDM- or FKM-rubber O-rings.

OO. Check Valves - PVC, Union-Type Ball Check:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Asahi/America**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**Hayward Flow Control; Hayward Industries, Inc.**]
e. [**IPEX USA LLC**]
f. [**Legend Valve & Fitting, Inc**]
g. [**NIBCO INC.**]
h. [**Spears Manufacturing Company**]
i. [**Thermoplastic Valves, Inc**]
j. **<Insert manufacturer's name>**

3. Pressure Rating and Temperature: **125 psig (860 kPa) 150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 check valve schedule articles.

4. Body Material: PVC.
5. Body Design: Union-type ball check.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
8. Ball: PVC.
9. Seals: EPDM- or FKM-rubber O-rings.

2.8 GATE VALVES

A. Gate Valves, Threaded or Soldered Ends - Bronze, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Jenkins Valves; a Crane Co. brand**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Milwaukee Valve Company**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**WATTS; A Watts Water Technologies Company**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**FNW; Ferguson Enterprises, Inc.**]
   e. [**Jenkins Valves; a Crane Co. brand**]
   f. [**KITZ Corporation**]
   g. [**Lance Valves**]
   h. [**Milwaukee Valve Company**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**WATTS; A Watts Water Technologies Company**]
   m. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 gate valve schedule articles.

7. Stem: Bronze.
8. Disc: Solid wedge; bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

B. Gate Valves, Threaded or Soldered Ends - Bronze, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jenkins Valves; a Crane Co. brand**]
   f. [**KITZ Corporation**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**WATTS; A Watts Water Technologies Company**]
   m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jenkins Valves; a Crane Co. brand**]
   f. [**KITZ Corporation**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Powell Valves**]
   j. [**Red-White Valve Corp.**]
   k. [**Stockham; a Crane Co. brand**]
   l. [**WATTS; A Watts Water Technologies Company**]
   m. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **200 psig (1380 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
6. Ends: Threaded or soldered. See Part 3 gate valve schedule articles.
7. Stem: Bronze.
8. Disc: Solid wedge; bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron, bronze, or aluminum.

C. Gate Valves, Threaded Ends - Bronze, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Lance Valves**]
g. [**Milwaukee Valve Company**]
h. [**Powell Valves**]
i. [**Red-White Valve Corp.**]
j. [**Stockham; a Crane Co. brand**]
k. [**WATTS; A Watts Water Technologies Company**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-80, Type 1.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: Solid wedge, bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

D. Gate Valves, Threaded Ends - Bronze, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]

f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Hammond Valve**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Stockham; a Crane Co. brand**]
i. [**WATTS; A Watts Water Technologies Company**]
j. **<Insert manufacturer's name>**

3. Standard: MSS SP-80, Type 2.
4. CWP Rating: **300 psig (2070 kPa)**.
5. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
6. Ends: Threaded.
7. Stem: Bronze.
8. Disc: Solid wedge, bronze.
9. Packing: Asbestos free.
10. Handwheel: Malleable iron[**, bronze, or aluminum**].

E. Gate Valves, Press Ends - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Hammond Valve**]
d. [**Milwaukee Valve Company**]
e. [**NIBCO INC.**]
f. **<Insert manufacturer's name>**

3. Standard: MSS SP-80.

4. CWP Rating: Minimum **200 psig (1380 kPa)**.
5. Body Material: Bronze with integral seat and union-ring bonnet.
6. Ends: Press.
7. Press Ends Connection Rating: Minimum **200 psig (1380 kPa)**.
8. Stem: Brass or bronze RS or NRS. See Part 3 gate valve schedule articles.
9. Disc: Solid wedge, bronze.
10. Packing: Graphite.
11. Port: Full.
12. Handwheel: Malleable iron, bronze, or aluminum.

F. Gate Valves, Flanged Ends - Iron, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**Jomar Valve**]
    i. [**Kennedy Valve Company; a division of McWane, Inc.**]
    j. [**KITZ Corporation**]
    k. [**Lance Valves**]
    l. [**Legend Valve & Fitting, Inc**]
    m. [**Powell Valves**]
    n. [**Zurn Industries, LLC**]
    o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
    c. [**Cooper Valves**]
    d. [**Crane Fluid Systems; Crane Co.**]
    e. [**Flomatic Valves; Flomatic Corporation**]
    f. [**FNW; Ferguson Enterprises, Inc.**]
    g. [**Jenkins Valves; a Crane Co. brand**]
    h. [**Jomar Valve**]
    i. [**Kennedy Valve Company; a division of McWane, Inc.**]
    j. [**KITZ Corporation**]
    k. [**Lance Valves**]
    l. [**Legend Valve & Fitting, Inc**]
    m. [**Powell Valves**]
    n. [**Zurn Industries, LLC**]
    o. **<Insert manufacturer's name>**

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.

5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

G. Gate Valves, Flanged Ends - Iron, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jomar Valve**]
   f. [**Kennedy Valve Company; a division of McWane, Inc.**]
   g. [**KITZ Corporation**]
   h. [**Lance Valves**]
   i. [**Legend Valve & Fitting, Inc**]
   j. [**Milwaukee Valve Company**]
   k. [**Powell Valves**]
   l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**WATTS; A Watts Water Technologies Company**]
   n. [**Zurn Industries, LLC**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Hammond Valve**]
   e. [**Jomar Valve**]
   f. [**Kennedy Valve Company; a division of McWane, Inc.**]
   g. [**KITZ Corporation**]
   h. [**Lance Valves**]
   i. [**Legend Valve & Fitting, Inc**]
   j. [**Milwaukee Valve Company**]
   k. [**Powell Valves**]
   l. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**WATTS; A Watts Water Technologies Company**]
   n. [**Zurn Industries, LLC**]
   o. **<Insert manufacturer's name>**

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.

7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

H. Gate Valves, Flanged Ends - Iron, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**FNW; Ferguson Enterprises, Inc.**]
   g. [**Jenkins Valves; a Crane Co. brand**]
   h. [**KITZ Corporation**]
   i. [**Victaulic Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**Cooper Valves**]
   d. [**Crane Fluid Systems; Crane Co.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**FNW; Ferguson Enterprises, Inc.**]
   g. [**Jenkins Valves; a Crane Co. brand**]
   h. [**KITZ Corporation**]
   i. [**Victaulic Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

I. Gate Valves, Flanged Ends - Iron, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**FNW; Ferguson Enterprises, Inc.**]
d. [**Hammond Valve**]
e. [**KITZ Corporation**]
f. [**Milwaukee Valve Company**]
g. [**Powell Valves**]
h. [**Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America**]
i. [**Victaulic Company**]
j. [**WATTS; A Watts Water Technologies Company**]
k. [**Zurn Industries, LLC**]
l. <**Insert manufacturer's name**>

3. Standard: MSS SP-70, Type I.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **500 psig (3450 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Disc: Solid wedge.
10. Packing and Gasket: Asbestos free.

J. Gate Valves - CPVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
4. Body Material: CPVC.
5. Body Design: NRS.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket, socket or threaded, threaded, or flanged. See Part 3 gate valve schedule articles.
8. Gate and Stem: Plastic.
9. Seals: EPDM rubber.
10. Handle: Wheel.

K. Gate Valves - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Asahi/America**]
b. [**KITZ Corporation**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Pressure Rating and Temperature: **125 psig (860 kPa)**, **150 psig (1035 kPa)**, or other pressure at **73 deg F (23 deg C)** or other temperature. See Part 3 gate valve schedule articles.
4. Body Material: PVC.
5. Body Design: NRS.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded. See Part 3 gate valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].
8. Gate and Stem: Plastic.
9. Seals: EPDM rubber.
10. Handle: Wheel.

2.9 PLUG VALVES

A. Plug Valves, Lubricated Type, Threaded Ends - Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**DeZURIK**]
   e. [**Flowserve Corporation**]
   f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
   g. [**Nordstrom; a Flowserve Corporation brand**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**American Valve, Inc**]
   c. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   d. [**DeZURIK**]
   e. [**Flowserve Corporation**]
   f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
   g. [**Nordstrom; a Flowserve Corporation brand**]
   h. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I, single gland.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

B. Plug Valves, Lubricated Type, Flanged Ends - Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Crispin Valve**]
   b. [**DeZURIK**]
   c. [**Flomatic Valves; Flomatic Corporation**]
   d. [**Flowserve Corporation**]
   e. [**GA Industries, Inc**]
   f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
   g. [**Kennedy Valve Company; a division of McWane, Inc.**]
   h. [**National Oilwell Varco**]
   i. [**NIBCO INC.**]
   j. [**Nordstrom; a Flowserve Corporation brand**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crispin Valve**]

b. [**DeZURIK**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**Flowserve Corporation**]
e. [**GA Industries, Inc**]
f. [**Homestead Valve: a division of Olson Technologies, Inc.**]
g. [**Kennedy Valve Company; a division of McWane, Inc.**]
h. [**National Oilwell Varco**]
i. [**NIBCO INC.**]
j. [**Nordstrom; a Flowserve Corporation brand**]
k. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **150 psig (1035 kPa)**.
6. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
7. Plug: Cast iron or bronze with sealant groove.

C. Plug Valves, Lubricated Type, Threaded Ends - Cylindrical, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flowserve Corporation**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flowserve Corporation**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

D. Plug Valves, Lubricated Type, Flanged Ends - Cylindrical, Class 125:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flomatic Valves; Flomatic Corporation**]
b. [**Flowserve Corporation**]

c. [**Homestead Valve: a division of Olson Technologies, Inc.**]
d. [**National Oilwell Varco**]
e. [**Nordstrom; a Flowserve Corporation brand**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Flomatic Valves; Flomatic Corporation**]
b. [**Flowserve Corporation**]
c. [**Homestead Valve: a division of Olson Technologies, Inc.**]
d. [**National Oilwell Varco**]
e. [**Nordstrom; a Flowserve Corporation brand**]
f. **<Insert manufacturer's name>**

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **200 psig (1380 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

E. Plug Valves, Lubricated Type, Threaded Ends - Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DeZURIK**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**DeZURIK**]
b. [**Homestead Valve: a division of Olson Technologies, Inc.**]
c. [**National Oilwell Varco**]
d. [**Nordstrom; a Flowserve Corporation brand**]
e. **<Insert manufacturer's name>**

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

F. Plug Valves, Lubricated Type, Flanged Ends - Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**DeZURIK**]
c. [**Flowserve Corporation**]
d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**National Oilwell Varco**]
g. [**Nordstrom; a Flowserve Corporation brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**DeZURIK**]
c. [**Flowserve Corporation**]
d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
e. [**Kennedy Valve Company; a division of McWane, Inc.**]
f. [**National Oilwell Varco**]
g. [**Nordstrom; a Flowserve Corporation brand**]
h. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type I single gland or Type II regular gland. See Part 3 plug valve schedule articles.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): **300 psig (2070 kPa)**.
6. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
7. Plug: Cast iron or bronze with sealant groove.

G. Plug Valves, Lubricated Type, Threaded Ends - Cylindrical, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Flowserve Corporation**]
b. [**National Oilwell Varco**]
c. [**Nordstrom; a Flowserve Corporation brand**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Flowserve Corporation**]
b. [**National Oilwell Varco**]
c. [**Nordstrom; a Flowserve Corporation brand**]
d. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

H. Plug Valves, Lubricated Type, Flanged Ends - Cylindrical, Class 250:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Flowserve Corporation**]
   b. [**National Oilwell Varco**]
   c. [**Nordstrom; a Flowserve Corporation brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Flowserve Corporation**]
   b. [**National Oilwell Varco**]
   c. [**Nordstrom; a Flowserve Corporation brand**]
   d. <**Insert manufacturer's name**>

3. Standard: MSS SP-78, Type IV.
4. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): **400 psig (2760 kPa)**.
5. Body Material: ASTM A48/A48M or ASTM A126, Grade 40 cast iron with lubrication-sealing system.
6. Plug: Cast iron or bronze with sealant groove.

I. Plug Valves, Eccentric Type, Flanged Ends - with Resilient Seat, 175 CWP.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Clow Valve Company; a subsidiary of McWane, Inc.
   b. DeZURIK.
   c. Flowserve Corporation.
   d. GA Industries, Inc.
   e. Homestead Valve: a division of Olson Technologies, Inc.
   f. Kennedy Valve Company; a division of McWane, Inc.
   g. Milliken Valve Company; a Mueller brand.
   h. National Oilwell Varco.
   i. Nordstrom; a Flowserve Corporation brand.
   j. Val-Matic Valve & Manufacturing Corp.
   k. <**Insert manufacturer's name**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:
3. Standard: MSS SP-108.
4. CWP Rating: **175 psig (1200 kPa)** minimum.
5. Body and Plug: ASTM A48/A48M, gray iron; ASTM A126, gray iron; or ASTM A536, ductile iron.
6. Bearings: Oil-impregnated bronze or stainless steel.
7. Ends: Flanged.
8. Stem-Seal Packing: Asbestos free.
9. Plug, Resilient-Seat Material: Suitable for potable-water service unless otherwise indicated.

2.10 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Babbitt Steam Specialty Co**]
3. [**Roto Hammer Industries; Rotork**]
4. [**Trumbull Industries**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2. [**Babbitt Steam Specialty Co**]
3. [**Roto Hammer Industries; Rotork**]
4. [**Trumbull Industries**]
5. **<Insert manufacturer's name>**

C. Description: Valve actuation assembly with sprocket rim, chain guides, chain[**, and attachment brackets for mounting chainwheels directly to handwheels**].

1. Sprocket Rim with Chain Guides: [**Ductile iron**][**Ductile or cast iron**][**Cast iron**][**Aluminum**][**Bronze**], of type and size required for valve.[**Include zinc or epoxy coating.**]
2. Chain: [**Hot-dip, galvanized steel**][**Brass**][**Stainless steel**], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance,

and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for [**globe**][**butterfly**][**gate**][**and**][**plug**] valves [**NPS 4 (DN 100)**]<**Insert pipe size**> and larger and more than [**96 inches (2400 mm)**]<**Insert dimension**> above floor. Extend chains to [**60 inches (1520 mm)**]<**Insert dimension**> above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves: [**Center-guided type**][**and**][**plate type**], in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

J. Valve Tags: Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing, except Steam and Steam Condensate Piping: Valve ends may be grooved.
8. For Grooved-End Steel Piping, except Steam and Steam Condensate Piping: Valve ends may be grooved.
9. Wafer-Type Valves: Flanged connections.

3.5 CHILLED-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.6 CONDENSER-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.7 HEATING-WATER ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; [**threaded**][**soldered**] ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.8 LOW-PRESSURE STEAM ANGLE OR GLOBE VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.9 HIGH-PRESSURE STEAM ANGLE OR GLOBE VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.10 STEAM-CONDENSATE ANGLE OR GLOBE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Angle valves, threaded ends - bronze, Class 125.
2. Angle valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.
3. Globe valves, threaded or soldered ends - bronze, Class 125; threaded ends.
4. Globe valves, threaded ends - bronze, Class 150; [**PTFE**][**stainless steel**] disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Globe valves, flanged ends - iron, Class 125.
2. Globe valves, flanged ends - iron, Class 250.

3.11 CHILLED-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.

5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.12 COOLING-COIL CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
2. Ball valves, press ends - brass, two piece with full port and brass trim.
3. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
4. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
6. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.

B. For CPVC Pipe:

1. CPVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

C. For PVC Pipe:

1. PVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.13 CONDENSER-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F**

(23 deg C)]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. For PVC Pipe:

1. PVC Union-Type Ball Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.14 HEATING-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**][**soldered**] ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
5. Ball valves, press ends - brass, two piece with full port and stainless steel trim.
6. Ball valves, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**][**soldered**] ends.
7. Ball valves, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.
8. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**][**soldered**] ends.
9. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
10. Ball valves, threaded ends - bronze, one piece with bronze trim.
11. Ball valves, threaded ends - bronze, one piece with stainless steel trim.
12. Ball valves, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**][**soldered**] ends.
13. Ball valves, press ends - bronze, two piece with full port and bronze or brass trim.
14. Ball valves, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**][**soldered**] ends.
15. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
16. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
17. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
18. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
19. Ball valves, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**][**soldered**] ends.
20. Ball valves, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**][**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.

2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.15 LOW-PRESSURE STEAM BALL VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.16 LOW-PRESSURE CLEAN STEAM BALL VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.17 HIGH-PRESSURE STEAM BALL VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded ends - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded ends - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.18 HIGH-PRESSURE CLEAN STEAM BALL VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.19 STEAM-CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and brass trim.
2. Ball valves, threaded ends - brass, two piece with full port and stainless steel trim.
3. Ball valves, threaded ends - brass, two piece with regular port and brass trim.
4. Ball valves, threaded ends - brass, two piece with regular port and stainless steel trim.
5. Ball valves, threaded ends - brass, three piece with full port and brass trim.
6. Ball valves, threaded ends - brass, three piece with full port and stainless steel trim.
7. Ball valves, threaded ends - bronze, two piece with full port and bronze or brass trim.
8. Ball valves, threaded ends - bronze, two piece with full port and stainless steel trim.
9. Ball valves, threaded ends - bronze, two piece with regular port and bronze or brass trim.
10. Ball valves, threaded ends - bronze, two piece with regular port and stainless steel trim.
11. Ball valves, threaded ends - bronze, three piece with full port and bronze or brass trim.
12. Ball valves, threaded ends - bronze, three piece with full port and stainless steel trim.
13. Ball valves, threaded ends - bronze, three piece with regular port and bronze or brass trim.
14. Ball valves, threaded ends - bronze, three piece with regular port and stainless steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.

3.20 CLEAN STEAM-CONDENSATE BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Ball valves, threaded ends - stainless steel, two piece with full port.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Ball valves, flanged ends - stainless steel, two piece with full port.

3.21 CHILLED-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP,

[**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.22 CONDENSER-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc: [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.23 HEATING-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc: [**150**][**200**] CWP, [**EPDM**][**NBR**] seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**][**200**] CWP,

[**EPDM**][**NBR**] seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP.
8. Butterfly valves, grooved end - ductile iron, 300 CWP.
9. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
10. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.24 LOW-PRESSURE STEAM BUTTERFLY VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.25 LOW-PRESSURE CLEAN STEAM BUTTERFLY VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.26 HIGH-PRESSURE STEAM BUTTERFLY VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high-performance, Class 150 [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high-performance, Class 300 [**carbon steel**][**stainless steel**] body.

3.27 HIGH-PRESSURE CLEAN STEAM BUTTERFLY VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.28 STEAM-CONDENSATE BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; [**carbon steel**][**stainless steel**] body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; [**carbon steel**][**stainless steel**] body.

3.29 CLEAN-STEAM-CONDENSATE BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.30 CHILLED-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].
17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

E. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

F. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.31 CONDENSER-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].

17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact water, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

E. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

F. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.32 HEATING-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, lift type, threaded ends - bronze, with nonmetallic disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
4. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
5. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
6. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.
7. Check valves, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
5. Check valves, center guided - iron, globe, with metal seat, Class 125.
6. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
7. Check valves, center guided - iron, globe, with metal seat, Class 150.
8. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
9. Check valves, center guided - iron, globe, with metal seat, Class 250.
10. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
11. Check valves, center guided - iron, globe, with metal seat, Class 300.
12. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**].
13. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**].
14. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**].
15. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**].
16. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**].
17. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**].
18. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**].
19. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**].
20. Check valves, dual-plate type - iron, with metal seat, Class 125.
21. Check valves, dual-plate type - iron, with metal seat, Class 150.
22. Check valves, dual-plate type - iron, with metal seat, Class 250.
23. Check valves, dual-plate type - iron, with metal seat, Class 300.
24. Check valves, single-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
25. Check valves, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
26. Check valves, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
27. Check valves, single-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
28. Check valves, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
29. Check valves, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

C. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

D. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

1. Check valves, swing type, grooved ends - iron, 300 CWP.

3.33 LOW-PRESSURE STEAM CHECK VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.

4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.34 HIGH-PRESSURE STEAM CHECK VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.35 STEAM-CONDENSATE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
3. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
5. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.36 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Chilled-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

4. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved ends - iron, 300 CWP.

B. Condenser-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.

e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved-end - iron, 300 CWP.

C. Heating-Water Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, spring loaded, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, spring loaded, globe, with metal seat, Class 300.

k. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
m. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, spring loaded, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, spring loaded, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300):

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

4. Pipe NPS 3 to NPS 12 (DN 80 to DN 300):

a. Check valves, swing type, grooved ends - iron, 300 CWP.

D. Steam-Condensate Pump Discharge:

1. Pipe NPS 2 (DN 50) and Smaller:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.
c. Check valves, swing type, threaded - bronze, with bronze disc, Class 150.
d. Check valves, swing type, threaded - bronze, with nonmetallic disc, Class 150.

2. Pipe NPS 2-1/2 (DN 65) and Larger for Steam Condensate Pumps:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.
c. Check valves, center guided - iron, compact wafer, with metal seat, Class 125.
d. Check valves, center guided - iron, globe, with metal seat, Class 125.
e. Check valves, center guided - iron, compact wafer, with metal seat, Class 150.
f. Check valves, center guided - iron, globe, with metal seat, Class 150.
g. Check valves, center guided - iron, compact wafer, with metal seat, Class 250.
h. Check valves, center guided - iron, globe, with metal seat, Class 250.
i. Check valves, center guided - iron, compact wafer, with metal seat, Class 300.
j. Check valves, center guided - iron, globe, with metal seat, Class 300.
k. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.
l. Check valves, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**][**NBR**] seat.

m. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
n. Check valves, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**][**NBR**] seat.
o. Check valves, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
p. Check valves, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**][**NBR**] seat.
q. Check valves, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.
r. Check valves, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**][**NBR**] seat.

3. Pipe NPS 2-1/2 to NPS 12 (DN 65 to DN 300) for Steam Condensate Pumps:

a. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
b. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.37 CHILLED-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

C. CPVC Pipe:

1. CPVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. PVC Pipe:

1. PVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.38 CONDENSER-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

C. CPVC Pipe:

1. CPVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100) and smaller**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

D. PVC Pipe:

1. PVC Gate Valve: [**NPS 2 (DN 50) and smaller**][**NPS 4 (DN 100)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**> at [**73 deg F (23 deg C)**]<**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**][**or**][**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**][**Socket or threaded**][**Threaded**][**Flanged**].

3.39 HEATING-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**][**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**][**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.
5. Gate valves, press ends - bronze; [**RS**][**NRS**].

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.40 LOW-PRESSURE STEAM GATE VALVE SCHEDULE - 15 PSIG (104 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.41 HIGH-PRESSURE STEAM GATE VALVE SCHEDULE - MORE THAN 15 PSIG (104 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.42 STEAM-CONDENSATE GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; threaded ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.43 CHILLED-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.44 CONDENSER-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.45 HEATING-WATER PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.
2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

3.46 STEAM-CONDENSATE PLUG VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Plug valves, lubricated type, threaded ends - Class 125.

2. Plug valves, lubricated type, flanged ends - Class 125; [**Type I single gland**][**or**][**Type II regular gland**].
3. Plug valves, lubricated type, threaded ends - cylindrical, Class 125.
4. Plug valves, lubricated type, flanged ends - cylindrical, Class 125.
5. Plug valves, lubricated type, threaded ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
6. Plug valves, lubricated type, flanged ends - Class 250; [**Type I single gland**][**or**][**Type II regular gland**].
7. Plug valves, lubricated type, threaded ends - cylindrical, Class 250.
8. Plug valves, lubricated type, flanged ends - cylindrical, Class 250.
9. Plug valves, eccentric type, flanged ends - with resilient seat, 175 CWP.

END OF SECTION 23 05 23 00

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Task	Specification	Specification Description
23 05 23 00	22 05 23 00	General-Duty Valves for Plumbing Piping
23 05 23 00	22 15 13 00	General-Service Compressed-Air Piping
23 05 23 00	23 05 00 00a	Coatings for HVAC
23 05 23 00	23 21 13 00	Hydronic Piping
23 05 23 00	23 21 23 00	Hydronic Pumps
23 05 23 00	23 23 00 00	Refrigerant Piping

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SECTION 23 05 29 00 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - carbon steel.
2. Pipe hangers and supports - stainless steel.
3. Pipe/tube hangers and supports - copper.
4. Pipe hangers - metal, trapeze type.
5. Pipe hangers - FRP.
6. Strut support system - metal, rod type.
7. Strut support system - metal, cable type.
8. Strut support system - FRP.
9. Strut support system - rooftop-mounted pipe stand, compact.
10. Strut support system - rooftop-mounted pipe stand, single base, single pipe, low profile.
11. Strut support system - rooftop-mounted pipe stand, single base, single pipe, high profile.
12. Strut support system - rooftop-mounted pipe stand, multiple pipe, high profile.
13. Strut support system - rooftop-mounted pipe stand, curb-mounted type.
14. Thermal hanger shield insert - calcium silicate.
15. Thermal hanger shield insert - polyisocyanurate.
16. Thermal hanger shield insert - phenolic.
17. Thermal hanger shield insert - cellular glass.
18. Fastener system - powder-actuated fasteners.
19. Fastener system - mechanical expansion anchors.
20. Equipment supports.
21. Equipment stands, outdoor type.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230500 "Common Work Results for HVAC" for pipe guides and anchors.
3. [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**] for vibration isolation devices.
4. [**Section 233113 "Metal Ducts"**][**and**][**Section 233116 "Nonmetal Ducts"**] for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: [**Signed and sealed by a qualified professional engineer.**] Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Rooftop-mounted strut support systems.
4. FRP strut support systems.
5. Pipe stands.

6. Equipment supports.

C. Delegated Design Submittals: For [**trapeze hangers**][**and**][**strut support systems**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for [**trapeze hangers**][**strut support systems**] .
2. Detail fabrication/assembly and design calculations for each type of strut support system, by manufacturer's technical representative.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

3. Product Data for Cradle-to-Cradle Certification:

a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

4. Product Data for Health Product Declaration Compliance:

a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

5. Product Data for Declare Certification:

a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

6. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For structural-steel and pipe welding.

B. Delegated Design Engineer Qualifications: For [**trapeze hangers**][**and**][**strut support systems**] .

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2025 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**trapeze hangers**][**strut support systems,**][**and**] equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**].

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment [**and obtain approval from authorities having jurisdiction**] .

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

6. Hanger Rods: Continuous-thread rod, nuts, and washers made of [**carbon steel**][**stainless steel**].

B. Pipe Hangers and Supports - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]
   d. [**Rocket Rack; Robroy Industries**]

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**stainless steel**].

C. Pipe/Tube Hangers and Supports - Copper:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**FNW; Ferguson Enterprises, Inc.**]

2. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-plated steel**][**stainless steel**].

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Pipe Hangers - Metal, Trapeze Type: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon steel shapes with MSS SP-58 carbon steel hanger rods, nuts, saddles, and U-bolts.

2.4 PIPE HANGERS - FRP

A. Pipe Hangers - FRP, Clevis Type:

1. Description: Similar to MSS SP-58, Type 1, factory-fabricated steel pipe hanger, except hanger is made of FRP resin.

2. Hanger Rods: Continuous-thread [**stainless steel**] rod, washer, and nuts made of

[**FRP**][**polyurethane**][**stainless steel**].

3. Flammability: ASTM D635, ASTM E84, and UL 94.

B. Pipe Hangers - FRP, Strap Type:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of FRP resin.

   a. Flammability: ASTM D635, ASTM E84, and UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of [**stainless steel**].

2.5 STRUT SUPPORT SYSTEMS - METAL

A. Strut Support System - Metal, Rod Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Anvil; an ASC Engineered Solution**]
   c. [**Atkore Unistrut**]
   d. [**CADDY; brand of nVent Electrical plc**]
   e. [**Carpenter & Paterson, Inc**]
   f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   g. [**Empire Industries, Inc.**]
   h. [**Flex-Strut Inc.**]
   i. [**G-Strut**]
   j. [**Haydon Corp.**]
   k. [**PHD Manufacturing, Inc**]
   l. [**Rocket Rack; Robroy Industries**]
   m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]

2. Description: Factory-fabricated pipe-support assembly made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.

3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

4. Struts: Continuous slotted [**carbon steel**][**stainless steel, Type 304**][**stainless steel, Type 316**][**extruded-aluminum**] [**channel with inturned lips**][**angle**].
5. Strut Width: Selected for applicable load criteria.
6. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized steel**][**stainless steel**] .

8. Metallic Coating: [**Plain**][**Pregalvanized G90 (Z275)**][**Electroplated zinc**][**Hot-dip galvanized**][**Gold (yellow zinc dichromate) galvanized**] .
9. Paint Coating: [**Green epoxy, acrylic, or urethane**].
10. Plastic Coating: [**PVC**].

B. Strut Support System - Metal, Cable Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Gripple Inc.**]

2. Description: Factory-fabricated pipe-support system, consisting of cable pipe clamps and associated vibration isolation rubber pads, slotted channel brackets, wire rope suspension components, and associated accessories for a complete piping suspension system; no tools required for manual assembly in the field to support multiple parallel pipe routing.
3. Standards:

   a. ICC-ES PMG Product Certificate.
   b. Brackets: Fire rated; tested to F120 in accordance with BS EN 1363-1.

4. Components:

   a. Pipe Clamps: Size-adjustable [**standard**][**compact**][**and**][**field-height-adjustable**] clamps with [**rubber pad, 14 dBa noise reduction**][**and**][**large rubber pad, 18 dBa noise reduction**][**acoustic rubber pad, 23 dBa noise reduction**] ; with sleeve to prevent galvanic corrosion.
   b. Brackets: Slotted steel channels furnished in pre-cut lengths to suit specific system application for Project.
   c. Suspension Components: Hanging cables with adjustable fastener; can be pre-installed on the brackets using pre-fitted washer/nuts or retention clips.

      1) Wire Rope: High tensile steel wire rope, complying with ASTM A1023/A1023M, ASTM A641/A641M Class A zinc coating; [**7 by 7**][**and**][**7 by 19**] cross-sectional construction; having a tensile strength of **256,000 psi (1770 N/sq mm)**; lengths, diameters, and wire construction [**to accommodate design loads**][**as indicated on Shop Drawings**] .

         a) Locking screw/release button.
         b) Foot attachment type to suit application.
         c) End Fix Type: [**Loop**][**strap hook**][**eyelet**].

   d. Adjustable Fastener: Mild steel (Type EN1A), bright zinc-plated, one-channel body; encasing a series of Type 302 stainless steel springs with serrated self-locking Grade 40 chrome steel balls; adjustable by means of an integrated mechanism, and capable of accommodating load of [**100 lb (45 kg)**][**200 lb (90 kg)**][**500 lb (225 kg)**] .

2.6 STRUT SUPPORT SYSTEMS - FRP

A. Strut Support System - FRP:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atkore Unistrut**]
b. [**Champion Fiberglass, Inc**]
c. [**G-Strut**]
d. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]

2. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

a. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
b. Struts: Continuous slotted FRP channel with inturned lips.
c. Strut Width: Selected for applicable load criteria.
d. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.

e. Fitting and Accessory Materials: Same as those for channels and angles [**except metal items may be stainless steel**] .
f. Rated Strength: Selected to suit applicable load criteria.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 STRUT SUPPORT SYSTEMS - ROOFTOP MOUNTED

A. Strut Support System - Rooftop-Mounted Pipe Stand, Compact:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**G-Strut**]
b. [**MIRO Industries Inc.**]
c. [**PHP Systems/Design**]
d. [**RectorSeal HVAC; a CSW Industrials Company**]

2. Description: Shop-fabricated assembly made of manufactured corrosion-resistant components to support rooftop-mounted piping.
3. Configuration: Single-base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

4. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

5. Hardware: Galvanized steel or polycarbonate.
6. Accessories: Protection pads.

B. Strut Support System - Rooftop-Mounted Pipe Stand, Single Base, Single Pipe, Low Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**G-Strut**]
b. [**MIRO Industries Inc.**]

c. [**PHP Systems/Design**]

2. Description: Shop-fabricated assembly made of manufactured corrosion-resistant components to support rooftop-mounted piping.
3. Configuration: Single-base unit with vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
4. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

5. Vertical Members: Two, [**galvanized-steel**][**stainless steel**] , continuous-thread **1/2-inch (12-mm)** rods.
6. Horizontal Member: Adjustable-height, [**galvanized-steel**][**stainless steel**] pipe support channels.
7. Pipe Supports: [**Roller**][**Strut clamps**][**Clevis hanger**][**Swivel hanger**] .
8. Hardware: [**Galvanized**][**Stainless**] steel.
9. Accessories: Protection pads.
10. Height: [**12 inches (300 mm) above roof**].

C. Strut Support System - Rooftop-Mounted Pipe Stand, Single Base, Single Pipe, High Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]

2. Description: Single-base unit with vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
3. Base: Single, vulcanized rubber or molded polypropylene.

4. Vertical Members: Two, [**galvanized-steel**][**stainless steel**] , continuous-thread **1/2-inch (12-mm)** rods.
5. Horizontal Member: One, adjustable-height, [**galvanized-steel**][**stainless steel**] pipe support slotted channel or plate.
6. Pipe Supports: [**Roller**][**Clevis hanger**][**Swivel hanger**] .
7. Hardware: [**Galvanized**][**Stainless**] steel.

8. Accessories: Protection pads; **1/2-inch (12-mm)** continuous-thread [**galvanized-steel**][**stainless steel**] rod.
9. Height: [**36 inches (900 mm) above roof**].

D. Strut Support System - Rooftop-Mounted Pipe Stand, Multiple Pipe, High Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]

2. Description: Assembly of bases with vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

3. Bases: Two or more, [**vulcanized rubber**][**molded polypropylene**].

4. Vertical Members: Two or more, [**galvanized-steel**][**stainless steel**] channels.
5. Horizontal Members: One or more, adjustable-height, [**galvanized-steel**][**stainless steel**] pipe support(s).
6. Pipe Supports: [**Roller**][**Strut clamps**][**Clevis hanger**][**Swivel hanger**] .
7. Hardware: [**Galvanized**][**Stainless**] steel.

8. Accessories: Protection pads [**; 1/2-inch (12-mm) continuous-thread rod**] .
9. Height: [**36 inches (900 mm) above roof**].

E. Strut Support System - Rooftop-Mounted Pipe Stand, Curb-Mounted Type: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 THERMAL HANGER SHIELD INSERTS

A. Thermal Hanger Shield Insert - Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Bergen Pre-Insulated Pipe Supports, Inc.**]
   b. [**National Pipe Hanger Corporation**]
   c. [**Pipe Shields Inc.**]
   d. [**Rilco Manufacturing Co., Inc**]
   e. [**Value Engineered Products, Inc.; an ASC Engineered**]

2. Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with **100 psi (688 kPa)** minimum compressive strength.

   a. ASTM E84, Flame Spread/Smoke Developed: 5/5.

3. Application: For hot piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

B. Thermal Hanger Shield Insert - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Buckaroos, Inc.**]
   b. [**KB Enterprise**]
   c. [**National Pipe Hanger Corporation**]
   d. [**Value Engineered Products, Inc.; an ASC Engineered**]

2. Insulation-Insert Material: ASTM C591, Type VI, Grade 1 polyisocyanurate with **125 psi (862 kPa)** minimum compressive strength and vapor barrier.

   a. ASTM E84, Flame Spread/Smoke Developed: 25/450.

3. Application: For insulated [**hot**][**and**][**cold**] piping not installed in return-air plenums.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

C. Thermal Hanger Shield Insert - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Buckaroos, Inc.**]

2. Insulation-Insert Material: Rigid phenolic foam insulation, ASTM C1126, Type III, with ASTM E96 zero perm vapor barrier.

   a. Minimum Compressive Strength, ASTM D1621: [**40 psi (276 kPa) minimum perpendicular to rise and 50 psi (345 kPa) minimum parallel to rise**][**70 psi (483 kPa) minimum perpendicular to rise and 90 psi (620 kPa) minimum parallel to rise**] .
   b. ASTM E84, Flame Spread/Smoke Developed: 25/50.

3. Application: For [**hot**][**and**][**cold**] piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

D. Thermal Hanger Shield Insert - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Rilco Manufacturing Co., Inc**]

2. Insulation-Insert Material: ASTM C552, Type II cellular glass with **100 psi (688 kPa)**minimum compressive strength and vapor barrier.

   a. ASTM E84, Flame Spread/Smoke Developed: 0/0.

3. Application: For insulated [**hot**][**and**][**cold**] piping.
4. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
5. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.
6. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

2.9 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities required for supported loads and building

materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hilti, Inc.**]
   b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   c. [**MKT Fastening, LLC**]

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Empire Industries, Inc.**]
   c. [**Hilti, Inc.**]
   d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   e. [**MKT Fastening, LLC**]

2. Indoor Applications: [**Zinc-coated**][**stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.10 EQUIPMENT SUPPORTS

A. Equipment Support: Welded, shop- or field-fabricated equipment support made from structural carbon steel shapes.

2.11 EQUIPMENT STANDS, OUTDOOR TYPE

A. Equipment Stands, Outdoor Type: Individual foot supports with elevated, adjustable channel crossbars and clamps/fasteners/bolts for ground- or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on-site.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**DiversiTech Corp.**]
   b. [**MIRO Industries Inc.**]
   c. [**RectorSeal HVAC; a CSW Industrials Company**]

2. Foot Material: Rubber or polypropylene.
3. Rails Material: Hot-dip galvanized carbon steel.

4. Wind/Sliding Load Resistance: Up to [**100 mph (44 mps)**] minimum.

2.12 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION OF HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus [**200 lb (90 kg)**].

3.2 INSTALLATION OF HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] and larger [**and at changes in direction of piping**] . Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Thermal hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

   a. Thermal hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): **12 inches (305 mm)** long and **0.048 inch (1.22 mm)** thick.
   b. NPS 4 (DN 100): **12 inches (305 mm)** long and **0.06 inch (1.52 mm)** thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): **18 inches (457 mm)** long and **0.06 inch (1.52 mm)** thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): **24 inches (610 mm)** long and **0.075 inch (1.91 mm)** thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): **24 inches (610 mm)** long and **0.105 inch (2.67 mm)** thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Pipe Hangers and Supports - Metal: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

H. Pipe Hangers - Metal, Trapeze Type: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M, carbon steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. Pipe Hangers - FRP: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Strut Support Systems - Metal: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems. Install in accordance with manufacturer's written installation instructions.

K. Strut Support Systems - FRP: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems. Install in accordance with manufacturer's written installation instructions.

L. Thermal Hanger Shield Inserts: Install in pipe hanger or shield for insulated piping.

M. Fastener Systems:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches (100 mm)** thick after concrete is placed and cured. Use installers that are trained and certified [**by power tool manufacturer**][**in accordance with the AHJ**] .
2. Install mechanical-expansion anchors after concrete is placed and completely cured.
3. Install fasteners in accordance with manufacturer's written instructions.
4. Install lag screw wood fasteners in accordance with manufacturer's written instructions.

N. Strut Support Systems - Rooftop Mounted:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

O. Hangers and Supports, General: Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

P. Equipment Supports:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [**trapeze pipe hangers**][**and**][**equipment supports**] .

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches (40 mm)**].

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.

2. Comply with requirements in [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**Section 099600 "High-Performance Coatings"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Comply with requirements in [**Section 099114 "Exterior Painting (MPI Standards)"**][**Section 099124 "Interior Painting (MPI Standards)"**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
4. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon steel [**pipe hangers and supports**][**metal trapeze pipe hangers**][**and**][**metal framing systems**] and attachments for general service applications.

F. Use [**stainless steel pipe hangers**][**FRP pipe hangers**][**and**][**FRP strut systems**] and [**stainless steel**][**corrosion-resistant**] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**][**stainless steel**] attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated,

stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F (566 deg C)**, pipes **NPS 4 to NPS 24 (DN 100 to DN 600)**, requiring up to **4 inches (100 mm)** of insulation.
3. Carbon Steel or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36 (DN 20 to DN 900)**, requiring clamp flexibility and up to **4 inches (100 mm)** of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4 (DN 15 to DN 100)**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8 (DN 20 to DN 200)**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8 (DN 10 to DN 200)**.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3 (DN 10 to DN 80)**.
12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36 (DN 65 to DN 900)** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30 (DN 25 to DN 750)**, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24 (DN 65 to DN 600)**, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42 (DN 50 to DN 1050)** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24 (DN 50 to DN 600)** if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30 (DN 50 to DN 750)** if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
2. Carbon Steel or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24 (DN 20 to DN 600)** if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to **6 inches (150 mm)** for heavy loads.
2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F (49 to 232 deg C)** piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): **750 lb (340 kg)**.
    b. Medium (MSS Type 32): **1500 lb (680 kg)**.
    c. Heavy (MSS Type 33): **3000 lb (1360 kg)**.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed **1-1/4 inches (32 mm)**.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use [**powder-actuated fasteners**][**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29 00

Task	Specification	Specification Description
23 05 29 00	21 05 00 00	Common Work Results for Fire Suppression
23 05 29 00	22 05 00 00	Common Work Results for Plumbing
23 05 29 00	22 05 29 00	Hangers and Supports for Plumbing Piping and Equipment
23 05 29 00	23 05 00 00	Common Work Results for HVAC
23 05 29 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 33 00 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-regulating, parallel-resistance heating cables.
2. Controls.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 220533 "Heat Tracing for Plumbing Piping."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality Control Reports: For specified tests and inspections.

B. Sample Warranties: For specified special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**][**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Self-Regulating, Parallel-Resistance Heating Cables:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**BriskHeat**]
   b. [**Chromalox, Inc.**]
   c. [**Delta-Therm Corporation**]
   d. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
   e. [**Raychem (a brand of Chemelex)**]
   f. [**Thermon, Inc.**]
   g. [**Trasor Corp.**]
   h. [**WarmlyYours Radiant, Inc.**]

2. Source Limitations: Obtain all heat tracing from single manufacturer.
3. Standard: IEEE 515.1.
4. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**] , stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
5. Electrical Insulating Jacket: Flame-retardant polyolefin.
6. Grounding Cover: [**Copper**][**Tinned-copper**] braid.

7. Cable Cover: [**Tinned-copper**][**Stainless steel**] braid [**and polyolefin outer jacket with ultraviolet inhibitor**] .
8. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
9. Maximum Operating Temperature (Power On): [**150 deg F (65 deg C)**].

10. Maximum Exposure Temperature (Power Off): [**185 deg F (85 deg C)**].
11. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

12. Capacities and Characteristics:

    a. Maximum Heat Output: [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**] .
    b. Electrical Characteristics for Single-Circuit Connection:

       1) Volts: [**120**][**208**][**240**][**277**][**480**] V.
       2) Phase: [**1**][**3**].
       3) Hertz: [**60**] Hz.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb temperature-control unit with adjustable range from [**30 to 50 deg F (minus 1 to plus 10 deg C)**].
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote temperature-sensing bulb on capillary, resistance temperature device, or thermistor for directly sensing ambient air or pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Control Panel:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Remote temperature sensors sense outside air temperature; programmable to energize the cable when temperature falls below [**34 to 44 deg F (1 to 7 deg C)**].
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30 A contactor to energize cable or close other contactors.
5. Ground-fault protection.
6. Single-point control of heat tracing for freeze protection.

7. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by central HVAC-control system. Coordinate type of connection ports with Section 230923 "Direct Digital Control (DDC) System for HVAC."

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: See Section 230553 "Identification for HVAC Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least **3 mils (0.08 mm)** thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): **3/4 inch (19 mm)** minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: **1-1/2 inches (38 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 230719 "HVAC Piping Insulation."

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Warning Tape: Install warning tape on piping insulation where piping is equipped with electric heating cables.

3.3 INSTALLATION OF CONTROLS

A. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

B. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

C. Install outside air and pipe temperature sensors.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect remote electronic temperature sensors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Test and Inspections: Perform the following [**with the assistance of a factory-authorized service representative**] :

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 23 05 33 00

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Task	Specification	Specification Description
23 05 33 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 48 00 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.
21. Seismically restrained isolation roof-curb rails.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies devices for fire-suppression equipment and systems.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" specifies devices for plumbing equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, mechanical, electrical, plumbing, or fire protection system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professional: Engage qualified professional structural engineer to design seismic and wind restraints.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Include load rating for each seismic-[**and wind-**]restraint device.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-**]restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic[**and wind**] restraints for components with other systems and equipment in the vicinity, including other supports and other seismic restraints.

C. Delegated Design Submittals:

1. All delegated design and submittals for [**seismic**][**and**][**wind**] restraints must be signed and sealed by a qualified professional structural engineer responsible for their preparation. Structural engineer is to possess qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete attachments.
2. For each seismic-restraint device, including [**seismic-restrained mounting,**][**pipe-riser resilient support,**][**snubber,**][**seismic restraint,**][**seismic-restraint accessory,**][**concrete anchor and insert,**][**and**][**restrained isolation roof-curb rail**] that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraint, Vibration Isolator, and Vibration Isolation Base Selection: Select and submit seismic restraints [**and**] vibration isolators [**, and vibration isolation bases**] complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Post-Installed Concrete Anchors and Concrete Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for

reinforcement use.
d. Seismic Design Calculations: Submit all input data and loading calculations.

3. For each wind-restraint device, including [**restraint - rigid,**][**restraint - cable,**][**restraint accessory,**][**concrete anchor,**][**and**][**concrete insert**] that is required by this Section or is indicated on Drawings, submit the following:

   a. Wind Restraints: Select and submit wind restraints complying with performance requirements, design criteria, and analysis data.
   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind-resistant loads. Include certification that device is approved by an NRTL for reinforcement use.
   c. Wind-Restraint Design Calculations: Submit all input data and loading calculations.

4. Seismic- and Wind-Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

5. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).
6. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
7. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-**] and seismic-restraint devices for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**][**and**][**testing agency**].

C. Welding certificates.

D. Air-Spring Isolator Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

1.6 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and Shop Drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.7 QUALIFICATIONS

A. Professional Structural Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete foundations.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring isolators**][**and**][**restrained-air-spring isolators**] to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified professional structural engineer to prepare seismic- and wind-restraint calculations in accordance with criteria specified in Section 018123 "Facility Seismic and Wind Criteria."

B. Seismic- and Wind-Restraint-Device Load Ratings: Devices are to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices are to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to authorities having jurisdiction**].

C. Consequential Damage: Provide additional seismic[**and wind**] restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals are to have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be labeled as such.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components are to be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
4. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
5. Size: Factory or field cut to match requirements of supported equipment.
6. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
7. Surface Pattern: Smooth, ribbed, or waffle pattern.
8. Infused nonwoven cotton or synthetic fibers.
9. Load-bearing metal plates adhered to pads.

10. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**]<**Insert compound**>.

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**NOVIA; a division of Carpenter & Paterson**]
    h. [**Vibration Eliminator Co., Inc**]
    i. [**Vibration Isolation**]
    j. [**Vibration Management Corp.**]
    k. [**VMC GROUP**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**NOVIA; a division of Carpenter & Paterson**]
    h. [**Vibration Eliminator Co., Inc**]
    i. [**Vibration Isolation**]
    j. [**Vibration Management Corp.**]
    k. [**VMC GROUP**]
    l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
4. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

5. Elastomeric Material: Molded, oil- and water- resistant neoprene rubber, silicone rubber, or other

elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**NOVIA; a division of Carpenter & Paterson**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**NOVIA; a division of Carpenter & Paterson**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
4. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to **500 psig (3447 kPa)**.
9. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to **500 psig (3447 kPa)**.
b. Top housing with [**attachment and leveling bolt**][**threaded mounting holes and internal leveling device**][**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
4. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to **500 psig (3447 kPa)**.
b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
c. Internal leveling bolt that acts as blocking during installation.

5. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
6. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping

Housing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Vibration Eliminator Co., Inc**]
    h. [**Vibration Isolation**]
    i. [**Vibration Management Corp.**]
    j. [**VMC GROUP**]
    k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
4. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**][**non-adjustable**] snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to **500 psig (3447 kPa)**.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-

Inch- (13-mm-) Thick Neoprene :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Vibration Eliminator Co., Inc**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Vibration Eliminator Co., Inc**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain resilient pipe-riser supports from single manufacturer.
4. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum **1/2-inch- (13-mm-)** thick neoprene.
5. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
6. Maximum Load Per Support: **500 psig (3447 kPa)** on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Vibration Eliminator Co., Inc**]
   d. [**Vibration Management Corp.**]
   e. [**VMC GROUP**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]

c. [**Vibration Eliminator Co., Inc**]
d. [**Vibration Management Corp.**]
e. [**VMC GROUP**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain resilient pipe guides from single manufacturer.
4. Description: Resilient pipe guide with telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum **1/2-inch- (13-mm-)** thick neoprene.
5. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and reinsertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Vibration Management Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Vibration Management Corp.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air-spring isolators from single manufacturer.
4. Arrangement: [**Single**][**or**][**multiple**].
5. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
6. Maximum Natural Frequency: 3 Hz.
7. Operating Pressure Range: **25 to 100 psig (172 to 690 kPa)**.
8. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
9. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]

c. [**Vibration Management Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Vibration Management Corp.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
4. Arrangement: [**Single**][**or**][**multiple**].
5. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to **500 psig (3447 kPa)**.
   b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

6. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
10. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
11. Maximum Natural Frequency: [**3 Hz**]<**Insert frequency**>.
12. Operating Pressure Range: **25 to 100 psig (172 to 690 kPa)**.
13. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
14. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**NOVIA; a division of Carpenter & Paterson**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Isolation**]
   h. [**Vibration Management Corp.**]
   i. [**VMC GROUP**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**NOVIA; a division of Carpenter & Paterson**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Isolation**]
   h. [**Vibration Management Corp.**]
   i. [**VMC GROUP**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
4. Description: Elastomeric hanger mounted in a steel frame with upper and lower steel hanger rods.
5. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
6. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**NOVIA; a division of Carpenter & Paterson**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Isolation**]
   h. [**Vibration Management Corp.**]
   i. [**VMC GROUP**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**NOVIA; a division of Carpenter & Paterson**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Isolation**]

h. [**Vibration Management Corp.**]
i. [**VMC GROUP**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain spring hangers from single manufacturer.
4. Description: Combination coil-spring and elastomeric-insert hanger.
5. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
6. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
7. Minimum Additional Travel: 50 percent of the required deflection at rated load.
8. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
9. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
10. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
11. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
12. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Vibration Management Corp.**]
4. [**VMC GROUP**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Vibration Management Corp.**]
4. [**VMC GROUP**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain snubbers from single manufacturer.

D. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14, Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.16 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rigid-type restraints from single manufacturer.

D. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]

3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. **<Insert manufacturer's name>**

C. Source Limitations: Obtain cable-type restraints from single manufacturer.

D. Seismic- and Wind-Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

E. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**TOLCO Incorporated**]
7. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**TOLCO Incorporated**]
7. **<Insert manufacturer's name>**

C. Source Limitations: Obtain restraint accessories from single manufacturer.

D. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

E. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**][**and**][**restraint cables**].

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and

steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Powers Fasteners**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Powers Fasteners**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
4. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Powers Fasteners**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]

c. [**Hilti, Inc.**]
d. [**Powers Fasteners**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
4. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-restraint applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)** that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Powers Fasteners**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Powers Fasteners**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete inserts from single manufacturer.

D. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

E. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**NOVIA; a division of Carpenter & Paterson**]
5. [**Vibration Eliminator Co., Inc**]
6. [**Vibration Isolation**]
7. [**Vibration Management Corp.**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**NOVIA; a division of Carpenter & Paterson**]
5. [**Vibration Eliminator Co., Inc**]
6. [**Vibration Isolation**]
7. [**Vibration Management Corp.**]
8. [**VMC GROUP**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

D. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

F. Concrete Inertia Base: [**Factory-fabricated**][**or**][**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.22 SEISMICALLY RESTRAINED ISOLATION ROOF-CURB RAILS

A. Seismically Restrained Isolation Roof-Curb Rails:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**California Dynamics Corporation**]
   c. [**Kinetics Noise Control, Inc**]
   d. [**NOVIA; a division of Carpenter & Paterson**]
   e. [**Thybar Corporation**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Management Corp.**]
   h. [**VMC GROUP**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**California Dynamics Corporation**]
   c. [**Kinetics Noise Control, Inc**]
   d. [**NOVIA; a division of Carpenter & Paterson**]
   e. [**Thybar Corporation**]
   f. [**Vibration Eliminator Co., Inc**]
   g. [**Vibration Management Corp.**]
   h. [**VMC GROUP**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain restrained isolation roof-curb rails from single manufacturer.
4. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic[**and wind**] forces.
5. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist

seismic[**and wind**] forces.

6. Lower Support Assembly: To be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure and a wood nailer for attaching roof materials, and to be insulated with a minimum of **2 inches (50 mm)** of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
7. Snubber Bushings: All-directional, elastomeric snubber bushings at least **1/4 inch (6 mm)** thick.
8. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- [**and wind-**]restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Assemblies: Where not specifically indicated otherwise, select sizes of components so strength is adequate to carry static[**, wind load,**] and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROLS AND SEISMIC RESTRAINTS FOR HVAC PIPING AND EQUIPMENT

A. Provide seismic-[**and wind-**]restraint devices and vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**, wind restraints,**] must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
3. Install seismic-restraint[**, and wind-restraint**] devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.
3. Brace a change of direction longer than **12 feet (3.7 m)**.

H. Ductwork Restraints:

1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**][**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**][**ASCE/SEI 7.**][**See Section 233113 "Metal Ducts" for Seismic Hazard Level (SHL).**][**See Section 233113 "Metal Ducts" for "Connection Level" performance requirement for OSHPD jurisdictions.**]<**Insert requirement.**>
2. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.
3. Brace a change of direction longer than **12 feet (3.7 m)**.
4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
5. Install cable restraints on ducts that are suspended with vibration isolators.

I. Install seismic-[**and wind**]restraint cables so they do not bend across edges of adjacent equipment or building structure.

J. Install seismic-[**and wind-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install tank valve into each air isolator.
2. Inflate each isolator to [**height**][**and**][**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**][**constant**] air supply.
3. Inflate isolators to [**height**][**and**][**or**][**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than [**four**]<**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 23 05 48 00

SECTION 23 05 48 00A - VIBRATION INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical vibration switches.
2. Electronic vibration switches.
3. Combination vibration switches and transmitters.
4. Vibration transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 DEFINITIONS

A. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories indicating default control signal with loss of power, calibration data specific to each unique application, and electrical power requirements.
3. Include product description with complete technical data, performance curves, and product specification sheets.
4. Include installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring and cable.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades:

1. Product installation location shown in relationship to room, conduit, duct, pipe, and equipment.
2. Sizes and locations of wall access panels for instruments installed behind walls.
3. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each vibration instrument, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Source quality-control reports.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: To include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MECHANICAL VIBRATION SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**FW Murphy Production Controls**]
2. [**IMI Sensors; a division of PCB Piezotronics**]
3. [**Metrix Instrument Co.**]
4. [**Robertshaw**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**FW Murphy Production Controls**]
2. [**IMI Sensors; a division of PCB Piezotronics**]
3. [**Metrix Instrument Co.**]
4. [**Robertshaw**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain all mechanical vibration switches from a single manufacturer.

D. Description: Inertia-sensitive armature mechanism trips on high vibration and operates snap action switch.

E. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a NRTL, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.

F. Performance:

1. Frequency Range: Zero to [**60**][**100**][**300**]<**Insert value**> Hz.
2. Vibration Range: Zero to [**2**][**5**][**7**][**16**]<**Insert value**> g.
3. Temperature Limits: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**][**Minus 40 to 158 deg F (Minus 40 to 70 deg C)**][**Minus 40 to 200 deg F (Minus 40 to 93 deg C)**]<**Insert temperature range**>.

G. Switch Type: Electromechanical [**SPDT**][**or**][**DPDT**] snap switch.

1. Electrical Rating: [**5**][**7**][**15**]<**Insert value**> A at [**120**][**or**][**480**] V ac.

H. Start Delay: Time delay during equipment startup to prevent switch from nuisance tripping.

I. Operator Interface:

1. Vibration Set-Point Adjustment: Zero to 100 percent of range.
2. Reset: Local push-button reset on exterior of switch[**and reset coil for remote reset by operator through a DDC system interface**].

J. Enclosure:

1. Material: Cast aluminum.
2. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**].
3. Electrical Connection: Screw terminals.
4. Conduit Connection: **3/4-inch (21-mm)** trade size.

2.2 ELECTRONIC VIBRATION SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**IMI Sensors; a division of PCB Piezotronics**]
2. [**Metrix Instrument Co.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**IMI Sensors; a division of PCB Piezotronics**]
2. [**Metrix Instrument Co.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain all electronic vibration switches from a single manufacturer.

D. Description: Electronic switch with accelerometer-based velocity response.

E. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.

F. Performance:

1. Frequency Range: [**3 to 500**][**7 to 1000**]<**Insert value**> Hz.
2. Vibration Range: [**Zero to 1.0 inch (25 mm)**]<**Insert value**> per second.
3. Temperature Limits: [**Minus 40 to 212 deg F (Minus 20 to 100 deg C)**][**Minus 40 to 185 deg F (Minus 20 to 85 deg C)**][**Minus 4 to 167 deg F (Minus 20 to 75 deg C)**]<**Insert temperature range**>.

G. Functional Characteristics:

1. Trip Logic: Field selectable, normally open/normally closed, latching/nonlatching, automatic/manual reset.

   a. Solid-State Relay: [**500**]<**Insert value**> mA at 24 to 240 V ac or dc; normally open leakage up to [**1**]<**Insert value**> mA.
   b. Triac: [**5**]<**Insert value**> A inductive, [**60**]<**Insert value**> A surge for one cycle; normally open leakage is [**10**]<**Insert value**> mA.

2. Start Trip Timer: [**30**][**45**][**60**]<**Insert value**> seconds.
3. Monitor Trip Delay: [**3**]<**Insert value**> seconds.

H. Operator Interface:

1. Vibration Set-Point Adjustment: Tamperproof graduated dial or software programmable, or configurable through a switch USB connection to personal computer.

I. Instrument Display:

1. Trip Indicator: Flashing LED.
2. LCD Display: Numerical display of vibration level.

J. Enclosure:

1. Material: Cast aluminum or stainless steel.
2. Screw-on cover.
3. Rating: NEMA 250, Type 4.
4. Electrical Connection: Screw terminal block or three-wires, [**40 inches (1000 mm)**][**72 inches (1800 mm)**][**120 inches (3000 mm)**]<**Insert length**> long.
5. Conduit Connection: **1/2-inch (13-mm)** trade size or larger. Provide sealed entry for instruments with wire connections.
6. Flange mounting adapter, as applicable.

2.3 COMBINATION VIBRATION SWITCHES AND TRANSMITTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**IMI Sensors; a division of PCB Piezotronics**]
2. [**Metrix Instrument Co.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**IMI Sensors; a division of PCB Piezotronics**]
2. [**Metrix Instrument Co.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain all combination vibration switches and transmitters from a single manufacturer.

D. Description: Field-configurable, electronic combination switches and transmitters.

E. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.

F. Performance:

1. Frequency Range: [**2 to 1000**]<**Insert value**> Hz.
2. Vibration Range: [**0 to 1.5 inches (0 to 38 mm)**][**0 to 3 inches (0 to 75 mm)**][**0.10 to 1.5 inches (3 to 38 mm)**][**0.20 to 3 inches (6 to 75 mm)**]<**Insert value**> per second.
3. Accuracy: Within [**10**]<**Insert value**> percent of setpoint.
4. Repeatability: Within [**2**]<**Insert value**> percent of setpoint.
5. Ambient Temperature Limits: [**Minus 22 to 158 deg F (Minus 30 to 70 deg C)**][**Minus 20 to 140 deg F (Minus 29 to 60 deg C)**]<**Insert temperature range**>.
6. Ambient Relative Humidity: [**0 to 100**][**1 to 100**]<**Insert value**>; noncondensing.

G. Analog Output Current Signal:

1. Two-wire, 4 to 20 mA dc current source.
2. Signal capable of operating into [**450**]<**Insert value**>-ohm load.

H. Digital Output Signal: [**Single**][**or**][**dual**][**Single or dual, as required by application,**] alarm relay(s).

1. Electromechanical (SPDT) Relay: [**5**][**10**]<**Insert value**> A at [**120**][**240**]<**Insert value**> V ac.
2. Solid-State Relay: [**5**][**10**]<**Insert value**> A at [**120**][**240**]<**Insert value**> V ac.
3. Triac: [**5**][**10**]<**Insert value**> A at [**120**][**240**]<**Insert value**> V ac.

I. Display: Separate LED for each alarm set point. LED lights upon exceeding setpoint.

J. Operator Interface:

1. Set-Point Adjustment: Internally accessible adjustable dial(s) or pushbutton(s).
2. Alarm Reset: [**Alarm condition automatically clears when vibration levels fall below switch set point.**][**Alarm condition cleared by operator through manual reset button found on the instrument.**][**Alarm condition cleared remotely by operator through DDC system interface.**]
3. Adjustable Time Delays: Intended to prevent false trips during equipment startup and short-term vibration spikes.

K. Accelerometer: [**Integral**][**or**][**external**].

L. Enclosure:

1. Material: Cast aluminum.
2. Screw-on cover.
3. Rating: NEMA 250, [**Type 4X**][**Type 7**][**Type 9**].

4. Electrical Connection: Screw terminals.
5. Conduit Connection: **1/2-inch (13-mm)** or **3/4-inch (21-mm)** trade size.

2.4 VIBRATION TRANSMITTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dwyer Instruments, Inc**]
2. [**IMI Sensors; a division of PCB Piezotronics**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dwyer Instruments, Inc**]
2. [**IMI Sensors; a division of PCB Piezotronics**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain all vibration transmitters from a single manufacturer.

D. Description: Loop-powered vibration transmitters with current output.

E. Performance:

1. Frequency Range: [**3 to 1000**][**10 to 1000**]<**Insert value**> Hz.
2. Vibration Range: [**Zero to 0.5 inch (13 mm)**][**Zero to 1.0 inch (25 mm)**][**Zero to 2.0 inch (50 mm)**]<**Insert value**> per second.
3. Accuracy: Within [**1**][**3**]<**Insert value**> percent of measured value.
4. Ambient Temperature Limits: [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**Minus 22 to 221 deg F (Minus 30 to 105 deg C)**]<**Insert temperature range**>.

F. Analog Output Current Signal:

1. Two-wire, 4 to 20 mA dc current source.
2. Signal capable of operating into [**500**][**1000**]<**Insert value**>-ohm load.

G. Enclosure Construction:

1. Material: Type 316 stainless steel.
2. Rating: NEMA 250, [**Type 6**][**or**][**Type 6P**].
3. Electrical Connection: Screw-on cable connector.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Test and inspect assembled vibration instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION INSTRUMENT APPLICATIONS

A. Mechanical Vibration Switches: <**Insert application**>.

B. Electronic Vibration Switches: <**Insert application**>.

C. Combination Vibration Switches and Transmitters: <**Insert application**>.

D. Vibration Transmitters: <**Insert application**>.

3.3 INSTALLATION

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

C. Properly support instrument wiring and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

D. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of [**Type 316L**

stainless steel]<**Insert material**>.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to location, elevation, orientation, or other applicable considerations that impact performance.

D. Verify that wiring is correct and secure.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to comply with instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11 in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a voltage meter at zero, 50, and 100 percent of range.
2. Check analog current signals using a current meter at zero, 50, and 100 percent of range.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Switches: Calibrate switches to make or break contact at set points indicated.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.11 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain speed instruments.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 05 48 00A

Task	Specification	Specification Description
23 05 48 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 48 13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.
21. Restrained isolation roof-curb rails.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.

3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device [**and wind-force-restraint**]component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

   a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators, wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
   b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
   c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
   d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
   e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Wind-Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
   c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**][**UL**][**FM Approvals**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection

changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

F. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:

   a. <**Insert list**>.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring mounts**][**and**][**restrained-air-spring mounts**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to

the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**][**UL product listing**][**FM Approvals**][**an evaluation service member of ICC-ES**][**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

1. Wind-Load Performance: Equipment shall withstand the effects of high wind events determined in accordance with [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**]<**Insert requirement**>.

B. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**]<**Insert ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate design wind-load calculations with vibration isolation requirements. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" less than **60 feet (18.3 m)**.
d. PART 4: Buildings with "h" greater than **60 feet (18.3 m)** and less than **160 feet (48.8 m)**.
e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. Kd = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**][**C**][**D**].
f. Kzt = Topographic Factor: <**Insert factor**>.
g. Ke = Ground Elevation Factor: <**Insert factor**>.
h. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
i. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.

j. qz = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. qh = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
l. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.
m. Enclosure Classification: <**Insert classification**>.
n. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.

4. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" greater than **60 feet (18.3 m)**.
d. PART 4: Buildings with "h" less than **160 feet (48.8 m)**.
e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

a. Risk Category: [**I**][**II**][**III**][**IV**][**V**].
b. h = Mean roof height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. Kd = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**][**C**][**D**].
f. Kzt = Topographic Factor: <**Insert factor**>.
g. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
j. qh = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.
l. Enclosure Classification: <**Insert classification**>.
m. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.

6. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

a. I = Importance Factor: <**Insert factor**>.
b. h = Mean Roof Height: <**Insert value**>.
c. V = Basic Wind Speed: <**Insert value**>.
d. Kd = Wind Directionality Factor: <**Insert factor**>.
e. Exposure Category: [**B**][**C**][**D**].
f. Kzt = Topographic Factor: <**Insert factor**>.
g. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
h. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
i. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source

approved by authorities having jurisdiction.

j. qh = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.

k. G = Gust-Effect Factor: [**0.85**]<**Insert factor**>.

l. GCpi = Internal Pressure Coefficient: <**Insert coefficient**>.

m. GCp = External Pressure Coefficient: <**Insert coefficient**>.

n. Cf = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.

o. Af = Projected Area Normal to the Wind: Except where "Cf" is specified for the actual surface area. Value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

C. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in [**ASCE/SEI 7-05**][**ASCE/SEI 7-10**][**ASCE/SEI 7-16**] so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Minimum deflection as indicated on Drawings.
6. Pad Material: Oil- and water-resistant rubber.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: [**Resilient**][**and**][**elastomeric**]<**Insert compound**>.

   a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]

d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

4. Minimum deflection as indicated on Drawings.
5. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]

g. [**Mason Industries, Inc.**]
h. [**NOVIA; a division of Carpenter & Paterson**]
i. [**Vibration Eliminator Co., Inc**]
j. [**Vibration Isolation**]
k. [**Vibration Management Corp.**]
l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

4. Minimum deflection as indicated on Drawings.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]
   l. [**VMC GROUP**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**NOVIA; a division of Carpenter & Paterson**]
   i. [**Vibration Eliminator Co., Inc**]
   j. [**Vibration Isolation**]
   k. [**Vibration Management Corp.**]

l. [**VMC GROUP**]
m. <**Insert manufacturer's name**>

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to **500 psi (3447 kPa)**.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
9. Minimum deflection as indicated on Drawings.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Isolation Technology, Inc**]
e. [**Kinetics Noise Control, Inc**]
f. [**Korfund**]
g. [**Mason Industries, Inc.**]
h. [**Vibration Eliminator Co., Inc**]
i. [**Vibration Isolation**]
j. [**Vibration Management Corp.**]
k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.
8. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
    b. Top housing with [**attachment and leveling bolt**][**threaded mounting holes and internal leveling device**][**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Mason Industries, Inc.**]
    h. [**NOVIA; a division of Carpenter & Paterson**]
    i. [**Vibration Eliminator Co., Inc**]
    j. [**Vibration Isolation**]
    k. [**Vibration Management Corp.**]
    l. [**VMC GROUP**]
    m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Ace Mountings Co., Inc.**]
    b. [**CADDY; brand of nVent Electrical plc**]
    c. [**California Dynamics Corporation**]
    d. [**Isolation Technology, Inc**]
    e. [**Kinetics Noise Control, Inc**]
    f. [**Korfund**]
    g. [**Mason Industries, Inc.**]
    h. [**NOVIA; a division of Carpenter & Paterson**]
    i. [**Vibration Eliminator Co., Inc**]
    j. [**Vibration Isolation**]
    k. [**Vibration Management Corp.**]
    l. [**VMC GROUP**]
    m. **<Insert manufacturer's name>**

3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Minimum deflection as indicated on Drawings.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]
   k. [**VMC GROUP**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Isolation Technology, Inc**]
   e. [**Kinetics Noise Control, Inc**]
   f. [**Korfund**]
   g. [**Mason Industries, Inc.**]
   h. [**Vibration Eliminator Co., Inc**]
   i. [**Vibration Isolation**]
   j. [**Vibration Management Corp.**]

k. [**VMC GROUP**]
l. <**Insert manufacturer's name**>

3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**][**non-adjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum **1/2-inch- (13-mm-)** Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. <**Insert manufacturer's name**>

3. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
4. Maximum Load Per Support: **500 psi (3447 kPa)** on isolation material providing equal isolation in all directions.
5. Minimum deflection as indicated on Drawings.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum **1/2-inch- (13-mm-)** Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Dynamics Corporation**]
   b. [**Kinetics Noise Control, Inc**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Eliminator Co., Inc**]
   e. [**Vibration Management Corp.**]
   f. [**VMC GROUP**]
   g. <**Insert manufacturer's name**>

3. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]
   c. [**Mason Industries, Inc.**]
   d. [**Vibration Management Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Firestone Industrial Products Company**]

c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

3. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
4. Maximum Natural Frequency: 3 Hz.
5. Operating Pressure Range: **25 to 100 psi (172 to 690 kPa)**.
6. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
7. Minimum deflection as indicated on Drawings.
8. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Firestone Industrial Products Company**]
c. [**Mason Industries, Inc.**]
d. [**Vibration Management Corp.**]
e. <**Insert manufacturer's name**>

3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to **500 psi (3447 kPa)**.
b. Top plate with [**threaded mounting holes**][**elastomeric pad**].
c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Minimum deflection as indicated on Drawings.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
10. Maximum Natural Frequency: 3 Hz.
11. Operating Pressure Range: **25 to 100 psi (172 to 690 kPa)**.

12. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
13. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ace Mountings Co., Inc.**]
   b. [**CADDY; brand of nVent Electrical plc**]
   c. [**California Dynamics Corporation**]
   d. [**Kinetics Noise Control, Inc**]
   e. [**Mason Industries, Inc.**]
   f. [**NOVIA; a division of Carpenter & Paterson**]
   g. [**Vibration Eliminator Co., Inc**]
   h. [**Vibration Isolation**]
   i. [**Vibration Management Corp.**]
   j. [**VMC GROUP**]
   k. <**Insert manufacturer's name**>

3. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
4. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
5. Minimum deflection as indicated on Drawings.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Kinetics Noise Control, Inc**]
e. [**Mason Industries, Inc.**]
f. [**NOVIA; a division of Carpenter & Paterson**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ace Mountings Co., Inc.**]
b. [**CADDY; brand of nVent Electrical plc**]
c. [**California Dynamics Corporation**]
d. [**Kinetics Noise Control, Inc**]
e. [**Mason Industries, Inc.**]
f. [**NOVIA; a division of Carpenter & Paterson**]
g. [**Vibration Eliminator Co., Inc**]
h. [**Vibration Isolation**]
i. [**Vibration Management Corp.**]
j. [**VMC GROUP**]
k. <**Insert manufacturer's name**>

3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Minimum deflection as indicated on Drawings.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
10. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
11. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]

4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Kinetics Noise Control, Inc**]
3. [**Mason Industries, Inc.**]
4. [**Vibration Management Corp.**]
5. [**VMC GROUP**]
6. **<Insert manufacturer's name>**

C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**][**ACI 318-11 Appendix D for 2012 IBC**][**ACI 318-14 Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum **1/4-inch (6-mm)** air gap, and minimum **1/4 inch (6 mm)** thick.

2.16 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**California Dynamics Corporation**]
4. [**Cooper B-line; brand of Eaton, Electrical Sector**]
5. [**Hilti, Inc.**]
6. [**Isolation Technology, Inc**]
7. [**TOLCO Incorporated**]
8. [**VMC GROUP**]
9. **<Insert manufacturer's name>**

C. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Gripple Inc.**]
4. [**Loos & Co. Inc.**]
5. [**VMC GROUP**]
6. <**Insert manufacturer's name**>

C. Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**][**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

D. Restraint cable assembly and cable fittings must comply with [**ASCE/SEI 19-10**][**ASCE/SEI 19-16**]. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Hilti, Inc.**]
5. [**Loos & Co. Inc.**]
6. [**Mason Industries, Inc.**]
7. [**TOLCO Incorporated**]
8. <**Insert manufacturer's name**>

C. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod.

D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**][**and**][**restraint cables**].

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]
   f. <**Insert manufacturer's name**>

3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Unistrut**]
   b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   c. [**Hilti, Inc.**]
   d. [**Mason Industries, Inc.**]
   e. [**Powers Fasteners**]
   f. <**Insert manufacturer's name**>

3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**][**ASCE/SEI 7-10, Ch. 13**][**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of **10 hp (7.46 kW)** that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]

2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**Cooper B-line; brand of Eaton, Electrical Sector**]
3. [**Hilti, Inc.**]
4. [**Mason Industries, Inc.**]
5. [**Powers Fasteners**]
6. **<Insert manufacturer's name>**

C. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]
8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**Mason Industries, Inc.**]
5. [**NOVIA; a division of Carpenter & Paterson**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Isolation**]
8. [**Vibration Management Corp.**]
9. [**VMC GROUP**]
10. **<Insert manufacturer's name>**

C. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)**

clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Concrete Inertia Base: [**Factory-fabricated**][**or**][**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than **1-inch (25-mm)** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.22 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**NOVIA; a division of Carpenter & Paterson**]
5. [**Thybar Corporation**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Management Corp.**]
8. [**VMC GROUP**]
9. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**CADDY; brand of nVent Electrical plc**]
2. [**California Dynamics Corporation**]
3. [**Kinetics Noise Control, Inc**]
4. [**NOVIA; a division of Carpenter & Paterson**]
5. [**Thybar Corporation**]
6. [**Vibration Eliminator Co., Inc**]
7. [**Vibration Management Corp.**]
8. [**VMC GROUP**]
9. **<Insert manufacturer's name>**

C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

D. Upper Frame: Shall provide continuous and captive support for equipment.

E. Lower Support Assembly: Shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of **2 inches (50 mm)** of rigid glass-fiber insulation on inside of assembly.

1. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
2. Minimum deflection as indicated on Drawings.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation [**and wind-load control**]devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION AND WIND-LOADCONTROL DEVICES

A. Provide vibration [**and wind-load**]control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators[**and wind-load restraints**] must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
3. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.
3. Brace a change of direction longer than **12 feet (3.7 m)**.

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**][**OSHPD**][**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**][**and**][**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**][**constant**] air supply.
3. Inflate isolators to [**height**][**and**][**or**][**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of equipment bases with requirements of isolated equipment specified in this and other Sections. Where dimensions of base are indicated on Drawings, they may require adjustment to accommodate isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least [**four**]<**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

END OF SECTION 23 05 48 13

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Task	Specification	Specification Description
23 05 48 13	21 05 48 00	Vibration And Seismic Controls For Fire-Suppression Piping And Equipment
23 05 48 13	22 05 48 00	Vibration And Seismic Controls For Plumbing Piping And Equipment
23 05 48 13	22 15 13 00	General-Service Compressed-Air Piping
23 05 48 13	23 05 00 00a	Coatings for HVAC
23 05 48 13	23 05 48 00	Vibration and Seismic Controls for HVAC
23 05 48 13	23 05 48 00a	Vibration Instruments
23 05 48 13	23 21 13 00	Hydronic Piping
23 05 48 13	22 11 16 00a	Steam And Condensate Piping
23 05 48 13	23 23 00 00	Refrigerant Piping

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SECTION 23 05 53 00 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Stencils.
7. Valve tags.
8. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-Numbering Scheme: For each piping system.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**Craftmark Pipe Markers**]
e. [**emedco**]
f. [**Kolbi Pipe Marker Co.**]
g. [**LEM Products Inc.**]

h. [**Marking Services Inc.**]
i. [**Pipemarker.com; Brimar Industries, Inc.**]
j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: [**Brass, 0.032-inch (0.8-mm)**][**stainless steel, 0.025-inch (0.64-mm)**][**aluminum, 0.032-inch (0.8-mm)**][**anodized aluminum, 0.032-inch (0.8-mm)**] minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
5. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**Craftmark Pipe Markers**]
e. [**emedco**]
f. [**Kolbi Pipe Marker Co.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Pipemarker.com; Brimar Industries, Inc.**]
j. [**Seton Identification Products; a Brady Corporation company**]

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.
5. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
6. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Carlton Industries, LP**]
3. [**Champion America**]
4. [**Craftmark Pipe Markers**]
5. [**emedco**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**National Marker Company**]
9. [**Pipemarker.com; Brimar Industries, Inc.**]
10. [**Seton Identification Products; a Brady Corporation company**]
11. [**Stranco, Inc.**]

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to **160 deg F (71 deg C)**.

E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.

F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E [**and other applicable codes and standards**] .

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Craftmark Pipe Markers**]
3. [**National Marker Company**]
4. [**Pipemarker.com; Brimar Industries, Inc.**]
5. [**Seton Identification Products; a Brady Corporation company**]

B. Material: Vinyl.

C. Minimum Thickness: **0.005 inch (0.12 mm)**.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: **160 deg F (70 deg C)**.

G. Minimum Width: [**2 inches (50 mm)**][**4 inches (100 mm)**] .

2.4 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
2. [**Brady Corporation**]
3. [**Carlton Industries, LP**]
4. [**Champion America**]
5. [**Craftmark Pipe Markers**]
6. [**emedco**]
7. [**Kolbi Pipe Marker Co.**]
8. [**LEM Products Inc.**]
9. [**Marking Services Inc.**]
10. [**Pipemarker.com; Brimar Industries, Inc.**]
11. [**Seton Identification Products; a Brady Corporation company**]

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [**partially cover**][**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on [**main**] distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**] .

2.5 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Carlton Industries, LP**]
3. [**Champion America**]
4. [**Craftmark Pipe Markers**]
5. [**emedco**]
6. [**Kolbi Pipe Marker Co.**]
7. [**LEM Products Inc.**]
8. [**Marking Services Inc.**]
9. [**Pipemarker.com; Brimar Industries, Inc.**]
10. [**Seton Identification Products; a Brady Corporation company**]

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**] thick, and having predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C)**.

E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.

F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on [**main**] distribution ducts. Arrows may be either integral with label or may be applied separately.

3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**] .

2.6 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Craftmark Pipe Markers**]
b. [**Kolbi Pipe Marker Co.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]

2. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**][**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**] .
3. Stencil Material: Aluminum, brass, or fiberboard.

4. Stencil Paint: Exterior, gloss, [**alkyd enamel**][**acrylic enamel**] in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**][**acrylic enamel**] . Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

B. Stencils for Ducts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Craftmark Pipe Markers**]
b. [**Kolbi Pipe Marker Co.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]

2. Lettering Size: Minimum letter height of **1-1/4 inches (32 mm)** for viewing distances of up to **15 ft. (4-1/2 m)** and proportionately larger lettering for greater viewing distances.
3. Stencil Material: [**Aluminum**][**Brass**][**Fiberboard**][**Fiberboard or metal**].
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.
6. Letter and Background Color: Color as indicated for specific application under Part 3.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Craftmark Pipe Markers**]
b. [**Kolbi Pipe Marker Co.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]

2. Lettering Size: Minimum letter height of **1/2 inch (13 mm)** for viewing distances of up to **72 inches (1830 mm)** and proportionately larger lettering for greater viewing distances.
3. Stencil Material: [**Aluminum**][**Brass**][**Fiberboard**][**Fiberboard or metal**].
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.

5. Identification Paint: Exterior, [**alkyd enamel**][**acrylic enamel**]. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.7 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.**]
2. [**Brady Corporation**]
3. [**Carlton Industries, LP**]
4. [**Champion America**]
5. [**Craftmark Pipe Markers**]
6. [**emedco**]
7. [**Kolbi Pipe Marker Co.**]
8. [**LEM Products Inc.**]
9. [**Marking Services Inc.**]
10. [**Pipemarker.com; Brimar Industries, Inc.**]
11. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** numbers.

1. Tag Material: [**Brass, 0.04-inch (1.0-mm)**][**stainless steel, 0.024-inch (0.61-mm)**][**aluminum, 0.031-inch (0.79-mm)**][**anodized aluminum, 0.031-inch (0.79-mm)**] minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass [**wire**][**link chain**][**beaded chain**][**S-hook**] .

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.8 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Brady Corporation**]
2. [**Champion America**]
3. [**Craftmark Pipe Markers**]
4. [**emedco**]
5. [**Kolbi Pipe Marker Co.**]
6. [**LEM Products Inc.**]
7. [**Marking Services Inc.**]
8. [**Pipemarker.com; Brimar Industries, Inc.**]

9. [**Seton Identification Products; a Brady Corporation company**]

B. Description: Preprinted [**or partially preprinted**] accident-prevention tags of plasticized card stock [**with matte finish suitable for writing**] .

1. Size: [**3 by 5-1/4 inches (75 by 133 mm) minimum**][**Approximately 4 by 7 inches (100 by 178 mm)**].
2. Fasteners: [**Brass grommet and wire**][**Reinforced grommet and wire or string**] .
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Equipment Label Colors:

1. [**White letters on an ANSI Z535.1 safety-blue background**].

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF WARNING SIGNS AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Warning Sign and Label Colors: In accordance with requirements of OSHA [**and other applicable codes and standards**] .

1. [**Black letters on an ANSI Z535.1 safety-yellow background**].

C. Locate warning signs and labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E [**and other applicable codes and standards**] .

3.5 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: [**Yellow background with black diagonal stripes**].

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than **6 ft. (2 m)** of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.6 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in [**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stencils for Piping: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, [**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within **3 ft. (1 m)** of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within **3 ft. (1 m)** of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of [**25 ft. (8 m)**] along each run. Reduce intervals to [**10 ft. (3.0 m)**] in areas of congested piping, ductwork, and equipment.

E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of **125 deg F (52 deg C)** or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

F. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe-Label Color Schedule:

1. Chilled-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**].
2. Condenser-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**].
3. Heating Water Piping: [**White letters on an ANSI Z535.1 safety-green background**].
4. Refrigerant Piping: [**White letters on an ANSI Z535.1 safety-blue background**].
5. Low-Pressure Steam Piping: [**Black letters on an ANSI Z535.1 safety-yellow**

background][**White letters on an ANSI Z535.1 safety-green background**].
6. High-Pressure Steam Piping: [**Black letters on an ANSI Z535.1 safety-yellow background**][**White letters on an ANSI Z535.1 safety-green background**].
7. Steam Condensate Piping: [**Black letters on an ANSI Z535.1 safety-yellow background**][**White letters on an ANSI Z535.1 safety-green background**].
8. Toxic and Corrosive Fluids: [**Black letters on an ANSI Z535.1 safety-orange background**].
9. Flammable Fluids: [**Black letters on an ANSI Z535.1 safety-yellow background**].
10. Combustible Fluids: [**White letters on an ANSI Z535.1 safety-brown background**].
11. Potable and Other Water: [**White letters on an ANSI Z535.1 safety-green background**].
12. Compressed Air: [**White letters on an ANSI Z535.1 safety-blue background**].

3.7 INSTALLATION OF DUCT LABELS

A. Install [**plastic-laminated**][**self-adhesive**] duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For air supply ducts: [**White letters on blue background**].
b. For air return ducts: [**White letters on blue background**].
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: [**White letters on blue background**].

B. Stencils for Ducts: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

1. For all air ducts: [**Black letters on white background**].

C. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of [**20 ft. (6 m)**] where exposed or are concealed by removable ceiling system.

D. Stenciled Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. [**Black letters on White background**].

3.8 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Chilled Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
b. Condenser Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
c. Refrigerant: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**] .
d. Hot Water: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
e. Gas: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].

f. Low-Pressure Steam: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
g. High-Pressure Steam: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].
h. Steam Condensate: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] , [**round**][**square**].

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.9 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: [**Black letters on an ANSI Z535.1 safety-yellow background**].

B. Attach warning tags, with proper message, to equipment and other items where [**indicated on Drawings**][**scheduled**] .

END OF SECTION 23 05 53 00

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Task	Specification	Specification Description
23 05 53 00	22 05 53 00	Identification for Plumbing Piping and Equipment
23 05 53 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 66 00 - ANTIMICROBIAL ULTRAVIOLET LAMP SYSTEMS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Antimicrobial UV-C lamp system for large air-handling unit.
2. Antimicrobial UV-C lamp systems for packaged air-handling equipment.
3. Controls.

1.2 DEFINITIONS

A. UV-C: Ultraviolet-C short-wave spectrum.

B. UV-C Lamp System: Unit including UV lamp, power supply, housing, and supports.

C. UVGI: Ultraviolet germicidal irradiation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product description with complete technical data, performance data, and product specification sheets.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating power, distribution range, control signal over range, default control signal with loss of power, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Installation instructions, including factors affecting performance.
4. Include UV-C lamp system modeling and calculations as described in "Intensity" Paragraph in "Installation of Antimicrobial Ultraviolet Lamp Systems for HVAC, General" Article.

B. Shop Drawings: For each UV-C lamp system.

1. Include plans, elevations, sections, mounting, and attachment details.
2. Include details of UV-C lamp system assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product Data: For lamps, indicating mercury content and lamp life.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and sections, drawn to scale, on which the following items are shown

and coordinated with each other, using input from installers of the items involved:

1. Structural members of equipment to which lamp systems will be attached.
2. Air-handling unit penetrations.
3. Access points for service of lamps and power supplies.
4. Power [**and communications for diagnostics and alarms**] connections.

B. Product Certificates: For each type of UV lamp, fixture, and system.

C. Product Test Reports: For each type of UV lamp and fixture, for tests performed by [**a qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**] .

D. Field Quality Control Reports: For specified tests and inspections.

E. Qualification Statements: For testing laboratory providing data for UV lamps and fixtures [**testing agency**][**and**][**factory-authorized service representative**] .

F. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lamp systems.

1. Provide a list of all lamp and fixture types used on Project.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to the Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. UV-C Lamps: [**10 for every 100**] of each type and rating installed. Furnish no fewer than one of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer to [**assist with tests and inspections**][**perform startup services**][**and**][**train the Owner's personnel**] .

B. Testing Agency Qualifications: An independent agency qualified to perform specified field tests.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period, System: [**Five**] years from date of Substantial Completion.
2. Warranty Period, Lamp: [**One**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain antimicrobial UV-C lamp systems for HVAC from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Test UV-C lamp systems in accordance with ASHRAE 185.1.
2. Test UV-C lamp systems in accordance with ASHRAE 185.2.

C. UL 8802 compliance.

2.3 ANTIMICROBIAL UV-C LAMP SYSTEMS FOR HVAC AIR-HANDLING EQUIPMENT

A. Antimicrobial UV-C Lamp System for Large Air-Handling Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Air & Water, Inc.**]
b. [**American Ultraviolet**]
c. [**DiversiTech Corp.**]
d. [**Dust Free; a Rectorseal brand**]
e. [**Fresh-Aire UV; a division of DiversiTech**]
f. [**Ultravation, Inc.**]
g. [**UV Resources**]

2. Description: UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, lamp holder [**and manufacturer's lamp supporting structure**] .

3. Power Supply: UL listed, single phase, [**120**][**277**] V ac, [**50**][**60**] Hz, and with a programmed rapid start.

a. Controller: High power factor, Class P, Sound Rated A, Type 1 Outdoor, and with inherent thermal protection and without polychlorinated biphenyl.
b. Operating Temperature: From [**34 to 194 deg F (1 to 90 deg C)**].
c. Wiring Harness: Plug in.
d. Electrical Connection: Single-point electrical connection [**with service disconnect**] .

4. UV-C Lamps: Encapsulated lamps, with lamp wattage and model number visibly printed on all lamps; less than 8 mg of mercury in each lamp. UV-C lamps are not to produce ozone in accordance with UL 2998.

a. Quantity and Type: [**One 145-W UV-C lamp**][**One 75-W UV-C lamp**].
b. Output: UV-C energy, primarily at the 253.7 nm wavelength with a 360-degree energy distribution.
c. Operating Temperature: From [**34 to 158 deg F (1 to 70 deg C)**], 100 percent relative humidity, at any velocity.

d. Lamp Protection: [**Sealed, encased**][**Teflon coated**][**Quartz glass-encased**] to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
e. Lamp Life: Minimum of [**9000 hours**] with greater than 85 percent of initial intensity at end of lamp life.

5. Power Supply Housing: [**Galvanized**][**Stainless**] steel, minimum **20-gauge (0.813-mm)**, powder-coated finish, NEMA 250, Type 4X, for installation inside of air-handling units.

a. Power Supply Capacity: [**One**][**Two**][**Four**][**Six**] lamp(s).

6. Lamp Support Structure: Stainless steel support channel or angle framing to suit UV lamp layout and interface with power supply housing.
7. Wiring Loom: UV-C-resistant jacket materials.

a. Conduit/Cable: UL 2998, [**galvanized**][**stainless**] steel flexible metal conduit. Provide minimum extension of **5 ft. (1.5 m)** from power supply housing to junction box.

8. Lamp Plug, Holder, and Lamp Clamp: Four-pin type to accommodate a single-ended high-output lamp.

a. Lamp Plug and Holder Construction:

1) UV-resistant materials.
2) Designed to connect lamp to the plug.

b. UL Listing: Listed and labeled to UL.
c. Lamp Clamp Construction:

1) UV-resistant materials.
2) Watertight connection.
3) Provide a seal between the single-ended UV lamp and the lamp plug to prevent electrical shock, connection shorts, and lamp or power supply failure, from lamp pin oxidation or arcing.

d. Position: Adjustable positioning of lamp holder and lamp clamp.

9. Lamp Holsters: Dual lamp holsters permanently affixed within the irradiated cavity to interior surface of an air-handling unit or to vertical supports.

a. Lamp Holster Construction: UV-C-resistant materials.

10. Controls:

a. See Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and Section 230993.11 "Sequence of Operations for HVAC DDC" or control sequences on Drawings for operating and interlock controls for UV-C lamp systems.
b. Interface with DDC System for HVAC: Factory-installed hardware and software (where applicable) to enable the DDC system for HVAC to monitor, control, and display local

status and alarms.

c. Lamp and Power Supply Monitoring Panel:

1) Panel to monitor UV-C lamp status and intensity.
2) Factory assembled and tested.
3) Construction is to be designed to withstand installed conditions.
4) Communication interface with BAS.

B. Antimicrobial UV-C Lamp Systems for Packaged Air-Handling Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Air & Water, Inc.**]
b. [**American Ultraviolet**]
c. [**Dust Free; a Rectorseal brand**]
d. [**Fresh-Aire UV; a division of DiversiTech**]
e. [**Ultravation, Inc.**]
f. [**UV Resources**]

2. Description: Factory-assembled UV-C lamp system consisting of power supply, [**NEMA 250, Type 4X**] power supply housing, four each, **1/2- or 3/4-inch (12.7- or 19-mm)** electrical knockouts, power supply with integrated lamp plug, lamp compression nut, and encapsulated UV lamp, for [**packaged air-handling units**][**rooftop units**][**fan-coil units**][**split-system air conditioners**][**heat pumps**][**PTACs**][**unit ventilators**][**on-duct**] .
3. Power Supply: UL listed, single phase, 120 or 240 V ac, 50 or 60 Hz, and with a programmed rapid start.

a. Power Factor: High power factor, Class P, Sound Rated A, Type 1 Outdoor, and with inherent thermal protection and without polychlorinated biphenyl.
b. Output: Automatically sense and maximize lamp output, energy efficiency, and reliability for lamp lengths from **17 to 61 inches (432 to 1549 mm)**.
c. Operating Temperature: From **34 to 194 deg F (1 to 90 deg C)**.
d. Safety: Integral interlock switch on power supply.
e. Power Consumption: Maximum **15 W/sq. ft. (161.5 W/sq. m)**.
f. Electrical Connection: Single electrical connection [**with service disconnect**] .

4. UV-C Lamps: Encapsulated lamps with lamp wattage and model number visibly printed on all lamps; less than 8 mg of mercury in each lamp. Lamps are not to produce ozone, in accordance with UL 2998.

a. Quantity and Type: [**One**][**T5, hot cathode, single-ended, four pin**].
b. Output: UV-C energy, primarily at 253.7 nm wavelength with a 360-degree energy distribution.
c. Base: Long-mount base lamp. Lamp filament extends into the airstream beyond plenum walls and insulation.
d. Operating Temperature: From **34 to 158 deg F (1 to 70 deg C)**, 100 percent relative humidity, at any velocity.
e. Lamp Protection: Hermetically sealed with a thin layer of UV-C-transmissible fluorinated ethylene propylene to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
f. Lamp Life: Minimum of [**9000 hours**] with greater than 85 percent of initial output at end of

lamp life.

5. Power Supply Housing: High-performance, polycarbonate, equipped with lamp support for lamp lengths up to **61 inches (1549 mm)** and a weathertight cover with an integrated seal. Housing contains all components in one integral assembly for safety and serviceability without tools.

    a. Interlock: Disrupt lever on the cover actuates the interlock switch to disconnect or restore power when removed or installed. Padlock eyelets lock the housing cover to guard against unwanted entry.
    b. Surface Installation Mounting: Four mounting holes and gasket to seal housing to the mounting surface.

6. Lamp Holder and Lamp Clamp: Four-pin type to accommodate a single-ended lamp.

    a. Lamp Holder Construction:

        1) UV-resistant materials.
        2) Designed to connect the lamp to the plug.

    b. Lamp Clamp Construction:

        1) UV-resistant materials.
        2) Watertight connection.
        3) Provide a seal between the single-ended UV lamp and the lamp plug to prevent electrical shock, connection shorts, and lamp or power supply failure, from lamp pin oxidation or arcing.

7. Controls:

    a. Comply with requirements in Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and in Section 230993.11 "Sequence of Operations for HVAC DDC."
    b. Interface with DDC System for HVAC: Factory-installed hardware and software (where applicable) to enable the DDC system for HVAC to monitor, control, and display status and alarms.
    c. Lamp and Power Supply Monitoring: Factory assembled and tested, consisting of housing, PC board, and wire block. Construction is designed to withstand installation inside air-handling unit airstream.

        1) Housing: Industrial-grade plastic equipped with a direct-reading high-output green LED, two mounting holes, and an external wiring block for wiring to a remote sensing or input device. PC board converts inductive field into a regulated electromotive force of 1 to 5 V dc, maximum.
        2) Wiring Block: One positive and one negative terminal for 18 AWG and smaller wire.

    d. Remote Monitor(s): Installed outside the plenum in a suitable NEMA enclosure to directly or remotely monitor the lamp and power supply combination, with option for a single signal to the DDC system.
    e. Operating Control: Monitor lamp and power supply combination and provide a single on/off signal to the DDC system. UV-C lamp system operates continuously. Interlock UV-C lamp system operation with air-handling unit and component access doors. When an access door is opened, UV-C lamp system is de-energized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for UV-C lamp system to verify actual locations of UV lamps and electrical connections before UV-C lamp system installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ANTIMICROBIAL ULTRAVIOLET LAMP SYSTEMS FOR HVAC, GENERAL

A. Install UV-C lamp systems in accordance with manufacturer's written installation manual and drawings unless otherwise indicated.

B. Install UV lamps in each UV-C lamp system.

C. Install UV-C lamp systems in accessible locations to allow service and maintenance.

D. Provide sufficient length of wiring loom to facilitate lamp connection to a remotely located power supply housing, such that lamp and loom can be mounted anywhere in the system.

E. Seal air-handling unit penetrations to maintain integrity of air-handling unit casings.

F. Irradiation: Quantity of UV lamps are to be installed to provide an equal distribution of available UV-C energy. When installed, UV-C energy produced is to be in direct line-of-sight to allow the lowest possible reflected and shadowed losses, distributed in a 360-degree pattern within the cavity or plenum space.

G. Intensity: UV-C lamp system modeling is to be included in the submittal and must contain necessary calculations to demonstrate that submitted lamp wattage complies with ASHRAE-recommended minimum of 100 microwatts/sq. cm equally distributed on the target coil surface.

H. Housing Installation: Install power supply housing [**inside**][**outside**] air-handling equipment.

I. UV Lamp Installation: Mount UV lamp to irradiate surfaces, as well as the available line of sight airstream, through proper lamp placement, and incident angle reflection.

J. Safety: Comply with requirements in UL 60335-2-40. Provide mechanical interlock switch on access panels and doors to UV lamp systems to ensure that UV-C lamp systems will be de-energized when these accesses are opened. Warning signs and labels are specified in Section 230553 "Identification for HVAC Piping and Equipment."

K. Signage: Comply with requirements in UL 60335-2-40. Mark access panels and doors to UV-C lamp systems with warning signs stating, "WARNING: UV LIGHT SOURCE" and "DISCONNECT POWER BEFORE SERVICING." Warning signs and labels are specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 INSTALLATION OF ANTIMICROBIAL UV-C LAMP SYSTEM FOR LARGE AIR-HANDLING EQUIPMENT

A. Size and rate supports for UV-C lamp system weight.

B. Provide support for UV-C lamp system without causing deflection of air-handling unit casing.

C. Provide vertical supports on interior air-handling unit surfaces for UV-C lamp system.

D. Equipment supports are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.4 ELECTRIC CONNECTIONS

A. Provide electrical power and service disconnects to products requiring electrical connections.

B. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

C. Comply with requirements for service disconnects in Section 262816 "Enclosed Switches and Circuit Breakers."

D. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify UV-C lamp systems with equipment labels. Comply with requirements for equipment labels specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

3.8 ADJUSTING

A. After installation, adjust UV-C lamp systems and supports to maximize exposure to surfaces, before energizing system.

3.9 CLEANING

A. Wipe lamps clean using manufacturers' recommended cleaning methods and materials.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections [**with the assistance of a factory-authorized service representative**] :

1. Operational Test: After installing UV-C lamp systems, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Safety Interlock: Confirm proper operation of safety interlock power switches on access panels and doors.

3. UV-C lamp systems and components will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner’s maintenance personnel to adjust, operate, and maintain UV-C lamp systems.

END OF SECTION 23 05 66 00

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Task	Specification	Specification Description
23 05 66 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 05 93 00 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. TAB of Air Systems:

   a. Constant-volume air systems.
   b. Dual-duct systems.
   c. Variable-air-volume systems.
   d. Multizone systems.
   e. Induction-unit systems.

2. TAB of Hydronic Piping Systems:

   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.

3. TAB of fuel oil systems for HVAC.
4. TAB of steam and condensate piping systems.
5. TAB of equipment.
6. TAB of existing HVAC systems and equipment.
7. Procedures for exhaust hoods.
8. Sound tests.
9. Vibration tests.
10. Duct-leakage tests verification.
11. Pipe-leakage tests verification.
12. UFAD plenum-leakage tests verification.
13. HVAC-controls verification.
14. Smoke-control system tests.
15. Stair-pressurization system tests.
16. Elevator-pressurization system tests.

B. Related Requirements:

1. Section 220593 "Testing, Adjusting, and Balancing for Plumbing" for TAB of plumbing systems and equipment.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. FFT: Fast Fourier transform.

C. INCE: Institute of Noise Control Engineering

D. NC: Noise criteria.

E. NEBB: National Environmental Balancing Bureau.

F. RC: Room criteria.

G. TAB: Testing, adjusting, and balancing.

H. TABB: Testing, Adjusting, and Balancing Bureau.

I. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

J. TDH: Total dynamic head.

K. UFAD: Underfloor air distribution.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at [**Project site**]<**Insert location**> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of [**14**]<**Insert number**> days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Requirements for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.4 ACTION SUBMITTALS

A. Sustainable Design Submittals:

1. Air-Balance Report: Documentation indicating that the Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report: Documentation indicating that the Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
3. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes v1.4, Section 3.1.2.4 - "IAQ during Construction."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within [**30**][**45**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, provide a summary report of the examination review required in "Examination" Article, if issues are discovered that may preclude the proper testing and balancing of the systems. Submit a summary report of the examination review required in "Examination" Article.

C. Strategies and Procedures Plan: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within [**30**][**60**][**90**]<**Insert number**> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article, to be used and filled out by systems installers verifying that systems are ready for TAB.

E. Certified TAB Reports: Within [**14**][**21**][**30**]<**Insert number**> days of completion of testing and balancing work.

1. Submit one copy of the final TAB report to the design professional of record's firm. Provide [**five**]<**Insert number**> additional copies to Contractor.

F. Sample Report Forms: For each specified report.

G. Instrument Calibration Reports: Include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration and calibration interval.

1.6 QUALITY ASSURANCE

A. TAB Specialist Firm's Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist firm and certified by AABC.
2. TAB Technician: Employee of the TAB specialist firm and certified by AABC.

B. TAB Specialist Firm's Qualifications: Certified by [**NEBB**][**or**][**TABB**] .

1. TAB Certified Professional: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**] .
2. TAB Technician: Employee of the TAB specialist firm and certified by [**NEBB**][**or**][**TABB**] .
3. TAB specialist firm is to be independent, third-party, and unaffiliated with Contractor.

C. Sound and Vibration Specialists: [**NEBB-certified Sound and Vibration Technician**][**TABB-certified Sound and Vibration Technician**][**INCE Board-certified professional**][**Vibration Institute Category I Certified Vibration Analyst**][**Vibration Institute Category II Certified Vibration Analyst**][**Vibration Institute Category III Certified Vibration Analyst**][**Vibration Institute Category IV Certified Vibration Analyst**][**or**][**licensed professional engineer who specializes in acoustical engineering**]<**Insert sound and vibration certification**> .

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE 111 Compliance: For testing and balancing of HVAC systems.

1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.3.3 - "System Balancing."

G. Code and Authorities Having Jurisdiction Compliance: Furnish TAB services that comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 TAB SPECIALIST FIRMS

A. Subject to compliance with requirements, [**engage one of the following**][**available TAB specialist firm that may be engaged include, but are not limited to, the following**] :

1. <**Insert, in separate subparagraphs, TAB specialist firm's name**> .

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in system designs that may preclude proper TAB of systems and equipment. Submit Contract Documents Examination Report summary of findings.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for TAB.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

E. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean and permanent filters are installed, and equipment with functioning controls is ready for operation.

F. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning as indicated on Drawings or in the Specifications.

G. Verify, with installation Contractor, that startup strainer screens have been replaced with permanent screens and that all strainers have been cleaned.

H. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine air vents to verify that air has been removed from all hydronic systems.

K. Observe demonstration of operating safety interlocks and controls on HVAC equipment.

L. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checklists of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed and are in normal operating positions.
j. Note location of balancing devices that are inaccessible.
k. UFAD-Specific Requirements:

1) Verify that raised access panels are installed.
2) Verify that air plenums are free of debris.
3) Verify that air plenum dividers are installed.
4) Follow procedures to measure Category 1 and 2 leakage in AABC's "National Standards to Total System Balance."

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been completed in accordance with applicable code and authorities having jurisdiction.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Verify that pressure at highest point in the system is a minimum of [**5 psig (34.5 kPa)**]<**Insert minimum pressure**> .
f. Strainers are pulled and cleaned.
g. Control valves are functioning in accordance with the controls sequence of operation.
h. Shutoff and balance valves have been verified to be 100 percent open.
i. Pumps are started and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete, and safeties are verified.
l. Note location of balancing devices that are inaccessible.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [**AABC's "National Standards for Total System Balance"**][**ASHRAE 111**][**NEBB's "Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems"**][**SMACNA's "HVAC Systems - Testing, Adjusting & Balancing"**][**and**][**SMACNA's "TAB Procedural Guide"**] and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Installing Contractor to Perform the Following:

a. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
b. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
c. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
d. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP**][**and**] units.

E. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Pumps.
3. Fans and ventilators.
4. Air curtains.
5. Terminal units.
6. Commercial kitchen hoods.
7. Boilers.
8. Deaerators.
9. Furnaces.
10. Radiant heaters.
11. Unit heaters.
12. Solar collectors.
13. Heat exchangers.
14. Condensing units.
15. Condensers.
16. Water chillers.

17. Cooling towers.
18. Energy-recovery units.
19. Air-handling units.
20. Heating and ventilating units.
21. Rooftop air-conditioning units.
22. Heating-only makeup air units.
23. Dedicated outdoor-air units.
24. Packaged air conditioners.
25. Self-contained air conditioners.
26. Computer-room air conditioners.
27. Split-system air conditioners.
28. Variable-refrigerant-flow systems.
29. Heat pumps.
30. Valance heating and cooling units.
31. Chilled beams.
32. Coils.
33. Fan coil units.
34. Unit ventilators.
35. Radiators.
36. Convectors.
37. Finned-tube radiation heaters.
38. Radiant-heating [**cables**][**piping**][**and**][**panels**] .
39. Humidifiers.
40. Dehumidification units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain approved submittals and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare single-line schematic diagram of systems or color-coded HVAC drawings for the purpose of identifying HVAC components, including each air terminal unit and each air diffuser, register, and grille.

C. For variable-air-volume systems, develop a plan to simulate diversity and include in TAB plan.

D. Determine suitable locations in main and branch ducts for accurate duct-airflow measurements.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.

F. Verify that motor controllers are equipped with properly sized thermal protection.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.

2. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet.
   b. Measure static pressure directly at the fan inlet.
   c. Measure static pressure differential across each component that makes up the air-handling system.
   d. Apply artificial loading of filters to simulate a dirty filter pressure drop condition at the time static pressures are measured.

3. Obtain approval from [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all volume dampers have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets' and outlets' airflow. Apply correction factors as applicable for each size and style of air device.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design range. Readjust to within design tolerance if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Traverse the supply airflow in full airside economizer mode. Observe the mixed air plenum pressure as compared to normal operation: return air dampers open and minimum outside air varying to 100 percent outside air dampers fully open and return air dampers fully closed. Mixed air pressure is to remain constant plus/minus 20 percent or, otherwise, damper/fan adjustments will be required.
5. Mark all final settings.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.8 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Adjust the dual-duct systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge. On systems with separate hot-deck and cold-deck fans, verify the location

of the sensor on each deck.

2. Verify that the system is under static pressure control.
3. Verify that the high static pressure safety is set below the maximum static pressure rating of the ductwork.
4. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point, so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses. Perform this procedure for the hot deck and for the cold deck.
5. Calibrate and balance each terminal unit's hot deck and cold deck for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for full cooling. Some controllers require starting with minimum set point. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factors as required for design cold-deck maximum airflow and hot-deck minimum airflow. Record calibration factors.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for full heating.
    e. Measure airflow and adjust calibration factors as required for design cold-deck minimum airflow and hot-deck maximum airflow. Record calibration factors. If no minimum calibration is available, note any deviation from design airflow. Verify that the airflow when damper is closed is zero.

6. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity (cooling coil or fan), adjust terminals for maximum and minimum airflow so that connected total matches cooling coil or fan selection and simulates actual load in the building. In systems with separate hot-deck and cold-deck fans, diversity consideration applies to each individual fan.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.

7. Measure the fan(s) static pressures as follows:

    a. Measure static pressure directly at the fan outlet.
    b. Measure static pressure directly at the fan inlet.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

8. Set final return and outside airflow to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets.
    b. Verify that all terminal units are delivering design airflow under system maximum flow.

9. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point, to maintain the optimum system static pressure. Record set point and give to controls Contractor.
10. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to deliver within design value tolerances if necessary.
b. Re-measure and confirm that total airflow is within design value tolerances.
c. Re-measure final fan operating data, speed, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans via air flow measurements in the supply, return, relief, and outside air flow paths.

11. Record final fan-performance data.

3.9 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. Set the air terminal units to maximum airflow. Record the following for each air terminal unit:

a. Design maximum airflow.
b. Tested and balanced maximum airflow.
c. BAS system maximum airflow.
d. BAS damper position.
e. Adjust the air-handling unit fan airflow until one air terminal unit damper position is 85 percent open.
f. Record the duct static pressure sensor and set the fan static pressure controller to the recorded static pressure sensor.
g. Record the fan operating Hz.
h. If the system has filters that will exceed **0.5 inch wg (125 Pa)** pressure differential when dirty, simulate the dirty filter pressure drop and repeat all the above recorded readings ("a" through "g"), noting dirty filter condition.
i. With N+1, isolate one fan and repeat all the above recorded readings ("a" through "g"),

noting N+1 condition.

j. Each condition must have all air-handling- unit data recorded, including static pressure profiles at outdoor air, return air, relief air, total supply air, supply air fan suction and discharge, return air fan suction and discharge, and relief air fan suction and discharge.

6. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet.
   b. Measure static pressure directly at the fan inlet.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point, to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.10 PROCEDURES FOR MULTIZONE SYSTEMS

A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.

B. The procedures for multizone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.

C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.

D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

   1. Measure total airflow.

      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor air conditions.
      b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.

   2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet.
b. Measure static pressure directly at the fan inlet.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review record Drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

F. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlet and outlet airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

G. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.11 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser, to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet.
b. Measure static pressure directly at the fan inlet.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review record Drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.

F. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speeds, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.12 GENERAL PROCEDURES FOR HYDRONIC PIPING SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.

C. Prepare schematic diagrams of systems' record Drawings piping layouts.

D. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
5. Verify that motor controllers are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

E. Measure and record upstream and downstream pressure of each piece of equipment.

F. Measure and record upstream and downstream pressure of pressure-reducing valves.

G. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

1. Check settings and operation of each safety valve. Record settings.

3.13 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling. Before pump impellers are trimmed, verify if any future load requirements and close throttling valve, noting the position.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition. While operating pump(s) at maximum flow conditions, verify pump(s) are operating below nameplate and are non-overloading through full range of operation.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.
6. Use coil pressure drop to determine flow if no flow meter measurement exists.
7. Use temperatures and flows to calculate actual capacity on each coil and heat exchanger.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or by capacity method calculation.
2. Use coil pressure drop to determine flow.
3. Perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set. Add and mark all balanced valve positions for valves that do not have memory stops.

3.14 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:

1. Adjust pumps to deliver total design flow with variable-frequency drive(s) set to 60 Hz.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

c. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling. Before pump impellers are trimmed, verify future load requirements and close throttling valve, noting the position.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition. While operating pump(s) at maximum flow conditions, verify pump(s) are operating below nameplate and are non-overloading through full range of operation.
3. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow by using manually balancing valve.
c. Re-measure each main and branch after all have been adjusted.

4. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

5. For systems with pressure-independent valves at terminals:

a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

6. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

7. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
8. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, verify the pressure at the controller sensor and set the controller to the measured pressure at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions. Reverify the pressure at the controller.
9. Mark final settings and verify that all memory stops have been set.
10. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, static pressure profile,

and variable-frequency drive Hz.

c. Mark final settings.

D. For systems with flow diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves located closest to the pump(s).
3. Adjust pumps to deliver total design flow.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gauge heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

   c. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling. Before pump impellers are trimmed, verify future load requirements and close throttling valve, noting the position.

4. Monitor motor performance during procedures, and do not operate motor in an overloaded condition. While operating pump(s) at maximum flow conditions, verify pump(s) are operating below nameplate and are non-overloading through full range of operation.
5. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

6. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

7. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

8. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

9. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
10. Prior to verifying final system conditions, determine system pressure-differential set point(s).
11. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
12. Mark final settings and verify that memory stops have been set.
13. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.15 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design flow.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size. Before pump impellers are trimmed, verify future load requirements and close throttling valve, noting the position.
    e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling. Before pump impellers are trimmed, verify future load requirements and close throttling valve, noting the position.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition. While operating pump(s) at maximum flow conditions, verify pump(s) are operating below nameplate and are non-overloading through full range of operation.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been balanced.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.16 PROCEDURES FOR STEAM AND CONDENSATE PIPING SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.17 PROCEDURES FOR STEAM-TO-WATER HEAT EXCHANGERS

A. Measure, adjust, and record water flow to within specified tolerances.

B. Measure and record inlet and outlet water temperatures.

C. Measure and record inlet steam pressure and condensate outlet pressure.

D. Check and record settings and operation of safety and relief valves.

3.18 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

A. Measure, adjust, and record water flow to within specified tolerances.

B. Measure and record inlet and outlet water temperatures.

C. Measure and record pressure drop.

D. Check and record settings and operation of safety and relief valves.

3.19 PROCEDURES FOR MOTORS

A. Motors: [**1/2**]<**Insert value**> hp and larger; test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation. Verify and report Hz at maximum and minimum flows.

3.20 PROCEDURES FOR WATER CHILLERS

A. Air-Cooled Chillers: Balance water flow through each evaporator to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer or via chiller control panel readout.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts or via chiller control panel readout.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts or via chiller control panel readout.
5. Capacity: Calculate in **tons (kilowatts)** of cooling via chiller control panel readout.
6. Verify condenser-fan rotation and record fan and motor data, including number of fans and entering- and leaving-air temperatures.

B. Water-Cooled Chillers: Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer or via chiller control panel readout.

4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts or via chiller control panel readout.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts or via chiller control panel readout.
6. Capacity: Calculate in **tons (kilowatts)** of cooling via chiller control panel readout.

3.21 PROCEDURES FOR COOLING TOWERS

A. Performance Testing: Comply with [**CTI ATC-105**][**Cooling tower AABC performance test in AABC's "National Standards for Total System Balance"**][**SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," Ch. 15 "Hydronic System TAB Procedures"**]<**Insert test procedure**> .

B. Closed-Circuit Cooling Towers: Balance total condenser-water flows to towers and cells. Measure and record the following data:

1. Unit number.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Number of cells.
6. Capacity in cooling tons.
7. Design and actual fan rpm.
8. Flow rate in **gpm (L/s)**.
9. Condenser-water flow to each cell of the cooling tower.
10. Pressure drop through each cell.
11. Entering- and leaving-water temperatures.
12. Wet- and dry-bulb temperatures of entering air.
13. Wet- and dry-bulb temperatures of leaving air.
14. Barometric pressure, wind speed, and wind direction.
15. Condenser-water flow rate recirculating through the cooling tower.
16. Cooling-tower spray pump discharge pressure.
17. Condenser-water flow through bypass.
18. Makeup-water flow rate.
19. Makeup-water temperature.
20. Fan, motor, and motor controller operating data.
21. Cooling-tower spray pump and motor operating data.
22. Heater operating data.

C. Open-Circuit Cooling Towers: Balance total condenser-water flows to towers and cells. Measure and record the following data:

1. Condenser-water flow to each cell of the cooling tower.
2. Pressure at each inlet connection.
3. Entering- and leaving-water temperatures.
4. Range (cooling tower inlet water temperature minus cooling tower outlet water temperature).
5. Makeup-water flow rate.
6. Makeup-water temperature.
7. Wet- and dry-bulb temperatures of entering air.
8. Wet- and dry-bulb temperatures of leaving air.
9. Approach (ambient wet bulb minus leaving water temperature).
10. Barometric pressure, wind speed, and wind direction.
11. Fan, motor, and motor controller operating data.
12. Heater operating data.

3.22 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record operating data of compressor(s), fan(s), and motors.

3.23 PROCEDURES FOR AIR-COOLED CONDENSERS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record operating data of fan(s) and motor(s).

3.24 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Record relief valve(s) pressure setting.
5. Fan, motor, and motor controller operating data.

B. Steam Boilers:

1. Measure and record entering-water temperature.
2. Measure and record feedwater flow.
3. Record leaving-steam pressure and temperature from installed gauges.
4. Record relief valve(s) pressure setting.
5. Fan, motor, and motor controller operating data.

C. Boilers with Flue Gas Economizers:

1. Measure and record entering- and leaving-water temperature.
2. Measure and record water flow rate.
3. Measure and record water pressure drop.

D. Gas-Fired Boilers:

1. Test and document proper operation of emergency gas shut-down switch.

3.25 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.
8. Use coil pressure drop to determine flow if no flow meter measurement exists.
9. Use temperatures and flows to calculate actual capacity on each coil and heat-transfer coils.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Record full load kW.
7. Record fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Record inlet steam pressure from installed gauge.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.

3.26 PROCEDURES FOR EXHAUST HOODS

A. Room Pressure: Measure and record room pressure with respect to atmosphere and adjacent space with hoods in room initially not operating and then with hoods operating.

B. Makeup Air: Systems supplying source of makeup air to hoods are to be in operation during testing and balancing of exhaust hoods.

1. Measure and record temperature of makeup air entering hood. If hood makeup air is from multiple sources having different temperatures, measure and record the airflow and temperatures of each source and calculate the weighted average temperature.
2. Use simulated smoke to observe supply air-distribution air patterns in vicinity of hoods. Consult with hood manufacturer and report conditions that have a detrimental effect on intended capture, containment, and other attributes effecting proper operation.

C. Rooms with Multiple Hoods: Test each hood separately, one at a time, and repeat tests with all hoods intended to operate simultaneously by design.

D. Canopy Hoods: Measure and record the following:

1. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity.
2. Measure velocity across hood face and calculate hood airflow.

a. Clearly indicate the direction of flow at each point of measurement.
b. Measure velocity across opening on not less than [12-inch (300-mm)]<**Insert dimension**> centers. Record velocity at each measurement, and calculate average velocity.

3. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

E. Laboratory Fume Hoods:

1. See Section 115313 "Laboratory Fume Hoods" for testing requirements in "Performance Requirements" Article.
2. Measure and record the following:

a. Pressure drop across hood.
b. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity. If hood is connected to exhaust duct distribution through an exhaust device with integral airflow measurement, that reading may be used in lieu of a duct traverse.
c. Face velocity across open hood face and calculate hood airflow.

1) Clearly indicate the direction of flow at each point of measurement.
2) Measure face velocity across opening, using imaginary grid pattern and calibrated fixed anemometer readings per grid in accordance with ASHRAE 110 airflow face velocity measurement procedure.

d. ASHRAE 110 Capture and Containment Testing:

1) With room and laboratory fume hood operating at design conditions, perform an "as-installed" performance test of the laboratory fume hood in accordance with the following ASHRAE 110 tests:

a) Flow visualization procedure.
b) Tracer gas test procedure.

F. Kitchen Grease Hoods:

1. Testing Procedure:

a. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's written instructions. Consult hood manufacturer to determine hood airflow using recorded information.
b. Type 2: Measure and record airflow by duct traverse.
c. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

2. Testing: Testing procedure is to be in accordance with AABC's "National Standards for Total System Balance."

G. Authorities Having Jurisdiction Tests: Conduct additional tests required by authorities having jurisdiction.

3.27 SOUND TESTS

A. After systems are balanced and Substantial Completion, with all systems operating at normal conditions and with all spaces completed and finished for occupancy, measure and record sound levels at [**five**][**10**][**15**]<**Insert number**> locations as designated by Architect. All building mechanical, electrical, and plumbing equipment, which may affect sound readings, must be operational.

B. Sound-Level Testing Meter Instrumentation - Minimum Requirements:

1. Portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. Capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (Leq).
3. Capable of using one-third octave band filters to measure frequencies from 31.5 Hz to 8000 Hz.
4. Accuracy of plus/minus two decibels.
5. Current NIST-traceable annual calibration. Calibrate instruments prior to taking measurements and after taking measurements each day of use.

C. Test Procedures - Indoors:

1. Measure and record sound levels at the following rooms: <**Insert list of room numbers and names where sound testing is required**> .
2. For each room/location tested, select a measurement location that has the greatest anticipated sound level. If testing multiple locations for each room type, select at least one location that is near and at least one location that is remote from the predominant sound source.
3. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
4. Equipment is to be operating at design values.
5. Sound-testing firm is to have access to controls hardware, software, and onsite technical support at no cost to the sound-testing firm. The installing contractors are to provide a controlled, steady-state environment (flow, pressure, control, and temperature) during the duration of sound testing.
6. Use a microphone suitable for the type of noise levels measured that is compatible with meter.
7. At each measurement location, record a set of background sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment off.
8. At each measurement location, record a set of sound pressure levels, with fast time constant and minimum time duration of 60 seconds, in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**][**31.5 Hz to 4000 Hz (RC)**] with the equipment operating.
9. Take readings no closer than **36 inches (900 mm)** from a wall or from the operating equipment and approximately **48 inches (1200 mm)** from the floor, with the meter held or mounted on a tripod.

D. Test Procedures - Outdoors:

1. Make outdoor measurements at [**property lines**]<**Insert location(s)**> .
2. Make measurements when background noise sources are at a minimum or when they do not affect equipment sound levels such as when the background noise levels are at least 10 dB less than the equipment noise levels.
3. Use microphone suitable for the type of noise levels measured that is compatible with the meter and as recommended by the sound-level meter manufacturer.
4. Provide a windshield for outside measurements whenever wind speed is greater than **5 mph (8 Km/h)**.

E. Reporting:

1. The final report is to contain the following information at a minimum:

a. Report Title Page: Page indicating Project name, names of Project Architect, engineer, HVAC Contractor, and sound measurement firm with names, addresses, and telephone numbers.
b. Report Certification Page: Page indicating Project name, sound measurement firm name, name of individual performing measurements, and all required sound technician certifications.
c. Table of Contents: Identify report sections and total number of pages in each section.
d. Report Summary/Remarks: Narrative description of system setup conditions, results, and deficiencies.
e. Instrument Calibration Section: List of instruments to be used to verify the reported data, containing the name/type of each instrument, manufacturer, model number, serial number, calibration date and dates of use, and NIST-traceable calibration certificates.
f. Sound Measurement Data Sheets: Record sound measurements on sound measurement report forms, indicating the decibel levels measured for both "background" and "building system operating" readings. Record each tested location on a separate NC or RC chart. Record the following information on the forms:

1) Date and time of test.
2) Equipment Operational Parameters: Speed and frequency at time of measurements.
3) Indoor Measurements: Space location within the building, including floor level and room space number.
4) Outdoor Measurements: Location identifier such as location relative to equipment, building, or property line.
5) Indicate where measurements meet or exceed design criteria.

3.28 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than [**3**]<**Insert number**>[**for pumps and fans,**][**5**]<**Insert number**>[**for chillers and compressors**] .

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. Meter is to automatically identify engineering units, frequency resolution, filter bandwidth, amplitude, and frequency scale values.
3. Meter is to be able to measure machine vibration displacement in mils of deflection; velocity in inches per second (meters/sec); and acceleration in G's (or g-force), inches per second squared (G's, meters per second squared).
4. Calibration of instrument and transducer must be NIST traceable and must be current during the time period measurements are being made. Vibration instruments and transducers must have NIST-traceable calibration every 12 months. Verify calibration date is current for vibration meter before taking readings.

C. Pretest Procedures:

1. Before any vibration measurements are made, confirm that the following items have been completed and any deficiencies found are reported to the appropriate parties for remedy:

a. Verify that all vibration isolators are installed in accordance with respective manufacturer's written instructions.
b. Verify that piping, duct, and conduit penetrations through mechanical equipment room envelope are sealed, and that there is no rigid contact with building structure.

c. Inspect steel isolation bases for cracked welds and bending/twisting of steel members.
d. Inspect concrete isolation bases for cracked concrete. Check isolator retainer brackets to be sure they are not loose. Concrete base must be flat and true level.
e. Examine elastomeric isolators for cracks in the rubber and for loose bonds between the rubber and the steel plates and other steel components. Verify clearance is provided between bolts and the side of bolt holes to prevent short circuiting.
f. Examine steel spring isolators for loose or missing bolts, nuts, and lock washers. Verify springs are not overloaded or underloaded, completely collapsed, or cocked. Verify rubber or glass-fiber pad between bottom steel spring plate and the concrete/supporting structure is in place.
g. Inspect isolators that have seismic restraint devices to make sure that all shims have been removed and supportive nuts have been properly adjusted to allow for free floating of the isolated system.
h. Verify that seismic restraints are not preventing proper functioning of vibration isolation function.
i. Verify space under isolated bases are clean and free of debris that could cause short-circuiting.
j. Verify that shipping bolts associated with spring isolators have been removed so that they do not short-circuit the system.
k. Verify flexible piping, hoses, and expansion joint types, lengths, and locations are as specified.
l. Verify that electrical and control connections do not restrain movement of the vibration-isolated equipment.
m. Verify flexible connections between fans and ductwork "bellow" as designed when fans are operating.
n. Verify that hanger isolator rods are free of misalignment and not in rigid contact with the hanger housing.

D. Test Procedures:

1. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not adversely influence measurements of equipment being tested.
2. Observe if there is equipment in the building that might interfere with testing. Note the equipment to the Construction Manager and request resolution before testing begins.
3. Take measurements when exterior vibration sources, such as trains, roadway traffic, adjacent construction activities, and the like, are at a minimum level.
4. Attach and secure vibration transducer in accordance with the most current edition of [**NEBB's "Procedural Standards for Measurement of Sound and Vibration**]<**Insert reference document**> .
5. Measure and record vibration levels [**in at least 1.25 Hz (75 rpm) increments over a minimum frequency range of 5 to 1000 Hz (300 to 60,000 rpm)**]<**Insert increment requirements**> .
6. Measure and record acceleration and/or velocity and/or displacement readings on equipment; bearing and equipment base in the vertical, horizontal, and axial planes; or as per-contract specifications, where measurements can be performed safely and where measurement locations are accessible.

   a. Pumps:

      1) Pump Bearing: Drive end and opposite end.
      2) Motor Bearing: Drive end and opposite end.
      3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
      4) Building: Floor adjacent to pump/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

   b. Fans and HVAC Equipment with Fans:

1) Fan Bearing: Drive end and opposite end.
2) Motor Bearing: Drive end and opposite end.
3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator; vertical axis only.

c. Chillers and HVAC Equipment with Compressors:

1) Compressor Bearing: Drive end and opposite end.
2) Motor Bearing: Drive end and opposite end.
3) Equipment Base: Top and side, within **6 inches (152 mm)** of one isolator.
4) Building: Floor adjacent to pump/motor, within **6 inches (152 mm)** of one isolator; vertical axis only.

7. FFT Analyzer Settings:

a. Windowing: Hanning.
b. Averages: At least two.
c. Frequency Range: **5 to 1000 Hz (300 to 60,000 rpm)**.
d. Frequency Resolution: At least **1.25 Hz (75 rpm)**.
e. Line of Resolution: At least 800.
f. Detection: Peak, peak-to-peak, or RMS.
g. Averaging: Exponential.

E. Reporting:

1. Vibration Measurement Report Forms:

a. For each measurement location, record vibration measurements on appropriate test forms, showing the following information:

1) Date of test.
2) Equipment designation, location, motor horsepower, and equipment operational parameters (speed/frequency) at time of test.
3) Measured acceleration, [**in units of G's (g-force), inches/seconds squared (meters/seconds squared)**]<**Insert units of measure**> .
4) Measured deplacement, [**in units of inches, mils (millimeters)**]<**Insert units of measure**> .
5) Vibration level plot of vibration amplitude versus frequency for each measurement location.
6) Verify vibration amplitude level plot versus frequency for each measurement location.

2. Verify actual vibration against vibration limits. Follow the [**General Machinery Vibration Severity Chart**][**or**][**Vibration Acceleration General Severity Chart**] from [**ASHRAE Handbook - "HVAC Applications," Ch. "Noise and Vibration Control"**][**NEBB's "Procedural Standard for Measurement of Sound and Vibration"**][**or**][**AABC's "National Standards for Total System Balance"**] . Acceptable levels of vibration are normally "smooth" to "good."
3. Include General Machinery Vibration Severity Chart with all conditions plotted.
4. Test each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
5. Include horizontal-vertical-axial measurements for tests.

3.29 DUCT-LEAKAGE TESTS VERIFICATION

A. Witness the duct-leakage testing performed by Installer.

B. Duct-leakage testing is to be performed by a technician certified by [**AABC**][**NEBB**][**TABB**][**or**]<**Insert other equivalent approved agency**> in accordance with SMACNA's "HVAC Air Duct Leakage Test Manual" and IAPMO's Uniform Mechanical Code, "Duct Leakage Tests" Article.

C. Verify that proper test methods are used and that leakage rates are within specified limits.

D. Report deficiencies observed.

3.30 PIPE-LEAKAGE TESTS VERIFICATION

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.31 UFAD PLENUM-LEAKAGE TESTS VERIFICATION

A. UFAD Plenum-Leakage Testing Performed by TAB Specialist:

1. Verify that leakage rates are within specified limits for Category 1 and for Category 2 leakage utilizing [**technology similar to door fan test rigs**]<**Insert testing method**> .
2. Report results and deficiencies observed.

B. UFAD Plenum-Leakage Testing Witnessed by TAB Specialist:

1. Witness the UFAD plenum pressure testing performed by Installer.
2. Verify that proper test methods are used and that leakage rates are within specified limits for Category 1 and for Category 2 leakage.
3. Report deficiencies observed.

3.32 HVAC-CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Work to ensure the system is operating within the design limitations and gain a mutual understanding of intended controls performance.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.33 PROCEDURES FOR STAIR-PRESSURIZATION SYSTEM TESTS

A. Before testing, observe each pressurized stair enclosure to verify construction is complete. Verify the following:

1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
2. Firestopping and sealants are installed.
3. Doors, door closers, and door gaskets are installed and adjusted.
4. If applicable, window installation is complete.
5. Stair-pressurization fans and associated controls are installed and functioning properly.
6. Stair-pressurization duct distribution and air outlets are installed.
7. Life-safety dampers (smoke or combination fire and smoke) are installed and functioning properly.

B. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.

C. Test each stair enclosure as a single system. If multiple fans serve a single stair enclosure, operate fans as intended by the design.

D. Initial Air Balance: Open doors to floors where indicated by design and measure, adjust, and record the airflow of each of the following:

1. Stair-pressurization fan. For ducted systems, measure fan airflow by duct Pitot-tube traverse unless duct distribution does not permit accurate readings.
2. Air outlet supplying stair enclosure.
3. Adjust enclosure total airflow to achieve design pressurization.
4. Adjust method of stair enclosure pressure relief to prevent overpressurization.

E. Pressurization Test and Adjustments:

1. After air balancing is complete, perform stair enclosure-pressurization tests.
2. Establish a consistent procedure for recording data throughout entire test.
3. Use stair side of doors as pressure reference point.

   a. Positive Pressure: Floor side of door higher than stair side.
   b. Negative Pressure: Floor side of door lower than stair side.

4. With HVAC systems and stair-pressurization systems off, measure and record the following:

   a. Pressure difference across each stair enclosure door, with all doors in the stair enclosure closed.
   b. Force necessary to open each door, using a spring-type scale.
   c. Adjustment needed to achieve design pressurization of enclosure total airflow.
   d. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.

5. With HVAC systems operating in normal mode and stair-pressurization systems off, measure and record the following:

a. Pressure difference across each stair enclosure door, with all doors in the stair enclosure closed.
b. Force necessary to open each door, using a spring-type scale.
c. Adjustment needed to achieve design pressurization of enclosure total airflow.
d. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.

6. With HVAC systems and stair-pressurization system operating simultaneously, perform the following:

a. Place HVAC systems in normal operating mode, including equipment not used to implement smoke control, such as air-handling units, exhaust fans, and similar equipment.
b. Measure and record pressure difference across each stair enclosure door, with all doors in stair enclosure closed.
c. Use a spring scale to measure and record the force needed to open all stair enclosure doors.
d. Adjust enclosure total airflow to achieve design pressurization.
e. Adjust method of stair enclosure pressure relief to prevent overpressurization.
f. Additional Tests for Designs with Open Doors:

1) With exit door to outdoors in open position, measure and record pressure difference across each of the remaining closed stair enclosure doors.
2) Open additional doors (up to the number indicated by design) one at a time, and measure and record pressure difference across each remaining closed stair enclosure door after the opening of each additional door.
3) For each different test condition, measure and record the direction and velocity through each of the open doors by a traverse of every [**1 sq. ft. (0.093 sq. m)**]<**Insert requirement**> grid of door opening.
4) For each different test condition, calculate average of door velocity measurements. Compare average velocity to design and governing code requirements.
5) Adjust enclosure total airflow to achieve design pressurization.
6) Adjust method of stair enclosure pressure relief to prevent overpressurization.

7. Repeat pressurization tests with the smoke-control systems and HVAC systems operating.
8. Criteria for Acceptance:

a. Compliance with design requirements.
b. Compliance with code requirements.
c. Compliance with additional requirements required by authorities having jurisdiction.

F. Operational Tests:

1. Check proper activation of stair-pressurization system(s) in response to all means of activation, both automatic and manual.
2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:

a. Normal.
b. Alarm.
c. Manual override.
d. Return to normal.

3. Verify smoke detector at pressurization fan de-energizes fan and closes isolation damper when smoke detector is activated and in alarm.
4. If standby power is provided for pressurization systems, test to verify pressurization systems operate while on both normal and standby power.

5. Check operation in accordance with design indicated.

G. Authority Having Jurisdiction Tests: Conduct additional tests required by authorities having jurisdiction.

H. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.

3.34 PROCEDURES FOR ELEVATOR-PRESSURIZATION SYSTEM TESTS

A. Before testing, observe each pressurized elevator enclosure to verify construction is complete. Verify the following:

1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
2. Firestopping and sealants are installed.
3. Doors are installed and adjusted. Elevator car doors are recalled to the default recall floor, and elevator car doors on recall floor are open.
4. If applicable, window installation is complete.
5. Pressurization fans and associated controls are installed and functioning properly.
6. Pressurization duct distribution and air outlets are installed.
7. Life-safety dampers (smoke or combination fire and smoke) are installed and functioning properly.

B. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.

C. Test each elevator enclosure as a single system. If multiple fans serve a single elevator enclosure, operate fans as intended by the design.

D. Initial Air Balance: Open elevator car doors to recall floor indicated by design, and measure, adjust, and record the airflow of each:

1. Pressurization fan. For ducted systems, measure fan airflow by duct pitot-tube traverse unless duct distribution does not permit accurate readings.
2. Air outlet supplying elevator enclosure.
3. Adjustment needed to achieve design pressurization of enclosure total airflow.
4. Adjustment to method of elevator enclosure pressure relief, to prevent overpressurization.

E. Pressurization Tests and Adjustments:

1. After air balancing is complete, perform elevator enclosure pressurization tests.
2. Establish a consistent procedure for recording data throughout entire test.
3. Use elevator car side of doors as pressure reference point.

   a. Positive Pressure: Floor side of door higher than elevator car side.
   b. Negative Pressure: Floor side of door lower than elevator car side.

4. With HVAC systems and elevator-pressurization systems off, measure and record the following:

   a. Pressure difference across each elevator enclosure door, with all doors in the elevator enclosure closed.
   b. Adjustment needed to achieve design pressurization of enclosure total airflow.
   c. Adjustment needed to method of stair enclosure pressure relief, to prevent

overpressurization.

5. With HVAC systems operating in normal mode and elevator pressurization systems off, measure and record the following:

    a. Pressure difference across each elevator enclosure door, with all doors in the elevator enclosure closed.
    b. Adjustment needed to achieve design pressurization of enclosure total airflow.
    c. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.

6. With HVAC systems and elevator pressurization system operating simultaneously, perform the following:

    a. Place HVAC systems in normal operating mode, including equipment not used to implement smoke control, such as air-handling units, exhaust fans, and similar equipment.
    b. Measure and record pressure difference across each stair enclosure door, with all doors in stair enclosure closed.
    c. Adjust enclosure total airflow to achieve design pressurization.
    d. Adjust method of elevator enclosure pressure relief to prevent overpressurization.

7. Repeat pressurization tests with smoke-control systems and HVAC systems operating.
8. Criteria for Acceptance:

    a. Compliance with design requirements.
    b. Compliance with code requirements.
    c. Compliance with additional requirements of authorities having jurisdiction.

F. Operational Tests:

1. Check proper activation of elevator-pressurization system(s) in response to all means of activation, both automatic and manual.
2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:

    a. Normal.
    b. Alarm.
    c. Manual override.
    d. Return to normal.

3. Verify smoke detector at pressurization fan de-energizes fan and closes isolation damper when smoke detector is activated and in alarm.
4. If standby power is provided for pressurization systems, test to verify pressurization systems operate while on both normal and standby power.
5. Check operation in accordance with design indicated.

G. Authority Having Jurisdiction Tests: Conduct additional tests required by authorities having jurisdiction.

H. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.

3.35 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTS

A. Before testing smoke-control systems, review design documents to understand operating requirements

and design intent:

1. Review boundaries of each smoke zone.
2. Review location, size, and operating characteristics of equipment, such as smoke and fire smoke dampers.
3. Review sequence of operation, smoke-control matrix, operating status of equipment, and position of smoke and fire dampers for each smoke zone alarm condition.
4. Review location and type of alarm detection used to initiate smoke control for each smoke zone.
5. Review other smoke-control system attributes not listed but required for code compliance and acceptance by authorities having jurisdiction.

B. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary.

1. Verify that windows, doors, walls, ceilings, and floors (six-sided boundary) are closed and that applicable safing, gasket, and firestops and sealants are installed.
2. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

C. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.

D. Measure, adjust, and record airflow of each smoke-control system, with all fans that are a part of system operating as intended by the design.

1. Measure, adjust, and record the airflow of each fan. For ducted systems, measure fan airflow by duct Pitot-tube traverse.
2. Measure, adjust, and record the airflow of each exhaust inlet and supply outlet.
3. Measure, adjust, and record airflow in main and branch ducts.

E. Smoke Control by Pressurization: After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system designed for isolation by using pressurization boundaries:

1. Verify the boundaries of each smoke-control zone.
2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high- and low-pressure side of each door.
3. With the system operating in the smoke-control mode and with each separate zone in the smoke-control system activated, perform the following:

   a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones.

      1) Make measurements with doors that separate the smoke zone from the other zones closed.
      2) Clearly indicate the high- and low-pressure side of the door.
      3) Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.

   b. Continue to activate each separate smoke zone within each smoke-control system and make pressure-difference measurements.
   c. After testing a smoke zone's smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone's smoke-

control system.

d. Verify that controls necessary to prevent excessive pressure differences are functional and operating within design set points and limits.

F. Smoke-Control Systems for Atriums and Other Large-Volume Spaces: After air balancing is complete, perform the following testing for each smoke-control system serving atriums and other large-volume spaces:

1. Verify and document the boundaries served by each smoke-control system.
2. Identify and document closed doors, open doors, and other boundary openings to be left open to adjacent areas and that are to be protected by airflow alone.
3. With the HVAC systems in their normal mode of operation and smoke-control systems not operating, measure and record the following:

   a. Pressure difference across each door that separates the smoke-zone from adjacent zones.
   b. Velocity for each point in traverse across each boundary opening:

      1) Clearly indicate the direction of flow.
      2) Measure velocity across opening on [**12-inch (300-mm)**]<**Insert dimension**> centers using a vane anemometer. Calculate and report airflow.

4. With system operating in the smoke-control mode, measure and record the following:

   a. Pressure difference across each door that separates the smoke zone from adjacent zones.
   b. Velocity for each point in traverse across each opening:

      1) Clearly indicate the direction of flow.
      2) Measure velocity across opening on [**12-inch (300-mm)**]<**Insert dimension**> centers using a vane anemometer. Calculate and report airflow.

5. Verify system operation and make adjustments to achieve design pressure differences and air velocities within design set points and upper operating limits.

G. Operational Tests: As described in the sequences of operation and in the smoke-control matrix.

1. Check the proper activation of each zone of each smoke-control system in response to all means of activation, both automatic and manual.
2. Check automatic activation in response to fire alarm signals received from the building's fire alarm system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zone of each smoke-control system occurs.
3. Check and record proper operation of fans, dampers, and related equipment for each separate zone of each smoke-control system:

   a. Zone in which a smoke-control system automatically activates.
   b. Type of signal that activates smoke-control system, such as sprinkler flow or smoke detector.
   c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.
   d. Positive-pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
   e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted to verify that the intended control configuration is achieved.
   f. Fan(s) "OFF" as required to implement the smoke-control system.
   g. Damper(s) "OPEN" or at an adjustable position where maximum airflow must be achieved.
   h. Damper(s) "CLOSED" where no airflow should take place.

i. Auxiliary functions to achieve the smoke-control system configuration, such as changes or override of normal operating pressure and temperature-control set points.
j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.
k. Check operation in accordance with design indicated.

H. Authority Having Jurisdiction Tests: Conduct additional tests required by authorities having jurisdiction. [**Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.**]

I. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.

3.36 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the condition of filters.
5. Check the condition of coils.
6. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB after Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. Balance each air outlet.

3.37 TOLERANCES

A. Set HVAC system's airflow rates and water-flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: [**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**> . If design value is less than **100 cfm (47 L/s)**, flow rate is within **10 cfm (4.7 L/s)**.
2. Air Outlets and Inlets: [**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**> . If design value is less than **100 cfm (47 L/s)**, flow rate is within **10 cfm (4.7 L/s)**.
3. Heating-Water Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**> . If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
4. Chilled-Water Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**> . If design value is less than **10 gpm (0.63 L/s)**, flow rate is within 10 percent.
5. Condenser-Water Flow Rate: [**Plus or minus 5 percent**][**Plus or minus 10 percent**][**Plus 10 percent or minus 5 percent**]<**Insert value**> .

B. Maintaining pressure relationships as designed is to have priority over the tolerances specified above. If the above tolerances change the relative positive or negative airflow from/into the space, tolerances are to be adjusted so as to keep the relative positive cfm or negative cfm from/into the space a constant cfm differential.

3.38 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare [**weekly**][**biweekly**][**monthly**]<**Insert time interval**> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.39 FINAL TESTING AND BALANCING REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist firm and technician.
3. Project name.
4. Project location.
5. Project Architect's name, firm, and address.
6. Project engineer's name, firm, and address.
7. Project Contractor's name, firm, and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fan performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. [**Variable-frequency controller**][**Inlet vane**] settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.

d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in **inches (mm)**, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in **inches (mm)**, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in **cfm (L/s)**.
b. Total system static pressure in **inches wg (Pa)**.
c. Fan speed.
d. Inlet and discharge static pressure in **inches wg (Pa)**.
e. For each filter bank, filter static-pressure differential in **inches wg (Pa)**.
f. Preheat-coil static-pressure differential in **inches wg (Pa)**.
g. Cooling-coil static-pressure differential in **inches wg (Pa)**.
h. Heating-coil static-pressure differential in **inches wg (Pa)**.
i. List for each internal component with pressure-drop, static-pressure differential in **inches wg (Pa)**.
j. Outdoor airflow in **cfm (L/s)**.
k. Return airflow in **cfm (L/s)**.
l. Outdoor-air damper position.
m. Return-air damper position.
n. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in **fins per inch (mm)** o.c.
f. Make and model number.
g. Face area in **sq. ft. (sq. m)**.
h. Tube size in **NPS (DN)**.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in **cfm (L/s)**.
b. Average face velocity in **fpm (m/s)**.
c. Air pressure drop in **inches wg (Pa)**.

d. Outdoor-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
e. Return-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
f. Entering-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
g. Leaving-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
h. Water-flow rate in **gpm (L/s)**.
i. Water pressure differential in **feet of head or psig (kPa)**.
j. Entering-water temperature in **deg F (deg C)**.
k. Leaving-water temperature in **deg F (deg C)**.
l. Recorded inlet steam pressure in **psig (kPa)**, as read from installed gauge.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Motor horsepower and speed.
h. Motor volts, phase, and hertz.
i. Motor full-load amperage and service factor.
j. Sheave make, size in **inches (mm)**, and bore.
k. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in **cfm (L/s)**.
b. Entering-air temperature in **deg F (deg C)**.
c. Leaving-air temperature in **deg F (deg C)**.
d. Air temperature differential in **deg F (deg C)**.
e. Entering-air static pressure in **inches wg (Pa)**.
f. Leaving-air static pressure in **inches wg (Pa)**.
g. Air static-pressure differential in **inches wg (Pa)**.
h. Motor voltage at each connection.
i. Motor amperage for each phase.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in **Btu/h (kW)**.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in **cfm (L/s)**.
i. Face area in **sq. ft. (sq. m)**.
j. Minimum face velocity in **fpm (m/s)**.

2. Test Data (Indicated and Actual Values):

   a. Heat output in **Btu/h (kW)**.
   b. Airflow rate in **cfm (L/s)**.
   c. Air velocity in **fpm (m/s)**.
   d. Entering-air temperature in **deg F (deg C)**.
   e. Leaving-air temperature in **deg F (deg C)**.
   f. Voltage at each connection.
   g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in **inches (mm)**, and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.

2. Motor Data:

   a. Motor make and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in **inches (mm)**, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in **cfm (L/s)**.
   b. Total system static pressure in **inches wg (Pa)**.
   c. Fan speed.
   d. Discharge static pressure in **inches wg (Pa)**.
   e. Suction static pressure in **inches wg (Pa)**.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

   a. System fan and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in **deg F (deg C)**.
   d. Duct static pressure in **inches wg (Pa)**.
   e. Duct size in **inches (mm)**.
   f. Duct area in **sq. ft. (sq. m)**.
   g. Indicated airflow rate in **cfm (L/s)**.
   h. Indicated velocity in **fpm (m/s)**.
   i. Actual airflow rate in **cfm (L/s)**.
   j. Actual average velocity in **fpm (m/s)**.

k. Barometric pressure in **psig (Pa)**.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in **sq. ft. (sq. m)**.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in **cfm (L/s)**.
b. Air velocity in **fpm (m/s)**.
c. Preliminary airflow rate as needed in **cfm (L/s)**.
d. Preliminary velocity as needed in **fpm (m/s)**.
e. Final airflow rate in **cfm (L/s)**.
f. Final velocity in **fpm (m/s)**.
g. Space temperature in **deg F (deg C)**.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in **cfm (L/s)**.
b. Entering-water temperature in **deg F (deg C)**.
c. Leaving-water temperature in **deg F (deg C)**.
d. Water pressure drop in **feet of head or psig (kPa)**.
e. Entering-air temperature in **deg F (deg C)**.
f. Leaving-air temperature in **deg F (deg C)**.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.

f. Water flow rate in **gpm (L/s)**.
g. Water pressure differential in **feet of head or psig (kPa)**.
h. Required net positive suction head in **feet of head or psig (kPa)**.
i. Pump speed.
j. Impeller diameter in **inches (mm)**.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in **feet of head or psig (kPa)**.
b. Pump shutoff pressure in **feet of head or psig (kPa)**.
c. Actual impeller size in **inches (mm)**.
d. Full-open flow rate in **gpm (L/s)**.
e. Full-open pressure in **feet of head or psig (kPa)**.
f. Final discharge pressure in **feet of head or psig (kPa)**.
g. Final suction pressure in **feet of head or psig (kPa)**.
h. Final total pressure in **feet of head or psig (kPa)**.
i. Final water flow rate in **gpm (L/s)**.
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration and interval.

3.40 VERIFICATION OF TAB REPORT

A. The TAB specialist firm's test and balance technician is to conduct the final verification in the presence of [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] .

B. [**Architect**][**Owner**][**Construction Manager**][**Commissioning Authority**] are to randomly select measurements, documented in the final report, to be rechecked. Rechecking is to be limited to the lesser of either [**10**]<**Insert number**> percent of the total measurements recorded or the extent of measurements that can be accomplished in [**a normal 8-hour business day**]<**Insert value**> .

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements are to be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than [**10**][**20**]<**Insert number**> percent of the total measurements checked during the final inspection, the TAB are to be considered incomplete and are to be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists are to recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes are to be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.41 REVERIFICATION

A. TAB specialist firm technicians are to recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and balancing device settings to include all changes; resubmit final report and request a second verification.

B. If the second verification also fails, [**Owner**][**Architect**] may contact [**AABC headquarters regarding the AABC National Performance Guaranty**][**TABB Quality Assurance Program, Customer Complaint Procedures**]<**Insert guaranty organization**> .

3.42 ADDITIONAL TESTS

A. Within [**90**]<**Insert number**> days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93 00

Task	Specification	Specification Description
23 05 93 00	02 41 19 00	Selective Demolition
23 05 93 00	23 05 00 00a	Coatings for HVAC

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SECTION 23 07 13 00 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber duct insulation.
2. Mineral wool duct insulation.
3. Flexible elastomeric duct insulation.
4. Polyolefin duct insulation.
5. Fire-rated duct insulation systems.
6. Insulation adhesives.
7. Insulation mastics and coatings.
8. Insulation sealants.
9. Field-applied insulation jackets.
10. Field-applied fabric-reinforcing mesh for insulation.
11. Field-applied cloths for insulation.
12. Vapor-retarder tapes.
13. Insulation securements.
14. Insulation corner angles.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct insulation liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties, and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
2. Sheet Jacket Materials: **12 inches (300 mm)** square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Product Data: For coatings, indicating VOC content.
4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:

a. One **10-ft. (3-m)** section each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. One rectangular and round transition fitting.
e. Four support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes, and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 DUCT INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 GLASS-FIBER DUCT INSULATION

A. Duct Insulation Wrap - Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

3. Description: Glass-fiber blanket duct insulation wrap consisting of glass fibers bonded with a thermosetting resin.
4. Suitable for maximum use temperature up to **450 deg F (232 deg C)** in accordance with ASTM C411.
5. Standards: ASTM C553, Type II, and ASTM C1290.
6. Without Insulation Facing: Type I.
7. Factory-Applied Insulation Facing:

   a. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   b. FSP: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type III.
   c. Vinyl: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

B. Duct Insulation Wrap - High-Temperature, Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: High-temperature, glass-fiber blanket duct insulation wrap consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C553, Type V, suitable for maximum use temperature up to **1000 deg F (650 deg C)**.
5. Unfaced.

C. Duct Insulation Wrap - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass-fiber board duct insulation wrap consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type IA or Type IB.
5. Suitable for use temperature between **35 deg F (1.7 deg C)** and **250 deg F (121 deg C)** for jacketed and between **35 deg F (1.7 deg C)** and **450 deg F (232 deg C)** for unfaced in accordance with ASTM C411.
6. Unfaced.

7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
   b. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

D. Duct Insulation Wrap - High-Temperature, Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

3. Description: High-temperature, glass-fiber board duct insulation wrap consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1000 deg F (650 deg C)** in accordance with ASTM C411.

E. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**Knauf Insulation**]
   d. [**Manson Insulation Inc.**]
   e. [**Owens Corning**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass-fiber, pipe and tank insulation wrap consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for use between **35 deg F (1.7 deg C)** and **850 deg F (454 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facings:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.4 MINERAL WOOL DUCT INSULATION

A. Duct Insulation Wrap - Mineral Wool Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool blanket duct insulation wrap consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C553.
5. Unfaced.
6. Suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447.

B. Duct Insulation Wrap - Mineral Wool Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool board, duct insulation wrap consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1100 deg F (600 deg C)** in accordance with ASTM C411.

C. Duct Insulation Wrap - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool, pipe and tank insulation wrap consisting of fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facings:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.5 FLEXIBLE ELASTOMERIC DUCT INSULATION

A. Duct Insulation Wrap - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric duct insulation wrap.
4. Standard: ASTM C534/C534M, Type II for sheet materials.
5. Grade 1, suitable for use between **minus 70 deg F (minus 57 deg C)** and **plus 220 deg F (plus 104 deg C)**.

2.6 POLYOLEFIN DUCT INSULATION

A. Duct Insulation Wrap - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Armacell LLC**]
   b. [**Sekisui Voltek, LLC**]
   c. [**Thermaduct**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armacell LLC**]
   b. [**Sekisui Voltek, LLC**]
   c. [**Thermaduct**]
   d. <**Insert manufacturer's name**>

3. Description: Polyethylene-type of polyolefin thermal plastic duct insulation wrap.
4. Standard: ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.7 FIRE-RATED DUCT INSULATION SYSTEMS

A. Duct Insulation - Fire-Rated Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: Structural-grade, press-molded, xonolite calcium silicate fireproofing board insulation.
4. Standard: ASTM C656, Type II, Grade 6, suitable for operating temperatures up to **1700 deg F (927 deg C)**.
5. Fire-Rating Requirements: Insulation assembly to be tested and certified to provide a [**1**][**2**] -hour fire rating by an NRTL acceptable to authorities having jurisdiction.

B. Duct Insulation - Fire-Rated Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Building and Construction**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Thermal Ceramics**]
   d. [**Unifrax Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Building and Construction**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Thermal Ceramics**]
   d. [**Unifrax Corporation**]
   e. <**Insert manufacturer's name**>

3. Description: High-temperature, flexible, blanket duct insulation with FSK jacket.
4. Fire-Rating Requirements: Insulation assembly to be tested and certified to provide a [**1**][**2**] -hour fire rating by an NRTL acceptable to authorities having jurisdiction.
5. Factory-Applied Insulation Facing:

   a. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with

ASTM C1136, Type II.

2.8 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
6. Service Temperature Range: [**Plus 20 to 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.
8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**Childers Brand; H. B. Fuller Construction Products**]
   d. [**Foster Brand; H. B. Fuller**]
   e. [**K-Flex USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**Childers Brand; H. B. Fuller Construction Products**]
d. [**Foster Brand; H. B. Fuller**]
e. [**K-Flex USA**]
f. <**Insert manufacturer's name**>

3. Verify adhesives have a VOC content of [**50**]<**Insert number**> g/L or less.
4. Standard: MIL-A-24179A, Type II, Class I.

D. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

E. Insulation Adhesive for ASJ and FSK Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]

c. [**Mon-Eco Industries, Inc.**]
d. **<Insert manufacturer's name>**

3. Description: Adhesive for bonding FSK jacket lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

F. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dow Consumer Solutions**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Sekisui Voltek, LLC**]
f. [**Speedline Corporation**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Dow Consumer Solutions**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Sekisui Voltek, LLC**]
f. [**Speedline Corporation**]
g. **<Insert manufacturer's name>**

3. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.
4. Description: PVC jacket adhesive to be compatible with and as recommended in writing in PVC jacket manufacturer's literature.

2.9 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

B. Duct Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aeroflex USA**]
b. [**Childers Brand; H. B. Fuller Construction Products**]
c. [**Foster Brand; H. B. Fuller**]

d. [**Knauf Insulation**]
e. [**Vimasco Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Childers Brand; H. B. Fuller Construction Products**]
c. [**Foster Brand; H. B. Fuller**]
d. [**Knauf Insulation**]
e. [**Vimasco Corporation**]
f. <**Insert manufacturer's name**>

3. Suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
5. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Duct Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Duct insulation vapor-retarder mastic, solvent-based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Duct Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Aeroflex USA**]
b. [**Childers Brand; H. B. Fuller Construction Products**]
c. [**Eagle Bridges - Marathon Industries**]
d. [**Foster Brand; H. B. Fuller**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Childers Brand; H. B. Fuller Construction Products**]
c. [**Eagle Bridges - Marathon Industries**]
d. [**Foster Brand; H. B. Fuller**]
e. <**Insert manufacturer's name**>

3. Description: Duct insulation vapor-retarder mastic, solvent-based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Eagle Bridges - Marathon Industries**]
c. [**Foster Brand; H. B. Fuller**]
d. [**Knauf Insulation**]
e. [**Mon-Eco Industries, Inc.**]
f. [**Vimasco Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Eagle Bridges - Marathon Industries**]
c. [**Foster Brand; H. B. Fuller**]
d. [**Knauf Insulation**]
e. [**Mon-Eco Industries, Inc.**]
f. [**Vimasco Corporation**]
g. <**Insert manufacturer's name**>

3. Description: Duct insulation breather mastic, water-based, suitable for indoor and outdoor use on above ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at

manufacturer's recommended dry film thickness.

5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .
7. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.10 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Verify sealant has a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Eagle Bridges - Marathon Industries**]
c. [**Foster Brand; H. B. Fuller**]
d. [**Mon-Eco Industries, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Eagle Bridges - Marathon Industries**]
c. [**Foster Brand; H. B. Fuller**]
d. [**Mon-Eco Industries, Inc.**]
e. <**Insert manufacturer's name**>

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ, PVDC, and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Materials to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.11 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C921, Type I unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Duct Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**P.I.C. Plastics, Inc.**]
    c. [**Proto Corporation**]
    d. [**Speedline Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**P.I.C. Plastics, Inc.**]
    c. [**Proto Corporation**]
    d. [**Speedline Corporation**]
    e. <**Insert manufacturer's name**>

3. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
4. Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .

D. Duct Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johns Manville; a Berkshire Hathaway company**]
    b. [**RPR Products, Inc.**]
    c. <**Insert manufacturer's name**>

3. Jacket Material - Aluminum:

    a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
    b. Standard: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.

d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .

4. Jacket Material - Stainless Steel:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: ASTM A240/A240M.
c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Foster Brand; H. B. Fuller**]
b. [**MFM Building Products Corp.**]
c. [**Polyguard Products, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Foster Brand; H. B. Fuller**]
b. [**MFM Building Products Corp.**]
c. [**Polyguard Products, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum foil.
4. Vapor Barrier/Waterproofing Membrane: **60 mils (1.5 mm)** thick.

F. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Building and Construction**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Building and Construction**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

3. Description:

   a. Vapor barrier and waterproofing jacket for installation over insulation located aboveground, outdoors or indoors.
   b. Specialized jacket to have five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive.
   c. Outer aluminum surface coated with UV-resistant coating for protection from environmental contaminants.

4. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
5. Flame-Spread/Smoke Developed Index: 25/50 as tested in accordance with ASTM E84.
6. Aluminum Finish: [**Embossed**][**Smooth**] .
7. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

2.12 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Mesh for Duct Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Woven glass-fiber mesh of approximately **6 oz./sq. yd. (203 g/sq. m)** with a thread count of **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)** for covering duct insulation.

B. Woven Polyester Mesh for Duct Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering duct and duct fittings insulation.
4. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.13 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Alpha Associates, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Associates, Inc.**]
b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.14 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Aeroflex USA**]

c. [**Avery Dennison Corporation, Specialty Tapes Division**]
d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
e. [**Knauf Insulation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Aeroflex USA**]
c. [**Avery Dennison Corporation, Specialty Tapes Division**]
d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
e. [**Knauf Insulation**]
f. <**Insert manufacturer's name**>

3. Description: White vapor-retarded tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert value**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
4. Width: [**3 inches (75 mm)**]<**Insert value**> .
5. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
6. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
7. Elongation: [**2**]<**Insert number**> percent.
8. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.

9. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   c. <**Insert manufacturer's name**>

3. Description: White, vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: [**500**]<**Insert number**> percent.
9. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**]<**Insert value**> in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .

5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

2.15 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**RPR Products, Inc.**]
   c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Pins and Hangers - Capacitor-Discharge-Weld Pins:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**AGM Industries, Inc**]
      2) [**Gemco**]
      3) [**Midwest Fasteners, Inc**]
      4) [**Nelson Stud Welding**]
      5) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**AGM Industries, Inc**]

2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Material: [**Mild steel with copper coating**][**Stainless steel**][**Aluminum**] , fully annealed for capacitor-discharge welding.
d. Shank: [**0.106 inch (2.6 mm)**][**0.135 inch (3.5 mm)**] diameter.
e. Length: To suit depth of insulation indicated.

2. Insulation Pins and Hangers - Cupped-Head, Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) <**Insert manufacturer's name**>

c. Material: [**Galvanized steel**][**Stainless steel**] , fully annealed for capacitor-discharge welding.
d. Shank: [**0.106 inch (2.6 mm)**][**0.135 inch (3.5 mm)**] diameter.
e. Length: To suit depth of insulation indicated, with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.

3. Insulation Hangers - Metal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) **<Insert manufacturer's name>**

c. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated in schedules, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated in schedules.
f. Adhesive: Recommended in writing by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates without damaging insulation, hangers, and substrates.

4. Insulation Hangers - Nonmetal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) **<Insert manufacturer's name>**

c. Description: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated in schedules, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Perforated nylon sheet, **0.030 inch (0.76 mm)** thick by **1-1/2 inches (38 mm)** in diameter.
e. Spindle: Nylon, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated in schedules, up to **2-1/2 inches (63 mm)**.
f. Adhesive: Recommended in writing by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates without damaging insulation, hangers, and substrates.

5. Insulation Hangers - Self-Sticking Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]

2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

c. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated in schedules, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated in schedules.
f. Adhesive-backed base with a peel-off protective cover.

6. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
d. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Insulation Washers - Nonmetal, Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C & F Wire Products**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**RPR Products, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**C & F Wire Products**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**RPR Products, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.16 INSULATION CORNER ANGLES

A. Insulation Corner Angle - PVC:

1. Thickness: [**30 mils (0.8 mm)**]<**Insert dimension**> .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Insulation Corner Angle - Aluminum:

1. Thickness: [**0.040 inch (1.0 mm)**]<**Insert dimension**> .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angle - Stainless Steel:

1. Thickness: [**0.024 inch (0.61 mm)**]<**Insert dimension**> .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that duct systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSULATION INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents [**, unless otherwise approved by the Engineer-of-record**] .

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
4. For below ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 INSTALLATION OF INSULATION AT PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least **2 inches (50 mm)**.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least **2 inches (50 mm)**.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC DUCT INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Square and Rectangular Ducts and Plenums:

1. Provide **1/4 inch (6.4 mm)** more per side for a tight, compression fit.
2. Cut sheet insulation with the following dimensions:

   a. Width of duct plus **1/4 inch (6.4 mm)**, one piece.
   b. Height of duct plus **1/4 inch (6.4 mm)**, plus thickness of insulation, two pieces.
   c. Width of duct plus **1/4 inch (6.4 mm)**, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

   a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last **1/4 inch (6.4 mm)** where sheets will butt together.
   b. Roll sheet down into position.
   c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

   a. Peel back release paper in **6- to 8-inch (150- to 203-mm)** increments and line up sheet.
   b. Press firmly to activate adhesive.

c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
d. Allow **1/4-inch (6.4-mm)** overlap for compression at butt joints.
e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

E. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.6 INSTALLATION OF POLYOLEFIN DUCT INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Square and Rectangular Ducts and Plenums:

1. Provide **1/4 inch (6.4 mm)** more per side for a tight, compression fit.
2. Cut sheet insulation with the following dimensions:

a. Width of duct plus **1/4 inch (6.4 mm)**, one piece.
b. Height of duct plus **1/4 inch (6.4 mm)**, plus thickness of insulation, two pieces.
c. Width of duct plus **1/4 inch (6.4 mm)**, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last **1/4 inch (6.4 mm)** where sheets will butt together.
b. Roll sheet down into position.
c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

a. Peel back release paper in **6- to 8-inch (150- to 203-mm)** increments and line up sheet.
b. Press firmly to activate adhesive.
c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
d. Allow **1/4-inch (6.4-mm)** overlap for compression at butt joints.
e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.7 INSTALLATION OF GLASS-FIBER DUCT INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Weld-Pin Installation: Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions **18 inches (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
   b. On duct sides with dimensions larger than **18 inches (450 mm)**, place pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below **50 deg F (10 deg C)** at **18-ft. (5.5-m)** intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches (75 mm)**.

5. Overlap unfaced blankets a minimum of **2 inches (50 mm)** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches (450 mm)** o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each

surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch-(150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches (150 mm)** o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Weld-Pin Installation: Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions **18 inches (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
   b. On duct sides with dimensions larger than **18 inches (450 mm)**, space pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below **50 deg F (10 deg C)** at **18-ft. (5.5-m)** intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches (75 mm)**.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch-(150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches (150 mm)** o.c.

3.8 INSTALLATION OF MINERAL WOOL DUCT INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Weld-Pin Installation: Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions **18 inches (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
    b. On duct sides with dimensions larger than **18 inches (450 mm)**, place pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below **50 deg F (10 deg C)** at **18-ft. (5.5-m)** intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches (75 mm)**.

5. Overlap unfaced blankets a minimum of **2 inches (50 mm)** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches (450 mm)** o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch-(150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches (150 mm)** o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions **18 inches (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
    b. On duct sides with dimensions larger than **18 inches (450 mm)**, space pins **16 inches**

(400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-ft. (5.5-m) intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.9 INSTALLATION OF FIELD-APPLIED CLOTHS FOR INSULATION

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

   1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

   1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.10 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field Applied - FSK:

   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints.
2. Seal with manufacturer's recommended adhesive.
3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.11 INSTALLATION OF FIRE-RATED DUCT INSULATION SYSTEMS

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components and assemblies including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation.
2. Extent of inspection is limited to [**one**]<**Insert number**> location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

E. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

F. Prepare test and inspection reports.

3.14 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Round and Flat-Oval, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.

3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

B. Concealed, Round and Flat-Oval, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

C. Concealed, Round and Flat-Oval, Outdoor-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

D. Concealed, Round and Flat-Oval, Exhaust-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

E. Concealed, Rectangular, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

F. Concealed, Rectangular, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

G. Concealed, Rectangular, Outdoor-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

H. Concealed, Rectangular, Exhaust-Air Duct Insulation between Isolation Damper and Penetration of Building Exterior: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: [**Duct Insulation - Fire-Rated Blanket**][**Duct Insulation - Fire-Rated Board**] ; thickness as required to achieve fire rating indicated under Part 2 product type.

J. Concealed, Supply-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

K. Concealed, Return-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

L. Concealed, Outdoor-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

M. Concealed, Exhaust-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert**

dimension> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

4. Duct Insulation Wrap - Mineral Wool Board: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

N. Exposed, Round and Flat-Oval, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
4. Duct Insulation Wrap - Mineral Wool Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Duct Insulation Wrap - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

O. Exposed, Round and Flat-Oval, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
4. Duct Insulation Wrap - Mineral Wool Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Duct Insulation Wrap - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

P. Exposed, Round and Flat-Oval, Outdoor-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
4. Duct Insulation Wrap - Mineral Wool Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Duct Insulation Wrap - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

Q. Exposed, Round and Flat-Oval, Exhaust-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches**

(75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.

3. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

R. Exposed, Rectangular, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4-lb/cu. ft. (64-kg/cu. m)][6-lb/cu. ft. (96-kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

S. Exposed, Rectangular, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

T. Exposed, Rectangular, Outdoor-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**>

nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

U. Exposed, Rectangular, Exhaust-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

V. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Duct insulation, fire-rated [**blanket**][**board**] ; thickness as required to achieve fire rating indicated in Part 2 "Fire-Rated Duct Insulation Systems" Article.

W. Exposed, Supply-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

X. Exposed, Return-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
2. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**>

nominal density.

5. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Duct Insulation Wrap - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

Y. Exposed, Outdoor-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

Z. Exposed, Exhaust-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

3.16 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, Round and Flat-Oval, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

C. Concealed, Round and Flat-Oval, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.

2. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

D. Concealed, Round and Flat-Oval, Outdoor-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

E. Concealed, Rectangular, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

F. Concealed, Rectangular, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

G. Concealed, Supply-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert**

dimension> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

H. Concealed, Return-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

I. Exposed, Round and Flat-Oval, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
2. Duct Insulation Wrap - Glass-Fiber, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Duct Insulation Wrap - Mineral Wool Blanket: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
4. Duct insulation Wrap - Mineral Wool, Pipe and Tank: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.

J. Exposed, Round and Flat-Oval, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

K. Exposed, Rectangular, Supply-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> and [**0.75 lb/cu. ft. (12 kg/cu. m)**][**1.5 lb/cu. ft. (24 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**>

nominal density.

4. Duct Insulation Wrap - Mineral Wool Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

L. Exposed, Rectangular, Return-Air Duct Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

M. Exposed, Supply-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

N. Exposed, Return-Air Plenum Insulation: To be one of the following:

1. Duct Insulation Wrap - Glass-Fiber Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> and [0.75 lb/cu. ft. (12 kg/cu. m)][1.5 lb/cu. ft. (24 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)] nominal density.
2. Duct Insulation Wrap - Glass-Fiber Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Duct Insulation Wrap - Mineral Wool Blanket: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
4. Duct Insulation Wrap - Mineral Wool Board: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

3.17 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Ducts and Plenums, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.18 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Ducts and Plenums, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

2. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

3. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Ducts and Plenums, Exposed to View, Larger than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger than 72 Inches (1800 mm):

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep**

corrugations][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

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SECTION 23 07 16 00 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium-silicate equipment insulation.
2. Cellular-glass equipment insulation.
3. Flexible elastomeric equipment insulation.
4. Glass-fiber equipment insulation.
5. Mineral wool equipment insulation.
6. Polyisocyanurate equipment insulation.
7. Polyolefin equipment insulation.
8. Polystyrene equipment insulation.
9. Insulating cements.
10. Insulation adhesives.
11. Insulation mastics and coatings.
12. Insulation sealants.
13. Field-applied insulation jackets.
14. Field-applied fabric-reinforcing mesh for insulation.
15. Field-applied cloths for insulation.
16. Vapor-retarder tapes.
17. Insulation securements.
18. Insulation corner angles.

B. Related Requirements:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
2. Sheet Jacket Materials: **12 inches (300 mm)** square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.
11. Product Data: For sealants, indicating VOC content.
12. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

a. One chilled-water pump and one heating-hot-water pump.
b. One tank or vessel.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to Project site in unopened containers. The packaging is to include the name of the manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application. Before preparing equipment Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes, and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 EQUIPMENT INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Breeching Insulation Schedule," "Indoor HVAC Equipment Insulation Schedule," and "Outdoor, Aboveground Equipment Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel are to have a leachable chloride content of less than

50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM-SILICATE EQUIPMENT INSULATION

A. Equipment Insulation - Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
   c. <**Insert manufacturer's name**>

3. Description: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement.
4. Standard: ASTM C533, Type I or Type II.
5. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR-GLASS EQUIPMENT INSULATION

A. Equipment Insulation - Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

3. Description: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Block Insulation: Type I.
6. Special-Shaped Insulation: Type III.
7. Board Insulation: Type IV.
8. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
9. Equipment insulation without facing.
10. Equipment Insulation with Factory-Applied Facing:

    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
    c. FSK Facing: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
    d. FSP Facing: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type III.
    e. Vinyl Facing: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.5 FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Equipment Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Aeroflex USA**]
    b. [**Armacell LLC**]
    c. [**K-Flex USA**]
    d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric equipment insulation.
4. Standard: ASTM C534/C534M, Type II for sheet materials.
5. Suitable for use temperature between **minus 70 deg F (minus 57 deg C)** and **plus 220 deg F (plus 104 deg C)**.

2.6 GLASS-FIBER EQUIPMENT INSULATION

A. Equipment Insulation - Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

3. Description: Glass fiber blanket equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Suitable for maximum use temperature up to **450 deg F (232 deg C)** in accordance with ASTM C411.
5. Unfaced, Type I.
6. Factory-Applied Insulation Facing:

    a. FSK: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
    b. Vinyl: White vinyl with a permeance of **1.3 perms (0.86 metric perm)** when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

B. Equipment Insulation - High-Temperature, Glass-Fiber Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Johns Manville; a Berkshire Hathaway company**]
    c. [**Knauf Insulation**]
    d. [**Manson Insulation Inc.**]
    e. [**Owens Corning**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]

b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. **<Insert manufacturer's name>**

3. Description: High-temperature glass-fiber equipment blanket insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C553, Type V.
5. Unfaced.
6. Suitable for maximum use temperature up to **1000 deg F (650 deg C)**.

C. Equipment Insulation - Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. **<Insert manufacturer's name>**

3. Description: Glass-fiber board equipment insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type IA or Type IB.
5. Suitable for maximum use temperature between **35 deg F (1.7 deg C)** and **250 deg F (121 deg C)** for jacketed and between **35 deg F (1.7 deg C)** and **450 deg F (232 deg C)** for unfaced in accordance with ASTM C411.
6. Unfaced.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

D. Equipment Insulation - High-Temperature, Glass-Fiber Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: High-temperature, glass-fiber board insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1000 deg F (650 deg C)** in accordance with ASTM C411.

E. Equipment Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass-fiber, pipe and tank insulation consisting of glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for use temperature between **35 deg F (1.7 deg C)** and **850 deg F (454 deg C)**, in

accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.7 MINERAL WOOL EQUIPMENT INSULATION

A. Equipment Insulation - Mineral Wool Blanket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

3. Description: Mineral wool equipment insulation blanket consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C553.
5. Unfaced.
6. Suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447.

B. Equipment Insulation - Mineral Wool Board:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Owens Corning**]
   c. [**ROCKWOOL**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool board equipment insulation consisting of basalt volcanic rock-derived fibers bonded with a thermosetting resin.
4. Standard: ASTM C612, Type III, unfaced.
5. Suitable for maximum use temperature up to **1100 deg F (600 deg C)** in accordance with ASTM C411.

C. Equipment Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool, pipe and tank insulation consisting of fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facings:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type III.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.

2.8 POLYISOCYANURATE EQUIPMENT INSULATION

A. Equipment Insulation - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Duna USA Inc.**]
b. [**Dyplast Products**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Duna USA Inc.**]
b. [**Dyplast Products**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. <**Insert manufacturer's name**>

3. Description: Prefabricated, rigid cellular polyisocyanurate material intended for use as thermal insulation.
4. Standard: ASTM C591.
5. Type I or Type IV, except thermal conductivity (k-value) does not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
6. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less for thicknesses of up to **1.5 inches (38 mm)** as tested in accordance with ASTM E84.
7. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

2.9 POLYOLEFIN EQUIPMENT INSULATION

A. Equipment Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

3. Description: Polyethylene type of polyolefin thermal plastic equipment insulation.
4. Standard: ASTM C1427, Type I, Grade I for tubular materials and Type II, Grade I for sheet materials.

2.10 POLYSTYRENE EQUIPMENT INSULATION

A. Equipment Insulation - Polystyrene:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dow Chemical Co., sold through Polyguard Products, Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dow Chemical Co., sold through Polyguard Products, Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. <**Insert manufacturer's name**>

3. Description: Rigid, extruded cellular polystyrene intended for use as thermal insulation.
4. Standards: ASTM C578, Type IV or VIII.
5. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

2.11 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ramco Insulation, Inc.**]
b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.12 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]
d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
6. Service Temperature Range: [**Plus 20 to 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.
8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of

[**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

3. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
4. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of **minus 100 to plus 200 deg F (minus 73 to plus 93 deg C)**.
4. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive for Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.
4. Adhesive: As recommended by phenolic and polyisocyanurate manufacturer and with a VOC content of 50 g/L or less.

F. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. <**Insert manufacturer's name**>

3. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.
4. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
5. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
6. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
7. Service Temperature Range: **40 to 200 deg F (4 to plus 93 deg C)**.
8. Color: [**Black**]<**Insert color**> .

G. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
5. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.

H. Insulation Adhesive for Polystyrene:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Description: Solvent- or water-based, synthetic resin adhesive with a service temperature range of **minus 20 to plus 140 deg F (29 to plus 60 deg C)**.
4. Adhesive: As recommended by polystyrene manufacturer and with a VOC content of 50 g/L or less.

I. Insulation Adhesive for ASJ, FSK, and PVDC Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]

b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. **<Insert manufacturer's name>**

3. Description: Adhesive for bonding ASJ, FSK, and PVDC jacket lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.

J. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Sekisui Voltek, LLC**]
e. [**Speedline Corporation**]
f. [**The Dow Chemical Company**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Sekisui Voltek, LLC**]
e. [**Speedline Corporation**]
f. [**The Dow Chemical Company**]
g. **<Insert manufacturer's name>**

3. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.
4. Description: PVC jacket adhesive to be compatible with and as recommended in PVC jacket manufacturer's literature.

2.13 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. VOC Content: 300 g/L or less.

3. Low-Emitting Materials: Verify mastic coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. VOC Content: 300 g/L or less.
5. Low-Emitting Materials: Verify mastic coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. VOC Emissions: Verify mastic coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
7. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.
6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent based, suitable for outdoor use on below-ambient services.

4. Water-Vapor Permeance: ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water based, suitable for indoor and outdoor use on above-ambient surfaces.
4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perms)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .

2.14 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: [**Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
5. Color: White or gray.
6. Verify sealant has a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Verify sealant has a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ, PVDC, and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Verify sealant has a VOC content of 420 g/L or less.

2.15 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Equipment Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Speedline Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Speedline Corporation**]
e. <**Insert manufacturer's name**>

3. Description: High-impact-resistant, UV-resistant PVC complying with ASTM C1784, Class 16354-C.
4. Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated tank heads and tank side panels.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. **<Insert manufacturer's name>**

3. Jacket Material - Aluminum:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: ASTM A240/A240M.
c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.

5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. <**Insert manufacturer's name**>

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum foil.
4. Vapor Barrier/Waterproofing Membrane: **60 mils (1.5 mm)** thick.

F. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. <**Insert manufacturer's name**>

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
5. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.
6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.

8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

G. Insulation Jacket, Field Applied - Indoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for indoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **4 mils (0.10 mm)** thick.
5. Permeance: **0.02 perm (0.013 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

H. Insulation Jacket, Field Applied - Outdoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for outdoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier/Waterproofing Membrane: **6 mils (0.15 mm)** thick.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

I. Insulation Jacket, Field Applied - PVDC-SSL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. **<Insert manufacturer's name>**

3. Description: PVDC jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
4. Thickness: **6 mils (0.15 mm)**.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

2.16 FIELD-APPLIED FABRIC-REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. **<Insert manufacturer's name>**

3. Description: Woven glass-fiber mesh for covering equipment insulation.
4. Weight: Approximately **4 oz./sq. yd. (114 g/sq. m)**.
5. Thread Count: **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)**.

B. Woven Polyester Mesh for Equipment Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. <**Insert manufacturer's name**>

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.17 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Associates, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I, plain weave.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.18 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**11.5 mils (0.29 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. <**Insert manufacturer's name**>

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]<**Insert value**> .
6. Thickness: [**6.5 mils (0.16 mm)**]<**Insert value**> .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]<**Insert value**> in width.
8. Elongation: [**2**]<**Insert number**> percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]<**Insert value**> in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
c. <**Insert manufacturer's name**>

3. Description: White, vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: [**500**]<**Insert number**> percent.
9. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**]<**Insert value**> in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M Industrial Adhesives and Tapes Division**]
b. [**Avery Dennison Corporation, Specialty Tapes Division**]
c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
d. [**Knauf Insulation**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

E. Vapor-Retarder Tape - PVDC, for Indoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for indoor applications.
4. Width: [**3 inches (75 mm)**]<**Insert value**> .
5. Film Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]<**Insert value**> .
7. Elongation at Break: [**145**]<**Insert number**> percent.
8. Tensile Strength: [**55 psi (379 kPa)**]<**Insert value**> in width.

F. Vapor-Retarder Tape - PVDC, for Outdoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for outdoor applications.
4. Width: [**3 inches (75 mm)**]<**Insert value**> .
5. Film Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]<**Insert value**> .
7. Elongation at Break: [**145**]<**Insert number**> percent.
8. Tensile Strength: [**55 psi (379 kPa)**]<**Insert value**> in width.

2.19 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Insulation Pins and Hangers - Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) <**Insert manufacturer's name**>

c. Material: [**Mild steel with copper coating**][**Stainless steel**][**Aluminum**] , fully annealed for capacitor-discharge welding.
d. Shank: [**0.106 inch (2.6 mm)**][**0.135 inch (3.5 mm)**] diameter.
e. Length: To suit depth of insulation indicated in schedules.

2. Insulation Pins and Hangers - Cupped-Head, Capacitor-Discharge-Weld Pins:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) **<Insert manufacturer's name>**

c. Material: [**Galvanized-steel**][**Stainless steel**] pin, fully annealed for capacitor-discharge welding.
d. Shank: [**0.106 inch (2.6 mm)**][**0.135 inch (3.5 mm)**] diameter.
e. Length: To suit depth of insulation indicated in schedules, with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.

3. Insulation Pins and Hangers - Metal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**CL WARD & Family Inc.**]
3) [**Gemco**]
4) [**Midwest Fasteners, Inc**]
5) [**Nelson Stud Welding**]
6) **<Insert manufacturer's name>**

c. Description: Baseplate welded to projection spindle that is capable of holding insulation, of thickness indicated in schedules, securely in position indicated when self-locking washer is in place.
d. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated in schedules.

f. Adhesive: Recommended in writing by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation Hangers - Nonmetal, Adhesively Attached, Perforated Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) <**Insert manufacturer's name**>

c. Description: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated in schedules, securely in position indicated when self-locking washer is in place.
d. Baseplate Material: Perforated, nylon sheet, **0.030 inch (0.76 mm)** thick by **1-1/2 inches (38 mm)** in diameter.
e. Spindle: Nylon, **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated in schedules, up to **2-1/2 inches (63 mm)**.
f. Adhesive: Recommended in writing by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Insulation Hangers - Self-Sticking Base:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) <**Insert manufacturer's name**>

c. Description: Baseplate welded to projecting spindle that is capable of holding insulation, of

thickness indicated in schedules, securely in position indicated when self-locking washer is in place.

d. Baseplate Material: Galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.

e. Spindle: [**Copper- or zinc-coated, low-carbon steel**][**Aluminum**][**Stainless steel**] , fully annealed; **0.106-inch- (2.6-mm-)** diameter shank; length to suit depth of insulation indicated in schedules.

f. Adhesive-backed base with a peel-off protective cover.

6. Insulation Washers - Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**AGM Industries, Inc**]
2) [**Gemco**]
3) [**Midwest Fasteners, Inc**]
4) [**Nelson Stud Welding**]
5) **<Insert manufacturer's name>**

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, [**galvanized-steel**][**aluminum**][**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

d. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Insulation Washers - Nonmetal, Insulation Retaining:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]
3) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Gemco**]
2) [**Midwest Fasteners, Inc**]

3) **<Insert manufacturer's name>**

c. Description: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.

C. Insulation Staples: Outward-clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

D. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**C & F Wire Products**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**RPR Products, Inc.**]
   d. **<Insert manufacturer's name>**

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

2.20 INSULATION CORNER ANGLES

A. Insulation Corner Angle - PVC:

1. Thickness: Minimum [**30 mils (0.8 mm)**]**<Insert dimension>** .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Insulation Corner Angle - Aluminum:

1. Thickness: Minimum [**0.040 inch (1.0 mm)**]**<Insert dimension>** .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Aluminum in accordance with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Insulation Corner Angle - Stainless Steel:

1. Thickness: [**0.024 inch (0.61 mm)**]**<Insert dimension>** .
2. Dimensions: Minimum **1 by 1 inch (25 by 25 mm)**.
3. Material: Stainless steel in accordance with ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that equipment to be insulated has been tested and is free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range of between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF EQUIPMENT INSULATION, GENERAL

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in

accordance with the Contract Documents [**, unless otherwise approved by the Engineer-of-record**] .

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

P. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on **6-inch (150-mm)** centers, starting at corners. Install **3/8-inch- (10-mm-)** diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from [**galvanized steel**][**aluminum**][**or**][**stainless steel**] , at least [**0.040 inch (1.0 mm)**][**0.050 inch (1.3 mm)**][**0.060 inch (1.6 mm)**] thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 INSTALLATION OF MINERAL WOOL EQUIPMENT INSULATION

A. Secure mineral wool equipment insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Insulation Hangers and Speed Washers: Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
    d. Do not compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins, and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least **3 inches (75 mm)**.
8. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 INSTALLATION OF GLASS-FIBER EQUIPMENT INSULATION

A. Secure glass-fiber equipment insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**][**50**]<**Insert number**> percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Insulation Hangers and Speed Washers: Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing to be **3 inches (75 mm)** from insulation end joints and **16 inches (400 mm)** o.c. in both directions.
   d. Do not compress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins, and attach speed washers.
   g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   h. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
   i. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately **6 inches (150 mm)** from each end. Install wire or cable between two circumferential girdles **12 inches (300 mm)** o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of **48 inches (1200 mm)** o.c. Use this network for securing insulation with tie wire or bands.
   j. Stagger joints between insulation layers at least **3 inches (75 mm)**.
   k. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   l. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
   m. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.6 INSTALLATION OF CALCIUM-SILICATE EQUIPMENT INSULATION

A. On Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive

and press on one layer of glass cloth. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Apply [**100**]<**Insert value**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.

C. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 INSTALLATION OF WOVEN GLASS-FIBER CLOTH FOR INSULATION

A. Where woven glass-fiber jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.9 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
2. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

D. Insulation Jacket, Field Applied - PVDC:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal.
2. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
3. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

E. Insulation Jacket, Field Applied - PVDC-SSL:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**]<**Insert number**> location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule" and "Outdoor, Aboveground Equipment Insulation Schedule" articles. For large equipment, remove only a portion adequate to determine compliance.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.12 BREECHING INSULATION SCHEDULE

A. Round, Exposed Breeching and Connector Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.

B. Round, Concealed Breeching and Connector Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.

C. Rectangular, Exposed Breeching and Connector Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and **4 lb/cu. ft. (64 kg/cu. m)** nominal density.
5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

D. Rectangular, Concealed Breeching and Connector Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: **4 inches (100 mm)** thick.
2. Equipment Insulation - High-Temperature Glass-Fiber Blanket: **3 inches (75 mm)** thick and **3 lb/cu. ft. (48 kg/cu. m)** nominal density.
3. Equipment Insulation - High-Temperature Glass-Fiber Board: **3 inches (75 mm)** thick and [**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Blanket: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool Board: **3 inches (75 mm)** thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.

3.13 INDOOR HVAC EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thickness are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

D. Heat-Exchanger (Water-to-Water for Cooling Service) Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
9. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
10. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

E. Heat-Exchanger (Water-to-Water for Heating Service) Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**>

thick.

F. Steam-to-Steam Generator Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.

G. Steam-to-Hot-Water Converter Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
5. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Mineral Wool Blanket: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
7. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
8. Equipment Insulation - Mineral Wool Pipe and Tank: [**2 inches (38 mm)**]<**Insert dimension**> thick.

H. Hot-Water-to-Steam Converter Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool Pipe and Tank: [**2 inches (38 mm)**]<**Insert dimension**> thick.

I. Chilled-Water Pump Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

J. Condenser-Water Pump Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

K. Dual-Service Heating and Cooling Pump Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
4. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.

L. Heating-Hot-Water Pump Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

M. Heat-Recovery Pump Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation -Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

N. Steam Condensate Pump and Boiler Feedwater Pump Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (38 mm)**]<**Insert dimension**> thick.

O. Chilled-Water Expansion/Compression Tank Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.

6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

P. Condenser-Water Expansion/Compression Tank Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**1 inch (25 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

Q. Dual-Service Heating and Cooling Expansion/Compression Tank Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inch (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inch (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inch (50 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

R. Heating-Hot-Water Expansion/Compression Tank Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.

S. Heat-Recovery Expansion/Compression Tank Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.

7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

T. Chilled-Water Air-Separator Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

U. Condenser-Water Air-Separator Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**1 inch (25 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**1 inch (25 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**1.5 inches (38 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

V. Dual-Service Heating and Cooling Air-Separator Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**2 inches (50 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (250 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

W. Heating-Hot-Water Air-Separator Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation- Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4**

lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.

6. Equipment Insulation - Mineral Wool, Pipe and Tank: [2 inches (50 mm)]<**Insert dimension**> thick.

X. Heat-Recovery Air-Separator Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [2 inches (50 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [1 inch (25 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [2 inches (50 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [2 inches (50 mm)]<**Insert dimension**> thick.
7. Equipment Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.
8. Equipment Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

Y. Thermal Storage Tank (Brine, Water, Ice) Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [4 inches (100 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
3. Equipment Insulation - Glass-Fiber, Pipe and Tank: [3 inches (75 mm)]<**Insert dimension**> thick.
4. Equipment Insulation - Mineral Wool Board: [3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool, Pipe and Tank: [3 inches (75 mm)]<**Insert dimension**> thick.
6. Equipment Insulation - Polyisocyanurate (Outdoor Application Only): [3 inches (75 mm)]<**Insert dimension**> thick.
7. Equipment Insulation - Polystyrene (Outdoor Application Only): [3 inches (75 mm)]<**Insert dimension**> thick.

Z. Deaerator Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [3 inches (75 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [3 inches (75 mm)]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [3 inches (75 mm)]<**Insert dimension**> thick and [4 lb/cu. ft. (64 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)][8 lb/cu. ft. (128 kg/cu. m)]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [3 inches (75 mm)]<**Insert dimension**> thick.

AA. Steam Condensate Tank and Receiver Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [3 inches (75 mm)]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [3 inches (75 mm)]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [2 inches (50 mm)]<**Insert dimension**> thick and [2 lb/cu. ft. (32 kg/cu. m)][3 lb/cu. ft. (48 kg/cu. m)][6 lb/cu. ft. (96 kg/cu. m)] nominal density.

4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.

BB. Steam Flash-Tank, Flash-Separator, Moisture-Separator, and Blow-Off-Tank Insulation: To be one of the following:

1. Equipment Insulation - Calcium Silicate: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
3. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
4. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
5. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**][**8 lb/cu. ft. (128 kg/cu. m)**]<**Insert density**> nominal density.
6. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.

CC. Piping System Filter-Housing Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
4. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.

3.14 OUTDOOR, ABOVEGROUND EQUIPMENT INSULATION SCHEDULE

A. Heated, Fuel-Oil Storage Tank Insulation: To be one of the following:

1. Equipment Insulation - Cellular Glass: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Equipment Insulation - Glass-Fiber Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**2 lb/cu. ft. (32 kg/cu. m)**][**3 lb/cu. ft. (48 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**] nominal density.
3. Equipment Insulation - Glass-Fiber, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
4. Equipment Insulation - Mineral Wool Board: [**2 inches (50 mm)**]<**Insert dimension**> thick and [**4 lb/cu. ft. (64 kg/cu. m)**][**6 lb/cu. ft. (96 kg/cu. m)**]<**Insert density**> nominal density.
5. Equipment Insulation - Mineral Wool, Pipe and Tank: [**2 inches (50 mm)**]<**Insert dimension**> thick.
6. Equipment Insulation - Polyisocyanurate: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.

3.15 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Equipment, Exposed to View, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.16 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Equipment, Exposed to View, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**][**, with Z-shaped locking seam**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032**

inch (0.81 mm)][0.040 inch (1.0 mm)] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**][**, with Z-shaped locking seam**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

E. Equipment, Exposed to View, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

END OF SECTION 23 07 16 00

SECTION 23 07 19 00 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Calcium-silicate pipe insulation.
2. Cellular-glass pipe insulation.
3. Flexible elastomeric pipe insulation.
4. Glass-fiber pipe insulation.
5. Mineral wool pipe insulation.
6. Phenolic pipe insulation.
7. Polyisocyanurate pipe insulation.
8. Polyolefin pipe insulation.
9. Polystyrene pipe insulation.
10. Insulating cements.
11. Insulation adhesives.
12. Insulation mastics and coatings.
13. Insulation sealants.
14. Field-applied insulation jackets.
15. Field-applied fabric reinforcing mesh for insulation.
16. Field-applied cloths for insulation.
17. Vapor-retarder tapes.
18. Insulation securements.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 230716 "HVAC Equipment Insulation" for equipment insulation.
3. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
4. Section 232213.13 "Underground Steam and Condensate Heating Piping" for steam and condensate piping for steam-type tank heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail attachment and covering of heat tracing inside insulation.
4. Detail insulation application at pipe expansion joints for each type of insulation.
5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
6. Detail removable insulation at piping specialties.
7. Detail application of field-applied jackets.

8. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
2. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
3. Jacket Materials for Pipe: **12 inches (300 mm)** long by **NPS 2 (DN 50)**.
4. Sheet Jacket Materials: **12 inches (300 mm)** square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.
11. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
12. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field Quality Control Reports: For specified tests and inspections.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program [**, certified by the Department of Labor, Bureau of Apprenticeship and Training**] .

1.5 MOCKUPS

A. Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

   a. One **10-ft. (3-m)** section of **NPS 2 (DN 50)** straight pipe.
   b. One each of a 90-degree threaded, welded, and flanged elbow.
   c. One each of a threaded, welded, and flanged tee fitting.
   d. One **NPS 2 (DN 50)** or smaller valve and one **NPS 2-1/2 (DN 65)** or larger valve.
   e. Four support hangers, including hanger shield and insert.
   f. One threaded strainer and one flanged strainer with removable portion of insulation.
   g. One threaded reducer and one welded reducer.
   h. One pressure temperature tap.
   i. One mechanical coupling.
   j. One union.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size [**, as well as ASTM standard designation, and maximum use temperature**] .

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems [**and after installing and testing heat tracing**] . Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 PIPING INSULATION MATERIALS, GENERAL

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products are not to contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel are to have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are to be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials are not to use CFC or HCFC blowing agents in the manufacturing process.

2.3 CALCIUM-SILICATE PIPE INSULATION

A. Pipe Insulation - Calcium Silicate, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]

b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**TPS Industrial; a trademark of Chase Manufacturing, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: ASTM C533, flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement, Type I.
4. Standard: ASTM C533, Type I.
5. Prefabricated Fitting Covers: ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.4 CELLULAR-GLASS PIPE INSULATION

A. Pipe Insulation - Cellular Glass, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Owens Corning**]
   b. <**Insert manufacturer's name**>

3. Description: Preformed cellular glass pipe insulation of inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
4. Standard: ASTM C552.
5. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
6. Without Insulation Facing: Type II, Class 1.
7. Factory-Applied Insulation Facing: Type II, Class 2.

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.5 FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Pipe Insulation - Flexible Elastomeric:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**K-Flex USA**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**K-Flex USA**]
d. <**Insert manufacturer's name**>

3. Description: Closed-cell or expanded-rubber flexible elastomeric pipe insulation.
4. Standard: ASTM C534/C534M, Type I, for tubular materials; Type II for sheet materials.
5. Suitable for maximum use temperature between **minus 70 deg F (minus 57 deg C)** and **plus 220 deg F (plus 104 deg C)**.

2.6 GLASS-FIBER PIPE INSULATION

A. Pipe Insulation - Glass-Fiber, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Knauf Insulation**]
c. [**Manson Insulation Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Knauf Insulation**]
c. [**Manson Insulation Inc.**]
d. [**Owens Corning**]
e. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin.
4. Suitable for maximum use temperature up to **850 deg F (454 deg C)** in accordance with ASTM C411. Comply with ASTM C547.
5. Preformed Pipe Insulation: Type I, Grade A.
6. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Glass-Fiber, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Manson Insulation Inc.**]
e. [**Owens Corning**]
f. <**Insert manufacturer's name**>

3. Description: Glass fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for use temperature between **35 deg F (1.7 deg C)** and **850 deg F (454 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 MINERAL WOOL PIPE INSULATION

A. Pipe Insulation - Mineral Wool, Preformed:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to **1200 deg F (650 deg C)** in accordance with ASTM C447.
4. Standard: ASTM C547.
5. Preformed Pipe Insulation: Type II, Grade A.
6. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

B. Pipe Insulation - Mineral Wool, Pipe and Tank:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]
c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**Owens Corning**]

c. [**ROCKWOOL**]
d. <**Insert manufacturer's name**>

3. Description: Mineral wool fibers bonded with a thermosetting resin.
4. Standard: ASTM C1393.
5. Suitable for maximum use temperature up to **1000 deg F (538 deg C)**, in accordance with ASTM C411.
6. Semirigid board material.
7. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type III.
   c. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   d. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 PHENOLIC PIPE INSULATION

A. Pipe Insulation - Phenolic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Kingspan Tarec Industrial Insulation NV**]
   c. [**Polyguard Products, Inc.**]
   d. [**Resolco Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. [**Kingspan Tarec Industrial Insulation NV**]
   c. [**Polyguard Products, Inc.**]
   d. [**Resolco Inc.**]
   e. <**Insert manufacturer's name**>

3. Description: Prefabricated phenolic pipe insulation of rigid, expanded, closed-cell structure.
4. Standard: ASTM C1126.
5. Prefabricated Pipe Insulation: Type III.
6. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
7. Unfaced.
8. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with

an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.

c. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 POLYISOCYANURATE PIPE INSULATION

A. Pipe Insulation - Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Duna USA Inc.**]
   b. [**Dyplast Products**]
   c. [**Johns Manville; a Berkshire Hathaway company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Duna USA Inc.**]
   b. [**Dyplast Products**]
   c. [**Johns Manville; a Berkshire Hathaway company**]
   d. <**Insert manufacturer's name**>

3. Description: Prefabricated, rigid cellular polyisocyanurate pipe insulation intended for use as thermal insulation.
4. Standard: ASTM C591.
5. Type IV, except thermal conductivity (k-value) to not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
6. Flame-spread index is to be 25 or less, and smoke-developed index is to be 50 or less for thicknesses of up to **1.5 inch (38 mm)** as tested in accordance with ASTM E84.
7. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
8. Unfaced.
9. Factory-Applied Insulation Facing:

   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.10 POLYOLEFIN PIPE INSULATION

A. Pipe Insulation - Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armacell LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armacell LLC**]
   b. <**Insert manufacturer's name**>

3. Description: Polyethylene-type of polyolefin thermal plastic pipe insulation.
4. Standard: ASTM C1427, Type I, Grade 1, for tubular materials and Type II, Grade 1, for sheet materials [**, self-seal**] .

2.11 POLYSTYRENE PIPE INSULATION

A. Pipe Insulation - Polystyrene:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dow Chemical Co., sold through Polyguard Products, Inc.**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dow Chemical Co., sold through Polyguard Products, Inc.**]
   b. [**Johns Manville; a Berkshire Hathaway company**]
   c. <**Insert manufacturer's name**>

3. Description: Rigid, extruded cellular polystyrene intended for use as thermal insulation.
4. Standard: ASTM C578, Type I-XII for board or Type XIII for pipe insulation, except thermal conductivity (k-value) does not exceed **0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K)** after 180 days of aging.
5. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

2.12 INSULATING CEMENTS

A. Insulating Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

3. Standard: ASTM C195.

B. Insulating Cement for Expanded or Exfoliated Vermiculite:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

3. Standard: ASTM C196.

C. Hydraulic-Setting Insulating and Finishing Cement for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ramco Insulation, Inc.**]
   b. <**Insert manufacturer's name**>

3. Standard: ASTM C449.

2.13 INSULATION ADHESIVES

A. Materials are to be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Insulation Adhesive for Lagging Cloth:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Vimasco Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Vimasco Corporation**]
    d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class I, Grade A.
4. Adhesives to be compatible with insulation materials, jackets, and substrates.
5. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
6. Service Temperature Range: [**Plus 20 to 180 deg F (Minus 6 to plus 82 deg C)**][**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] .
7. Color: White.
8. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

C. Insulation Adhesive for Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Vimasco Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Childers Brand; H. B. Fuller Construction Products**]
    b. [**Foster Brand; H. B. Fuller**]
    c. [**Mon-Eco Industries, Inc.**]
    d. [**Vimasco Corporation**]
    e. <**Insert manufacturer's name**>

3. Description: Fibrous, sodium-silicate-based adhesive with a service temperature range of **50 to 800 deg F (10 to 427 deg C)**.
4. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

D. Insulation Adhesive for Cellular Glass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Adhesive: As recommended by cellular-glass manufacturer and with a VOC content of 80 g/L or less.

E. Insulation Adhesive for Phenolic and Polyisocyanurate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. <**Insert manufacturer's name**>

3. Description: Solvent-based resin adhesive, with a service temperature range of **minus 75 to plus 300 deg F (minus 59 to plus 149 deg C)**.
4. Adhesive: As recommended by phenolic and polyisocyanurate manufacturer and with a VOC content of 50 g/L or less.

F. Insulation Adhesive, Solvent Based for Flexible Elastomeric and Polyolefin:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]

c. [**Foster Brand; H. B. Fuller**]
d. [**K-Flex USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aeroflex USA**]
b. [**Armacell LLC**]
c. [**Foster Brand; H. B. Fuller**]
d. [**K-Flex USA**]
e. <**Insert manufacturer's name**>

3. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of [**80**]<**Insert value**> g/L or less.
4. Description: Solvent-based adhesive for flexible elastomeric and polyolefin insulation.
5. Flame-spread index is to be 25 or less and smoke-developed index is to be 50 or less as tested in accordance with ASTM E84.
6. Wet Flash Point: Below **0 deg F (minus 18 deg C)**.
7. Service Temperature Range: **40 to 200 deg F (4 to 93 deg C)**.
8. Color: [**Black**]<**Insert color**> .

G. Insulation Adhesive for Glass Fiber and Mineral Wool:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Standard: MIL-A-3316C, Class 2, Grade A.
4. Adhesive: As recommended by mineral-fiber manufacturer and with a VOC content of 80 g/L or less.
5. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

H. Insulation Adhesive for Polystyrene:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Description: Solvent- or water-based, synthetic resin adhesive with a service temperature range of **minus 20 to plus 140 deg F (minus 29 to plus 60 deg C)**.
4. Adhesive: As recommended by polystyrene manufacturer and with a VOC content of 50 g/L or less.

I. Insulation Adhesive for ASJ, FSK, and PVDC Facings/Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Insulation adhesive for bonding ASJ, FSK, and PVDC facing/jacket insulation lap seams and joints.
4. Standard: MIL-A-3316C, Class 2, Grade A.
5. Verify adhesives have a VOC content of 80 g/L or less.
6. Verify adhesives have a VOC content of 80 g/L or less.

J. Insulation Adhesive for PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Sekisui Voltek, LLC**]

e. [**Speedline Corporation**]
f. [**The Dow Chemical Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**P.I.C. Plastics, Inc.**]
c. [**Proto Corporation**]
d. [**Sekisui Voltek, LLC**]
e. [**Speedline Corporation**]
f. [**The Dow Chemical Company**]
g. <**Insert manufacturer's name**>

3. Adhesive: As recommended by PVC jacket manufacturer and with a VOC content of 50 g/L or less.
4. Description: PVC jacket adhesive to be compatible with and as recommended in writing in PVC jacket manufacturer's literature.

2.14 INSULATION MASTICS AND COATINGS

A. Materials are to be compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. VOC Content: 300 g/L or less.
3. Low-Emitting Materials: Verify mastic coatings comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. VOC Content: 300 g/L or less.
5. Low-Emitting Materials: Verify mastic coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. VOC Emissions: Verify mastic coatings contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
7. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify mastics comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Insulation Vapor-Retarder Mastic - Water Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Aeroflex USA**]
   b. [**Childers Brand; H. B. Fuller Construction Products**]
   c. [**Knauf Insulation**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Childers Brand; H. B. Fuller Construction Products**]
   c. [**Knauf Insulation**]
   d. [**Vimasco Corporation**]
   e. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, water based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Standard: MIL-PRF-19565C, Type II, for permeance requirements [**, with supplier listing on DOD QPD - Qualified Products Database**] .
7. Color: [**White**]<**Insert color**> .

C. Insulation Vapor-Retarder Mastic - Solvent Based, Indoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent based, suitable for indoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **0 to 180 deg F (Minus 18 to plus 82 deg C)**.

6. Color: [**White**]<**Insert color**> .

D. Insulation Vapor-Retarder Mastic - Solvent Based, Outdoor Use:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

3. Description: Insulation vapor-retarder mastic, solvent based, suitable for outdoor use on below-ambient services.
4. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
5. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
6. Color: [**White**]<**Insert color**> .

E. Insulation Breather Mastic - Water Based, Indoor/Outdoor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Knauf Insulation**]
   d. [**Mon-Eco Industries, Inc.**]
   e. [**Vimasco Corporation**]
   f. <**Insert manufacturer's name**>

3. Description: Insulation breather mastic, water based, suitable for indoor and outdoor use on above-ambient surfaces.

4. Water-Vapor Permeance: ASTM E96/E96M, greater than **1.0 perm (0.66 metric perm)** at manufacturer's recommended dry film thickness.
5. Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**][**Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**] .
6. Color: [**White**]<**Insert color**> .
7. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of [**50**]<**Insert number**> g/L or less.

2.15 INSULATION SEALANTS

A. Insulation Joint Sealant:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. [**Owens Corning**]
   e. <**Insert manufacturer's name**>

3. Permanently flexible, elastomeric sealant.

   a. Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**][**Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**] .
   b. Color: White or gray.

4. Sealant shall have a VOC content of 420 g/L or less.

B. Flashing Sealant for FSK and Metal Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Mon-Eco Industries, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Mon-Eco Industries, Inc.**]
d. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: Aluminum.
7. Sealant shall have a VOC content of 420 g/L or less.

C. Flashing Sealant for ASJ, PVDC, and PVC Jackets:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. <**Insert manufacturer's name**>

3. Flashing sealant to be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
6. Color: White.
7. Sealant shall have a VOC content of 420 g/L or less.

2.16 FIELD-APPLIED INSULATION JACKETS

A. Field-applied jackets are to comply with ASTM C1136, Type I, unless otherwise indicated.

B. Insulation Jacket, Field Applied - FSK:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Pipe Insulation Jacket, Field Applied - PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Airex Manufacturing Inc.**]

b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Airex Manufacturing Inc.**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**P.I.C. Plastics, Inc.**]
d. [**Proto Corporation**]
e. [**Speedline Corporation**]
f. **<Insert manufacturer's name>**

3. Description: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C.
4. Thickness: As indicated in "Outdoor, Field-Applied Insulation Jacket Schedule" Article under Part 3.
5. Jacket: Roll stock ready for shop or field cutting and forming.
6. Adhesive: As recommended in writing by jacket material manufacturer.
7. Color: [**White**][**Color-code jackets based on system. Color as selected by Architect**] .
8. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

D. Insulation Jacket, Field Applied - Metal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. **<Insert manufacturer's name>**

3. Jacket Material - Aluminum:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
c. Finish and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.

d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**53-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Jacket Material - Stainless Steel:

a. Description: [**Sheet and roll stock ready for shop or field sizing**][**Factory cut and rolled to size**] .
b. Standard: ASTM A240/A240M.
c. Material Type, Finish, and Thickness: As indicated in "Indoor, Field-Applied Insulation Jacket Schedule" and "Outdoor, Field-Applied Insulation Jacket Schedule" articles under Part 3.
d. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
e. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**][**3-mil- (0.075-mm-) thick polysurlyn**] .
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Owens Corning**]
b. [**Polyguard Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Owens Corning**]

b. [**Polyguard Products, Inc.**]
c. **<Insert manufacturer's name>**

3. Description: Underground direct-buried jacket of rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
4. Vapor Barrier and Waterproofing Membrane: **125 mils (3.2 mm)** thick.

F. Insulation Jacket, Field Applied - Outdoor, Self Adhesive (Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**MFM Building Products Corp.**]
   b. [**Polyguard Products, Inc.**]
   c. **<Insert manufacturer's name>**

3. Description: Self-adhesive outdoor asphaltic jacket of rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**][**stucco-embossed**] aluminum-foil.
4. Vapor Barrier and Waterproofing Membrane: **60 mils (1.5 mm)** thick.

G. Insulation Jacket, Field Applied - Indoor/Outdoor, Self Adhesive (Non-Asphaltic):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**3M**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. **<Insert manufacturer's name>**

3. Description: Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors.
4. Specialized jacket consisting of five layers of laminated aluminum and polyester film.
5. Adhesive Lap: Self-adhesive, low-temperature acrylic, pressure-sensitive adhesive lap.

6. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
7. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 as tested in accordance with ASTM E84.
8. Aluminum Finish: [**Embossed**][**Smooth**] .
9. Outer Aluminum Surface: Coated with UV-resistant coating for protection from environmental contaminants.

H. Insulation Jacket, Field Applied - Indoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for indoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier and Waterproofing Membrane: **4 mils (0.10 mm)** thick.
5. Permeance: **0.02 perm (0.013 metric perm)** as tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

I. Insulation Jacket, Field Applied - Outdoor, PVDC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: PVDC jacket for outdoor applications with white PVDC biaxially oriented barrier film.
4. Vapor Barrier and Waterproofing Membrane: **6 mils (0.15 mm)** thick.
5. Permeance: **0.01 perm (0.007 metric perm)** as tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

J. Insulation Jacket, Field Applied - PVDC-SSL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. <**Insert manufacturer's name**>

3. Description: PVDC jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
4. Thickness: **6 mils (0.15 mm)**.
5. Permeance: **0.01 perm (0.007 metric perm)** when tested in accordance with ASTM E96/E96M.
6. Flame-Spread/Smoke-Developed Index: Flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

2.17 FIELD-APPLIED FABRIC REINFORCING MESH FOR INSULATION

A. Woven Glass-Fiber Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. <**Insert manufacturer's name**>

3. Description: Woven glass-fiber mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **2 oz./sq. yd. (68 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.

B. Woven Polyester Mesh for Pipe Insulation, Field Applied:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Childers Brand; H. B. Fuller Construction Products**]
b. [**Foster Brand; H. B. Fuller**]
c. [**Vimasco Corporation**]

d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Childers Brand; H. B. Fuller Construction Products**]
   b. [**Foster Brand; H. B. Fuller**]
   c. [**Vimasco Corporation**]
   d. **<Insert manufacturer's name>**

3. Description: Woven polyester mesh for covering pipe and pipe fittings insulation.
4. Weight: Approximately **1 oz./sq. yd. (34 g/sq. m)**.
5. Thread Count: **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**.
6. Weave Type: Leno.

2.18 FIELD-APPLIED CLOTHS FOR INSULATION

A. Woven Glass-Fiber Cloth, Field Applied, for Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Alpha Associates, Inc.**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Alpha Associates, Inc.**]
   b. **<Insert manufacturer's name>**

3. Description: Woven glass-fiber cloth.
4. Standard: MIL-C-20079H, Type I.
5. Weave: Plain.
6. Weight: Minimum of **8 oz./sq. yd. (271 g/sq. m)**, presized.

2.19 VAPOR-RETARDER TAPES

A. Vapor-Retarder Tape for ASJ:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Aeroflex USA**]
   c. [**Avery Dennison Corporation, Specialty Tapes Division**]
   d. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   e. [**Knauf Insulation**]
   f. **<Insert manufacturer's name>**

3. Description: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]**<Insert value>** .
6. Thickness: [**11.5 mils (0.29 mm)**]**<Insert value>** .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]**<Insert value>** in width.
8. Elongation: [**2**]**<Insert number>** percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]**<Insert value>** in width.
10. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Vapor-Retarder Tape for FSK:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. **<Insert manufacturer's name>**

3. Description: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive.
4. Standard: ASTM C1136.
5. Width: [**3 inches (75 mm)**]**<Insert value>** .
6. Thickness: [**6.5 mils (0.16 mm)**]**<Insert value>** .
7. Adhesion: [**90 ounces force/inch (1.0 N/mm)**]**<Insert value>** in width.
8. Elongation: [**2**]**<Insert number>** percent.
9. Tensile Strength: [**40 lbf/inch (7.2 N/mm)**]**<Insert value>** in width.
10. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Vapor-Retarder Tape for PVC:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   c. <**Insert manufacturer's name**>

3. Description: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.
4. Application: Suitable for indoor and outdoor applications.
5. Width: [**2 inches (50 mm)**]<**Insert value**> .
6. Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
7. Adhesion: [**64 ounces force/inch (0.7 N/mm)**]<**Insert value**> in width.
8. Elongation: [**500**]<**Insert number**> percent.
9. Tensile Strength: [**18 lbf/inch (3.3 N/mm)**]<**Insert value**> in width.

D. Vapor-Retarder Tape - Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**3M Industrial Adhesives and Tapes Division**]
   b. [**Avery Dennison Corporation, Specialty Tapes Division**]
   c. [**Ideal Tape Co., Inc., an American Biltrite Company**]
   d. [**Knauf Insulation**]
   e. [**Sekisui Voltek, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Aluminum-foil vapor-retarder tape with acrylic adhesive.
4. Width: [**2 inches (50 mm)**]<**Insert value**> .
5. Thickness: [**3.7 mils (0.093 mm)**]<**Insert value**> .
6. Adhesion: [**100 ounces force/inch (1.1 N/mm)**]<**Insert value**> in width.
7. Elongation: [**5**]<**Insert number**> percent.
8. Tensile Strength: [**34 lbf/inch (6.2 N/mm)**]<**Insert value**> in width.

E. Vapor-Retarder Tape - PVDC, for Indoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: White vapor-retarder PVDC tape with acrylic adhesive, for indoor applications.
4. Width: [**3 inches (75 mm)**]<**Insert value**> .
5. Film Thickness: [**2 mils (0.05 mm)**]<**Insert value**> .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]<**Insert value**> .
7. Elongation at Break: [**120**]<**Insert number**> percent.
8. Tensile Strength: [**20 psi (138 kPa)**]<**Insert value**> in width.

F. Vapor-Retarder Tape - PVDC, for Outdoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johns Manville; a Berkshire Hathaway company**]
   b. <**Insert manufacturer's name**>

3. Description: White vapor-retarder PVDC tape with acrylic adhesive for outdoor applications.
4. Width: [**3 inches (75 mm)**]<**Insert value**> .
5. Film Thickness: [**6 mils (0.15 mm)**]<**Insert value**> .
6. Adhesive Thickness: [**1.5 mils (0.04 mm)**]<**Insert value**> .
7. Elongation at Break: [**145**]<**Insert number**> percent.
8. Tensile Strength: [**55 psi (379 kPa)**]<**Insert value**> in width.

2.20 INSULATION SECUREMENTS

A. Insulation Bands:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Johns Manville; a Berkshire Hathaway company**]
b. [**RPR Products, Inc.**]
c. <**Insert manufacturer's name**>

3. Insulation Bands - Stainless Steel: ASTM A240/A240M, [**Type 304**][**or**][**Type 316**] ; **0.015 inch (0.38 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
4. Insulation Bands - Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] wide with [**wing seal**][**or**][**closed seal**] .
5. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Staples: Outward-clinching insulation staples, nominal **3/4 inch (19 mm)** wide, stainless steel or Monel.

C. Insulation Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C & F Wire Products**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**RPR Products, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**C & F Wire Products**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**RPR Products, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: [**0.080-inch (2.0-mm) nickel-copper alloy**][**0.062-inch (1.6-mm) soft-annealed, stainless steel**][**0.062-inch (1.6-mm) soft-annealed, galvanized steel**] .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils (0.127 mm)** thick and an epoxy finish **5 mils (0.127 mm)** thick if operating in a temperature range between **140 and 300 deg F (60 and 149 deg C)**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 INSTALLATION OF PIPING INSULATION, GENERAL

A. Requirements in this article apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

E. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents [**, unless otherwise approved by the Engineer-of-record**] .

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

L. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

N. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches (50 mm)**][**4 inches (100 mm)**] o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

O. Cut insulation in a manner to avoid compressing insulation.

P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Q. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least [**4 inches (100 mm)**]<**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

R. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

S. Installation of Insulation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [**prefabricated fitting insulation**][**or**][**mitered or routed fittings**] made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [**prefabricated fitting insulation**][**or**][**sectional pipe insulation**] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using [**prefabricated fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [**prefabricated fitting insulation**][**or**][**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union". Match size and color of pipe labels.

T. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

U. Install removable insulation covers [**at locations indicated on the Drawings**] . Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF CALCIUM-SILICATE PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least **1 inch (25 mm)**. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Finish flange insulation same as pipe insulation.

C. On Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When prefabricated insulation sections of insulation are not available, install mitered sections of calcium-silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. On Valves and Pipe Specialties:

1. Install pipe insulation, quads, hex sections, or beveled lag segments, adhered together, of calcium-silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.6 INSTALLATION OF CELLULAR-GLASS PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. On Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. On Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC PIPE INSULATION

A. On Equipment and Tanks:

1. Apply [**100**]<**Insert number**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

B. On Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. On Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. On Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when

available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Finish: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 INSTALLATION OF GLASS-FIBER PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. On Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. On Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF MINERAL WOOL PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. On Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. On Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF PHENOLIC PIPE INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch (300-mm)** intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches (75 mm)**. Secure inner layer with **0.062-inch (1.6-mm)** wire spaced at **12-inch (300-mm)** intervals. Secure outer layer with stainless steel bands at **12-inch (300-mm)** intervals.

B. On Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming

insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with jackets with vapor retarder on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

C. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

D. On Pipe Fittings and Elbows:

1. Install prefabricated insulation sections, or mitered or routed fittings, of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. On Valves and Pipe Specialties:

1. Install prefabricated insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic.
3. All insulation is tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. On Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and same thickness as that of adjacent pipe insulation, not to exceed **1-1/2-inch (38-mm)** thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

C. On Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. On Valves and Pipe Specialties:

1. Install prefabricated sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.12 INSTALLATION OF POLYOLEFIN PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive [**or via self-seal mechanism**] to eliminate openings in insulation that allow passage of air to surface being insulated.

B. On Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. On Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. On Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 INSTALLATION OF POLYSTYRENE PIPE INSULATION

A. On Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.

2. For insulation with jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic.
3. All insulation is tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. On Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and make thickness same as that of adjacent pipe insulation, not to exceed **1-1/2 inches (38 mm)**.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness that of as pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

C. On Pipe Fittings and Elbows:

1. Install prefabricated insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. On Valves and Pipe Specialties:

1. Install prefabricated section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.14 INSTALLATION OF FIELD-APPLIED CLOTHS FOR INSULATION

A. Where woven glass-fiber cloths are indicated, install directly over bare insulation or insulation with factory-applied facings.

1. Draw cloths smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.15 INSTALLATION OF FIELD-APPLIED INSULATION JACKETS

A. Insulation Jacket, Field Applied - FSK:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Insulation Jacket, Field Applied - PVC:

1. Install with **1-inch (25-mm)** overlap at longitudinal seams and end joints.

2. Seal with manufacturer's recommended adhesive.
3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Insulation Jacket, Field Applied - Metal:

1. Install with **2-inch (50-mm)** overlap at longitudinal seams and end joints.
2. Overlap longitudinal seams arranged to shed water.
3. Seal end joints with weatherproof sealant recommended by insulation manufacturer.
4. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

D. Insulation Jacket, Field-Applied - Outdoor, Self-Adhesive Asphaltic:

1. Install in accordance with manufacturer's written installation instructions.

E. Insulation Jacket, Field-Applied - Indoor/Outdoor, Self-Adhesive (Non-Asphaltic):

1. Install in accordance with manufacturer's written installation instructions.

F. Insulation Jacket, Field Applied - PVDC:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

G. Insulation Jacket, Field Applied - PVDC-SSL:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in [**Section 099113 "Exterior Painting"**][**Section 099114 "Exterior Painting (MPI Standards)"**] and [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

1. Flat Acrylic Finish: [**Two**]<**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**]<**Insert number**> locations of straight pipe, [**three**]<**Insert number**> locations of threaded fittings, [**three**]<**Insert number**> locations of welded fittings, [**two**]<**Insert number**> locations of threaded strainers, [**two**]<**Insert number**> locations of welded strainers, [**three**]<**Insert number**> locations of threaded valves, and [**three**]<**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.

2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water Piping below 60 Deg F (16 Deg C):

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

B. Chilled Water and Brine Piping, 40 Deg F (5 Deg C) and below:

1. Insulation for Pipe Sizes NPS 3 (DN 80) and Smaller: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 4 (DN 100) to NPS 12 (DN 300): To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.

3. Insulation for Pipe Sizes NPS 14 (DN 350) and Larger: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.

b. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Pipe and Tank: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Pipe and Tank: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.

C. Chilled Water and Brine Piping, Above 40 Deg F (5 Deg C):

1. Insulation for Pipe Sizes NPS 12 (DN 300) and Smaller: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 14 (DN 350) and Larger: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.

D. Condenser-Water Supply and Return Piping:

1. Insulation for Pipe Sizes NPS 12 (DN 300) and Smaller: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)][1-1/2 inches (38 mm)]<**Insert dimension**> thick.

f. Pipe Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 14 (DN 350) Larger: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.

E. Heating-Hot-Water Supply and Return Piping, 200 Deg F (93 Deg C) and Below:

1. Insulation for Pipe Sizes NPS 12 (DN 300) and Smaller: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Phenolic: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 14 (DN 350) and Larger: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.

F. Heating-Hot-Water Supply and Return Piping, Above 200 Deg F (93 Deg C):

1. Insulation for Pipe Sizes NPS 3/4 (DN 20) and Smaller: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1-1/2 inches (38 mm)][2 inches (50

mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 1 (DN 25) and Larger: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.

G. Steam and Steam Condensate Piping, Boiler Blowdown Piping, Steam and Steam Condensate Vent Piping, Drain Piping, and Safety Relief Vent Piping 350 Deg F (177 Deg C) and Below:

1. Insulation for Pipe Sizes NPS 3/4 (DN 20) and Smaller: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 1 (DN 25) and Larger: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Glass-Fiber, Pipe and Tank: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Mineral Wool, Pipe and Tank: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.

H. Steam and Steam Condensate Piping, Boiler Blowdown Piping, Steam and Steam Condensate Vent Piping, Steam and Steam Condensate Drain Piping, and Safety Relief Vent Piping Above 350 Deg F (177 Deg C):

1. Insulation for Pipe Sizes NPS 3/4 (DN 20) and Smaller: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50**

mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> thick.

2. Insulation for Pipe Sizes NPS 1 (DN 25) and Larger: To be one of the following:

a. Pipe Insulation - Calcium Silicate, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Glass-Fiber, Pipe and Tank: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Preformed: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Mineral Wool, Pipe and Tank: [**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick.

I. Refrigerant Suction and Hot-Gas Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

J. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Flexible Elastomeric: [**2 inches (50 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Polyolefin: [**2 inches (50 mm)**]<**Insert dimension**> thick.

K. Refrigerant Liquid Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [**1 inch (25 mm)**]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [**1 inch (25 mm)**]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [**1 inch (25 mm)**]<**Insert dimension**> thick.
g. Pipe Insulation - Polyolefin: [**1 inch (25 mm)**]<**Insert dimension**> thick.

L. Dual-Service Heating and Cooling Piping, 40 to 200 Deg F (5 to 93 Deg C):

1. Insulation for NPS 12 (DN 300) and Smaller: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.

2. Insulation for NPS 14 (DN 350) and Larger: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Mineral Wool, Preformed: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Pipe and Tank: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Phenolic: [1-1/2 inches (38 mm)][2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> thick.

M. Heat-Recovery Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [1-1/2 inches (38 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Glass-Fiber, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Mineral Wool, Preformed: [1 inch (25 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Mineral Wool, Pipe and Tank: [1 inch (25 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Phenolic: [1 inch (25 mm)]<**Insert dimension**> thick.
h. Pipe Insulation - Polyisocyanurate: [1 inch (25 mm)]<**Insert dimension**> thick.
i. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [3 inches (75 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [3 inches (75 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [3 inches (75 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [2 inches (50 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Polystyrene: [2 inches (50 mm)]<**Insert dimension**> thick.

B. Condenser-Water Supply and Return Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

   a. Pipe Insulation - Cellular Glass, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   b. Pipe Insulation - Flexible Elastomeric: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   e. Pipe Insulation - Phenolic: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   f. Pipe Insulation - Polyisocyanurate: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   g. Pipe Insulation - Polystyrene: [**2 inches (50 mm)**]<**Insert dimension**> thick.

C. Heating-Hot-Water Supply and Return Piping, 200 Deg F (93 Deg C) and Below:

1. Insulation for All Pipe Sizes: To be one of the following:

   a. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.
   b. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   c. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   d. Pipe Insulation - Phenolic: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   e. Pipe Insulation - Polyisocyanurate: [**2 inches (50 mm)**]<**Insert dimension**> thick.

D. Heating-Hot-Water Supply and Return Piping, Above 200 Deg F (93 Deg C):

1. Insulation for All Pipe Sizes: To be one of the following:

   a. Pipe Insulation - Calcium Silicate, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.
   b. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.
   c. Pipe Insulation - Glass-Fiber, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.
   d. Pipe Insulation - Mineral Wool, Preformed: [**2 inches (50 mm)**]<**Insert dimension**> thick.

E. Steam and Steam Condensate Piping and Safety Relief Vent Piping, 350 Deg F (177 Deg C) and Below:

1. Insulation for All Pipe Sizes: To be one of the following:

   a. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.
   b. Pipe Insulation - Cellular Glass, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.
   c. Pipe Insulation - Glass-Fiber, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.
   d. Pipe Insulation - Mineral Wool, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.

F. Steam and Steam Condensate Piping and Safety Relief Vent Piping Above 350 Deg F (177 Deg C):

1. Insulation for All Pipe Sizes: To be one of the following:

   a. Pipe Insulation - Calcium Silicate, Preformed: [**5 inches (125 mm)**]<**Insert dimension**> thick.
   b. Pipe Insulation - Cellular Glass, Preformed: [**5 inches (125 mm)**]<**Insert dimension**> thick.
   c. Pipe Insulation - Glass-Fiber, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.
   d. Pipe Insulation - Mineral Wool, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.

G. Refrigerant Suction and Hot-Gas Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [2 inches (50 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Polystyrene: [2 inches (50 mm)]<**Insert dimension**> thick.

H. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. Insulation for All Pipe Sizes: To be the following:

a. Pipe Insulation - Flexible Elastomeric: [2 inches (50 mm)]<**Insert dimension**> thick.

I. Refrigerant Liquid Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Flexible Elastomeric: [1 inch (25 mm)][2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Polyolefin: [1 inch (25 mm)]<**Insert dimension**> thick.

J. Heat-Recovery Piping:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Flexible Elastomeric: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
f. Pipe Insulation - Polyisocyanurate: [2 inches (50 mm)]<**Insert dimension**> thick.
g. Pipe Insulation - Polystyrene: [2 inches (50 mm)]<**Insert dimension**> thick.

K. Dual-Service Heating and Cooling:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [3 inches (75 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
d. Pipe Insulation - Phenolic: [2 inches (50 mm)]<**Insert dimension**> thick.
e. Pipe Insulation - Polyisocyanurate: [2 inches (50 mm)]<**Insert dimension**> thick.

L. Fuel Oil Piping, Heated:

1. Insulation for All Pipe Sizes: To be one of the following:

a. Pipe Insulation - Cellular Glass, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
b. Pipe Insulation - Glass-Fiber, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.
c. Pipe Insulation - Mineral Wool, Preformed: [2 inches (50 mm)]<**Insert dimension**> thick.

3.21 OUTDOOR, UNDERGROUND, PIPING INSULATION SCHEDULE

A. Insulation for belowground piping is specified in Section 232113.13 "Underground Hydronic Piping" and Section 232213.13 "Underground Steam and Condensate Heating Piping."

B. Chilled Water Piping, All Sizes: Pipe insulation - cellular glass, preformed, [**2 inches (50 mm)**]<**Insert dimension**> thick.

C. Condenser-Water Supply and Return Piping, All Sizes: Pipe insulation - cellular glass, preformed, [**2 inches (50 mm)**]<**Insert dimension**> thick.

D. Heating-Hot-Water Supply and Return Piping, All Sizes, 200 Deg F (93 Deg C) and Below: Pipe insulation - cellular glass, preformed, [**3 inches (75 mm)**]<**Insert dimension**> thick.

E. Heating-Hot-Water Supply and Return Piping, All Sizes, Above 200 Deg F (93 Deg C):

1. Pipe Insulation - Calcium Silicate, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.
2. Pipe Insulation - Cellular Glass, Preformed: [**3 inches (75 mm)**]<**Insert dimension**> thick.

F. Steam and Steam Condensate Piping, All Sizes, 350 Deg F (177 Deg C) and Below:

1. Pipe Insulation - Calcium Silicate, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.
2. Pipe Insulation - Cellular Glass, Preformed: [**4 inches (100 mm)**]<**Insert dimension**> thick.

G. Steam and Steam Condensate Piping, All Sizes, Above 350 Deg F (177 Deg F):

1. Pipe Insulation - Calcium Silicate, Preformed: [**5 inches (125 mm)**]<**Insert dimension**> thick.
2. Pipe Insulation - Cellular Glass, Preformed: [**5 inches (125 mm)**]<**Insert dimension**> thick.

H. Dual-Service Heating and Cooling Piping, All Sizes, 40 to 200 Deg F (4 to 93 Deg C): Pipe insulation - cellular glass, preformed, [**3 inches (75 mm)**]<**Insert dimension**> thick.

I. Fuel Oil Piping, All Sizes, Heated: Pipe insulation - cellular glass, preformed, [**2 inches (50 mm)**]<**Insert dimension**> thick.

3.22 INDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.23 OUTDOOR, FIELD-APPLIED INSULATION JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed from View:

1. None.
2. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**] .

3. Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Painted Aluminum: [**Smooth**][**Corrugated**][**Stucco embossed**] .

   a. Thickness: [**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**][**0.032 inch (0.81 mm)**] .

5. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth No. 2B finish**][**corrugated**][**stucco embossed**] .

   a. Thickness: [**0.010 inch (0.25 mm)**][**0.016 inch (0.41 mm)**][**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

D. Piping, Exposed to View:

1. PVC: [**Standard**][**Color-coded by system**] .

   a. Thickness: [**20 mils (0.5 mm)**][**30 mils (0.8 mm)**][**40 mils (1.0 mm)**] .

2. Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

3. Painted Aluminum: [**Smooth**][**Stucco embossed**] with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.0 mm)**] .

4. Stainless Steel: [**Type 304**][**or**][**Type 316**] , [**smooth**][**stucco embossed**] , with [**1-1/4-inch- (32-mm-) deep corrugations**][**2-1/2-inch- (65-mm-) deep corrugations**][**4-by-1-inch (100-by-25-mm) box ribs**] .

   a. Thickness: [**0.020 inch (0.51 mm)**][**0.024 inch (0.61 mm)**] .

3.24 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 23 07 19 00

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SECTION 23 08 00 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:

1. Energy supply systems.
2. Heat generation systems.
3. Cooling generation systems.
4. Central-station air-handling systems.
5. Air, steam, and hydronic distribution systems.
6. Heating and cooling terminal and unitary equipment.
7. HVAC controls.
8. TAB verification.
9. <**Insert additional systems**>.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. IgCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

F. TAB: Testing, adjusting, and balancing.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**BAS**][**and**][**HVAC**] testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Div. 23 Subcontractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning

Requirements" and ASHRAE 202 and to resolve any issues with the CxA.

2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to [**BAS**][**and**][**HVAC**] to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements and ASHRAE 202."

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

   a. Instrument or tool identification number.
   b. Equipment schedule designation of equipment for which the instrument or tool is required.
   c. Manufacturer, make, model, and serial number.
   d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians performing BAS Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations are to have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum [**three years'**]<**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum [**three years'**]<**Insert time**> experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.

4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

   a. Be calibrated by manufacturer with current calibration tags permanently affixed.
   b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

2. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 Cx PROCESS

A. Perform Cx process in accordance with Section 019113 "General Commissioning Requirements" for [**BAS**][**and**][**HVAC**] and in accordance with the following:

1. [**IgCC, which requires compliance with ASHRAE 202**].
2. [**ASHRAE 202**].
3. [**Commissioning standards acceptable to the authority having jurisdiction**].
4. <**Insert standard**>.

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each [**BAS**][**and**][**HVAC**] system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**IgCC and**] ASHRAE 202. Contractor performs the following:

1. Review [**BAS**][**and**][**HVAC**] preliminary construction checklists and provide written comments on checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**]<**Insert number**> days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)" When performing tests. Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each [**BAS**][**and**][**HVAC**] system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**IgCC and ASHRAE 202**][**ASHRAE 202**].

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."

3. Use only construction checklists, marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed and provide pertinent details and other information.

C. Systems required to be commissioned under IgCC:

1. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.
2. Air-curtain systems.
3. Water-pumping and -mixing systems over **5 hp (4 kW)** and purification systems.
4. Renewable energy systems and energy storage systems.
5. Energy and building management and demand-control systems.

D. Additional systems required to be commissioned:

1. Energy supply systems, including the following:

   a. Fuel-oil supply.
   b. Fuel gas supply.
   c. Central-plant steam supply.
   d. Central-plant hot-water supply.
   e. Solar-energy supply.
   f. Renewable energy systems.
   g. Energy storage systems.
   h. Demand-control systems.
   i. <**Insert supply sources**>.

2. Heat generation systems, including the following:

   a. Boilers.
   b. Furnaces.
   c. Fuel-fired unit heaters.
   d. Auxiliary equipment.
   e. <**Insert equipment**>.

3. Cooling generation systems, including the following:

   a. Water chillers.
   b. Cooling towers.
   c. Direct-expansion refrigeration systems.
   d. <**Insert systems**>.

4. Air-handling systems, including the following:

   a. Supply, return, and exhaust air fans, motors, and drives.
   b. Automatic and gravity dampers.
   c. Heating and cooling devices.
   d. Humidification and dehumidification devices.
   e. Air filters.
   f. Hangers and supports.
   g. Interlock between air-handling system and fire/smoke alarm system.
   h. <**Insert components**>.

5. Air duct systems, including the following:

a. Duct systems.
b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
c. Duct-mounted access doors and panels.
d. Hangers and supports.
e. <**Insert components**>.

6. Air curtain systems.

a. Supply air fans and motors.
b. Heating and cooling devices.
c. <**Insert components**>.

7. Steam and hydronic distribution systems, including the following:

a. Steam distribution piping systems.
b. Condensate piping systems, including condensate pumps and all accessories.
c. Hydronic piping systems and all accessories.
d. Pumps and all accessories.
e. Sleeves and sleeve seals.
f. Meters and gauges.
g. General-duty and specialty valves.
h. Hangers and supports
i. Heat tracing.
j. <**Insert systems**>.

8. Refrigerant piping, including the following:

a. Refrigerant piping, fittings, and specialties.
b. Refrigerant charge.
c. Sleeves and sleeve seals.
d. Meters and gauges.
e. General-duty and specialty valves.
f. Hangers and supports.
g. <**Insert components**>.

9. Smoke-control systems, including the following:

a. Exhaust and makeup fans, motors, and drives.
b. Exhaust and makeup air distribution systems.
c. Smoke dampers.
d. Smoke detectors.
e. Fire and smoke alarm system interface.
f. <**Insert system**>.

10. Heating and cooling terminal and unitary equipment, including the following:

a. Unit ventilators.
b. Unit heaters.
c. Fan-coil units.
d. Finned-tube radiation.
e. Electric heating.
f. Unitary heating and cooling equipment.
g. <**Insert units**>.

11. Vibration isolation systems.

12. Controls and instrumentation, including the following:

    a. Energy monitoring and recording system.
    b. Controllers and sensors.
    c. Automatic control valves, dampers, and actuators.
    d. Control interface with fans, pumps, dampers, and other equipment and systems.
    e. Demand-control systems.
    f. <**Insert systems**>.

13. TAB Verification:

    a. Airflow.
    b. Water flow.
    c. Space pressurization.

14. Documentation:

    a. Mechanical systems manuals.
    b. Documentation of required commissioning.

15. Mechanical insulation, including the following:

    a. Duct and plenum insulation.
    b. HVAC piping insulation.

16. <**Insert additional systems**>.

3.3 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

    1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA,

and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO HVAC SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in HVAC Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment"**][**Section 230548.13 "Vibration Controls for HVAC Piping and Equipment"**].
2. Components to Be Tested:

   a. Vibration isolation control devices in HVAC systems.
   b. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.
4. Test Conditions, Constant Speed Equipment: Measure vibration of the facility structure at [**three**]<**Insert number**> locations designated by Owner's witness while the isolated equipment operates.
5. Test Conditions, Variable Speed Equipment: Measure vibration of the facility structure at [**three**]<**Insert number**> locations designated by Owner's witness at the following operating conditions:

   a. Maximum speed.

b. Minimum speed.
c. Critical speed.

6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Heat Tracing in HVAC Systems:

1. Prerequisites: Acceptance of results of construction checklists for heat tracing specified in HVAC systems. Comply with requirements listed in Section 230533 "Heat Tracing for HVAC Piping."
2. Equipment and Systems to Be Tested:

a. Self-regulating, parallel-resistance heating cables.
b. Heat tracing circuit controller.

3. Test Purpose:

a. Evaluate response to ambient temperature below freeze-protection set point.
b. Evaluate heating cable fault alarm.

4. Test Conditions:

a. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> above freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is energized.
b. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> below freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is de-energized.
c. Simulate an electrical fault on the heating cable.

5. Acceptance Criteria:

a. Freeze-protection circuit is energized at set-point temperature of minus **2 deg F (1 deg C)**.
b. Freeze-protection circuit is de-energized at set-point temperature of plus **2 deg F (1 deg C)**.
c. Heater trace circuit controller initiates an alarm of cable fault. Alarm is correctly reported at the alarm panel.

3.7 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.

E. Conditions of the Test:

1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Systems operating in full heating mode[**with minimum outside-air volume**].
3. Systems operating in full cooling mode[**with minimum outside-air volume**].
4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:

1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.8 HEATING CONTROL SYSTEM Cx TESTS

A. Heating-Water Supply Temperature Control:

1. Prerequisites: Installation verification of the following:

a. Startup of [**boiler**]<**Insert boiler designation**>[**steam to hot-water converter**]<**Insert converter designation**><**Insert prime heating-water equipment**>.
b. Startup of heating-water pump(s) <**Insert pump designation(s)**>.
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; [**thermostat**][**thermistor temperature sensor**][**resistance temperature sensor**]<**Insert device designation**>.
e. Output Device: Control valve <**Insert device designation**>.
f. Display the following at the operator's workstation:

1) Heating-water supply temperature.
2) Heating-water supply temperature set point.
3) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device <**Insert device designation**>.
4. Conditions of the Test:

a. Minimum heating-water flow.
b. Midrange Heating-Water Flow: [**50 to 60**]<**Insert number(s)**> percent of maximum.
c. Maximum heating-water flow.

5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> of set point.

B. Heating-Water Supply Temperature Reset:

1. Prerequisites: Installation verification of the following:

a. Startup of [**boiler**]<**Insert boiler designation**>[**steam to hot-water converter**]<**Insert converter designation**><**Insert prime heating-water equipment**>.

b. Startup of heating-water pump(s) <**Insert pump designation(s)**>.
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; [**thermostat**][**thermistor temperature sensor**][**resistance temperature sensor**]<**Insert device designation**>.
e. Input Device: Outdoor-air temperature; [**electric, outdoor-air-reset controller**][**outdoor-air sensor**].
f. Output Device: Control valve <**Insert device designation**>.
g. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Heating-water supply temperature.
3) Heating-water supply temperature set point.
4) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device <**Insert device designation**> in response to variable outdoor-air temperature input; [**electric, outdoor-air-reset controller**][**outdoor-air sensor**]<**Insert device designation**>.
4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.

a. Low Temperature: Outdoor-air temperature between [**minus 30 and 0 deg F (minus 34 and minus 18 deg C)**]<**Insert temperature range**>.
b. Midrange Temperature: Outdoor-air temperature between [**30 and 45 deg F (minus 1 and plus 7 deg C)**]<**Insert temperature range**>.
c. High Temperature: Outdoor-air temperature above [**65 deg F (18 deg C)**]<**Insert temperature**>.

5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> of set point.

a. [**195 deg F (90 deg C)**]<**Insert temperature**> heating water when outdoor-air temperature is [**minus 30 deg F (minus 34 deg C)**]<**Insert temperature**>.
b. [**130 deg F (54 deg C)**]<**Insert temperature**> heating water when outdoor-air temperature is [**65 deg F (18 deg C)**]<**Insert temperature**>.
c. Under all conditions, heating-water supply temperature is within plus or minus [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> of set point.

C. Control Primary Circulating Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of heating-water pump(s) <**Insert pump designation(s)**>.
b. Input Device: Outdoor-air temperature; [**electric, outdoor-air-reset controller**][**outdoor-air sensor**]<**Insert device designation**>.
c. Output Device: Heating-water pump; [**starter**][**DDC system command to starter**]<**Insert device designation**> relay.
d. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Operating status of primary circulating pump(s).

2. Scope: Heating-water pump(s) <**Insert pump designation(s)**> and associated controls.
3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; [**electric, outdoor-air-reset controller**][**outdoor-air sensor**]<**Insert device designation**>.

4. Conditions of the Test:

   a. High Temperature: Outdoor-air temperature above [**65 deg F (18 deg C)**]<**Insert temperature**>.
   b. Low Temperature: Outdoor-air temperature below [**65 deg F (18 deg C)**]<**Insert temperature**>.

5. Acceptance Criteria:

   a. High Temperature: Pump(s) are off when outside-air temperature is above [**65 deg F (18 deg C)**]<**Insert temperature**>.
   b. Low Temperature: Pump(s) are on when outside-air temperature is below [**65 deg F (18 deg C)**]<**Insert temperature**>.

3.9 CHILLER SYSTEM Cx TESTS

A. Start-and-Stop Condenser-Water Pump(s):

1. Prerequisites: Installation verification of the following:

   a. Startup of condenser-water pump(s) <**Insert pump designation(s)**>.
   b. Startup of cooling tower <**Insert cooling tower designation**>.
   c. Input Device: Water pressure transducer <**Insert device designation**>.
   d. Input Device: [**Space thermostat**][**DDC system outdoor-air temperature**]<**Insert device designation**>.
   e. Input Device: [**Time clock**][**DDC system time schedule**]<**Insert device designation**>.
   f. Output Device: Hard wired through motor starter; [**DDC system binary output**]<**Insert device designation**>.
   g. Output Device: [**Time clock**][**Binary output**]<**Insert device designation**>.
   h. Display the following at the operator's workstation:

      1) Low-level cooling-tower sump alarm.
      2) Outdoor-air temperature.
      3) Cooling (software) demand indication.
      4) Time and time schedule.
      5) Condenser-water pump(s) on-off status.
      6) Condenser-water pump(s) on-off indication.
      7) Condenser-water flow indication.

2. Scope:

   a. Condenser-water system, including condenser-water pump(s), cooling towers, and associated controls.

3. Purpose:

   a. Condenser-water pump(s) lockout.
   b. Condenser-water pump(s) start.
   c. Condenser-water pump(s) shutdown.
   d. Low-level cooling-tower sump alarm.
   e. Condenser-water pump(s) time-of-day schedule.

4. Conditions of the Test:

   a. Verify Lockout: Start with condenser-water pump enable-input devices in the "disable"

state to prevent pump start. One by one, place the enable-input devices in the "enable" state, and then return each to the "disable" state before placing the next enable-input device to the "enable" state.

b. Verify Start: Start with condenser-water pump enable-input devices in the "disable" state to prevent pump start. One by one, place the enable-input devices in the "enable" state.

c. Verify Shutdown: Place all enable-input devices in the "enable" state to allow the pump(s) to start. One by one, place the enable-input devices in the "disable" state, and then return each to the "enable" state before placing the next enable-input device to the "disable" state.

d. Verify Schedule: Compare condenser-water pump start-and-stop schedule times with Owner-approved time-of-day schedule.

5. Acceptance Criteria:

a. Lockout: No single enable-input device starts the pump(s) when released to the "enable" state.

b. Start: Condenser-water pump(s) start when, and only when, all enable-input devices are in the "enable" state.

c. Shutdown: Each enable-input device stops the condenser-water pump(s) when placed in the "disable" state, regardless of the state of other enable-input devices.

d. Schedule: Condenser-water pump start-and-stop schedule times agree with Owner-approved time-of-day schedule.

B. Start-and-Stop Chilled-Water Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of chilled-water pump(s) <**Insert pump designation(s)**>.

b. Startup of condenser-water pump(s) <**Insert pump designation(s)**>.

c. Startup of cooling tower <**Insert cooling tower designation**>.

d. Input Device: Flow switch in condenser-water circuit <**Insert device designation**>.

e. Output Device: [**Starter**][**DDC system command to starter**]<**Insert device designation**> relay.

f. Display one of the following at the operator's workstation:

1) Chilled-water flow indication.

2) Condenser-water flow indication.

3) Chilled-water pump(s) on-off status.

4) Chilled-water pump(s) on-off indication.

2. Scope: Chilled-water system, including chilled-water pump(s), associated controls, and condenser-water system controls.

3. Purpose:

a. Chilled-water pump(s) start.

b. Chilled-water pump(s) shutdown.

4. Conditions of the Test:

a. Verify Start: Start with chilled-water pump enable-input device in the "disable" state to prevent pump start. Place the enable-input device in the "enable" state.

b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the pump(s) to run. Then place the enable-input device in the "disable" state.

5. Acceptance Criteria:

a. Start: Chilled-water pump(s) start when, and only when, the enable-input device is in the "enable" state.
b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.

C. Start-and-Stop Cooling-Tower Fans(s):

1. Prerequisites: Installation verification of the following:

a. Input Device: Flow switch in condenser-water circuit <**Insert device designation**>.
b. Output Device: [**Starter**][**DDC system command to starter**]<**Insert device designation**> relay.
c. Display:

1) Condenser-water flow indication.
2) Cooling-tower fan(s) on-off indication.

2. Scope: Condenser-water system, including cooling tower, condenser-water pump(s), and associated controls.
3. Purpose:

a. Cooling-tower fan(s) start.
b. Cooling-tower fan(s) shutdown.

4. Conditions of the Test:

a. Verify Start: Start with cooling-tower fan enable-input device in the "disable" state to prevent fan(s) start. Place the enable-input device in the "enable" state.
b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the fan(s) to run. Then place the enable-input device in the "disable" state.

5. Acceptance Criteria:

a. Start: Chilled-water pump(s) start when, and only when, the enable-input device is in the "enable" state.
b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.

D. Alternative Chiller(s):

1. Prerequisites: Installation verification of the following:

a. Input Device: [**Electric alternator**][**DDC system software**]<**Insert device designation**>.
b. Output Device: [**Chiller**][**DDC system command to chiller**]<**Insert device designation**> terminal strip.
c. Display:

1) Chiller(s) on-off indication.
2) Chiller failure alarm.

2. Scope:

a. Chilled-water system and associated controls.
b. Condenser-water system and associated controls.

3. Purpose:

   a. Lead-lag rotation of chillers.
   b. Replacement of failed chiller in rotation.
   c. Adding and dropping chillers as follows: <**Insert sequence and parameters**>.
   d. Replacement of failed chiller in add/drop sequence.
   e. Chiller failure alarm initiation.

4. Conditions of the Test:

   a. Lead-Lag Rotation - Chiller Start: Create a number of chilled-water system start-stop cycles equal to the number of chillers plus one.
   b. Lead-Lag Rotation - Lead Chiller Fail: Disable the lead chiller while it is running.
   c. Lead-Lag Rotation - Lag Chiller Fail: Disable a lag chiller while it is running.
   d. Lead-Lag Rotation - Chiller Start Fail: Disable a chiller while it is in standby mode. Initiate a lead-lag rotation call for the disabled chiller to start.
   e. Add/Drop Sequence - Increasing Demand: Increase chilled-water demand incrementally to observe the corresponding addition of chillers. Increase demand gradually as the load approaches the set point for adding the next chiller, to permit observation of the actual load at the time the next chiller is enabled.
   f. Add/Drop Sequence - Decreasing Demand: Decrease chilled-water demand incrementally to observe the corresponding dropping of chillers. Decrease demand gradually as the load approaches the set point for dropping the next chiller, to permit observation of the actual load at the time the next chiller is disabled.

5. Acceptance Criteria:

   a. Lead-Lag Rotation - Chiller Start: On each chilled-water system start event, the [**other**][**next**] chiller in rotation starts as the lead chiller, and the previous lead chiller, is designated as the [**last-**]lag chiller.
   b. Lead-Lag Rotation - Lead Chiller Fail: When the lead chiller fails, the [**other**][**next**] chiller in rotation starts as the lead chiller, and a chiller failure alarm, is initiated for the failed chiller.
   c. Lead-Lag Rotation - Lag Chiller Fail: When the lag chiller fails, [**the next chiller in rotation starts as the lead chiller, and**]a chiller failure alarm is initiated for the failed chiller.
   d. Lead-Lag Rotation - Chiller Start Fail: When a chiller fails to start, [**the next chiller in rotation starts in its place, and**]a chiller failure alarm is initiated for the failed chiller.
   e. Add/Drop Sequence - Increasing Demand: Chillers are added at the specified load set point, plus or minus [**5**]<**Insert number**> percent. Chilled-water supply temperature remains stable within plus or minus [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> of set point.
   f. Add/Drop Sequence - Decreasing Demand: Chillers are dropped at the specified load set point, plus or minus [**5**]<**Insert number**> percent. Chilled-water supply temperature remains stable within plus or minus [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> of set point.
   g. Add/Drop Sequence - Operating Chiller Fail: When an operating chiller fails, the next chiller in sequence starts and a chiller failure alarm is initiated for the failed chiller.
   h. Add/Drop Sequence - Chiller Start Fail: When a chiller fails to start, the next chiller in sequence starts in its place and a chiller failure alarm is initiated for the failed chiller.

3.10 TERMINAL UNIT EQUIPMENT Cx TESTS

A. VAV Terminal Air Units with Coils:

1. Prerequisites: Installation verification of the following:

a. Occupancy Input Device: Occupancy sensor.
b. Occupancy Output Device: DDC system binary output.
c. Room Temperature Input Device: [**Room thermostat**][**Electronic temperature sensor**].
d. Room Temperature Output Device: [**Pneumatic**][**Electronic**] damper actuators and control-valve operators.
e. Display the following at the operator's workstation:

1) Room/area served.
2) Room occupied/unoccupied.
3) Room temperature indication.
4) Room temperature set point.
5) Room temperature set point, occupied.
6) Room temperature set point, unoccupied.
7) Air-damper position as percentage open.
8) Control-valve position as percentage open.

2. Scope: VAV terminal air units with [**hydronic**][**steam**] coils in supply-air systems, and associated controls.
3. Purpose:

a. Occupancy-dependent room temperature set-point reset.
b. Room temperature control.

4. Conditions of the Test:

a. Cx Test Demonstration Sampling Rate: [**10**]<**Insert number**> percent of each model/size unit.
b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point, plus or minus [**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point, plus or minus [**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.

5. Acceptance Criteria:

a. Temperature Control - Occupied:

1) Control system status changes from "occupied" to "unoccupied" after the specified time.
2) Room temperature is stable at occupied set point, plus or minus [**1.0 deg F (0.6 deg C)**]<**Insert temperature**> within [**10**]<**Insert number**> minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> during transition.

b. Temperature Control - Unoccupied:

1) Control system status changes from "unoccupied" to "occupied" [**immediately**][**after five minutes of continuous occupancy**].
2) Room temperature is stable at unoccupied set point, plus or minus [**1.0 deg F (0.6 deg C)**]<**Insert temperature**> within [**30**]<**Insert number**> minutes of occupancy.

3.11 AIR-HANDLING SYSTEM Cx TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:

a. Volume-Control Input Device: [**Static-pressure transmitter**][**Differential-pressure switch**] sensing supply-duct static pressure referenced to conditioned-space static pressure.
b. Volume-Control Output Device: [**Receiver controller**][**DDC system analog output**][**DDC system analog output to digital-to-pneumatic transducer**] to modulating damper actuator. Set inlet guide vanes to [**minimum**][**closed**] position when fan is stopped.
c. Volume-Control Input Device: [**Static-pressure transmitter**][**Differential-pressure switch**] sensing supply-duct static pressure referenced to conditioned-space static pressure.
d. Volume-Control Output Device: [**Receiver controller**][**DDC system analog output**] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
f. High-Pressure Output Device: [**Receiver controller**][**DDC system binary output**] to [**alarm panel**][**motor starter**].
g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan [**inlet vane position**][**speed**].

2. Scope: VAV supply fan units and associated controls.
3. Purpose:

a. Supply-air discharge static pressure control.
b. Response to excess supply-air discharge static pressure condition.

4. Conditions of the Test:

a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: [**50 to 60**]<**Insert number(s)**> percent of maximum.
c. Maximum supply-air flow.
d. Excess supply-air discharge static pressure.

5. Acceptance Criteria:

a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus [**2**]<**Insert number**> percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure, plus or minus [**2**]<**Insert number**> percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:

a. Minimum Position Input Device: [**Time clock**][**DDC system time schedule**] .
b. Output Device: [**Receiver controller**][**DDC system analog output**][**DDC system analog output to digital-to-pneumatic transducer**] to modulating damper actuator(s).

c. Heating Reset Input Device: [**Room thermostat**][**DDC system software**] .
d. [**Supply**][**Mixed**]-Air Temperature Input Device: [**Duct-mounted thermostat**][**Electronic temperature sensor**].
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted [**thermostats**][**electronic temperature sensors**].
f. Display the following at the operator's workstation:

1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:

a. Occupied time control.
b. Minimum damper position control.
c. Heating reset control.
d. [**Supply**][**Mixed**]-air temperature control.
e. Cooling reset control.
f. Unoccupied time control.

4. Conditions of the Test:

a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. [**Supply**][**Mixed**]-Air Temperature Control: Override [**supply**][**mixed**]-air temperature set point to a value [**2.0 deg F (1.1 deg C)**]<**Insert temperature**> above current [**supply**][**mixed**]-air temperature.
e. Cooling Reset Control: Override outdoor-air [**temperature to a value that exceeds return-air temperature**][**enthalpy to a value that exceeds return-air enthalpy**].
f. Unoccupied Time Control: Advance to unoccupied schedule time.
g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at [**hourly**]<**Insert alternative recording frequency**> intervals. Submit trend data for [**24-hour**]<**Insert time**> periods in which natural conditions require heating reset control, [**supply**][**mixed**]-air temperature control, and cooling reset control.

1) Minimum position input device.
2) Heating reset input device.
3) [**Supply**][**Mixed**]-air temperature input device.
4) Cooling reset input device.

5. Acceptance Criteria:

a. Occupied Time Control: Mixed-air control is active in occupied mode.
b. Minimum Damper Position Control: Controller [**opens minimum outdoor-air dampers**][**positions outdoor-air dampers to minimum position**].
c. Heating Reset Control: Controller [**closes minimum outdoor-air dampers**][**sets outdoor-air dampers to minimum position**].
d. [**Supply**][**Mixed**]-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary [**supply**][**mixed**]-air temperature set point, plus or minus [**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air [**temperature exceeds return-air temperature**][**enthalpy exceeds return-air**

enthalpy].

f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.

g. Control Data Trend Log: Data verify control in accordance with sequence of control.

END OF SECTION 23 08 00 00

SECTION 23 09 00 00 - SPEED INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Speed switches.
2. Combination speed switches and transmitters.
3. Speed sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Product description with complete technical data and product specification sheets.
3. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades:

1. Product installation location shown in relationship to room, conduit, duct, pipe, and equipment.
2. Sizes and locations of wall access panels for instruments installed behind walls.
3. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each speed instrument, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Source quality-control reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: To include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 SPEED SWITCHES

A. Rotational Speed Switches, Noncontact Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Electro Sensors**]
   b. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Rockwell Automation, Inc.**]
   d. [**Torq Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Electro Sensors**]
   b. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Rockwell Automation, Inc.**]
   d. [**Torq Corporation**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all noncontact-type, rotational speed switches from a single manufacturer.
4. Description:

   a. Speed switch, sensor, and electronics housed in enclosure and used to measure shaft rotational speed without direct contact to motor or equipment shaft.
   b. Shaft-end-mounted disc or split collar wrap around shaft generates an alternating magnetic field sensed by the switch. Alternative technologies that use light in lieu of magnetic fields are acceptable contingent upon compliance with requirements indicated.
   c. Rotation: Nondirectional, clockwise or counterclockwise.

5. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.
6. Performance:

    a. Field-Adjustable Speed Range: [**0.1 to 100**][**0.5 to 5000**][**6 to 150**][**15 to 80**][**50 to 1000**][**100 to 5000**][**150 to 3600**]<**Insert speed range**> rpm.
    b. Set-Point Accuracy: [**0.5**][**1.5**][**3**][**5**]<**Insert value**> percent.
    c. Temperature Limits: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**][**Minus 22 to 140 deg F (Minus 30 to 60 deg C)**][**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
    d. Electrical Rating: [**1.8**][**5**][**10**]<**Insert value**> A at 115 or 240 V ac.

7. Switch Type: [**SPDT**][**or**][**DPDT**].
8. Operator Interface: Potentiometer; screw or pushbutton adjustment.
9. Enclosure:

    a. Material: [**Cast aluminum**][**Plastic**]<**Insert material**>.
    b. Removable cover.
    c. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**].
    d. Electrical Connection: Screw terminals.
    e. Conduit Connection: **3/4-inch (21-mm)** or **1-inch (27-mm)** trade size.

10. Disc, Guard, and Mounting Bracket Construction:

    a. Magnetic Disc: [**Nylon**][**or**][**PVC**]<**Insert material**>.
    b. Disc Guard: [**Aluminum**][**or**][**stainless steel**]<**Insert material**>.
    c. Magnetic Split Collar Wrap: [**Aluminum**][**PVC**][**or**][**stainless steel**]<**Insert material**>.
    d. Mounting Bracket: [**Aluminum**][**or**][**stainless steel**]<**Insert material**>.

B. Rotational Speed Switches, Contact Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Rockwell Automation, Inc.**]
    c. [**Torq Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Rockwell Automation, Inc.**]
    c. [**Torq Corporation**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all contact-type rotational speed switches from a single manufacturer.
4. Description:

a. Speed switch, sensor, and electronics housed in one enclosure and used to measure shaft rotational speed with direct contact to motor or equipment shaft.
b. Rotation: Nondirectional, clockwise or counterclockwise.

5. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Groups C and D; and Class II, Groups F and G.
6. Performance:

a. Field-Adjustable Ascending Speed Ranges: [**0.6 to 300**][**1 to 90**][**10 to 3700**][**15 to 80**][**50 to 1000**][**80 to 2550**][**600 to 3000**]<**Insert speed range**> rpm.
b. Descending Speed Range Set Point: [**15**][**20**]<**Insert value**> percent lower than ascending speed.
c. Repeatability: Within [**2**][**5**][**7**]<**Insert value**> percent of maximum speed in range.
d. Temperature Limits: [**Minus 60 to 250 deg F (Minus 51 to 121 deg C)**][**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**][**Minus 22 to 140 deg F (Minus 30 to 60 deg C)**][**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
e. Electrical Rating: [**3**][**5**][**10**]<**Insert value**> A at 120 or 240 V ac.

7. Switch Type: [**SPDT**][**or**][**DPDT**].
8. Operator Interface: Adjustment screw.
9. Enclosure:

a. Material: [**Cast aluminum**][**Cast iron**][**or**][**FRP**]<**Insert material**>.
b. Removable screw-on cover.
c. Rating: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**or**][**Type 4X**].
d. Electrical Connection: Screw terminals.
e. Conduit Connection: **3/4-inch (21-mm)** trade size.

2.2 COMBINATION SPEED SWITCHES AND TRANSMITTERS

A. Combination Rotational Speed Switches and Transmitters, Noncontact Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Electro Sensors**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Electro Sensors**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all noncontact-type combination rotational speed switches and transmitters from a single manufacturer.
4. Description:

a. Speed switch, sensor, transmitter, and electronics housed in enclosure and used to

measure shaft rotational speed without direct contact to motor or equipment shaft.
b. Shaft-end-mounted disc or split collar wrap around shaft generates an alternating magnetic field sensed by the combination switch and transmitter.
c. Rotation: Nondirectional, clockwise or counterclockwise.

5. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.
6. Performance:

a. Field-Adjustable Speed Range: [**0.1 to 9999**]<**Insert speed range**> rpm.
b. Speed Accuracy: Within [**0.7**]<**Insert value**> percent of actual speed.
c. Temperature Limits: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**]<**Insert temperature range**>.
d. Electrical Rating: [**5**]<**Insert value**> A at 250-V ac.

7. Analog Output Signal: 4 to 20 mA signal with programmable speed range endpoints; 4 mA for minimum speed and 20 mA for maximum speed.
8. Switch Type: SPDT; programmable for either failsafe over-speed alarm or failsafe under-speed alarm.
9. Digital Display: LCD; four digits indicating either rotational speed (rpm) or analog output signal (mA); alarm relay LED.
10. Operator Interface: Pushbutton adjustment.
11. Enclosure:

a. Material: Cast aluminum.
b. Removable cover.
c. Rating: NEMA 250, Type 4X.
d. Electrical Connection: Screw terminals.
e. Conduit Connection: **3/4-inch (21-mm)** trade size.

12. Disc, Guard, and Mounting Bracket Construction:

a. Magnetic Disc: Nylon.
b. Disc Guard: Aluminum or stainless steel.
c. Magnetic Split Collar Wrap: Aluminum, PVC, or stainless steel.
d. Mounting Bracket: Aluminum or stainless steel.

2.3 SPEED SENSORS AND TRANSMITTERS

A. Rotational Speed Sensors and Transmitters, Noncontact Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Electro Sensors**]
b. [**Process Control Systems**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Electro Sensors**]
b. [**Process Control Systems**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all noncontact-type rotational speed sensors and transmitters from a single manufacturer.
4. Description:

   a. Speed sensor, transmitter, and electronics housed in enclosure and used to measure shaft rotational speed without direct contact to motor or equipment shaft.
   b. Shaft-end-mounted disc or split collar wrap around shaft generates an alternating magnetic field sensed by the switch. Alternative technologies that use light in lieu of magnetic fields are acceptable contingent upon compliance with requirements indicated.
   c. Rotation: Nondirectional, clockwise or counterclockwise.

5. Hazardous Environment Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.
6. Performance:

   a. Field-Adjustable Speed Range: [**0.2 to 200**][**0.2 to 2000**][**5 to 10000**]<**Insert speed range**> rpm.
   b. Speed Accuracy: [**0.5**][**2**]<**Insert value**> percent.
   c. Temperature Limits: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**][**Minus 4 to 176 deg F (Minus 20 to 80 deg C)**]<**Insert temperature range**>.

7. Analog Output Signal: 4 to 20 mA[**or 0 to 10 V dc**].
8. Sensor Cable: Two-wire, shielded cable, minimum 22 gauge copper.
9. Enclosure:

   a. Material: Aluminum, stainless steel [**FRP**][**or**][**PVC**].
   b. Removable cover.
   c. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**].
   d. Electrical Connection: Screw terminals.
   e. Conduit Connection: **3/4-inch (21-mm)** trade size.

10. Disc, Guard, and Mounting Bracket Construction:

    a. Magnetic Disc: [**Nylon**]<**Insert material**>.
    b. Disc Guard: [**Aluminum**][**or**][**stainless steel**]<**Insert material**>.
    c. Magnetic Split Collar Wrap: [**Aluminum**][**PVC**][**or**][**stainless steel**]<**Insert material**>.
    d. Mounting Bracket: [**Aluminum**][**or**][**stainless steel**]<**Insert material**>.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Test and inspect assembled speed instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SPEED INSTRUMENT APPLICATIONS

A. Speed-Switch Applications:

1. Rotational Speed Switches, Noncontact Type: <**Insert application**>.
2. Rotational Speed Switches, Contact Type: <**Insert application**>.

B. Combination Speed Switch and Transmitter Applications:

1. Combination Rotational Speed Switches and Transmitters, Noncontact Type: <**Insert application**>.

C. Speed Sensor and Transmitter Applications:

1. Rotational Speed Sensors and Transmitters, Noncontact Type: <**Insert application**>.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support speed-switch wiring and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

C. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable

for environment.

4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of [**Type 316L stainless steel**]<**Insert material**>.

3.4 INSTALLATION OF SPEED SWITCHES

A. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.9 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to location, elevation, orientation, or other applicable considerations that impact performance.

D. Verify that wiring is correct and secure.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. Equipment and procedures used for calibration are to comply with instrument manufacturer's written instructions.
4. Provide diagnostic and test equipment for calibration and adjustment.
5. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
6. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
7. If, after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
8. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11 in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a voltage meter at zero, 50, and 100 percent of range.
2. Check analog current signals using a current meter at zero, 50, and 100 percent or range.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Switches: Calibrate switches to make or break contact at set points indicated.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain speed instruments.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 00 00

SECTION 23 09 23 00 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Direct digital control (DDC) system for HVAC.

B. Related Requirements:

1. Section 230923.13 "Energy Meters" for thermal and electric power energy meters that connect to DDC systems.
2. Section 230923.17 "Level Instruments" for liquid-level switches, sensors, and transmitters that connect to DDC systems.
3. Section 230923.22 "Position Instruments" for limit switches that connect to DDC systems.
4. Section 230923.33 "Vibration Instruments" for vibration instruments that connect to DDC systems.
5. Section 230923.43 "Weather Stations" for weather stations that connect to DDC systems.
6. Section 230993.11 "Sequence of Operations for HVAC DDC" for control sequences in DDC systems.
7. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical power and communications components

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. E/P: Voltage to pneumatic.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. I/P: Current to pneumatic.

O. LAN: Local area network.

P. LNS: LonWorks Network Services.

Q. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type

maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").

11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

R. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

T. Modbus TCP/IP: An open protocol for exchange of process data.

U. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

V. MTBF: Mean time between failures.

W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.

Z. POT: Portable operator's terminal.

AA. RAM: Random access memory.

BB. RF: Radio frequency.

CC. Router: Device connecting two or more networks at network layer.

DD. Server: Computer used to maintain system configuration, historical and programming database.

EE. TCP/IP: Transport control protocol/Internet protocol.

FF. UPS: Uninterruptible power supply.

GG. USB: Universal Serial Bus.

HH. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

II. VAV: Variable air volume.

JJ. WLED: White light emitting diode.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

    a. Workstations.
    b. Printers.
    c. Servers.
    d. Gateways.
    e. Routers.
    f. Protocol analyzers.
    g. DDC controllers.
    h. Enclosures.
    i. Electrical power devices.
    j. UPS units.
    k. Accessories.
    l. Instruments.
    m. Control dampers and actuators.
    n. Control valves and actuators.
    o. <**Insert product**>.

6. When manufacturer's product datasheets apply to a product series rather than a specific product

model, clearly indicate and highlight only applicable information.

7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, <**Insert product,**> and DDC controller.
2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity, and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden, and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:

   a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
   b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
   c. Drawings Size: <**Insert requirements**>.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

   a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
   b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
   c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
   d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
   e. Network communication cable and raceway routing.
   f. Information, drawn to scale, of <**Insert requirements**>.
   g. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services

for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

    a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
    b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
    c. A graphic showing location of control I/O in proper relationship to HVAC system.
    d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
    e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
    f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
    g. Narrative sequence of operation.
    h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

    a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
    b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
    c. Front, rear, and side elevations and nameplate legend.
    d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

    a. Each device connected to network with unique identification for each.
    b. Interconnection of each different network in DDC system.
    c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
    d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:

    a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
    b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
    c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
    d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

    a. Control signal cable and wiring between controllers and I/O.
    b. Point-to-point schematic wiring diagrams for each product.
    c. Control signal tubing to sensors, switches, and transmitters.
    d. Process signal tubing to sensors, switches, and transmitters.

e. Pneumatic main air and control signal tubing to pneumatic [**damper**][**and**][**valve**] actuators, pilot-positioners if applicable, and associated transducers.

11. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
c. Intended operator access between related hierarchical display screens.

E. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

a. Loss of power.
b. Loss of network communication signal.
c. Loss of controller signals to inputs and outpoints.
d. Operator workstation failure.
e. Server failure.
f. Gateway failure.
g. Network failure.
h. Controller failure.
i. Instrument failure.
j. Control damper and valve actuator failure.
k. <**Insert potential failure conditions**>.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

F. Samples:

1. For each of the following exposed product(s), installed in finished space for approval of selection of aesthetic characteristics:

a. Gas instruments specified in Section 230923.16 "Gas Instruments."
b. Moisture instruments specified in Section 230923.19 "Moisture Instruments."
c. Motion instruments specified in Section 230923.21 "Motion Instruments."
d. Pressure instruments specified in Section 230923.23 "Pressure Instruments."
e. Temperature instruments specified in Section 230923.27 "Temperature Instruments."
f. <**Insert devices**>.

G. Delegated Design Submittals: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.

a. Flow at Project design and minimum flow conditions.
b. Face velocity at Project design and minimum airflow conditions.

c. Pressure drop across damper at Project design and minimum airflow conditions.
d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
e. Maximum close-off pressure.
f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close, or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

a. Flow at Project design and minimum flow conditions.
b. Pressure-differential drop across valve at Project design flow condition.
c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

a. Instrument flow range.
b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
d. Pressure-differential loss across instrument at Project design flow conditions.
e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

H. Sustainable Design Submittals:

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings, reflected ceiling plans, or Building Information Model (BIM), and corresponding product installation details, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Qualification Statements:

1. Systems Provider's Qualification Data:

a. Resume of project manager assigned to Project.
b. Resumes of application engineering staff assigned to Project.
c. Resumes of installation and programming technicians assigned to Project.

d. Resumes of service technicians assigned to Project.
e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity, and building's primary function.
f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
h. Owner contact information for past project including name, phone number, and email address.
i. Contractor contact information for past project including name, phone number, and email address.
j. Architect[**and Engineer**] contact information for past project including name, phone number, and email address.

2. Manufacturer's qualification data.
3. Testing agency's qualification data.

C. Welding certificates.

D. Product Certificates:

1. Data Communications Protocol Certificates:

a. Certifying that each proposed DDC system component complies with ASHRAE 135.
b. Certifying that each proposed DDC system component complies with LonWorks.

2. <**Insert list of products**>.

E. Test and Evaluation Reports:

1. Product Test Reports: For DDC system equipment and components, for tests performed by [**a qualified testing agency**][**manufacturer**][**manufacturer and witnessed by a qualified testing agency**].
2. Preconstruction Test Reports: For each separate test performed.

F. Source Quality-Control Reports: For DDC system equipment and components.

G. Field Quality-Control Reports: For DDC system equipment and components.

H. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.

e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials and parts to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over [**four**]<**Insert time**>-year period following warranty period. Parts list to be indicated for each year.

C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during [**one**][**two**]<**Insert time**>-year period following warranty period.

D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Network Controller: [**One**]<**Insert quantity**>.
2. Programmable Application Controller: [**One**]<**Insert quantity**>.
3. Application-Specific Controller: [**One**]<**Insert quantity**>.
4. General-Purpose Relay: [**One**]<**Insert quantity**>.
5. Multifunction Time-Delay Relay: [**One**]<**Insert quantity**>.
6. Latching Relay: [**One**]<**Insert quantity**>.
7. Current-Sensing Relay: [**One**]<**Insert quantity**>.
8. Combination On-Off Status Sensor and On-Off Relay: [**One**]<**Insert quantity**>.
9. Transformer: [**One**]<**Insert quantity**>.
10. DC Power Supply: [**One**]<**Insert quantity**>.
11. <**Insert product**>.

1.8 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of [**five**][**10**]<**Insert number**> years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least [**three**][**five**]<**Insert number**> past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

   a. Product research and development.
   b. Product and application engineering.
   c. Product manufacturing, testing, and quality control.
   d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
   e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within <**Insert distance**> of Project.
3. Demonstrate past experience with installation of DDC system products being installed for period within [**three**][**five**]<**Insert number**> consecutive years before time of bid.
4. Demonstrate past experience on [**five**]<**Insert number**> projects of similar complexity, scope, and value.
5. Demonstrate past experience of each [**person**]<**Insert requirement**> assigned to Project.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support ongoing DDC system operation for a period of not less than [**five**]<**Insert number**> years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.
3. AWS D1.3/D1.3M.
4. AWS D1.4/D1.4M.

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.

1. Build mockups of completed installation where products are exposed to view and are located in areas with aesthetic requirements that warrant special attention, including the following spaces:

a. <**Insert specific locations for mockups**>.

2. Build mockups of completed installation for areas as indicated on Drawings.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on field mockups.

1. <**Insert configurations of assemblies**>.
2. Provide test assemblies representative of proposed materials and construction.
3. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
4. Notify Architect [**seven**]<**Insert number**> days in advance of dates and times when laboratory mockups will be tested.

B. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

1. <**Insert preconstruction requirements**>.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

a. Install updates only after receiving Owner's written authorization.

3. Perform warranty service during normal business hours and commence within [**8**][**16**][**24**]<**Insert number**> hours of Owner's warranty service request.
4. Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion.

a. For Gateway: [**Two**][**Three**]<**Insert number**>-year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Alerton Inc.**]
3. [**Automated Logic Corporation**]
4. [**Delta Controls Inc**]
5. [**Distech Controls**]
6. [**Honeywell International Inc.**]
7. [**Johnson Controls, Inc.**]
8. [**KMC Controls, Inc.**]
9. [**Reliable Controls Corporation**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Building Technologies Division**]
12. [**Trane**]
13. **<Insert manufacturer's name>**

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system consisting of[**high-speed,**] peer-to-peer network of distributed DDC controllers[**, other network devices**], operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system to be [**web based**][**or**][**web compatible**].

1. Web-Based Access to DDC System:

a. DDC system software based on server thin-client architecture, designed around open standards of web technology. DDC system server accessed using a web browser over DDC system network, using Owner's LAN, and remotely over Internet[**through Owner's LAN**].
b. Intent of thin-client architecture is to provide operators complete access to DDC system via a web browser. No special software other than a web browser is required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
c. Password-protected web access.

2. Web-Compatible Access to DDC System:

a. [**Workstation**][**and**][**or**][**server**] to perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
b. DDC system to support web browser access to building data. Operator using a standard web browser is able to access control graphics and change adjustable set points.
c. Password-protected web access.

2.4 PERFORMANCE REQUIREMENTS

A. Delivery of Selected Control Devices: Deliver to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

B. Delegated Design, Qualified Professional Engineer: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design DDC system to satisfy requirements indicated.

C. Delegated Design, Qualified Professional: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system manages HVAC systems.
b. DDC system operates HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system responds to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system operates while unattended by an operator and through operator interaction.
e. DDC system records trends and transactions of events and produces report information such as performance, energy, occupancies, and equipment operation.

D. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths complying with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**]<**Insert value**> or less.
2. Smoke-Developed Index: [**50**]<**Insert value**> or less.

E. DDC System Speed:

1. Response Time of Connected I/O:

a. Update AI point values connected to DDC system at least every [**five**][**two**] seconds for use by DDC controllers. Points used globally to also comply with this requirement.
b. Update BI point values connected to DDC system at least every [**five**][**two**]<**Insert number**> seconds for use by DDC controllers. Points used globally to also comply with this requirement.
c. AO points connected to DDC system to begin to respond to controller output commands within [**two**][**one**] second(s). Global commands to also comply with this requirement.
d. BO point values connected to DDC system to respond to controller output commands within [**two**][**one**]<**Insert number**> second(s). Global commands to also comply with this requirement.

2. Display of Connected I/O:

a. Update and display analog point COV connected to DDC system at least every

[**10**][**five**]<**Insert number**> seconds for use by operator.

b. Update and display binary point COV connected to DDC system at least every [**10**][**five**]<**Insert number**> seconds for use by operator.

c. Update and display alarms of analog and digital points connected to DDC system within [**45**][**30**][**15**]<**Insert number**> seconds of activation or change of state.

d. Update graphic display refresh within [**eight**][**four**]<**Insert number**> seconds.

e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

F. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions. Minimum spare bandwidth as follows:

1. Level 1 Networks: [**20**][**30**]<**Insert value**>.
2. Level 2 Networks: [**20**][**30**]<**Insert value**>.
3. Level 3 Networks: [**10**][**20**][**30**]<**Insert value**>.
4. <**Insert requirements**>.

G. DDC System Data Storage:

1. Include capability to archive not less than [**24**][**36**][**48**][**60**]<**Insert number**> consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
2. Local Storage:

   a. Provide [**server**]with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:

   a. Provide [**application-based**][**and**][**web browser**] interfaces to configure, upload, download, and manage data and to service plan with storage adequate to store all data for term indicated. Cloud storage uses IT industry standard database platforms and is capable of functions described in "DDC Data Access" Paragraph.

H. DDC Data Access:

1. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.
2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

I. Future Expandability:

1. DDC system size is expandable to an ultimate capacity of at least [**1.25**][**1.5**][**two**]<**Insert number**> times total I/O points indicated.
2. Design and install system networks to achieve ultimate capacity with only addition of DDC controllers, I/O, and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to remove and replace portions of network installation.
3. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.

J. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including

errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

    a. Thermal: Within [**5**][**3**][**1**]<**Insert number**> percent of reading.
    b. Electric Power: Within [**1**]<**Insert number**> percent of reading.
    c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

    a. Air: Within [**5**][**2**]<**Insert number**> percent of design flow rate.
    b. Air (Terminal Units): Within [**10**][**5**]<**Insert number**> percent of design flow rate.
    c. Fuel Oil: Within [**2**][**5**]<**Insert number**> percent of design flow rate.
    d. Natural Gas: Within [**2**][**5**]<**Insert number**> percent of design flow rate.
    e. Water: Within [**2**][**5**]<**Insert number**> percent of design flow rate.
    f. Steam: Within [**5**]<**Insert number**> percent of design flow rate.

3. Gas:

    a. Carbon Dioxide: Within [**50**]<**Insert value**> ppm.
    b. Carbon Monoxide: Within [**5**]<**Insert number**> percent of reading.
    c. Oxygen: Within [**5**]<**Insert number**> percent of reading.
    d. Refrigerant: Within [**5**]<**Insert number**> percent of reading.
    e. VOCs: Within [**5**]<**Insert number**> percent of reading.

4. Moisture (Relative Humidity):

    a. Air: Within [**5**][**2**]<**Insert number**> percent RH.
    b. Space: Within [**5**][**2**]<**Insert number**> percent RH.
    c. Outdoor: Within [**5**][**2**]<**Insert number**> percent RH.

5. Level: Within [**5**][**2**]<**Insert number**> percent of reading.
6. Pressure:

    a. Air, Ducts and Equipment: [**1**][**0.5**]<**Insert number**> percent of instrument [**range**][**span**].
    b. Space: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].
    c. Water: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].
    d. Steam: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].

7. Speed: Within [**10**][**5**]<**Insert number**> percent of reading.
8. Temperature, Dew Point:

    a. Air: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    b. Space: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    c. Outdoor: Within [**3 deg F**][**2 deg F**]<**Insert value**>.

9. Temperature, Dry Bulb:

    a. Air: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    b. Space: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    c. Outdoor: Within [**2 deg F**][**1 deg F**]<**Insert value**>.
    d. Chilled Water: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    e. Condenser Water: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    f. Heating Hot Water: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
    g. Energy Recovery Runaround Liquid: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.

h. Steam: Within [**2 deg F**][**1 deg F**]<**Insert value**>.
i. Temperature Difference: Within [**0.1 deg F**][**0.25 deg F**]<**Insert value**>.
j. <**Insert system**>.
k. Other Temperatures Not Indicated: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.

10. Temperature, Wet Bulb:

a. Air: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
b. Space: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
c. Outdoor: Within [**2 deg F**][**1 deg F**]<**Insert value**>.

11. Vibration: Within [**5**][**10**]<**Insert number**> percent of reading.

K. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:

1. Current:

a. Milliamperes: Nearest 1/100th of a milliampere.
b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Fuel Oil (Usage): **For gallons, nearest 1/10th of a gallon up to 100 gal.; nearest gallon for above 100 gal.**.
c. Natural Gas (Usage): **Nearest 1/10th of a unit (cubic feet, MCF, therm) up to 100 units; nearest unit for above 100 units**.
d. Thermal, Rate:

1) Heating: **For British thermal units per hour, nearest British thermal unit per hour up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For MBh, round to nearest MBh up to 1000 MBh; nearest 10 MBh between 1000 and 10,000 MBh; nearest 100 MBh above 10,000 MBh**.
2) Cooling: **For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons**.

e. Thermal, Usage:

1) Heating: **For British thermal unit, nearest British thermal unit up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For MBtu, round to nearest MBtu up to 1000 MBtu; nearest 10 MBtu between 1000 and 10,000 MBtu; nearest 100 MBtu above 10,000 MBtu**.
2) Cooling: **For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons**.

3. Flow:

a. Air: **Nearest 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm**.
b. Fuel Oil: **Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm**.
c. Natural Gas: **Nearest 1/10th of a cubic feet per hour through 100 cfh; nearest cubic feet per hour between 100 and 1000 cfh; nearest 10 cfh between 1000 and 10,000 cfh; nearest 100 cfh above 10,000 cfh**.
d. Water: **Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm**.
e. Steam: **Nearest 1/10th of a pound per hour through 100 lb/h; nearest pound per hour between 100 and 1000 lb/h; nearest 10 lb/h above 1000 lb/h**.

4. Gas:

a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
d. Refrigerant (ppm): Nearest ppm.
e. Volatile Organic Compounds (ppm): Nearest ppm

5. Moisture (Relative Humidity):

a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: **Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches**.
7. Speed:

a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: **Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm**.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:

a. Air, Ducts and Equipment: **Nearest 1/10th of an inch water closet**.
b. Space: **Nearest 1/100th of an inch water closet**.
c. Steam: **Nearest 1/10th of pounds per square inch gauge through 100 psig; nearest pounds per square inch gauge above 100 psig**.
d. Water: **Nearest 1/10 of a pound per square inch gauge through 100 psig; nearest pound per square inch gauge above 100 psig**.

10. Temperature:

a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
b. Outdoor: Nearest degree.
c. Space: Nearest 1/10th of a degree.
d. Chilled Water: Nearest 1/10th of a degree.
e. Condenser Water: Nearest 1/10th of a degree.
f. Heating Hot Water: Nearest degree.
g. Heat Recovery Runaround: Nearest 1/10th of a degree.
h. Steam: Nearest degree.

11. Vibration: **Nearest 1/10th of an inch per second**.
12. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.

L. Control Stability: Control variables indicated within the following limits:

1. Flow:

   a. Air, Ducts and Equipment, except Terminal Units: Within [**5**][**2**]<**Insert number**> percent of design flow rate.
   b. Air, Terminal Units: Within [**10**][**5**]<**Insert number**> percent of design flow rate.
   c. Water: Within [**2**][**5**]<**Insert number**> percent of design flow rate.
   d. Steam: Within [**5**]<**Insert number**> percent of design flow rate.

2. Gas:

   a. Carbon Dioxide: Within [**50**]<**Insert value**> ppm.
   b. Carbon Monoxide: Within [**5**]<**Insert number**> percent of reading.
   c. Oxygen: Within [**5**]<**Insert number**> percent of reading.

3. Moisture (Relative Humidity):

   a. Air: Within [**5**][**2**]<**Insert number**> percent RH.
   b. Space: Within [**5**][**2**]<**Insert number**> percent RH.
   c. Outdoor: Within [**5**][**2**]<**Insert number**> percent RH.

4. Level: Within [**5**][**2**]<**Insert number**> percent of reading.
5. Pressure:

   a. Air, Ducts and Equipment: [**1**][**0.5**]<**Insert number**> percent of instrument [**range**][**span**].
   b. Space: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].
   c. Water: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].
   d. Steam: Within [**1**][**0.5**][**0.25**]<**Insert number**> percent of instrument [**range**][**span**].

6. Temperature, Dew Point:

   a. Air: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
   b. Space: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.

7. Temperature, Dry Bulb:

   a. Air: Within [**2 deg F**][**1 deg F**][**0.5 deg F**]<**Insert value**>.
   b. Space: Within [**2 deg F**][**1 deg F**][**0.5 deg F**]<**Insert value**>.
   c. Chilled Water: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
   d. Condenser Water: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
   e. Heating Hot Water: Within [**2 deg F**][**1 deg F**][**0.5 deg F**]<**Insert value**>.
   f. Energy Recovery Runaround Liquid: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
   g. <**Insert system**>.

8. Temperature, Wet Bulb:

   a. Air: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.
   b. Space: Within [**1 deg F**][**0.5 deg F**]<**Insert value**>.

M. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

    a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
    b. Outdoors, Unprotected: [**Type 4**][**Type 4X**].
    c. Indoors, Heated with Filtered Ventilation: [**Type 1**][**Type 2**]<**Insert type**>.
    d. Indoors, Heated with Non-Filtered Ventilation: [**Type 2**][**Type 12**]<**Insert type**>.
    e. Indoors, Heated and Air-Conditioned: [**Type 1**]<**Insert type**>.
    f. Mechanical Equipment Rooms:

        1) Chiller and Boiler Rooms: [**Type 12**][**Type 4**][**Type 4X**]<**Insert type**>.
        2) Air-Moving Equipment Rooms: [**Type 1**][**Type 2**][**Type 12**]<**Insert type**>.

    g. Localized Areas Exposed to Washdown: [**Type 4**][**Type 4X**]<**Insert type**>.
    h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
    i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**][**Type 4X**]<**Insert type**>.
    j. Hazardous Locations: Explosion-proof rating for condition.
    k. <**Insert location and enclosure requirements**>.

N. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated[**, cooled**], and ventilated as required by instrument and application.

2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
    b. Outdoors, Unprotected: [**Type 4**][**Type 4X**].
    c. Indoors, Heated with Filtered Ventilation: [**Type 1**][**Type 2**]<**Insert type**>.
    d. Indoors, Heated with Non-Filtered Ventilation: [**Type 2**][**Type 12**]<**Insert type**>.
    e. Indoors, Heated and Air-conditioned: [**Type 1**]<**Insert type**>.
    f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: [**Type 12**][**Type 4**][**Type 4X**]<**Insert type**>.
2) Air-Moving Equipment Rooms: [**Type 1**][**Type 2**][**Type 12**]<**Insert type**>.

g. Localized Areas Exposed to Washdown: [**Type 4**][**Type 4X**]<**Insert type**>.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**][**Type 4X**]<**Insert type**>.
j. Hazardous Locations: Explosion-proof rating for condition.
k. <**Insert location and enclosure requirements**>.

O. DDC System Reliability:

1. Design, install, and configure DDC controllers, [**gateways,**][**routers,**][**and**]<**Insert product**> to yield a MTBF of at least [**40,000**][**20,000**]<**Insert number**> hours, based on a confidence level of at least [**90**]<**Insert number**> percent. MTBF value includes any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment being controlled, operational, and under automatic control.
3. See Drawings for critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated.

P. Electric Power Quality:

1. Power-Line Surges:

a. Protect [**susceptible**]DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.1 and IEEE C62.41.2.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-microsecond waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-microssecond waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

a. Protect [**susceptible**]DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:

1) At 85 percent load, output voltage to not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage to not deviate by more than [**2**][**3**]<**Insert number**> percent of nominal.
3) Accomplish full correction of load switching disturbances within [**five**]<**Insert number**> cycles, and 95 percent correction within [**two**]<**Insert number**> cycles of onset of disturbance.
4) Total harmonic distortion to not exceed [**2**][**3**]<**Insert number**> percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

Q. Backup Power Source:

1. Serve DDC system products that control HVAC systems and equipment served by a backup power source also from a backup power source.

R. UPS:

1. DDC system products powered by UPS units are to include the following:

   a. Servers.
   b. Gateways.
   c. DDC controllers[**, except application-specific controllers**].
   d. Desktop workstations.
   e. <**Insert equipment**>.

2. DDC system instruments and actuators powered by UPS units are to include the following:

   a. Instruments: [**Where indicated on Drawings;**]where associated with the following systems controlled by DDC system:

      1) <**Insert list of systems**>.

   b. Damper Actuators: [**Where indicated on Drawings;**]where associated with the following systems controlled by DDC system:

      1) <**Insert list of systems**>.

   c. Valve Actuators: [**Where indicated on Drawings;**]where associated with the following systems controlled by DDC system:

      1) <**Insert list of systems**>.

S. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Dampers:

1. Include panel-mounted, two-position, selector switch for each automatic control damper being controlled by DDC controller.
2. Label each switch with damper designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to damper.
4. With switch in "Auto" position, control signal to damper actuator with control loop output signal from DDC controller.
5. With switch in "Manual" position, control signal to damper actuator at panel with either an integral or a separate switch to include local control.

a. For Binary Control Dampers: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close damper. With switch in "Open" position, open damper.
b. For Analog Control Dampers: A gradual switch with "Close" and "Open" switch limits indicated. Operator switches knob to adjust damper to any position from close to open.

6. DDC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller to signal an override condition to alert operator that damper is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate damper while at panel without DDC controller [**installed**][**and**][**operational**].
8. Terminal equipment including [**VAV units,**][**fan-coil units,**][**and**][**unit heaters**] do not require manual override unless otherwise indicated by sequence of operation.

B. Manual Override of Control Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control valve being controlled by DDC controller.
2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, control signal to valve actuator with a control loop output signal from DDC controller.
5. With switch in "Manual" position, control signal to valve actuator at panel with either an integral or a separate switch to include local control.

a. For Binary Control Valves: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close valve. With switch in "Open" position, open valve.
b. For Analog Control Valves: A gradual switch with "Open" and "Close" switch limits indicated. Operator rotates switch knob to adjust valve to any position from close to open.

6. DDC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller to signal an override condition to alert operator that valve is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate valve while at panel without DDC controller [**installed**][**and**][**operational**].
8. Terminal equipment including [**VAV units,**][**fan-coil units,**][**and**][**unit heaters**] do not require manual override unless otherwise indicated by sequence of operation.

2.6 SYSTEM ARCHITECTURE

A. System architecture consisting of no more than [**two**][**or**][**three**]<**Insert number**> levels of LANs.

1. Level 2 LAN: Connect network controllers and operator workstations.
2. Level 1 or Level 2 LAN: Connect [**Level 1**][**or**][**Level 2**] programmable application controllers to other programmable application controllers and to network controllers.
3. Level 2 or Level 3 LAN: Connect [**Level 2**][**or**][**Level 3**] application-specific controllers to [**programmable application controllers and to network controllers**][**application-specific controllers**].

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: [**100**][**10**][**2.5**][**1.25**]<**Insert value**> Mbps.
2. LAN Connecting Programmable Application Controllers: [**1000**][**100**]<**Insert value**> kbps.

3. LAN Connecting Application-Specific Controllers: [**115,000**][**76,800**][**38,400**][**19,200**]<**Insert value**> bps.

C. Provide dedicated[**and separated**] DDC system LANs that are not shared with other building systems and tenant data and communication networks.

D. Provide modular system architecture with inherent ability to expand to not less than [**1.25**][**1.5**][**two**]<**Insert number**> times system size indicated with no impact to performance indicated.

E. Configure architecture to [**eliminate**][**or**][**minimize**] need to remove and replace existing network equipment for system expansion.

F. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.

G. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.

H. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling-system air-handling unit(s). Basically, create DDC system LAN that aligns with air-handling system being controlled.
2. <**Insert additional requirements**>.

2.7 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator able to access entire DDC system through any of multiple means including, but not limited to, the following:

1. Desktop and portable workstation with hardwired connection through LAN port.
2. Portable operator terminal with hardwired connection through LAN port.
3. Portable operator workstation with wireless connection through LAN router.
4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
5. Remote connection through web access.

B. Make access to system, regardless of operator means used, transparent to operator.

C. Network Ports: For hardwired connection of desktop or portable workstation. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:

1. Each mechanical equipment room.
2. Each boiler room.
3. Each chiller room.
4. Each outdoor on-grade yard and elevated platform with equipment connected to DDC system.
5. Each different roof level with roof-mounted equipment connected to DDC system.
6. Security system command center.
7. Fire-alarm system command center.
8. <**Insert additional locations**>.

D. Desktop Workstations:

1. Connect [**Owner-furnished**]desktop workstation(s) to DDC system Level 1 LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.

E. Portable Workstations:

1. Connect [**Owner-furnished**]portable workstation(s) to DDC system Level 1 LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Connect to DDC system [**Level 2**][**or**][**Level 3**] LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
4. Connect to system through a wireless router connected to Level 1 LAN.
5. Connect to system through a cellular broadband data service.
6. Portable workstation able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
8. Have dynamic graphic displays that are identical to desktop workstations.

F. POT:

1. Connect DDC controller through a communications port local to controller.
2. Able to communicate with any DDC system controller that is directly connected [**or with LAN**][**or connected to DDC system**].

G. Mobile Device (Tablet and Smart Phone):

1. Connect Owner-furnished mobile devices to system through a wireless router connected to LAN[**and cellular data service**].
2. Able to communicate with any DDC controller connected to DDC system using [**dedicated application**][**and**][**secure web access**].

H. Critical Alarm Reporting:

1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.
2. Send alarm notification to multiple recipients that are assigned for each alarm.
3. Notify recipients by any or all means, including email, text message, and prerecorded phone message to mobile and landline phone numbers.

I. Simultaneous Operator Use: Capable of accommodating up to [**five**][**10**][**20**]<**Insert number**> simultaneous operators that are accessing DDC system through any of operator interfaces indicated.

2.8 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. IP.
4. ISO/IEC/IEEE 8802-3, Ethernet.

5. <**Insert type**>.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. IP.
4. ISO/IEC/IEEE 8802-3, Ethernet.
5. <**Insert type**>.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. TIA 485-A.
4. IP.
5. ISO/IEC/IEEE 8802-3, Ethernet.
6. <**Insert type**>.

2.9 NETWORK COMMUNICATION PROTOCOL

A. Use network communication protocol(s) that are open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. Use ASHRAE 135 communication protocol as sole and native protocol used throughout entire DDC system.
2. DDC system to not require use of gateways except to integrate HVAC equipment and other building systems and equipment; not required to use ASHRAE 135 communication protocol.
3. If used, gateways to connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Use operator workstations, controllers, and other network devices that are tested and listed by BTL.

C. CTA-709.1-D Protocol:

1. Open implementation of LonWorks technology using CTA 709.1-D communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.
2. Use LNS for all network management including addressing and binding of network variables.

   a. Submit final LNS database with Project closeout submittals.
   b. All devices are to be online and commissioned into LNS database.

3. Use CTA-709.1-D protocol for all connected device. Install so SCPT output from any node on network can be bound to any other node in the domain.

D. Industry Standard Protocols:

1. Use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:

a. ASHRAE 135.
b. CTA-709.1-D.
c. Modbus Application Protocol Specification V1.1b3.
d. <**Insert standard protocol**>.

2. Operator workstations [**and network controllers**]are to communicate through [**ASHRAE 135**][**or**][**CTA-709.1-D**] protocol.
3. Provide portions of DDC system networks using ASHRAE 135 communication protocol as an open implementation of network devices complying with ASHRAE 135. Use network devices that are tested and listed by BTL.
4. Provide portions of DDC system networks using CTA-709.1-D communication protocol as an open implementation of LonWorks technology using CTA-709.1-D communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Provide portions of DDC system networks using Modbus Application Protocol Specification V1.1b3 communication protocol as an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b3.
6. Use gateways to connect networks and network devices with different protocols.

2.10 DDC SYSTEM WIRELESS NETWORKS

A. Use [**Zigbee**][**or**][**an open industry standard and technology used by multiple DDC system manufacturers**]<**Insert wireless technology**> technology to create a wireless mesh network to provide wireless connectivity for network devices at multiple system levels including communications from programmable application controllers and application-specific controllers to temperature sensors and from network controllers to programmable application controllers and application-specific controllers.

B. Design and install wireless networks to comply with DDC system performance requirements indicated using wireless network devices that can co-exist on same network with hardwired devices.

C. Provide hardwired controllers capable of retrofitting to wireless devices with no special software.

D. Provide a wireless coordinator for wireless interface between programmable application controllers, application-specific controllers, and network controllers.

E. Wireless Coordinators:

1. Use for initiation and formation of each wireless mesh network.
2. Use direct-sequence spread spectrum RF technology.
3. Operate on 2.4 GHz ISM Band.
4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to 47 CFR 15, Subpart B, Class A.
6. Operate as a bidirectional transceiver with sensors and routers to confirm and synchronize data transmission.
7. Capable of communication with sensors and routers up to a maximum distance of **250 ft.** in line of sight.
8. Include visual indicators to provide diagnostic information required for operator verification of operation.

F. Wireless Routers:

1. Use wireless routers with any controller to provide a wireless interface to a network controller, through a wireless coordinator.
2. Use direct-sequence spread spectrum RF technology.
3. Operate on 2.4 GHz ISM Band.

4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to 47 CFR 15, Subpart B, Class A.
6. Operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
7. Capable of communication with other mesh network devices at a maximum distance of **250 ft.** in line of sight.
8. Include indication for use in commissioning and troubleshooting.

G. Wireless Temperature Sensors:

1. Wireless temperature sensors to sense and transmit room temperatures, temperature set point, room occupancy notification, and low battery condition to an associated router.
2. Use direct-sequence spread spectrum RF technology.
3. Operate on 2.4 GHz ISM Band.
4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to 47 CFR 15, Subpart B, Class A.
6. Include set-point adjustment between [**55 to 85 deg F**]<**Insert range**>.
7. Configure so multiple sensors can report to a router connected to DDC controller for averaging or high and low selection.

H. One-to-One Wireless Network Receivers:

1. One-to-one wireless receivers receive wireless RF signals containing temperature data from multiple wireless room temperature sensors and communicate information to programmable application controllers or application-specific controllers.

   a. Use direct-sequence spread spectrum RF technology.
   b. Operate on 2.4 GHz ISM Band.
   c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
   d. FCC compliant to 47 CFR 15, Subpart B, Class A.
   e. Operate as a bidirectional transceiver with sensors to confirm and synchronize data transmission.
   f. Capable of communication up to a distance of **200 ft.**.
   g. Include visual indication of the following:

      1) Power.
      2) Receiver activity.
      3) Wireless RF transmission from wireless sensors.
      4) No transmission, weak signal, adequate signal, or excellent signal.

I. One-to-One Wireless Network Sensors:

1. One-to-one wireless sensors sense and report room temperatures to one-to-one receiver.

   a. Use direct-sequence spread spectrum RF technology.
   b. Operate on 2.4 GHz ISM Band.
   c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
   d. FCC compliant to 47 CFR 15, Subpart B, Class A.
   e. Include set-point adjustment between **55 to 85 deg F**.

2.11 DDC DESKTOP WORKSTATION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.

C. Performance Requirements:

1. May dictate equipment exceeding minimum requirements indicated.
2. ENERGY STAR compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

   a. Capacity: [**8**]<**Insert value**>[**GB**].
   b. Speed and Type: [**1333**]<**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

   a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
   b. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
   c. Capacity: <**Insert number and measurement unit**>.
   d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
   e. Cache Buffer Size: <**Insert number and measurement unit**>.
   f. <**Insert requirements**>.

4. Second Hard Drive:

   a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
   b. Capacity: <**Insert number and measurement unit**>.
   c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
   d. Cache Buffer Size: <**Insert number and measurement unit**>.
   e. <**Insert requirements**>.

5. Optical Read and Write Drive:

   a. Include with at least 2 MB of data buffer.
   b. Type: <**Insert type**>.
   c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
   d. Minimum Average Access Time: <**Insert number**> ms.
   e. Nominal Data Transfer Rates:

      1) Reading: <**Insert value**>[**MB**][**TB**]/s.
      2) Writing: <**Insert value**>[**MB**][**TB**]/s.

   f. Average access time of 150 ms or less.
   g. MTBF of at least 100,000 power-on hours.

6. At least four expansion slots of [**32**][**64**]<**Insert number**> bit.
7. Video Card:

    a. Resolution: [**1920 by 1200**]<**Insert values**> pixels.
    b. RAM: <**Insert value**>[**MB**][**GB**][**TB**].
    c. Controller Speed: <**Insert value**>[**MHz**][**GHz**].
    d. On-Board Memory Speed: <**Insert value**>[**MHz**][**GHz**].
    e. On-Board Memory Data Width: <**Insert number**> bit.

8. Sound Card:

    a. At least 128 voice wavetable synthesis.
    b. Capable of delivering three-dimensional sound effects.
    c. High-resolution, 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

9. Network Interface Card: Include card with connection, as applicable.

    a. 10-100-1000 base TX Ethernet with RJ-45 connector port.
    b. 100 base FX Ethernet with SC or ST port.

E. Wireless Ethernet, 802.11 ac:

1. Optical Modem: Full duplex link for connection to optical fiber cable provided.
2. I/O Ports:

    a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    b. One serial port.
    c. One parallel port.
    d. Two PS/2 ports.
    e. One RJ-45.
    f. One stereo line-in and headphone/line-out on back panel.
    g. One microphone and headphone connector on front panel.
    h. One IEEE 1394 on front and back panel with PCI-e card.
    i. One ESATA port on back panel.

3. Battery: Life of at least three years to maintain system clock/calendar and ROM, at a minimum.

F. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to **72 inches** in front of workstation.

G. Pointing Device:

1. Two- or three-button mouse.
2. Wireless operation within up to **72 inches** in front of workstation.

H. Flat Panel Display Monitor:

1. Display:

a. Color display with <**Insert inches**> diagonal viewable area.
b. [**Digital**][**or**][**analog**] input signal.
c. Aspect Ratio: [**16 to 9**]<**Insert value**>.
d. Antiglare display.
e. Response Time: <**Insert number**> ms.
f. Dynamic Contrast Ratio: [**50000 to 1**]<**Insert ratio**>.
g. Brightness: [**250 cd/sq. m**]<**Insert value**>.
h. Tilt adjustable base.
i. ENERGY STAR compliant.
j. Resolution: [**1920 by 1080**]<**Insert value**> pixels at 60 Hz with pixel size of [**0.277**]<**Insert number**> mm or smaller.
k. Number of Displays: [**One**][**Two**]<**Insert number**>.

I. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

J. I/O Cabling: Include applicable cabling to connect I/O devices.

2.12 PORTABLE WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Description: A self-contained computer designed to allow for normal use in different locations and conditions.

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. ENERGY STAR compliant.
3. Hardware and software to support local downloading to DDC controllers.
4. Data transfer rate to DDC controller is to be at network speed.

D. Processor:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

a. Capacity: <**Insert value**>[**GB**][**TB**].
b. Speed and Type: <**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

a. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
b. Capacity: <**Insert number and measurement unit**>.

c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
d. Cache Buffer Size: <**Insert number and measurement unit**>.
e. <**Insert requirements**>.

4. Video Card: <**Insert number and measurement unit**> of RAM.

E. I/O Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 3.0 ports.
4. Ethernet port.
5. HDMI port.
6. IEEE 1394 port.

F. Battery:

1. Capable of supporting operation of portable workstation for a minimum of [**8**]<**Insert number**> hours.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Battery(ies): [**One**][**Two**].

G. Keyboard:

1. 85-key [**backlit**]keyboard.
2. Full upper- and lowercase ASCII keyset.

H. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.

I. Display:

1. <**Insert inches**> diagonal or larger high-definition WLED color display.
2. Antiglare screen.
3. [**1920 by 1080**]<**Insert value**> pixel resolution.
4. Brightness: 300 nits.

J. Network Interfaces:

1. Network Interface Card: Include card with connection, as application.

a. 10-100-1000 base TX Ethernet with RJ-45 connector port.
b. 100 base FX Ethernet with SC or ST port.

2. Wireless:

a. Internal with integrated antenna, capable of supporting WiFi standards 802.11 a/b/g/n.

K. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD discs and data, audio, recordable, and rewritable compact discs.
2. Nominal Data Transfer Rates:

a. Reading: <**Insert number**>[**MB**][**TB**]/s.

b. Writing: <**Insert number**>[**MB**][**TB**]/s.

3. 160-ms access time.

L. Accessories:

1. Nylon carrying case.
2. Docking station.
3. Mobile broadband card.
4. Wireless optical mouse.
5. <**Insert value**>[**GB**][**TB**] portable hard drive.
6. Light-sensitive web cam and noise-cancelling digital array microphone.
7. Category 6a patch cable. Minimum cable length is to be <**Insert length**>.
8. HDMI cable. Minimum cable length is to be <**Insert length**>.
9. <**Insert accessories**>.

2.13 PORTABLE OPERATOR TERMINALS

A. Description: Handheld device with integral keypad or touch screen operator interface.

B. Display: Multiple lines of text display for use in operator interaction with DDC system.

C. Cable: Flexible [**coiling**]cable, at least **36 inches** long, with a plug-in jack for connection to DDC controllers, network ports, or instruments with an integral LAN port. As an alternative to hardwired connection, POTs may be accessible to DDC controllers through a wireless network connection.

D. Power POTs through network connection.

E. Connection of POTs to DDC system to not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.

F. POTs to give operator ability to do the following:

1. Display and monitor BI point status.
2. Change BO point set point (on or off, open or closed).
3. Display and monitor analog point values.
4. Change analog control set points.
5. Command a setting of AO point.
6. Display and monitor I/O point in alarm.
7. Add a new or delete an existing I/O point.
8. Enable and disable I/O points, initiators, and programs.
9. Display and change time and date.
10. Display and change time schedules.
11. Display and change run-time counters and run-time limits.
12. Display and change time and event initiation.
13. Display and change control application and DDC parameters.
14. Display and change programmable offset values.
15. Access DDC controller initialization routines and diagnostics.
16. <**Insert requirements**>.

2.14 SERVERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Description: x86-based permanently installed computer used for client-server computing.

C. Mounting: [**Rack**][**Blade**][**Tower**][**Tower able to be rack mounted**].

D. Power: [**Single**][**Dual**] power supply, minimum [**300**]<**Insert value**> W.

E. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. ENERGY STAR compliant.
3. Minimum Processor Speed: <**Insert gigahertz**>.
4. RAM:

   a. Capacity: <**Insert value**>[**GB**][**TB**].
   b. Speed and Type: <**Insert value**> MGz, <**Insert type**>.
   c. Expandable Capacity: <**Insert value**>[**GB**][**TB**].

5. Redundant Array of Independent Discs: [**Zero**][**One**][**Two**][**Three**][**Four**][**Five**]<**Insert number**> configuration.
6. Drive Bays: Eight at **2.5 inches** or eight at **3.5 inches**.
7. Hard-Drive Storage: [**Two**][**Three**][**Four**] drives each with <**Insert value**>[**GB**][**TB**] storage and nominal rotational speed of 7200 rpm.
8. Network Interface: [**Dual-port gigabit Ethernet**][**Optical fiber**].
9. DVD +RW drive.
10. Color, flat-screen display with <**Insert inches**> diagonal viewable area.
11. Keyboard and mouse.
12. Next-day on-site warranty for [**two**][**three**]<**Insert number**>-year period following Substantial Completion.

F. Servers are to include the following:

1. Full-feature backup server (server and backup minimum requirement).
2. Software licenses.
3. Cable installation between server(s) and network.

G. Web Server:

1. If required to be separate, include web server hardware and software to match, except backup server is not required.
2. Firewalls between server web and networks.
3. Password protection for access to server from web server.
4. Cable installation between the server(s) and building Ethernet network.

H. Power each server through a [**dedicated**]UPS unit.

2.15 PRINTERS

A. Black and White Laser Printer:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brother International Corporation**]
   b. [**Epson America, Inc.**]
   c. [**Hewlett-Packard Company**]
   d. <**Insert manufacturer's name**>

2. [**1200 by 1200**]<**Insert value**> dots per inch resolution.
3. First sheet printed within 10 seconds.
4. <**Insert number**> page per minute rated print speed at best quality mode.
5. Print buffer with at least <**Insert value**> MB of RAM, expandable to at least 288 MBs.
6. Complies with ENERGY STAR requirements.
7. Capable of handling letter- and legal-size paper and overhead transparencies.
8. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with <**Insert number**> sheet capacity.
9. At least <**Insert number**> page toner/cartridge capacity.

B. Color Laser Printer:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brother International Corporation**]
   b. [**Epson America, Inc.**]
   c. [**Hewlett-Packard Company**]
   d. <**Insert manufacturer's name**>

2. [**1200 by 1200**]<**Insert value**> dots per inch resolution black and white, [**1200 by 1200**]<**Insert value**> dots per inch resolution black and white and color.
3. First sheet printed within 10 seconds.
4. <**Insert number**> page per minute rated print speed at best quality mode.
5. Print buffer with at least [**512**]<**Insert value**> MB of RAM, expandable to at least [**one**]<**Insert value**> GB.
6. Complies with ENERGY STAR requirements.
7. Capable of handling letter- and legal-size paper and overhead transparencies.
8. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with 500 <**Insert number**> sheet capacity.
9. Two-sided printing.
10. At least <**Insert number**> page toner/cartridge capacity.

C. Color Inkjet Printer:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brother International Corporation**]
b. [**Epson America, Inc.**]
c. [**Hewlett-Packard Company**]
d. <**Insert manufacturer's name**>

2. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
3. Print quality of [**1200 by 600**]<**Insert value**> dots per inch with black on inkjet paper and [**4800 by 1200**]<**Insert value**> dots per inch color printing on premium photo paper.
4. Rated speed of <**Insert number**> pages per minute printing black and white in normal mode and <**Insert number**> pages per minute printing color in normal mode.
5. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with <**Insert number**> sheet capacity.
6. Capable of handling letter- and legal-size paper and overhead transparencies.
7. <**Insert value**> MB of RAM.
8. Duplex printing (printing on both sides of paper).

D. Dot Matrix Printer:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Epson America, Inc.**]
b. [**OKI Data Americas**]
c. <**Insert manufacturer's name**>

2. Letter-quality, wide-carriage, 24-pin dot matrix printer.
3. <**Insert number**> kb print buffer.
4. Minimum Print Speed:

a. <**Insert number**> characters per second (draft).
b. <**Insert number**> characters per second (letter quality).

5. [**Seven**]<**Insert number**> print fonts.
6. Continuous - forms feed with manual single sheet feed.
7. Capable of handling **16-inch-** wide continuous-feed paper.

2.16 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**][**or**][**64-**]bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system capable of operating DOS and Microsoft Windows applications.
3. Database management software to manage all data on an integrated and non-redundant basis. Additions and deletions to database are to be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software to manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software to include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and

online data modification capability.

6. Scheduling software to schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity and send to printer.
6. Security Access:

    a. Use password control for operator access to DDC system.
    b. Assign an alphanumeric password (field assignable) to each operator.
    c. Grant operators access to DDC system by entry of proper password.
    d. Use same operator password regardless of which computer or other operator interface means are used.
    e. Automatically update additions or changes made to passwords.
    f. Assign each operator an access level to restrict access to data and functions the operator is cable of performing.
    g. Provide software with at least five access levels.
    h. Assign each menu item an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
    i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.

7. Data Segregation:

    a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
    b. Include at least [**32**]<**Insert number**> segregation groups.
    c. Make segregation groups selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
    d. Make points assignable to multiple segregation groups. Display and output of data to printer or monitor is to occur where there is a match of operator or peripheral segregation group assignment and point segregations.
    e. Make alarms displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
    f. Assign operators and peripherals to multiple segregation groups and make all assignments online programmable and under password control.

8. Operators able to perform commands including, but not limited to, the following:

    a. Start or stop selected equipment.
    b. Adjust set points.
    c. Add, modify, and delete time programming.
    d. Enable and disable process execution.
    e. Lock and unlock alarm reporting for each point.
    f. Enable and disable totalization for each point.
    g. Enable and disable trending for each point.

h. Override control loop set points.
i. Enter temporary override schedules.
j. Define holiday schedules.
k. Change time and date.
l. Enter and modify analog alarm limits.
m. Enter and modify analog warning limits.
n. View limits.
o. Enable and disable demand limiting.
p. Enable and disable duty cycle.
q. Display logic programming for each control sequence.
r. <**Insert requirements**>.

9. Reporting:

a. Generated automatically and manually.
b. Sent to displays, printers and disc files.
c. Types of Reporting:

1) General listing of points.
2) List points currently in alarm.
3) List of off-line points.
4) List points currently in override status.
5) List of disabled points.
6) List points currently locked out.
7) List of items defined in a "Follow-Up" file.
8) List weekly schedules.
9) List holiday programming.
10) List of limits and deadbands.
11) <**Insert types**>.

10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
5. Make graphic displays online user definable and modifiable using the hardware and software provided.
6. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
7. Make graphics online programmable and under password control.
8. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics to also contain software points.
10. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected

to facilitate operator understanding.

11. Provide a back-trace feature to permit operator to move upward in the hierarchy using a pointing device. Back trace to show all previous penetration levels. Include operator with option of showing each graphic full-screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
14. Include operator with means to directly access graphics without going through penetration path.
15. Make dynamic data assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
18. Provide dynamic points with operator adjustable update rates on a per point basis from [**one**]<**Insert value**> second to over a [**minute**]<**Insert value**>.
19. For operators with appropriate privilege, command points directly from display using pointing device.

    a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
    b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
    c. Include a keyboard equivalent for those operators with that preference.

20. Give operator ability to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot, and other information on other quadrants on screen. This feature allows real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:

    a. Online context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords and contain text and graphics to clarify system operation.

        1) If help feature does not have ability to bridge on keywords for more information, provide a complete set of user manuals in an indexed word-processing program, which runs concurrently with operating system software.

    c. Available for Every Menu Item:

        1) Index items for each system menu item.

22. Provide graphic generation software to allow operator ability to add, modify, or delete system graphic displays.

    a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols[**similar to those indicated**].
    b. Use a pointing device in conjunction with a drawing program to allow operator to perform the following:

        1) Define background screens.
        2) Define connecting lines and curves.
        3) Locate, orient, and size descriptive text.

4) Define and display colors for all elements.
5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

   a. Room layouts with room identification and name.
   b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
   c. Location and identification of each hardware point being controlled or monitored by DDC system.
   d. <**Insert requirements**>.

3. Control schematic for each of following, including a graphic system schematic representation[**, similar to that indicated on Drawings,**] with point identification, set point and dynamic value indication[**, sequence of operation**][**and**][**control logic diagram**].
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, [**gateways**][**operator workstations**][**and**][**other network devices**].

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. At a minimum, include the following modification capability:

   a. Operator Assignment: Designation of operator passwords, access levels, point segregation, and auto sign-off.
   b. Peripheral Assignment: Assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points, and enabling and disabling of printout of operator changes.
   c. System Configuration and Diagnostics: Communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points, and application programs and initiation of diagnostics.
   d. System Text Addition and Change: English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time, and trouble condition.
   e. Time and Schedule Change: Time and date set, time and occupancy schedules, exception and holiday schedules, and daylight-savings time schedules.
   f. Point related change capability is to include the following:

      1) System and point enable and disable.
      2) Run-time enable and disable.
      3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
      4) Assignment of alarm and warning limits.

g. Application program change capability is to include the following:

1) Enable and disable of software programs.
2) Programming changes.
3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Provide software to allow operator ability to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Make additions and modifications online programmable using operator workstations, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, upload and record database on hard drive and disc for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences. Also include, at a minimum, the following:

a. Proportional control (P).
b. Proportional plus integral (PI).
c. Proportional plus integral plus derivative (PID).
d. Adaptive and intelligent self-learning control.

1) Algorithm monitors loop response to output corrections and adjust loop response characteristics in accordance with time constant changes imposed.
2) Algorithm operates in a continuous self-learning manner and retains in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal to," "Not Equal to," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers[**, gateways**][**and other network devices**].
2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display is to include the following:

a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.

5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege

level and segregation assignments.

6. Send email alarm messages to designated operators.
7. Send email, page, text, and voice messages to designated operators for critical alarms.
8. Categorize and process alarms by class.

    a. Class 1:

        1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
        2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
        3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.

    b. Class 2:

        1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
        2) Acknowledgement may be through a multiple alarm acknowledgment.

    c. Class 3:

        1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
        2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
        3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
        4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.

    d. Class 4:

        1) Routine maintenance or other types of warning alarms.
        2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, make it possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Setup each report so data content, format, interval, and date are operator definable.
3. Sample and store report data on DDC controller, within storage limits of DDC controller, and then uploaded to archive on [**workstation**][**server**] for historical reporting.
4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Store reports and logs on [**workstations**][**and**][**servers**] hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Make reports and logs readily printable and set to be print either on operator command or at a

specific time each day.

H. Standard Reports: Provide standard DDC system reports with operator ability to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

   a. Alarm history.
   b. System messages.
   c. System events.
   d. Trends.
   e. <**Insert requirement**>.

I. Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.

J. Tenant Override Reports: Prepare Project-specific reports.

1. Daily report showing total time in hours that each tenant has requested after-hours HVAC.
2. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
3. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.
4. Annual summary report that shows after-hours HVAC usage on a monthly basis.

K. HVAC Equipment Reports: Prepare Project-specific reports.

1. Chiller Report: Daily report showing operating conditions of each chiller in accordance with ASHRAE 147 including, but not limited to, the following:

   a. Chilled-water entering temperature.
   b. Chilled-water leaving temperature.
   c. Chilled-water flow rate.
   d. Chilled-water inlet and outlet pressures.
   e. Evaporator refrigerant pressure and temperature.
   f. Condenser refrigerant pressure and liquid temperature.
   g. Condenser-water entering temperature.
   h. Condenser-water leaving temperature.
   i. Condenser-water flow rate.
   j. Refrigerant levels.
   k. Oil pressure and temperature.
   l. Oil level.
   m. Compressor refrigerant discharge temperature.
   n. Compressor refrigerant suction temperature.
   o. Addition of refrigerant.
   p. Addition of oil.
   q. Vibration levels or observation that vibration is not excessive.
   r. Motor amperes per phase.
   s. Motor volts per phase.
   t. Refrigerant monitor level (PPM).
   u. Purge exhaust time or discharge count.
   v. Ambient temperature (dry bulb and wet bulb).
   w. Date and time logged.

x. <**Insert requirement**>.

2. <**Insert requirements for each type of HVAC equipment requiring a report**>.

L. Utility Reports: Prepare Project-specific reports.

1. Electric Report:

a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
c. Include annual report showing monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
d. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as lighting, receptacles, and HVAC equipment showing daily electrical consumption and peak electrical demand.
e. For each weekly, monthly, and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.

2. Natural Gas Report:

a. Include weekly, monthly, and annual report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
b. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
c. For each weekly, monthly, and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.

3. Service Water Report:

a. Include weekly, monthly, and annual report showing daily service water consumption and peak service water demand with time and date stamp for each meter.
b. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as cooling tower makeup and irrigation showing daily service water consumption and peak service water demand.
c. For each weekly, monthly. and annual report, include sum total of all submeters in building showing service water consumption and peak service water demand.

4. <**Insert requirements for each utility requiring a report**>.

M. Energy Reports: Prepare Project-specific daily, weekly, monthly, [**and annual**][**, annual and since-installed**] energy reports.

1. Prepare report for each purchased energy utility, indicating the following:

a. Time being reported with beginning and end date, and time indicated.
b. Consumption in units of measure commonly used to report specific utility consumption over time.
c. Gross area served by utility.
d. Consumption per unit area served using utility-specific unit of measure.
e. Cost per utility unit.
f. Utility cost per unit area.
g. Convert all utilities to a common energy consumption unit of measure and report for each

utility.
h. Consumption per unit area using common unit of measure.

2. Prepare report for each renewable energy source, indicating the following:

a. Time being reported with beginning and end date, and time indicated.
b. Harvested energy in units of measure commonly used to report specific harvested energy consumption over time.
c. Gross area served by renewable energy source.
d. Harvested energy per unit area served using specific unit of measure.
e. Cost per purchased utility unit displaced by renewable energy.
f. Cost savings attributed to harvested energy source.
g. Cost savings per unit area attributed to harvested energy.
h. Convert all renewable energy sources to a common energy consumption unit of measure and report for each.
i. Harvested energy per unit area using common unit of measure.

3. Prepare purchased energy utility report for each submetered area that indicates the following:

a. Time being reported with beginning and end date, and time indicated.
b. Gross area served.
c. Energy consumption by energy utility type.
d. Energy consumption per unit area by energy utility type.
e. Total energy consumption of all utilities in common units of measure.
f. Total energy consumption of all utilities in common units of measure per unit area.
g. Unit energy cost by energy utility type.
h. Energy cost by energy utility type.
i. Energy cost per unit area by energy utility type.
j. Total cost of all energy utilities.
k. Total cost of all energy utilities per unit area.

4. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report is to indicate the following:

a. Time being reported with beginning and end date, and time indicated.
b. Gross area served.
c. Energy consumption by energy utility type.
d. Energy consumption per unit area by energy utility type.
e. Total energy consumption of all utilities in common units of measure.
f. Total energy consumption of all utilities in common units of measure per unit area.
g. Unit energy cost by energy utility type.
h. Energy cost by energy utility type.
i. Energy cost per unit area by energy utility type.
j. Total cost of all energy utilities.
k. Total cost of all energy utilities per unit area.

N. HVAC System Efficiency Reports: Prepare Project-specific [**daily**][**weekly**][**monthly**][**and annual**][**, annual and since-installed**] HVAC system efficiency reports.

1. Prepare report for [**each**]chilled-water system, indicating the following:

a. Time being reported with beginning and end date, and time indicated.
b. Cooling energy supplied during period.
c. Power energy consumed during period by cooling equipment used to produce cooling energy supplied.[**List power consumed for each individual piece of equipment in system and summed total of all equipment in system.**]

d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.
f. Units of measure used in report to be consistent with units indicated for system.

2. Prepare report for [**each**]heating hot-water system, indicating the following:

a. Time being reported with beginning and end date, and time indicated.
b. Heating energy supplied during period.
c. Fuel consumed during period by boilers used to produce heating energy supplied.[**List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
e. Units of measure used in report are to be consistent with units indicated for system.

3. Prepare report for [**each**]steam system, indicating the following:

a. Time being reported with beginning and end date, and time indicated.
b. Heating energy supplied during period.
c. Fuel consumed during period by boilers used to produce heating energy supplied.[**List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
e. Units of measure used in report are to be consistent with units indicated for system.

4. <**Insert requirements for each HVAC system requiring a report**>.

O. Weather Reports:

1. Include daily report showing the following:

a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
c. Daily minimum, maximum, and average outdoor dew point temperature.
d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**]<**Insert temperature**>.
e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**]<**Insert temperature**>.
f. Daily minimum, maximum, and average outdoor carbon dioxide level.
g. Daily minimum, maximum, and average relative humidity.
h. Daily minimum, maximum, and average barometric pressure.
i. Daily minimum, maximum, and average wind speed and direction.

2. Include weekly report showing the following:

a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
c. Daily minimum, maximum, and average outdoor dew point temperature.
d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**]<**Insert temperature**>.
e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**]<**Insert temperature**>.

f. Weekly minimum, maximum, and average outdoor carbon dioxide level.
g. Daily minimum, maximum, and average relative humidity.
h. Daily minimum, maximum, and average barometric pressure.
i. Daily minimum, maximum, and average wind speed and direction.

3. Include monthly report showing the following:

a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
c. Daily minimum, maximum, and average outdoor dew point temperature.
d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**]<**Insert temperature**>.
e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**]<**Insert temperature**>.
f. Monthly minimum, maximum, and average outdoor carbon dioxide level.
g. Daily minimum, maximum, and average relative humidity.
h. Daily minimum, maximum, and average barometric pressure.
i. Daily minimum, maximum, and average wind speed and direction.

4. Include annual (12-month) report showing the following:

a. Monthly minimum, maximum, and average outdoor dry-bulb temperature.
b. Monthly minimum, maximum, and average outdoor wet-bulb temperature.
c. Monthly minimum, maximum, and average outdoor dew point temperature.
d. Number of heating degree-days for each month calculated from a base temperature of [**55 deg F**]<**Insert temperature**>.
e. Number of cooling degree-days for each month calculated from a base temperature of [**65 deg F**]<**Insert temperature**>.
f. Annual minimum, maximum, and average outdoor carbon dioxide level.
g. Monthly minimum, maximum, and average relative humidity.
h. Daily minimum, maximum, and average barometric pressure.
i. Daily minimum, maximum, and average wind speed and direction.

P. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Associate trends into groups, and setup a trend report for each group.
3. Store trends within DDC controller and uploaded to hard drives automatically on reaching [**75**]<**Insert number**> percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Make trend intervals operator selectable from 10 seconds up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
6. When drive storage memory is full, overwrite oldest data with most recent data.
7. Make archived and real-time trend data available for viewing numerically and graphically by operators.

Q. Custom Trends: Operator-definable custom trend log for any I/O point in DDC system.

1. Include each trend with interval, start time, and stop time.
2. Sample and store data on DDC controller, within reaching [**75**]<**Insert number**> percent storage limits of DDC controller, and then uploaded to archive on [**workstation**][**server**] hard drives.
3. Make data retrievable for use in spreadsheets and standard database programs.

R. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming Software: [**As follows**][**Any of the following**][**One of the following**]:

    a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for DDC control systems.

        1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
        2) Make programming tools viewable in real time to show present values and logical results of each function block.

    b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
    c. Line by Line and Text Based: Programming is to declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

S. Database Management Software:

1. Where a separate SQL database is used for information storage, include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Secure database access using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Include database management function summarizing information on trend, alarm, event, and audit for the following database management actions:

    a. Backup.
    b. Purge.
    c. Restore.

4. Database management software supporting the following:

    a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
    b. Maintenance: Include method of purging records from trend, alarm, event, and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
    c. Backup: Include means to create a database backup file and select a storage location.
    d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.

5. Information of current database activity, including the following:

    a. Ready.
    b. Purging record from a database.
    c. Action failed.
    d. Refreshing statistics.
    e. Restoring database.

f. Shrinking a database.
g. Backing up a database.
h. Resetting Internet information services.
i. Starting network device manager.
j. Shutting down the network device manager.
k. Action successful.

6. Database management software monitoring functions is to continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and email message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window with the following Sections:

   a. Allow operator to set and review scan intervals and start times.
   b. Email: Allow operator to create and review email and phone text messages to be delivered when a warning or an alarm is generated.
   c. Warning: Allow operator to define warning limit parameters, set reminder frequency, and link email message.
   d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency, and link email message.
   e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event, and audit databases as well as operator proper security access to restore a database.

9. Monitoring settings taskbar with following informational icons:

   a. Normal: Indicates by color and size, or other easily identifiable means, that all databases are within their limits.
   b. Warning: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their warning limit.
   c. Alarm: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their alarm limit.

2.17 ANALYTICS SOFTWARE

A. Scope: Incorporate analytics software into DDC System:

1. Licensing, without Recurring Cost: No re-occurring cost for licensing and subscriptions.
2. Licensing: With or without re-occurring cost for licensing and subscriptions.

   a. For products with re-occurring costs, provide incremental costs broken down over a [**five**][**10**]<**Insert value**>-year operating period that begins at Substantial Completion.
   b. Setup service agreements direct to Owner.

3. Purpose: Analyze energy and operational data to identify faults and opportunities for improved performance and reduced energy use.
4. Verification: Verify that HVAC systems and associated sequence of operations are executing as specified or as described on Drawings, through the analysis of energy and operational data, identification of faults showing where control sequences are not functioning as prescribed, and identification of opportunities for improved performance in the operation of systems.

B. Use during Project Life:

1. During Construction: Use for verification of performance during startup, commissioning, and final acceptance of DDC system.

2. During Warranty Period: Use for continuous operational tuning of DDC system and verification of operation and designed to identify warranty issues preemptively, thus reducing failures and potential down time.
3. After Warranty Period: Use to diagnose ongoing operational degradation and for Owner to perform continuous monitoring-based commissioning.

C. Minimum Features and Capabilities:

1. Operating Systems: Current version of Windows-based operating systems.
2. Time Series Database: Database technology, designed for efficient storage and analysis of large volumes of time series data, using tagging to model and describe data; supports an open-source tagging standard.
3. Data Import: Ability to accept and normalize data from a variety of sources including SQL compatible databases, CSV format files, XML format files or web services, and other EDI techniques. Once imported, software is to provide a unified data format to enable analytics algorithms to identify patterns across different data sets.
4. Open Interfaces: Open, REST-based APIs to enable integration with third-party software applications. Open APIs are to enable data to be entered/imported into database, exported from database, posting of analytic queries, and output of analytic results. APIs are to be fully documented and available as part of standard product.
5. Host: Local deployed on DDC system network.
6. Weather Data Service: Built-in worldwide weather service providing weather data including, but not limited to, the following:

    a. Current temperature.
    b. High temperature for the day.
    c. Low temperature for the day.
    d. Sunrise and sunset times.
    e. Relative humidity.
    f. Degree days (heating and cooling with adjustable balance point value).
    g. Seven-day forecast.
    h. Historical weather data extending back at least one year.

7. Email Notification: Automatic notification of detected issues via email including, but not limited to, the following:

    a. Immediate notification of detected issues.
    b. Daily digest or summary of detected issues.
    c. Ability to delineate which notifications are sent to which recipients down to the level of specifying individual issues sent to individual recipients.

D. Hardware Requirements:

1. Host on a server in a virtual environment complying with Owner's security requirements.
2. Comply with standard software and hardware profiles required by Owner.

E. Analytic Rules:

1. Custom Rule Development: Develop customized rules and algorithms tailored to operational needs and characteristics of individual facilities and needs of monitoring and verification project and fault-detection requirements of Project without depending on manufacturer for rule development. Provide tools for user development and full documentation.
2. Standard Analytic Functions: Library of standard analytic functions is to use these standard analytic functions as elements to build custom analytic rules for specific needs of individual facilities.

3. Existing library of not less than 200 standard analytic rules written for applications similar to those required for this Project.

F. Reporting:

1. Standard Views of Analytic Results: Standard views to present analytic results, automatically generated when issues are found by analytic rules including, but not limited to, the following:

   a. Rules violations across a portfolio of sites, rules violations per site, including time, date, and duration of all violations.
   b. Ability to assign cost relationships to rule logic to provide cost per violation.
   c. Standard filters to enable operator to easily look at rule violations by site, data, and violation type for any selected date or date range.
   d. Automatic calculation and presentation of Key Performance Indicators (KPIs) and to define custom KPIs as needed.

2. Custom Views of Analytic Results:

   a. Any standard system view is to be able to be saved as a custom report including its configuration criteria, e.g., time range, sites, rule violations, or other configuration options as applicable to standard system view.
   b. Created by making queries against the database and saving the query as a saved report executed by single mouse click.
   c. Export: Support report views export into CSV, Excel, XML, and HTML format, accomplished in a couple of mouse clicks.

G. Energy-Specific Reporting and Information Presentation Tools:

1. Greenhouse Gas Analysis: Energy/carbon dioxide relationships; easily changed and added without involvement of software manufacturer.
2. Energy Baseline: Quantify and define energy consumption and demand baselines (including weather normalization metrics) and compare actual and forecasted energy demand and consumption against those baselines.
3. Benchmarking: Multisite benchmarking to compare energy consumption and demand profiles and baselines across all buildings within Owner's portfolio.
4. Forecasting: Forecast near-future loads by using historic trends and forecasted weather data.
5. Financial Analysis: Calculate costs based on energy consumption and demand and energy costs and associate costs with any faults discovered by any analytic function and perform model- or tariff-based calculations to determine costs.
6. Tracking of Key Performance Indicators: Definition and tracking of user-defined key performance indicators/operational metrics. Examples include energy demand and consumption normalized for area and weather, peak demand, and consumption shown with minimum and maximum ranges across any user-selectable period.
7. Correlation of Energy Use with Equipment Operation: Automatically present views showing correlation between energy demand and consumption and operation of loads associated with that usage. Include the following:

   a. All submeters and virtual meters.
   b. Weather data as a selectable item.

H. Implementation:

1. Apply analytic rules to all HVAC systems and equipment monitored and controlled by DDC system. To extent available, use a subset of rules in existing rules library.
2. Implement rules to aid in determining proper operation of any HVAC system with a programmed sequence of operation.

3. Generate reports to aid in verification of proper operation during initial system startup and commissioning to supplement (not replace) commissioning agent reports.
4. Prepare quarterly reports summarizing faults detected and KPIs, including recommended corrective action.

I. Training:

1. Train Owner sufficiently to use software without need for external support.

2.18 MAINTENANCE MANAGEMENT SOFTWARE

A. Scope:

1. Include complete and functional software-driven maintenance management system to perform scheduling of preventive maintenance and generation of work orders, for mechanical and electrical equipment and systems, and other equipment and systems indicated.
2. Automatically generate work orders from alarm conditions, run time, and calendar time. For each work order generated, list parts, tools, and craftspeople and define task to be performed.
3. Use work orders generated to schedule a repair or preventive maintenance routine.
4. Use work orders to track completion of work, parts used, and total cost of repair.
5. Include a database inventory tracking system to automatically update inventory database to show quantity of tools, repair parts, and expendables used for a work order.
6. Print work orders and preventive maintenance schedules[**on a printer assigned solely to maintenance management function**].

B. Additional Hardware Requirements:

1. Maintenance management software is to not require additional hardware[**, except for an additional printer that is dedicated to maintenance management**].

C. Integration: Integrate maintenance management software into DDC system.

D. Software Requirements:

1. From main menu of maintenance management system, use selection of icons to penetrate to individual functions described below.
2. Work Orders:

a. Automatically generate work orders initiated from alarm conditions, accumulated run time, or calendar time. Work orders generated are to specify a particular task to be accomplished including labor, material, and tools needed to accomplish work.
b. Include at least two of the following types of work orders:

1) Corrective and Emergency Maintenance: Generate for a specific job or repair for emergency, breakdown, or scheduled work.
2) Preventive Maintenance: Use on a periodic basis to generate preventive maintenance work orders.

c. Include the following functions:

1) Work Order Tracking: Perform every function related to processing work orders including creating, approving and initiating work orders, checking their status history, and closing or reworking them when appropriate.
2) Work Requests: Report any problems that require corrective maintenance activity

generated by dispatchers and those people designated to request work orders.
3) Quick Reporting: Report work done on an open work order or a small job.
4) Work Manager: Specify type of labor to be applied to a specific work order at specific times. Include capability to dispatch one or more laborers to top-priority jobs on as-needed basis and to interrupt work in progress to reassign labor to higher priority tasks.

d. Reports:

1) Daily Maintenance Schedule by Supervisor: List a schedule of open work orders for a specified date by supervisor.
2) Equipment Cost Roll-up Report: Include a roll-up of equipment costs incurred since the date the report was last run.
3) Delinquent Work Order Report: List open work orders whose target completion date is earlier than the date the report is run.
4) Employee Job Assignments: List labor codes that have job assignments for specified date.
5) Daily Work Order Assignment: List work orders that have labor assignments for specified date.
6) Estimated versus Actual Work Order Costs: List a cost summary of outstanding work orders.
7) Open Work Orders Report: List open work orders for locations and equipment.

3. Inventory:

a. Include an inventory tracking system to keep track of stocked, non-stocked, and special-order items.
b. Link inventory tracking to database and when items are consumed, as noted on a work order issued by system, and automatically update inventory of stocked items.
c. Include the following functions:

1) Inventory Control: Enter, display, and update information on each inventory item. Allow viewing of master inventory records that are independent of storeroom locations or item/location records. Include a screen that lists inventory transactions that move items in or out of inventory or from one storeroom location to another. Minimum information tracked is to include the following:

a) Vendors supply items.
b) Item balances, including the bin and lot level for each storeroom location.
c) Alternative items.

2) Issues and Transfers: Issue stock directly from inventory, with or without a work order. When transfer of stock from one location to another location occurs, provide appropriate adjustments in stock balance record. Include a trace record of stock transfers from one storeroom to another.
3) Item Assembly Structures: Include modeling of equipment with inventory items and building of equipment and location hierarchies.
4) Metered Material Usage:

a) Track usage by a piece of equipment.
b) Record against a standing work order for a selected piece of equipment.
c) Include a material usage transaction for each item of material used and provide as an input to calculation for per unit material consumption report for a piece of equipment.

d. Reports:

1) Inventory Analysis Report: List for a given storeroom location, inventory items analysis information that allows quick identification of which inventory items represent greatest monetary investment for dollar value and rate of turnover.
2) Inventory Cycle Count Report: List for a specified storeroom, inventory items that are due to be cycle-counted, based on cycle-count frequency and last count date.
3) Economic Order Quantity Report: For a given storeroom location, display optimum economic ordering quantity for items in selected results set.
4) Inventory Pick Report: A pick list, by work order for items needed to be pulled from a designated storeroom's inventory for work orders having a target start date of specified date.
5) Suggested Order Report: List inventory items in selected results set that are due to be recorded, for a specified storeroom location, based on the following calculation: Suggest a reorder if current balance minus reserve quantity plus on-order quantity is less than reorder point.
6) Reorder Point Report: List selected set of items and optimum minimum level to have in stock based on demand, lead delivery time, and a reserve safety stock.
7) Inventory Valuation Report: Gives an accounting of cost of current inventory, for inventory records in a designated storeroom location.
8) Item Order Status: Lists items on order.
9) List of Expired Items: Lists expired lot items in a storeroom. Report is to include item number, description, expiration date, bin number, lot number, manufacturer lot number, and quantity of expired items in that lot and bin.
10) Item Availability at All Locations: Lists alternative storeroom locations for selected items.
11) Where Used Report: List equipment on which item is recorded as being used.

4. Equipment:

a. Include equipment and location records; establish relationships between equipment, between locations, and between equipment and locations; track maintenance costs; and enter and review meter readings.
b. Include the following functions:

1) Equipment: Store equipment numbers and corresponding information including equipment class, location, vendor, up/down status, and maintenance costs for each piece of equipment. Include building of equipment assemblies. Provide equipment assemblies hierarchical ordering for arrangement of buildings, departments, equipment, and sub-assemblies.
2) Operating Locations: Facilitate creation of records for operating locations of equipment, and track equipment that is used in multiple locations. In addition, allow hierarchical organization of equipment operating in facility by means of grouping equipment locations into areas of responsibility.
3) Failure Codes: Develop and display failure hierarchies to acquire an accurate history of types of failures that affect equipment and operating locations.
4) Condition Monitoring: Display time-related or limit measurements recorded for a piece of equipment. Generate work orders from this screen and to take immediate action on problem conditions.

c. Reports:

1) Availability Statistic by Location: List equipment availability by location over a user-specified period.
2) Equipment Failure Summary: List total number of failures by problem code for a piece of equipment for specified period.
3) Detailed Equipment Failure Report by Equipment: List of failure reports for the

current piece of equipment for specified period.
4) Equipment Hierarchy Report: List of equipment.
5) Equipment History Graphs: Include a graphical report in histogram format that displays equipment breakdown history over a specified period.
6) Equipment Measurement Report: Tabular listing and description of each measurement point for a piece of equipment and history of measurements taken for that point.
7) Maintenance Cost by Equipment: List of transactions costs for elected equipment in the specified date range.
8) Failure Count by Equipment: Graphically report number of failures for each piece of equipment showing number of failures for each piece of equipment over a specified period, occurrence of each problem code within set of failures, and failures by problem code.
9) Failure Analysis Graphs: Graphically report number of failures for each piece of equipment over a specified period, number of occurrences of each problem code within set of failures, and failures by problem code.
10) Failure Code Hierarchy Report: List of failure codes in each level of failure hierarchy.
11) Location Failure Summary: A summary for each selected location of failures reported and any hierarchy level locations for specified period.
12) Failure Summary by Location: A summary of failures for selected location and their subordinate locations that are part of hierarchical system.
13) Detailed Failure Report by Location: List all failures for selected location and its subordinate locations that are part of hierarchical system.
14) Maintenance Cost by System: List of total costs reported in a given date range for locations in selected hierarchical system.
15) Location Hierarchy Report: Lists member locations of hierarchical system displayed in hierarchical fashion.

5. Purchasing:

a. Include preparation and generation of purchase requisitions and purchase orders; to report receipt of both items and services, match invoices with purchase orders and receipts and define and convert foreign currencies.
b. Include the following functions:

1) Purchase Requisition: Create and process purchase requisitions for items and services.
2) Purchase Orders: Create and process purchase orders for items and services from scratch or from purchase requisitions. Record receipts of items and services.
3) Invoices: Include functionality to match purchase orders with invoices and receipts. It is also possible to match a service receipt to an invoice. Project for entering of an invoice for bills that do not require purchase orders or receipts.
4) Currency Management: Define currencies and specify exchange rates. Include preparation of purchase requisitions and purchase orders in currency of vendor while tracking costs in systems base currency.

c. Reports:

1) Invoice Approval Report: Include an approval form for entered invoices.
2) Inventory Receipts Register: List purchase orders and inventory received for user-specified time frame.
3) Direct Purchase Back-Order Report: List of items ordered as a direct purchase not received by required delivery date.
4) Standard Purchase Order: A printing of primary purchase order with vendors shipping information, and items purchased.
5) Purchase Order Status Report: List of purchase orders whose status has changed

during a certain period.
6) Standard Purchase Requisition: A printing of primary purchase requisition, including vendor name and shipping information.

6. Job Plans:

a. Include creation of a detailed description of work to be performed by work order. Job plan is to contain operations, procedures and list of estimated material, labor, and tools required for work.

7. Labor:

a. Store information on employees, contractors, and crafts and include the following functions:

1) Labor: Create, modify, and view employee records. Employee records are to contain pay rate, overtime worked, overtime refused, specials skills, and certifications.
2) Crafts: Create, modify, and view craftspeople records.
3) Labor Reporting: Report labor usage by employee or craft externally from work orders module.

b. Reports:

1) Employee Attendance Analysis: List of planned attendance, actual attendance, and vacation and sick time in hours as a percentage of planned attendance for selected employees for specified period.
2) Labor Productivity Analysis: List of actual labor hours by labor report category showing each by percentage.
3) Labor Availability versus Commitments by Crafts: A graphical report that details available labor hours versus committed work order hours by craft and day.

8. Calendars:

a. Establish calendar records indicating working time for equipment, location, craft, and labor records.

9. Resources:

a. Include entry and retrieval of data associated with resources required to maintain facility and to include the following functions:

1) Companies: Establish and update data on vendors and other companies.
2) Tools: Create and maintain information on the tools used on jobs. Make information contained within this module available to job plans and work orders.
3) Service Contracts: Specify information on service contracts with vendors or manufacturers.

10. Custom Applications:

a. Include creation of customized database tables and application screens that supplement functions specified.

11. Setup:

a. Include configuration of database, security, and setup applications.
b. Perform the following functions:

1) Reports and Other Applications: Register reports and other applications for use within system.
2) Documents: Enter, track, and link information from Drawings to equipment and inventory items.
3) Chart of Accounts: Add or modify accounts; set up financial periods; enter inventory accounts, company accounts, and resource recovery accounts; and define tax codes and rates.
4) Signature Security: Establish each user's access rights to modules, applications, screens, and options.
5) Database Configuration: Customize database, including adjusting field lengths and modifying data types.
6) Application Setup: Change position of icons and menu items on the main menu screen.
7) Application Launching: Allow for connecting of third-party applications to data fields and push buttons.

12. Utilities:

a. Include utilities module that allows system administrator to customize system and to maintain database.
b. Include the following functions:

1) Interactive SQL: Include access to database for database management functions of import/export and backup.
2) Edit Windows: Display a dialog box to customize an application.
3) Archive Data: Remove records from database and store them for future reference.

E. Documentation:

1. Include complete documentation for system consisting of a User Manual and Systems Administrator Guide.
2. Describe how to use each application module and screen with step-by-step instructions detailing entry and retrieval of data for functions specified.
3. Include a step-by-step description of how each report is defined and retrieved.
4. Bind documentation and clearly title it indicating volume number and use.

2.19 OFFICE APPLICATION SOFTWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Microsoft Corporation**]
2. <**Insert manufacturer's name**>

B. Include current version of office application software at time of Substantial Completion.

C. Office application software package to include multiple separate applications and use a common platform for all applications.

1. Database.
2. Email.

3. Presentation.
4. Publishing.
5. Spreadsheet.
6. Word processing.
7. <**Insert application**>.

2.20 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, <**Insert equipment,**> and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems where indicated, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network, and vice versa, where applicable.
2. Write to all writable object properties on non-BACnet network from BACnet network, and vice versa, where applicable.
3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet, and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs in accordance with ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media with ability to modify, download, backup, and restore gateway configuration.

2.21 ASHRAE 135 PROTOCOL ANALYZER

A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.

B. Include the following minimum capabilities:

1. Capture and store to a file data traffic on all network levels.
2. Measure bandwidth usage.
3. Filtering options with ability to ignore select traffic.

2.22 CTA-709.1-D NETWORK HARDWARE

A. Routers:

1. Network routers, including routers configured as repeaters, are to comply with requirements of CTA-709.1-D and include connection between two or more CTA-709.3 TP/FT-10 channels or

between two or more CTA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.

2. IP Routers:

   a. Perform layer three routing of CTA-709.1-D packets over an IP network in accordance with CTA-852-C.
   b. Include appropriate connection to IP network and connections to CTA-709.3 TP/FT-10 or TP/XF-1250 network.
   c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CTA-852-C Configuration Server (for CTA-852-C configuration), but do not rely on these services for configuration.
   d. Capable of manual configuration via a console RS-232 port.

B. Gateways:

1. Perform bidirectional protocol translation from one non-CTA-709.1-D protocol to CTA-709.1-D.
2. Incorporate a network connection to TP/FT-10 network in accordance with CTA-709.3 and a connection for non-CTA-709.1-D network.

2.23 WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Dual-Band Wireless Routers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASUSTek Computer Inc.**]
   b. [**Cisco Linksys**]
   c. [**D-Link Corporation/D-Link Systems, Inc.**]
   d. [**NETGEAR Inc.**]
   e. <**Insert manufacturer's name**>

2. Description: High-speed, dual-band router with integral Ethernet ports and USB port.
3. Technology: IEEE 802.11; 2.4 and 5 GHz speed bands.
4. Wireless Speed: Up to [**300**]<**Insert number**> Mbps on 2.4 GHz band and up to [**2400**]<**Insert number**> Mbps on 5 GHz band.
5. Compatibility: IEEE 802.11 ac wireless devices.
6. Ethernet Ports: Four, gigabit (1000 Mbps).
7. USB Port: One, USB 2.0 or 3.0.
8. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 in accordance with IEEE 802.11.

B. Tri-Band Wireless Routers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASUSTek Computer Inc.**]
   b. [**Cisco Linksys**]
   c. [**NETGEAR Inc.**]
   d. <**Insert manufacturer's name**>

2. Description: High-speed, tri-band router with integral Ethernet ports and USB port.

3. Technology: IEEE 802.11; 2.4 and 5 GHz speed bands.
4. Wireless Speed: Up to [**600**]<**Insert number**> Mbps on 2.4 GHz band and up to [**4800**]<**Insert number**> Mbps on two 5 GHz bands.
5. Compatibility: IEEE 802.11 [**ac**][**or**][**ax**] wireless devices.
6. Ethernet Ports: [**Four**]<**Insert number**>, gigabit [**1000**][**2500**]<**Insert number**> Mbps.
7. USB Port: One, USB 2.0 or 3.0.
8. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 in accordance with IEEE 802.11.

2.24 DDC CONTROLLERS

A. DDC system consisting of a combination of network controllers, programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.

C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware suitable for anticipated ambient conditions.
2. Controllers located in conditioned space rated for operation at [**32 to 120 deg F**]<**Insert temperature range**>.
3. Controllers located outdoors rated for operation at [**40 to 150 deg F**]<**Insert temperature range**>.

F. Power and Noise Immunity:

1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within **36 inches** of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

   a. Network Controllers: [**50**][**60**][**70**]<**Insert number**> percent.
   b. Programmable Application Controllers: Not less than [**60**][**70**][**80**]<**Insert number**> percent.
   c. Application-Specific Controllers: Not less than [**70**][**80**][**90**]<**Insert number**> percent.

2. Memory for DDC controller's operating system and database are to include the following:

   a. Monitoring and control.
   b. Energy management, operation, and optimization applications.
   c. Alarm management.
   d. Historical trend data of all connected I/O points.
   e. Maintenance applications.
   f. Operator interfaces.
   g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:

   a. [**10**][**20**]<**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
   b. Minimum Spare I/O Points per Controller:

      1) AIs: [**Two**][**Three**]<**Insert number**>.
      2) AOs: [**Two**][**Three**]<**Insert number**>.
      3) BIs: [**Three**][**Five**]<**Insert number**>.
      4) BOs: [**Three**][**Five**]<**Insert number**>.
      5) Option to provide universal I/O to meet spare requirements.

2. Programmable Application Controllers:

   a. [**10**][**20**]<**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
   b. Minimum Spare I/O Points per Controller:

      1) AIs: [**Two**][**Three**]<**Insert number**>.
      2) AOs: [**Two**][**Three**]<**Insert number**>.
      3) BIs: [**Three**][**Five**]<**Insert number**>.
      4) BOs: [**Three**][**Five**]<**Insert number**>.
      5) Option to provide universal I/O to meet spare requirements.

3. Application-Specific Controllers:

   a. [**10**]<**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
   b. Minimum Spare I/O Points per Controller:

      1) AIs: [**One**][**Two**]<**Insert number**>.
      2) AOs: [**One**][**Two**]<**Insert number**>.
      3) BIs: [**One**][**Two**]<**Insert number**>.
      4) BOs: [**One**][**Two**]<**Insert number**>.
      5) Option to provide universal I/O to meet spare requirements.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. General Requirements for CTA-709.1-D DDC Controllers:

1. LonMark certified.
2. Distinguishable and accessible switch, button, or pin, when pressed is to broadcast its 48-bit Node ID and Program ID over network.
3. TP/FT-10 transceiver in accordance with CTA-709.3 and connections for TP/FT-10 control network wiring.
4. TP/XF-1250 transceiver in accordance with CTA-709.3 and connections for TP/XF-1250 control network wiring.
5. Communicate using CTA-709.1-D protocol.
6. Controllers configured into subnets, as required, to comply with performance requirements indicated.
7. Network communication through LNS network management and database standard for CTA-

709.1-D network devices.

8. Locally powered, not powered through network connection.
9. Functionality required to support applications indicated including, but not limited to, the following:

    a. I/Os indicated and as required to support sequence of operation and application in which it is used. SNVTs to have meaningful names identifying the value represented by SNVT. Unless SNVT of an appropriate engineering type is unavailable, all network variables to be of SNVT with engineering units appropriate to value the variable represents.
    b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.

10. Programmable controllers comply with "LonMark Interoperability Guidelines" and have LonMark certification.

K. I/O Point Interface:

1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

    a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
    b. Compatible with, and field configurable to, sensor and transmitters installed.
    c. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of [**8**][**12**]<**Insert value**> bits or better to comply with accuracy requirements indicated.
    d. Signal conditioning including transient rejection for each AI.
    e. Capable of being individually calibrated for zero and span.
    f. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
    g. External conversion resistors are not permitted.

5. AOs:

    a. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of [**8**][**12**]<**Insert value**> bits or better to comply with accuracy requirements indicated.
    b. Output signals range of [**4 to 20 mA dc**][**or**][**0 to 10 V dc**] as required to include proper control of output device.
    c. Capable of being individually calibrated for zero and span.
    d. Drift is to be not greater than 0.4 percent of range per year.
    e. External conversion resistors are not permitted.

6. BIs:

    a. Accept contact closures and ignore transients of less than 5 ms duration.
    b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
    c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
    d. Sense "dry contact" closure without external power (other than that provided by controller)

being applied.

e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.

7. BOs:

a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
3) Minimum contact rating to be 1 A at 24 V ac.
4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.

b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs to be selectable for either normally open or normally closed operation.
d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.
e. Limit use of three-point floating devices to VAV terminal unit control applications[**, and other applications indicated on Drawings,**]<**Insert applications**>. Control algorithms to operate actuator to one end of its stroke once every [**12**][**24**]<**Insert time**> hours for verification of operator tracking.

2.25 NETWORK CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Include enough memory to support its operating system, database, and programming requirements with spare memory indicated.
4. Share data between networked controllers and other network devices.
5. Operating system of controller to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Include network controllers with a real-time clock.
7. Controller to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller is to assume a predetermined failure mode and generate an alarm notification.
8. Make controllers fully programmable.

B. Communication:

1. Network controllers communicate with other devices on DDC system [**Level 1**]<**Insert level**> network.
2. Network controller to also perform routing if connected to network of programmable application controllers and application-specific controllers.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to [**desktop operator's workstation**][**portable operator's workstation**][**POT**][**or**][**mobile device**].
2. Local Keypad and Display:

    a. Equip controller with local keypad and digital display for interrogating and editing data.
    b. Use of keypad and display requires a security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain Basic Input Output System (BIOS) and programming information in event of power loss for at least [**72**][**96**]<**Insert number**> hours.

2.26 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Include controllers [**that perform scheduling**]with a real-time clock.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to [**desktop operator's workstation**][**portable operator's workstation**][**POT**][**or**][**mobile device**].
2. Local Keypad and Display:

    a. Equip controller with local keypad and digital display for interrogating and editing data.
    b. Protect use of keypad and display by security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.27 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and continued control functions without being connected to network.
2. Share data between networked controllers and other network devices.

B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.

C. Operator Interface: Equip controllers with a service communications port for connection to [**desktop workstation**][**portable operator's workstation**][**POT**][**or**][**mobile device**].[**Connection is to extend to port on space temperature sensor that is connected to controller.**]

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.28 CONTROLLER SOFTWARE

A. General:

1. Software applications are to reside and operate in controllers. Edit applications through operator workstations[**or mobile devices**].
2. Identify I/O points by up to [**30**]<**Insert number**>-character point name and up to [**16**]<**Insert number**>-character point descriptor. Use same names throughout, including at operator workstations.
3. Execute control functions within controllers using DDC algorithms.
4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Secure operator access using individual security passwords and user names.
2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
3. Record operator log-on and log-off attempts.
4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:

1. Weekly Schedules:

a. Include separate schedules for each day of week.
b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

a. Include capability for operator to define up to 99 special or holiday schedules.
b. Place schedules on scheduling calendar with ability to repeated each year.
c. Operator able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Include operator with a method of grouping together equipment based on function and location.
3. Include groups that may be for use in scheduling and other applications.

E. Binary Alarms:

1. Set each binary point to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Provide each analog object with both high and low alarm limits.
2. Include capability to automatically and manually disable alarming.

G. Alarm Reporting:

1. Include ability for operators to determine action to be taken in event of an alarm.
2. Route alarms to appropriate operator workstations based on time and other conditions.
3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.

H. Remote Communication:

1. Include ability for system to notify operators by phone message, text message, and email in event of an alarm.

I. Electric Power Demand Limiting:

1. Monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded,

action will be taken to restore loads in a predetermined manner.

3. Accomplish demand reduction by the following means:

    a. Reset air-handling-unit supply temperature set points.
    b. Reset space temperature set points.
    c. De-energize equipment based on priority.

4. Base demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:

    a. Addition and deletion of loads controlled.
    b. Changes in demand intervals.
    c. Changes in demand limit for meter(s).
    d. Maximum shutoff time for equipment.
    e. Minimum shutoff time for equipment.
    f. Select rotational or sequential shedding and restoring.
    g. Shed and restore priority.

7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly, and annual basis:

    a. Total electric consumption.
    b. Peak demand.
    c. Date and time of peak demand.
    d. Daily peak demand.

J. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:

    a. Two-position (on/off, open/close, slow/fast) control.
    b. Proportional control.
    c. Proportional plus integral (PI) control.
    d. Proportional plus integral plus derivative (PID) control.

        1) Include PID algorithms with direct or reverse action and anti-windup.
        2) Algorithm to calculate a time-varying analog value used to position an output or stage a series of outputs.
        3) Make controlled variable, set point, and PID gains operator-selectable.

    e. Adaptive (automatic tuning).

M. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include algorithm that calculates a sliding-window average (rolling average). Make algorithm flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include algorithm that calculates a fixed-window average. Use a digital input signal to define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. Protect BO points from short cycling.
2. Feature to allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI [**and BO**]points.
2. Assign a high run-time alarm, if required, by operator.

2.29 ENCLOSURES

A. General:

1. House each controller and associated control accessories in [**single**]enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
2. Do not house more than one controller in single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual, wall-mounted, single-door enclosures maximum of [**36 inches**]<**Insert dimension**> wide and [**48 inches**][**60 inches**]<**Insert dimension**> high.
6. Individual, wall-mounted, double-door enclosures maximum of [**60 inches**]<**Insert dimension**> wide and [**36 inches**]<**Insert dimension**> high.
7. Freestanding enclosures maximum of [**48 inches**]<**Insert dimension**> wide and [**72 inches**]<**Insert dimension**> high.
8. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
9. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door.[**For enclosures with windows, include pocket on bottom of enclosure.**]

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect [**pneumatic,**]electric, and electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and

standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than [**10**][**20**]<**Insert number**> percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install maximum of two wires on each side of terminal.
9. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with [**engraved, laminated phenolic**]nameplates (black letters on a white background). Nameplates are to have at least **1/4-inch-** high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
14. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least [**15**][**25**]<**Insert number**> percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction, and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Hammond Mfg. Co. Inc**]
   c. [**Hoffman; brand of nVent Electrical plc**]
   d. [**Saginaw Control and Engineering**]
   e. <**Insert manufacturer's name**>

2. NRTL listed in accordance with UL 50 or UL 50E.
3. Construct enclosure of steel, not less than the following:

a. Enclosure Size Less Than 24 Inches (600 mm): [**0.053 inch**][**or**][**0.067 inch**] thick.
b. Enclosure Size 24 Inches (600 mm) and Larger: [**0.067 inch**][**or**][**0.093 inch**] thick.

4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Exterior Color: [**White**][**Gray**][**Selected by Architect**][**Manufacturer's standard**]<**Insert color**>.
   b. Interior Color: [**White**][**Gray**][**Manufacturer's standard**].

5. Hinged door full size of front face of enclosure and supported using the following:

   a. Enclosures Sizes Less Than 36 Inches (900 mm) Tall: Multiple butt hinges.
   b. Enclosures Sizes 36 Inches (900 mm) Tall and Larger: Continuous piano hinges.

6. Removable internal panel with [**white**][**or**][**gray**] polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Size Less Than 24 Inches (600 mm): [**Solid**][**or**][**perforated**] steel, **0.053 inch** thick.
   b. Size 24 Inches (600 mm) and Larger: Solid [**aluminum, 0.10 inch**][**or**][**steel, 0.093 inch**] thick.

7. Internal panel mounting hardware, grounding hardware, and sealing washers.
8. Grounding stud on enclosure body.
9. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall-Mounted, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Hammond Mfg. Co. Inc**]
   c. [**Hoffman; brand of nVent Electrical plc**]
   d. [**Saginaw Control and Engineering**]
   e. <**Insert manufacturer's name**>

2. NRTL listed in accordance with UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Single-door enclosure sizes up to **60 inches tall by 36 inches wide**.
7. Double-door enclosure sizes up to **36 inches tall by 60 inches wide**.
8. Construct enclosure of steel, not less than the following:

   a. Size Less Than 24 Inches (600 mm): [**0.053 inch**][**or**][**0.067 inch**] thick.
   b. Size 24 Inches (600 mm) and Larger: **0.067 inch** thick.

9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Exterior Color: [**White**][**Gray**][**Selected by Architect**][**Manufacturer's standard**]<**Insert**

color>.
b. Interior Color: [**White**][**Gray**][**Manufacturer's standard**].

10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
    b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
    c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.

11. Double-door enclosures with overlapping door design to include unobstructed full-width access.

    a. Single-door enclosures **48 inches** and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

12. Removable internal panel with [**white**][**or**][**gray**] polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches (600 mm): [**Solid**][**or**][**perforated**] steel, **0.053 inch** thick.
    b. Size 24 Inches (600 mm) and Larger: Solid [**aluminum, 0.10 inch**][**or**][**steel, 0.093 inch**] thick.

13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Wall-Mounted, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    b. [**Hammond Mfg. Co. Inc**]
    c. [**Hoffman; brand of nVent Electrical plc**]
    d. [**Saginaw Control and Engineering**]
    e. <**Insert manufacturer's name**>

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Construct enclosure of [**Type 304**][**or**][**Type 316L**] stainless steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): **0.053 inch** thick.
    b. Size 24 Inches (600 mm) and Larger: **0.067 inch** thick.

6. Outside body and door of enclosure with brushed No. 4 finish.
7. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
    b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
    c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.

8. Corner-formed door, full size of enclosure face, supported using continuous piano hinge full length of door.
9. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, [**Type 304**][**or**][**Type 316L**] stainless steel handle with integral locking mechanism.
10. Removable internal panel of **0.093-inch** stainless steel.
11. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
12. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
13. Include enclosure with stainless steel mounting brackets.

G. Freestanding, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    b. [**Hammond Mfg. Co. Inc**]
    c. [**Hoffman; brand of nVent Electrical plc**]
    d. [**Saginaw Control and Engineering**]
    e. <**Insert manufacturer's name**>

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Single-door enclosure sizes up to **84 inches tall by 36 inches wide**.
6. Double-door enclosure sizes up to **84 inches tall by 72 inches wide**.
7. Construct enclosure of steel, not less than **0.067 inch** thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: [**White**][**Gray**][**Selected by Architect**][**Manufacturer's standard**]<**Insert color**>.
    b. Interior Color: [**White**][**Gray**][**Manufacturer's standard**].

9. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
11. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
12. Removable back covers.
13. Removable solid steel internal panel, **0.093 inch** thick, with [**white**][**or**][**gray**] polyester powder coating that is electrostatically applied and then baked to bond to substrate.
14. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
15. Grounding stud on enclosure body.
16. Thermoplastic pocket on inside of door for record Drawings and Product Data.
17. Nominal **4-inch-** tall integral lifting base, not less than **0.123 inch** thick, with predrilled holes for attachment to mounting surface.
18. Equip each top end of enclosure with lifting tabs, not less than **0.172 inch** thick, or not less than two lifting eyes.
19. Internal rack-mount shelves and angles, as required by application.

H. Freestanding, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
b. [**Hammond Mfg. Co. Inc**]
c. [**Hoffman; brand of nVent Electrical plc**]
d. [**Saginaw Control and Engineering**]
e. **<Insert manufacturer's name>**

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Type 12 Enclosure Sizes:

   a. Single-door enclosure sizes up to **90 inches tall by 36 inches wide**.
   b. Double-door enclosure sizes up to **90 inches tall by 72 inches wide**.

6. Type 4 Enclosure Sizes:

   a. Single-door enclosure sizes up to **72 inches tall by 36 inches wide**.
   b. Double-door enclosure sizes larger than **36 inches** wide.

7. Construct enclosure of steel, not less than **0.093 inch** thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Exterior Color: [**White**][**Gray**][**Selected by Architect**][**Manufacturer's standard**]**<Insert color>**.
   b. Interior Color: [**White**][**Gray**][**Manufacturer's standard**].

9. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
10. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
11. Removable solid steel internal panel, **0.093 inch** thick, with [**white**][**or**][**gray**] polyester powder coating that is electrostatically applied and then baked to bond to substrate.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.
15. Equip top of enclosure with no fewer than two lifting eyes.
16. Internal rack-mount shelves and angles, as required by application.

I. Freestanding, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   b. [**Hammond Mfg. Co. Inc**]
   c. [**Hoffman; brand of nVent Electrical plc**]
   d. [**Saginaw Control and Engineering**]
   e. **<Insert manufacturer's name>**

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Construct enclosure of [**Type 304**][**or**][**Type 316L**] stainless steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): **0.053 inch** thick.
    b. Size 24 Inches (600 mm) and Larger: **0.067 inch** thick.

6. Outside enclosure and door of enclosure with brushed No. 4 finish.
7. Doors:

    a. Single-door enclosure sizes up to **36 inches** wide.
    b. Double-door enclosure sizes larger than **36 inches** wide.
    c. Corner-formed door(s) with continuous perimeter oil-resistant gasket, full size of enclosure face, supported using continuous piano hinge full length of door.
    d. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, [**Type 304**][**or**][**Type 316L**] stainless steel handle with integral locking mechanism.

8. Removable internal panel of **0.093-inch** stainless steel.
9. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
10. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
11. Include enclosure with stainless steel mounting brackets.
12. Thermoplastic pocket on inside of door for record Drawings and Product Data.
13. Equip top of enclosure with no fewer than two lifting eyes.
14. Internal rack-mount shelves and angles, as required by application.

J. Accessories:

1. Electric Heater:

    a. Aluminum housing with brushed finish.
    b. Thermostatic control with adjustable set point from **0 to 100 deg F**.
    c. Capacity: 100, 200, 400, and 800 W, as required by application.
    d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:

    a. Number and size of fans, filters, and grilles, as required by application.
    b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
    c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
    d. Thermostatic control with adjustable set point from **32 to 140 deg F**.
    e. Airflow Capacity at Zero Pressure:

        1) 4-Inch (100-mm) Fan: **100 cfm**.
        2) 6-Inch (150-mm) Fan: **240 cfm**.
        3) 10-Inch (250-mm) Fan: **560 cfm**.

    f. Maximum operating temperature of **158 deg F**.
    g. **4-inch** fan thermally protected and provided with permanently lubricated ball-bearings.

h. **6- and 10-inch** fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
i. Dynamically balanced impellers molded from polycarbonate material.
j. Fan furnished with power cord and polarized plug for power connection.
k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
l. Removable Intake and Exhaust Grilles: [**ABS plastic**][**or**][**stainless steel**], of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
m. Filters for NEMA 250, Type 1 Enclosures: Washable [**foam**][**or**][**aluminum**], of size to match intake grille.
n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.

3. Air Conditioner:

a. Electric-powered, self-contained, air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
b. Thermostatic control with adjustable set point from **60 to 120 deg F**.
c. Enclosure side or top mounting with unit capacity, as required by application.
d. Designed for closed-loop cooling with continuous operation in ambient environments up to **125 deg F**.
e. HFC refrigerant.
f. Reusable and washable air filter.
g. High-performance, industrial-grade, and high-efficiency fans.
h. Furnished with power cord and polarized plug for power connection.
i. Condensate management system with base pan side drain.
j. Mounting hardware, gaskets, mounting template, and instruction manual furnished with unit.
k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil, and thermostat.

4. Thermoelectric Humidifier:

a. ABS plastic enclosure.
b. Capacity of **8 oz.** of water per 24 hours.
c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
d. Controlled to maintain enclosure relative humidity at adjustable set point.
e. Unit power supply is internally wired to enclosure electrical power source.

5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:

a. **0.25-inch-** thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit to be factory or shop installed before shipment to Project.

6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:

a. **0.125-inch-** thick, polycarbonate window mounted in enclosure door material.
b. Window attached to door with screw fasteners and continuous strip of high-strength, double-sided tape around window perimeter.
c. Window kit is factory or shop installed before shipment to Project.

7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:

a. **0.25-inch-** thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit to be factory or shop installed before shipment to Project.

8. Bar handle with keyed cylinder lock set.

2.30 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allen Bradley; by Rockwell Automation**]
b. [**Eaton**]
c. [**IDEC Corporation**]
d. [**Omron Americas**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. NRTL listed.
3. Heavy-duty, electromechanical type; rated for at least [**10**]<**Insert value**> A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with [**8-pin octal**][**or**][**multiblade**] plug for DPDT relays and [**11-pin octal**][**or**][**multiblade**] plug for three-pole double-throw relays.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a [**clear transparent**]polycarbonate dust-tight cover.
8. Include LED indication[**and push-to-test button to test manual operation of relay without power on coil**].
9. Performance:

a. Mechanical Life: At least [**10**]<**Insert number**> million cycles.
b. Electrical Life: At least [**100,000**]<**Insert number**> cycles at rated load.
c. Pickup Time: [**15**][**20**]<**Insert value**> ms or less.
d. Dropout Time: [**10**][**20**]<**Insert value**> ms or less.
e. Pull-in Voltage: [**85**]<**Insert number**> percent of rated voltage.
f. Dropout Voltage: [**50**][**10**]<**Insert number**> percent of nominal rated voltage.
g. Power Consumption: [**2**][**5**] VA or less.
h. Ambient Operating Temperatures: **Minus 40 to 115 deg F**.

10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Allen Bradley; by Rockwell Automation**]
    b. [**Eaton**]
    c. [**IDEC Corporation**]
    d. [**Omron Americas**]
    e. [**Siemens Industry, Inc., Building Technologies Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. NRTL listed.
3. Continuous-duty type, rated for at least [**10**]<**Insert value**> A at 240 V ac and 60 Hz.
4. Relay with up to [**4**][**8**]<**Insert number**> programmable functions to provide on/off delay, interval, and recycle timing functions.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a dust-tight cover.
8. Include knob and dial scale for alternative digital interface for setting delay time.
9. Visual Status Indication: Power "On"[**and Output "On"**] status.
10. Performance:

    a. Mechanical Life: At least [**10**]<**Insert number**> million cycles.
    b. Electrical Life: At least [**100,000**]<**Insert number**> cycles at rated load.
    c. Timing Ranges: Multiple ranges from [**0.1**]<**Insert number**> seconds to [**100**]<**Insert number**> minutes.
    d. Repeatability: Within [**2**]<**Insert number**> percent.
    e. Recycle Time: [**45**]<**Insert value**> ms.
    f. Minimum Pulse-Width Control: [**50**]<**Insert value**> ms.
    g. Power Consumption: 5 VA or less.
    h. Ambient Operating Temperatures: **Minus 40 to 115 deg F**.

11. Equip relays with transient suppression to limit transients to non-damaging levels.
12. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
13. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Allen Bradley; by Rockwell Automation**]
    b. [**Eaton**]
    c. [**IDEC Corporation**]
    d. [**Omron Americas**]
    e. [**Siemens Industry, Inc., Building Technologies Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. NRTL listed.

3. Continuous-duty type, rated for at least [**10**]<**Insert value**> A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a [**clear transparent**]polycarbonate dust-tight cover.
8. Performance:

    a. Mechanical Life: At least [**10**]<**Insert number**> million cycles.
    b. Electrical Life: At least [**100,000**]<**Insert number**> cycles at rated load.
    c. Pickup Time: [**15**][**20**]<**Insert value**> ms or less.
    d. Dropout Time: [**10**][**20**]<**Insert value**> ms or less.
    e. Pull-in Voltage: [**85**]<**Insert number**> percent of rated voltage.
    f. Dropout Voltage: [**50**][**10**]<**Insert number**> percent of nominal rated voltage.
    g. Power Consumption: [**2**][**5**]<**Insert value**> VA or less.
    h. Ambient Operating Temperatures: **Minus 40 to 115 deg F**.

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

D. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Functional Devices Inc**]
    c. [**NK Technologies**]
    d. [**Square D; Schneider Electric USA**]
    e. <**Insert manufacturer's name**>

2. NRTL listed.
3. Monitors ac current.
4. Independent adjustable controls for pickup and dropout current.
5. Energized when supply voltage is present and current is above pickup setting.
6. De-energizes when monitored current is below dropout current.
7. Dropout current is adjustable from [**50**]<**Insert number**> to [**95**]<**Insert number**> percent of pickup current.
8. Visual indication of contact status.
9. Include current transformer, if required for application.
10. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, [**Type 1**][**or**][**Type 12**] enclosure for indoors applications and NEMA 250, [**Type 4**][**or**][**Type 4X**] for outdoor applications.

E. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Functional Devices Inc**]

b. [**Veris Industries**]
c. <**Insert manufacturer's name**>

2. Description:

a. On-off control and on-off status indication in a single device.
b. LED status indication of activated relay and current trigger.
c. Closed-Open-Auto override switch located on the load side of relay.

3. Performance:

a. Ambient Temperature: **Minus 30 to 140 deg F**.
b. Voltage Rating: Single-phase loads rated for 300 V ac. Three-phase loads rated for 600 V ac.

4. Status Indication:

a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
b. Current Sensor Range: As required by application.
c. Current Set Point: [**Fixed**][**Adjustable**][**Fixed or adjustable, as required by application**].
d. Current Sensor Output:

1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
2) Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
3) Analog, 0 to 5 or 10 V dc.
4) Analog, 4 to 20 mA, loop powered.

5. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, [**Type 1**][**Type 12**]<**Insert type**> enclosure for indoor applications; NEMA 250, [**Type 4**][**Type 4X**]<**Insert type**> enclosure for outdoor applications.

2.31 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional [**25**][**50**]<**Insert number**> percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: [**40**][**100**]<**Insert value**> VA.
3. Protection: Provide transformers with both primary and secondary fuses.[**Integral circuit breaker is acceptable in lieu of fuses.**]
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. Power-Line Conditioners:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Emerson Electric Co., Automation Solutions**]
c. [**SolaHD; Emerson Electric Co., Automation Solutions**]
d. <**Insert manufacturer's name**>

2. General Power-Line Conditioner Requirements:

    a. Design to ensure maximum reliability, serviceability, and performance.
    b. Overall function of power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. Power-line conditioner is to provide isolated, regulated, transient, and noise-free sinusoidal power to loads served.

3. Standards: NRTL listed per UL 1012.
4. Performance:

    a. Single phase, continuous, 100 percent duty rated kVA/kW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
    b. Automatically regulate output voltage to within [**2**]<**Insert number**> percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.

        1) At 75 Percent Load: Output voltage automatically regulated to within [**3**]<**Insert number**> percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
        2) At 50 Percent Load: Output voltage automatically regulated to within [**3**]<**Insert number**> percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
        3) At 25 Percent Load: Output voltage automatically regulated to within [**3**]<**Insert number**> percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.

    c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to maximum harmonic content of [**5**]<**Insert number**> percent.
    d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero to 100 to zero percent.
    e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when output is taken from no load to full-resistive load, or vice versa. Recovery from partial resistive load changes is corrected in a shorter period.
    f. K Factor: [**30**]<**Insert value**>, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
    g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
    h. Attenuate load-generated odd current harmonics [**23**]<**Insert value**> dB at the input.
    i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
    j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.1 and IEEE C62.41.2.
    k. Common-mode noise attenuation of [**140**]<**Insert value**> dB.
    l. Transverse-mode noise attenuation of [**120**]<**Insert value**> dB.
    m. With loss of input power for up to 16.6 ms, output sine wave remains at usable ac voltage levels.
    n. Reliability of [**200,000**]<**Insert number**> hours' MTBF.
    o. At full load, when measured at 1 m distance, audible noise is not to exceed [**54**]<**Insert value**> dB.
    p. Approximately [**92**]<**Insert number**> percent efficient at full load.

5. Transformer Construction:

    a. Ferroresonant, dry type, convection cooled, 600 V class. Transformer windings of Class H

(220 deg C) insulated copper.
b. Use Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40 deg C ambient temperature.
c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
e. Configure transformer secondary in 240/120 V split with 208 V tap or straight 120 V, depending on power output size.
f. Electrically isolate the transformer secondary windings from primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
g. Include interface terminals for output power hot, neutral, and ground conductors.
h. Label leads, wires, and terminals to correspond with circuit wiring diagram.
i. Vacuum impregnate transformer with epoxy resin.

6. Cabinet Construction:

a. Design for panel or floor mounting.
b. NEMA 250, [**Type 1**][**or**][**Type 2**] enclosure for indoor applications. NEMA 250, [**Type 3R**]<**Insert type**> for outdoor applications.
c. Manufacture the cabinet from heavy gauge steel complying with UL 50 or UL 508A.
d. Include textured baked-on paint finish.

C. DC Power Supplies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acopian Technical Company**]
b. [**Emerson Electric Co., Automation Solutions**]
c. [**IDEC Corporation**]
d. [**Omron Americas**]
e. <**Insert manufacturer's name**>

2. Description: Linear or switched, regulated power supplies with ac input to [**one**][**or**][**multiple**] dc output(s).

a. Include both line and load regulation to ensure stable output.
b. To protect both power supply and load, include power supply with an automatic current limiting circuit.

3. Features:

a. Connection: Plug-in style suitable for mating with standard [**8-pin octal**]socket. Include power supply with mating mounting socket.
b. Housing: Enclose circuitry in a housing.
c. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
d. Mounting: DIN rail.
e. Visual status indicator.
f. <**Insert feature**>.

4. Performance:

a. Input Voltage: Nominally [**120**]<**Insert value**> V ac, 60 Hz.

b. Output Voltage: Nominally [**24**]<**Insert value**> V dc with plus or minus [**1**]<**Insert value**> V dc adjustment.
c. Output Current: Minimum [**100**]<**Insert value**> mA.
d. Load Regulation: Within [**0.1**]<**Insert number**> percent.
e. Line Regulation: Within [**0.05**]<**Insert number**> percent.
f. Stability: Within [**0.1**]<**Insert number**> percent of rated volts after warmup period.
g. Ripple: [**1**]<**Insert value**> mV rms.

2.32 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. Furnish local UPS units, of type indicated, installed with DDC system.

B. DIN Rail Mounted UPS:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**APC by Schneider Electric**]
b. [**Emerson Electric Co., Automation Solutions**]
c. [**Phoenix Contact**]
d. <**Insert manufacturer's name**>

2. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
3. Performance:

a. Capacity: Load not to exceed [**75**]<**Insert number**> percent of rated capacity.
b. Efficiency: Minimum [**94**]<**Insert number**> percent.
c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
d. Load Power Factor Range (Crest Factor): [**0.65 to 1.0**]<**Insert range**>.
e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
f. On Battery Output Voltage: Sine wave.
g. Inverter Overload Capacity: Minimum [**150**]<**Insert number**> percent for 30 seconds.
h. Battery Backup: [**Five**][**10**][**15**]<**Insert number**> minutes of operation at [**full**]<**Insert value**> load with battery power.
i. Battery Recharge Time: Maximum of [**four**][**six**]<**Insert number**> hours to 90 percent capacity after full discharge.
j. Transfer Time: [**6**]<**Insert value**> ms.
k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B.

4. Automatic bypass operation during fault or overload conditions.
5. Integral line-interactive, power condition topology to eliminate all power contaminants.
6. Include power switch and visual indication of power, battery, fault[**, and temperature**].
7. Include audible alarm of faults with silence feature.
8. Include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[**and connect points to DDC system**].
9. Batteries: Sealed; maintenance free; replacement without dropping load.

C. Tower UPS Models through 1000 VA:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**APC by Schneider Electric**]
b. [**Eaton**]
c. [**Toshiba International Corporation**]
d. <**Insert manufacturer's name**>

2. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
3. Performance:

a. Capacity: Load not to exceed [**75**]<**Insert number**> percent of rated capacity.
b. Efficiency: Complying with ENERGY STAR requirements; minimum [**91**]<**Insert number**> percent.
c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
d. Load Power Factor Range (Crest Factor): [**0.65 to 1.0**]<**Insert range**>.
e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
f. On Battery Output Voltage: Sine wave.
g. Inverter Overload Capacity: Minimum [**150**]<**Insert number**> percent for 30 seconds.
h. Battery Backup: [**Five**][**10**][**15**]<**Insert number**> minutes of operation at [**full**]<**Insert value**> load with battery power.
i. Battery Recharge Time: Maximum of [**four**][**six**]<**Insert number**> hours to 90 percent capacity after full discharge to cutoff.
j. Transfer Time: [**0**]<**Insert value**> ms.
k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B; 6 kV/200 and 500 A; 100 kHz ring wave.

4. Automatic bypass operation during fault or overload conditions.
5. Integral line-interactive, power condition topology to eliminate all power contaminants.
6. Include power switch and visual indication of power, battery, fault, and temperature.
7. Include audible alarm of faults and front panel silence feature.
8. Receptacles: Minimum [**four**]<**Insert number**>, NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
9. Remote Alarms: Include dry contacts (digital output points) [**or serial communication interface**]for low battery condition and battery-on (primary utility power failure)[**and connect points to DDC system**].
10. Batteries: Sealed type; maintenance free. Battery replacement is to be front accessible by user without dropping load.
11. Install tower models in enclosures rated for location.

D. UPS Models through 3000 VA: [**Tower**][**and**][**Rack**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**APC by Schneider Electric**]
b. [**Eaton**]
c. [**Toshiba International Corporation**]
d. <**Insert manufacturer's name**>

2. NRTL Listing: UL 1778.
3. Provide continuous, regulated output power without using batteries during brown-out, surge, and

spike conditions.

4. Performance:

   a. Capacity: Load not to exceed [**75**]<**Insert number**> percent of UPS rated capacity.
   b. Efficiency: Complying with ENERGY STAR requirements; minimum [**91**]<**Insert number**> percent.
   c. Input Voltage: Single phase, 120 V ac, plus 20 to minus 30 percent.
   d. Power Factor: Minimum [**0.95**]<**Insert value**> at full load.
   e. Output Voltage: Single phase, 120 V ac, within [**2**][**3**] percent.
   f. Inverter overload capacity to be minimum [**150**]<**Insert number**> percent for 30 seconds.
   g. Battery Backup: [**Five**][**10**][**15**]<**Insert number**> minutes of operation at [**full**]<**Insert value**> load with battery power.
   h. Battery Recharge Time: Maximum of [**6**][**8**]<**Insert number**> hours to 90 percent capacity.
   i. Transfer Time: [**0**]<**Insert value**> ms.
   j. <**Insert additional performance requirement**>.

5. LCD display with operator interface.
6. Receptacles: Minimum [**6**]<**Insert number**>, NEMA WD 1, NEMA WD 6 Configuration 5-15R or 5-20R receptacles.
7. Automatic bypass operation during fault or overload conditions.
8. Remote Alarms: Include dry contacts (digital output points) [**or serial communication interface**]for low battery condition and battery-on (primary utility power failure)[**and connect points to DDC system**].
9. Batteries: Sealed; maintenance free.
10. Enclosures: Install tower models in enclosures rated for location.[**Install rack models installed on matching racks, as applicable to particular installation location and space availability/configuration.**]

2.33 PRESSURE INSTRUMENT SIGNAL AIR PIPING AND TUBING

A. Products in this article are intended for use with the following:

   1. Main air and signal air to pneumatically controlled instruments, actuators, and other control devices and accessories.
   2. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.

B. Copper Tubing:

   1. Seamless phosphor deoxidized copper, drawn tempered[**, or soft annealed**], with chemical and physical properties in accordance with ASTM B75/B75M.
   2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
   3. Diameter, as required by application, not less than nominal [**1/4 inch**][**3/8 inch**]<**Insert size**>.
   4. Wall thickness, as required by application, but not less than **0.030 inch**.
   5. Copper Tubing Connectors and Fittings - Brass, Compression Type:

      a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

         1) [**BrassCraft Manufacturing Co.; a Masco company**]
         2) [**DK-LOK USA**]
         3) [**Mid-America Fittings, LLC; A Midland Industries Company**]

4) [**Parker (Parker Hannifin)**]
5) **<Insert manufacturer's name>**

b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.

6. Copper Tubing Connectors and Fittings - Copper, Solder-Joint Type:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) [**Paul Mueller Company**]
4) **<Insert manufacturer's name>**

b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.

C. Galvanized-Steel Piping (for Pneumatic/Pressure Instrument Signal Air):

1. Pipe: ASTM A53/A53M, Schedule 40.
2. Fittings: Galvanized malleable iron, ASME B16.3, Class 150.

D. Polyethylene Tubing: ([**For Pneumatic/**]Pressure Instrument Signal Air).

1. Fire-resistant, black virgin polyethylene in accordance with ASTM D1248, Type 1, Class C, and Grade 5.
2. Complying with stress crack test in accordance with ASTM D1693.
3. Diameter, as required by application, of not less than nominal **1/4 inch**.
4. Polyethylene Tubing Connectors and Fittings - Brass, Barb Fittings:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**BrassCraft Manufacturing Co.; a Masco company**]
2) [**DK-LOK USA**]
3) [**Mid-America Fittings, LLC; A Midland Industries Company**]
4) [**Parker (Parker Hannifin)**]
5) **<Insert manufacturer's name>**

b. Tapered and beaded hose barbs of push-on design; intended for low-pressure applications only.

5. Polyethylene Tubing Connectors and Fittings - Brass, Compression Type:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**BrassCraft Manufacturing Co.; a Masco company**]
2) [**DK-LOK USA**]

3) [**Mid-America Fittings, LLC; A Midland Industries Company**]
4) [**Parker (Parker Hannifin)**]
5) **<Insert manufacturer's name>**

b. Specially designed for jointing polyethylene tubing to provide leak-free seal without twisting or weakening polyethylene tubing.

2.34 PROCESS TUBING

A. Products in this article are intended for signals to instruments connected to liquid and steam systems.

B. Copper Tubing:

1. Seamless phosphor deoxidized copper, drawn tempered with chemical and physical properties in accordance with ASTM B75/B75M.
2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
3. Diameter, as required by application, of not less than nominal [**3/8 inch**][**1/2 inch**]**<Insert size>**.
4. Wall thickness, as required by application, but not less than **0.030 inch**.
5. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Compression Type:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**BrassCraft Manufacturing Co.; a Masco company**]
2) [**DK-LOK USA**]
3) [**Mid-America Fittings, LLC; A Midland Industries Company**]
4) [**Parker (Parker Hannifin)**]
5) **<Insert manufacturer's name>**

b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.

6. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Solder-Joint Type:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
2) [**NIBCO INC.**]
3) **<Insert manufacturer's name>**

b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.

C. Stainless Steel Tubing (for Process Tubing):

1. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, and free from scale.
2. Chemical and physical properties in accordance with ASTM A269/A269M.
3. Diameter, as required by application, of not less than nominal [**3/8 inch**][**1/2 inch**]**<Insert size>**.
4. Wall thickness, as required by application, but not less than **0.035 inch**.

5. Furnish stainless steel tubing in [**20 ft.**] straight random lengths.

D. Stainless Steel Tubing Connectors and Fittings (for Process Tubing) - Stainless Steel, Compression Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DK-LOK USA**]
   b. [**Parker (Parker Hannifin)**]
   c. [**Sizto Tech Corporation (STC)**]
   d. <**Insert manufacturer's name**>

2. Connectors and fittings constructed from Type 316 stainless steel, with collets, flareless type.
3. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.
4. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

2.35 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum [**18**][**16**][**14**]<**Insert value**> AWG.
2. Conductors: 7/24 soft annealed copper strand with **2- to 2.5-inch** lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum [**18**][**20**][**22**]<**Insert value**> AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a **2- to 2.5-inch** lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:

   a. Twisted Pair: Black and white.
   b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum [**18**][**20**][**22**]<**Insert value**> AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a **2- to 2.5-inch** lay.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:

   a. Twisted Pair: Black and white.

b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Comply with following requirements for balanced twisted pair cable described in [**Section 260523 "Control-Voltage Electrical Power Cables."**][**Section 271513 "Communications Copper Horizontal Cabling."**]

a. Plenum rated.
b. Unique color that is different from other cables used on Project.

2.36 RACEWAYS

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.37 OPTICAL FIBER CABLE AND CONNECTORS

A. Comply with requirements in Section 271323 "Communications Optical Fiber Backbone Cabling" for optical fiber backbone cabling and connectors.

B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber horizontal cabling and connectors.

2.38 ACCESSORIES

A. Pneumatic Pressure Gauges:

1. Face Size: **1.5-inch-** diameter face for pressures up through **30 psig** and **2.5-inch-** diameter face for greater pressures.
2. Face Markings: White dial face with black printing; **1 psig** increment for scale ranges through **30 psig** and **2 psig** increment for larger ranges.
3. Accuracy: Within [**0.5**][**1**]<**Insert number**> percent of full-scale range.
4. Applications: Include separate gauges for branch pressure and main pressure tubing.

B. Pressure Electric Switches:

1. Description: Diaphragm-operated, snap-acting switch.
2. Performance:

a. Rating: Resistance loads at [**120**]<**Insert value**> V ac.
b. Set Point: Adjustable from [**3 to 20 psig**]<**Insert pressure range**>.

c. Differential: Adjustable from [**2 to 6 psig**]<**Insert pressure range**>.

3. Body and Switch Housing: Metal.

C. Control Damper Blade Limit Switches:

1. Application: Sense positive open and/or closed position of damper blades.
2. NEMA 250, [**Type 13**]<**Insert type**>, oiltight construction. Install in instrument enclosure where required for additional environmental protection.
3. Arrange for mounting application, and to prevent "over-center" operation.

D. I/P and E/P Transducers:

1. Commercial Grade:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ControlAir, Inc.**]
2) [**Dwyer Instruments, Inc**]
3) [**KMC Controls, Inc.**]
4) [**MAMAC Systems, Inc.**]
5) <**Insert manufacturer's name**>

b. Description: Transducer converting an electronic current (I) or voltage (E) AO signal to a proportional [**or stepped**]pneumatic signal. Unless otherwise required by operating sequence, use **3 to 15 psig** pneumatic signal for pneumatic actuation.

c. Features:

1) Auto/manual output switch, manual output control, and output pressure gauge.
2) Separate zero and span calibration adjustments.

d. Performance:

1) Accuracy: Within [**1.0**]<**Insert number**> percent of output span.
2) Linearity: Within [**0.5**][**1.0**]<**Insert number**> percent of output span.
3) Output Capacity: Not less than [**550 scim**]<**Insert value**> at **15 psig**.
4) Maximum Pressure: [**30 psig**][**40 psig**]<**Insert value**> of supply pressure without damage.
5) Vibration: Construct entire assembly so that shock and vibration will not harm transducer or affect accuracy.

e. Applications:

1) Terminal Units: Fan-coil units, VAV units, unit heaters, and <**Insert equipment**>.
2) <**Insert applications**>.

2. Industrial Grade:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ControlAir, Inc.**]
2) [**Fischer; Emerson Electric Co., Automation Solutions**]
3) [**Marsh Bellofram**]
4) <**Insert manufacturer's name**>

b. Description: Transducer converting an electronic current (I) or voltage (E) AO signal to a proportional pneumatic signal (P). Unless otherwise required by operating sequence, use **3 to 15 psig** pneumatic signal for pneumatic actuation. Stepped pneumatic signal is unacceptable.

c. Features:

1) Adjustments: Separate zero and span calibration adjustments.
2) Conduit Connections: Nominal **1/2 inch**.
3) Enclosure: NEMA 250, [**Type 4X**]<**Insert type**>.
4) Pressure Gauge: Integral output pressure gauge.

d. Performance:

1) Accuracy: Within [**0.5**][**1.0**]<**Insert number**> percent of output span.
2) Hysteresis: Within [**0.5**]<**Insert number**> percent of output span.
3) Linearity: Within [**0.5**][**0.75**]<**Insert number**> percent of output span.
4) Repeatability: Within [**0.5**]<**Insert number**> percent of output span.
5) Output Capacity: Not less than [**5**]<**Insert value**> scfm at **15 psig**.
6) Air Consumption: Maximum of [**5**]<**Insert value**> scfh at **15 psig**.
7) Ambient Temperature: Suitable for operation in ambient temperature range of **minus 20 to 150 deg F**.
8) Pressure: Up to [**50 psig**]<**Insert value**> without damage.
9) Vibration: Construct entire assembly so shock and vibration will not harm transducer or affect accuracy.

e. Applications:

1) All applications, except for terminal units and other applications with commercial-grade transducers.
2) <**Insert applications**>.

E. E/P Switch:

1. Body: Cast aluminum or brass; three pipe body (common, normally open, and normally closed).
2. Internal Components: Brass, copper, steel, or stainless steel.
3. Connections: Barb, or threaded for mating to compression fittings.
4. Rating: **30 psig** when installed in systems below **25 psig**; **150 psig** when installed in systems above **25 psig**.
5. Features: Include coil transient suppression.

F. Instrument Enclosures:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hammond Mfg. Co. Inc**]
b. [**Hoffman; brand of nVent Electrical plc**]
c. [**Saginaw Control and Engineering**]

d. **<Insert manufacturer's name>**

2. Application: Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
3. Certification: NRTL listed and labeled to UL 50 or UL 508A as applicable.
4. Subpanel:

   a. Size enclosure with least 25 percent spare area on subpanel.
   b. Mount instrument(s) within enclosure on internal subpanel(s).

5. Identification: Include on face of enclosure an engraved, laminated phenolic nameplate for each instrument installed within enclosure.
6. Pneumatic Pressure Gauges: Include main pressure gauge and a branch pressure gauge for each pneumatic device installed inside enclosure.
7. Raceways: For enclosures housing multiple instruments, route tubing, cable, and wiring within enclosure in a raceway having continuous removable cover.
8. Access: Provide enclosures larger than [**12 inches**]**<Insert dimension>** with hinged full-size face cover.
9. Security: Equip enclosures with lock and common key.

G. Manual Valves:

1. Brass Needle Valves:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**BrassCraft Manufacturing Co.; a Masco company**]
      2) [**Parker (Parker Hannifin)**]
      3) **<Insert manufacturer's name>**

   b. Pressure Rating: **150 psig**.
   c. Temperature Rating: **250 deg F**.
   d. Body: Brass.
   e. Seat: Brass.
   f. Handle: Aluminum, brass, or stainless steel T-bar handle.
   g. Connections: Include tubing connections.
   h. Applications: Copper and polyethylene pneumatic tubing.

2. Stainless Steel Needle Valves:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**DK-LOK USA**]
      2) [**Parker (Parker Hannifin)**]
      3) [**Sizto Tech Corporation (STC)**]
      4) **<Insert manufacturer's name>**

   b. Pressure Rating: **5000 psig**.
   c. Temperature Rating: **450 deg F**.
   d. Body: Type 316 stainless steel.

e. Seat: Type 316 stainless steel.
f. Packing: [**PTFE**]<**Insert material**>.
g. Handle: Aluminum or stainless steel T-bar handle.
h. Connections: Include tubing connections.
i. Applications: Copper pneumatic tubing; copper and stainless steel process tubing.

3. Bronze Body Ball Valves:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
2) [**Milwaukee Valve Company**]
3) [**NIBCO INC.**]
4) <**Insert manufacturer's name**>

b. Standard: MSS SP-110.
c. SWP Rating: **150 psig**.
d. CWP Rating: **600 psig**.
e. Body Design: Two piece.
f. Body Material: Bronze.
g. Ends: Threaded.
h. Seats: PTFE.
i. Stem: Stainless steel.
j. Ball: Stainless steel, vented.
k. Handle: Stainless steel with vinyl grip.
l. Port: Full.

H. Retractable, Wall-Mounted Cabinet for Portable Workstations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AtlasIED**]
b. [**Lowell Manufacturing Co.**]
c. <**Insert manufacturer's name**>

2. Description: Surface-mounted or recessed wall cabinet for tilt-out operation of laptop computers and large-format mobile devices.
3. Cabinet Load Limit: [**50 lb**]<**Insert value**>.
4. Cabinet Material: Carbon steel.
5. Cabinet Finish: Powder-coat epoxy; manufacturer's standard color.
6. Features include the following:

a. Oil-filled dampers for controlled lowering of equipment to operational position.
b. 3RU EIA mounting rails.
c. Removable laptop shelf.
d. Separate top compartment with mounting area, hinged rail.
e. Front ventilation slots.
f. Security key lock access.
g. Knockouts for conduit connections on top and bottom of cabinet.

h. <**Insert additional features**>.

7. Field Coordination: Provide inside center of backbox with provision to mount a field-furnished and -installed, single-gang electrical outlet box.

2.39 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag bearing the following information:

a. Service (Example): "Instrument Air."
b. Pressure Range (Example): **0 to 30 psig**.

2. Letter size minimum of [**0.25 inch**]<**Insert dimension**> high.
3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded blue with contrasting white center exposed by engraving through outer layer.
4. Include tag with brass grommet, chain, and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. [**Self-adhesive label**][**Laminated acrylic or melamine plastic sign**] bearing unique identification.

a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size as follows:

a. Servers: Minimum of [**0.5 inch**]<**Insert dimension**> high.
b. DDC Controllers: Minimum of [**0.5 inch**]<**Insert dimension**> high.
c. Gateways: Minimum of [**0.5 inch**]<**Insert dimension**> high.
d. Repeaters: Minimum of [**0.5 inch**]<**Insert dimension**> high.
e. Enclosures: Minimum of [**0.5 inch**]<**Insert dimension**> high.
f. Electrical Power Devices: Minimum of [**0.25 inch**]<**Insert dimension**> high.
g. UPS units: Minimum of [**0.5 inch**]<**Insert dimension**> high.
h. Accessories: Minimum of [**0.25 inch**]<**Insert dimension**> high.
i. Instruments: Minimum of [**0.25 inch**]<**Insert dimension**> high.
j. Control Damper and Valve Actuators: Minimum of [**0.25 inch**]<**Insert dimension**> high.

3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
4. Fastened with drive pins.
5. Instruments, control devices, and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum [**1.5 inches**]<**Insert dimension**> in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following

requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "HVAC Controls"[**using engraved phenolic tag**].
3. For raceways housing pneumatic tubing, add phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least [**0.25 inch**]<**Insert dimension**>beyond white border.

2.40 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate the following in accordance with industry standards for each product, and to verify DDC system reliability specified in performance requirements:

1. DDC controllers.
2. Gateways.
3. Routers.
4. <**Insert product**>.

B. Product(s) [**and**][**material(s)**] will be considered defective if [**it does**][**they do**] not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.
2. Equipment to Be Connected:

a. Domestic water booster pumps specified in Section 221123.13 "Domestic-Water Packaged Booster Pumps."
b. Sewage pump stations specified in Section 221343 "Facility Packaged Sewage Pumping Stations."
c. Sump pumps specified in Section 221429 "Sump Pumps."
d. Air-compressors and air driers specified in Section 221519 "General-Service Packaged Air Compressors and Receivers" and Section 226119 "Compressed-Air Equipment for Laboratory and Healthcare Facilities."
e. Domestic water softeners specified in Section 223100 "Domestic Water Softeners."
f. Domestic water heaters specified in Section 223300 "Electric, Domestic-Water Heaters" and Section 223400 "Fuel-Fired, Domestic-Water Heaters."
g. Vacuum equipment specified in Section 226219 "Vacuum Equipment for Laboratory and Healthcare Facilities."
h. Processed water equipment specified in Section 226719 "Processed Water Equipment for Laboratory and Healthcare Facilities."
i. Air curtains specified in Section 233433.16 "Industrial Air Curtains."
j. Air-terminal units specified in Section 233600 "Air Terminal Units."
k. Kitchen hoods specified in Section 233813 "Commercial-Kitchen Hoods."
l. Boilers specified in Section 235213 "Electric Boilers."
m. Boilers specified in Section 235216 "Condensing Boilers."
n. Boilers specified in Section 235223 "Cast-Iron Boilers."
o. Boilers specified in Section 235233 "Water-Tube Boilers."
p. Boilers specified in Section 235239 "Fire-Tube Boilers."
q. Feedwater equipment specified in Section 235313 "Boiler Feedwater Pumps."
r. Deaerators specified in Section 235316 "Deaerators."
s. Chillers specified in Section 236413.13 "Direct-Fired Absorption Water Chillers."
t. Chillers specified in Section 236413.16 "Indirect-Fired Absorption Water Chillers."
u. Chillers specified in Section 236416 "Centrifugal Water Chillers."
v. Chillers specified in Section 236423.13 "Air-Cooled, Scroll Water Chillers."
w. Chillers specified in Section 236423.16 "Water-Cooled, Scroll Water Chillers."
x. Chillers specified in Section 236426.13 "Air-Cooled, Rotary-Screw Water Chillers."
y. Chillers specified in Section 236426.16 "Water-Cooled, Rotary-Screw Water Chillers."
z. Cooling towers specified in Section 236513.13 "Open-Circuit, Forced-Draft Cooling Towers."
aa. Cooling towers specified in Section 236513.16 "Closed-Circuit, Forced-Draft Cooling Towers."
bb. Cooling towers specified in Section 236514.13 "Open-Circuit, Induced-Draft, Counterflow Cooling Towers."
cc. Cooling towers specified in Section 236514.14 "Open-Circuit, Induced-Draft, Crossflow Cooling Towers."
dd. Cooling towers specified in Section 236514.16 "Closed-Circuit, Induced-Draft, Counterflow

Cooling Towers."

ee. Cooling towers specified in Section 236514.17 "Closed-Circuit, Induced-Draft, Combined-Flow Cooling Towers."

ff. Heat wheels specified in Section 237223.13 "Packaged Indoor Heat Wheel Energy Recovery Units" and Section 237223.23 "Packaged, Outdoor, Heat Wheel Energy Recovery Units."

gg. Heat exchangers specified in Section 237223.19 "Packaged Indoor Fixed Plate Energy Recovery Units" and Section 237223.29 "Packaged, Outdoor, Fixed Plate Energy Recovery Units"

hh. Air-handling units specified in Section 237313.13 "Indoor, Basic Air-Handling Units."

ii. Air-handling units specified in Section 237313.16 "Indoor, Semi-Custom Air-Handling Units."

jj. Air-handling units specified in Section 237313.19 "Indoor, Custom Air-Handling Units."

kk. Heating and ventilating units specified in Section 237333.16 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units."

ll. Heating and ventilating units specified in Section 237339 "Indoor, Direct-Fired Heating and Ventilating Units."

mm. Air-handling units specified in Section 237343.16 "Outdoor, Semi-Custom Air-Handling Units."

nn. Air-handling units specified in Section 237343.19 "Outdoor, Custom Air-Handling Units."

oo. Roof-top units specified in Section 237416.11 "Packaged, Small-Capacity, Rooftop Air-Conditioning Units."

pp. Roof-top units specified in Section 237416.13 "Packaged, Large-Capacity, Rooftop Air-Conditioning Units."

qq. Make-up air units specified in Section 237423.13 "Packaged, Direct-Fired, Outdoor, Heating-Only Makeup-Air Units."

rr. Make-up air units specified in Section 237423.16 "Packaged, Indirect-Fired, Outdoor, Heating-Only Makeup-Air Units."

ss. Dedicated outdoor-air units specified in Section 237433 "Dedicated Outdoor-Air Units."

tt. Packaged terminal air-conditioners specified in Section 238113.11 "Packaged Terminal Air-Conditioners, Through-Wall Units."

uu. Packaged terminal air-conditioners specified in Section 238113.12 "Packaged Terminal Air-Conditioners, Freestanding Units."

vv. Packaged terminal air-conditioners specified in Section 238113.13 "Packaged Terminal Air-Conditioners, Outdoor, Wall-Mounted Units."

ww. Computer-room air-conditioning units specified in Section 238123.11 "Small Capacity (6 Tons (21 kW) and Smaller), Computer-Room Air-Conditioners, Floor-Mounted Units."

xx. Computer-room air-conditioning units specified in Section 238123.12 "Large Capacity (7 Tons (25 kW) and Larger), Computer-Room Air-Conditioners, Floor-Mounted Units."

yy. Computer-room air-conditioning units specified in Section 238123.13 "Computer-Room Air Conditioners, Ceiling-Mounted Units."

zz. Computer-room air-conditioning units specified in Section 238123.14 "Computer-Room Air Conditioners, Console Units."

aaa. Computer-room, rack-mounted cooling equipment specified in Section 238123.18 "Computer-Room, Rack-Cooling Equipment."

bbb. Variable refrigerant flow units specified in Section 238129 "Variable-Refrigerant-Flow HVAC Systems."

ccc. Fan-coil units specified in Section 238219 "Fan Coil Units."

ddd. Unit ventilators specified in Section 238223 "Unit Ventilators."

eee. Wetted-element humidifiers specified in Section 238413.16 "Wetted-Element Humidifiers."

fff. Atomizing humidifiers specified in Section 238413.19 "Atomizing Humidifiers."

ggg. Direct-steam-injection humidifiers specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."

hhh. Self-contained steam humidifiers specified in Section 238413.29 "Self-Contained Steam Humidifiers."

iii. Heat exchanger humidifiers specified in Section 238413.36 "Heat Exchanger Humidifiers."
jjj. Dehumidification units specified in Section 238416.13 "Outdoor, Mechanical Dehumidification Units" and in Section 238416.16 "Indoor, Mechanical Dehumidification Units."
kkk. Switchboards specified in Section 262300 "Low-Voltage Switchgear."
lll. Motor-control centers specified in Section 262419 "Motor-Control Centers."
mmm. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."
nnn. Diesel emergency engine generators specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."
ooo. Gaseous emergency engine generators specified in Section 263213.16 "Gas-Engine-Driven Generator Sets."
ppp. Bi-fuel emergency engine generators specified in Section 263213.19 "Bi-Fuel-Engine-Driven Generator Sets."
qqq. UPS specified in Section 263353 "Static Uninterruptible Power Supply."
rrr. Refrigerant monitoring specified in Section 284400 "Refrigerant Detection and Alarm."
sss. <**Insert equipment and Section number and title**>.

B. Communication Interface to Other Building Systems:

1. DDC system communicates with systems having communication interface.
2. Systems to Be Connected:

a. Elevators specified in Section 142100 "Electric Traction Elevators."
b. Elevators specified in Section 142113 "Electric Traction Freight Elevators."
c. Elevators specified in Section 142400 "Hydraulic Elevators."
d. Elevators specified in Section 142413 "Hydraulic Freight Elevators."
e. Escalators specified in Section 143100 "Escalators."
f. Automated water treatment systems specified in Section 232500 "HVAC Water Treatment."
g. Automated water treatment systems specified in Section 232516 "Water Treatment for Open-Loop Hydronic Systems."
h. Automated water treatment systems specified in Section 232519 "Water Treatment for Steam System Feedwater."
i. Power monitoring specified in Section 260913 "Electrical Power Monitoring."
j. Lighting controls specified in Section 260936 "Modular Dimming Controls."
k. Lighting controls specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
l. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
m. Fire-alarm system specified in Section 284600 "Fire Detection and Alarm."
n. Fire-alarm system specified in Section 284614 "Single- and Multiple-Station Alarms."
o. Access controls specified in Section 281300 "Access Control System Software and Database Management."
p. Intrusion detection specified in Section 283100 "Intrusion Detection."
q. Perimeter security specified in Section 283121 "Area and Perimeter Intrusion Detection."
r. <**Insert system and Section number and title**>.

3.3 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.
2. Load software and demonstrate functional compliance with each control sequence of operation indicated.

3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:

    a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
    b. Equipment faults and system recovery with fault annunciation.
    c. Analog and Boolean value alarming and annunciation.

4. Develop a method for testing interfaces before deployment.
5. Submit documentation supporting compliance upon request.

3.4 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. Interface DDC systems with existing systems to achieve integration indicated.
2. Monitoring and Control of DDC System by Existing Control System:

    a. Satisfy DDC system performance requirements when monitoring and controlling DDC system by existing control system.
    b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in DDC system from existing control system using existing control system software and operator workstations.
    c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
    d. Make interface of DDC system into existing control system transparent to operators of existing control system and allow operators to [**program, monitor, and control**][**monitor and control**] DDC system from any operator workstation connected to existing control system.
    e. <**Insert requirements**>.

3. Integration of Existing Control System into DDC System:

    a. Satisfy existing control system performance requirements when monitoring and controlling existing control system through DDC system.
    b. Operator to upload, download, monitor, alarm, report, trend, control, and program every I/O point in existing system from DDC system using operator workstations and software provided. Combined systems to share one database.
    c. Make interface of existing control system I/O points into DDC system transparent to operators. Make all operational capabilities identical regardless of whether I/O already exists, or I/O is being installed.
    d. <**Insert requirements**>.

B. Integration with Existing Enterprise System:

1. Interface DDC system with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
2. Owner's control system integrator to provide the following services:

    a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
    b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.

c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

3. Engage Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

4. Control System Integrator Contact Information:

a. Company: <**Insert name**>.
b. Company Street Address: <**Insert address**>.
c. Company Contact: <**Insert name**>.
d. Phone Number: <**Insert phone number**>.
e. Email Address: <**Insert email address**>.

5. Attend meetings with control system integrator to integrate DDC system.

3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control dampers, which are specified in Section 230923.12 "Control Dampers."
2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."
4. <**Insert additional control devices**>.

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches, and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments."
4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
5. Liquid[**and steam**] temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
6. Pipe- and tank-mounted thermowells. Liquid[**and steam**] thermowells are specified in Section 230923.27 "Temperature Instruments."
7. <**Insert additional control devices**>.

3.6 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer[**and supervise installation for compliance with requirements**].

1. [**Programmable application**][**or**][**application-specific**] controller.
2. Unit-mounted DDC control dampers and actuators, which are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted airflow sensors, switches, and transmitters, which are specified in Section 230923.14 "Flow Instruments."
4. Unit-mounted gas sensors, and transmitters, which are specified in Section 230923.16 "Gas Instruments."
5. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
6. Unit-mounted pressure sensors, switches, and transmitters, which are specified in Section 230923.23 "Pressure Instruments."
7. Unit-mounted speed sensors, switches, and transmitters, which are specified in Section 230923.24 "Speed Instruments."
8. Unit-mounted temperature sensors, switches, and transmitters. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
9. Relays.
10. <**Insert additional control devices**>.

B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. [**Programmable application**][**or**][**application-specific**] controller.
2. Electric damper actuator. Damper actuators are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted flow and pressure sensors, transmitters, and transducers. Flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Relays.
6. <**Insert additional control devices**>.

C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.

1. [**Programmable application**][**or**][**application-specific**] controller.
2. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
3. Flow and pressure switches. Air and liquid flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
5. Relays.
6. <**Insert control devices**>.

3.7 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to <**Insert value**> force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

   a. Laboratory exhaust-air streams.
   b. Process exhaust-air streams.
   c. <**Insert conditions**>.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant

from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.8 INSTALLATION OF WORKSTATIONS

A. Desktop Workstation Installation:

1. Install [**Owner-furnished**]workstation(s) at location(s) indicated on Drawings.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex, electrical power receptacle.
3. Install DDC system software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power [**each**]workstation through a [**dedicated**]UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstation Installation:

1. Install DDC system software on [**Owner-furnished**]workstation(s) and verify that software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated on Drawings as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's[**and Architect's**] review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Make final editing on-site with Owner's[**and Architect's**] review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

D. Retractable, Wall-Mounted Cabinet for Portable Operator's Workstation Installation:

1. Install retractable, wall-mounted portable operator's workstation cabinet(s) at location(s) indicated on Drawings.
2. Install retractable, wall-mounted portable operator's workstation cabinet(s) at following location(s) and at additional locations indicated on Drawings:

    a. Each mechanical room.
    b. Chiller room.
    c. Boiler room.
    d. <**Insert location**>.

3. Connect each cabinet to [**120 V, single-phase, 60 Hz**]<**Insert power requirements**> field power source and install single gang electrical box with [**NEMA WD 6, Type 20R duplex**]<**Insert receptacle type**> receptacle and metal cover plate in cabinet. Comply with requirements in Section 262726 "Wiring Devices."
4. Connect each cabinet to Ethernet network and install an Ethernet network port for connection to portable operator workstation Ethernet cable. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

3.9 INSTALLATION OF POT

A. Install [**one**][**two**]<**Insert quantity**> POT(s).

B. Turn over POTs to Owner at Substantial Completion.

C. Install software on each POT and verify that software functions properly.

3.10 INSTALLATION OF SERVERS

A. Install server(s) at location(s) indicated on Drawings.

B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed server location in Shop Drawings.

C. Install software indicated on server(s) and verify that software functions properly.

D. Develop Project-specific graphics, trends, reports, logs, and historical database.

E. Power servers through [**dedicated**]UPS unit. Locate UPS adjacent to server. Install rack-mounted UPS units for powering rack-mounted servers and tower UPS units for tower servers.

3.11 INSTALLATION OF PRINTERS

A. Install [**Owner-furnished**]printers at location(s) indicated on Drawings.

B. Install applicable printer software on [**Owner-furnished**]workstations and verify that software functions properly.

3.12 INSTALLATION OF GATEWAYS

A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.

a. <**Insert requirements**>.

B. Test gateways to verify that communication interface functions properly.

3.13 INSTALLATION OF ROUTERS

A. Install routers if required for DDC system communication interface requirements indicated.

1. Install router(s) required to suit indicated requirements.

a. <**Insert requirements**>.

B. Test routers to verify that communication interface functions properly.

3.14 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply[**and to UPS units where indicated**].

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated.[**Provide minimum quantity indicated.**]
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within [**72 inches**][**84 inches**]<**Insert dimension**> of finished floor.

F. Installation of Programmable Application Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated.[**Provide minimum quantity indicated.**]
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within [**72 inches**][**84 inches**]<**Insert dimension**> of finished floor, except where dedicated controllers are installed at terminal units.

G. Application-Specific Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers to satisfy requirements indicated.[**Provide minimum quantity indicated.**]
2. For controllers not mounted directly on equipment being controlled, install controllers in a [**protected**]location that is easily accessible by operators.

3.15 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Install wireless routers to achieve optimum performance and best possible coverage.

B. Mount wireless routers in a protected location that is within [**60 inches**]<**Insert requirement**> of floor and easily accessible by operators.

C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.

D. Install wireless router with latest version of applicable software and configure wireless router with security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.

E. Test and adjust wireless routers for proper operation with all types (such as, laptops, smartphones, and tablets) of wireless devices intended for use by operators.

3.16 INSTALLATION OF ENCLOSURES

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators.
10. <**Insert devices**>.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250 Enclosures: [**Type 1**]<**Insert type**>; use [**painted steel**][**galvanized-steel**][**corrosion-resistant-coated steel**] strut and hardware.
2. For NEMA 250 Enclosures and Enclosures Located Outdoors: [**Type 4**][**Type 4X**]<**Insert type**>; use stainless steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align [**top**][**or**][**bottom**] of adjacent enclosures[**of like size**].

D. Install floor-mounted enclosures located [**in mechanical equipment rooms**]on concrete housekeeping pads. Attach enclosure legs using [**galvanized-steel**][**or**][**stainless steel**] anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.17 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for electrical power raceways and boxes.

3.18 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section

260553 "Identification for Electrical Systems" for identification products and installation.

B. Install [**self-adhesive labels**][**laminated acrylic or melamine plastic signs**] with unique identification on face for each of the following:

1. Server.
2. Gateway.
3. Router.
4. Protocol analyzer.
5. DDC controller.
6. Enclosure.
7. Electrical power device.
8. UPS unit.
9. Accessory.

C. Install unique instrument identification for each instrument connected to DDC controller.

D. Install unique identification for each control [**damper**][**and**][**valve**] actuator connected to DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

1. Permanently attach to equipment that can be automatically started by DDC control system.
2. Locate where highly visible near power service entry points.

3.19 INSTALLATION OF NETWORKS

A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus, or when distance between devices exceeds <**Insert distance**>:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. <**Insert network device**>.

B. Install balanced twisted pair [**or optical fiber**]cable when connecting between the following network devices[**located in same building**]:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. <**Insert network device**>.

C. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:

1. Gateways.
2. Gateways and network controllers or programmable application controllers.

3. Routers.
4. Routers and network controllers or programmable application controllers.
5. Network controllers and programmable application controllers.
6. Programmable application controllers.
7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.
9. <**Insert network device**>.

D. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.20 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

a. Assign and document a MAC address unique to its network for every network device.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. MS/TP Networks: Assign from 00 to 64.

2. Network Numbering:

a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.
c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN is to support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field to support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

1) Example 1: Device object name for device controlling heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."

5. Object Name Property Text for Other Than Device Objects:

a. Object name property field is to support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.

1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

a. Assign object identifier property numbers according to [**Drawings**][**or**][**tables**] indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented, and be unique for like object types within device.

3.21 INSTALLATION OF AIR SIGNAL PIPING AND TUBING

A. Above-Grade Air Signal Piping and Tubing Installation:

1. Material Application:

a. Install copper tubing, except as follows:

1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when [**concealed behind accessible ceilings**][**and**][**concealed in walls and connecting wall-mounted instruments with recessed connections**].

b. Install copper tubing for sizes up through [**NTS 1**]<**Insert size**> and install galvanized-steel pipe for larger sizes, except as follows:

1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing where exposed to view.
2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when [**concealed behind accessible ceilings**][**and**][**concealed in walls and connecting wall-mounted instruments with recessed connections**].

c. Pneumatic Tubing: Install copper tubing[**, unless other accessible materials are indicated,**] for pneumatic main and control signals to instruments including, but not limited to, the following:

1) Pneumatic actuators.
2) I/P transducers.
3) Sensors.
4) Switches.
5) Transmitters.
6) <**Insert instrument**>.

d. Install copper tubing[**, unless other accessible materials are indicated,**] for air signals to instruments including, but not limited to, the following:

1) Sensors.
2) Switches.
3) Transmitters.
4) <**Insert instrument**>.

e. Install drawn-temper copper tubing, except within **36 inches** of device terminations tubing is to be annealed-tempered copper tubing.

f. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
g. Install [**barbed**][**or**][**compression**] fittings to connect polyethylene tubing to instruments, control devices, and accessories.

2. Routing:

a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling, or behind architectural enclosures or covers.
c. Install piping and tubing plumb and parallel to and at right angles with building construction.
d. Install multiple runs of tubing or piping in equally spaced parallel lines.
e. Install piping and tubing not to interfere with access to valves, equipment, duct, and equipment access doors, or obstruct personnel access and passageways of any kind.
f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit, and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on Record Drawings.
g. Install vibration loops in copper tubing when connecting to instruments and actuators that vibrate.

3. Support:

a. Space supports in accordance with MSS SP-58, except support spacing not to exceed **60 inches**.
b. Support copper tubing with copper hangers, clips, and tube trays.
c. Do not use tape for support or dielectric isolation.
d. Install supports at each change in direction and at each branch take-off.
e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
h. Brace supports to prevent lateral movement.
i. Paint steel support members that are not galvanized or zinc coated.
j. Support polyethylene tubing same as copper tubing.

4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Protect exposed tubing in mechanical equipment rooms [**and similar utility spaces**]from mechanical damage within [**76 inches**][**84 inches**][**96 inches**]<**Insert dimension**> above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
6. Joining and Makeup:

a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
b. Install dirt leg with an isolation valve and threaded plug at each main air, connection to panel, pneumatic pilot positioner, and PRV station.
c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on the other end.
d. Make tubing bends with tube-bending tool. Hard-bends or wrinkled or flattened bends are unacceptable.

e. Install tube fittings in accordance with manufacturer's written instructions.
f. Do not make tubing connections to a fitting before completing makeup of the connection.
g. Align tubing with fitting. Avoid springing tube into position; this may result in excessive stress on both tubing and fitting with possible resulting leaks.
h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for proper connection.
i. Check tubing for correct diameter and wall thickness.
j. Cut tube ends square and deburr. Exercise care during cutting to keep tubing round.
k. Thread pipe on a threading machine. Ream inner edges of pipe ends, and file and grind to remove burrs.
l. Wrap pipe threads with single wrap of PTFE tape.
m. Protect piping and tubing from entrance of foreign matter.

7. Do not exceed 50 percent fill capacity where tubing is installed in conduit. Support conduit in accordance with NFPA 70 unless otherwise indicated.

B. Below-Grade Air Signal Piping and Tubing Installation:

1. Install tubing below-grade in a continuous Schedule 80, PVC conduit.
2. Do not exceed 50 percent fill capacity; minimum size [**2 inches**][**4 inches**]<**Insert size**>.
3. Install top of conduit at depth of at least [**24 inches**][**36 inches**]<**Insert distance**> below finished grade.
4. Install tubing in raceways dedicated to only tubing. Do not combine electrical conductors and tubing in raceways.

C. Identify above-grade piping and tubing as follows:

1. Every **50 ft.** of straight run.
2. At least once for each branch within **36 inches** of main tee.
3. At each change in direction.
4. Within **36 inches** of each ceiling, floor, roof, and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. At each valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.

D. Valve Installation for Pneumatic Tubing:

1. Install valves full size of piping and tubing.
2. Install at the following locations:

a. At each branch.
b. Before and after each PRV.
c. Before and after each air dryer.
d. At each control device.

3. Locate valves to be readily accessible from floor.
4. Install needle valves for isolation and throttling applications.[**Option to install ball valves in lieu of needle valves for isolation only applications.**]

3.22 INSTALLATION OF PROCESS TUBING

A. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are

not limited to, the following:

1. Meters.
2. Sensors.
3. Switches.
4. Transmitters.

B. Support tubing in accordance with MSS SP-58, but at intervals no more than **60 inches** apart.

C. Install minimum **NPS 1/2** process tubing for industrial-grade sensors, transmitters, and switches. Install bushings where required.

D. Make smooth tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.

E. Support tubing independent of other trades.

F. Route tubing parallel to and at right angles to building construction.

G. Install tubing concealed in areas with ceilings.

H. Install dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.

I. Insulate process piping and tubing connected to hot water and steam systems for personnel protection if surface temperature exceeds **120 deg F**. Only insulate piping and tubing within maintenance personnel reach from floor, platform, or catwalk.

J. Wrap pipe threads of fitting in process tubing with service temperatures below **350 deg F** with single wrap of PTFE tape.

K. Coat pipe threads of fittings on process tubing in services with temperatures exceeding **350 deg F** with pipe compound before being made up to reduce possibility of galling.

L. Do not make tubing connections to a fitting before completing makeup of connection.

M. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.

N. Do not install fittings close to a bend. Straight length of tubing, not deformed by bending, is required for proper connection.

O. Align tubing with fitting when installed. Avoid springing tube into position.

P. Install tubing with extreme care to keep foreign matter out of system. Plug open tubing ends to keep out dust, dirt, and moisture.

Q. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.

R. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within [**76 inches**][**84 inches**][**96 inches**]<**Insert dimension**> above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.

S. Below-Grade Process Tubing Installation:

1. Install tubing below-grade in a continuous Schedule 80, PVC conduit.
2. Do not exceed 50 percent fill capacity; minimum size [**2 inches**][**4 inches**]<**Insert size**>.
3. Install top of conduit at depth of at least [**24 inches**][**36 inches**]<**Insert distance**> below finished grade.
4. Install tubing in raceways dedicated to only process tubing. Do not combine electrical conductors and tubing in raceways.

T. Identify above-grade process tubing as follows:

1. Every **50 ft.** of straight run.
2. At least once for each branch within **36 inches** of main tee.
3. Near each change in direction.
4. Within **36 inches** of each ceiling, floor, roof, and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. Near each isolation valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.

U. Process Tubing Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:

   a. Process connection.
   b. Inlet to each instrument including, sensors, transmitters, switches, gauges, and other control devices.

3. Locate valves to be readily accessible from floor.
4. Install needle valves for isolation and throttling applications.[**Option to install ball valves in lieu of needle valves for isolation only applications.**]

3.23 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

   a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

   a. Clamp cable over jacket in a junction box.

b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.24 INSTALLATION OF OPTICAL FIBER CABLE SYSTEMS

A. Comply with installation requirements in Section 271323 "Communications Optical Fiber Backbone Cabling."

B. Comply with installation requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

3.25 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Testing of Air-Signal Tubing:

1. Test for leaks and obstructions.
2. Disconnect each pipe and tubing line before test is performed, and blowout dust, dirt, trash, condensate, and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Use of compressed air from oil-free compressor with air dryer is an acceptable alternative for test.
3. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
4. Connect pressure source to near end of tubing run with needle valve between air supply and tubing run.
5. Connect pressure gauge accurate to within 0.5 percent of test between shutoff needle valve and

tubing run under test.

6. For air signal tubing, apply test pressure of [**1.5**][**2.0**]<**Insert value**> times instrument operating pressure range. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period to not exceed [**0.1**]<**Insert number**> percent of test pressure.
7. For pneumatic system pressures above **30 psig**, apply pressure of [**1.1**][**1.5**]<**Insert value**> times operating pressure to tubing run. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period to not exceed [**1 psig**]<**Insert value**>.
8. For pneumatic system pressures **30 psig** and below, apply pressure of [**1.5**][**2.0**]<**Insert value**> times operating pressure to tubing run. Record pressure in tubing run every five minutes for one hour. Allowable drop in pressure in one-hour period to not exceed [**0.5 psig**]<**Insert value**>.

E. Optical Fiber Cable Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. At a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Perform testing according to test plan supplied by DDC system manufacturer. Correct defective Work or material and retest. At a minimum, final testing for cable system, including spare cable, to verify compliance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use optical fiber time-domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.26 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment are secure.

6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that valve ball, disc, or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:

   a. Sensing element type and proper material.
   b. Length and insertion.

3.27 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than [**30**]<**Insert number**> seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than [**30**]<**Insert number**> seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.28 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.29 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

   a. Upper quarter of range.
   b. Lower quarter of range.
   c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.30 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After [**review**][**approval**] of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting, and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power[**and loss of signal**].
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power[**and loss of signal**].
18. Meter, sensor, and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
26. Record Drawings are completed.
27. <**Insert additional requirements**>.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of DDC system and sequences of operation in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
6. Submit Test Plan documentation [**10**][**20**]<**Insert number**> business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. 24 hours after initial validation test, do as follows:

    a. Re-check I/O points that required corrections during initial test.
    b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. 24 Hours after second validation test, do as follows:

    a. Re-check I/O points that required corrections during second test.
    b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

    a. Heavy load to be occurrence of [**50**]<**Insert number**> percent of total connected binary COV, one-half of which represents "alarm" condition, and [**50**]<**Insert number**> percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:

    a. Reaction to COV and alarm conditions during HLC.
    b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

    a. Alarm reporting at printer beginning no more than [**two**]<**Insert number**> seconds after initiation (time zero) of HLC.
    b. All alarms, both binary and analog, are reported and printed; none are lost.
    c. Compliance with response times specified.

6. Prepare and submit report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.

3.31 VERIFICATION OF DDC SYSTEM WIRELESS NETWORK

A. DDC system Installer is to design wireless DDC system networks to comply with performance requirements indicated.

B. Verify wireless network performance through field testing and document results in a field test report.

C. Testing and verification of all wireless devices to include, but not be limited to, the following:

1. Speed.
2. Online status.
3. Signal strength.

3.32 FINAL REVIEW

A. Submit written request to Architect [**Owner**][**Commissioning Agent**][**and**][**Construction Manager**] when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.
5. <**Insert additional requirements**>.

B. Upon receipt of written request for final review, [**Architect**][**Owner**][**Commissioning Agent**][**and**][**Construction Manager**] to start review within [**xx business days**][**reasonable period**] and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Compensation for Subsequent Reviews: Should more than [**two**]<**Insert number**> reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.

E. Prepare and submit closeout submittals[**and begin procedures indicated in "Extended Operation Test" Article**] when no deficiencies are reported.

F. Part of DDC system final review to include demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration to include, but not be limited to, the following:

a. Accuracy and calibration of [**10**][**20**]<**Insert number**> I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers

until total I/O points being reviewed that satisfy requirements equals quantity indicated.

b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to [**10**][**20**]<**Insert number**> I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.

c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.

d. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.

e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.

f. Trends, summaries, logs, and reports set up for Project.

g. For up to [**three**]<**Insert number**> HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.

h. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.

i. Software's ability to edit control programs offline.

j. Data entry to show Project-specific customizing capability including parameter changes.

k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.

l. Execution of digital and analog commands in graphic mode.

m. Spreadsheet and curve plot software and its integration with database.

n. Online user guide and help functions.

o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.

p. System speed of response compared to requirements indicated.

q. For Each Controller: Applies to [**network**][**and**][**programmable application**] controllers.

1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
4) Electric Power: Ability to disconnect any controller safely from its power source.
5) Wiring Labels: Match control drawings.
6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.[**Use ASHRAE 135 protocol analyzer to help identify devices, view**

network traffic, and verify interoperability.] Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.[**Modifications are made with messages and write services initiated by operator using workstation graphics, or by completing a field in menu with instructional text.**]
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

    a) Display of network device status.
    b) Display of BACnet object information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

t. <**Insert additional requirements**>.

3.33 EXTENDED OPERATION TEST

A. Operate DDC system for operating period of [**14**][**21**][**28**]<**Insert number**> consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.

B. Provide operator familiar with DDC system installed to man an operator workstation [**while on-site**]during eight hours of each normal business day occurring during operating period.

C. During operating period, DDC system to demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.

1. Correct defects of hardware and software when they occur.

D. Definition of Failures and Downtime during Operating Period:

1. Failed I/O point constituting downtime is I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
2. Downtime is when any I/O point in DDC system is unable to fulfill its required function.
3. Calculate downtime as elapsed time between detected point failure as confirmed by operator, and time point is restored to service.
4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation is to be 0.5 hours.
5. Log downtime in hours to nearest 0.1 hour.
6. Power outages do not count as downtime, but do suspend test hours unless systems are provided with UPS and served through a backup power source.
7. Hardware or software failures caused by power outages do count as downtime.

E. During operating period, log downtime and operational problems are encountered.

1. Identify source of problem.
2. Provide written description of corrective action taken.
3. Record duration of downtime.
4. Maintain log showing the following:

a. Time of occurrence.
b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
c. Downtime for each failed I/O point.
d. Running total of downtime and total time of I/O point after each problem has been restored.

5. Make log available to Owner for review at any time.

F. For DDC system to pass extended operation test, total downtime is limited to [**1**][**2**]<**Insert number**> percent of total point-hours during operating period.

1. If DDC system testing results fail to comply with minimum requirements of passing at end of operating period indicated, extend operating period one consecutive day at a time until DDC system passes requirement.

G. Base evaluation of DDC system passing test on the following calculation:

1. Count downtime on point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
2. One point-hour of downtime is one I/O point down for one hour. For example, three I/O points down for five hours is total of 15 point-hours of downtime. Four points down for one-half hour is two point-hours of downtime.
3. Example Calculation: Maximum allowable downtime for 30-day test for DDC system with 1000 total I/O points (combined analog and binary) and passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.

H. Prepare test and inspection reports.

3.34 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.35 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**]<**Insert number**> months' full maintenance by DDC system manufacturer's authorized service representative. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.36 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for [**one**][**two**]<**Insert number**> year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**one**][**two**]<**Insert number**> year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

1. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.37 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

a. Provide not less than [**five**][**10**][**15**]<**Insert number**> days of training total.
b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
c. Break down total days of training into not more than [**two**][**three**][**four**]<**Insert number**> separate training classes.
d. Schedule training so each training class is not less than [**one**][**two**][**three**]<**Insert number**> consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner [**20**]<**Insert number**> business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least [**10**][**15**][**20**]<**Insert number**> business days of notice in advance of training.
3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to

be split in half with [**15**][**30**]<**Insert number**>-minute break between sessions. Morning and afternoon sessions to be separated by [**30**][**60**]<**Insert number**>-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed [**eight**]<**Insert number**> hours per day.

4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session.[**Indicate which attendees, if any, joined for only part of training sessions**].

E. Training Attendee Headcount:

1. Plan in advance of training for [**two**][**three**][**five**]<**Insert number**> attendees.
2. Make allowance for Owner to add up to [**one**][**two**]<**Insert number**> attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. [**High school**][**High school and technical school**][**High school and four-year college**]<**Insert level**> education and degree.
2. [**Basic**][**Intermediate**][**Advanced**] user knowledge of computers and office applications.
3. [**Basic**][**Intermediate**][**Advanced**] knowledge of HVAC systems.
4. [**Basic**][**Intermediate**][**Advanced**] knowledge of DDC systems.
5. [**Basic**][**Intermediate**][**Advanced**] knowledge of DDC system and products installed.

G. Attendee Training Manuals:

1. Provide each attendee with color hard copy of all training materials and visual presentations.
2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Use instructors who have provided not less than [**five**]<**Insert number**> years of instructional training on not less than [**five**]<**Insert number**> past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions to ensure DDC system security.

J. Training Outline:

1. Submit training outline for Owner review at least [**10**]<**Insert number**> business day before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session, and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Use operator workstation that is to be used with DDC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide operator workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.

13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:

    a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
    g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
    h. <**Insert requirement**>.

N. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs offline.
7. Creating, deleting, and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices,

and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing DDC system components.
16. <**Insert requirement**>.

O. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.
9. <**Insert requirement**>.

P. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with [**two**]<**Insert number**> copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 23 09 23 00

SECTION 23 09 23 00A - LEAK DETECTION INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Leak-detection switches.
2. Multi-zone leak-detection monitoring controllers.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating control signal, default control signal with loss of power, and electrical power requirements.
2. Product description with complete technical data and product specification sheets.
3. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: To include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LEAK-DETECTION SWITCHES

A. Point-Type, Leak-Detection Switches:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**RectorSeal HVAC; a CSW Industrials Company**]
b. [**Veris Industries**]
c. [**Vertiv Co.**]
d. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**RectorSeal HVAC; a CSW Industrials Company**]
b. [**Veris Industries**]
c. [**Vertiv Co.**]
d. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain point-type, leak-detection switches from single manufacturer.
4. Features:

a. Alarms: [**Audible**][**and**][**visual**] alarm with relay output for remote indication.
b. Operation: Alarm activation based on detection of liquid by change in resistance.

5. Performance:

a. Field Power: 24 V ac or dc.
b. Service: [**Water**][**or**][**conductive liquid as indicated**]<**Insert service**>.
c. Temperature Limits: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
d. Sensing Height: Adjustable.

6. Construction:

a. Electric Connection: [**Cable**][**Plug-in connector**][**or**][**screw terminals**].
b. Enclosure: [**Acrylic, ABS plastic**][**or**][**painted metal**].
c. Switch Type: [**DPDT**][**SPDT**][**or**][**SPST**] relay.

B. Cable-Type, Leak-Detection Switches:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Veris Industries**]
b. [**Vertiv Co.**]
c. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Veris Industries**]
b. [**Vertiv Co.**]

c. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cable-type, leak-detection switches from single manufacturer.
4. Control Module Features:

   a. Power and alarm LEDs.
   b. Alarm test switch.
   c. Continuous cable integrity self-check.

5. Performance:

   a. Service: Water or other conductive liquid.
   b. Switch Type: DPDT.
   c. Electric Connection: Screw terminals.
   d. Conduit Connection: **0.5 inch (13 mm)**.

6. Construction:

   a. Control Module Enclosure: Painted metal.
   b. Cable: Hydrophobic.
   c. Cable Length:

      1) As required by application.
      2) Standard Cable Lengths: [**5 ft. (1500 mm)**][**10 ft. (3 m)**][**15 ft. (4.5 m)**][**20 ft. (6 m)**][**25 ft. (7.5 m)**][**30 ft. (9 m)**][**40 ft. (12 m)**][**50 ft. (15 m)**][**100 ft. (30 m)**]<**Insert length**>.
      3) Field Extendable: Cable with connector on each end for field extension.

   d. NRTL Listing: NRTL listed for application where cable is installed in air plenums.

7. Field Power: 24 V ac or 24 to 30 V dc unless otherwise required by application.
8. Non-sensing Cable: Non-sensing cable may be used to extend sensing cable length in areas where sensing is not required. Non-sensing cable is not to affect performance or accuracy of readings.
9. Accessories: Cable cross and tee cable connectors, end connectors, and attachment clips.

2.2 MULTI-ZONE LEAK-DETECTION MONITORING CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Veris Industries**]
   2. [**Vertiv Co.**]
   3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**Veris Industries**]
   2. [**Vertiv Co.**]
   3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain all multi-zone leak-detection monitoring controllers from single manufacturer.

D. Description: Operation as stand-alone device with operator configuring, monitoring, locating, and acknowledging leaks locally, or through connection to building control network and access through internet interface, which can display location where the alarm occurred.

E. Performance:

1. Altitude: Suitable for Project site altitude.
2. Cable Length, Maximum: [**10,000 ft. (3000 m)**]<**Insert length**>.
3. Cable Length, Minimum: [**30 ft. (9 m)**]<**Insert length**>.
4. Detection Accuracy: Within [**2 ft. (600 mm) plus or minus 0.5**]<**Insert number**> percent of cable length.
5. Detection Repeatability: Within [**2 ft. (600 mm) plus or minus 0.25**]<**Insert number**> percent of cable length.
6. Detection Response Time: Adjustable between [**5 and 900**]<**Insert range**> seconds, in [**5**]<**Insert value**> -second intervals.
7. Relative Humidity: 5 to 95 percent, noncondensing.
8. Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
9. Zones: Monitoring of up to [**100**]<**Insert quantity**> separate zones.

F. Enclosure: NEMA 250, Type 1.

G. Features:

1. Alarm Notifications:

   a. Local Audible Alarm: [**85**]<**Insert value**> dBA at [**2 ft. (600 mm)**]<**Insert distance**> with silence feature.
   b. Local visual alarms through display.
   c. Remote alarm notification through interface with building control system.
   d. E-mail alarm notifications.

2. Display: Color, backlit, LCD screen.
3. Logs:

   a. Event Log: Last [**1000**]<**Insert number**> events.
   b. Trend Logs: Cable current level for each of last [**365**]<**Insert number**> days.

4. Password Protection: Password-protected local and remote access to change configuration, but not to view operating status.

H. Remote Control Interface:

1. Hardwired Analog Points: 4 to 20 mA.
2. Hardwired Digital Points:

   a. Leak Detection: [**Two**]<**Insert quantity**> zones.
   b. Cable Break: [**Two**]<**Insert quantity**> zones.
   c. Maintenance: One zone.

3. Serial Communications:

   a. RS-485: [**Modbus RTU**][**BACnet MS/TP**]<**Insert protocol**>.
   b. Ethernet: [**Modbus TCP/IP**]<**Insert protocol**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LEAK-DETECTION INSTRUMENT APPLICATION

A. Leak-Detection Switches (Point Type): <**Insert application**>.

B. Leak-Detection Switches (Cable Type): <**Insert application**>.

C. Multi-Zone Leak-Detection Monitoring Controller: <**Insert application**>.

3.3 INSTALLATION, GENERAL

A. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

B. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force, or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 INSTALLATION OF LEAK-DETECTION SWITCHES

A. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent movement.

B. Fasten cable-type leak detection product to floor or supporting substrate using accessory clips furnished with product or a comparable product if furnished separately. Secure clip to floor and cable according to cable installation instructions.

3.5 ELECTRICAL POWER CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and

Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA/NEIS 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire and cable is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation for applicable considerations that impact performance.

D. Apply test fluid to floor or substrate to check proper switch operation. Test fluid is to be the same as for operation.

1. For cable-type leak detectors, check multiple locations across cable length. Number of locations will increase with length of cable.

a. Up to **20 ft. (6 m)**: [**Two**]<**Insert quantity**>, equally spaced.
b. Up to **50 ft. (3 m)**: [**Four**]<**Insert quantity**>, equally spaced.
c. Up to **200 ft. (60 m)**: [**Six**]<**Insert quantity**>, equally spaced.
d. Up to **1000 ft. (300 m)**: [**Eight**]<**Insert quantity**>, equally spaced.
e. <**Insert test requirements**>.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. Equipment and procedures used for calibration are to meet instrument manufacturer's written instructions.
4. Provide diagnostic and test equipment for calibration and adjustment.
5. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
6. If after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
7. Comply with field-testing requirements and procedures indicated by ASHRAE's Guideline 11 in the absence of specific requirements, and to supplement requirements indicated.

B. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

C. Switches: Calibrate switches that are adjustable to make or break contact at set points indicated.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

END OF SECTION 23 09 23 00A

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SECTION 23 09 23 00B - POSITION INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Position limit switches.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include operating characteristics, electrical characteristics, and furnished accessories indicating default control signal with loss of power and electrical power requirements.
2. Include product description with complete technical data and product specification sheets.

B. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For position instruments.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 POSITION LIMIT SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Eaton; Cutler Hammer**]
2. [**Honeywell International Inc.**]
3. [**OMRON Corporation**]
4. [**Siemens Industry, Inc., Building Technologies Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton; Cutler Hammer**]
2. [**Honeywell International Inc.**]
3. [**OMRON Corporation**]
4. [**Siemens Industry, Inc., Building Technologies Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain position limit switches from single manufacturer.

D. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.

E. Performance:

1. Life Expectancy: Not less than [**5**][**10**][**30**]<**Insert value**> million mechanical operations and [**50,000**][**100,000**][**750,000**][**10 million**]<**Insert value**> electrical operations.
2. Operating Frequency: [**300**]<**Insert value**> mechanical operations per minute and [**30**]<**Insert value**> electrical operations per minute.
3. Voltage: 125, 250, 480, and 600 V ac or 8, 12, 14, 24, 30, 48, 125, and 250 V dc, as required by application.
4. Current Rating: As required by application.
5. Temperature Rise: [**90 deg F (50 deg C)**]<**Insert temperature rise**>.
6. Ambient Temperature: [**14 to 175 deg F (Minus 10 to 79 deg C)**][**Minus 20 to 185 deg F (Minus 29 to 85 deg C)**]<**Insert temperature range**>.
7. Ambient Relative Humidity: [**35 to 95**]<**Insert relative humidity range**> percent.

F. Construction:

1. Enclosure Material: Metal with corrosion-resistant finish[**or plastic**].
2. NEMA 250, [**Type 1**][**Type 3**][**Type 4**][**Type 4X**][**or**][**Type 12**]<**Insert type**> enclosure, as required by application
3. Switch Type: SPDT or DPDT, as required by application.
4. Status Indicator: Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
5. Electrical Connection: Screw or plug-in terminals.
6. Conduit Connection: **1/2 inch NPT (16 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for

installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to [**seismic**][**or**][**external**] loads.

C. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 INSTALLATION OF POSITION INSTRUMENTS

A. Mounting Location:

1. Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.
2. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic sign, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic sign with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation that impacts performance.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

B. Switches: Calibrate switches to make or break contact at set points indicated.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate position instruments and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After installing position instruments, and after electrical circuitry has been energized, start units to confirm proper operation.
2. Test and adjust position instruments. Replace damaged and malfunctioning instruments.

D. Position instruments will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting position instruments to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

1. Verify operation at outer limits.

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or

defective components, lubrication, cleaning, and adjusting as required for proper <**Insert equipment**> operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for direct-digital control systems specified in Section 230923 "Direct-Digital Control (DDC) System for HVAC."

B. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain position instruments.

C. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 00B

SECTION 23 09 23 00C - SEQUENCE OF OPERATIONS FOR HVAC DDC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:

1. Section 230923 "DDC Systems for HVAC" for control equipment.

1.2 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

1.3 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.4 HEATING CONTROL SEQUENCES

A. Control Circulating Pump(s):

1. Input Device:

a. Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**]<**Insert device**>.

b. Location: [**Outdoor-air**][**Room**]<**Insert location**>.
c. Transference: DDC controller.

2. Output Device:

a. Device: Command to electric relay.
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action:

a. Energize pump(s) at outdoor-air temperatures below [**65 deg F (18 deg C)**]<**Insert temperature**>.
b. Energize pump(s) at room temperatures below [**72 deg F (22 deg C)**]<**Insert temperature**>.
c. Enable [**additional circulating pump(s)**][**, alternate pump(s)**][**, heating-water supply temperature control**][**and**][**, heating-water supply temperature reset**] control sequences.

B. Additional Circulating Pump(s):

1. Input Device:

a. Device: Liquid pressure differential [**switch**][**transmitter**].
b. Location: Between the primary supply and return piping.
c. Transference: DDC controller.

2. Output Device:

a. Device: Binary output.
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action:

a. Energize pump(s) and maintain operation when differential pressure drops below [**30**]<**Insert number**> percent of specified pump head.
b. Energize pump(s) and maintain operation when differential pressure drops below <**Insert pressure differential in psig (kPa)**> of specified pump head.

C. Circulating Pump(s) Failure Alarm:

1. Input Device:

a. Device: Liquid pressure differential [**switch**][**transmitter**].
b. Location: Between the primary supply and return piping.
c. Transference: DDC controller.

2. Output Device:

a. Device: DDC controller.
b. Transference: Operator's workstation.

3. Action:

a. Signal alarm condition, no pressure differential between supply and return piping.

D. Alternate Pump(s):

1. Input:

a. Device: DDC controller.
b. Location: Software, <**Insert software definition**>.
c. Transference: Software.

2. Output Device:

a. Device: DDC controller.
b. Location: Motor controller.
c. Transference: Motor-controller relay.

3. Action: Operate pump(s) on lead-lag, alternating each startup.
4. Action: Operate pump(s) on lead-lag, alternating on <**Insert value**> run hours.

E. Control Circulating Pump(s) Speed:

1. Input Device:

a. Device: Liquid pressure differential transmitter.
b. Location: Heating supply and return piping.
c. Transference: DDC controller.

2. Output Device:

a. Device: Analog command.
b. Location: Motor controller.
c. Transference: Variable-frequency motor controller.

3. Action:

a. Control pump speed to maintain pressure differential of <**Insert psig (kPa)**>.

F. Heating-Water Supply Temperature Control:

1. Input:

a. Device: [**Liquid temperature sensor**][**or**][**liquid temperature sensor with liquid temperature transmitter**].
b. Location: Heating-water supply.
c. Transference: DDC controller.

2. Output:

a. Device: Control-valve actuator.
b. Location: Heating-water supply.
c. Transference: Control-valve actuator.

3. Action:

a. Modulate control valve to maintain heating-water supply temperature.

b. Reset heating-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

1) [**195 deg F (90 deg C)**]<**Insert highest heating temperature**> heating water when outdoor-air temperature is [**minus 30 deg F (minus 35 deg C)**]<**Insert lowest outdoor-air temperature**>.
2) [**130 deg F (54 deg C)**]<**Insert lowest heating temperature**> heating water when outdoor-air temperature is **75 deg F (24 deg C)**.

G. Heating-Water Supply Temperature Reset:

1. Input:

a. Device: [**Liquid temperature sensor**][**Liquid temperature sensor with liquid temperature transmitter**].
b. Location: Outdoor-air and heating-water supply.
c. Transference: DDC controller.

2. Output:

a. Device: DDC controller to boiler controls.
b. Location: Local panel.
c. Transference: Boiler control panel.

3. Action:

a. Reset heating-water supply temperature in response to greatest heating demand to maintain at least one cooling control valve 90 percent open.
b. Reset heating-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

1) [**195 deg F (90 deg C)**]<**Insert highest heating temperature**> heating water when outdoor-air temperature is [**minus 30 deg F (minus 35 deg C)**]<**Insert lowest outdoor-air temperature**>.
2) [**130 deg F (54 deg C)**]<**Insert lowest heating temperature**> heating water when outdoor-air temperature is [**75 deg F (24 deg C)**]<**Insert highest outdoor-air temperature**>.
3) [**150 deg F (65 deg C)**]<**Insert temperature**> minimum heating-water temperature.

H. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system status, on-off.
3. Outdoor-air temperature.
4. Room temperature.
5. Circulating pump(s) on-off status (enabled or disabled).
6. Circulating pump(s) on-off indication (operating or not operating).
7. Additional circulating pump(s) pressure differential.
8. Additional circulating pump(s) pressure differential set point.
9. Additional circulating pump(s) on-off indication (operating or not operating).
10. Circulating pump(s) alarm pressure differential.
11. Circulating pump(s) alarm pressure differential set point.
12. Alarm (circulating pump(s) failure).
13. Circulating pump(s) speed pressure differential.
14. Circulating pump(s) speed pressure differential set point.

15. Circulating pump(s) speed.
16. Heating-water supply temperature.
17. Heating-water return temperature.
18. Heating-water control-valve position.
19. Heating-water supply temperature set point.
20. Heating-water control-point output valve.

1.5 CENTRAL CHILLED-WATER SYSTEM SEQUENCES

A. Central Chilled-Water System Time Schedule:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action:

1) Enable startup, initiation, and control.
2) Energize condenser-water pumps on occupied/unoccupied cycle.
3) Energize condenser-water pumps on day/night cycle.
4) After chilled-water system shutdown, operate pump(s) for an additional [**3 minutes**]<**Insert time**>.

2. Display:

a. Time and time schedule.

B. Start and Stop Condenser-Water Pump(s):

1. Enable:

a. Input:

1) Device: [**Level**][**Liquid pressure**] switch.
2) Location: [**Cooling tower sump**][**Pump suction**].

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Motor-controller relay.

c. Action: Confirm adequate water level [**in cooling-tower sump**][**at pump suction**] and energize pump(s).

2. Enable:

a. Input:

1) Device: [**Level transmitter**][**or**][**liquid pressure transmitter**].
2) Location: [**Cooling tower sump**][**Pump suction**].
3) Transference: DDC controller.

b. Output:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Motor-controller relay.

c. Action: Confirm adequate water level [**in cooling-tower sump**][**at pump suction**] at pressures above <**Insert psig (kPa)**> and energize pump(s).

3. Enable:

a. Input:

1) Device: DDC controller outdoor-air temperature.
2) Location: Outdoors.
3) Transference: Binary output.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Confirm outdoor-air temperature is above [**50 deg F (10 deg C)**]<**Insert temperature**> and energize pump(s).

4. Enable:

a. Input:

1) Device: DDC controller.
2) Location: Software demand.
3) Transference: Binary output.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Confirm cooling demand from ventilation system(s) and energize pump(s).

5. Display:

a. Low-level cooling-tower sump alarm.
b. Outdoor-air temperature.
c. Cooling (software) demand indication.
d. Time and time schedule.

e. Condenser-water pump(s) on-off status (enabled or disabled).
f. Condenser-water pump(s) on-off indication (operating or not operating).

C. Start and Stop Chilled-Water Pump(s):

1. Input:

a. Device: [**Flow**][**Pressure differential**] switch.
b. Location: Chilled-water piping.
c. Transference: [**Control voltage relay**][**DDC controller**].

2. Output:

a. Device: [**Hard wired**][**Binary output**].
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action: Energize pump(s) when the condenser-water pump(s) and system start.
4. Display:

a. Chilled-water flow indication.
b. Chilled-water pump(s) on-off status (enabled or disabled).
c. Chilled-water pump(s) on-off indication (operating or not operating).

D. Start and Stop Cooling-Tower Fan(s):

1. Input:

a. Device: [**Flow**][**Pressure differential**] switch.
b. Location: Condenser-water piping.
c. Transference: [**Control relay**][**DDC controller**].

2. Output:

a. Device: [**Hard wired**][**Binary output**].
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action: Energize fan(s) when the condenser-water pump(s) and system start.
4. Display:

a. Condenser-water flow indication.
b. Cooling-tower fan(s) on-off indication (operating or not operating).

E. Start and Stop Chillers:

1. Input:

a. Device: [**Flow**][**or**][**pressure differential**] switch.
b. Location: Chilled-[**and condenser-**]water piping.
c. Transference: [**Chiller controls**][**DDC controller**].

2. Output:

a. Device: [**Hard wired**][**Binary output**].

b. Location: Chiller control panel.
c. Transference: Chiller controls.

3. Action: Energize chiller(s) internal control circuit when the condenser-water and chilled-water pump(s), and system start.
4. Display:

a. Condenser-water flow indication.
b. Chilled-water flow indication.
c. Chiller on-off indication (operating or not operating).
d. Chilled-water supply and return temperature.
e. Chilled-water temperature control-point adjustment.

F. Start and Stop Chiller(s):

1. Input:

a. Device: Flow switches.
b. Location: Condenser-water and chilled-water circuit.
c. Transference: [**Chiller terminal strip**][**DDC system**].

2. Output:

a. Device: [**Hard wired**][**Binary output**].
b. Location: Chiller control panel.
c. Transference: Chiller controls.

3. Action: Energize chiller internal control circuit when the condenser-water and chilled-water pump(s), and system start.
4. Display:

a. Condenser-water flow indication.
b. Chilled-water flow indication.
c. Chiller(s) on-off status (enabled or disabled).
d. Chiller(s) on-off indication (operating or not operating).
e. Chilled-water supply and return temperature.
f. Chilled-water temperature control-point adjustment.

G. Alternate Chiller(s):

1. Input:

a. Device: DDC controller.
b. Location: DDC software, <**Insert software definition**>.
c. Transference: DDC software.

2. Output Device:

a. Device: DDC controller command to chiller.
b. Location: Chiller control panel.
c. Transference: Chiller controls.

3. Action:

a. Operate chiller(s) on lead-lag, [**alternating each startup**][**based on adjustable runtime hour set point**].
b. Start additional chiller when load exceeds capacity of operating chillers as follows:

1) When common chilled-water supply temperature exceeds set point for a [**30-minute**]<**Insert time**> period.
2) When chiller power draw has reached its operator adjustable high limit for a [**30-minute**]<**Insert time**> period.
3) When combination of outdoor temperature and time schedule ensure enough run-time before time schedule shutdown.

c. Stop chiller when load capacity of operating chillers drops to less than [**110**]<**Insert number**> percent of capacity of next chiller to be shut down for a [**30-minute**]<**Insert time**> period.

4. Action: <**Insert sequence and parameters**>.
5. Display: Chiller(s) on-off indication (operating or not operating).

H. Alarm Chiller(s) Start Failure:

1. Input:

a. Device: [**Software signal**][**Hardwired**]<**Insert devices**>.
b. Location: Chiller control panel.
c. Transference: DDC controller.

2. Output:

a. Device: DDC controller.
b. Transference: Operator's workstation.

3. Action: Signal alarm on signal from chiller control panel.
4. Display:

a. Chiller "failure-to-start" indication.
b. <**Insert chiller controller alarm points**>.

I. Start and Stop Chiller(s):

1. Input:

a. Device: Chiller control panel.
b. Location: Chiller.
c. Transference: DDC controller.

2. Output:

a. Device: DDC controller.
b. Transference: Operator's workstation.

3. Action: Report chiller electronic control, operating, and alarm functions.
4. Display:

a. <**See chiller Sections for listing**>.

J. Chilled-Water Level:

1. Input:

   a. Device: [**Level switch**][**Liquid level sensor**].
   b. Location: Expansion tank.
   c. Transference: DDC controller.

2. Input:

   a. Device: Liquid gage pressure switch.
   b. Location: Makeup-water piping downstream from pressure-reducing valve.
   c. Transference: DDC controller.

3. Output:

   a. Device: DDC controller.
   b. Transference: Operator's workstation.

4. Action: Signal alarm on [**expansion tank low level**][**low pressure**].
5. Display: [**Expansion tank low-level**][**Low-pressure**] alarm.

K. Chilled-Water Supply Temperature:

1. Input:

   a. Device: [**Liquid temperature sensor**][**or**][**liquid temperature sensor with liquid temperature transmitter**].
   b. Location: [**Common**]chilled-water supply piping.
   c. Transference: DDC controller.

2. Output:

   a. Device: DDC controller signal.
   b. Location: Local panel.
   c. Transference: Chiller control panel.

3. Action: Maintain chilled-water supply temperature.

   a. Reset chilled-water supply temperature in response to greatest cooling demand to maintain at least one cooling control valve 90 percent open.
   b. Reset chilled-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

      1) [**44 deg F (7 deg C)**]<**Insert highest chilled-water temperature**> chilled water when outdoor-air temperature is [**80 deg F (26 deg C)**]<**Insert highest outdoor-air temperature**>.
      2) [**54 deg F (12 deg C)**]<**Insert lowest chilled-water temperature**> chilled water when outdoor-air temperature is [**60 deg F (15 deg C)**]<**Insert lowest operating outdoor-air temperature**>.

   c. Reset chilled-water supply temperature based on constant return chilled-water temperature of [**54 deg F (12 deg C)**]<**Insert temperature**>.
   d. <**Insert reset strategy**>.

4. Display:

   a. Chilled-water supply temperature.
   b. Chilled-water supply temperature set point.

L. Condenser-Water Temperature:

1. Input:

   a. Device: [**Liquid temperature sensor**][**Liquid temperature sensor with liquid temperature transmitter**].
   b. Location: [**Cooling-tower sump**][**Common condenser-water supply piping**].
   c. Transference: DDC controller.

2. Output:

   a. Device: Analog output.
   b. Location: DDC controller.
   c. Transference: Control-valve actuator.

3. Action: Modulate control valve open to cooling tower and closed to bypass to maintain when condenser-water supply temperature is above [**85 deg F (29 deg C)**]<**Insert value**> temperature set point. Modulate control valve closed to cooling tower and open to bypass when condenser-water supply temperature is below [**55 deg F (13 deg C)**]<**Insert value**> temperature set point.
4. Output:

   a. Device: DDC controller control relay.
   b. Location: DDC controller.
   c. Transference: Fan starter relay.

5. Action:

   a. Cycle tower fan(s) on and off to maintain [**55 deg F (13 deg C)**]<**Insert value**> temperature set point.
   b. Cycle tower fan(s) on and off to maintain condenser-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

      1) [**85 deg F (29 deg C)**]<**Insert highest condenser-water temperature**> condenser water when outdoor-air temperature is [**80 deg F (26 deg C)**]<**Insert highest outdoor-air temperature**>.
      2) [**55 deg F (13 deg C)**]<**Insert lowest condenser-water temperature**> condenser water when outdoor-air temperature is [**55 deg F (13 deg C)**]<**Insert lowest operating outdoor-air temperature**>.

6. Output Assuming Fans Have Associated Variable-Frequency Motor-Control Circuitry:

   a. Device: DDC controller digital output.
   b. Location: DDC controller.
   c. Transference: Fan variable-speed controller.

7. Action Assuming Fans Have Associated Variable-Frequency Motor-Control Circuitry: Cycle tower fan(s) on and modulate fan speed from minimum to maximum to maintain [**55 deg F (13 deg C)**]<**Insert value**> temperature set point.
8. Action: Cycle tower fan(s) on and off to maintain condenser-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

a. [85 deg F (29 deg C)]<**Insert highest condenser-water temperature**> condenser water when outdoor-air temperature is [80 deg F (26 deg C)]<**Insert highest outdoor-air temperature**>.
b. [55 deg F (13 deg C)]<**Insert lowest condenser-water temperature**> condenser water when outdoor-air temperature is [55 deg F (13 deg C)]<**Insert lowest operating outdoor-air temperature**>.

9. Display:

a. Control-valve(s) position.
b. Cooling-tower fan(s) on-off indication (operating or not operating).
c. Cooling-tower fan(s) speed.
d. Condenser-water supply temperature.
e. Condenser-water supply temperature set point.
f. Condenser-water return temperature.

M. Cooling-Tower Sump Heater:

1. Input:

a. Device: [**Two-stage**]thermostat.
b. Location: Cooling tower sump.
c. Transference: Heater relay and control-valve actuator.

2. Output:

a. Device: Heater relay and control-valve actuator.
b. Location: Electric heater control panel and control-valve actuator in sump drain.
c. Transference: Electric heater contactor and control-valve actuator.

3. Action:

a. Energize sump heater if sump temperature falls below [40 deg F (4.5 deg C)]<**Insert value**> temperature set point.
b. Open control valve in sump heater drain piping if sump temperature falls below [35 deg F (1.5 deg C)]<**Insert value**> temperature set point.

4. Display:

a. Cooling-tower sump temperature.
b. Cooling-tower sump heater on-off indication (operating or not operating).
c. Cooling-tower control valve open-close indication.

N. Cooling-Tower Sump Heater:

1. Input:

a. Device: [**Liquid temperature sensor**][**or**][**liquid temperature sensor with liquid temperature transmitter**].
b. Location: Cooling tower sump.
c. Transference: DDC controller.

2. Output:

a. Device: Binary output.
b. Location: Electric heater control panel [**and solenoid valve in sump drain**][**and control-valve actuator in sump drain**].
c. Transference: Electric heater contactor [**and solenoid valve**][**and control-valve actuator**].

3. Action:

a. Energize sump heater if sump temperature falls below <**Insert value**> temperature set point.
b. Open control valve in sump heater drain piping if sump temperature falls below <**Insert value**> temperature set point.

4. Display:

a. Cooling-tower sump temperature.
b. Cooling-tower sump heater on-off indication (operating or not operating).
c. Cooling-tower control valve open-close indication.

O. Control Circulating Pump(s) Speed:

1. Input Device:

a. Device: [**Liquid pressure differential transmitter**][**Liquid flow meter**][**Liquid flow sensor**].
b. Location: Chilled-water supply and return piping[**and condenser-water supply and return piping**] to chiller.
c. Transference: DDC controller.

2. Output Device:

a. Device: DDC controller.
b. Location: Motor controller.
c. Transference: Pump variable-speed controller.

3. Action:

a. Control pump speed to maintain flow through chiller.
b. Report pressure drop and flow.

P. Circulation through Chiller:

1. Input Device:

a. Device: [**Liquid pressure differential transmitter**][**Liquid flow meter**][**Liquid flow sensor**].
b. Location: Chilled-water supply and return piping[**and condenser-water supply and return piping**] to chiller.
c. Transference: DDC controller.

2. Output Device:

a. Device: DDC controller.

3. Action:

a. Report pressure drop and flow through chiller.

Q. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system status, on-off.
3. Low-level cooling-tower sump alarm.
4. Outdoor temperature.
5. Cooling (software) demand indication.
6. Time and time schedule.
7. Condenser-water pump(s) on-off status (enabled or disabled).
8. Condenser-water pump(s) on-off indication (operating or not operating).
9. Condenser-water flow indication.
10. Chilled-water pump(s) on-off status (enabled or disabled).
11. Chilled-water pump(s) on-off indication (operating or not operating).
12. Cooling-tower fan(s) on-off indication (operating or not operating).
13. Chilled-water flow indication.
14. Refrigeration machine on-off indication (operating or not operating).
15. Chilled-water supply temperature.
16. Chilled-water return temperature.
17. Chilled-water temperature control-point adjustment.
18. Chiller(s) on-off status (enabled or disabled).
19. Chiller(s) on-off indication (operating or not operating).
20. Chiller "failure-to-start" indication.
21. Expansion tank low-level alarm.
22. Condenser-water sump (return) control-point temperature.
23. Condenser-water sump (return) temperature.
24. Condenser-water control-valve position.
25. Condenser-water supply temperature.
26. Cooling-tower sump temperature.
27. Cooling-tower sump heater on-off indication (operating or not operating).
28. Cooling-tower sump drain indication.
29. Chiller(s) power input (instantaneous).
30. Chilled-water pressure drop through chiller.
31. Chilled-water flow through chiller.
32. Condenser-water pressure drop through chiller.
33. Condenser-water flow through chiller.
34. Chiller condenser-water supply and return temperature.
35. Chiller chilled-water supply and return temperature.
36. System capacity in tons.
37. **<Insert requirement>**.

1.6 AIR-HANDLING-UNIT CONTROL SEQUENCES

A. Air-Handling Unit Time Schedule:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action:

1) Enable startup, initiation, and control.
2) Energize unit on occupied/unoccupied cycle.
3) Energize unit on day/night cycle.
4) Energize unit on duty cycle.
5) Energize return-air fans [**30 seconds**]<**Insert time**> after supply fans are energized.
6) Do not enable mixed-air control during morning warm-up period.

a) Unoccupied: Position outdoor-air[**and relief-air**] dampers closed and return-air dampers open.

7) Do not enable humidifier control during morning warm-up period.
8) Enable control of heating coil(s) during morning warm-up period.
9) Energize coil circulating pump(s).
10) Return heating control valves to normal position when unit is cycled on.
11) Do not enable cooling-coil control during morning warm-up period.

B. Start and Stop Supply Fan(s):

1. Enable:

a. Input:

1) Device: Low limit temperature switch with [**manual**][**automatic**] reset.
2) Location: Upstream of cooling coil.
3) Transference: Starter relay.

b. Output:

1) Device: Hard wired to motor controller[**and DDC controller**].
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action:

1) Allow start if temperature is above [**37 deg F (3 deg C)**]<**Insert temperature**>.
2) Signal alarm if fan fails to start as commanded.

2. Enable:

a. Input:

1) Device: Low limit temperature switch with [**manual**][**automatic**] reset.
2) Location: [**Supply airstream**]<**Insert location**>.
3) Transference: Starter relay.

b. Output:

1) Device: Hard wired to motor controller[**and DDC controller**].
2) Location: Motor controller.

3) Input Transference: Starter relay.

c. Action:

1) Allow start if temperature is below [**120 deg F (49 deg C)**]<**Insert temperature**>.
2) Signal alarm if fan fails to start as commanded.

3. Enable:

a. Input:

1) Device: Smoke detector with auxiliary contact [**manual**][**automatic**] reset.
2) Location: Duct mounted [**before**][**and**][**after**][**supply fan**][**air-handling unit**].
3) Location: Mounted in air-handling unit.
4) Transference: Starter relay.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Output Device: Hard wired through motor controller; DDC controller alarm.
d. Action:

1) Allow start if airstream is free of products of combustion.
2) Signal alarm if fan fails to start as commanded.

C. Supply Fan(s) Variable-Volume Control:

1. Fan Speed Control:

a. Input:

1) Device: Air pressure transmitter.
2) Location: Supply-duct static pressure referenced to ambient-space static pressure.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: Variable-frequency motor controller.

c. Action:

1) Maintain constant supply-duct static-pressure set point of <**Insert value**>.
2) Set-Point Reset (for Systems with DDC of Individual Zone Terminals): Reset static-pressure set point based on the zone requiring the most pressure; reset set point lower until one zone damper is nearly wide open.
3) Set variable-frequency drive to minimum speed when fan is stopped.

2. Fan Airflow:

a. Input:

1) Device: Airflow [**sensor**][**transmitter**].
2) Location: Supply duct.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action: Report supply-duct airflow.

3. High Pressure:

a. Input:

1) Device: Air pressure switch.
2) Location: Supply duct referenced to outside the duct.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output; DDC controller.
2) Transference: Starter relay; operator's workstation.

c. Action: When static pressure rises above excessive-static-pressure set point of <**Insert value**>:

1) Stop fan.
2) Signal alarm.

D. Return Fan(s) Variable-Volume Control:

1. Fan Speed Control:

a. Input:

1) Device: Airflow [**sensor**][**transmitter**].
2) Location: Supply airstream and return airstream.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Variable-frequency drive.
3) Transference: Variable-frequency drive controller.

c. Action:

1) Maintain constant airflow offset between supply- and return-air fans.
2) Set variable-frequency drive to minimum speed when fan is stopped.

2. Fan Speed Control:

a. Input:

1) Device: Air pressure [**sensor**][**differential transmitter**].

2) Location: Indoor space static pressure referenced to outdoor static pressure.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: Variable-frequency motor controller.

c. Action:

1) Maintain constant indoor static-pressure set point of [**0.02-inch wg (5 Pa)**]<**Insert value**> positive for outdoors.
2) Set variable-frequency drive to minimum speed when fan is stopped.

d. Action: Maintain constant indoor static pressure.

E. Preheat Coil:

1. Freeze Protection:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**][**Thermostat**].
2) Location: After preheat coil.
3) Transference: [**DDC controller**][**Starter relay**].

b. Output:

1) Device: [**Binary output**][**Hard wired**].
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Allow start if duct temperature is above [**33 deg F (1 deg C)**]<**Insert temperature**>.

2. Low-Temperature Operation:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**]<**Insert device**>.
2) Location: Outdoor air.
3) Transference: DDC controller.

b. Output Device:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action:

1) Energize coil circulating pump(s) at outdoor-air temperatures below [**35 deg F (2 deg C)**]<**Insert temperature**>.

3. [**Supply**][**Discharge**]-Air Temperature:

   a. Input:

      1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
      2) Location: [**Supply**][**Discharge**] airstream.
      3) Transference: DDC controller.

   b. Output:

      1) Device: Analog output.
      2) Location: Control valve.
      3) Transference: Control-valve actuator.

   c. Action: Maintain air-temperature set point of [**55 deg F (13 deg C)**]<**Insert temperature**>.

F. Mixed-Air Control:

1. Minimum Position:

   a. Input:

      1) Device: DDC controller.
      2) Location: Time schedule.
      3) Transference: DDC controller.

   b. Input:

      1) Device: Flow measuring station.
      2) Location: Outdoor-air intake.
      3) Transference: DDC controller.

   c. Output:

      1) Device: Analog output.
      2) Location: Outdoor damper.
      3) Transference: Damper actuator(s).

   d. Action:

      1) Open [**minimum outdoor-air dampers**][**outdoor-air dampers to minimum position**].
      2) Modulate outdoor-air dampers to maintain minimum airflow at set point of <**Insert value**>.

2. Heating Reset:

   a. Input:

      1) Device: DDC controller.
      2) Location: Software.
      3) Transference: DDC controller.

   b. Output:

1) Device: Analog output.
2) Location: Outdoor dampers.
3) Transference: Damper actuator(s).

c. Action: [**Close minimum outdoor-air dampers**][**Set outdoor-air dampers to minimum position**].

3. Carbon Dioxide Reset:

a. Input:

1) Device: Carbon dioxide transmitter.
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Dampers.
3) Transference: Damper actuator(s).

c. Action: Reset minimum outdoor-air damper position to maintain carbon dioxide set point of <**Insert value**>.

4. [**Supply**][**Mixed**]-Air Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: [**Supply-airstream**][**Mixed-air plenum**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Damper section.
3) Transference: Damper actuator(s).

c. Action:

1) Modulate outdoor-, return-, and relief-air dampers to maintain air-temperature set point of [**55 deg F (13 deg C)**]<**Insert temperature**>.
2) Do not enable control during morning warm-up period.

5. Cooling Reset:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**][**and moisture sensors and transmitters**].
2) Location: Outdoor- and return-air ducts.
3) Input Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Outdoor- and return-air ducts.
3) Transference: Damper actuator(s).

c. Action: Set outdoor-air dampers to minimum position when outdoor-air [**temperature exceeds return-air temperature**][**enthalpy exceeds return-air enthalpy**].

G. Humidifier:

1. Input:

a. Device: Moisture sensor and transmitter.
b. Location: [**Return airstream**][**Supply airstream**][**Space**]<**Insert location**>.
c. Transference: DDC controller.

2. Output:

a. Device: Analog output.
b. Location: Humidifier.
c. Transference: [**Valve actuator**][**and**][**pump**].

3. Action:

a. [**Modulate humidity control valve**][**Cycle humidifier pump**][**Cycle humidifier pump and modulate humidity control valve**].
b. Maintain humidity in straight-line relationship for the following conditions:

1) 20 percent when outdoor-air temperature is [**minus 30 deg F (minus 35 deg C)**]<**Insert temperature**>.
2) 40 percent when outdoor-air temperature is [**75 deg F (24 deg C)**]<**Insert temperature**>.

H. Evaporative Cooler:

1. Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: [**Supply**][**Discharge**] airstream.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Evaporative cooler.
3) Transference: [**Valve actuator**][**and**][**pump**].

c. Action:

1) [**Modulate evaporative cooler control valve**][**and**][**cycle evaporative cooler pump**].

2) Maintain air-temperature set point of [**55 deg F (13 deg C)**]<**Insert temperature**>.

2. Humidity Limit:

a. Input:

1) Device: Moisture sensor and transmitter.
2) Location: [**Return airstream**][**Supply airstream**][**Space**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Evaporative cooler.
3) Transference: [**Valve actuator**][**and**][**pump**].

c. Action:

1) Return [**humidity control valve**][**humidifier pump**][**humidifier pump and humidity control valve**] to their normal position.
2) Signal high humidity alarm.

I. Filters:

1. Differential Pressure:

a. Input:

1) Device: Pressure differential [**switch**][**transmitter**].
2) Location: Filter bank.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.
2) Location: DDC controller.
3) Transference: Operator's workstation.

c. Action: Signal alarm on [**low- and**]high-pressure conditions.

J. [**Hydronic**][**Steam**] Heating Coil:

1. [**Supply**][**Discharge**]-Air Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: [**Supply**][**Discharge**]-air [**duct**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.

2) Location: Heating-coil control valve.
3) Input Transference: Normally [**open**][**closed**] valve actuator.

c. Action:

1) Maintain supply-air-temperature set point of [**55 deg F (13 deg C)**]<**Insert temperature**> by modulating heating-coil control valve.
2) Maintain supply-air-temperature set point in straight-line relationship for the following conditions:

a) [**65 deg F (18 deg C)**]<**Insert temperature**> when return-air temperature is [**70 deg F (21 deg C)**]<**Insert temperature**>.
b) [**55 deg F (13 deg C)**]<**Insert temperature**> when return-air temperature is [**75 deg F (24 deg C)**]<**Insert temperature**>.

3) Maintain supply-air-temperature set point within limits in response to space temperature reset:

a) Minimum [**55 deg F (13 deg C)**]<**Insert temperature**>.
b) Maximum [**131 deg F (55 deg C)**]<**Insert temperature**>.

4) During morning warm-up period, maintain supply-air-temperature set point of [**80 deg F (27 deg C)**]<**Insert temperature**>.

2. Space Temperature Reset:

a. Input:

1) Device: Space [**air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Indoor spaces served by system.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Heating-coil control valve.
3) Input Transference: Normally [**open**][**closed**] valve actuator.

c. Action:

1) Reset supply-air temperature in response to greatest heating demand.
2) Supply-Air-Temperature Reset: Reset the supply-air temperature to outdoor temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

3. Low-Temperature Operation:

a. Input Device:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**]<**Insert device**>.
2) Location: Outdoor air.
3) Transference: DDC controller.

b. Output Device:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action:

1) Energize coil circulating pump(s) at outdoor-air temperatures below [**35 deg F (2 deg C)**]<**Insert temperature**>.

K. Hydronic Cooling Coil:

1. [**Supply**][**Discharge**]-Air Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**transmitter**].
2) Location: [**Supply**][**Discharge**]-air [**duct**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Cooling-coil valve.
3) Input Transference: Valve actuator.

c. Action:

1) Maintain supply-air-temperature set point of [**55 deg F (13 deg C)**]<**Insert temperature**> by modulating cooling-coil control valve.
2) Maintain supply-air-temperature set point within limits in response to space temperature reset:

a) Minimum [**55 deg F (13 deg C)**]<**Insert temperature**>.
b) Maximum [**68 deg F (20 deg C)**]<**Insert temperature**>.

3) Supply-Air-Temperature Reset: Reset the supply-air temperature to outdoor temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

2. Temperature Reset:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Return-air [**duct**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Cooling-coil control valve.

3) Transference: Valve actuator.

c. Action: Reset supply-air temperature in straight-line relationship for the following conditions:

1) [**65 deg F (18 deg C)**]<**Insert temperature**> when return-air temperature is [**70 deg F (21 deg C)**]<**Insert temperature**>.
2) [**55 deg F (13 deg C)**]<**Insert temperature**> when return-air temperature is [**75 deg F (24 deg C)**]<**Insert temperature**>.

d. Action:

1) Reset supply-air temperature in response to greatest cooling demand.
2) Supply-Air-Temperature Reset: Reset the supply-air temperature to outdoor temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

3. Space Temperature Reset:

a. Input:

1) Device: Space [**air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Spaces served by system.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Cooling coil.
3) Input Transference: Valve actuator.

c. Action:

1) Reset supply-air temperature in response to greatest cooling demand.
2) Supply-Air-Temperature Reset: Reset the supply-air temperature to outdoor temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

4. Space Humidity Reset:

a. Input:

1) Device: Humidity sensor and transmitter.
2) Location: Return-air [**duct**]<**Insert location**>.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Cooling-coil control valve.
3) Transference: Valve actuator.

c. Action: Reset supply-air temperature to [**55 deg F (13 deg C)**]<**Insert temperature**> to maintain space relative humidity of [**45**]<**Insert number**> percent.

L. Multizone Damper Control:

1. Spaces Temperature:

a. Input Device:

1) Device: [**Air-temperature sensors**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Spaces served by system.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Multizone head.
3) Transference: Damper actuators.

c. Action: Maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

M. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.

N. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system on-off indication (operating or not operating).
3. DDC system occupied/unoccupied mode.
4. Outdoor-air-temperature indication.
5. Supply-fan on-off indication (operating or not operating).
6. Supply duct static-pressure indication.
7. Supply duct static-pressure set point.
8. Supply-fan airflow rate.
9. Supply-fan speed.
10. Return-fan on-off indication (operating or not operating).
11. Space static-pressure indication.
12. Space static-pressure set point.
13. Return-fan airflow rate.
14. Return-fan speed.
15. Preheat-coil air-temperature indication.
16. Preheat-coil air-temperature set point.
17. Preheat-coil pump on-off indication (operating or not operating).
18. Preheat-coil control-valve position.
19. Mixed-air-temperature indication.
20. Mixed-air-temperature set point.
21. Mixed-air damper position.
22. Relative humidity indication.
23. Relative humidity set point.
24. Relative humidity control-valve position.
25. Filter air-pressure-drop indication.
26. Filter low-air-pressure drop set point.

27. Filter high-air-pressure drop set point.
28. [**Supply**][**Discharge**]-air-temperature indication.
29. [**Supply**][**Discharge**]-air-temperature set point.
30. Heating-coil leaving-air-temperature indication.
31. Heating-coil leaving-air-temperature set point.
32. Heating-coil pump on-off indication (operating or not operating).
33. Heating-coil control-valve position.
34. Hot-deck air-temperature indication.
35. Hot-deck air-temperature set point.
36. Cooling-coil leaving-air-temperature indication.
37. Cooling-coil leaving-air-temperature set point.
38. Cooling-coil control-valve position.
39. Cold-deck air-temperature indication.
40. Cold-deck air-temperature set point.
41. Space temperature indication.
42. Space temperature set point.
43. Multizone damper position.

1.7 TERMINAL UNIT OPERATING SEQUENCE

A. Cabinet Unit Heater, [**Hydronic**][**Steam**]:

1. Space Temperature from Line-Voltage Thermostat:

a. Input:

1) Device: Line-voltage thermostat.
2) Location: Space.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Cycle fan to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

2. Space Temperature from Air-Temperature Sensor:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Occupied space.
3) Transference: DDC controller.

b. Output Device:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Output Device:

1) Device: Analog output.

2) Location: Control valve.
3) Transference: Control-valve actuator.

d. Action: [**Cycle fan**][**Modulate valve**] to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

3. Low-Temperature Safety:

a. Input Device: Line-voltage, on-off thermostat; mounted.

1) Device: Line-voltage thermostat.
2) Location: [**Return heating-water**][**Condensate**] pipe.

b. Output Device:

1) Device: Hard wired.
2) Location: Motor controller.
3) Input Transference: Starter relay.

c. Action: Stop fan when [**return heating-water**][**condensate**] temperature falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.

B. Cabinet Unit Heater, Electric:

1. Input:

a. Device: Line-voltage thermostat.
b. Location: Occupied space.

2. Output:

a. Device: Hard wired.
b. Location: Motor-controller and heater relay.
c. Transference: Starter relay.

3. Action: Cycle fan to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

C. Unit Heater, [**Hydronic**][**Steam**]:

1. Space Temperature from Line-Voltage Thermostat:

a. Input:

1) Device: Line-voltage thermostat.
2) Location: Space.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Cycle fan to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

2. Space Temperature from Air-Temperature Sensor:

   a. Input:

      1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
      2) Location: Space.
      3) Transference: DDC controller.

   b. Output Device:

      1) Device: Binary output.
      2) Transference: Starter relay.

   c. Output Device:

      1) Device: Analog output.
      2) Location: Control valve.
      3) Transference: Control-valve actuator.

   d. Action: [**Cycle fan**][**Modulate valve**] to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

3. Low-Temperature Safety:

   a. Input Device: Line-voltage, on-off thermostat; pipe mounted.

      1) Device: Line-voltage thermostat.
      2) Location: [**Return heating-water**][**Condensate**] pipe.

   b. Output Device:

      1) Device: Hard wired.
      2) Location: Motor controller.
      3) Input Transference: Starter relay.

   c. Action: Stop fan when [**return heating-water**][**condensate**] temperature falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.

D. Unit Heater, Electric: Space thermostat cycles fan and sequences stages of heating.

1. Space Temperature:

   a. Input:

      1) Device: Electric multistage thermostat.
      2) Location: Space.

   b. Output:

      1) Device: Hard wired.
      2) Location: Unit control panel.
      3) Transference: Electric multistage contactors.

   c. Action: Sequence electric coil stages to maintain [**75 deg F (24 deg C)**]<**Insert value**>

space temperature.

E. Combustion-Air Unit Heaters:

1. Space Temperature from Line-Voltage Thermostat:

a. Input:

1) Device: Thermostat.
2) Location: Space.

b. Output:

1) Device: Low-voltage wiring.
2) Location: Control valve.
3) Transference: Valve actuator.

2. Space Temperature from Air-Temperature Sensor:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate valve to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

F. Radiant Heating Cable, Electric:

1. Space Temperature:

a. Input:

1) Device: Electric thermostat.
2) Location: Space.

b. Output:

1) Device: Line-voltage wiring.
2) Location: Junction box.
3) Transference: Cable.

c. Action: Cycle power to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature set point.

G. Radiant Heating Panel, Electric:

1. Space Temperature:

   a. Input:

      1) Device: Electronic thermostat.
      2) Location: Space.

   b. Output:

      1) Device: Low-voltage wiring.
      2) Location: Junction box.
      3) Transference: Line-voltage relay.

   c. Action: Cycle power to maintain the following space temperature set points:

      1) Occupied: [**75 deg F (24 deg C)**]<**Insert temperature**>.
      2) Unoccupied: [**65 deg F (18 deg C)**]<**Insert temperature**>.

H. Radiant Heating Panel, Hydronic:

1. Space Temperature from Line-Voltage Thermostat:

   a. Input:

      1) Device: Electronic thermostat.
      2) Location: Space.

   b. Output:

      1) Device: Low-voltage wiring.
      2) Location: Control valve.
      3) Transference: Valve actuator.

   c. Action: Cycle valve open and closed to maintain temperature set point.

2. Space Temperature from Air-Temperature Sensor:

   a. Input:

      1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
      2) Location: Space.
      3) Transference: DDC controller.

   b. Output:

      1) Device: DDC analog output.
      2) Location: Control valve.
      3) Transference: Valve actuator.

   c. Action: Modulate valve to maintain the following space temperature set points:

      1) Occupied: [**75 deg F (24 deg C)**]<**Insert temperature**>.
      2) Unoccupied: [**65 deg F (18 deg C)**]<**Insert temperature**>.

I. Two-Pipe, Single-Coil, Fan-Coil Unit:

1. Manual Start:

a. Input:

1) Device: Fan switch.
2) Location: Integral to thermostat.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Start and stop fan.

2. Space Temperature:

a. Input:

1) Device: Electronic thermostat.
2) Location: Space.

b. Output:

1) Device: Low-voltage wiring.
2) Location: Control valve.
3) Transference: Valve.

c. Action: Modulate valve to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

3. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Start and stop fan.

4. Space Temperature from Air-Temperature Sensor:

a. Input:

1) Device: Air-temperature sensor.
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate valve to maintain the following space temperature set points:

1) Occupied: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Unoccupied: [**65 deg F (18 deg C)**]<**Insert temperature**>.

5. System Changeover:

a. Input:

1) Device: Liquid temperature sensor [**or**][**liquid temperature sensor with liquid transmitter**].
2) Location: Supply-water piping.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Reverse control-valve action to switch from heating to cooling.

J. Four-Pipe, Hydronic Fan-Coil Unit:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action: Start and stop fan, and enable control.

2. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuators.

c. Action: Modulate control valves to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

K. Unit Ventilator:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output.
2) Location: Fan motor controller and damper.
3) Transference: Starter relay and damper actuators.

c. Action: Start and stop fan, move outdoor- and return-air dampers to [**minimum**][**maximum**] outdoor-air position, and enable control.

2. Space Temperature - Valves:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate heating-water control valve and chilled-water control valve in sequence to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

3. Space Temperature - Dampers:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature RTD transmitter**].
2) Location: Mixed-air plenum.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Dampers.
3) Transference: Damper actuators.

c. Action: Modulate outdoor- and return-air dampers to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

4. Supply-Air-Temperature Limit:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Discharge air.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve and dampers.
3) Transference: Valve and damper actuators.

c. Action: Override space temperature set point to control valves and dampers to prevent discharge air from dropping below a minimum set point of <**Insert value**>.

5. Warm-up Cycle:

a. Input:

1) Device: DDC controller.
2) Location: Time schedule.
3) Input Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve and damper.
3) Transference: Valve and damper actuators.

c. Action: Open heating-water control valve, close outdoor-air damper, and open return-air damper.

L. Heating Coils, [**Hydronic**][**Steam**]:

1. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate valve to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

M. Heating Coils, Electric:

1. Space Temperature:

a. Input:

1) Device: Electric thermostat.
2) Location: Space.
3) Transference: Low-voltage control.

b. Output:

1) Device: Pilot relays.
2) Location: Heating-coil electrical cabinet.
3) Transference: Line-voltage relays.

c. Action: Sequence stages of heating to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

N. Radiators and Convectors, [**Hydronic**][**Steam**]:

1. Occupancy:

a. Input:

1) Device: Occupancy sensor.
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action: Report occupancy and enable occupied temperature set point.

2. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate valve to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature set point.

1) Occupied Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Unoccupied Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

O. Radiators and Convectors, Electric:

1. Space Temperature:

a. Input:

1) Device: Electric thermostat.
2) Location: Space.
3) Transference: Low-voltage control.

b. Output:

1) Device: Pilot relays.
2) Location: Radiator electrical cabinet.
3) Transference: Line-voltage relays.

c. Action: Sequence stages of heating to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature set point.

P. Constant-Volume, Terminal Air Units, [**Hydronic**][**Steam**]:

1. Occupancy:

a. Input:

1) Device: Occupancy sensor.
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action: Report occupancy and enable occupied temperature set point.

2. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate valve to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

Q. Variable-Air-Volume Terminal Air Units with [**Hydronic**][**Steam**] Coils:

1. Occupancy:

a. Input:

1) Device: Occupancy sensor.
2) Location: Space.
3) Transference: DDC controller.

b. Device: DDC controller.
c. Action: Report occupancy and enable occupied temperature set point.

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

2. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control damper and valve actuators.
3) Input Transference: Control damper and valves.

c. Action: Modulate damper and valve to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
5) Modulate damper actuator from full open to minimum position.
6) When damper is at minimum position, modulate reheat coil valve from closed to open.
7) If occupied space temperature is not maintained with valve open, modulate damper actuator from minimum position to [**100**]<**Insert number**> percent open.
8) Reverse the sequence for full heating to full cooling.

R. Dual-Duct, Variable-Air-Volume Terminal Air Units:

1. Occupancy:

a. Input:

1) Device: Occupancy sensor.
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action: Report occupancy and enable occupied temperature set point.

1) Occupied Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Unoccupied Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.

2. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Damper actuator(s).
3) Transference: Dampers.

c. Action: Modulate dampers to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
5) When occupied space temperature is below set point, close cold-deck damper to minimum position and open hot-deck damper.
6) When occupied space temperature is above set point, close hot-deck damper to minimum position and open cold-deck damper.

S. Sequence Control:

1. Space Temperature:

a. Input:

1) Device: [**Air-temperature sensor**][**or**][**air-temperature sensor with air-temperature RTD transmitter**].
2) Location: Space.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control damper and valve actuators.
3) Input Transference: Control dampers and valves.

c. Action: Modulate valves and dampers to maintain the following space temperature set points:

1) Occupied Cooling Temperature: [**75 deg F (24 deg C)**]<**Insert temperature**>.
2) Occupied Heating Temperature: [**70 deg F (24 deg C)**]<**Insert temperature**>.
3) Unoccupied Cooling Temperature: [**85 deg F (24 deg C)**]<**Insert temperature**>.
4) Unoccupied Heating Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
5) Modulate damper actuator from open to minimum position.
6) When damper is at minimum position, modulate finned-tube radiation valve from closed to fully open.
7) When finned-tube radiation valve is fully open, modulate reheat coil valve from closed to fully open.
8) If occupied space temperature is not maintained with both valves open, modulate damper actuator from minimum position to [**100**]<**Insert number**> percent open.
9) Reverse the sequence for full heating to full cooling.

T. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system on-off indication (operating or not operating).
3. DDC system occupied/unoccupied mode.
4. Outdoor-air-temperature indication.
5. Cabinet Unit Heater, Hydronic:

a. Space temperature indication.
b. Space temperature set point.
c. Fan on.

6. Unit Heater, Hydronic:

a. Space temperature indication.
b. Space temperature set point.
c. Fan on.

7. Combustion-Air Unit Heaters:

a. Space temperature indication.
b. Space temperature set point.
c. Control-valve position.

8. Radiant Heating Panel, Hydronic:

a. Space temperature indication.
b. Space temperature set point.
c. Control-valve position.

9. Two-Pipe, Single-Coil, Fan-Coil Unit:

a. Space temperature indication.
b. Space temperature set point.
c. Control-valve position.
d. Supply-water temperature indication.

10. Four-Pipe, Hydronic Fan-Coil Unit:

a. Space temperature indication.
b. Space temperature set point.
c. Control-valve position.

11. Unit Ventilator:

a. DDC system on-off indication (operating or not operating).
b. Space temperature indication.
c. Space temperature set point.
d. Control-valve position.
e. Damper position.

12. Heating Coils, Hydronic:

a. Space temperature indication.
b. Space temperature set point.
c. Control-valve position.

13. Radiators and Convectors, Hydronic:

a. Space/area served.
b. Space temperature indication.
c. Space temperature set point.
d. Space temperature set point, occupied.
e. Space temperature set point, occupied standby.

f. Space temperature set point, unoccupied.
g. Control-valve position as percentage open.

14. Constant-Volume, Terminal Air Units, Hydronic:

a. Space/area served.
b. Space occupied/unoccupied.
c. Space temperature indication.
d. Space temperature set point, occupied.
e. Space temperature set point, unoccupied.
f. Control-valve position as percentage open.

15. Variable-Air-Volume Terminal Air Units with Hydronic Coils:

a. Space/area served.
b. Space occupied/unoccupied.
c. Space temperature indication.
d. Space temperature set point.
e. Space cooling and heating temperature set point, occupied.
f. Space cooling and heating temperature set point, unoccupied.
g. Air-damper position as percentage open.
h. Control-valve position as percentage open.

16. Dual-Duct, Variable-Air-Volume Terminal Air Units:

a. Space/area served.
b. Space occupied/unoccupied.
c. Occupied space temperature indication.
d. Occupied space temperature set point, occupied.
e. Occupied space temperature set point, unoccupied.
f. Hot-deck damper position as percentage open.
g. Cold-deck damper position as percentage open.

17. Sequence Control:

a. Space/area served.
b. Space occupied/unoccupied.
c. Space temperature indication.
d. Space temperature set point, occupied.
e. Space temperature set point, unoccupied.
f. Damper position as percentage open.
g. Control-valve positions as percentage open.

1.8 VENTILATION SEQUENCES

A. Combustion-Air, Makeup Unit Control, Electric:

1. Initiation:

a. Input:

1) Device: Auxiliary contact.
2) Location: Served appliance.

b. Output:

1) Device: Hard wired.
2) Location: Served appliance.
3) Transference: Starter relay and electric solenoid.

c. Action: Start fan when appliance burner starts.

2. Space Temperature:

a. Input:

1) Device: Electronic multistage thermostat.
2) Location: Space.

b. Output:

1) Device: Hard wired.
2) Location: Unit control panel.
3) Transference: Electric multistage contactors.

c. Action: Sequence electric coil stages to maintain [**75 deg F (24 deg C)**]<**Insert value**> space temperature.

B. Combustion-Air, Makeup Unit Control, [**Hydronic**][**Steam**]:

1. Initiation:

a. Input:

1) Device: Auxiliary contact.
2) Location: Served appliance.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay and electric solenoid.

c. Action: Start fan when appliance burner starts.

2. Space Temperature:

a. Input:

1) Device: Electronic thermostat.
2) Location: Space.

b. Output:

1) Device: Hard wired.
2) Location: Control valve.
3) Transference: Valve actuator.

c. Action: Modulate control valve to maintain [**75 deg F (24 deg C)**]<**Insert value**> space

temperature set point.

C. Gravity Roof Ventilator:

1. Input:

a. Device: [**Occupancy sensor**][**Electric thermostat**].
b. Location: Space.

2. Output:

a. Device: Hard wired.
b. Location: Control damper.
c. Transference: Damper actuator.

3. Action: Open control damper when space [**is occupied**][**temperature rises above set point**].

D. Exhaust Fan: [**Occupancy sensor**][**Light switch**][**Room thermostat**].

1. Input:

a. Device: [**Occupancy sensor**][**Light switch**][**Electric thermostat**].
b. Location: Space.

2. Output:

a. Device: Hard wired.
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action: Cycle fan on when [**space is occupied**][**lights are turned on**][**space temperature rises above set point**].

E. Kitchen Exhaust Fan: Occupancy sensor.

1. Input:

a. Device: Occupancy sensor.
b. Location: Space.

2. Output:

a. Device: Hard wired.
b. Location: Motor controller.
c. Transference: Starter relay.

3. Action: Start fan and energize makeup air unit when space is occupied.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 09 23 00C

Task	Specification	Specification Description
23 09 23 00	23 09 00 00	Speed Instruments

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SECTION 23 09 23 11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball-style control valves.
2. Butterfly-style control valves.
3. Globe-style control valves.
4. Pressure-independent control valves.
5. Solenoid valves.
6. Self-contained temperature-regulating valves.
7. Electric and electronic control valve actuators.
8. Pneumatic control valve actuators.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 DEFINITIONS

A. Cv: Valve coefficient.

B. DDC: Direct digital control.

C. EPT: Ethylene-propylene terpolymer rubber.

D. HNBR: Hydrogenated nitrile butadiene rubber.

E. NBR: Nitrile butadiene rubber.

F. PEEK: Polyether Ether Ketone rubber.

G. PTFE: Polytetrafluoroethylene.

H. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

I. RTFE: Glass-fiber-reinforced PTFE.

J. TFM: A chemically modified PTFE.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Ball-style control valves.
2. Butterfly-style control valves.
3. Globe-style control valves.
4. Pressure-independent control valves.
5. Solenoid valves.
6. Self-contained temperature-regulating valves.
7. Electric and electronic control valve actuators.
8. Pneumatic control valve actuators.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

D. Delegated Design Submittals:

1. Schedule and design calculations for control valves and actuators, including the following:

a. Flow at project design and minimum flow conditions.
b. Pressure differential drop across valve at project design flow condition.
c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst-case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Control valve installation location indicated in relationship to room, duct, pipe, and equipment.
2. Size and location of wall access panels for control valves installed behind walls.
3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

D. Code Compliance: Comply with governing energy code.

E. Delegated Design: Engage a qualified professional[**engineer**], as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

F. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

G. Backup Power Source: Serve control valve actuators from a backup power source where associated with systems and equipment served by a backup power source.

H. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

I. Selection Criteria:

1. Suitable for operation throughout full range of system operating conditions encountered.

   a. Chilled Water: <**Insert pressure and coincident temperature requirements**>.
   b. Condenser Water: <**Insert pressure and coincident temperature requirements**>.
   c. Heat Recovery: <**Insert pressure and coincident temperature requirements**>.
   d. Heating Hot Water: <**Insert pressure and coincident temperature requirements**>.
   e. Steam: <**Insert pressure and coincident temperature requirements**>.
   f. <**Insert system and requirements**>.

2. Control Valve Leakage: FCI 70-2, [**Class IV**]<**Insert class**> or less leakage, unless otherwise indicated.
3. Control Valve Pattern: [**Straight-through**][**Three-way**][**or**][**, six-way**], as indicated on Drawings.
4. Control Valve Flow Characteristics, Unless Otherwise Indicated:

   a. Modulating, Two-Way Pattern: Equal percentage.
   b. Modulating Three-Way Pattern: Linear flow. Total flow through the valve to be constant regardless of the valve's position.
   c. Modulating Butterfly Valves: [**Linear flow**][**or**][**Equal percentage**].

5. Fail-Safe Positions, Unless Otherwise Indicated:

a. Chilled Water: [**Close**][**Last position**][**Open**].
b. Condenser Water: [**Close**][**Last position**][**Open**].
c. Heat Recovery: [**Close**][**Last position**][**Open**].
d. Heating Hot Water: [**Close**][**Last position**][**Open**].
e. Steam: [**Close**][**Last position**][**Open**].
f. <**Insert system and fail-safe position**>.

6. Stable Operation: Select control valves and actuators for stable operation throughout full range of operation, from design Cv at design flow to minimum Cv.
7. Control Valve Styles:

a. Hydronic Systems:

1) Pipe Sizes NPS 2 (DN 50) and Smaller: [**Ball-**][**or**][**globe-**]style control valves.
2) Pipe Sizes Larger than NPS 2 (DN 50): [**Ball-**][**butterfly-**][**or**][**globe-**]style control valves.

b. Steam Systems: Use [**ball-**][**or**][**globe-**]style control valves.

J. Sizing Criteria: Unless otherwise indicated, select control valve size using the following:

1. ISA Standards:

a. Control Valve Sizes and Flow Coefficients: ISA 75.01.01.
b. Control Valve Characteristics and Rangeability: ISA 75.11.01.

2. Correction Factors: Consider viscosity, flashing, and cavitation corrections when selecting control valves.
3. Ball-Style Control Valves: Select valve size with design Cv at design flow between [**65**]<**Insert number**> and [**75**]<**Insert number**> degrees of valve full open position and minimum Cv between [**15**]<**Insert number**> and [**25**]<**Insert number**> percent of open position.
4. Butterfly-Style Control Valves: Select valve size with design Cv at design flow between [**65**]<**Insert number**> and [**75**]<**Insert number**> degrees of valve full open position and minimum Cv between [**15**]<**Insert number**> and [**25**]<**Insert number**> percent of open position.
5. Globe-Style Control Valves: Select valve size to pass the design Cv at design flow with not more than [**95**]<**Insert number**> percent of stem travel.
6. Modulating Control Valves in Hydronic Systems:

a. Select modulating control valve sizes at terminal equipment for a design Cv based on a pressure drop of [**5 psig (34 kPa)**][**7 psig (48 kPa)**]<**Insert value**> at design flow.
b. Calculate control valve minimum Cv at [**10**]<**Insert number**> percent of control valve design flow, with a coincident pressure differential equal to [**the system design pump head**]<**Insert requirement**>.
c. <**Insert requirement**>.

7. Modulating Control Valves Steam Systems: Select modulating valve sizes for steam service with a pressure drop at design flow equal to lesser of the following:

a. [**50**]<**Insert number**> percent of the valve inlet pressure.
b. [**50**]<**Insert number**> percent of the absolute steam pressure at the valve inlet.

8. Two-Position Valves: Select two-position control valves for full pipeline size.

K. Pneumatic, Two-Position Control Valve Opening and Closing Characteristic:

1. Provide a smooth opening and closing characteristic slow enough to avoid an excessive rapid change in system pressure and potential water hammer.
2. Provide an adjustable opening time (full closed to full open) and an adjustable closing time (full open to full closed) ranging from zero to [**10**][**15**][**30**]<**Insert value**> seconds. Make opening and closing times independently adjustable.

L. Pneumatic Control Signal Distance Limitation: Not to exceed [**100 ft. (30 m)**][**200 ft. (60 m)**]<**Insert distance**> from controller. For longer distances, provide an electric/electronic control signal to the valve/actuator and an electric solenoid valve or electro-pneumatic transducer locally at the valve/actuator to convert the control signal to pneumatic.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Threaded Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bonomi North America, Inc.**]
   c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bonomi North America, Inc.**]
   c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Milwaukee Valve Company**]
   f. [**NIBCO INC.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain threaded end two-way ball valves from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
   c. Flow Characteristic: Modified equal percentage.
   d. Leakage: FCI 70-2, [**Class IV**][**Class VI**] or less.
   e. Hydronic Pressure:

      1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal **600 psig (4137 kPa)**.
      2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal **400 psig (2758 kPa)**.
      3) Close-off Pressure: [**200 psig (1379 kPa)**]<**Insert pressure**>.

4) Pressure Differential (Maximum): [**50 psig (345 kPa)**]<**Insert pressure**>.

f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
g. Saturated Steam Pressure: [**35 psig (215 kPa) for bronze body control valves**][**50 psig (345 kPa) for stainless steel body control valves**]<**Insert pressure**>.

5. Construction for Ball Valves with Threaded Ends, Two Way:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Cast [**bronze**][**or**][**carbon steel**][**stainless steel**].
c. End Connections: Female threaded (NPT) ends.
d. Ball: Stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension[**extending beyond OD of insulation**].
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

B. Ball Valves with Flanged Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bonomi North America, Inc.**]
b. [**Milwaukee Valve Company**]
c. [**NIBCO INC.**]
d. [**Valve Solutions, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bonomi North America, Inc.**]
b. [**Milwaukee Valve Company**]
c. [**NIBCO INC.**]
d. [**Valve Solutions, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flanged end two-way ball valves from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.

b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
c. Flow Characteristic: Modified equal percentage.
d. Leakage: FCI 70-2, Class VI or less.
e. Hydronic Pressure:

1) Rating: ASME B16.34, [**Class 150**][**Class 300**][**or**][**Class 150 or 300 required by application**].
2) Close-off Pressure: Equal to rating.
3) Pressure Differential (Maximum): <**Insert pressure**>.

f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
g. Saturated Steam Pressure:

1) Rating: Maximum [**50 psig (345 kPa)**][**150 psig (1034 kPa)**]<**Insert pressure**>
2) Close-off Pressure: Equal to pressure rating.
3) Differential (Maximum): <**Insert pressure**>.

5. Standards for Ball Valves with Flanged Ends, Two Way: ASME B16.34, MSS SP-72.
6. Features:

a. Full [**or standard**] port.
b. Replaceable ball, seat and stem packing.
c. Pressure equalized between body cavity and the line flow.
d. Mounting pad for actuator.

7. Construction:

a. Size Range: **NPS 1/2 to NPS 12 (DN 13 to DN 300)**.
b. Body: Cast [**steel**][**or**][**stainless steel**]; two pieces.
c. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges.
d. Ball: Stainless steel; vented.
e. Ball Seats: Reinforced PTFE.
f. Stem: Material to match ball; blowout-proof design.
g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure.

C. Ball Valves with Threaded Ends, Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bonomi North America, Inc.**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Siemens Industry, Inc., Building Technologies Division**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bonomi North America, Inc.**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Siemens Industry, Inc., Building Technologies Division**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain threaded end three-way ball valves from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
c. Flow Characteristic: Modified linear flow.
d. Leakage: FCI 70-2, [**Class III**][**Class IV**][**Class VI**] or less.
e. Hydronic Pressure:

1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal **600 psig (4137 kPa)**.
2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal **400 psig (2758 kPa)**.
3) Close-off Pressure: [**200 psig (1379 kPa)**]<**Insert pressure**>.
4) Pressure Differential (Maximum): [**50 psig (345 kPa)**]<**Insert pressure**>.

f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.

5. Construction:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Cast [**bronze**][**or**][**stainless steel**].
c. End Connections: Female threaded (NPT) ends.
d. Ball: Stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension[**extending beyond OD of insulation**].
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

D. Ball Valves with Characterized Disk and Threaded Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
c. Flow Characteristic: Equal percentage.
d. Leakage: FCI 70-2, [**Class IV**][**Class VI**] or less.
e. Hydronic Pressure:

1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal **600 psig (4137 kPa)**.
2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal **400 psig (2758 kPa)**.
3) Close-off Pressure: [**200 psig (1379 kPa)**]<**Insert pressure**>.
4) Pressure Differential (Maximum): [**50 psig (345 kPa)**]<**Insert pressure**>.

f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
g. Rangeability: [**300**]<**Insert number**> to 1.

5. Construction:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Cast bronze or forged brass[**with nickel plating**].
c. End Connections: Female threaded (NPT) ends.
d. Ball: [**Chrome-plated brass or bronze**][**or**][**300 series stainless steel**].
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: [**Glass-filled PTFE,**][**Noryl,**][**polyphthalamide resin,**] Tefzel or stainless steel.
g. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension[**extending beyond OD of insulation**].
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

E. Ball Valves with Characterized Disk and Flanged Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bray Commercial**]
   c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bray Commercial**]
   c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way ball valves, with characterized disk and flanged ends, from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
   c. Flow Characteristic: Equal percentage.
   d. Leakage: FCI 70-2, [**Class III**][**Class IV**][**Class VI**] or less.
   e. Hydronic Pressure:

      1) Rating: In accordance with ASME B16.1, Class B.
      2) Close-off Pressure:

         a) Class 125: **175 psig (1207 kPa)**.
         b) Class 250: **310 psig (2137 kPa)**.

      3) Pressure Differential (Maximum): [**50 psig (345 kPa)**]<**Insert pressure**>.

   f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
   g. Rangeability: [**300**]<**Insert number**> to 1.

5. Construction:

   a. Size Range: **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**.
   b. Body: Cast iron, Class B in accordance with ASME B16.1.
   c. End Connections: Flanged, Class 125 or 250 in accordance with ASME B16.1.

d. Ball: Stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension: Material to match ball; blowout-proof design.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

F. Ball Valves with Characterized Disk and Threaded Ends, Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   c. [**Johnson Controls, Inc.**]
   d. [**Siemens Industry, Inc., Building Technologies Division**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   c. [**Johnson Controls, Inc.**]
   d. [**Siemens Industry, Inc., Building Technologies Division**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain three-way ball valves, with characterized disk and threaded ends, from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
   c. Flow Characteristics:

      1) A-Port: Equal percentage.
      2) B-Port: Modified for constant common port flow.

   d. Leakage: FCI 70-2, [**Class IV**][**Class VI**] or less for A-port; [**one**][**two**] percent for B-port.
   e. Hydronic Pressure:

      1) Rating for Sizes NPS 1 (DN 25) and Smaller: Nominal **600 psig (4137 kPa)**.
      2) Rating for Sizes NPS 1-1/4 through NPS 2 (DN 32 through DN 50): Nominal **400 psig (2758 kPa)**.
      3) Close-off Pressure: [**200 psig (1379 kPa)**]<**Insert pressure**>.
      4) Pressure Differential (Maximum): [**50 psig (345 kPa)**]<**Insert pressure**>.

   f. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
   g. Rangeability: [**300**]<**Insert number**> to 1.

5. Construction:

   a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
   b. Body: Cast bronze or forged brass[**with nickel plating**].
   c. End Connections: Female threaded (NPT) ends.
   d. Ball: [**Chrome-plated brass or bronze**][**or**][**300 series stainless steel**].
   e. Ball Seats: Reinforced PTFE.
   f. Characterizing Disk: [**Glass-filled PTFE,**][**Noryl,**][**polyphthalamide resin,**] Tefzel or stainless steel.
   g. Stem and Stem Extension:

      1) Material to match ball.
      2) Blowout-proof design.
      3) For valves installed in insulated piping systems, provide stem extension[**extending beyond OD of insulation**].
      4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

   h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

G. Ball Valves with Characterized Disk, Six Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   c. [**IMI Hydronic Engineering Inc**]
   d. [**Johnson Controls, Inc.**]
   e. [**Siemens Industry, Inc., Building Technologies Division**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   c. [**IMI Hydronic Engineering Inc**]
   d. [**Johnson Controls, Inc.**]
   e. [**Siemens Industry, Inc., Building Technologies Division**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain six-way ball valves, with characterized disk, from single manufacturer.
4. Description: Functionality of four two-way control valves. One control valve and electronic actuator performs changeover and modulating control for a single coil in a four-pipe system with full close-off for both heating and cooling.
5. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.

b. Flow Characteristics: Equal percentage or linear.
c. Leakage: Zero.
d. Hydronic Pressure:

1) Rating: **230 psig (1585 kPa)**.
2) Close-off Pressure: [**50 psig (345 kPa)**]<**Insert pressure**>.
3) Pressure Differential (Maximum): [**15 psig (103 kPa)**]<**Insert pressure**>.

e. Hydronic Process Temperature Range: [**43 to 180 deg F (6 to 82 deg C)**]<**Insert temperature range**>.

6. Construction:

a. Size Range: **NPS 1/2 to NPS 1 (DN 13 to DN 25)**.
b. Body: Forged brass[**with nickel plating**].
c. End Connections: Female threaded (NPT) ends.
d. Ball: Chrome-plated brass or bronze, stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Chrome-plated steel, brass, or stainless steel.
g. Stem and Stem Extension: Material to match ball; blowout-proof design.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

H. Ball Valves with Segmented Ball, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bray Commercial**]
b. [**Fischer; Emerson Electric Co., Automation Solutions**]
c. [**Flo-Tite, Inc.**]
d. [**Flowserve Corporation**]
e. [**Max-Air Technology Inc.**]
f. [**Valve Solutions, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bray Commercial**]
b. [**Fischer; Emerson Electric Co., Automation Solutions**]
c. [**Flo-Tite, Inc.**]
d. [**Flowserve Corporation**]
e. [**Max-Air Technology Inc.**]
f. [**Valve Solutions, Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way ball valves, with segmented ball, from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.

b. Controllable Flow Range: [**75**][**Insert number**] percent open.
c. Flow Characteristic: Equal percentage or modified equal percentage.
d. Leakage: FCI 70-2, Class VI.
e. Hydronic Pressure:

1) Rating: ASME B16.34, [**Class 150**][**Class 300**][**or**][**Class 150 or 300 as required by application**].
2) Close-off Pressure: [**250 psig (1724 kPa)**]<**Insert pressure**>.
3) Pressure Differential (Maximum): [**Approximately 1/3 inlet pressure**]<**Insert pressure**>.

f. Hydronic Process Temperature Rating: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**][**Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**]<**Insert temperature range**>.
g. Saturated Steam Pressure:

1) Rating: Maximum [**50 psig (345 kPa)**][**125 psig (862 kPa)**]<**Insert pressure**>
2) Close-off Pressure: [**50 psig (345 kPa)**][**125 psig (862 kPa)**]<**Insert pressure**>.
3) Differential (Maximum): <**Insert pressure**>.

h. Rangeability: [**300**]<**Insert number**> to 1.

5. Standards: ASME B16.10, ASME B16.34.
6. Features:

a. Stem and ball pinned and welded.
b. Replaceable ball, seat and packing.

7. Construction:

a. Size Range: [**NPS 1 to NPS 12 (DN 25 to DN 300)**][**NPS 1 to NPS 16 (DN 25 to DN 400)**][**NPS 1 to NPS 24 (DN 25 to DN 600)**]<**Insert size range**>.
b. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges. Female threaded (NPT) ends are also acceptable for valve sizes **NPS 2 (DN 50)** and smaller.
c. Face-to-Face Dimensions: ASME B16.10 or ISA S75.08.02.
d. Body: Cast [**carbon**][**or**][**stainless**] steel.
e. Ball: Stainless steel.
f. Seat: TFM or reinforced PTFE.
g. Stem: Stainless steel.
h. Stem Packing: PTFE V-rings.
i. Label each valve with following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Flow directional arrow.

I. Ball Valves with Segmented Ball, Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Valve Solutions, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Valve Solutions, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain three-way ball valves, with segmented ball, from single manufacturer.
4. Arrangement: Two single-port valves mated to a fabricated tee with interconnecting mechanical linkage[**or a single three-way valve with two ports**].
5. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: [**75**]<**Insert number**> percent open.
   c. Flow Characteristic: Equal percentage.
   d. Leakage: FCI 70-2, Class VI.
   e. Hydronic Pressure:

      1) Rating: ASME B16.34, [**Class 150**][**Class 300**][**or**][**Class 150 or 300 as required by application**].
      2) Close-off Pressure: **250 psig (1724 kPa)**.
      3) Pressure Differential (Maximum): [**Approximately one-third inlet pressure**]<**Insert pressure**>.

   f. Hydronic Process Temperature Rating: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
   g. Rangeability: [**300**]<**Insert number**> to 1.

6. Standards: ASME B16.10, ASME B16.34.
7. Features:

   a. Stem and ball pinned and welded.
   b. Replaceable ball, seat and shaft packing.

8. Construction:

   a. Size Range: [**NPS 3 to NPS 12 (DN 80 to DN 300)**]<**Insert size**>
   b. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges.
   c. Face-to-Face Dimensions: ASME B16.10 or ISA S75.08.02.
   d. Body: Cast [**carbon**][**or**][**stainless**] steel.
   e. Ball: Stainless steel.
   f. Seat: TFM or graphite reinforced PTFE.
   g. Stem: Stainless steel.
   h. Stem Packing: PTFE V-rings and graphite packing follower.
   i. Label each valve with following:

      1) Manufacturer's name, model number, and serial number.
      2) Body size.
      3) Flow directional arrow.

J. Ball Valves with Full Ball and Characterized V-Notch, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bray Commercial**]
b. [**Flo-Tite, Inc.**]
c. [**Flow-Tek; a subsidiary of Bray International**]
d. [**Valve Solutions, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bray Commercial**]
   b. [**Flo-Tite, Inc.**]
   c. [**Flow-Tek; a subsidiary of Bray International**]
   d. [**Valve Solutions, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way ball valves, with full ball and characterized v-notch, from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: [**80**][**Insert number**] percent open.
   c. Flow Characteristic: Equal percentage[**or modified equal percentage**].
   d. Leakage: FCI 70-2, Class VI.
   e. Hydronic Pressure:

      1) Rating:

         a) Sizes NPS 2 (DN 50) and Smaller: ASME B16.34, Class 300 or 600.
         b) Larger Sizes: ASME B16.34, [**Class 150**][**Class 300**][**or**][**Class 150 or 300 as required by application**].

      2) Close-off Pressure: Equal to rating.
      3) Pressure Differential (Maximum): [**Approximately 1/3 inlet pressure**]<**Insert pressure**>.

   f. Hydronic Process Temperature Rating: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**][**Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**]<**Insert temperature range**>.
   g. Saturated Steam Pressure:

      1) Rating: Maximum [**50 psig (345 kPa)**][**150 psig (1034 kPa)**]<**Insert pressure**>
      2) Close-off Pressure: Equal to pressure rating at maximum temperature.
      3) Differential (Maximum): <**Insert pressure**>.

   h. Rangeability: Varies from 200 to 1 up to [**800**]<**Insert number**> to 1 based on notch pattern of ball.

5. Standards: ASME B16.34, MSS SP-72.
6. Features:

   a. Full[**or standard**] port.
   b. Replaceable ball, seat, shaft bushings, and packing.
   c. Pressure equalized between body cavity and the line flow.
   d. Universal mounting pad complying with ISO 5211 for actuator mounting.

7. Construction:

   a. Size Range: **NPS 1/2 to NPS 12 (DN 15 to DN 300)**.
   b. Sizes NPS 2 (DN 50) and Smaller:

      1) End Connections: Female threaded (NPT) ends complying with ASME B1.20.1 or flanged ends suitable for mating to ASME B16.5 flanges.
      2) Stem Seals: Live-loaded, self-adjusting, primary and secondary sealing using belleville washers.

         a) Primary Seal: Combination of thrust washer and thrust washer protector.
         b) Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.

   c. Sizes Larger than NPS 2 (DN 50):

      1) Stem Seals: Independent packing gland, adjusted without removing mounting hardware or operator, and contoured to uniformly distribute load across packing.

         a) Primary Seal: Combination of thrust washer and thrust washer protector.
         b) Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.

      2) Flanged ends suitable for mating to ASME B16.5 flanges.

   d. Face-to-Face Dimension: ASME B16.10 short or long pattern, or ISA S75.08.02.
   e. Body: [**Carbon**][**or**][**stainless**] steel; two- or three-piece design.
   f. Ball: Stainless steel.
   g. Seat: Reinforced PTFE, TFM, PEEK.
   h. Shaft: Stainless steel.

8. Label each valve with following:

   a. Manufacturer's name, model number, and serial number.
   b. Body size.
   c. Flow directional arrow.

2.3 BUTTERFLY-STYLE CONTROL VALVES

A. Butterfly Valves with Resilient Seats, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bonomi North America, Inc.**]
   c. [**Bray Commercial**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**Keystone; Emerson Electric Co., Automation Solutions**]
   g. [**Max-Air Technology Inc.**]
   h. [**Max-Seal, Inc.**]
   i. [**Milwaukee Valve Company**]
   j. [**NIBCO INC.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]

l. [**Valve Solutions, Inc.**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bonomi North America, Inc.**]
   c. [**Bray Commercial**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**Keystone; Emerson Electric Co., Automation Solutions**]
   g. [**Max-Air Technology Inc.**]
   h. [**Max-Seal, Inc.**]
   i. [**Milwaukee Valve Company**]
   j. [**NIBCO INC.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. [**Valve Solutions, Inc.**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way butterfly valves, with resilient seats, from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Flow Characteristic: Linear or modified equal percentage.
   c. Leakage: Bubble tight.
   d. Hydronic Pressure:

      1) Rating: Minimum [**150 psig (1034 kPa)**][**175 psig (1207 kPa)**][**200 psig (1379 kPa)**][**250 psig (1724 kPa)**]<**Insert pressure**>.
      2) Shutoff Pressure: Minimum [**150 psig (1034 kPa)**][**175 psig (1207 kPa)**][**200 psig (1379 kPa)**][**250 psig (1724 kPa)**]<**Insert pressure**>.
      3) Differential (Maximum): <**Insert pressure**>.

   e. Hydronic Process Temperature Range: [**0 to 225 deg F (Minus 18 to plus 107 deg C)**]<**Insert temperature range**>.

5. Standards: MSS SP-67.
6. Features:

   a. Bidirectional, dead end service[**with downstream flange removed**].
   b. Extended neck of body to accommodate up to **2-inch- (50-mm-)** thick insulation.
   c. Replaceable disc, shaft bearings/bushings[**and seat**].

7. Construction:

   a. Size Range: [**NPS 2 to NPS 12 (DN 65 to DN 300)**][**NPS 2 to NPS 24 (DN 65 to DN 600)**]<**Insert size range**>
   b. Body: Cast iron or ductile iron; single flange, fully lugged and suitable for mating to ASME B16.5 flanges.
   c. Disc: [**Aluminum bronze**][**nylon-coated ductile iron**][**or**][**stainless steel**]<**Insert material**>.
   d. Seat: Reinforced [**EPDM**]<**Insert material**>.

e. Stem(s): Stainless steel.
f. Stem Bushings: Reinforced PTFE.
g. Corrosion-resistant nameplate indicating the following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Body and trim materials.
4) Flow arrow.

B. Butterfly Valves with Resilient Seats, Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. [**Valve Solutions, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. [**Valve Solutions, Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain three-way butterfly valves, with resilient seats, from single manufacturer.
4. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
5. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Linear or modified equal percentage.
c. Leakage: Bubble tight.
d. Hydronic Pressure:

1) Rating: Minimum [**150 psig (1034 kPa)**][**175 psig (1207 kPa)**][**200 psig (1379 kPa)**]<**Insert pressure**>.
2) Close-off Pressure: Minimum [**150 psig (1034 kPa)**][**175 psig (1207 kPa)**][**200 psig (1379 kPa)**]<**Insert pressure**>.
3) Differential (Maximum): <**Insert pressure**>.

e. Hydronic Process Temperature Range: [**0 to 225 deg F (Minus 18 to plus 107 deg C)**]<**Insert temperature range**>.

6. Standards: MSS SP-67.

7. Features:

   a. Bidirectional service.
   b. Extended neck of body to accommodate up to **2-inch- (50-mm-)** thick insulation.
   c. Replaceable disc, shaft bearings/bushings[**and seat**].

8. Construction:

   a. Size Range: [**NPS 2 to NPS 12 (DN 65 to DN 300)**][**NPS 2 to NPS 24 (DN 65 to DN 600)**]<**Insert size range**>
   b. Body: Cast iron or ductile iron; single flange, fully lugged and suitable for mating to ASME B16.5 flanges.
   c. Disc: [**Aluminum bronze**][**Nylon-coated ductile iron**][**or**][**stainless steel**]<**Insert material**>.
   d. Stem(s): Stainless steel.
   e. Seat: Reinforced [**EPDM**][**or**]<**Insert material**>.
   f. Stem Bearings/Bushings: Reinforced PTFE.
   g. Corrosion-resistant nameplate indicating the following:

      1) Manufacturer's name, model number, and serial number.
      2) Body size.
      3) Body and trim materials.
      4) Flow arrow.

C. High-Performance Butterfly Valves, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bray Commercial**]
   c. [**Fischer; Emerson Electric Co., Automation Solutions**]
   d. [**Flowserve Corporation**]
   e. [**Keystone; Emerson Electric Co., Automation Solutions**]
   f. [**Max-Seal, Inc.**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Valve Solutions, Inc.**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bray Commercial**]
   c. [**Fischer; Emerson Electric Co., Automation Solutions**]
   d. [**Flowserve Corporation**]
   e. [**Keystone; Emerson Electric Co., Automation Solutions**]
   f. [**Max-Seal, Inc.**]
   g. [**Milwaukee Valve Company**]
   h. [**NIBCO INC.**]
   i. [**Valve Solutions, Inc.**]

j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way high-performance butterfly valves from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Flow Characteristic: Linear or modified equal percentage.
   c. Leakage: FCI 70-2, Class VI.
   d. Hydronic Pressure:

      1) Rating: ASME B16.34, [**Class 150**][**Class 300**][**or**][**Class 150 or 300 as required by application**].
      2) Close-off Pressure: Equal to rating.
      3) Pressure Differential (Maximum): <**Insert pressure**>.

   e. Hydronic Process Temperature Rating: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**][**Minus 20 to plus 450 deg F (Minus 29 to plus 232 deg C)**]<**Insert temperature range**>.
   f. Saturated Steam Pressure

      1) Rating: Maximum [**50 psig (345 kPa)**][**150 psig (1034 kPa)**]<**Insert pressure**>
      2) Close-off Pressure: Equal to pressure rating.
      3) Differential (Maximum): <**Insert pressure**>.

   g. Rangeability: [**100**]<**Insert number**> to 1.

5. Standards: ASME B16.34, MSS SP-68.
6. Features:

   a. Bidirectional, end-of-line service[**with downstream flange removed**].
   b. Extended neck of body to accommodate up to **2-inch- (50-mm-)** thick insulation.
   c. Replaceable seat, disc and shaft bearings/bushings.

7. Construction:

   a. Size Range: [**NPS 2-1/2 to NPS 36 (DN 65 to DN 900)**]<**Insert size range**>
   b. Body: Cast [**steel**][**or**][**stainless steel**]; single flange, fully lugged and suitable for mating to ASME B16.5 or ASME B16.47 flanges.
   c. Disc: Stainless steel.
   d. Seat: Reinforced PTFE [**or**]<**Insert material**> with stainless steel retaining ring.
   e. Stem(s): Stainless steel.
   f. Stem Bearings: Stainless steel.
   g. Stem Packing: PTFE.
   h. Corrosion-resistant nameplate indicating the following:

      1) Manufacturer's name, model number, and serial number.
      2) Body size.
      3) Body and trim materials.
      4) Body rating.
      5) Arrow indicating direction of flow.

2.4 GLOBE-STYLE CONTROL VALVES

A. General Requirements:

1. Body Dimensions: Comply with ISA 75.08.01.
2. Field Service: Construct the valves to be serviceable from the top with replaceable seats and plugs.
3. Field-Interchangeable Trim:

    a. Cage Guided Valves: Available with field-interchangeable trim for different valve flow characteristics, such as equal percentage, linear, and quick opening.
    b. Industrial Valves **NPS 1 (DN 25)** and Larger: Available with reduced trim one nominal size smaller.

4. Nameplate: Corrosion-resistant, indicating the following:

    a. Manufacturer's name, model number, and serial number.
    b. Body and trim size.
    c. Arrow indicating direction of flow.

B. Globe Valves NPS 2 (DN 50) and Smaller, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**IMI Hydronic Engineering Inc**]
    c. [**Johnson Controls, Inc.**]
    d. [**Siemens Industry, Inc., Building Technologies Division**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**IMI Hydronic Engineering Inc**]
    c. [**Johnson Controls, Inc.**]
    d. [**Siemens Industry, Inc., Building Technologies Division**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way globe valves, **NPS 2 (DN 50)** and smaller, from single manufacturer.
4. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Equal percentage.
    c. Leakage: [**FCI 70-2, Class VI**][**FCI 70-2, Class IV for brass trim**][**or**][**0.05 percent of maximum flow for stainless steel trim**]<**Insert leakage**>.
    d. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.15, Class 250.
        2) Close-off Pressure: Equal to pressure rating at maximum temperature.
        3) Pressure Differential (Maximum): [**30 psig (207 kPa) for sizes through NPS 2 (DN 50)**][**35 psig (207 kPa)**]<**Insert pressure**>.

    e. Saturated Steam Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Pressure Differential (Maximum): [**15 psig (103 kPa) for control valves with brass trim**][**100 psig (689 kPa) for control valves with stainless steel trim**]<**Insert pressure**>.

f. Ambient Operating Temperature: **35 to 150 deg F (2 to 65 deg C)**.
g. Process Temperature Range:

1) Hydronic: **35 to 248 deg F (2 to 120 deg C)**.
2) Steam: Temperature at saturated steam pressure.

h. Rangeability: [**100**]<**Insert number**> to 1.

5. Construction:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Cast bronze or forged brass; ASME B16.15, Class 250.
c. End Connections: [**Female NPT threaded ends**], [**Unions with solder ends**][**Unions with threaded ends**].
d. Bonnet: Bronze or brass, threaded.
e. Plug: Top guided.
f. Brass Trim:

1) Packing: Self-adjusting Ethylene Propylene Rubber (EPR) rings or PTFE V-ring.
2) Plug: Brass.
3) Seat: Bronze or molded elastomeric disk.
4) Stem: Stainless steel.

g. Stainless Steel Trim:

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

C. Globe Valves NPS 2 (DN 50) and Smaller, Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Johnson Controls, Inc.**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Johnson Controls, Inc.**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain three-way globe valves, **NPS 2 (DN 50)** and smaller, from single manufacturer.
4. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Linear.
    c. Leakage: [**FCI 70-2, Class VI**][**FCI 70-2, Class IV for brass trim**][**or**][**0.05 percent of maximum flow for stainless steel trim**]<**Insert leakage**>.
    d. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.15, Class 250.
        2) Close-off Pressure: Equal to pressure rating at maximum temperature.
        3) Pressure Differential (Maximum): [**30 psig (207 kPa) for sizes through NPS 2 (DN 50)**][**35 psig (207 kPa)**]<**Insert pressure**>.

    e. Ambient Operating Temperature: **35 to 150 deg F (2 to 65 deg C)**.
    f. Hydronic Process Temperature Range: **35 to 248 deg F (2 to 120 deg C)**.
    g. Rangeability: [**25 to 1**][**100 to 1**]<**Insert rangeability**>.

5. Construction:

    a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
    b. Body: Cast bronze or forged brass; ASME B16.15, Class 250.
    c. End Connections: [**Female NPT threaded ends**], [**Unions with solder ends**][**Unions with threaded ends**].
    d. Bonnet: Bronze or brass, threaded.
    e. Plug: Top guided.
    f. Brass Trim:

        1) Packing: Self-adjusting Ethylene Propylene Rubber (EPR) rings or PTFE V-ring.
        2) Plug: Brass
        3) Seat: Bronze or molded elastomeric disk.
        4) Stem: Stainless steel.

D. Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Bray Commercial**]
    c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
    d. [**Johnson Controls, Inc.**]
    e. [**Siemens Industry, Inc., Building Technologies Division**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Bray Commercial**]
    c. [**Honeywell Building Solutions; Honeywell International, Inc.**]

d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way globe valves, **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**, from single manufacturer.
4. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: [**Equal percentage**][**or**][**linear**].
c. Leakage: [**FCI 70-2, Class IV**][**0.1 percent of maximum flow**]<**Insert leakage**>.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.1, [**Class 125**][**Class 250**][**or**][**Class 125 or 250 as required by application**].
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): [**25 psig (172 kPa)**]<**Insert pressure**>.

e. Hydronic Process Temperature: [**35 to 280 deg F (2 to 138 deg C)**]<**Insert temperature range**>.
f. Saturated Steam Pressure:

1) Rating: In accordance with ASME B16.1, [**Class 125**][**Class 250**][**or**][**Class 125 or 250 as required by application**].
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): [**15 psig (689 kPa)**]<**Insert pressure**>.

g. Ambient Operating Temperature: [**0 to 150 deg F (Minus 18 to 65 deg C)**]<**Insert temperature range**>.
h. Rangeability: [**10 to 1**][**50 to 1**][**85 to 1**][**100 to 1**]<**Insert rangeability**>.

5. Construction:

a. Size Range: **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**.
b. Body: Cast iron; ASME B16.1.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Bonnet: Cast iron; bolted.
e. Plug: Top or bottom guided.
f. Brass or Bronze Trim:

1) Packing: EPT rings or PTFE V-ring.
2) Plug: Brass or bronze.
3) Seat: Brass or bronze.
4) Stem: Stainless steel.

g. Stainless Steel Trim:

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

E. Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Three Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Honeywell Building Solutions; Honeywell International, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Siemens Industry, Inc., Building Technologies Division**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain three-way globe valves, **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**, from single manufacturer.
4. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Linear.
c. Leakage: [**FCI 70-2, Class III**][**FCI 70-2, Class IV**][**0.01 percent of maximum flow**]<**Insert leakage**>.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.1, [**Class 125**][**Class 250**][**or**][**Class 125 or 250 as required by application**].
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): [**25 psig (172 kPa)**]<**Insert pressure**>.

e. Hydronic Process Temperature: [**35 to 280 deg F (2 to 138 deg C)**]<**Insert temperature range**>.
f. Ambient Operating Temperature: [**0 to 150 deg F (Minus 18 to 65 deg C)**]<**Insert temperature range**>.
g. Rangeability: [**10 to 1**][**50 to 1**][**100 to 1**]<**Insert rangeability**>.

5. Construction:

a. Size Range: **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**.
b. Body: Cast iron; ASME B16.1.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Bonnet: Cast iron; bolted.
e. Plug: Top or bottom guided.
f. Brass or Bronze Trim:

1) Packing: EPT rings or PTFE V-ring.
2) Plug: Brass or bronze.
3) Seat: Brass or bronze.
4) Stem: Stainless steel.

g. Stainless Steel Trim:

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

F. Industrial-Grade Globe Valves NPS 3/4 (DN 20) and Smaller, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Spence Engineering Company, Inc**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Spence Engineering Company, Inc**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way industrial-grade globe valves, **NPS 3/4 (DN 20)** and smaller, from single manufacturer.
4. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: [**Equal percentage**][**or**][**linear**].
c. Leakage: FCI 70-2, [**Class IV**][**Class VI**].
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): [**35 psig (207 kPa)**][**100 psig (689 kPa)**]<**Insert pressure**>.

e. Hydronic Process Temperature Range: [**0 to 400 deg F (Minus 18 to 204 deg C)**]<**Insert temperature range**>.
f. Saturated Steam Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating.
3) Pressure Differential (Maximum): [**100 psig (689 kPa)**]<**Insert pressure**>.

g. Ambient Operating Temperature: [**Minus 20 to 150 deg F (Minus 29 to 65 deg C)**]<**Insert temperature range**>.
h. Rangeability: [**100 to 1**]<**Insert rangeability**>.

5. Construction:

a. Size Range: **NPS1/2 to NPS 3/4 (DN 15 to DN 20)**.
b. Body: Bronze.
c. End Connections: Female NPT threaded.
d. Bonnet: Bronze; screwed or bolted.
e. Packing: PTFE V-ring.
f. Plug: Top or cage guided; balanced or unbalanced.
g. Plug and Stem: Stainless steel.
h. Seat: Stainless steel with PTFE insert.

G. Industrial-Grade Globe Valves NPS 1 (DN 25) and Larger, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fischer; Emerson Electric Co., Automation Solutions**]
   b. [**Flowserve Corporation**]
   c. [**Jordan Valve; Richards Industries Company**]
   d. [**Spirax Sarco Limited**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fischer; Emerson Electric Co., Automation Solutions**]
   b. [**Flowserve Corporation**]
   c. [**Jordan Valve; Richards Industries Company**]
   d. [**Spirax Sarco Limited**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way industrial-grade globe valves from single manufacturer.
4. Performance:

   a. Stem Action: Linear stem travel.
   b. Flow Characteristic: [**Equal percentage**][**Linear**][**or**][**quick opening**].
   c. Leakage: FCI 70-2, [**Class IV**][**Class V**][**Class VI**].
   d. Hydronic Pressure:

      1) Rating for Cast-Iron Body Valves: In accordance with ASME B16.1, Class 125 or 250, as required by application.
      2) Rating for Cast-Steel and Stainless Steel Body Valves: In accordance with ASME B16.34, Class 150 or 300, as required by application.
      3) Close-off Pressure: Equal to pressure rating.
      4) Pressure Differential (Maximum): [**35 psig (207 kPa)**][**100 psig (689 kPa)**]<**Insert pressure**>.

   e. Hydronic Process Temperature: [**0 to 450 deg F (Minus 18 to 232 deg C)**]<**Insert temperature range**>.
   f. Saturated Steam Pressure:

      1) Rating for Cast-Iron Valves: In accordance with ASME B16.1, Class 125 or 250, as required by application.
      2) Rating for Cast-Steel and Stainless Steel Valves: In accordance with ASME B16.34,

Class 150 or 300, as required by application.
3) Close-off Pressure: Equal to pressure rating.
4) Pressure Differential (Maximum): [**100 psig (689 kPa)**]<**Insert pressure**>.

g. Ambient Operating Temperature: [**Minus 20 to 150 deg F (Minus 29 to 65 deg C)**]<**Insert temperature range**>.
h. Rangeability: [**50 to 1**][**100 to 1**]<**Insert rangeability**>.

5. Features:

a. Interchangeable, restricted-capacity and full-size trim.
b. Interchangeable, cage and plug styles for three different flow characteristics: equal percentage, linear and quick opening.
c. Trim options to prevent damage caused by cavitation where required by application.

6. Construction:

a. Size Range: **NPS 1 to NPS 30 (DN 50 to DN 750)**.
b. Body: Cast [**iron**][**carbon steel**][**or**][**stainless steel**].
c. End Connections:

1) NPS 2 (DN 50) and Smaller: Female NPT threaded or flanged suitable for mating to ASME B16.5 flanges.
2) NPS 2-1/2 (DN 65) and Larger: Raised face flanges suitable for mating to ASME B16.5 or ASME B16.47 flanges.

d. Bonnet: Bolted, material to match body.
e. Packing: PTFE V-ring.
f. Plug: Cage guided and balanced.
g. Plug, Seat, Cage, and Stem: Stainless steel plug and seat with hardened facing, stainless steel cage and stem.
h. Stem: Thread and pin stem to plug; polished finish.

2.5 PRESSURE-INDEPENDENT CONTROL VALVES

A. Pressure-Independent Ball Valves NPS 2 (DN 50) and Smaller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]
c. [**Griswold Controls, LLC**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]

c. [**Griswold Controls, LLC**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-independent ball valves, **NPS 2 (DN 50)** and smaller, from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Flow Characteristic: Equal percentage.
c. Leakage: Zero.
d. Hydronic Pressure Rating: **360 psig (2482 kPa)**.
e. Hydronic Close-off Pressure: **200 psig (1379 kPa)**.
f. Process Temperature Range: Between **35 to 250 deg F (2 to plus 121 deg C)**.
g. Rangeability: 100 to 1.

5. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by one of the follow methods:

a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of [**5 to 50 psig (34 to 345 kPa)**]<**Insert pressure range**>.
b. Integral Electronic Regulation: Electronic flow meter and control signal to maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.

1) Flow Measurement: Within 2 percent of actual reading.
2) Flow Control: Within 5 percent of set point.
3) Pressure Differential Range: [**5 to 50 psig (34 to 345 kPa)**]<**Insert pressure range**>.

6. Construction:

a. Body: Bronze or forged brass[**, nickel plated**].
b. End Connections: Female threaded (NPT) ends.
c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
d. Diaphragm: HNBR or EPDM.
e. Ball: Chrome-plated brass or stainless steel.
f. Seats: RTFE.
g. Stem and Stem Extension: Material to match ball; blowout-proof design.
h. Stem Seal: RTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.

B. Pressure-Independent Ball Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Bray Commercial**]

c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Belimo Aircontrols (USA), Inc**]
   b. [**Bray Commercial**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain pressure-independent ball valves **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)** from single manufacturer.
4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Flow Characteristic: Equal percentage.
   c. Leakage: Zero.
   d. Hydronic Pressure Rating: In accordance with ASME B16.1, Class 125 or 250, as required by application.
   e. Hydronic Close-off Pressure:

      1) Class 125: **175 psig (1207 kPa)**.
      2) Class 250: **310 psig (2137 kPa)**.

   f. Process Temperature Range: Between **35 to 250 deg F (2 to plus 121 deg C)**.
   g. Rangeability: 100 to 1.

5. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by one of the follow methods:

   a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of [**5 to 50 psig (34 to 345 kPa)**]**<Insert pressure range>**.
   b. Integral Electronic Regulation: Electronic flow meter and control signal to maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.

      1) Flow Measurement: Within 2 percent of actual reading.
      2) Flow Control: Within 5 percent of set point.
      3) Pressure Differential Range: **5 to 50 psig (34 to 345 kPa)**.

6. Construction:

   a. Body: Cast iron; ASME B16.1.
   b. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
   c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
   d. Ball: Stainless steel.
   e. Seats: RTFE.
   f. Stem and Stem Extension: Material to match ball; blowout-proof design.
   g. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.

C. Pressure-Independent Globe Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bell & Gossett; a Xylem brand**]
    b. [**Bray Commercial**]
    c. [**Danfoss, Inc.**]
    d. [**Flow Control Industries, Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bell & Gossett; a Xylem brand**]
    b. [**Bray Commercial**]
    c. [**Danfoss, Inc.**]
    d. [**Flow Control Industries, Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain threaded end pressure-independent globe valves from single manufacturer.
4. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: [**Equal percentage**][**or**][**linear**].
    c. Flow Control: Within 5 percent of set point.
    d. Leakage: FCI 70-2, Class IV.
    e. Hydronic Pressure Rating: [**250 psig (2482 kPa)**][**360 psig (2482 kPa)**]<**Insert pressure range**>.
    f. Hydronic Close-off Pressure: [**90 psig (620 kPa)**][**140 psig (965 kPa)**]<**Insert pressure range**>.
    g. Process Temperature Range: Between **35 to 240 deg F (2 to plus 115 deg C)**.
    h. Rangeability: [**50**]<**Insert number**> to 1.

5. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of [**5 to 60 psig (34 to 414 kPa)**]<**Insert pressure range**>.
6. Construction:

    a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
    b. Body: Bronze or forged brass.
    c. End Connections: Female threaded (NPT) ends.
    d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
    e. Diaphragm: HNBR or EPDM.
    f. O-Rings: EPDM.
    g. Plug: Brass or stainless steel.
    h. Spring: Stainless steel.
    i. Stem: Stainless steel.

D. Pressure-Independent Globe Valves with Flanged Ends:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bell & Gossett; a Xylem brand**]
   b. [**Bray Commercial**]
   c. [**Danfoss, Inc.**]
   d. [**Flow Control Industries, Inc.**]
   e. [**Flowcon Americas LLC**]
   f. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   g. [**IMI Hydronic Engineering Inc**]
   h. [**Siemens Industry, Inc., Building Technologies Division**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bell & Gossett; a Xylem brand**]
   b. [**Bray Commercial**]
   c. [**Danfoss, Inc.**]
   d. [**Flow Control Industries, Inc.**]
   e. [**Flowcon Americas LLC**]
   f. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   g. [**IMI Hydronic Engineering Inc**]
   h. [**Siemens Industry, Inc., Building Technologies Division**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flanged end pressure-independent globe valves from single manufacturer.
4. Performance:

   a. Stem Action: Linear stem travel.
   b. Flow Characteristic: [**Equal percentage**][**or**][**linear**].
   c. Flow Control: Within 5 percent of set point.
   d. Leakage: FCI 70-2, Class IV.
   e. Hydronic Pressure Rating: [**175 psig (1207 kPa)**][**250 psig (2482 kPa)**][**360 psig (2482 kPa)**]<**Insert pressure range**>.
   f. Hydronic Close-off Pressure: [**90 psig (620 kPa)**]<**Insert pressure range**>.
   g. Process Temperature Range: Between **35 to 240 deg F (2 to plus 115 deg C)**.
   h. Rangeability: [**50**]<**Insert number**> to 1.

5. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of [**5 to 60 psig (34 to 414 kPa)**]<**Insert pressure range**>.
6. Construction:

   a. Size Range: [**NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**][**NPS 2-1/2 to NPS 10 (DN 65 to DN 250)**].
   b. Body: Cast iron or ductile iron.
   c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
   d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.

e. Diaphragm: HNBR or EPDM.
f. O-Rings: EPDM.
g. Plug: Brass or stainless steel.
h. Spring: Stainless steel.
i. Stem: Stainless steel.

2.6 SOLENOID VALVES

A. Brass and Bronze Solenoid Valves, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASCO; Emerson Electric Co., Automation Solutions**]
b. [**Danfoss, Inc.**]
c. [**Parker (Parker Hannifin)**]
d. [**Sizto Tech Corporation (STC)**]
e. [**Velcor Engineering Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASCO; Emerson Electric Co., Automation Solutions**]
b. [**Danfoss, Inc.**]
c. [**Parker (Parker Hannifin)**]
d. [**Sizto Tech Corporation (STC)**]
e. [**Velcor Engineering Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way brass and bronze solenoid valves from single manufacturer.
4. Performance:

a. Ambient Operating Temperature: [**32 to 125 deg F (0 to 52 deg C)**]<**Insert temperature range**>.
b. Leakage: Bubbletight.
c. Hydronic Operating Pressure:

1) Maximum: [**125 psig (862 kPa)**][**150 psig (1034 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert pressure**>.
2) Minimum Operating: [**0 psig (0 kPa)**][**5 psig (34 kPa)**]<**Insert pressure**>.

d. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120 deg C)**]<**Insert temperature range**>.
e. Saturated Steam Pressure: [**15 psig (103 kPa)**][**125 psig (862 kPa)**]<**Insert pressure**>.
f. Speed of Response: Manufacturer's [**standard design**][**or**][**slow-closing design to reduce potential water hammer**].
g. Voltage: Coordinate with field power source.

5. Features:

a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.
b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
c. Override: Integral manual override.

6. Construction:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Brass or bronze.
c. End Connections: Female threaded (NPT) ends.
d. Discs and Seats: NBR, EPDM or PTFE.
e. Orifice: Select size for performance required by application.
f. Wetted Parts: Stainless steel.
g. Coil: Copper [**or**]<**Insert material**>.
h. Coil Insulation: [**Class F**][**or**][**Class H**].
i. Solenoid Enclosure: NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.

B. Stainless Steel Solenoid Valves, Two Way:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASCO; Emerson Electric Co., Automation Solutions**]
b. [**Danfoss, Inc.**]
c. [**Parker (Parker Hannifin)**]
d. [**Sizto Tech Corporation (STC)**]
e. [**Velcor Engineering Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASCO; Emerson Electric Co., Automation Solutions**]
b. [**Danfoss, Inc.**]
c. [**Parker (Parker Hannifin)**]
d. [**Sizto Tech Corporation (STC)**]
e. [**Velcor Engineering Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain two-way stainless steel solenoid valves from single manufacturer.
4. Performance:

a. Ambient Operating Temperature: [**32 to 125 deg F (0 to 52 deg C)**]<**Insert temperature range**>.
b. Leakage: Bubbletight.
c. Hydronic Operating Pressure:

1) Maximum: [**125 psig (862 kPa)**][**150 psig (1034 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert pressure**>.
2) Minimum Operating: [**0 psig (0 kPa)**][**5 psig (34 kPa)**]<**Insert pressure**>.

d. Hydronic Process Temperature Range: [**0 to 250 deg F (Minus 18 to plus 120**

deg C)]<**Insert temperature range**>.
e. Saturated Steam Pressure: [**15 psig (103 kPa)**][**125 psig (862 kPa)**]<**Insert pressure**>.
f. Speed of Response: Manufacturer's [**standard design**][**or**][**slow-closing design to reduce potential water hammer**].
g. Voltage: Coordinate with field power source.

5. Features:

a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.
b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
c. Override: Integral manual override.

6. Construction:

a. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
b. Body: Stainless steel.
c. End Connections: Female threaded (NPT) ends.
d. Discs and Seats: NBR, EPDM, or PTFE.
e. Orifice: Select size for performance required by application.
f. Wetted Parts: Stainless steel.
g. Coil: Silver [**or**]<**Insert material**>.
h. Coil Insulation: [**Class F**][**or**][**Class H**].
i. Solenoid Enclosure: NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.

2.7 SELF-CONTAINED TEMPERATURE-REGULATING VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Jordan Valve; Richards Industries Company**]
2. [**Spence Engineering Company, Inc**]
3. [**Spirax Sarco Limited**]
4. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Jordan Valve; Richards Industries Company**]
2. [**Spence Engineering Company, Inc**]
3. [**Spirax Sarco Limited**]
4. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain self-contained temperature-regulating valves from single manufacturer.

D. Description:

1. Self-contained and self-operated temperature-regulating valve. Direct acting or reverse acting, as required by application.
2. Direct Acting: A rise in temperature at the sensing bulb vaporizes some of the liquid in the bulb,

forcing the remaining liquid through a capillary to apply pressure at the diaphragm, in turn closing the fail-safe open valve.

3. Reverse Acting: A rise in temperature at the sensing bulb vaporizes some of the liquid in the bulb, forcing the remaining liquid through a capillary to apply pressure at the diaphragm, in turn opening the fail-safe closed valve.

E. Performance:

1. Leakage: Comply with FCI 70-2, Class IV.
2. Hydronic Pressure:

   a. Rating: [**125 psig (862 kPa)**][**150 psig (1034 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert pressure**>.
   b. Close-off: [**Equal to rating**]<**Insert pressure**>.
   c. Differential: [**5 psig (34 kPa)**]<**Insert pressure**>.

3. Hydronic Process Temperature Range: Match to applications of up to [**0 to 250 deg F (minus 18 to plus 120 deg C)**]<**Insert temperature range**>.

   a. Drains from Hot Equipment to Sanitary Sewer System: **105 to 140 deg F (40 to 60 deg C)**.
   b. <**Insert description of application**>.

4. Saturated Steam Pressure: [**15 psig (103 kPa)**][**125 psig (862 kPa)**]<**Insert pressure**>.
5. Operating Range: Control flow from between [**5**]<**Insert number**> to 100 percent of rated capacity.
6. Sizing: Size to pass the design flow required with not more than 95 percent of the stem lift while operating at design pressure.

F. Features:

1. Interchangeable trim for one size smaller.
2. <**Insert feature**>.

G. Construction:

1. Size Range: **NPS 1/2 to NPS 2 (DN 13 to DN 50)**.
2. Body: [**Bronze**][**carbon steel**][**ductile iron**][**or**][**stainless steel**].
3. End Connections: Female threaded (NPT) ends.
4. Trim: 300 series stainless steel.
5. Seats: 300 series stainless steel, PTFE.
6. Actuator Yoke: Aluminum, cast iron or carbon steel.
7. Capillary, Bulb, and Armor: [**Copper**][**or**][**300 series stainless steel**] bulb and capillary with stainless steel armor.
8. Thermal Fill Material: Match to the temperature range.
9. Thermowell: [**Type 316 stainless steel**][**or**]<**Insert material**> thermowell sized to fit the bulb and pipe.

2.8 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Asahi/America**]
2. [**Belimo Aircontrols (USA), Inc**]

3. [**Bray Commercial**]
4. [**Fischer; Emerson Electric Co., Automation Solutions**]
5. [**Flo-Tite, Inc.**]
6. [**Flowserve Corporation**]
7. [**Honeywell International Inc.**]
8. [**Jordan Valve; Richards Industries Company**]
9. [**Keystone; Emerson Electric Co., Automation Solutions**]
10. [**Max-Air Technology Inc.**]
11. [**Max-Seal, Inc.**]
12. [**Milwaukee Valve Company**]
13. [**NIBCO INC.**]
14. [**Spence Engineering Company, Inc**]
15. [**Spirax Sarco Limited**]
16. [**Valve Solutions, Inc.**]
17. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Asahi/America**]
2. [**Belimo Aircontrols (USA), Inc**]
3. [**Bray Commercial**]
4. [**Fischer; Emerson Electric Co., Automation Solutions**]
5. [**Flo-Tite, Inc.**]
6. [**Flowserve Corporation**]
7. [**Honeywell International Inc.**]
8. [**Jordan Valve; Richards Industries Company**]
9. [**Keystone; Emerson Electric Co., Automation Solutions**]
10. [**Max-Air Technology Inc.**]
11. [**Max-Seal, Inc.**]
12. [**Milwaukee Valve Company**]
13. [**NIBCO INC.**]
14. [**Spence Engineering Company, Inc**]
15. [**Spirax Sarco Limited**]
16. [**Valve Solutions, Inc.**]
17. **<Insert manufacturer's name>**

C. Furnish control valves with factory-installed actuators from control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

D. Actuators for Control Valves in Hydronic Systems: Select actuators to close off against system pump shutoff head.

E. Actuators for Control Valves in Steam Systems: Select actuators to close off against [**1.1**][**1.2**][**1.5**]**<Insert number>** times steam design pressure.

F. Type: Motor operated, with or without gears, electric and electronic.

G. Voltage:

1. [**See Drawings**][**Voltage selection is delegated to professional designing control system**][**24 V**][**120 V**]**<Insert requirement>**.
2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

3. Actuator to function properly within a range of [**85**]<**Insert number**> to [**120**]<**Insert number**> percent of nameplate voltage.

H. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. 100 up to 400 W: Ground steel gears, oil immersed; shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

I. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

J. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

K. Two-Position Actuators: Single direction, spring-return or reversing type.

L. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportionally to input signal, modulates throughout its angle of rotation, and is suitable for [**zero to 10**][**or**][**2 to 10**] V dc [**and**][**4 to 20 mA**] signals.
   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
   d. Programmable Multifunction:

      1) Control input, position feedback, and running time are to be factory or field programmable.
      2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service data, including at a minimum, number of hours powered and number of hours in motion.

M. Position Feedback:

1. [**Equip**][**Where indicated, equip**] two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of [**open**][**and**][**close**] position.
2. [**Equip**][**Where indicated, equip**] modulating actuators with a position feedback through [**current**][**or**][**voltage**] signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

N. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on

loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

O. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

P. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve stem without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

Q. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [**minus 20 to plus 120 deg F (minus 29 to plus 49 deg C)**]<**Insert temperature range**>.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from [**5 to 95**]<**Insert numbers**> percent relative humidity, noncondensing.

R. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, [**Type 2**][**or**][**Type 4**] for indoor and protected applications.
3. NEMA 250, [**Type 4**][**or**][**Type 4X**] for outdoor and unprotected applications.
4. NEMA 250, [**Type 7**][**or**][**Type 9**] for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.

S. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation[**, and as follows:**][**.**]

   a. Operate valve from fully closed to fully open position within [**15**][**30**][**60**][**75**][**90**][**150**]<**Insert number**> seconds.
   b. Operate valve from fully open to fully closed position within [**15**][**30**][**60**][**75**][**90**][**150**]<**Insert number**> seconds.
   c. Move valve to fail-safe position within [**5**][**15**][**30**]<**Insert number**> seconds.

T. Sound: Where actuators are located in tenant-occupied rooms with a room sound level criteria of [**NC-35**]<**Insert NC level**> or lower, comply with the following sound levels:

1. Spring Return: [**45**]<**Insert number**>dBA.
2. Nonspring Return: [**45**]<**Insert number**> dBA.

2.9 PNEUMATIC CONTROL VALVE ACTUATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Asahi/America**]
2. [**Bray Commercial**]
3. [**Fischer; Emerson Electric Co., Automation Solutions**]
4. [**Flo-Tite, Inc.**]
5. [**Flowserve Corporation**]
6. [**Honeywell Building Solutions; Honeywell International, Inc.**]
7. [**Johnson Controls, Inc.**]
8. [**Jordan Valve; Richards Industries Company**]
9. [**Keystone; Emerson Electric Co., Automation Solutions**]
10. [**Max-Air Technology Inc.**]
11. [**Max-Seal, Inc.**]
12. [**Milwaukee Valve Company**]
13. [**NIBCO INC.**]
14. [**Siemens Industry, Inc., Building Technologies Division**]
15. [**Spence Engineering Company, Inc**]
16. [**Spirax Sarco Limited**]
17. [**Valve Solutions, Inc.**]
18. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Asahi/America**]
2. [**Bray Commercial**]
3. [**Fischer; Emerson Electric Co., Automation Solutions**]
4. [**Flo-Tite, Inc.**]
5. [**Flowserve Corporation**]
6. [**Honeywell Building Solutions; Honeywell International, Inc.**]
7. [**Johnson Controls, Inc.**]
8. [**Jordan Valve; Richards Industries Company**]
9. [**Keystone; Emerson Electric Co., Automation Solutions**]
10. [**Max-Air Technology Inc.**]
11. [**Max-Seal, Inc.**]
12. [**Milwaukee Valve Company**]
13. [**NIBCO INC.**]
14. [**Siemens Industry, Inc., Building Technologies Division**]
15. [**Spence Engineering Company, Inc**]
16. [**Spirax Sarco Limited**]
17. [**Valve Solutions, Inc.**]
18. <**Insert manufacturer's name**>

C. Source Limitations:

1. Furnish control valves with factory-installed actuators by control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

D. Actuators for Control Valves in Hydronic Systems: Select actuators to close off against system pump shutoff head.

E. Actuators for Control Valves in Steam Systems: Select actuators to close off against [**1.1**][**1.2**][**1.5**]<**Insert number**> times steam design pressure.

F. Equip pneumatic modulating actuators with a positive positioner, having the following performance characteristics:

1. Linearity: Within [**1**]<**Insert number**> percent of output signal span.
2. Hysteresis: [**0.5**]<**Insert value**> percent of the span.

G. Provide each positioner with an integrally mounted air set and pressure gauges for supply, input, and output. Operate on a **3 to 15 psig (21 to 103 kPa)** input signal unless otherwise required by the application to comply with the control sequence of operation.

H. Rate actuators for a pressure of at least [**1.1**]<**Insert value**> times main supply air pressure to actuator, but not less than [**25 psig (172 kPa)**]<**Insert pressure**>.

I. Single-Action (Spring-Return) Diaphragm Actuators:

1. Travel: As required by application.

   a. Rotary travel for control of quarter-turn (0 to 90 degrees) control valves.
   b. Linear travel for control valves with linear stem travel.

2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

   a. Diaphragm: Reinforced synthetic rubber or nitrile. Provide actuators with replaceable diaphragms[**where indicated for the application**].
   b. Diaphragm Casing and Plate: Cast iron, steel, or cast aluminum.
   c. Spring, stem, and spring adjuster: Steel or steel alloy.
   d. Yoke: Cast iron, steel, or cast aluminum.

J. Double-Action (Air-to-Air) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (0 to 90 degrees) valves.
2. Fail-Safe Position (Loss of Air): Last position.
3. Construction:

   a. Body: Anodized extruded-aluminum alloy.
   b. End Caps: Cast-aluminum alloy.
   c. Pistons: Cast-aluminum alloy.
   d. Piston O-Ring Seals: NBR.
   e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
   f. Travel Stops: Adjustable, stainless steel.
   g. Fasteners: Stainless steel.

K. Single-Action (Spring-Return) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (0 to 90 degrees) control valves.
2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

   a. Body: Anodized extruded-aluminum alloy.
   b. End Caps: Cast-aluminum alloy.
   c. Pistons: Cast-aluminum alloy.

d. Piston O-Ring Seals: NBR.
e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
f. Springs: [**Coated**]steel or steel alloy.
g. Travel Stops: Adjustable, stainless steel.
h. Fasteners: Stainless steel.

L. Provide actuator with adjustable stops for both maximum and minimum positions.

M. Local Manual Override: Where indicated, provide actuators with an external manual adjustment mechanism to allow manual positioning of the valve through the actuator.

N. Local Position Indication: Provide a position indicator and graduated scale on each actuator. Indicate open and closed travel limits.

O. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. Install actuator(s) in a supplemental enclosure with a heater and controller where required by application.

P. Position Feedback Signal:

1. [**Equip**][**Where indicated, equip**] two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of [**open**][**and**][**close**] position.
2. [**Equip**][**Where indicated, equip**] modulating actuators with a position feedback through [**current**][**or**][**voltage**] signal for remote monitoring.

Q. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation[**, and as follows**].

a. Operate valve from fully closed to fully open position within [**15**][**30**]<**Insert number**> seconds.
b. Operate valve from fully open to fully closed position within [**15**][**30**]<**Insert number**> seconds.
c. Move valve to fail-safe position within [**5**][**15**][**30**]<**Insert number**> seconds.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. <**Insert system**> System, <**Insert unique application**>, Two-Way Applications Controlled by Flow: [**Ball valves**][**Ball valves with characterized disk**][**Ball valves with segmented ball**][**Ball valves with full ball and characterized V-notch**][**Pressure-independent valves**][**Butterfly valves**][**High-performance butterfly valves**][**Globe valves**][**Industrial-grade globe valves**][**Solenoid valves**].
3. <**Insert system**> System, <**Insert unique application**>, Two-Way Applications Controlled by Pressure: [**Ball valves**][**Ball valves with characterized disk**][**Ball valves with segmented ball**][**Ball valves with full ball and characterized V-notch**][**Pressure-independent valves**][**Butterfly valves**][**High-performance butterfly valves**][**Globe valves**][**Industrial-grade, globe valves**][**Solenoid valves**].
4. <**Insert system**> System, <**Insert unique application**>, Two-Way Applications Controlled by Temperature: [**Ball valves**][**Ball valves with characterized disk**][**Ball valves with segmented ball**][**Ball valves with full ball and characterized V-notch**][**Pressure-independent valves**][**Butterfly-style valves**][**High-performance butterfly valves**][**Globe valves**][**Industrial-grade globe valves**][**Solenoid valves**][**Self-contained temperature-regulating valves**].
5. <**Insert system**> System, <**Insert unique application**>, Three Way, Controlled by Temperature: [**Ball valves**][**Ball valves with characterized disk**][**Ball valves with segmented**][**Butterfly-style valves**][**Globe valves**].
6. Steam System, <**Insert unique application**>, Two Way, Controlled by Temperature: [**Ball valves**][**Ball valves with segmented ball**][**Ball valves with full ball and characterized V-notch**][**Globe valves**][**Industrial-grade globe valves**][**Solenoid valves**][**Self-contained temperature-regulating valves**].

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support control valves and actuators, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic event, wind, or other forces common to the application.

D. Provide ceiling, floor, roof, and wall openings [**and sleeves**]required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Seal penetrations made in fire-rated and acoustically rated assemblies.

F. Fastening Hardware:

1. Wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from

floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 CONTROL VALVES

A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Drain Valves:

1. Install drain valves in piping upstream and downstream of each control valve larger than [**NPS 2 (DN 50)**][**NPS 4 (DN 100)**]<**Insert pipe size**>.
2. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold.

D. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve[**larger than**]<**Insert pipe size**>.

E. Three-Valve Bypass Manifold: Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing isolation valves in inlet and discharge piping of control valve and a manual throttling valve in bypass pipe.

1. <**Insert applications**>.

F. Valve Orientation:

1. Where possible, install [**ball**][**and**][**globe**] valves that are installed in horizontal piping, with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping, with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access, and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least [**12 inches (300 mm)**]<**Insert distance**> of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt-tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Use same designation at each end for each piece of wire, cable, and tubing for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with valve identification on valve[**and on face of ceiling directly below valves concealed above ceilings**]. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than [**15**]<**Insert time**> seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions

to confirm proper position indication.

END OF SECTION 23 09 23 11

Task	Specification	Specification Description
23 09 23 11	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 11	23 09 23 00a	Leak Detection Instruments
23 09 23 11	23 09 23 00b	Position Instruments
23 09 23 11	23 09 00 00	Speed Instruments
23 09 23 11	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular control dampers with airfoil blades.
2. Rectangular control dampers with flat blades.
3. Rectangular control dampers with insulated blades.
4. Rectangular control dampers with integral airflow monitoring.
5. Rectangular control dampers with integral airflow control.
6. Rectangular industrial-duty control dampers.
7. Round control dampers.
8. Round industrial-duty control dampers.
9. Electric and electronic control-damper actuators.
10. Pneumatic control-damper actuators.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

C. Thermal Efficiency Ratio (E): Comparison of a tested damper's thermal performance against a v-groove blade reference damper. A damper with the same thermal efficiency as the reference damper would have an E value of 0 percent, while a damper that is 4 times as efficient would have an E value of 200 percent.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Rectangular control dampers with airfoil blades.
2. Rectangular control dampers with flat blades.
3. Rectangular control dampers with insulated blades.
4. Rectangular control dampers with integral airflow monitoring.
5. Rectangular control dampers with integral airflow control.
6. Rectangular industrial-duty control dampers.
7. Round control dampers.
8. Round industrial-duty control dampers.

9. Electric and electronic control-damper actuators.
10. Pneumatic control-damper actuators.

B. Product Data Submittals: For each damper and actuator.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

D. Delegated Design Submittals:

1. Schedule and design calculations for control dampers and actuators, including the following:

a. Unique designation for each damper/actuator assembly.
b. Service/application.
c. Damper assembly size.
d. Damper assembly weight, including actuator(s).
e. Damper and actuator action (modulating or two position).
f. Flow at project design and minimum flow conditions.
g. Face velocity at project design and minimum airflow conditions.
h. Pressure drop across damper at project design and minimum airflow conditions.
i. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
j. Maximum close-off pressure.
k. Leakage airflow at maximum system pressure differential (fan close-off pressure).
l. Damper torque required at worst-case condition for sizing actuator.
m. Actuator selection indicating torque provided.
n. Actuator fail-safe position on loss of power and loss of signal.
o. Remarks listing special requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Product installation location indicated in relationship to room, duct, and equipment.
2. Size and location of wall access panels for control dampers and actuators installed behind walls.
3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable outdoor ventilation requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Code Compliance: Comply with governing energy code.

E. Delegated Design: Engage a qualified professional[**engineer**], as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

F. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

G. Backup Power Source: Serve control-damper actuators from a backup power source where associated with systems and equipment served by a backup power source.

H. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

I. Selection Criteria:

1. Multi-Blade Damper Configuration: [**See Drawings**][**As follows unless otherwise indicated on Drawings**]:

   a. Two-Position Control: [**Opposed**][**or**][**parallel**].
   b. Equipment Isolation Applications: [**Opposed**][**or**][**parallel**].
   c. Face and Bypass Applications: [**Opposed**][**or**][**parallel**].
   d. Outdoor/Return Air-Mixing Applications: [**Opposed**][**or**][**parallel**].
   e. All Other Applications: [**Opposed**][**or**][**parallel**].
   f. <**Insert application**>.

2. Pressure and Temperature: Control dampers suitable for operating conditions encountered by the application[**and following conditions unless otherwise indicated on Drawings**]:

   a. Supply Air: <**Insert pressure and coincident temperature requirements**>.
   b. Return Air: <**Insert pressure and coincident temperature requirements**>.
   c. Outdoor Air: <**Insert pressure and coincident temperature requirements**>.
   d. Mixed Air: <**Insert pressure and coincident temperature requirements**>.
   e. Exhaust Air: <**Insert pressure and coincident temperature requirements**>.
   f. <**Insert system and requirements**>.

3. Fail-Safe Positions: [**See Drawings**][**As follows unless otherwise indicated on Drawings**]:

a. Supply Air: [**Close**][**Last position**][**Open**].
b. Return Air: [**Close**][**Last position**][**Open**].
c. Outdoor Air: [**Close**][**Last position**][**Open**].
d. Mixed Air: [**Close**][**Last position**][**Open**].
e. Exhaust Air: [**Close**][**Last position**][**Open**].
f. <**Insert system and requirements**>.

4. Select dampers with smooth and stable operation throughout full range of operation over varying pressures and temperatures encountered.
5. Sizing: [**See Drawings**][**As follows unless otherwise indicated on Drawings**]

   a. Modulating Dampers: Select damper size for a pressure drop of <**Insert number**> percent of fan total static pressure unless otherwise indicated.
   b. Two-Position Dampers: Full size of duct or equipment connection unless otherwise indicated.

6. Pneumatic, Two-Position Control-Damper Opening and Closing Characteristic:

   a. Provide a smooth opening and closing characteristic slow enough to avoid an excessive rapid change in system pressure.
   b. Provide an adjustable opening time (full closed to full open) and an adjustable closing time (full open to full closed) ranging from zero to [**10**][**15**][**30**]<**Insert value**> seconds. Make opening and closing times independently adjustable.

7. Pneumatic Control Signal Distance Limitation: Not to exceed [**100 ft. (30 m)**][**200 ft. (60 m)**]<**Insert distance**> from controller. For longer distances, provide an electric/electronic control signal to the damper/actuator and an electric solenoid valve or electro-pneumatic transducer locally at the damper/actuator to convert the control signal to pneumatic.

2.2 RECTANGULAR CONTROL DAMPERS WITH AIRFOIL BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

   a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Aluminum Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]

d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. [**TAMCO (T. A. Morrison & Co. Inc.)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. [**TAMCO (T. A. Morrison & Co. Inc.)**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

a. Leakage:

1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: [**0.05 in. wg (12.5 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/180**]<**Insert deflection**> of blade length.
d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**4000 fpm (20 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.125 inch (3 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.

2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, [**0.07 inch (1.8 mm)**]<**Insert thickness**> thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**6 inches (150 mm)**]<**Insert width**>.

c. Seals:

1) Blades: Replaceable; extruded Santoprene, silicone, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are mechanically attached in extruded blade slots.
2) Jambs: Replaceable; stainless steel, compression type[**or mechanically attached extruded silicone**].

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**acetal**][**Celcon/polycarbonate**][**nylon**][**synthetic**][**or**] stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel or stainless steel) to match damper frame[**or adjoining duct**].
4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish, minimum of **0.0007 inch (0.018 mm)** thick, for aluminum surfaces in contact with airstream.

2) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

C. Rectangular Control Dampers with Galvanized-Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with galvanized-steel airfoil blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

   a. Leakage:

      1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
      2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

   b. Pressure Drop: [**0.06 in. wg (15 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
   c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/180**]<**Insert deflection**> of blade length.
   d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
   e. Velocity: Up to [**4000 fpm (20 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: ASTM A653/A653M galvanized steel, minimum [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM A653/A653M galvanized steel, [**0.05 inch (1.3 mm)**]<**Insert thickness**> thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**8 inches (200 mm)**]<**Insert width**>.

c. Seals:

1) Blades: Replaceable; extruded silicone, vinyl, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: [**Plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**acetal**][**nylon**][**or**] stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of galvanized steel.
4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

1) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.

D. Rectangular Control Dampers with Stainless Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Greenheck Fan Corporation**]
c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Greenheck Fan Corporation**]
c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with stainless steel airfoil blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

a. Leakage:

1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: [**0.06 in. wg (15 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/180**]<**Insert deflection**> of blade length.
d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**4000 fpm (20 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: Type 304 stainless steel, minimum [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: Type 304 stainless steel, [**0.05 inch (1.3 mm)**]<**Insert thickness**> thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**8 inches (200 mm)**]<**Insert width**>.

c. Seals:

1) Blades: Replaceable; extruded silicone as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: Type 303 or 304 stainless steel.
3) Mechanically attached to blades.

e. Bearings:

1) Material: [**Molded nylon or**]stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: Stainless steel.
2) Material: Type 304 or 316 stainless steel.
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

   a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
   b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of materials to match damper frame.

4) Match end connections (flange or sleeve) to field connections.

2.3 RECTANGULAR CONTROL DAMPERS WITH FLAT BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Aluminum Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with aluminum flat blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

a. Leakage:

1) AMCA 511, Class 1, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3.2 cfm/sq. ft. (16.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: [**0.08 in. wg (20 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: [**2.0 in. wg (500 Pa)**]<**Insert pressure**>.
d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**2000 fpm (10 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.08 inch (2 mm)**][**0.125 inch (3 mm)**] thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls and equipment.
3) Width: Not less than **5 inches (125 mm)**.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, **0.125 inch (3 mm)** thick.
3) Shape: Single thickness.
4) Length: As required by pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed **6 inches (150 mm)**.

c. Seals:

1) Blades: Replaceable; extruded silicone or vinyl, as required by performance requirements. Mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum **0.5 inch (13 mm)**.
2) Material: Aluminum or plated steel.
3) Mechanically attached to blades.

e. Bearings:

1) Material: Celcon, polycarbonate or synthetic, mounted in frame.

f. Linkage:

1) Hardware: Plated or stainless steel.
2) Material: Aluminum or plated steel.
3) Mounting: Concealed in frame.

g. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish for aluminum surfaces in contact with airstream.

C. Rectangular Control Dampers with Galvanized-Steel Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with galvanized-steel flat blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

   a. Leakage:

      1) AMCA 511, Class II, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **5.4 cfm/sq. ft. (27.4 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.

   b. Pressure Drop: [**0.1 in. wg (25 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
   c. Pressure Rating: [**2.0 in. wg (500 Pa)**][**3.0 in. wg (750 Pa)**][**4.0 in. wg (1000 Pa)**]<**Insert pressure**>.
   d. Temperature: [**Minus 20 to plus 185 deg F (Minus 29 to plus 85 deg C)**]<**Insert temperature range**>.
   e. Velocity: Up to [**2000 fpm (10 m/s)**]<**Insert velocity**>.

6. Construction:

   a. Frame:

      1) Material: ASTM A653/A653M galvanized steel, minimum [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
      2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
      3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

   b. Blades:

      1) Configuration: Parallel or opposed blade configuration as required by application.
      2) Material: ASTM A653/A653M galvanized steel, [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
      3) Shape: Single thickness with bends for reinforcing.

4) Length: As required by pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**8 inches (200 mm)**]<**Insert width**>.

c. Seals:

1) Blades: Replaceable; extruded silicone, vinyl, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: [**Plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**nylon**][**or**][**synthetic**], or stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of galvanized steel.
4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

1) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.

D. Rectangular Control Dampers with Stainless Steel Flat Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with stainless steel flat blades and frames, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

a. Leakage:

1) AMCA 511, Class II, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **5.4 cfm/sq. ft. (27.4 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: [**0.1 in. wg (25 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: [**2.0 in. wg (500 Pa)**][**3.0 in. wg (750 Pa)**][**4.0 in. wg (1000 Pa)**]<**Insert pressure**>.
d. Temperature: [**Minus 20 to plus 185 deg F (Minus 29 to plus 85 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**2000 fpm (10 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: Type 304 stainless steel, minimum [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: Type 304 stainless steel, [**0.06 inch (1.6 mm)**]<**Insert thickness**> thick.
3) Shape: Single thickness with bends for reinforcing.
4) Length: As required by pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**8 inches (200 mm)**]<**Insert width**>.

c. Seals:

1) Blades: Replaceable; extruded silicone, vinyl, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: Type 304 or 316 stainless steel.
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**nylon**][**or**][**synthetic**], or stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: Stainless steel.
2) Material: Type 304 or 316 stainless steel.
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of Type 304 stainless steel.
4) Match end connections (flange or sleeve) to field connections.

2.4 RECTANGULAR CONTROL DAMPERS WITH INSULATED BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Rectangular Control Dampers with Insulated Aluminum Airfoil Blades:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow United Industries; Mestek, Inc.**]
   b. [**Greenheck Fan Corporation**]
   c. [**Johnson Controls, Inc.**]
   d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   e. [**TAMCO (T. A. Morrison & Co. Inc.)**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow United Industries; Mestek, Inc.**]
   b. [**Greenheck Fan Corporation**]
   c. [**Johnson Controls, Inc.**]
   d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   e. [**TAMCO (T. A. Morrison & Co. Inc.)**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with insulated aluminum airfoil blades, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance, air leakage, and thermal performance.**]
5. Performance:

   a. Leakage:

      1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
      2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

   b. Pressure Drop: [**0.05 in. wg (12.5 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
   c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**>, not less than [**8.0 in. wg (2000 Pa)**]<**Insert pressure**>.
   d. Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
   e. Thermal Performance:

      1) R-Value: [**2.2**]<**Insert value**> or higher.
      2) Thermal Efficiency Ratio (E): [**345**]<**Insert value**> or higher when tested in accordance with AMCA 500D.

   f. Velocity: Up to [**4000 fpm (20 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.08 inch (2 mm)**][**0.125 inch (3 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, [**0.07 inch (1.8 mm)**]<**Insert thickness**> thick.
3) Shape: Airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**6 inches (150 mm)**]<**Insert width**>.
6) Insulation: Hollow airfoil blade internally insulated with expanded polyurethane foam for thermal performance indicated.
7) Thermal Break: Complete thermal break with blades in full closed position.

c. Seals:

1) Blades: Replaceable; extruded EPDM, Santoprene or silicone, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Replaceable; polycarbonate, compression type[**or mechanically attached extruded silicone**].

d. Axles:

1) Diameter: Minimum [**0.44 inch (11 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: Aluminum or plated steel.
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded inner and outer bearings of [**acetal**][**Celcon**][**or**][**polycarbonate**], as required by operating conditions.
2) Mounting: Inner bearing fixed to axle, rotating within an outer bearing inserted in the frame, resulting in no metal-to-metal contact.
3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**].
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel, or stainless steel) to match damper frame[**or adjoining duct**].
4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish, minimum of **0.0007 inch (0.018 mm)** thick, for aluminum surfaces in contact with airstream.
2) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

C. Rectangular Control Dampers with Insulated Aluminum Airfoil Blades and Thermal Break Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Greenheck Fan Corporation**]
c. [**Johnson Controls, Inc.**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. [**TAMCO (T. A. Morrison & Co. Inc.)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow United Industries; Mestek, Inc.**]
b. [**Greenheck Fan Corporation**]
c. [**Johnson Controls, Inc.**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. [**TAMCO (T. A. Morrison & Co. Inc.)**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with insulated aluminum airfoil blades and thermal break, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance, air leakage, and thermal performance.**]
5. Performance:

a. Leakage:

1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential

static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: [**0.05 in. wg (12.5 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**>, not less than [**8.0 in. wg (2000 Pa)**]<**Insert pressure**>.
d. Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
e. Thermal Performance:

1) R-Value: [**2.2**]<**Insert value**> or higher.
2) Thermal Efficiency Ratio (E): [**345**]<**Insert value**> or higher when tested in accordance with AMCA 500D.

f. Velocity: Up to [**4000 fpm (20 m/s)**]<**Insert velocity**>.

6. Construction:

a. Frame:

1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.08 inch (2 mm)**][**0.125 inch (3 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert size**> for attachment to duct flanges, plenum walls, and equipment.
3) Thermal Break: Continuous extruded pocket at two locations, one on each side of closed damper blade, with polyurethane resin fill to achieve frame with no through metal.
4) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, [**0.07 inch (1.8 mm)**]<**Insert thickness**> thick.
3) Shape: Airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**6 inches (150 mm)**]<**Insert width**>.
6) Insulation: Hollow airfoil blade internally insulated with expanded polyurethane foam for thermal performance indicated.
7) Thermal Break: Complete thermal break with blades in full closed position.

c. Seals:

1) Blades: Replaceable; extruded EPDM, Santoprene or silicone, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Replaceable; polycarbonate, compression type[**or mechanically attached extruded silicone**].

d. Axles:

1) Diameter: Minimum [**0.44 inch (11 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.

2) Material: Aluminum or plated steel.
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded inner and outer bearings of [**acetal**][**Celcon**][**or**][**polycarbonate**], as required by operating conditions.
2) Mounting: Inner bearing fixed to axle, rotating within an outer bearing inserted in the frame, resulting in no metal-to-metal contact.
3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**].
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than [**12 inches (300 mm)**]<**Insert length**> for dampers without jackshafts and not less than [**16 inches (450 mm)**]<**Insert length**> for dampers with jackshafts.
b) Oversize damper and sleeve for duct connection size plus minimum [**4 inches (100 mm)**]<**Insert dimension**>.

3) Fabricate sleeve and transitions of materials (aluminum, galvanized steel, or stainless steel) to match damper frame[**or adjoining duct**].
4) Match end connections (flange or sleeve) to field connections.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish, minimum of **0.0007 inch (0.018 mm)** thick, for aluminum surfaces in contact with airstream.
2) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

2.5 RECTANGULAR CONTROL DAMPERS WITH INTEGRAL AIRFLOW MONITORING

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Rectangular Control Dampers with Aluminum Airfoil Blades and Integral Airflow Monitoring:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ebtron, Inc**]
   b. [**Greenheck Fan Corporation**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ebtron, Inc**]
   b. [**Greenheck Fan Corporation**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and integral airflow monitoring, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

   a. Leakage:

      1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
      2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

   b. Pressure Drop (Damper and Airflow Measurement): [**0.15 in. wg (37.5 Pa)**]<**Insert pressure**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure 5.3.
   c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/180**]<**Insert deflection**> of blade length.
   d. Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**>.
   e. Velocity (Damper Only): Up to [**4000 fpm (20 m/s)**][**5000 fpm (25 m/s)**]<**Insert velocity range**>.

6. Construction:

   a. Damper Frame:

      1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.125 inch (3 mm)**]<**Insert thickness**> thick.
      2) Arrangement: Hat-shaped channel with attachment to factory furnished sleeve.
      3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Damper Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, [**0.07 inch (1.8 mm)**]<**Insert thickness**> thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**6 inches (150 mm)**]<**Insert width**>.

c. Damper Seals:

1) Blades: Replaceable; extruded Santoprene, silicone, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Damper seals are to be mechanically attached in extruded blade slots.
2) Jambs: Replaceable; stainless steel, compression type[**or mechanically attached extruded silicone**].

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**acetal**][**Celcon/polycarbonate**][**nylon**][**synthetic**][**or**] stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mounting: Concealed in frame.

g. Sleeve:

1) General: Factory mount damper assembly and airflow measurement assembly in a common sleeve with a continuous-perimeter flanged face to mate to field connection. Coordinate field-mounting requirements for each application.
2) Length: Not less than [**15 inches (375 mm)**][**18 inches (450 mm)**]<**Insert dimension**>.
3) Material: [**Aluminum**][**galvanized steel**][**stainless steel**][**or**][**aluminum, galvanized steel, or stainless steel to match adjoining duct**].
4) Thickness:

a) Sleeve Face Sizes through [**24 inches (600 mm)**]<**Insert dimension**>: Minimum [**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**>.
b) Sleeves with Larger Face Size: Minimum [**12 gauge (2.7 mm)**][**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**>.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish, minimum of **0.0007 inch (0.018 mm)** thick, for aluminum surfaces in contact with airstream.
2) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted in accordance with paint manufacturer's instructions.
3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

7. Pressure Airflow Measurement:

a. Performance:

1) Accuracy: Within [**3**][**5**]<**Insert number**> percent of the actual flow rate between the range of minimum to design airflow and velocity. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
2) Velocity Range: [**300 to 2000 fpm (10 m/s)**][**300 to 5000 fpm (25 m/s)**][**Indicated on Drawings**]<**Insert velocity range**>.
3) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
4) Suitable for operation with untreated and unfiltered air.

b. Flow Straightener: Provide a straightening device as part of flow measurement assembly [**, if required**]to achieve specified accuracy with installed configuration indicated.
c. Flow Sensors: Hollow, ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles with anodized finish.
d. Placement: Locate upstream of damper.
e. Pressure Transducer: Housed in NEMA 250, [**Type 4**]<**Insert type**> painted enclosure.
f. Remote Output Signal: Zero- to 10 V dc [**or 4 to 20 mA**]scaled output signal proportional to flow for remote monitoring of actual airflow.
g. Tubing: Factory pipe transducer(s) to low- and high-pressure ports on flow sensors using manufacturer's standard tubing that is protected from damage during shipping and installation.
h. Factory Calibration: Factory calibrate each finished assembly before shipment in accordance with application-specific requirements.

8. Thermal Airflow Measurement:

a. Certification:

1) Listed and labeled in accordance with UL 873 or UL 60730.
2) BTL certified in accordance with ASHRAE 135.
3) 47 CFR, Ch. 1, Part 15, Subpart B, Class A device.

b. Performance:

1) Airflow Accuracy: Within [**3**][**5**]<**Insert number**> percent of the actual flow rate between the range of minimum to design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
2) Ambient Operating Humidity Range (Sensors and Transmitters): Zero to 99 percent, noncondensing.
3) Temperature Accuracy: Within **0.2 deg F (0.1 deg C)** over entire range.
4) Velocity Range: [**0 to 5000 fpm (25 m/s)**][**Indicated on Drawings**]<**Insert velocity**

range>.

5) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
6) Suitable for operation in untreated and unfiltered air.

c. Flow Straightener: Provide a straightening device as part of flow measurement assembly [**, if required**]to achieve specified accuracy with installed configuration indicated.

d. Sensors:

1) Number of sensors determined by manufacturer for application to comply with accuracy requirements indicated.
2) Temperature of each sensor assembly velocity weighted and averaged by transmitter before output if temperature sensor has an accuracy worse than **0.1 deg F (0.06 deg C)**.
3) Each sensor with two individually wired, hermetically sealed thermistors.
4) Mount thermistors in sensor using a marine-grade, waterproof material.
5) Protect thermistor leads, and do not expose to the environment.
6) Independently determine airflow rate and temperature at each sensor measurement point.
7) Furnish each sensor probe with an integral cable for connection to transmitter.
8) Sensor Probe Material: Anodized, extruded Alloy 6063 aluminum tube.
9) Probe Assembly Mounting Bracket Material: [**Plated**][**or**][**stainless**] steel.
10) Connection Enclosure: NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.

e. Transmitters:

1) Microprocessor based.
2) Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
3) Capable of field configuration and diagnostics using touch interface and digital display.
4) Password-protected programmable settings.
5) Field selectable between IP and SI units for airflow, temperature, and velocity.
6) Power supply, including the following:

a) On-off power switch.
b) Protection from transients and power surges.
c) Circuitry to ensure reset after power disruption, transients, and brownouts.
d) Transformer to convert field power source to operating voltage required.

7) Enclosure: NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.
8) Remote Signal Interface:

a) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, field selectable, 0 to 10 V dc or 4 to 20 mA.
b) RS-485: BACnet-MS/TP.
c) Ethernet: BACnet Ethernet, BACnet-IP.

9) Factory Calibration: Factory calibrate each airflow station at a minimum of [**16**]<**Insert value**> airflow rates and [**three**]<**Insert value**> temperatures to standards that are traceable to NIST.

9. Damper Actuator: Electric, modulating actuator with proportional control [**and position**

feedback]signals; complying with requirements in "Electric and Electronic Control-Damper Actuators" Article.

2.6 RECTANGULAR CONTROL DAMPERS WITH INTEGRAL AIRFLOW CONTROL

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

   a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Rectangular Control Dampers with Aluminum Airfoil Blades and Integral Airflow Control:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Greenheck Fan Corporation**]
   b. [**Johnson Controls, Inc.**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Greenheck Fan Corporation**]
   b. [**Johnson Controls, Inc.**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular control dampers, with aluminum airfoil blades and integral airflow control, from single manufacturer.
4. [**AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.**]
5. Performance:

   a. Leakage:

      1) AMCA 511, Class 1A, at **1 in. wg (250 Pa)** Differential Static Pressure: Leakage not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 in. wg (250 Pa)** differential static pressure when tested in accordance with AMCA 500D.
      2) AMCA 511, Class 1, at **4 in. wg (1000 Pa)** Differential Static Pressure: Leakage not to exceed **8 cfm/sq. ft. (40.6 L/s per sq. m)** against **4 in. wg (1000 Pa)** differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop (Damper and Flow Measurement): [**0.15 in. wg (37.5 Pa)**]<**Insert pressure**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure 5.3.
c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/180**]<**Insert deflection**> of blade length.
d. Temperature (Damper and Flow Measurement): [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**>.
e. Velocity (Damper Only): Up to [**4000 fpm (20 m/s)**][**5000 fpm (25 m/s)**]<**Insert velocity range**>.

6. Construction:

a. Damper Frame:

1) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, minimum [**0.125 inch (3 mm)**]<**Insert thickness**> thick.
2) Arrangement: Hat-shaped channel with attachment to factory-furnished sleeve.
3) Width: Not less than [**5 inches (125 mm)**]<**Insert width**>.

b. Damper Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles, [**0.07 inch (1.8 mm)**]<**Insert thickness**> thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed [**48 inches (1200 mm)**]<**Insert length**>.
5) Width: Not to exceed [**6 inches (150 mm)**]<**Insert width**>.

c. Damper Seals:

1) Blades: Replaceable; extruded Santoprene, silicone, [**or damper manufacturer-offered equivalent,**]as required by performance requirements. Mechanically attached in extruded blade slots.
2) Jambs: Replaceable; stainless steel, compression type[**or mechanically attached extruded silicone**].

d. Axles:

1) Diameter: Minimum [**0.375 inch (10 mm)**][**0.5 inch (13 mm)**]<**Insert diameter**>.
2) Material: [**Plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded [**acetal**][**Celcon/polycarbonate**][**nylon**][**synthetic**][**or**] stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: [**Plated**][**or**][**stainless**] steel.
2) Material: [**Aluminum,**][**plated steel**][**or**][**stainless steel**][**, specific to application indicated**].
3) Mounting: Concealed in frame.

g. Sleeve:

1) General: Factory mount damper assembly and airflow measurement assembly in a common sleeve with a continuous-perimeter flanged face to mate to field connection. Coordinate field-mounting requirements for each application.
2) Length: Not less than [**15 inches (375 mm)**][**18 inches (450 mm)**]<**Insert dimension**>.
3) Material: [**Galvanized steel**][**galvanized steel or stainless steel to match adjoining duct**][**or**][**stainless steel**].
4) Thickness:

a) Sleeve Face Sizes through [**24 inches (600 mm)**]<**Insert dimension**>: Minimum [**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**>.
b) Sleeves with Larger Face Size: Minimum [**12 gauge (2.7 mm)**][**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**>.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish, minimum of **0.0007 inch (0.018 mm)** thick, for aluminum surfaces in contact with airstream.
2) Paint surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.
3) Construct axles, damper linkage, and hardware of Type 316L stainless steel.

7. Pressure Airflow Measurement and Control:

a. Performance:

1) Accuracy: Within [**3**][**5**]<**Insert number**> percent of the actual flow rate between the range of minimum to design airflow and velocity. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
2) Velocity Range: [**150 to 2000 fpm (10 m/s)**][**Indicated on Drawings**]<**Insert velocity range**>.
3) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
4) Suitable for operation with untreated and unfiltered air.

b. Flow Straightener: Provide a straightening device as part of flow measurement assembly [**, if required**]to achieve specified accuracy with installed configuration indicated.
c. Flow Sensors: Hollow, ASTM B211/B211M, Alloy 6063 T5 extruded-aluminum profiles with anodized finish.
d. Placement: Locate upstream (inlet side) of damper.
e. Programmable Controller: Factory calibrated and programmed in nonvolatile memory for application-specific airflow set point(s) and range to control desired airflow. Include controller with the following:

1) On-off power switch.
2) Protection from transients and power surges.
3) Circuitry to ensure reset after power disruption, transients, and brownouts.

f. Remote Control and Monitoring Interface:

1) Airflow Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to

airflow.
2) Airflow Set Point: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to airflow.
3) Carbon Dioxide Level: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to carbon dioxide.
4) Damper Actuator Position Feedback: 0 to 10 V dc or 4 to 20 mA scaled output signal.
5) Damper Position Override Command: 0 to 10 V dc or 4 to 20 mA scaled input signal.
6) Set-Point Alarm: Binary signal.
7) <**Insert remote interface requirement**>.

g. Remote Control and Monitoring Serial Interface: RS-485, BACnet-MS/TP.
h. Terminal Strip: Screw terminals for interface to field wiring.
i. Transformer: Rated for not less than [**100**]<**Insert value**> V A. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
j. Tubing: Factory pipe transducer(s) to low- and high-pressure ports on flow sensors using manufacturer's standard tubing that is protected from damage during shipping and installation.
k. Control Enclosure: Factory mount controller, transducers, control transformer, terminal strip, and other control components and electronics within NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.
l. Factory Calibration: Factory calibrate each finished assembly before shipment to the application-specific requirements.

8. Thermal Airflow Measurement and Control:

a. Certification:

1) Listed and labeled in accordance with UL 873 or UL 60730.
2) BTL certified in accordance with ASHRAE 135.
3) 47 CFR, Ch. 1, Part 15, Subpart B, Class A device.

b. Performance:

1) Airflow Accuracy: Within [**3**][**5**]<**Insert number**> percent of the actual flow rate between the range of minimum to design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assemblies as required to comply with the stated accuracy over entire modulating range.
2) Ambient Operating Humidity Range (Sensors and Transmitters): Zero to 99 percent, noncondensing.
3) Temperature Accuracy: Within **0.2 deg F (0.1 deg C)** over entire range.
4) Velocity Range: [**0 to 3000 fpm (15 m/s)**][**0 to 5000 fpm (25 m/s)**][**Indicated on Drawings**]<**Insert velocity range**>.
5) Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
6) Suitable for operation in untreated and unfiltered air.

c. Flow Straightener: Provide a straightening device as part of flow measurement assembly [**, if required**]to achieve specified accuracy with installed configuration indicated.
d. Sensors:

1) Number of sensors determined by manufacturer for application to comply with accuracy requirements indicated.
2) Temperature of each sensor assembly velocity weighted and averaged by

transmitter before output if temperature sensor has an accuracy worse than **0.1 deg F (0.06 deg C)**.

3) Each sensor with two individually wired, hermetically sealed thermistors.
4) Mount thermistors in sensor using a marine-grade, waterproof material.
5) Protect thermistor leads, and do not expose to the environment.
6) Independently determine airflow rate and temperature at each sensor measurement point.
7) Furnish each sensor probe with an integral cable for connection to transmitter.
8) Sensor Probe Material: Anodized, extruded Alloy 6063 aluminum tube.
9) Probe Assembly-Mounting Brackets Material: [**Plated**][**or**][**stainless**] steel.
10) Connection Enclosure: NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.

e. Transmitters:

1) Microprocessor based.
2) Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
3) Capable of field configuration and diagnostics using touch interface and digital display.
4) Password-protected programmable settings.
5) Field selectable between IP and SI units for airflow, temperature, and velocity.
6) Power supply, including the following:

a) On-off power switch.
b) Protection from transients and power surges.
c) Circuitry to ensure reset after power disruption, transients, and brownouts.

7) Enclosure: NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.

f. Programmable Controller: Factory calibrated and programmed in nonvolatile memory for application-specific airflow set point(s) and range to control desired airflow. Include controller with the following:

1) On-off power switch.
2) Protection from transients and power surges.
3) Circuitry to ensure reset after power disruption, transients, and brownouts.
4) Digital display.
5) Capable of field configuration and diagnostics using touch interface and digital display.

g. Remote Control and Monitoring Interface:

1) Airflow Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to airflow.
2) Airflow Set Point: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to airflow.
3) Carbon Dioxide Level: 0 to 10 V dc or 4 to 20 mA scaled input signal proportional to carbon dioxide.
4) Damper Actuator Position Feedback: 0 to 10 V dc or 4 to 20 mA scaled output signal.
5) Damper Position Override Command: 0 to 10 V dc or 4 to 20 mA scaled input signal.
6) Set-Point Alarm: Binary signal.

7) Temperature Measurement: 0 to 10 V dc or 4 to 20 mA scaled output signal proportional to air temperature.
8) <**Insert remote interface requirement**>.

h. Remote Control and Monitoring Serial Interface: RS-485, BACnet-MS/TP; Ethernet, BACnet Ethernet, or BACnet-IP.
i. Terminal Strip: Screw terminals for interface to field wiring.
j. Transformer: Rated for not less than [**100**]<**Insert value**> V A. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
k. Control Enclosure: Factory mount controller, control transformer, and terminal strip within NEMA 250, [**Type 1 or 4 for indoor applications**][**Type 4 for outdoor applications**]<**Insert enclosure type**>.
l. Factory Calibration: Factory calibrate each airflow station at a minimum of [**16**]<**Insert value**> airflow rates and [**three**]<**Insert value**> temperatures to standards that are traceable to NIST.

9. Damper Actuator: Electric, modulating actuator with proportional control [**and position feedback**]signals; complying with requirements in "Electric and Electronic Control-Damper Actuators" Article.

2.7 RECTANGULAR INDUSTRIAL-DUTY CONTROL DAMPERS

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

a. Include intermediate reinforcing required between individual sections being joined together of same material (galvanized steel, stainless steel) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Rectangular Industrial-Duty Control Dampers with Galvanized-Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]

d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular industrial-duty control dampers, with galvanized-steel airfoil blades and frames, from single manufacturer.
4. Performance:

a. Leakage: Not to exceed [**3 cfm/sq. ft. (15.2 L/s per sq. m)**][**4 cfm/sq. ft. (20.3 L/s per sq. m)**]<**Insert value**> against [**1 in. wg (250 Pa)**]<**Insert value**> differential static pressure when tested in accordance with AMCA 500D.
b. Pressure Drop: [**0.1 in. wg (25 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.
c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/240**]<**Insert deflection**> of blade length, but not less than [**10 in. wg (2500 Pa)**]<**Insert pressure**>.
d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**][**Minus 40 to plus 400 deg F (Minus 40 to plus 204 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**4000 fpm (20 m/s)**][**5000 fpm (25 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

5. Construction:

a. Frame:

1) Material: Galvanized steel.
2) Shape: C-shaped channel.
3) Mating Face Size: Minimum [**2 inches (50 mm)**]<**Insert size**>.
4) Thickness: Minimum [**14 gauge (2 mm)**]<**Insert thickness**> thick.
5) Width: Not less than [**8 inches (250 mm)**][**open blade width plus 2 inches (50 mm)**]<**Insert dimension**>.

b. Blades:

1) Configuration: Parallel or opposed blade as required by application.
2) Material: Galvanized steel.
3) Thickness: Minimum [**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**> thick.
4) Shape: Hollow, airfoil.
5) Length: Not to exceed [**36 inches (900 mm)**][**48 inches (1200 mm)**][**60 inches (1500 mm)**]<**Insert dimension**>.
6) Width: Not to exceed [**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert dimension**>.

c. Seals:

1) Blades: Replaceable, mechanically attached [**silicone**][**or**][**stainless steel**]<**Insert material**>.
2) Jambs: Stainless steel, [**double**]compression type.

d. Axles:

1) Attachment: Mechanically attached to blades.
2) Diameter: Minimum **0.75 inch (19 mm)**.
3) Material: [**Plated**][**or**][**stainless**].

4) Length: [**Continuous across entire length of blade**]<**Insert length**>.

e. Bearings:

1) Material: Stainless steel.
2) Mounting: [**Bolted to frame**][**Pressed into frame**][**Bolted or pressed in frame**][**Outboard bearings bolted to frame with shaft seals**][**Mounting requirements as indicated by application**]<**Insert mounting requirements**>.
3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Arrangement: [**Blade-to-blade linkage concealed in frame**][**Blade-to-blade face linkage exposed to airstream**]<**Insert requirement**>.
2) Material: [**Plated**][**or**][**stainless**].
3) Hardware: Stainless steel.

g. Additional Corrosion Protection for Corrosive Environments:

1) [**Where indicated, paint**][**Paint**] surfaces exposed to airstream with an [**enamel**][**or**][**epoxy**]<**Insert finish**> finish. Prepare surfaces to be painted according to paint manufacturer's instructions.

C. Rectangular Industrial-Duty Control Dampers with Stainless Steel Airfoil Blades and Frames:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain rectangular industrial-duty control dampers, with stainless steel airfoil blades and frames, from single manufacturer.
4. Performance:

a. Leakage: Not to exceed [**3 cfm/sq. ft. (15.2 L/s per sq. m)**][**4 cfm/sq. ft. (20.3 L/s per sq. m)**]<**Insert value**> against [**1 in. wg (250 Pa)**]<**Insert value**> differential static pressure when tested in accordance with AMCA 500D.
b. Pressure Drop: [**0.1 in. wg (25 Pa)**]<**Insert pressure drop**> at [**1500 fpm (7.6 m/s)**]<**Insert velocity**> across a [**24-by-24-inch (600-by-600-mm)**]<**Insert size**> damper when tested in accordance with AMCA 500D, figure [**5.3**]<**Insert figure no.**>.

c. Pressure Rating: Damper close-off pressure equal to [**fan shutoff pressure**]<**Insert requirement**> with a maximum blade deflection of [**1/240**]<**Insert deflection**> of blade length, but not less than [**10 in. wg (2500 Pa)**]<**Insert pressure**>.
d. Temperature: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**][**Minus 40 to plus 400 deg F (Minus 40 to plus 204 deg C)**]<**Insert temperature range**>.
e. Velocity: Up to [**4000 fpm (20 m/s)**][**5000 fpm (25 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

5. Construction:

a. Frame:

1) Material: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.
2) Shape: C-shaped channel.
3) Mating Face Size: Minimum [**2 inches (50 mm)**]<**Insert size**>.
4) Thickness: Minimum [**14 gauge (2 mm)**]<**Insert thickness**> thick.
5) Width: Not less than [**8 inches (250 mm)**][**open blade width plus 2 inches (50 mm)**]<**Insert dimension**>.

b. Blades:

1) Configuration: Parallel or opposed blade as required by application.
2) Material: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.
3) Thickness: Minimum [**14 gauge (2 mm)**][**16 gauge (1.6 mm)**]<**Insert thickness**> thick.
4) Shape: Hollow, airfoil.
5) Length: Not to exceed [**36 inches (900 mm)**][**48 inches (1200 mm)**][**60 inches (1500 mm)**]<**Insert dimension**>.
6) Width: Not to exceed [**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert dimension**>.

c. Seals:

1) Blades: Replaceable, mechanically attached [**silicone**][**or**][**stainless steel**]<**Insert material**>.
2) Jambs: Type 316 stainless steel, [**double**]compression type.

d. Axles:

1) Attachment: Mechanically attached to blades.
2) Diameter: Minimum **0.75 inch (19 mm)**.
3) Material: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.
4) Length: [**Continuous across entire length of blade**]<**Insert length**>.

e. Bearings:

1) Material: Stainless steel.
2) Mounting: [**Bolted to frame**][**Pressed into frame**][**Bolted or pressed in frame**][**Outboard bearings bolted to frame with shaft seals**][**Mounting requirements as indicated by application**]<**Insert mounting requirements**>.
3) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Arrangement: [**Blade-to-blade linkage concealed in frame**][**Blade-to-blade face linkage exposed to airstream**]<**Insert requirement**>.
2) Material: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.
3) Hardware: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.

2.8 ROUND CONTROL DAMPERS

A. General Requirements:

1. Factory install actuator as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Round, Galvanized-Steel Control Dampers with Sleeve End Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, galvanized-steel control dampers with sleeve end connections from single manufacturer.
4. Performance:

a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.
b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)** damper when tested in accordance with AMCA 500D, figure 5.3.
c. Pressure Rating: [**4 in. wg (1000 Pa)**][**6 in. wg (1500 Pa)**][**8 in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6 in. wg (1500 Pa) for larger sizes**]<**Insert pressure**>.
d. Temperature: Up to [**180 deg F (82 deg C)**][**200 deg F (93 deg C)**]<**Insert temperature**>.
e. Velocity: Up to [**3000 fpm (15 m/s)**][**4000 fpm (20 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 24 inches (100 to 600 mm)**]<**Insert size range**>.
6. Construction:

   a. Frame:

      1) End Connection: Sleeve-type connection for mating to adjacent ductwork.
      2) Length: Minimum **6 inches (150 mm)**.
      3) Material: Galvanized steel, minimum **20 gauge (1.0 mm)** thick.
      4) Stiffeners: Outward-turned beads positioned approximately **1-1/2 inches (38 mm)** inboard of each end.
      5) Standoff: Provide **2-inch- (50-mm-)** high, sheet metal standoff for mounting actuator to axle while accommodating field-installed duct insulation.

   b. Blade: Double-thickness circular flat blades sandwiched together and constructed of galvanized steel.
   c. Blade Seal: EPDM, neoprene or silicone seal fully encompassing blade edge.
   d. Axle: **0.5-inch- (13-mm-)** diameter plated steel, mechanically attached to blade.
   e. Bearings: Bronze or stainless steel sleeve pressed into frame.

C. Round, Stainless Steel Control Dampers with Sleeve End Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, stainless steel control dampers with sleeve end connections from single manufacturer.
4. Performance:

   a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.
   b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)** damper when tested in accordance with AMCA 500D, figure 5.3.
   c. Pressure Rating: [**4 in. wg (1000 Pa)**][**6 in. wg (1500 Pa)**][**8 in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6 in. wg (1500 Pa) for larger sizes**]<**Insert pressure**>.

d. Temperature: Up to [**180 deg F (82 deg C)**][**200 deg F (93 deg C)**]<**Insert temperature**>.
e. Velocity: Up to [**3000 fpm (15 m/s)**][**4000 fpm (20 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 24 inches (100 to 600 mm)**]<**Insert size range**>.
6. Construction:

a. Frame:

1) End Connection: Sleeve-type connection for mating to adjacent ductwork.
2) Length: Minimum **6 inches (150 mm)**.
3) Material: Type 304 stainless steel, minimum **20 gauge (1.0 mm)** thick.
4) Stiffeners: Outward-turned beads positioned approximately **1-1/2 inches (38 mm)** inboard of each end.
5) Standoff: Provide **2-inch- (50-mm-)** high, sheet metal standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Double-thickness circular flat blades sandwiched together and constructed of Type 304 stainless steel.
c. Blade Seal: EPDM, neoprene or silicone seal fully encompassing blade edge.
d. Axle: **0.5-inch- (13-mm-)** diameter, Type 304 or 316 stainless steel, mechanically attached to blade.
e. Bearings: Bronze or stainless steel sleeve pressed into frame.

D. Round, Galvanized-Steel Control Dampers with Flanged End Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, galvanized-steel control dampers with flanged end connections from single manufacturer.
4. Performance:

a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.
b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)**

damper when tested in accordance with AMCA 500D, figure 5.3.

c. Pressure Rating: [**4 in. wg (1000 Pa)**][**6 in. wg (1500 Pa)**][**8 in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6 in. wg (1500 Pa) for larger sizes**]<**Insert pressure**>.

d. Temperature: Up to [**250 deg F (121 deg C)**]<**Insert temperature**>.

e. Velocity: Up to [**2500 fpm (13 m/s)**][**3000 fpm (15 m/s)**][**4000 fpm (20 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 48 inches (100 to 1200 mm)**]<**Insert size range**>.

6. Construction:

a. Frame:

1) Material: Galvanized steel, thickness as follows:

a) Sizes through **18 Inches (450 mm)** in Diameter: Minimum **16 gauge (1.6 mm)** thick.

b) Larger Sizes: Minimum **12 gauge (2.8 mm)** thick.

2) Flanges:

a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.

b) Face: Not less than **1-1/2 inches (38 mm)**.

c) Thickness: Minimum **12 gauge (2.8 mm)** thick.

3) Length (Flange Face to Face): Not less than **8 inches (200 mm)**.

4) Standoff: Provide **3-inch- (75-mm-)** high, standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Reinforced double-thickness circular flat blades sandwiched together or reinforced single-thickness circular flat blades; constructed of galvanized steel.

1) Double-Thickness Blades (Each Side):

a) Sizes through **18 Inches (450 mm)**: Minimum **18 gauge (1.3 mm)** thick.

b) Larger Sizes: Minimum **16 gauge (1.6 mm)** thick.

2) Single-Thickness Blades:

a) Sizes through **36 Inches (900 mm)**: Minimum **14 gauge (2 mm)** thick.

b) Larger Sizes: Minimum **12 gauge (2.8 mm)** thick.

c. Blade Stop: Located in airstream; galvanized steel, full-circumference bar[**or pin**].

d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge. For double-thickness blade designs, sandwich seal between blades.

e. Axle: Continuous, plated steel, mechanically attached to blade and angle reinforced as required.

1) Blade Diameter through **24 Inches (600 mm)**: Minimum **1/2-inch (13-mm)** axle diameter.

2) Larger Sizes: Minimum **3/4-inch (19-mm)** axle diameter.

f. Bearings: [**Bronze or**]stainless steel sleeve pressed into frame.

E. Round, Stainless Steel Control Dampers with Flanged End Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
   b. [**Arrow United Industries; Mestek, Inc.**]
   c. [**Greenheck Fan Corporation**]
   d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, stainless steel control dampers with flanged end connections from single manufacturer.
4. Performance:

   a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.
   b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)** damper when tested in accordance with AMCA 500D, figure 5.3.
   c. Pressure Rating: [**4 in. wg (1000 Pa)**][**6 in. wg (1500 Pa)**][**8 in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6 in. wg (1500 Pa) for larger sizes**]<**Insert pressure**>.
   d. Temperature: Up to [**250 deg F (121 deg C)**]<**Insert temperature**>.
   e. Velocity: Up to [**2500 fpm (13 m/s)**][**3000 fpm (15 m/s)**][**4000 fpm (20 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 48 inches (100 to 1200 mm)**]<**Insert size range**>.
6. Construction:

   a. Frame:

      1) Material: Type 304 stainless steel, thickness as follows:

         a) Sizes through **18 Inches (450 mm)** in Diameter: Minimum **16 gauge (1.6 mm)** thick.
         b) Larger Sizes: Minimum **12 gauge (2.8 mm)** thick.

      2) Flanges:

         a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.
         b) Face: Not less than **1-1/2 inches (38 mm)**.
         c) Thickness: Minimum **12 gauge (2.8 mm)** thick.

3) Length (Flange Face to Face): Not less than **8 inches (200 mm)**.
4) Standoff: Provide **3-inch- (75-mm-)** high, standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Reinforced double-thickness circular flat blades sandwiched together or reinforced single-thickness circular flat blades; constructed of Type 304 stainless steel.

1) Double-Thickness Blades (Each Side):

a) Sizes through **18 Inches (450 mm)**: Minimum **18 gauge (1.3 mm)** thick.
b) Larger Sizes: Minimum **16 gauge (1.6 mm)** thick.

2) Single-Thickness Blades:

a) Sizes through **36 Inches (900 mm)**: Minimum **14 gauge (2 mm)** thick.
b) Larger Sizes: Minimum **12 gauge (2.8 mm)** thick.

c. Blade Stop: Located in airstream; Type 304 stainless steel, full-circumference bar[**or pin**].
d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge. For double-thickness blade designs, sandwich seal between blades.
e. Axle: Continuous, Type 304 stainless steel, mechanically attached to blade and angle reinforced as required.

1) Blade diameter through **24 Inches (600 mm)**: Minimum **1/2-inch (13-mm)** axle diameter.
2) Larger Sizes: Minimum **3/4-inch (19-mm)** axle diameter.

f. Bearings: Stainless steel sleeve pressed into frame.

2.9 ROUND INDUSTRIAL-DUTY CONTROL DAMPERS

A. General Requirements:

1. Factory install actuator as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Round, Carbon Steel, Industrial-Duty Control Dampers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, carbon steel, industrial-duty control dampers from single manufacturer.
4. Performance:

   a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.
   b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)** damper when tested in accordance with AMCA 500D, figure 5.3.
   c. Pressure Rating: Minimum [**13 in. wg (3250 Pa)**]<**Insert pressure**>.
   d. Temperature: Up to [**250 deg F (121 deg C)**][**400 deg F (204 deg C)**]<**Insert temperature**>.
   e. Velocity: Up to [**5000 fpm (25 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 72 inches (100 to 1800 mm)**]<**Insert size range**>.
6. Construction:

   a. Frame:

      1) Material: Carbon steel.

         a) Sizes through **24 Inches (600 mm)** in Diameter: Minimum **10 gauge (4 mm)** thick.
         b) Sizes **26 through 48 Inches (650 through 1200 mm)** in Diameter: Minimum **1/4 inch (6 mm)** thick.
         c) Larger Sizes: Minimum **5/16 inch (8 mm)** thick.

      2) Flanges:

         a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.
         b) Face: Not less than **1-1/4 inches (31 mm)** for damper sizes through **12 inches (300 mm)** in diameter, **1-1/2 inches (38 mm)** for damper sizes **14 through 24 inches (350 through 600 mm)** in diameter, and **2 inches (50 mm)** for larger sizes.

      3) Length (Flange Face to Face):

         a) Sizes through **8 Inches (200 mm)** in Diameter: Not less than **6 inches (150 mm)**.
         b) Larger Sizes: Not less than **9 inches (225 mm)**.

      4) Standoff: Provide **3-inch (75-mm)** standoff for mounting actuator to axle while accommodating field-installed duct insulation.

   b. Blade: Reinforced circular flat blade constructed of carbon steel.

      1) Sizes through **24 Inches (600 mm)**: Minimum **0.15 inch (4 mm)** thick.

2) Sizes **26 through 48 Inches (650 through 1200 mm)**: Minimum **0.19 inch (5 mm)** thick.
3) Larger Sizes: Minimum **1/4 inch (6 mm)** thick.

c. Blade Stop: Full-circumference carbon steel bar, minimum **1/2 by 1/4 inch (13 by 6 mm)**.
d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge.
e. Axle: Continuous plated-steel axle mechanically attached to blade and angle reinforced as required.

1) Blade Diameter through **32 Inches (800 mm)**: Minimum **3/4 inch (19 mm)** in diameter axle.
2) Blade Diameter **33 through 44 Inches (825 through 1100 mm)**: Minimum **1-inch (19-mm)** axle diameter.
3) Blade Diameter **45 through 52 Inches (1125 through 1300 mm)**: Minimum **1-1/2-inch (38-mm)** axle diameter.
4) Larger Sizes: Minimum **2-inch (50-mm)** axle diameter.

f. Axle Shaft Seals: [**Viton O-rings**][**or**][**double gland stuffing boxes**] where indicated for application.
g. Bearings: [**Grease-lubricated ball bearings bolted to frame**][**Bolted grease-lubricated ball bearings located on outboard of frame with axle shaft seals**].

7. Finish: Prime and paint carbon steel surfaces with a corrosion-resistant finish as recommended by manufacturer and suitable for airstream encountered at temperature range indicated. Prepare surfaces to be finished according to paint manufacturer's requirements.

C. Round, Stainless Steel, Industrial-Duty Control Dampers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
b. [**Arrow United Industries; Mestek, Inc.**]
c. [**Greenheck Fan Corporation**]
d. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain round, stainless steel, industrial-duty control dampers from single manufacturer.
4. Performance:

a. Leakage: Not to exceed [**0.15 cfm/in. (0.0028 L/s per mm)**]<**Insert leakage**> of perimeter

blade at [**4 in. wg (1000 Pa)**]<**Insert pressure**> differential static pressure when tested in accordance with AMCA 500D.

b. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **12-inch (300-mm)** damper when tested in accordance with AMCA 500D, figure 5.3.

c. Pressure Rating: Minimum [**13 in. wg (3250 Pa)**]<**Insert pressure**>.

d. Temperature: Up to [**250 deg F (121 deg C)**][**400 deg F (204 deg C)**]<**Insert temperature**>.

e. Velocity: Up to [**5000 fpm (25 m/s)**][**6000 fpm (30 m/s)**]<**Insert velocity**>.

5. Size Range: [**4 to 72 inches (100 to 1800 mm)**]<**Insert size range**>.

6. Construction:

a. Frame:

1) Material: Stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.

a) Sizes through **24 Inches (600 mm)** in Diameter: Minimum **10 gauge (4 mm)** thick.

b) Sizes **26 through 48 Inches (650 through 1200 mm)** in Diameter: Minimum **1/4 inch (6 mm)** thick.

c) Larger Sizes: Minimum **5/16 inch (8 mm)** thick.

2) Flanges:

a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.

b) Face: Not less than **1-1/4 inches (31 mm)** for damper sizes through **12 inches (300 mm)** in diameter, **1-1/2 inches (38 mm)** for damper sizes **14 through 24 inches (350 through 600 mm)** in diameter, and **2 inches (50 mm)** for larger sizes.

3) Length (Flange Face to Face):

a) Sizes through **8 Inches (200 mm)** in Diameter: Not less than **6 inches (150 mm)**.

b) Larger Sizes: Not less than **9 inches (225 mm)**.

4) Standoff: Provide **3-inch (75-mm)** standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Reinforced circular flat blade constructed of stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.

1) Sizes through **24 Inches (600 mm)**: Minimum **0.15 inch (4 mm)** thick.

2) Sizes **26 through 48 Inches (650 through 1200 mm)**: Minimum **0.19 inch (5 mm)** thick.

3) Larger Sizes: Minimum **1/4 inch (6 mm)** thick.

c. Blade Stop: Full-circumference bar, minimum **1/2 by 1/4 inch (13 by 6 mm)** stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as indicated by application**]<**Insert type**>.

d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge.

e. Axle: Continuous axle mechanically attached to blade and angle reinforced as required. Axle constructed of stainless steel, [**Type 304**][**or**][**Type 316**][**Type 304 or 316 as**

indicated by application]<**Insert type**>.

1) Blade Diameter through **32 Inches (800 mm)**: Minimum **3/4-inch (19-mm)** axle diameter.
2) Blade Diameter **33 through 44 Inches (825 through 1100 mm)**: Minimum **1-inch (19-mm)** axle diameter.
3) Blade Diameter **45 through 52 Inches (1125 through 1300 mm)**: Minimum **1-1/2-inch (38-mm)** axle diameter.
4) Larger Sizes: Minimum **2-inch (50-mm)** axle diameter.

f. Axle Shaft Seals: [**Viton O-rings**][**or**][**double gland stuffing boxes**] where indicated for application.
g. Bearings: [**Grease-lubricated ball bearings bolted to frame**][**Bolted grease-lubricated ball bearings located on outboard of frame with axle shaft seals**].

7. Finish: [**Mill**]<**Insert finish**>.

2.10 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Select actuators to operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Select actuators with sufficient power and torque to close off against the maximum system pressures encountered. Actuators are to be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator is not to exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Operate multiple actuators required to drive a single damper assembly in unison.

E. Avoid the use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail-safe in desired position in the event of a power [**and signal**]failure.

I. Actuator Fail-Safe Positions: [**See Drawings.**][**As indicated below:**]

1. Exhaust Air: [**Close**][**Last position**][**Open**].
2. Outdoor Air: [**Close**][**Last position**][**Open**].
3. Supply Air: [**Close**][**Last position**][**Open**].
4. Return Air: [**Close**][**Last position**][**Open**].
5. <**Insert system and fail-safe position**>.

2.11 ELECTRIC AND ELECTRONIC CONTROL-DAMPER ACTUATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belimo Aircontrols (USA), Inc**]
2. [**Honeywell Building Solutions; Honeywell International, Inc.**]
3. [**Johnson Controls, Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Building Technologies Division**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belimo Aircontrols (USA), Inc**]
2. [**Honeywell Building Solutions; Honeywell International, Inc.**]
3. [**Johnson Controls, Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Building Technologies Division**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain electric and electronic control-damper actuators from single manufacturer.

D. Type: Motor operated, with or without gears, electric and electronic.

E. Voltage:

1. [**See Drawings**][**Voltage selection is delegated to professional designing control system**][**24 V**][**120 V**]<**Insert requirement**>.
2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.

F. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed-steel enclosures.
2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

G. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

H. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in

range.

2. Control Input Signal:

   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for [**0 to 10**][**or**][**2 to 10**] V dc [**and**][**4 to 20 mA**] signals.
   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
   d. Programmable Multifunction:

      1) Control input, position feedback, and running time are to be factory or field programmable.
      2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service data, including at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:

1. [**Equip**][**Where indicated, equip**] two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of [**open**][**and**][**close**] position.
2. [**Equip**][**Where indicated, equip**] modulating actuators with a position feedback through [**current**][**or**][**voltage**] signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

L. Fail-Safe:

1. Where indicated, provide actuator to fail-safe to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and setscrew method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [**minus 20 to plus 120 deg F (minus 29 to plus 49**

deg C)]<**Insert temperature range**>.

2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from [**5 to 95**]<**Insert numbers**> percent relative humidity, noncondensing.

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, [**Type 2**][**or**][**Type 4**] for indoor and protected applications.
3. NEMA 250, [**Type 4**][**or**][**Type 4X**] for outdoor and unprotected applications.
4. NEMA 250, [**Type 7**][**or**][**Type 9**] for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.

Q. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation[**, and as follows**].

   a. Operate damper from fully closed to fully open position within [**15**][**30**][**60**][**75**][**90**][**150**]<**Insert number**> seconds.
   b. Operate damper from fully open to fully closed position within [**15**][**30**][**60**][**75**][**90**][**150**]<**Insert number**> seconds.
   c. Move damper to fail-safe position within [**5**][**15**][**30**]<**Insert number**> seconds.

2. For actuators operating in smoke-control and other life-safety systems, comply with governing code and NFPA requirements.

R. Sound: Where actuators are located in tenant-occupied rooms with a room sound-level criteria of [**NC-35**]<**Insert NC level**> or lower, comply with the following sound levels:

1. Spring Return: [**45**]<**Insert number**> dBA.
2. Nonspring Return: [**45**]<**Insert number**> dBA.

2.12 PNEUMATIC CONTROL-DAMPER ACTUATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Honeywell Building Solutions; Honeywell International, Inc.**]
2. [**Johnson Controls, Inc.**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Building Technologies Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Honeywell Building Solutions; Honeywell International, Inc.**]
2. [**Johnson Controls, Inc.**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Building Technologies Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pneumatic control-damper actuators from single manufacturer.

D. Where two or more actuators are installed for interrelated operation in unison, such as dampers used for mixing, provide the dampers with a positive positioner.

E. Equip pneumatic modulating actuators with a positive positioner, having the following performance characteristics:

1. Linearity: Within [**1**]<**Insert value**> percent of output signal span.
2. Hysteresis: [**0.5**]<**Insert number**> percent of the span.

F. Provide each positioner with an integrally mounted air set and pressure gauges for instrument air supply, instrument input, and positioner output. Operate on a **3 to 15 psig (21 to 103 kPa)** input signal unless otherwise required by the application to comply with the control sequence of operation.

G. Rate actuators for a pressure of at least [**1.1**]<**Insert value**> times main supply air pressure to actuator, but not less than [**25 psig (172 kPa)**]<**Insert pressure**>.

H. Single-Action (Spring-Return) Diaphragm Actuators:

1. Travel: Rotary or linear travel as required by application.
2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

a. Diaphragm: Reinforced synthetic rubber or nitrile. Provide actuators with replaceable diaphragms[**where indicated for the application**].
b. Diaphragm Casing and Plate: Cast iron, steel, or cast aluminum.
c. Spring, Stem, and Spring Adjuster: Steel or steel alloy.
d. Yoke: Cast iron, steel, or cast aluminum.

I. Double-Action (Air-to-Air) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (zero to 90 degrees) control dampers.
2. Fail-Safe Position (Loss of Air): Last position.
3. Construction:

a. Body: Anodized extruded-aluminum alloy.
b. End Caps: Cast-aluminum alloy.
c. Pistons: Cast-aluminum alloy.
d. Piston O-Ring Seals: NBR.
e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
f. Travel Stops: Adjustable, stainless steel.
g. Fasteners: Stainless steel.

J. Single-Action (Spring-Return) Rack-and-Pinion Actuators:

1. Travel: Rotary travel for control of quarter-turn (zero to 90 degrees) control dampers.
2. Fail-Safe Position (Loss of Air): Air-to-open or air-to-close, as required by application.
3. Construction:

a. Body: Anodized extruded-aluminum alloy.
b. End Caps: Cast-aluminum alloy.
c. Pistons: Cast-aluminum alloy.
d. Piston O-Ring Seals: NBR.
e. Output Shaft and Pinion: Zinc-plated carbon steel or stainless steel.
f. Springs: Coated steel, steel, or steel alloy.
g. Travel Stops: Adjustable, stainless steel.

h. Fasteners: Stainless steel.

K. Provide actuator with adjustable stops for both maximum and minimum positions.

L. Local Manual Override: Where indicated, provide actuators with an external manual adjustment mechanism to allow manual positioning of the damper through the actuator.

M. Local Position Indication: Provide a position indicator and graduated scale on each actuator. Indicate open and closed travel limits.

N. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. Install actuator(s) in a supplemental enclosure with a heater and controller where required by application.

O. Position Feedback Signal:

1. [**Equip**][**Where indicated, equip**] two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of [**open**][**and**][**close**] position.
2. [**Equip**][**Where indicated, equip**] modulating actuators with a position feedback through [**current**][**or**][**voltage**] signal for remote monitoring.

P. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation[**, and as follows**].

a. Operate damper from fully closed to fully open position within [**15**][**30**]<**Insert number**> seconds.
b. Operate damper from fully open to fully closed position within [**15**][**30**]<**Insert number**> seconds.
c. Move damper to fail-safe position within [**5**][**15**][**30**]<**Insert number**> seconds.

2. For actuators operating in smoke-control and other life-safety systems, comply with governing code and NFPA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL-DAMPER APPLICATIONS

A. Select from damper types indicated to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Rectangular Control-Damper Applications:

1. Exhaust Air: [**Rectangular dampers with aluminum airfoil blades**][**Rectangular dampers with galvanized-steel airfoil blades**][**Rectangular dampers with stainless steel airfoil blades**][**Rectangular dampers with aluminum flat blades**][**Rectangular dampers with galvanized-steel flat blades**][**Rectangular dampers with stainless steel flat blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
2. Outdoor Air: [**Rectangular dampers with aluminum airfoil blades**][**Rectangular dampers with galvanized-steel airfoil blades**][**Rectangular dampers with stainless steel airfoil blades**][**Rectangular dampers with aluminum flat blades**][**Rectangular dampers with galvanized-steel flat blades**][**Rectangular dampers with stainless steel flat blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
3. Return Air: [**Rectangular dampers with aluminum airfoil blades**][**Rectangular dampers with galvanized-steel airfoil blades**][**Rectangular dampers with stainless steel airfoil blades**][**Rectangular dampers with aluminum flat blades**][**Rectangular dampers with galvanized-steel flat blades**][**Rectangular dampers with stainless steel flat blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
4. Supply Air: [**Rectangular dampers with aluminum airfoil blades**][**Rectangular dampers with galvanized-steel airfoil blades**][**Rectangular dampers with stainless steel airfoil blades**][**Rectangular dampers with aluminum flat blades**][**Rectangular dampers with galvanized-steel flat blades**][**Rectangular dampers with stainless steel flat blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

C. Rectangular Control Dampers with Insulated Blade Applications:

1. Exhaust Air: [**Rectangular dampers with insulated aluminum airfoil blades**][**Rectangular dampers with insulated aluminum airfoil blades and thermal break frames**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
2. Outdoor Air: [**Rectangular dampers with insulated aluminum airfoil blades**][**Rectangular dampers with insulated aluminum airfoil blades and thermal break frames**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
3. Return Air: [**Rectangular dampers with insulated aluminum airfoil blades**][**Rectangular dampers with insulated aluminum airfoil blades and thermal break frames**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
4. Supply Air: [**Rectangular dampers with insulated aluminum airfoil blades**][**Rectangular dampers with insulated aluminum airfoil blades and thermal break frames**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

D. Rectangular Control Dampers with Integral Airflow Applications:

1. Applications with Airflow Measurement: Rectangular dampers with aluminum airfoil blades and integral airflow measurement using [**pressure**][**or**][**thermal**] sensing.
2. Applications with Airflow Control: Rectangular dampers with aluminum airfoil blades and integral airflow control using [**pressure**][**or**][**thermal**] sensing.

E. Rectangular Industrial-Duty Control-Damper Applications:

1. Exhaust Air: [**Rectangular industrial-duty dampers with galvanized-steel airfoil blades**][**Rectangular industrial-duty dampers with stainless steel airfoil blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

2. Outdoor Air: [**Rectangular industrial-duty dampers with galvanized-steel airfoil blades**][**Rectangular industrial-duty dampers with stainless steel airfoil blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
3. Return Air: [**Rectangular industrial-duty dampers with galvanized-steel airfoil blades**][**Rectangular industrial-duty dampers with stainless steel airfoil blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
4. Supply Air: [**Rectangular industrial-duty dampers with galvanized-steel airfoil blades**][**Rectangular industrial-duty dampers with stainless steel airfoil blades**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

F. Round Control-Damper Applications:

1. Exhaust Air: [**Round galvanized steel dampers, sleeve ends**][**Round stainless steel dampers, sleeve ends**][**Round galvanized-steel dampers, flange ends**][**Round stainless steel dampers, flange ends**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
2. Outdoor Air: [**Round galvanized-steel dampers, sleeve ends**][**Round stainless steel dampers, sleeve ends**][**Round galvanized-steel dampers, flange ends**][**Round stainless steel dampers, flange ends**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
3. Return Air: [**Round galvanized-steel dampers, sleeve ends**][**Round stainless steel dampers, sleeve ends**][**Round galvanized-steel dampers, flange ends**][**Round stainless steel dampers, flange ends**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
4. Supply Air: [**Round galvanized-steel dampers, sleeve ends**][**Round stainless steel dampers, sleeve ends**][**Round galvanized-steel dampers, flange ends**][**Round stainless steel dampers, flange ends**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

G. Round Industrial-Duty Control-Damper Applications:

1. Exhaust Air: [**Round carbon steel, industrial-duty dampers**][**Round, stainless steel, industrial-duty dampers**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
2. Outdoor Air: [**Round carbon steel, industrial-duty dampers**][**Round, stainless steel, industrial-duty dampers**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
3. Return Air: [**Round carbon steel, industrial-duty dampers**][**Round, stainless steel, industrial-duty dampers**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.
4. Supply Air: [**Round carbon steel, industrial-duty dampers**][**Round, stainless steel, industrial-duty dampers**]; <**Insert value**> maximum air pressure and <**Insert value**> maximum air velocity.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic, wind, or other forces common to the application.

C. Provide ceiling, floor, roof, [**and**]wall openings[**, and sleeves**]required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1. Wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

   a. Laboratory exhaust airstreams.
   b. Process exhaust airstreams.
   c. <**Insert applications**>.

3. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 CONTROL DAMPERS

A. Install smooth transitions, not exceeding [**15**][**30**]<**Insert number**> degrees, to dampers larger or smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2. Install dampers with at least [**24 inches (600 mm)**]<**Insert distance**> of clear space on sides of dampers requiring service access unless more space is recommended by manufacturer. Provide code required clearances as applicable.

C. Service Access:

1. Install dampers and actuators to be accessible for visual inspection and service.
2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions.

E. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished

support alone cannot handle loading.

F. Attach field-installed actuator(s) to damper drive shaft.

G. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper[**and on face of ceiling where damper is concealed above ceiling**].

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power

Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and damper linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is smooth and unobstructed throughout operating range.
9. Pneumatic Control Dampers:

   a. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
   b. Verify air supply for each product is properly installed.
   c. Verify that pressure gauges are provided in each air line to damper actuator and positioner.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than [**30**]<**Insert value**> seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 23 12

Task	Specification	Specification Description
23 09 23 12	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 12	23 09 23 00a	Leak Detection Instruments
23 09 23 12	23 09 23 00b	Position Instruments
23 09 23 12	23 09 00 00	Speed Instruments
23 09 23 12	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 13 - ENERGY METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermal energy meters.
2. Electric power meters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.
3. Section 260913 "Electrical Power Monitoring" for electrical power meters not included in this Section.

1.2 DEFINITIONS

A. DDC: Direct-digital control.

B. DIN: Deutsche Institut fur Normung (German Institute for Standards).

C. DZR: Dezincification resistant.

D. Ethernet: Local area network based on IEEE 802.3.1.

E. EEPROM: Electrically erasable programmable read-only memory.

F. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

G. I/O: Input/output.

H. IP: Ingress protection ratings.

I. PEEK: Polyetheretherketone.

J. PLC: Programmable logic controller.

K. PPS: Polyphenylene sulfide.

L. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

N. RS-485: A TIA standard for multipoint communications using two twisted pairs.

O. RTD: Resistance temperature detector.

1.3 ACTION SUBMITTALS

A. Product Data: For [**thermal energy meters**][**electric power meters**], include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating electrical power requirements.
3. Product description with complete technical data, performance curves, and product specification sheets.

B. Sustainable Design Submittals:

1. Product Data for EA Credit 5, "Measurement and Verification": For continuous metering equipment.
2. Product Data for EA Credit "Advanced Energy Metering": For continuous metering equipment.
3. Product Data: For continuous metering equipment for energy consumption.

C. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product and component requiring a certificate.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For energy meters to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 THERMAL ENERGY METERS

A. Performance Requirements: Manufacturer is to certify that each energy meter complies with specified performance requirements and characteristics.

1. Product certificates are required.

B. Thermal Energy Meter with Insertion Impeller Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. <**Insert manufacturer's name**>

3. Description:

a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, user-interface keypad, installation hardware, color-coded interconnecting cabling, and installation instructions.
b. Factory calibrate each thermal energy meter and provide with calibration certification.

4. Performance:

a. Ambient Operating Temperature: [**32 to 130 deg F (0 to 55 deg C)**]<**Insert temperature range**>.
b. Energy Calculation Nonlinearity: Within [**0.05**]<**Insert number**> percent.
c. Flow Sensor Performance:

1) Accuracy: Within [**1**]<**Insert number**> percent of full-scale range.
2) Flow Velocity Range: [**0.5 to 30 fps (0.15 to 9.1 m/s)**]<**Insert velocity range**>.
3) Linearity: Within [**0.2**]<**Insert number**> percent of full-scale range.
4) Repeatability: Within [**0.3**]<**Insert number**> percent of full-scale range.
5) Pressure Drop: Not to exceed [**1 psig (6.89 kPa)**]<**Insert value**> at [**20 fps (6.1 m/s)**]<**Insert value**>.

d. Process Pipe Sizes: **NPS 3 (DN 80)** through [**NPS 36 (DN 900)**]<**Insert pipe size**>.
e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Pressure: Up to [**400 psig (2758 kPa)**][**325 psig (2241 kPa)**]<**Insert value**>.
2) Temperature: Up to [**221 deg F (105 deg C)**][**285 deg F (141 deg C)**]<**Insert value**>.

f. Process Temperature Accuracy: Differential temperature accuracy within [**0.15 deg F (0.08 deg C)**]<**Insert temperature**> over the calibrated range.

5. Meter Display: Backlit, LCD alphanumeric display on face of meter enclosure.

a. Total energy consumption.
b. Energy rate.
c. Flow rate.
d. Total flow consumption.
e. Supply temperature.
f. Return temperature.
g. Visual indication of power status (on/off) on face of enclosure.

6. Meter Electronics Enclosure:

    a. Remote mounted from temperature and flow sensors.
    b. Indoor Applications Only: NEMA 250, Type 1.
    c. Terminal strip for field wiring connections.
    d. Connections: Suitable for mating to field-installed conduit.

7. Power Supply:

    a. Field Power: 24 V ac, 50 or 60 Hz as required by the application.
    b. Internal Power: As required by flow meter.

8. Programming:

    a. Factory programmed for specific application and field programmable through keypad on face of enclosure.
    b. Programmed parameters and total energy and flow consumption stored in non-volatile EEPROM memory.

9. Output Signals:

    a. Total Energy, Flow Consumption: Isolated solid-state dry contact with 100 mA, 50 V rating and pulsed signal.
    b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero to 10 V dc for each.
    c. Option to use serial communication interface in lieu of hardwired signals

10. Serial Communication Interface: Compatible with host to share total energy and flow consumption, energy rate, flow rate, and supply and return temperature data.
11. Flow Sensor:

    a. Factory Calibration: Calibrate and tag each sensor and provide with a certificate of calibration.
    b. Wetted Metal Parts, Including Sensor Sleeve, Mounting Adapter, and Isolation Valve: [**Brass, bronze**][**or**][**Type 316 stainless steel**].
    c. Shaft: [**Tungsten carbide**][**or**][**Type 316 stainless steel**].
    d. Impeller: [**Nylon**][**or**][**ETFE**].
    e. Process Connection: **NPS 2 (DN 50)**.
    f. Insertion Depth: Threaded positioning nut for accurate sensor depth in the pipe.
    g. Electronics Enclosure:

        1) [**PPS**][**or**][**PEEK**] with Viton seal.
        2) Electrical Connection: Cable furnished with sensor.

    h. Installation Hardware: Provide installation hardware necessary to enable insertion and removal from the pipe without system shutdown.
    i. Isolation Valve: Provide sensor with full-port ball valve for system isolation.
    j. Sensor Cable: As required by manufacturer for field application.

12. Temperature Sensors:

    a. Enclosure: NEMA 250, Type 4 or equivalent; with conduit connections.
    b. Sensor Cable: As required by manufacturer for application.
    c. Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**Type II thermistor**].

d. Temperature Range: Matched pair; suitable for application.
e. Thermowells: Stainless steel; with NPT connections.

C. Thermal Energy Meter with Insertion Turbine Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**ONICON Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**ONICON Incorporated**]
   c. <**Insert manufacturer's name**>

3. Description:

   a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.
   b. Factory calibrate each thermal energy meter and provide with calibration certification traceable to NIST.

4. Performance:

   a. Ambient Operating Temperature: [**Minus 20 to 140 deg F (Minus 29 to 60 deg C)**]<**Insert temperature range**>.
   b. Energy Calculation Nonlinearity: Within [**0.05**]<**Insert number**> percent.
   c. Flow Sensor Accuracy:

      1) Within 1 percent of actual flow between the flow velocity range of [**3 to 30 fps (0.9 to 9 m/s)**]<**Insert velocity range**>.
      2) Within 2 percent of actual flow between the flow velocity range of [**0.4 to 20 fps (0.1 to 6.1 m/s)**]<**Insert velocity range**>.
      3) Within [**0.5**]<**Insert number**> percent of actual reading at the calibrated velocity.

   d. Flow Sensor Pressure Drop: Not to exceed [**1 psig (6.89 kPa)**]<**Insert value**> at [**20 fps (6.1 m/s)**]<**Insert value**> flow velocity in [**NPS 2 (DN 50)**]<**Insert pipe size**> pipe and decreasing in larger pipe with lower velocity.
   e. Process Pipe Sizes: **NPS 1-1/4 (DN 32)** through [**NPS 48 (DN 1200)**]<**Insert pipe size**>.
   f. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Pressure: Up to [**400 psig (2758 kPa)**]<**Insert value**>.
      2) Temperature: Within [**25 to 280 deg F (Minus 4 to 138 deg C)**]<**Insert value**>.

   g. Process Temperature Accuracy: Differential temperature accuracy within [**0.15 deg F (0.08 deg C)**]<**Insert temperature**> over the calibrated range.

5. Meter Display: Backlit, LCD alphanumeric display of the following on face of meter enclosure:

    a. Total energy consumption.
    b. Energy rate.
    c. Flow rate.
    d. Supply temperature.
    e. Return temperature.
    f. Visual indication of power status (on/off) on face of enclosure.

6. Meter Electronics Enclosure:

    a. Remote mounted from temperature and flow sensors.
    b. Indoor Applications: NEMA 250, Type 4 or 13.
    c. Outdoor Applications: NEMA 250, Type 4.
    d. Labeled terminal strip for field wiring connections.
    e. Connections: Suitable for mating to field-installed conduit.

7. Power Supply:

    a. Field Power: 24, 120, 240 V ac, 50 or 60 Hz as required by the application.
    b. Internal Power: As required by flow meter.

8. Programming:

    a. Factory programmed for specific application and field programmable through keypad on face of enclosure.
    b. Programmed parameters and total energy consumption stored in non-volatile EEPROM memory.

9. Output Signals:

    a. Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50 V rating and contact duration of 0.5, 1, 2, or 6 seconds.
    b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero to 10 V dc for each.
    c. Option to use serial communication interface in lieu of hardwired signals

10. Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.
11. Flow Sensor:

    a. Factory Calibration: Wet calibrate and tag each sensor to standards traceable to NIST, and provide each sensor with a certificate of calibration.
    b. Turbines:

        1) Single turbine sensors for pipe sizes **NPS 1-1/4 through NPS 2 (DN 32 through DN 50)**.
        2) Dual turbine sensors for pipe sizes **NPS 2-1/2 (DN 65)** and larger.
        3) Bidirectional dual turbine sensors where installed in bypass piping of size **NPS 2-1/2 (DN 65)** and larger.
        4) Dual sensors with dual contra-rotating turbine elements; each turbine element with its own rotational sensing system and an averaging circuit to reduce measurement errors due to a poor flow profile.
        5) Rotational sensing of each turbine accomplished electronically by sensing impedance change with an integral frequency output linear with flow rate and

individual top and bottom turbine outputs for diagnostic purposes.

6) Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts.

c. Construction: Wetted metal components of Type 316 stainless steel[**or bronze and nickel plated brass**], including the installation hardware.
d. Enclosure: House sensor electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover and conduit connections.
e. Installation Hardware: Provide installation hardware necessary to enable insertion and removal from the pipe without system shutdown.
f. Isolation Valve: Provide sensor with full-port [**Type 316 stainless steel**]ball valve for system isolation.
g. Sensor Cable: As required by manufacturer for field application.

12. Temperature Sensors:

a. Enclosure: NEMA 250, Type 4 with conduit connections.
b. Sensor Cable: As required by manufacturer for application.
c. Temperature Range: Matched pair; suitable for application.
d. Thermowells: Stainless steel; with NPT connections.

D. Thermal Energy Meter with Insertion Electromagnetic Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Dwyer Instruments, Inc**]
c. [**ONICON Incorporated**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Dwyer Instruments, Inc**]
c. [**ONICON Incorporated**]
d. <**Insert manufacturer's name**>

3. Description:

a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.
b. Factory calibrate each thermal energy meter and provide with calibration certification traceable to NIST.

4. Performance:

a. Ambient Operating Temperature: [**Minus 20 to 140 deg F (Minus 29 to 60 deg C)**]<**Insert temperature range**>.
b. Energy Calculation Nonlinearity: Within [**0.05**]<**Insert number**> percent.
c. Fluid Electrical Conductivity: Suitable for fluids with electrical conductivity between 20 to

60000 microseimens per centimeter.

d. Flow Sensor Accuracy:

1) Accuracy for velocities between [**2 and 20 fps (0.6 to 6.1 m/s)**]<**Insert velocity range**> to be within [**1**]<**Insert number**> percent of reading.
2) Accuracy for velocities less than [**2 fps (0.6 m/s)**]<**Insert velocity**> to be within [**0.02 fps (0.006 m/s)**]<**Insert velocity**>.

e. Flow Sensor Pressure Drop: Not to exceed [**0.1 psig (0.7 kPa)**]<**Insert value**> at [**12 fps (3.7 m/s)**]<**Insert value**> flow velocity in [**NPS 3 (DN 80)**]<**Insert pipe size**> pipe and decreasing in larger pipe with lower velocity.
f. Flow Sensor Velocity Range: [**0.25 to 20 fps (0.08 to 6.1 m/s)**]<**Insert flow velocity range**>.
g. Process Pipe Sizes: **NPS 1-1/4 (DN 32)** through [**NPS 48 (DN 1200)**]<**Insert pipe size**>.
h. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Pressure: Up to [**400 psig (2758 kPa)**]<**Insert value**>.
2) Temperature: Within [**25 to 250 deg F (Minus 4 to 121 deg C)**]<**Insert value**>.

i. Process Temperature Accuracy: Differential temperature accuracy within [**0.15 deg F (0.08 deg C)**]<**Insert temperature**> over the calibrated range.

5. Meter Display: Backlit, LCD alphanumeric display of the following on face of meter enclosure:

a. Total energy consumption.
b. Energy rate.
c. Flow rate.
d. Supply temperature.
e. Return temperature.
f. Visual indication of power status (on/off) on face of enclosure.

6. Meter Electronics Enclosure:

a. Remote mounted from temperature and flow sensors.
b. Indoor Applications: NEMA 250, Type 4 or 13.
c. Outdoor Applications: NEMA 250, Type 4.
d. Labeled terminal strip for field wiring connections.
e. Connections: Suitable for mating to field-installed conduit.

7. Power Supply:

a. Field Power: 24, 120, 240 V ac, 50 or 60 Hz as required by the application.
b. Internal Power: As required by flow meter.

8. Programming:

a. Factory programmed for specific application and field programmable through keypad on face of enclosure.
b. Programmed parameters and total energy consumption stored in non-volatile EEPROM memory.

9. Output Signals:

a. Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50 V rating and

contact duration of 0.5, 1, 2, or 6 seconds.
b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero to 10 V dc for each.
c. Option to use serial communication interface in lieu of hardwired signals

10. Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.
11. Flow Sensor:

a. Factory Calibration: Wet calibrate and tag each sensor to standards traceable to NIST, and provide each sensor with a certificate of calibration.
b. Sensor Head: Polysulfone.
c. Construction: Wetted metal components of Type 316 stainless steel, including the installation hardware.
d. Enclosure: House electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover and conduit connections.
e. Installation Hardware: Provide installation hardware necessary to enable insertion and removal from the pipe without system shutdown.
f. Isolation Valve: Provide sensor with full-port Type 316 stainless steel ball valve for system isolation.
g. Sensor Cable: As required by manufacturer for application.

12. Temperature Sensors:

a. Enclosure: NEMA 250, Type 4 with conduit connections.
b. Sensor Cable: As required by manufacturer for application.
c. Temperature Range: Matched pair; suitable for application.
d. Thermowells: Stainless steel; with NPT connections.

E. Thermal Energy Meter with In-Line Electromagnetic Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**ONICON Incorporated**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**ONICON Incorporated**]
c. **<Insert manufacturer's name>**

3. Description:

a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.
b. Factory calibrate each thermal energy meter and provide with calibration certification traceable to NIST.

4. Performance:

    a. Ambient Operating Temperature: [**Minus 20 to 140 deg F (Minus 29 to 60 deg C)**]<**Insert temperature range**>.
    b. Energy Calculation Nonlinearity: Within [**0.05**]<**Insert number**> percent.
    c. Fluid Electrical Conductivity: Suitable for fluids with electrical conductivity greater than 5 microseimens per centimeter.
    d. Flow Sensor Accuracy:

        1) Accuracy for velocities between [**2 and 20 fps (0.6 to 6.1 m/s)**]<**Insert velocity range**> to be within [**0.2**][**0.5**]<**Insert number**> percent of reading.
        2) Accuracy for velocities less than [**2 fps (0.6 m/s)**]<**Insert velocity**> to be within [**0.0004 fps (0.001 m/s)**]<**Insert velocity**>.

    e. Flow Sensor Pressure Drop: No permanent pressure drop.
    f. Flow Sensor Velocity: [**0.1 to 20 fps (0.03 to 6.1 m/s)**]<**Insert flow velocity range**>.
    g. Process Pipe Sizes: **NPS 1 (DN 25)** through [**NPS 48 (DN 1200)**]<**Insert pipe size**>.
    h. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

        1) Pressure: Up to [**225 psig (1551 kPa)**][**580 psig (3999 kPa)**]<**Insert value**>.
        2) Temperature: Within [**25 to 250 deg F (Minus 4 to 121 deg C)**]<**Insert value**>.

    i. Process Temperature Accuracy: Differential temperature accuracy within [**0.15 deg F (0.08 deg C)**]<**Insert temperature**> over the calibrated range.

5. Meter Display: Backlit, LCD alphanumeric display of the following on face of meter enclosure:

    a. Total energy consumption.
    b. Energy rate.
    c. Flow rate.
    d. Supply temperature.
    e. Return temperature.
    f. Visual indication of power status (on/off) on face of enclosure.

6. Meter Electronics Enclosure:

    a. Remote mounted from temperature and flow sensors.
    b. Indoor Applications: NEMA 250, Type 4 or 13.
    c. Outdoor Applications: NEMA 250, Type 4.
    d. Labeled terminal strip for field wiring connections.
    e. Connections: Suitable for mating to field-installed conduit.

7. Power Supply:

    a. Field Power: 24, 120, 240 V ac, 50 or 60 Hz as required by the application.
    b. Internal Power: As required by flow meter.

8. Programming:

    a. Factory programmed for specific application and field programmable through keypad on face of enclosure.
    b. Programmed parameters and total energy consumption stored in non-volatile EEPROM memory.

9. Output Signals:

   a. Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50 V rating and contact duration of 0.5, 1, 2, or 6 seconds.
   b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero to 10 V dc for each.
   c. Option to use serial communication interface in lieu of hardwired signals.

10. Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.
11. Flow Sensor:

   a. Factory Calibration: Wet calibrate and tag each sensor to standards traceable to NIST, and provide each sensor with a certificate of calibration.
   b. Body Connection: [**Flange, suitable for mating to adjacent pipe flange**][**or**][**wafer**].
   c. Body Material: [**Epoxy-coated carbon steel**][**Type 316 stainless steel**].
   d. Body Liner Material: [**PTFE**][**Ebonite**][**Polypropylene**].
   e. Flow Tube: Type 304 or 316 stainless steel.
   f. Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.
   g. Enclosure: House electronics in a NEMA 250, Type 4 enclosure with conduit connections.
   h. Sensor Cable: As required by manufacturer for application.

12. Temperature Sensors:

   a. Enclosure: NEMA 250, Type 4 with conduit connections.
   b. Sensor Cable: As required by manufacturer for application.
   c. Temperature Range: Matched pair; suitable for application.
   d. Thermowells: Stainless steel; with NPT connections.

F. Thermal Energy Meter, Compact Type, with In-Line Ultrasonic Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dwyer Instruments, Inc**]
   b. [**ONICON Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. [**ONICON Incorporated**]
   c. <**Insert manufacturer's name**>

3. Description:

   a. Flow Sensing Method: No moving parts; direct beam path wetted ultrasonic sensors utilizing differential transit time velocity measurement.
   b. Meter Size Range: [**NPS 1/2 (DN 13)**]<**Insert pipe size**> through [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**>.
   c. Factory Calibration:

1) Factory calibrate each meter against manufacturer's NIST-traceable flow standards and provide a certificate of calibration for each meter.
2) Factory calibrate temperature sensors against manufacturer's standards and provide a certificate of calibration.

d. Programming:

1) Configure and program each meter at factory for specific application without need for field programming. Field programming is available through the user interface or through the serial interface using an operator workstation.
2) Store program parameters and totalized values in nonvolatile flash memory.

e. Battery: Back-up real-time clock and calendar with lithium battery.
f. Approvals: BTL certified in accordance with ASHRAE 135.

4. Performance:

a. Energy calculations computation error of less than [**0.09**]<**Insert number**> percent with a temperature differential of [**30 deg F (17 deg C)**]<**Insert temperature**>.
b. Repeatability: Within 0.2 percent.
c. Ambient Temperature: [**Minus 10 to 130 deg F (Minus 23 to 54 deg C)**]<**Insert value**>.
d. Ambient Humidity: 5 to 90 percent relative humidity, noncondensing.
e. Flow accuracy of 1 percent for flow range:

1) NPS 1/2 (DN 13): [**0.6 to 15 gpm (0.038 to 0.95 L/s)**]<**Insert flow range**>.
2) NPS 3/4 (DN 20): [**0.6 and 15 gpm (0.038 and 0.95 L/s)**]<**Insert flow range**>.
3) NPS 1 (DN 25): [**1 to 25 gpm (0.063 to 1.58 L/s)**]<**Insert flow range**>.
4) NPS 1-1/4 (DN 32): [**3 to 60 gpm (0.189 to 3.78 L/s)**]<**Insert flow range**>.
5) NPS 1-1/2 (DN 40): [**5 to 100 gpm (0.315 to 6.31 L/s)**]<**Insert flow range**>.
6) NPS 2 (DN 50): [**8 to 150 gpm (0.505 to 9.46 L/s)**]<**Insert flow range**>.
7) NPS 2-1/2 (DN 65): [**12 to 225 gpm (0.757 to 14.19 L/s)**]<**Insert flow range**>.

f. Flow accuracy of 2 percent for flow range:

1) NPS 1/2 (DN 13): [**0.15 and 0.6 gpm (0.0009 and 0.038 L/s)**]<**Insert flow range**>.
2) NPS 3/4 (DN 20): [**0.15 and 0.6 gpm (0.009 and 0.038 L/s)**]<**Insert flow range**>.
3) NPS 1 (DN 25): [**0.25 and 1.0 gpm (0.016 and 0.063 L/s)**]<**Insert flow range**>.
4) NPS 1-1/4 (DN 32): [**0.6 and 3.0 gpm (0.038 and 0.189 L/s)**]<**Insert flow range**>.
5) NPS 1-1/2 (DN 40): [**1.0 and 5.0 gpm (0.063 and 0.315 L/s)**]<**Insert flow range**>.
6) NPS 2 (DN 50): [**1.5 and 8.0 gpm (0.095 and 0.505 L/s)**]<**Insert flow range**>.
7) NPS 2-1/2 (DN 65): [**2.5 and 12 gpm (0.158 and 0.758 L/s)**]<**Insert flow range**>.

g. Minimum Flow Rate:

1) NPS 1/2 (DN 13): [**0.03 gpm (0.002 L/s)**]<**Insert value**>.
2) NPS 3/4 (DN 20): [**0.03 gpm (0.002 L/s)**]<**Insert value**>.
3) NPS 1 (DN 25): [**0.05 gpm (0.003 L/s)**]<**Insert value**>.
4) NPS 1-1/4 (DN 32): [**0.12 gpm (0.008 L/s)**]<**Insert value**>.
5) NPS 1-1/2 (DN 40): [**0.20 gpm (0.013 L/s)**]<**Insert value**>.
6) NPS 2 (DN 50): [**0.30 gpm (0.019 L/s)**]<**Insert value**>.
7) NPS 2-1/2 (DN 65): [**0.50 gpm (0.032 L/s)**]<**Insert value**>.

h. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Pressure: Up to [**400 psig (2758 kPa)**]<**Insert value**>.
2) Temperature: Within [**32 to 250 deg F (0 to 121 deg C)**]<**Insert value**>.

i. Process Temperature Accuracy:

1) Each Sensor: Within [**0.25 deg F (0.14 deg C)**]<**Insert value**>.
2) Differential: Within [**0.18 deg F (0.10 deg C)**]<**Insert value**>.

j. Pressure Drop: [**1.5 psig (10 kPa)**]<**Insert value**> or less at following flow rate:

1) NPS 1/2 (DN 13): [**6.6 gpm (0.42 L/s)**]<**Insert value**>.
2) NPS 3/4 (DN 20): [**6.6 gpm (0.42 L/s)**]<**Insert value**>.
3) NPS 1 (DN 25): [**11 gpm (0.69 L/s)**]<**Insert value**>.
4) NPS 1-1/4 (DN 32): [**26 gpm (1.64 L/s)**]<**Insert value**>.
5) NPS 1-1/2 (DN 40): [**44 gpm (2.78 L/s)**]<**Insert value**>.
6) NPS 2 (DN 50): [**66 gpm (4.16 L/s)**]<**Insert value**>.
7) NPS 2-1/2 (DN 65): [**110 gpm (6.94 L/s)**]<**Insert value**>.

5. Network Connection:

a. TIA RS-485 serial interface.
b. ASHRAE 135, native BACnet MS/TP protocol.
c. Communicates energy consumption and rate, flow rate, supply and return temperature, peak and average values, interval data and network status.

6. Input Signals:

a. Three isolated totalizing pulse inputs for use with sinking open collector or dry contacts.
b. Rating: 30 V dc, 10-milliamp maximum.
c. Pulse duration of 50 milliseconds.
d. For use in totalizing pulses from external devices.
e. Totals accumulated at the meter, displayed locally and remotely through the network connection.

7. Display and Calculator:

a. Integral to meter and detachable for remote field mounting.
b. Backlight alphanumeric display and operator interface.
c. Same information communicated to network available on the display.

8. Meter:

a. Enclosure:

1) Polycarbonate with removable screw-on cover.
2) Rating: IEC 60529 IP65 or NEMA 250, Type 4.
3) Electrical Connections: Labeled screw terminals.
4) Conduit Connections: Two; trade size.

b. End Connections:

1) Sizes through NPS 2 (DN 50): Threaded, MNPT.
2) NPS 2-1/2 (DN 65): Flange face for mating to ASME B16.5, Class 150 raised face flange.

c. Wetted Materials: Lead-free brass containing not more than 15 percent zinc (DZR and

corrosion resistant), PEEK.

9. Power Supply:

   a. Field Power: 24 V ac, 50 or 60 Hz unless otherwise required by the application.

10. Temperature Sensors:

   a. Field-serviceable, matched pair of two-wire, 1000-ohm platinum RTDs.
   b. Provide one temperature sensor built into meter body for sizes through [**NPS 1 (DN 25)**]<**Insert pipe size**> and provide second sensor with threaded thermowell and threaded sensor connection for insertion in field piping.
   c. For larger meter sizes, provide supply and return sensors with threaded thermowell and threaded sensor connection for insertion in field piping.
   d. Thermowells: Brass for installation in copper tubing and stainless steel for installation in all other piping.

G. Thermal Energy Meter with Clamp-On Ultrasonic Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**Dwyer Instruments, Inc**]
   c. [**ONICON Incorporated**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**Dwyer Instruments, Inc**]
   c. [**ONICON Incorporated**]
   d. <**Insert manufacturer's name**>

3. Description:

   a. Flow Sensing Method: Non-invasive with no moving parts; ultrasonic differential transit time velocity measurement using nonwetted transducers. Method is suitable for use with clear fluids in pressurized metallic and nonmetallic pipes that are full.
   b. Factory Wet Calibration:

      1) Factory calibrate each meter against manufacturer's NIST-traceable flow standards and provide a certificate of calibration for each meter.
      2) Factory calibrate temperature sensors against manufacturer's standards and provide a certificate of calibration.

   c. Programming:

      1) Configure and program each meter at factory for specific application without need for field programming. Field programming is available through the user interface or through the serial interface using an operator workstation.

2) Store program parameters and totalized values in nonvolatile memory.

d. Battery: Back-up real-time clock and calendar with lithium battery.
e. Data Logger: Integral data log with minimum [**128**]<**Insert value**> MB of storage.

4. Performance:

a. Ambient Humidity: 5 to 90 percent relative humidity, noncondensing.
b. Ambient Operating Temperature: [**Minus 5 to 140 deg F (Minus 21 to 60 deg C)**]<**Insert temperature range**>.
c. Energy calculations computation error of less than [**0.09**]<**Insert number**> percent with a temperature differential of [**30 deg F (17 deg C)**]<**Insert temperature**>.
d. Repeatability: Within [**0.25**]<**Insert number**> percent.
e. Flow Sensor Accuracy:

1) Accuracy for velocities between [**1 and 20 fps (0.3 to 6.1 m/s)**]<**Insert velocity range**> to be within [**1**]<**Insert number**> percent of reading.
2) Accuracy for velocities less than [**1 fps (0.3 m/s)**]<**Insert velocity**> to be within [**0.01 fps (0.003 m/s)**]<**Insert velocity**>.

f. Flow Sensor Pressure Drop: No permanent pressure drop.
g. Flow Sensor Velocity Range: [**0.07 to 40 fps (0.02 to 12.2 m/s)**]<**Insert flow velocity range**>.
h. Process Pipe Sizes: **NPS 1/2 (DN 13)** through [**NPS 48 (DN 1200)**]<**Insert pipe size**>.
i. Process Temperature: Suitable for system maximum operating temperature.

1) Temperature: Within [**Minus 40 to 250 deg F (Minus 40 to 121 deg C)**]<**Insert value**>.

j. Process Temperature Accuracy:

1) Each Sensor: Within [**0.25 deg F (0.14 deg C)**]<**Insert value**>.
2) Differential: Within [**0.18 deg F (0.10 deg C)**]<**Insert value**>.

5. Meter Display and Operator Interface: Backlit, LCD alphanumeric display of the following on face of meter enclosure:

a. Total energy consumption.
b. Energy rate.
c. Flow rate.
d. Supply temperature.
e. Return temperature.
f. Visual indication of power status (on/off) on face of enclosure.

6. Meter Enclosure:

a. Remote mounted from temperature and flow sensors.
b. Rating: IEC 60529 IP67 or NEMA 250, Type 4X.
c. Construction: Polycarbonate with hinged cover.
d. Electrical and Control Cable Connections: Labeled screw terminals.
e. Conduit Connections: Manufacturer standard; trade size suitable for mating to field-installed conduit.

7. Input Signals:

a. Three isolated totalizing pulse inputs for use with sinking open collector or dry contacts.

b. Rating: 30 V dc, 10-milliamp maximum.
c. Pulse duration of 50 milliseconds.
d. For use in totalizing pulses from external devices.
e. Totals accumulated at the meter, displayed locally and remotely through the network connection.

8. Output Signals:

a. Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50 V rating with pulse.
b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero to 10 V dc for each.

9. Serial Network Interface:

a. TIA RS-485 serial interface for remoted monitoring.
b. ASHRAE 135, native BACnet MS/TP protocol.
c. Communicate energy consumption and rate, flow rate, supply and return temperature, peak and average values, interval data, and network status.

10. Power Supply:

a. Field Power: 24, 120, 240 V ac, 50 or 60 Hz as required by the application.
b. Internal Power: As required by flow meter.

11. Temperature Sensors:

a. Field-serviceable, matched pair of two-wire, 1000-ohm platinum RTDs. Supply and return sensors have threaded thermowell and threaded sensor connection for insertion in field piping.
b. Enclosure: NEMA 250, Type 4 with conduit connections.
c. Sensor Cable: As required by manufacturer for application.
d. Temperature Range: Suitable for application.
e. Thermowells: Stainless steel; with NPT connections.

12. Transducers:

a. Housing: Type 316 stainless steel; NEMA 250, Type 4 with trade-size conduit connections.
b. Mounting Kit: Type 304 or 316 stainless steel brackets and miscellaneous hardware; option to use 200 series stainless steel clamps.
c. Sensor Cable: As required by manufacturer for application.

2.2 ELECTRIC POWER METERS

A. Performance Requirements: Manufacturer is to certify that each electric power meter complies with specified performance requirements and characteristics. Certificate is required.

B. Electric Power Meter - Basic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Omron Americas**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. [**Veris Industries**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Omron Americas**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. [**Veris Industries**]
f. <**Insert manufacturer's name**>

3. Description: Separately mounted, permanently installed, electronic power meter.

a. Capable of metering four-wire wye, three-wire delta, and single-phase power systems.
b. For renewable energy applications, meters to include bidirectional monitoring and measurement of imported and exported power.
c. Include with current transformers and transducers suitable for the application.

4. Features:

a. Measured energy consumption stored in nonvolatile memory.
b. Programmable demand measurements for multiple intervals and varying durations.
c. Automatic phase reversal compensation so insensitive to CT load orientation.
d. Separate control power inputs so meter can be powered from a different power source than the power service being measured.
e. Configurable for use with different potential transformers.
f. Data Recording: Store values in nonvolatile memory; indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
g. Alarms: Transmit an output signal and show on display when alarmed. Provide for no fewer than [**3**]<**Insert number**> metered items.
h. Listed in accordance with UL 508.

5. Measurements:

a. Accumulated Real Energy (kWh): For each phase and total of all phases.
b. Accumulated Reactive Energy (kVARh): Total for all phases.
c. Apparent Energy (kVAh): Totals for all phases.
d. Net Present Demand for Real (kW), Reactive (kVAR) and Apparent (kVA) Power: Over a user-specified interval (block or sliding window).
e. Maximum (peak) real (kW), reactive (kVAR) and apparent (kVA) demand intervals.
f. Instantaneous Real (kW), Reactive (kVAR) and Apparent Power (kVA): By phase and in total.
g. Current (amps) for each phase and average of all phases.
h. Phase-to-phase voltage for each phase and average of all phase pairs.
i. Phase-to-neutral voltage for each phase pair and average of all phases.
j. Power factor for each phase and average of all phases.
k. AC frequency.

6. Performance:

a. Accuracy: [**Comply with ANSI C12.20, Class 0.5 and IEC 62053-22, Class 0,2S**]<**Insert requirements**>.
b. Ambient Humidity: Less than 95 percent, noncondensing.
c. Ambient Temperature: [**Minus 10 to 130 deg F (Minus 23 to 54 deg C)**]<**Insert value**>.
d. Current:

1) Rated Primary: [**5 to 600**]<**Insert range**> A.
2) Scaled: [**5 to 32000**]<**Insert range**> A.

e. Measured Voltage: [**90 to 600**]<**Insert range**> V ac, 50 or 60 Hz.

7. Enclosure:

a. Indoor Applications: NEMA 250, Type 1[**; DIN rail mount in accordance with IEC 60715 (EN)**].
b. Outdoor Applications: NEMA 250, Type 4 or 4X.

8. Display: Backlit LCD showing measured values, alarm functions, and outputs.
9. Digital Output Signals:

a. Alarm: Normally closed.
b. Real Energy: Pulse (normally open).

10. Serial Communication Interface: TIA RS-485 2-wire connection; [**BACnet MS/TP**][**and**][**or**][**Modbus RTU**] protocol.

C. Electric Power Meter - Multifunction, Fully Programmable:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allen Bradley; by Rockwell Automation**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allen Bradley; by Rockwell Automation**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Hardware:

a. Voltage Inputs:

1) [**Three**]<**Insert value**> voltage inputs, capable of measuring from zero to 347 V rms (line to neutral) or from zero to 600 V rms (line to line).

2) Provisions for direct connection to wye (star) systems up to 347/600 V ac. For higher voltage systems, use power transformers with 120, 277, or 347 V ac secondaries.
3) Voltage inputs with the following:

a) 1500 V ac continuous surge protection.
b) 25 percent of full-scale voltage over range capability.

b. Current Inputs:

1) [**Three**]<**Insert value**>; 5 A nominal (10 A full-scale).
2) Transformer coupled and accepting CTs with 5 A nominal (10 A full-scale) outputs.
3) Current inputs with the following:

a) 300 A surge protection for one second.
b) 25 percent of full-scale current continuous over range capability.

c. Power Supply:

1) Voltage: 95 to 240 V ac (within 10 percent) at 47 to 440 Hz, 110 to 300 V dc, or 20 to 60 V dc power source.
2) Load: Not to exceed 12 W.

d. On-board I/O:

1) [**Four**]<**Insert value**> digital (status) inputs.
2) [**Four**]<**Insert value**> optically isolated, digital (status) outputs with the following features:

a) Outputs with ability to provide pulse outputs according to any energy consumption levels.
b) Scalable units per pulse.

3) [**Four**]<**Insert value**> analog I/O operator selectable from:

a) Milliamp inputs.
b) Zero to 20 mA inputs.
c) Four zero to 1 mA outputs.
d) Four zero to 20 mA outputs.
e) Four zero to 1 mA inputs and four zero to 1 mA outputs.
f) Four zero to 20 mA inputs and four zero to 20 mA outputs.

4) Analog inputs and outputs accurate to within [**0.3**]<**Insert number**> percent of full scale.

e. Provisions for Future External I/O: Support up to [**four**]<**Insert value**> digital output devices and the following devices:

1) 120 V ac, 3.5 A, NO solid-state relay.
2) 120 V ac, 3.5 A, zero voltage turn-on, manual override relay.
3) 240 V ac, 3.5 A, NO solid-state relay.
4) 240 V ac, 3.5 A, zero voltage turn-on, manual override relay.
5) 60 V dc, 3.5 A, NO solid-state relay.
6) 60 V dc, 1.5 mA, zero voltage turn-on, manual override relay.
7) 60 V dc, 1.0 A, low-leakage, NO solid-state relay.
8) 200 V dc, 1.0 A, NO solid-state relay.
9) 100 V dc, 0.5 A, NO mechanical relay.

f. Communications:

1) Provide the following built-in communication ports of standard technology, as defined by IEEE:

a) [**Two**]<**Insert value**> optically isolated RS-485 communication ports, supporting data rates from 1200 to [**19,200**]<**Insert value**> bits per second.
b) One front-panel infrared optical port for TIA RS-232 communications, supporting data rates from 1200 to [**19,200**]<**Insert value**> bits per second as well as an ANSI Type II optocoupler.
c) Ethernet port with gateway that allows the host system to communicate through the Ethernet port to additional metering devices connected to the card's communication port. Include provisions for an internal Ethernet port compatible with 10Base-T Ethernet. Terminate Ethernet port using an RJ-45 connector.

2) Support the following communication capabilities, independently configurable:

a) Modbus RTU [**and**][**or**][**BACnet MS/TP**] protocol.
b) Simultaneous access through all communication ports to any measured or derived parameter.
c) Field-configurable protocols from the front display, or via communication ports, and be capable of being accomplished without resetting the meter or interrupting its operation in any way.
d) Provisions for flash firmware that can be field upgraded through any communication port, without de-commissioning the instrument or de-energizing the circuit or equipment. Firmware-upgrade procedure is able to recover from power failure during an upgrade.
e) Support time synchronization broadcast messages from a host computer system.

g. Mounting Options:

1) Panel cutout, using sliding clamps tightened by thumbscrews.
2) Transducer-type base unit with a remote backlit digital display, with cable for remote display applications.
3) Transducer-type base unit, locally mounted.
4) Allow operator to remove and replace the display panel without removing the instrument from the equipment in which it is mounted.

h. Front-Panel Display:

1) Programmable buttons that allow access to [**eight**]<**Insert value**> data display screens.
2) Display measured parameter with its corresponding label.
3) Display any [**four**]<**Insert value**> parameters simultaneously using alphanumeric characters.
4) Display any [**two**]<**Insert value**> parameters simultaneously using large alphanumeric characters.
5) Display any parameter using very large alphanumeric characters.
6) Display basic voltage, current, and power readings using extra-large alphanumeric characters.
7) Give operator ability to change parameter labels.
8) Feature a programmable time-out interval and adjustable contrast.

i. Enclosure: If installation requires meter to be installed in a dedicated enclosure, install meter in an NRTL-listed enclosure suitable for operating environment at meter location.

1) Indoors: NEMA 250, [**Type 1**][**or**][**Type 12**].
2) Outdoors: NEMA 250, [**Type 4**][**or**][**Type 4X**].

j. Memory: Non-volatile memory to store the following:

1) Setup data.
2) A time-stamped event log with the following features:
3) Support at least [**500**]<**Insert value**> events.

a) Number of records in the log to be programmable.
b) Record the date and time of each event, the cause and effect of the event, and the priority of the event.
c) Record events relating to set-point activity, relay operation, and self-diagnostics in the event log.
d) Time stamps with resolution of one millisecond.
e) Synchronize time stamps to within 100 ms between devices on the same serial communication medium.
f) Minimum event recording response time of one second.
g) Programmable priority of set-point events.

4) [**Two**]<**Insert value**> programmable data recorders that can each store up to [**16**]<**Insert value**> channels of historical trend data with the following features:

a) Each data recorder able to record any parameter, either measured or derived.
b) Enabled and trigger each data recorder manually or through internal operating conditions, including periodic timer or set-point activity.
c) Program the number of records (depth) of each data recorder and the overflow conditions (stop-when-full or circular).
d) Memory dynamically allocated between data recorders and event log to allow storage of any [**16**]<**Insert value**> parameters at [**15**]<**Insert value**>-minute intervals for not less than 30 days.

5) Min/Max data for any monitored parameter.

4. Meter:

a. Display web pages over a standard Internet browser and include real-time instantaneous values, accumulated energy values, and total harmonic distortion.
b. Automatically e-mail alarm notifications or scheduled system status updates. Send e-mail messages for receipt as ordinary e-mail message.
c. Send data logs on an event-driven or scheduled basis.
d. Accommodate high-speed [**Modbus TCP/IP**][**or**][**BACnet IP**]<**Insert type**> communications when connected to Ethernet port.

5. Meter to measure and calculate the following information at [**one**]<**Insert value**>-second intervals:

a. Voltage line-to-neutral and line-to-line for each phase and average of all three phases.
b. Percentage of voltage unbalance.
c. Current for each phase and average of three phases.
d. Percentage of current unbalance.
e. kW for each phase and total of three phases.
f. kVAR for each phase and total of three phases.

g. kVA for each phase and total of three phases.
h. kWh for total of three phases, provided as accumulating import, export, net, and total readings.
i. kVARh for total of three phases, provided as accumulating import, export, net, and total readings.
j. kVAh for total of three phases, provided as an accumulating net reading.
k. Power factor for each phase and total of three phases.
l. Frequency.
m. Harmonic distortion for each voltage and current input, provided as individual harmonic magnitudes up to the 15th harmonic and as total odd, total even, and total overall harmonic distortion; readings given as a percentage of fundamental.
n. K-factor calculations of the first 15 harmonics for all current inputs.

6. Operator interface features as follows:

a. Capable of calculating the following information for any reading at [**one**]<**Insert value**>-second intervals:

1) Thermal demand calculations for any parameter, with operator-programmable length of demand period to match local utility billing method.
2) Sliding window demands for any parameter with operator-programmable length of demand period and number of subperiods to match local utility billing method.
3) Predicted demand calculations of sliding window demand parameters, with operator-programmable predictive response characteristics.
4) Minimum value for any measured parameter.
5) Maximum value for any measured parameter.
6) Derived values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (equivalent PLC capabilities):

a) Arithmetic functions: division, multiplication, addition, subtraction, power, absolute value, square root, average, max, min, rms, sum, sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.
b) Trigonometric Functions: COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, and LOG10.
c) Logic Functions: Equal to, equal to or more than, equal to or less than, more than or less than, less than, more than, and, "OR," "NOT," and "IF."
d) Thermocouple Linearization Functions: Type J, Type K, Type R, Type RTD, or Type T.
e) Temperature Conversion Functions: degree C to degree F and degree F to degree C.

b. Direct display of all parameters on the front panel or remote display in user-programmable groups, using plain language labels. Make simultaneous access to all parameters available through any communication port.
c. Field programmable as follows:

1) Basic Parameters: Voltage input scale, voltage mode (wye, delta, single phase), current input scale, auxiliary input and output scales, and communication setup parameters are to be programmable from the front panel.
2) Additional Parameters: Set-point/relay and data log setup parameters are to be programmable through the communication port using a portable or remotely located computer terminal. Using ION modules, support customized configurations of all operating parameters.
3) Secure programming through a computer by user ID and password.
4) Secure programming at front panel by password.

d. Provide for creation of periodic or non-periodic schedules for up to [**two**]<**Insert number**> years. Schedules may be used to perform the following functions:

1) Demand control.
2) Load scheduling.
3) Logging.
4) Periodic resetting.

7. Alarming and set-point control to include following minimum requirements:

a. Set-point control of internal recording mechanisms and all digital output relays as follows:

1) [**12**]<**Insert number**> programmable set points, each of which is to respond to out-of-range and alarm conditions for any measured parameter.

a) Each set point with [**one**]<**Insert value**>-second minimum response time.
b) Each set point with programmable pick-up and drop-out levels (high and low limits) and time delays on operate and release.
c) Activity of each set point to generate an event of a programmable priority and able to support up to [**256**]<**Insert number**> levels of alarm severity.
d) Any set point programmable to any operating condition, and any number of available set points concurrently programmable to operate on a particular condition to support multiple threshold conditions.

2) Set points programmable to operate on any over or under condition for the following:

a) Any voltage or current input or average.
b) Voltage or current imbalance.
c) kW or kVAR forward or reverse.
d) kVA.
e) Power factor lag or lead.
f) Frequency.
g) kW or current demand on any phase, total, or average.
h) Individual harmonic distortion on any phase input.
i) Total harmonic distortion on any phase input.
j) Total even or odd harmonic distortion on any phase input.
k) Any maximum or minimum value.
l) Multiple energy accumulation conditions.
m) Phase reversal.
n) Pulse count levels.
o) Any internally derived value.

3) Any set-point condition able to control any number of digital output relays in an AND or an OR configuration, using pulse mode or latch mode operation, for control and alarm purposes. Digital outputs are operable remotely via any communication port.
4) Any set-point condition to provide breaker trip relay operation.
5) Consecutive alarm conditions and triggers with no "dead" time between events and no need for a rearming delay time between events.
6) Able to use any logical combination of any number of available set-point conditions to control any internal or external function or event.
7) Digital outputs with pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.

D. Electric Power Meter - Multifunction:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allen Bradley; by Rockwell Automation**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allen Bradley; by Rockwell Automation**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Hardware:

a. Voltage Inputs:

1) [**Three**]<**Insert value**> voltage inputs capable of measuring from zero to 400 V rms (line to neutral) or from zero to 690 V rms (line to line).
2) Provisions for direct connection for wye (Star) systems up to 347/600 V ac. For higher-voltage systems, use PTs with 120, 277, or 347 V ac secondaries.
3) Voltage inputs with the following:

a) 1500 V ac continuous surge protection.
b) 25 percent of full-scale voltage over range capability.

b. Current Inputs:

1) [**Three**]<**Insert value**> 5 A nominal (6 A full-scale) current inputs.
2) Current inputs transformer coupled and accepting CTs with 5 A nominal (6 A full-scale) outputs.
3) Current inputs with the following:

a) 120 A surge protection for one second.
b) 20 percent of nominal current continuous over range capability.

c. Power Supply:

1) Voltage: 100 to 240 V ac (within 10 percent) at 50 to 60 Hz, 110 to 300 V dc, or 20 to 60 V dc power source.
2) Load: Not exceed 15 W.

d. Onboard I/O: [**Two**]<**Insert value**> Form A solid-state digital (status) outputs with the following features:

1) The ability to be used to provide pulse outputs according to any energy consumption levels.
2) Rated 200 V ac/dc with a maximum current of 100 mA.

e. Communications:

1) Provide the following built-in communication ports of standard technology, as defined by the IEEE:

a) One optically isolated RS-485 communication port, supporting data rates from 1200 to [**19,200**]<**Insert value**> bits per second.

2) Communication ports with the following communication capabilities, independently configurable:

a) Modbus RTU [**and**][**or**][**BACnet MS/TP**] protocol.
b) Simultaneous access through all communication ports to any measured or derived parameter.
c) Protocols field configurable from the front display, or via communication ports, and capable of being accomplished without resetting the meter or interrupting its operation in any way.
d) Support time synchronization broadcast messages from a host computer system.

f. Mounting and Display:

1) Mounting Options:

a) Panel cutout, using sliding clamps tightened by thumbscrews.
b) Transducer-type base unit with a remote LED display with cable for remote display applications.
c) Transducer-type base unit locally mounted.
d) Allow the operator to remove and replace the display panel without removing the instrument from the equipment in which it is mounted.

g. Enclosure: If installation requires meter to be installed in a dedicated enclosure, install meter in an NRTL-listed enclosure suitable for operating environment at meter location.

1) Indoors: NEMA 250, [**Type 1**][**or**][**Type 12**].
2) Outdoors: NEMA 250, [**Type 4**][**or**][**Type 4X**].

h. Memory: Sufficient non-volatile memory to store setup data and accumulated energy values.

4. Meter to measure and calculate the following information:

a. Voltage line-to-neutral and line-to-line for each phase and average of three phases.
b. Current for each phase and average of three phases.
c. Peak current demand.
d. Neutral current.
e. Power (kW).
f. Peak power demand (kW).
g. Energy (kWh) import/export.
h. Power factor total.
i. Frequency.

5. Operator interface features as follows:

a. Display of all parameters on the front panel or remote display using plain language labels with simultaneous access to all parameters through any communication port.

b. Field programmable or configurable as follows:

1) Basic Parameters: Voltage input scale, voltage mode (wye, delta, single phase), current input scale, auxiliary input and output scales, and communication setup parameters.
2) Security provisions with password protection.
3) Digital outputs with pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 THERMAL ENERGY METER APPLICATIONS

A. Thermal Energy Meters with Insertion Impeller Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

B. Thermal Energy Meters with Insertion Turbine Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

C. Thermal Energy Meters with Insertion Electromagnetic Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

D. Thermal Energy Meters with In-Line Electromagnetic Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

E. Thermal Energy Meters, Compact Type, with In-Line Ultrasonic Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

F. Thermal Energy Meters with Clamp-On Ultrasonic Flow Sensor: <**Insert equipment type**>, <**Insert service**>.

3.3 ELECTRIC POWER METER APPLICATIONS

A. Electric Power Meter - Basic: <**Insert equipment type**>.

B. Electric Power Meter - Multifunction, Fully Programmable: <**Insert equipment type**>.

C. Electric Power Meter - Multifunction: <**Insert equipment type**>.

3.4 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert value**> force.

C. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

D. Mount meters located in mechanical and electrical rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of **42 to 72 inches (1050 to 1800 mm)**, but preferably at **60 inches (1500 mm)**above the adjacent floor, grade, or service catwalk or platform.

3.5 INSTALLATION OF THERMAL METERS

A. Install meters not integral to flow sensors in vicinity of flow sensor. Where multiple meters are serving same system and located in same room, co-locate them by system to provide service personnel a single and convenient location for inspection and service.

B. Install meter flow sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream.

C. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.

D. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on performance.

E. Install in-line meters with flanges or unions to provide drop-in and -out installation.

F. Insertion Meters:

1. Install system process connections full size of meter connection, but not less than [**NPS 1 (DN 25)**][**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**]<**Insert pipe size**>. Provide [**stainless steel**]bushing if required to mate to system connection.
2. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

3.6 INSTALLATION OF POWER METERS

A. Install meters not integral to flow sensors in vicinity of flow sensor. Where multiple meters are serving same system and located in same room, co-locate them by system to provide service personnel a single and convenient location for inspection and service.

B. Install meter flow sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream.

C. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.

D. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on performance.

E. Install in-line meters with flanges or unions to provide drop-in and -out installation.

3.7 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.8 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems."

3.9 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire and cable is to have the same designation at each end for operators to determine continuity at points of connection. Comply with

requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.10 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.11 CHECKOUT PROCEDURES

A. Checkout Requirements:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that sensors are installed correctly with respect to flow direction.
5. Verify that sensor attachment is properly secured and sealed.
6. Inspect meter tags against approved submittal.
7. Verify that recommended upstream and downstream distances have been maintained.

3.12 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. Equipment and procedures used for calibration are to meet instrument manufacturer's written instructions.
4. Provide diagnostic and test equipment for calibration and adjustment.
5. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
6. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
7. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11 in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

3.13 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper <**Insert equipment**> operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.14 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 13

Task	Specification	Specification Description
23 09 23 13	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 13	23 09 23 00a	Leak Detection Instruments
23 09 23 13	23 09 23 00b	Position Instruments
23 09 23 13	23 09 00 00	Speed Instruments
23 09 23 13	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 14 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Airflow-measurement stations and sensors.
2. Airflow switches.
3. Airflow transmitters.
4. Liquid flow meters.
5. Steam flow meters.
6. Liquid flow sensors (primary elements).
7. Steam flow sensors (primary elements).
8. Liquid flow switches.
9. Liquid flow transmitters.
10. Steam flow transmitters.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230923.12 "Control Dampers" for control dampers with integrated airflow measurement in a packaged assembly.
3. Section 230993.11 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
4. Section 232216 "Steam and Condensate Piping Specialties" for self-contained steam and condensate meters, with options to connection to the DDC system.

1.2 DEFINITIONS

A. BLE: Bluetooth low energy.

B. BTL: BACnet testing laboratories.

C. Ethernet: Local area network based on IEEE 802.3.1.

D. FEP: Fluorinated ethylene propylene.

E. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

F. PEEK: Polyetheretherketone.

G. PTFE: Polytetrafluoroethylene.

H. PPS: Polyphenylene sulfide.

I. RS-485: A TIA standard for multipoint communications using two twisted pairs.

J. RTD: Resistance temperature detector.

K. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Airflow-measurement stations and sensors.
2. Airflow switches.
3. Airflow transmitters.
4. Liquid flow meters.
5. Steam flow meters.
6. Liquid flow sensors (primary elements).
7. Steam flow sensors (primary elements).
8. Liquid flow switches.
9. Liquid flow transmitters.
10. Steam flow transmitters.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.
5. Product certificates.

C. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

D. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

E. Delegated Design Submittals:

1. Schedule and design calculations for flow instruments, including the following:

a. Flow at Project design and minimum flow conditions.
b. Pressure drop at Project design and minimum flow conditions.
c. Show a side-by-side direct comparison to performance characteristics indicated for each instrument.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

B. Product Test Reports: For each product, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[**, from the same production run,**] to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during [**one**][**two**]<**Insert number**>-year period following warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: [**Product manufacturer's qualified staff**][**Qualified professional engineer employed by the product manufacturer**] to select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Air sensors and transmitters are to have an extended range of [**10**][**20**]<**Insert number**> percent above Project design flow and [**10**][**20**]<**Insert number**> percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

B. Liquid and steam sensors, meters, and transmitters are to have an extended range of [**10**][**20**]<**Insert number**> percent above Project design flow and [**10**][**20**]<**Insert number**> percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

2.3 AIRFLOW-MEASUREMENT STATIONS AND SENSORS

A. Performance Requirements:

1. Adjustable for changes in system operational parameters.
2. Airflow Sensor and Transmitter Range: Extended range of [**10**][**20**]<**Insert number**> percent above Project design flow and [**10**][**20**]<**Insert number**> percent below minimum Project flow to signal abnormal flow conditions.
3. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.

   a. Product certificates are required.

B. Thermal Airflow-Measurement Stations:

1. Certification:

   a. Listed and labeled in accordance with UL 873 or UL 60730.
   b. BTL Certified in accordance with ASHRAE 135 where BACnet communication is required.
   c. Class A device in accordance with 47 CFR, Chapter I - "Federal Communications Commission," Part 15 - "Radio Frequency Devices," Subpart A - "General"; Subpart B - "FAA Notification Criteria."

2. Common Performance Requirements:

   a. Airflow Accuracy: Comply with following requirements unless otherwise indicated.

      1) Individual Airflow Accuracy: Within [**2**]<**Insert number**> percent of reading over the entire operating airflow velocity range from [**0 to 4000 fpm (0 to 20.3 m/s)**][**0 to 5000 fpm (0 to 25.4 m/s)**]<**Insert velocity range**>
      2) Thermal Airflow Station Assembly Airflow Accuracy: Within [**2**]<**Insert number**> percent of reading over the entire operating airflow range from [**0 to 4000 fpm (0 to 20.3 m/s)**][**0 to 5000 fpm (0 to 25.4 m/s)**]<**Insert velocity range**>.

         a) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.

   b. Process Air Temperature Accuracy: Within [**0.15 deg F (0.08 deg C)**]<**Insert temperature**> over entire operating range of [**minus 20 to plus 140 deg F (minus 29 to plus 60 deg C)**]<**Insert temperature range**>.
   c. Ambient Operating Temperature Range:

      1) Sensor: [**Minus 20 to plus 160 deg F (Minus 29 to plus 71 deg C)**]<**Insert temperature range**>.
      2) Transmitter: [**Minus 20 to plus 120 deg F (Minus 29 to plus 49 deg C)**]<**Insert temperature range**>.

   d. Ambient Operating Humidity Range:

      1) Sensor: Zero to [**100**]<**Insert number**> percent.
      2) Transmitter: Zero to [**95**]<**Insert number**> percent, non-condensing.

   e. Instruments to compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.

f. Reference Pressure Loss: [**0.05 inch wg (12.5 Pa) at 2000 fpm (10 m/s)**]<**Insert pressure loss requirements**>.
g. Electrical Power: 24 V ac (between 22.8 and 26.4 V ac under load), using a switching power supply that is overcurrent and overvoltage protected.

3. Common Instrument Requirements:

a. Manufacturer to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
b. Provide thermal airflow stations with one or more sensor nodes mounted in a probe, and a remotely mounted microprocessor-based transmitter at each measurement location.
c. Provide stations that can be adjusted in the field to accommodate changes in system operational parameters.
d. Sensor-Node and Probe Assemblies Features and Functions:

1) Number of sensors for each airflow station to be determined by manufacturer for each specific application to comply with accuracy indicated while complying with requirements indicated.
2) Each sensor to contain two individually wired, hermetically sealed thermistors.
3) Sensor Nodes: One self-heated and one zero-power thermistor, using the principle of thermal dispersion.
4) Airflow Rate and Temperature of Each Sensor: Equally weighted and averaged by the transmitter before sending output signal[**unless temperature sensor has an accuracy of 0.10 deg F (0.05 deg C)**].
5) Mount thermistors in sensor using a marine-grade, waterproof material.
6) Protect thermistor leads and internal probe cable and wire from exposure to the ambient environment. Seal and protect so that direct exposure to water will not affect instrument operation.
7) Each sensor assembly to independently determine airflow rate and temperature at each sensor measurement point.
8) Enclosure:

a) Indoor Applications: NEMA 250, Type 1, 4, 4X, or 12.
b) Outdoor Applications: NEMA 250, Type 4 or 4X.

9) Sensor-Probe Mounting Bracket Construction:

a) Aluminum Probes: Aluminum, Type 304 or Type 316 stainless steel mounting brackets.
b) Stainless Steel Probes: Type 304 or 316 stainless steel; type of stainless steel to match probe material.

10) Sensor-Node Construction: Two, bead-in-glass, hermetically sealed thermistors potted in a marine-grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Construct with only the thermistor located within the sensing node and all other electronic components outside the airstream.
11) Store sensor-node airflow and temperature calibration data in a serial memory chip, in the cable-connecting plug. Stored data does not require matching or adjustments to the transmitter in the field.
12) Performance rate and test with a 100 percent survival rate in a 30-day saltwater and acid vapor test with written independent laboratory results.
13) <**Insert requirements**>.

e. Transmitter Features and Functions:

1) Microprocessor based.

2) Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
3) Capable of field configuration and diagnostics using an onboard push-button interface and digital display.
4) Password-protected programmable settings.
5) Field selectable between IP and SI units for airflow, temperature, and velocity.
6) Include an integral power switch to operate on 24 V ac (isolation optional) and include the following:

    a) Integral protection from transients and power surges.
    b) Circuitry to ensure reset after power disruption, transients, and brownouts.
    c) Integral transformer to convert field power source to operating voltage required by instrument.

7) Enclosure:

    a) Indoor Applications: NEMA 250, Type 1, 4, 4X, or 12.
    b) Outdoor Applications: NEMA 250, Type 4 or 4X.

8) Remote Signal Interface Options: Specific interface options are listed for each application.

    a) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, field selectable, zero to 10 V dc or 4 to 20 mA.
    b) RS-485: BACnet-MS/TP, Modbus RTU.
    c) Ethernet: BACnet Ethernet, BACnet-IP, Modbus TCP/IP.

9) If quantity of sensors required by a single airflow station assembly exceeds capability of a single transmitter, provide multiple transmitters and associated software programming needed to support them operating as a single airflow station assembly through one transmitter that is remotely mounted and easily accessible from the floor.
10) High- and/or low-airflow alarm with user-defined set point and percentage of set-point tolerance.
11) Manual or automatic alarm reset, and low-limit cutoff value may be selected to disable the alarm.
12) Alarm delay function, field defined.
13) Sensor-node malfunction via the system status alarm. Ignore the sensor node that is in a fault condition.
14) Field configuration, diagnostics, and field output adjustment wizard that allow for a one- or two-point field adjustment to factory calibration for installations that require adjustment.
15) Automatic reset after power disruption, transients, and brownouts.
16) Integration Buffers: Separate integration buffers for display of airflow output, airflow signal output (analog and network), and individual sensor output (IR-interface).
17) <**Insert requirements**>.

4. Electrical Power and Control Signal Cable and Raceways:

    a. Indoor Applications: Only where exposed cable is allowed by installation requirements, interconnect components using exposed NRTL-listed plenum-rated cable complying with manufacturer's requirements; otherwise install cable in continuous conduit.
    b. Outdoor Applications: Fit instruments and devices with conduit connections for mating to field-installed conduit. Do not exposed wire and cable at any point.

5. Duct/Plenum Thermal Airflow-Measurement Station:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Air Monitor; an ONICON Brand**]
      2) [**Ebtron, Inc**]
      3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
      4) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**Air Monitor; an ONICON Brand**]
      2) [**Ebtron, Inc**]
      3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
      4) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain all duct/plenum airflow-measurement stations from a single manufacturer.
   d. Application: Duct/plenum sizes greater than **2 sq. ft. (0.18 sq. m)**.
   e. Airflow Station Performance:

      1) Independent processing of up to [**16**]<**Insert number**> separately wired sensor-node assemblies.
      2) Accuracy within [**3**]<**Insert number**> percent of reading for ducted applications, and within [**5**]<**Insert number**> percent of reading for non-ducted applications, when installed in accordance with manufacturer's recommended placement guidelines.

         a) Include the combined uncertainty of the sensor nodes and transmitter.
         b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

   f. Airflow Station Casing:

      1) Application: Factory install probes and sensor assemblies into an airflow station casing in lieu of field installing individual probes and sensors in ducts and plenums.
      2) Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
      3) Casing Depth: Minimum **8 inches (200 mm)**.
      4) Casing Flanges: Outward flange, minimum flange face **1.5 inches (38 mm)**.
      5) Joints and Seams: Continuously weld joints and seams. Clean galvanized areas damaged by welding and coat with galvanize paint.
      6) Materials:

         a) Aluminum, minimum **0.063 inch (1.6 mm)** thick, when connected to aluminum duct.
         b) Galvanized steel, minimum **0.079 inch (2.0 mm)** thick with coating complying with ASTM A653/A653M, **G90 (Z275)**, when connected to galvanized steel duct.
         c) Stainless steel, minimum **0.0781 inch (2.0 mm)** thick, when connected to stainless duct. Stainless steel, Type 304 or 316, to match adjoining duct.

7) Flow Straightener: Include each airflow station casing with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.

a) Individual Cell Size: **0.5 inches (13 mm)** wide across entering face, **3 inches (75 mm)** deep in direction of airflow, **0.002 inch (0.051 mm)** thick
b) Construct from Type 3003 aluminum for aluminum and galvanized steel casings.
c) Construct from Type 316 stainless steel for units for stainless steel casings.

g. Sensor-Node and Probe Assemblies:

1) Sensor-Node Calibration:

a) Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
b) Individually calibrated [**at a minimum of 16 calibration points**]<**Insert calibration points**> to NIST-traceable volumetric standards.
c) Accuracy within [**2**]<**Insert number**> percent of reading over the entire calibrated airflow range of [**0 to 5000 fpm (0 to 25.4 m/s)**]<**Insert velocity range**>.
d) Individually calibrate thermistors [**at a minimum of three temperatures**]<**Insert calibration requirements**> to NIST-traceable temperature standards.

2) Minimum number of independent sensor nodes for duct/plenum areas as follows:

a) Provide [**six**]<**Insert number**> for area greater than **2.0 through 4.0 sq. ft. (0.186 through 0.372 sq. m)**.
b) Provide [**eight**]<**Insert number**> for area greater than **4.0 through 8.0 sq. ft. (0.372 through 0.743 sq. m)**.
c) Provide [**12**]<**Insert number**> for area greater than **8.0 through 12.0 sq. ft. (0.743 through 1.11 sq. m)**.
d) Provide [**14**]<**Insert number**> for area greater than **12.0 through 14.0 sq. ft. (1.11 through 1.30 sq. m)**.
e) Provide [**16**]<**Insert number**> for area greater than **14.0 sq. ft. (1.30 sq. m)**.

3) For an aspect ratio of 1.5 or less, and an area of **25 sq. ft. (2.32 sq. m)** or greater, provide at least four probes.
4) Sensor-Probe Construction: [**Anodized, 6063 aluminum alloy tube**][**or**][**Type 316 stainless steel tube**], with each sensor probe containing one or more independently wired sensing nodes.

h. Transmitter:

1) Transmitter determines average airflow rate and temperature of connected sensor nodes in an array for a single location.
2) Operator Interface: Backlit, alphanumeric [**(16-character)**]LCD display with following remote interface capability:

a) Transmitter with Analog Outputs: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent-protected analog output signals. First output provides total airflow rate. Second output field is configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.

b) Transmitter with RS-485 Network Communications: The RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.

c) Transmitter with Analog Outputs, RS-485 Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, overcurrent-protected analog output signals and network output capability. First output provides total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. RS-485 (BACnet MS/TP, or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software is capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.

d) Transmitter with Analog Outputs, IP Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent-protected analog output signals and network output capability. First output provides the total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software is capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.

e) Transmitter with LonWorks Free Topology Network Interface: Connection capable of providing average airflow and temperature rates across the network.

f) Transmitter with Data-Logger Interface: Capable of logging airflow and temperature rates over specified time intervals.

6. Small Duct/Plenum Thermal Airflow-Measurement Stations:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain all small duct/plenum thermal airflow-measurement stations from a single manufacturer.
d. Application: Small duct/plenum size of **2 sq. ft. (0.18 sq. m)** or less.
e. Airflow Station Performance:

1) Independent processing of up to four separately wired sensor-node assemblies.
2) Accuracy within [**3**]<**Insert number**> percent of reading for ducted applications, and within [**5**]<**Insert number**> percent of reading for non-ducted applications, when installed in accordance with manufacturer's recommended placement guidelines.

a) Include the combined uncertainty of the sensor nodes and transmitter.
b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

f. Sensor-Node and Probe Assemblies:

1) Sensor-Node Calibration:

a) Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
b) Individually calibrated [**at a minimum of 16 calibration points**]<**Insert calibration points**> to NIST-traceable volumetric standards.
c) Accuracy within [**2**]<**Insert number**> percent of reading over the entire calibrated airflow range of [**0 to 5000 fpm (0 to 25.4 m/s)**]<**Insert velocity range**>.
d) Individually calibrate thermistors [**at a minimum of three temperatures**]<**Insert calibration requirements**> to NIST-traceable temperature standards.

2) Minimum number of independent sensor nodes for duct/plenums as follows:

a) Provide [**one**]<**Insert number**> for area up to **0.5 sq. ft. (0.046 sq. m)**.
b) Provide [**two**]<**Insert number**> for area greater than **0.5 through 1.0 sq. ft. (0.046 through 0.092 sq. m)**.
c) Provide four for area greater than **1.0 sq. ft. (0.092 sq. m)**.

3) For probes less than **8 inches (203 mm)**, provide one sensor node/probe.
4) Sensor-Probe Construction: [**Anodized, 6063 aluminum alloy tube**][**or**][**Type 316 stainless steel tube**], with each sensor probe containing one or more independently wired sensing nodes.

g. Transmitter:

1) Transmitter determines average airflow rate and temperature of connected sensor nodes in an array for a single location.

h. Operator Interface: Backlit, alphanumeric, LCD display with following remote interface:

1) Transmitter with Analog Outputs: Two field-selectable [**zero to 5 V dc,**][**1 to 5 V dc,**][**zero to 10 V dc,**][**or**][**2 to 10 V dc,**] scalable analog output signals. First output provides total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.
2) Transmitter with RS-485 Network Communications: RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.

7. Fan Array Thermal Airflow-Measurement Stations:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain all fan array thermal airflow-measurement stations from a single manufacturer.
d. Airflow Station Performance:

1) Independent processing of up to eight separately wired sensor-node assemblies.
2) Accuracy within [**10**]<**Insert number**> percent of reading under operating conditions, when installed in accordance with manufacturer's sensor density and placement guidelines, with no effect on fan performance.

a) Include the combined uncertainty of the sensor nodes and transmitter.
b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

3) Airflow Station Impact on Fan Performance: Sensor assemblies mounted in throat or face of fan inlet are not to negatively influence fan performance by reducing airflow more than [**1**]<**Insert number**> percent of Project design flow or negatively impact fan-generated sound. Document performance impact with submittal data, and make necessary adjustments to compensate for performance impact to fan in order to deliver not less than Project design airflow indicated.

e. Sensor-Node and Probe Assemblies:

1) Sensor-Node Calibration:

a) Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
b) Individually calibrated [**at a minimum of 16 calibration points**]<**Insert calibration points**> to NIST-traceable volumetric standards.
c) Accuracy within [**2**]<**Insert number**> percent of reading over the entire calibrated airflow range of [**0 to 10,000 fpm (0 to 50.8 m/s)**]<**Insert velocity range**>.
d) Individually calibrate thermistors [**at a minimum of three temperatures**]<**Insert calibration requirements**> to NIST-traceable temperature standards.

2) Sensor-Probe Construction: One sensor node mounted on a Type 304 stainless steel block with two adjustable zinc-plated steel rods connected to Type 304 stainless steel pivoting mounting feet.
3) Number of Independent Sensor Nodes, Fan Arrays: For one to [**8**]<**Insert number**> fans, one probe with one sensor node per probe in each fan inlet.

f. Transmitter:

1) Transmitter determines average airflow rate and temperature of each fan. Startup firmware facilitates the setup of multiple fans and fan areas.
2) Operator Interface: Backlit, alphanumeric [**(16-character)**]LCD display with following remote interface capability:

a) Transmitter with Analog Outputs: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent-protected analog output signals. First output provides total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.
b) Transmitter with RS-485 Network Communications: The RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.
c) Transmitter with Analog Outputs, RS-485 Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, overcurrent-protected analog output signals and network output capability. First output provides total airflow rate. Second output is to be field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. RS-485 (BACnet MS/TP, or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software is capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.
d) Transmitter with Analog Outputs, IP Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent-protected analog output signals and network output capability. First output provides the total airflow rate. Second

output is field configurable for temperature or low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software is capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.

e) Transmitter with LonWorks Free Topology Network Interface: Connection capable of providing average airflow and temperature rates across network.

f) Transmitter with Data-Logger Interface: Capable of logging airflow and temperature rates over specified time intervals.

8. Single-Width Single-Inlet (SWSI) and Double-Width Double-Inlet (DWDI) Centrifugal Fan Thermal Airflow-Measurement Stations:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain all SWSI and DWDI centrifugal fan thermal airflow-measurement stations from a single manufacturer.

d. Airflow Station Performance:

1) Independent processing of [**up to eight**]separately wired sensor-node assemblies.

2) Accuracy within [**10**]<**Insert number**> percent of reading under operating conditions, when installed in accordance with manufacturer's sensor density and placement guidelines, with no effect on fan performance.

a) Include the combined uncertainty of the sensor nodes and transmitter.

b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

3) Airflow Station Impact on Fan Performance: Sensor assemblies mounted in throat or face of fan inlet are not to negatively influence fan performance by reducing airflow

more than [**1**]<**Insert number**> percent of Project design flow or negatively impact fan-generated sound. Document performance impact with submittal data, and make necessary adjustments to compensate for performance impact to fan in order to deliver not less than Project design airflow indicated.

e. Sensor-Node and Probe Assemblies:

1) Sensor-Node Calibration:

a) Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
b) Individually calibrated [**at a minimum of 16 calibration points**]<**Insert calibration points**> to NIST-traceable volumetric standards.
c) Accuracy within [**2**]<**Insert number**> percent of reading over the entire calibrated airflow range of [**0 to 10,000 fpm (0 to 50.8 m/s)**]<**Insert velocity range**>.
d) Individually calibrate thermistors [**at a minimum of three temperatures**]<**Insert calibration requirements**> to NIST-traceable temperature standards.

2) Sensor-Probe Construction: One sensor node mounted on a Type 304 stainless steel block with two adjustable zinc-plated steel rods connected to Type 304 stainless steel pivoting mounting feet.
3) Number of Independent Sensor Nodes: Two probes with one sensor node per probe in each fan inlet.

f. Transmitter:

1) Transmitter determines average airflow rate and temperature of each fan. Startup firmware facilitates the setup of multiple fans and fan areas.
2) Operator Interface: Backlit, alphanumeric [**(minimum 16-character)**]LCD display with following remote interface capability:

a) Transmitter with Analog Outputs: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent-protected analog output signals. First output provides total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.
b) Transmitter with RS-485 Network Communications: The RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.
c) Transmitter with Analog Outputs, RS-485 Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, overcurrent-protected analog output signals and network output capability. First output provides total airflow rate. Second output is field configurable for temperature or low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. RS-485 (BACnet MS/TP, or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average

airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software is capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.

d) Transmitter with Analog Outputs, IP Network Communication, and Bluetooth Capability: Two field-selectable [**zero to 5 V dc,**][**zero to 10 V dc,**][**or**][**4 to 20 mA,**] scalable, isolated, and overcurrent protected analog output signals and network output capability. First output provides the total airflow rate. Second output is field configurable for temperature or low- and/or high-airflow set-point (user-defined) alarm, or system status alarm. Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures. Provide transmitter with a Bluetooth low-energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow, and temperature of the device and the airflow and temperature of each sensor node. Include Bluetooth software capable of capturing and displaying this transmission via download to Android or iOS phone or tablet. Bluetooth software provides setup parameters and airflow, temperature, and diagnostic data to be saved on the phone or tablet, or emailed.

e) Transmitter with LonWorks Free Topology Network Interface: Connection capable of providing average airflow and temperature rates across the network.

f) Transmitter with Data-Logger Interface: Capable of logging airflow and temperature rates over specified time intervals.

9. Air Terminal Unit Thermal Airflow-Measurement Stations:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**ONICON Incorporated**]
4) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
5) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Air Monitor; an ONICON Brand**]
2) [**Ebtron, Inc**]
3) [**ONICON Incorporated**]
4) [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
5) **<Insert manufacturer's name>**

c. Source Limitations: Obtain all air terminal unit thermal airflow-measurement stations from a single manufacturer.

d. Airflow Performance:

1) Independent processing of up to [**two**]**<Insert number>** separately wired sensor-

node assemblies.

2) Accuracy within [**3**]<**Insert number**> percent of reading when installed in accordance with manufacturer's recommended placement guidelines.

a) Include the combined uncertainty of the sensor nodes and transmitter.

b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

e. Sensor-Node and Probe Assemblies:

1) Sensor-Node Calibration:

a) Individually calibrated [**at a minimum of seven calibration points**]<**Insert calibration points**> to NIST-traceable volumetric standards from [**0 to 3000 fpm (0 to 15.2 m/s)**]<**Insert velocity range**>.

b) Individually calibrate thermistors [**at a minimum of three temperatures**]<**Insert calibration requirements**> to NIST-traceable temperature standards.

f. Minimum number of independent sensor nodes as follows:

1) Provide one for duct or terminal unit diameter of **4 inches (102 mm)**.

2) Provide [**two**]<**Insert number**> for duct or terminal diameters **5 through 16 inches (127 through 406 mm)**.

g. Sensor-Probe Construction: [**Anodized or mill-finish, 6063 aluminum alloy tube**][**or**][**Type 316 stainless steel tube**], with each sensor probe containing one or more independently wired sensing nodes.

h. Transmitter:

1) Transmitter determines average airflow rate and temperature of all connected sensor nodes in an array for a single location.

2) Operator Interface: Backlit, alphanumeric, LCD display with following remote interface:

3) Transmitter with Analog Outputs: Two field-selectable [**zero 5 V dc,**][**1 to 5 V dc,**][**zero to 10 V dc,**][**or**][**2 to 10 V dc,**] scalable analog output signals. First output provides total airflow rate. Second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.

4) Transmitter with RS-485 Network Communications: RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.

5) Contact Closure Relay: One dry contact relay with onboard jumper drives a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A maximum. Actuator is to be configurable as normally open or normally closed during setup.

10. Packaged HVAC Unit Thermal Airflow-Measurement Stations:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Ebtron, Inc**]

2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Ebtron, Inc**]
2) <**Insert manufacturer's name**>

c. Application: HVAC units, **12.5 tons (44.0 kW)** or smaller, such as [**fan coil units**][**packaged rooftop units**][**unit ventilators**][**and**]<**Insert equipment types**>.

d. Airflow Performance:

1) Independent processing of up to two separately wired sensor-node assemblies.
2) Accuracy within 10 percent of reading when installed in accordance with manufacturer's recommended placement guidelines.

a) Include the combined uncertainty of the sensor nodes and transmitter.
b) For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with accuracy requirement over entire operating range.

e. Sensor-Node and Probe Assemblies:

1) Sensor-Node Internal Wiring Connections: Sealed and protected from elements and suitable for direct exposure to water. Devices with exposed leads are unacceptable.
2) Sensor-Node Calibration:

a) Individually calibrated at a minimum of seven calibration points to NIST-traceable airflow standards from **0 to 3000 fpm (0 to 15.2 m/s)**.
b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.

3) Minimum number of independent sensor nodes as follows:

a) Provide one for diameter of **4 inches (102 mm)**.
b) Provide two for diameters **5 through 16 inches (127 through 406 mm)**.

4) Sensor-Probe Construction: Mill-finish, 6063 aluminum alloy tube, with each sensor probe containing one or more independently wired sensing nodes.

f. Transmitter:

1) Transmitter determines average airflow rate and temperature of all connected sensor nodes in an array for a single location.
2) User Interface: An alphanumeric, LCD display, with two field-selectable analog output signals or one isolated RS-485 (BACnet MS/TP or Modbus RTU) field-selectable network connection.
3) Transmitter with Analog Outputs: Two field-selectable [**zero to 5 V dc,**][**1 to 5 Vdc,**][**zero to 10 V dc,**][**or**][**2 to 10 V dc,**] scalable analog output signals. The first output provides total airflow rate. The second output is field configurable for temperature, low- and/or high-airflow set-point (user-defined) alarm, or system status alarm.
4) Transmitter with RS-485 Network Communications: RS-485 (BACnet MS/TP or Modbus RTU) network connection provides average airflow rate, temperature, high- and/or low-airflow set-point alarm, system status alarm, individual sensor-node

airflow rates, and individual sensor-node temperatures.

5) Contact Closure Relay: One dry contact relay with onboard jumper to drive a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A maximum. Actuator is to be configurable as normally open or normally closed during setup.

11. Data Center Server Rack Thermal Airflow/Pressure- and Temperature-Monitoring Applications:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Ebtron, Inc**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Ebtron, Inc**]
2) <**Insert manufacturer's name**>

c. Bidirectional airflow measurement station with temperature output and integral airflow alarming to determine exfiltration or infiltration airflow rate, and its direction and temperature at each measurement location.

d. Bidirectional airflow, or equivalent differential pressure data, is provided to the [**Building Automation System (BAS)**][**DDC System**]<**Insert control system**>, with system status indication, configurable airflow alarm, and internal diagnostics routines.

e. Sensor-Node and Probe Assemblies:

1) Sensor-Node Internal Wiring Connections: Sealed and protected from elements and suitable for direct exposure to water. Devices with exposed leads are unacceptable.
2) Sensor-Node Calibration:

a) Individually calibrated at a minimum of nine calibration points to NIST-traceable volumetric standards from **minus 2000 to plus 2000 fpm (minus 10.2 to plus 10.2 m/s)**.
b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.

f. Probe to Transmitter Cables: Integral, FEP jacket, plenum-rated CMP/CL2P, UL/cUL-listed cable, rated for exposures from **minus 67 to plus 392 deg F (minus 55 to plus 200 deg C)**, and UV tolerant, with terminal plug for connection to the remotely mounted transmitter.

g. Transmitter:

1) Integral Transmitter with Display: Mounted internally to the rack enclosure, an integral, minimum 16-character LCD display capable of simultaneously displaying airflow and temperature, and capable of displaying individual airflow and temperature readings.
2) Transmitter Interface: Four-button interface for field configuration and diagnostics.
3) Power Supply: On-off power switch, 110 V ac at 8 VA, fused and protected from overvoltage, overcurrent, and power surges. Provide dual independent and redundant power supplies.
4) Network Interface: One isolated Ethernet network connection (simultaneously

supporting field-selectable BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP protocols).

C. Velocity Pressure Pitot-Tube Airflow Sensor Stations for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

3. Description: Position multiple total- and static-pressure sensors at the center of equal area of the station cross section and interconnect by respective averaging manifolds. Use Log-Tchebycheff rule for traverse pattern for rectangular stations and equal area for circular and flat oval stations.

   a. For stations [**4 sq. ft. (0.4 sq. m)**]<**Insert area**> and smaller, use a minimum of [**one**]<**Insert number**> total-pressure sensor(s) and [**one**]<**Insert number**> static-pressure sensor(s) for every [**16 sq. in. (103 sq. cm)**]<**Insert area**> of station area.
   b. For stations larger than [**4 sq. ft. (0.4 sq. m)**]<**Insert area**>, use a minimum of [**one**]<**Insert number**> total-pressure sensor(s) and [**one**]<**Insert number**> static-pressure sensor(s) for every [**36 sq. in. (232 sq. cm)**]<**Insert area**> of station area.

4. Certification: Rate and test performance in accordance with AMCA 610.[**Factory apply AMCA seal to each station.**]
5. Performance:

   a. Flow Accuracy: Within [**2**]<**Insert number**> percent of actual airflow.
   b. Flow Velocity Range: [**400 to 4000 fpm (2.0 to 20.3 m/s)**]<**Insert flow velocity range**>.
   c. Pressure Rating: Suitable for maximum system pressure[**; but not less than 8 inches wg (2000 Pa)**].
   d. Pressure Loss: [**0.015 inch wg (3.8 Pa) at 1000 fpm (5 m/s), or 0.085 inch wg (22.5 Pa) at 2000 fpm (1 m/s)**]<**Insert pressure loss requirements**>.
   e. Self-Generated Sound: NC 40; sound level within duct not amplified.
   f. Temperature Range: [**Minus 20 to plus 200 deg F (Minus 19 to plus 93 deg C)**]<**Insert temperature range**>.

6. Casing:

   a. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
   b. Casing Depth: At least **8 inches (203 mm)**.
   c. Casing Flanges: Outward flange, minimum flange face **1.5 inches (38 mm)**.
   d. Joints and Seams: Continuously weld joints and seams. Clean galvanized areas damaged by welding and coat with galvanize paint.
   e. Materials:

      1) Aluminum, minimum **0.063 inch (1.6 mm)** thick, when connected to aluminum duct.

2) Galvanized steel, minimum **0.079 inch (2.0 mm)** thick with coating complying with ASTM A653/A653M, **G90 (Z275)**, when connected to galvanized-steel duct.
3) Stainless steel, minimum **0.0781 inch (2.0 mm)** thick, when connected to stainless steel duct. Use Type 304 or 316 stainless steel to match adjoining duct.

7. Flow Straightener: Include each airflow station with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.

   a. Individual Cell Size: **0.5 inches (13 mm)** wide across entering face, **3 inches (75 mm)** deep in direction of airflow, **0.002 inch (0.051 mm)** thick.
   b. Construct from Type 3003 aluminum for aluminum and galvanized-steel casings.
   c. Construct from Type 316 stainless steel for units for stainless steel casings.

8. Pitot-Tube Array: Construct pressure-sensor array from hard-drawn aluminum, copper, or stainless steel tubing, depending on casing material.

   a. For aluminum casings, use aluminum[**, copper or stainless steel**] tubing.
   b. For galvanized-steel casings, use copper or stainless steel tubing.
   c. For stainless steel casings, use stainless steel tubing.
   d. Copper Tubing: ASTM B75/B75M and ASTM B280; hard drawn with minimum tube wall thickness of **0.030 inch (0.8 mm)**.
   e. Stainless Steel Tubing: Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale with minimum wall thickness of **0.035 inch (0.9 mm)**.

      1) Chemical and physical properties in accordance with ASTM A269/A269M.

   f. Internal Piping: Include internal piping to interconnect pitot-tube array and extend to external pressure signal ports.
   g. External Pressure Signal Ports: Locate on exterior of casing and properly label each port: "Total (high)" and "Static (low)." Terminate each port with [**1/4-inch (6-mm)**] <**Insert size**> metal compression fittings for field connection to tubing.

9. Identification: Permanent identification label on each station casing indicating model number, size, area, and application-specific airflow range.
10. Flow Signal: Mate the station pressure signal ports in the field to airflow transmitters [**with 0.10 accuracy and auto-zero feature**][**with 0.25 accuracy and auto-zero feature**]<**Insert airflow transmitter type**> for airflow measurement.

D. Velocity Pressure Probe-Type Airflow Sensor Stations for Duct Airflow Measurement Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. [**Paragon Controls Incorporated**]
c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all velocity pressure probe-type airflow sensor stations for duct airflow measurement stations from a single manufacturer.
4. Description:

   a. Airflow stations utilizing one or more airflow traverse probe(s), factory mounted in a rigid welded casing, to sense and average separate total and static pressure traverses of the airstream.
   b. Multiple sets of total and static pressure sensing points, positioned along the length of each probe on an equal area basis, traverse the airstream and average the sensed pressures in separate internal manifolds.
   c. Factory install static and total pressure signal tubing connecting the individual probes together and terminate at the exterior of the casing for field connection.

5. Certification: Rate and test performance in accordance with AMCA 610.[**Factory apply AMCA seal to each station.**]
6. Performance:

   a. Flow Accuracy: Within [**2**]<**Insert number**> percent of actual airflow.
   b. Flow Velocity Range: [**400 to 4000 fpm (2.0 to 20.3 m/s)**][**100 to 10,000 fpm (0.51 to 50.8 m/s)**]<**Insert flow velocity range**>.
   c. Pressure Rating: Suitable for maximum system pressure[**; but not less than 8 inches wg (2000 Pa)**]<**Insert pressure**>.
   d. Pressure Loss: [**0.025 inch wg (6.3 Pa) at 2000 fpm (10 m/s), or 0.085 inch wg (22.5 Pa) at 4000 fpm (20 m/s)**]<**Insert pressure loss requirements**>.
   e. Self-Generated Sound: NC 40; sound level within the duct not amplified.
   f. Temperature Range: [**Minus 20 to plus 200 deg F (Minus 19 to plus 93 deg C)**]<**Insert temperature range**>.

7. Casing:

   a. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
   b. Casing Depth: Minimum **8 inches (200 mm)**.
   c. Casing Flanges: Outward flange, minimum flange face **1.5 inches (38 mm)**.
   d. Joints and Seams: Continuously weld joints and seams. Clean galvanized areas damaged by welding and coat with galvanize paint.
   e. Materials:

      1) Aluminum, minimum **0.063 inch (1.6 mm)** thick, when connected to aluminum duct.
      2) Galvanized steel, minimum **0.079 inch (2.0 mm)** thick with coating complying with ASTM A653/A653M, **G90 (Z275)**, when connected to galvanized-steel duct.
      3) Stainless steel, minimum **0.0781 inch (2.0 mm)** thick, when connected to stainless steel duct. Use Type 304 or 316 stainless steel to match adjoining duct.

8. Flow Straightener: Include each airflow station with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.

   a. Individual Cell Size: **0.5 inches (13 mm)** wide across entering face, **3 inches (75 mm)** deep in direction of airflow, **0.002 inch (0.051 mm)** thick.
   b. Construct from Type 3003 aluminum for aluminum and galvanized-steel casings.
   c. Construct from Type 316 stainless steel for units for stainless steel casings.

9. Airflow Probe Array: Construct station array using anodized extruded-aluminum probe(s) or stainless steel probe(s), depending on casing material. Each airflow traverse probe mounted within the station contains multiple total and static pressure sensors located along its exterior surface, and internally connected to their respective averaging manifolds. The flow sensors are not to protrude beyond the surface of the probe(s). Locate total and static pressure sensors at the centers of equal areas for rectangular stations and at equal concentric area centers (for circular ducts) across the station's face area.

    a. For aluminum casings, use anodized extruded-aluminum probes.
    b. For galvanized-steel casings, use anodized extruded-aluminum probes.
    c. For stainless steel casings, use Type 316 stainless steel probes.
    d. Copper Tubing: ASTM B75/B75M and ASTM B280; hard drawn with minimum tube wall thickness of **0.030 inch (0.8 mm)**.
    e. Stainless Steel Tubing: Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale with minimum wall thickness of **0.035 inch (0.9 mm)**.

        1) Chemical and physical properties in accordance with ASTM A269/A269M.

    f. Internal Piping: Include internal piping to interconnect individual probes and extend to external pressure signal ports. Use copper tubing to interconnect aluminum probes, and use stainless steel tubing to interconnect stainless steel probes.
    g. External Pressure Signal Ports: Locate on exterior of casing and properly label each port: "Total (high)" and "Static (low)." Terminate each port with [**1/4-inch (6-mm)**] <**Insert size**> metal compression fittings for field connection to tubing.

10. Identification: Permanent identification label on each station casing indicating model number, size, area, and application-specific airflow range.
11. Flow Signal: Mate the stations' pressure signal ports in the field to airflow transmitters [**with 0.10 accuracy and auto-zero feature**][**with 0.25 accuracy and auto-zero feature**]<**Insert airflow transmitter type**> for airflow measurement.

E. Velocity Pressure Probe-Type Airflow Sensors for Duct Airflow Measurement Stations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Air Monitor; an ONICON Brand**]
    b. [**Paragon Controls Incorporated**]
    c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Air Monitor; an ONICON Brand**]
    b. [**Paragon Controls Incorporated**]
    c. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all velocity pressure probe-type airflow sensors for duct airflow-measurement stations from a single manufacturer.

4. Description:

   a. One or more airflow traverse probe(s), for individual field installation in ducts, to sense and average separate total and static pressure traverses of airstream.
   b. Multiple sets of total and static pressure sensing points, positioned along length of each probe on an equal area basis, traverse the airstream and average the sensed pressures in separate internal manifolds.

5. Certification: Rate and test performance in accordance with AMCA 610.
6. Performance:

   a. Flow Accuracy: Within [**2**][**3**]<**Insert number**> percent of actual airflow.
   b. Flow Velocity Range: [**400 to 4000 fpm (2.0 to 20.3 m/s)**][**100 to 10,000 fpm (0.51 to 50.8 m/s)**]<**Insert flow velocity range**>.
   c. Pressure Loss: [**0.025 inch wg (6.3 Pa) at 2000 fpm (10 m/s), or 0.085 inch wg (22.5 Pa) at 4000 fpm (20 m/s)**]<**Insert pressure loss requirements**>.
   d. Temperature Range: [**Minus 20 to plus 200 deg F (Minus 19 to plus 93 deg C)**]<**Insert temperature range**>.

7. Airflow Probe Array: Construct field-installed duct arrays using either anodized extruded-aluminum probe(s) or stainless steel probe(s), depending on duct material. Each airflow traverse probe consists of multiple total and static pressure sensors located along its exterior surface, and internally connected to their respective averaging manifolds. The flow sensors are not to protrude beyond the surface of the probe(s). Locate total and static pressure sensors at the centers of equal areas for rectangular ducts and at equal concentric area centers for circular ducts across the duct cross sectional area.

   a. For aluminum ducts, use anodized extruded-aluminum probes.
   b. For galvanized-steel ducts, use anodized extruded-aluminum probes.
   c. For stainless steel ducts, use Type 316 stainless steel probes.
   d. External Pressure Signal Ports: Locate on exterior of casing and properly label each port: "Total (high)" and "Static (low)." Terminate each port with [**1/4-inch (6-mm)**] <**Insert size**> metal compression fittings for field connection to tubing.
   e. Probe Mounting Accessories: Factory supply each probe with mounting plates, brackets, gaskets, and hardware specific for each application.

      1) For anodized extruded-aluminum probes, use aluminum mounting plates and brackets with stainless steel hardware.
      2) For stainless steel probes, use Type 316 stainless steel mounting plates, brackets, and hardware.

8. Identification: Permanent identification label on each probe indicating model number and application-specific attributes.
9. Flow Signal: Interconnect individual airflow probes in the field and mate to airflow transmitters [**with 0.10 accuracy and auto-zero feature**][**with 0.25 accuracy and auto-zero feature**]<**Insert airflow transmitter type**> for airflow measurement.

F. Velocity Pressure Probe-Type Fan Inlet Airflow Traverse Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]

c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain all velocity pressure probe-type fan inlet airflow traverse sensors from a single manufacturer.
4. Description: Traverse manifold designed for mounting in fan inlets.

   a. Manifold contains multiple total- and static-pressure sensors placed at concentric area centers along the exterior surface of cylindrical manifold and internally connected to their respective averaging manifolds.
   b. Do not protrude beyond the surface of the manifold.

5. Performance:

   a. Design sensors so performance is not adversely affected by particle contamination present in the airstream.
   b. Sensors capable of producing steady, non-pulsating signals of standard total and static pressure without need for flow corrections or factors, with an accuracy of [**3**]**<Insert number>** percent of actual flow over a turndown range of [**6**]**<Insert value>** to 1.

6. Construction:

   a. Manifold (two per inlet) with dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings.
   b. Manifold Materials: [**Copper or anodized aluminum**][**or**][**Type 316 stainless steel**].
   c. Copper or Anodized Aluminum Manifolds: Unless otherwise required by application and without affecting the fan and sensor performance, use the following sizes:

      1) For fan inlets smaller than **20 inches (500 mm)**, use **0.375-inch (9-mm)** diameter.
      2) For fan inlets **20 inches (500 mm)** and larger, use **0.75-inch (19-mm)** diameter.

   d. Type 316 Stainless Steel Manifolds: Unless otherwise required by application and without affecting the fan and sensor performance, use the following sizes:

      1) For fan inlets smaller than **20 inches (500 mm)**, use **0.375-inch (9-mm)** diameter.
      2) For fan inlets **20 through 48 inches (500 through 1200 mm)**, use **0.75-inch (19-mm)** diameter.
      3) For fan inlets larger than **48 inches (1200 mm)**, use **1.0-inch (25-mm)** diameter.

7. Flow Signal: Mate the fan inlet sensors in field to airflow transmitters [**with 0.10 accuracy and auto-zero feature**][**with 0.25 accuracy and auto-zero feature**]**<Insert airflow transmitter type>** for airflow measurement.

G. Piezometer Ring Fan Inlet Airflow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ebm-papst Inc.**]
b. [**Twin City Fan & Blower**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ebm-papst Inc.**]
b. [**Twin City Fan & Blower**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all piezometer ring fan inlet airflow sensors from a single manufacturer.
4. Description:

a. In lieu of externally mounted fan inlet airflow sensors, option to provide fans with airflow measurement integral to fan inlet cones for continuous measurement of airflow rate.
b. Piezometer ring consists of multiple pressure sensor points strategically placed along the circumference of the fan inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
c. Sensor points are not to protrude beyond the surface of the inlet cone or be adversely affected by particle contamination present in the airstream.
d. Standard offering of the fan manufacturer with published literature and supporting test data to validate performance.

5. Performance:

a. Produces steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
b. Non-intrusive and not impacting fan performance.

6. Construction: Manufacturer's standard construction[**, except use copper tubing and brass fittings in lieu of poly tubing**].

H. Outdoor Airflow-Measurement System Using Differential Static Pressure:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. [**ONICON Incorporated**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. [**ONICON Incorporated**]
c. <**Insert manufacturer's name**>

3. Manufacturer needs to confirm that overall system and each system component complies with requirements.
4. Description: Flow measurement system using principle of differential static pressure across a known fixed resistance. System consists of a temperature sensor with one or more airflow (pressure) sensors connected to a remotely mounted microprocessor-based monitor/transmitter.

    a. Include one outdoor airflow-measurement system for each outdoor airflow-measurement application indicated on Drawings.
    b. Report airflow readings in either actual or standard conditions. Correct values for altitude and temperature.
    c. System is to directly measure airflow through an outdoor air inlet opening and report the measured airflow values through the monitor/transmitter local display, multiple analog outputs, and a single serial output for BACnet or Modbus.

5. Certification:

    a. AMCA certified for airflow-measurement accuracy when installed as a complete system.
    b. Class A device in accordance with 47 CFR, Chapter I - "Federal Communications Commission," Part 15 - "Radio Frequency Devices," Subpart A - "General"; Subpart B - "FAA Notification Criteria."
    c. Submit product certificates showing compliance.

6. Application: Manufacturer's factory engineering is to review each separate outdoor airflow application indicated on Drawings and select a system solution that complies with requirements indicated.

    a. Factory calibrate and configure system based on application and installation configuration.
    b. Possible installation applications to include the following:

        1) Air hoods included with HVAC equipment.
        2) Air louvers included with HVAC equipment.
        3) Casing included as part of this outdoor airflow-measurement system for field installation.
        4) Other applications indicated on Drawings.

    c. Possible airflow-measurement applications to include the following:

        1) Minimum outdoor airflow only.
        2) Total outdoor airflow (combined minimum and air economizer) measured as one value and reported as one value.
        3) Split Outdoor Airflows (Minimum and Air Economizer): Each airstream measured separately and reported separately, plus reported total airflow of combined airstreams.
        4) Dual outdoor airflow paths: Two airflows from a single transmitter.

7. Outdoor Duty:

    a. Performance not impacted by presence of dirt, debris, moisture, rain, and snow in the measured airstream.
    b. Performance not affected by wind direction, wind speed, and rapid changes in either, such as wind gusts, that are common in an outdoor environment.
    c. Measured airflow corrected for ambient temperature and atmospheric pressure.
    d. System components rated for outdoor duty, including interconnecting cable between temperature sensor and transmitter.

8. Performance:

    a. Accuracy:

        1) Flow: Combined system accuracy within 5 percent of flow reading over entire operating range.
        2) Temperature: Within 0.1 percent at **32 deg F (0 deg C)**.

    b. Adjustability: Accommodates changes in system operating parameters.
    c. Airflow Range (Extended): 15 percent above design airflow and 15 percent below minimum airflow indicated on Drawings.
    d. Auto Zero Feature:

        1) Accuracy: Within 0.1 percent of scale.
        2) Frequency: Configurable.

    e. Velocity Range: **100 to 2400 fpm (0.51 to 12.2 m/s)**.
    f. Repeatability: Within 0.2 percent.
    g. Ambient Temperature: **Minus 40 to plus 120 deg F (Minus 40 to plus 49 deg C)**.
    h. Ambient Humidity: Zero to 99 percent relative humidity, noncondensing.

9. Casing:

    a. Where required by the measurement application, factory mount airflow sensor(s) and temperature sensor, and flatten expanded metal screen in an airflow station casing to create a single assembly for field mounting.
    b. Material: [**Aluminum, 0.08 inch (2 mm) thick**][**Galvanized steel, 14 gauge thick**][**Type 304 stainless steel, 0.0781 inch (1.9 mm) thick**][**Type 316 stainless steel, 0.0781 inch (1.9 mm) thick**]<**Insert material**>.

        1) Factory prep, treat, and paint weld-damaged galvanized surfaces with a galvanize paint for corrosion protection comparable to adjacent undamaged galvanized surfaces.

    c. Joints and Seams: Continuously or intermittently welded and sealed.
    d. End Connections: Inlet and discharge ends of casing fitted with a flange face not less than **1.5 inches (38 mm)**.
    e. Flattened Expanded Metal Screen:

        1) Material: [**Aluminum, nominal 3/4-inch- (20-mm-) diamond mesh, 1/8-inch- (3-mm-) thick strands**][**Hot-dipped galvanized steel, nominal 1/2-inch- (13-mm-) thick diamond mesh, 0.077-inch- (2-mm-) thick stands**][**Type 304 stainless steel, nominal 3/4-inch- (20-mm-) thick diamond mesh, 0.077-inch- (2-mm-) thick stands**][**Type 316 stainless steel, nominal 3/4-inch- (20-mm-) thick diamond mesh, 0.077-inch- (2-mm-) thick stands**].
        2) Open Area: Not less than [**60**]<**Insert number**> percent.

    f. Internally manifold pressure sensor(s) together using nominal **1/4-inch- (6-mm-)** diameter [**Type 304**][**or**][**Type 316**] stainless steel tubing with compression fittings and extend to exterior of casing for field connection.

10. Airflow (Pressure) Sensor(s):

    a. Material: Type 316 stainless steel.
    b. Quantity: Determined by manufacturer's factory engineering personnel for each measurement application.

c. Size: Determined by manufacturer's factory engineering personnel for each measurement application.

11. Temperature Sensor: Three-wire, 100- or 1000-ohm platinum RTD in stainless steel sheath.
12. Monitor/Transmitter:

a. Enclosure:

1) Rating: NEMA 250, Type 4.
2) Cover: Hinged with display window.
3) Conduit Connection: Two, **1/2-inch (13-mm)** trade size.
4) Process Connections: Four **1/4-inch- (6-mm-)** compression fittings for receiving high/low inputs from two distinct flow arrays.

b. Local Display: Nominal **0.4-inch- (10-mm-)** diagonal color graphic LCD display.
c. Memory: Program parameters and data stored in nonvolatile FLASH memory.
d. Operator Interface: Field programmable; through menu using keypad on face of cover.

1) Units: Selectable between IP or SI for flow, temperature, and velocity.

e. Power Supply: 24 V ac, isolated and fused with reverse polarity protection.
f. Remote Control Interface:

1) Hardwired Analog Outputs: Three analog outputs, field selectable via menu for 4 to 20 mA, zero to 5 V dc, or zero to 10 V dc.
2) Analog Output Scaling: Field-programmable scaling of velocity, flow, and temperature based on configuration. Provide field characterization of flow rate. System to allow for a separate K factor for each of three known flow rates.
3) Serial Communication Interface: Field-selectable RS-485 network communications, either BACnet MS/TP or Modbus RTU.

g. Terminal Strip:

1) Screw- or plug-in connections.
2) Label each wiring connection.

2.4 AIRFLOW SWITCHES

A. Polymer Film Sail Airflow Switch:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]
b. [**Johnson Controls, Inc.**]
c. [**Penn Controls**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]
b. [**Johnson Controls, Inc.**]
c. [**Penn Controls**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all polymer film sail airflow switches from a single manufacturer.
4. Description: Vane-operated airflow switch.
5. Performance:

a. Electrical: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1) Normally Closed Full Load Current: [**1**]<**Insert value**> A at 120 V ac.
2) Normally Open Full Load Current: [**2**]<**Insert value**> A at 120 V ac.
3) Voltage: 24, 120, and 240 V ac.

b. Mounting: Suitable for mounting with air direction in horizontal, vertical (up or down).
c. Temperature:

1) Maximum Ambient Temperature: [**125 deg F (52 deg C)**]<**Insert temperature**>.
2) Maximum Process Temperature: [**170 deg F (77 deg C)**]<**Insert temperature**>.

d. Velocity:

1) Suitable for applications operating at velocities of up to [**400 fpm (2.0 m/s)**]<**Insert velocity**>.
2) Normally open switch actuates at [**250 fpm (1.3 m/s)**]<**Insert velocity**> and opens at [**75 fpm (0.4 m/s)**]<**Insert velocity**>.
3) Normally closed switch actuates at [**75 fpm (0.4 m/s)**]<**Insert velocity**> and closes at [**250 fpm (1.3 m/s)**]<**Insert velocity**>.

6. Construction:

a. Polyester film sail encasing a wire frame.
b. Sail actuates a SPDT snap switch.
c. Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
d. Enclosure:

1) Material: Zinc-plated steel.
2) Removable cover.
3) Rating: NEMA 250, Type 1 enclosure.
4) Wiring Connections: Labeled screw terminals.
5) Conduit Connections: **1/2-inch (16-mm)** trade size conduit knock outs on top and bottom.

B. Stainless Steel Single-Vane Airflow Switch:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. [**Johnson Controls, Inc.**]
c. [**Penn Controls**]

d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. [**Johnson Controls, Inc.**]
   c. [**Penn Controls**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all stainless steel single-vane airflow switches from a single manufacturer.
4. Description: Vane-operated airflow switch.

   a. Suitable for mounting with air direction in horizontal.

5. Performance:

   a. Electrical:

      1) Full Load Current: [**9.8**]<**Insert value**> A at 125 V ac.
      2) Voltage: 125, 240, and 480 V ac.

   b. Temperature:

      1) Maximum Ambient Temperature: [**125 deg F (52 deg C)**]<**Insert temperature**>.
      2) Maximum Process Temperature: [**180 deg F (82 deg C)**]<**Insert temperature**>.

   c. Velocity: Up to [**2000 fpm (10.2 m/s)**]<**Insert velocity**>.

      1) Field-Adjustable Velocity Set Point: [**400 to 1600 fpm (2.0 to 8.2 m/s)**]<**Insert velocity range**>.

6. Construction:

   a. Stainless steel vane.
   b. Vane actuates a SPDT snap switch.
   c. Screw set-point adjustment.
   d. Enclosure:

      1) Material: Die-cast metal.
      2) Enclosure with removable cover.
      3) Rating: NEMA 250, Type 1.
      4) Wiring Connections: Labeled screw terminals.
      5) Conduit Connections: **1-inch (27-mm)** trade size conduit knock outs on top and bottom.

2.5 AIRFLOW TRANSMITTERS

A. Airflow Transmitter with 0.10 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. <**Insert manufacturer's name**>

3. Description: Smart transmitter receives total- and static-pressure signals from a sensor (primary element), amplifies signals, extracts the square root, and scales the signals to produce 4 to 20 mA dc output signals linear to airflow and velocity or pressure.

a. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals to re-zero transmitter to within 0.1 percent of true zero.

4. Performance:

a. Range: As required by application with range of at least [**10**]<**Insert number**> percent below minimum airflow and [**10**]<**Insert number**> percent greater than design airflow.
b. Calibrated Span: Field adjustable, minus 40 percent of the range.
c. Accuracy: Within 0.10 percent of natural span.
d. Repeatability: Within 0.15 percent of calibrated span.
e. Linearity: Within 0.2 percent of calibrated span.
f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
g. Pressure: Surges of up to **25 psig (172 kPa)** will not harm transmitter.
h. Relative Humidity: Zero to 95 percent, noncondensing.
i. Temperature: **40 to 140 deg F (4 to 60 deg C)**.
j. Turndown: Flow and velocity turndown of 10 to 1; velocity pressure turndown of 100 to 1.
k. Vibration: Shock and vibration will neither harm transmitter, nor affect its performance.

5. Output Signals:

a. Analog Outputs. Two outputs, individually configurable for zero to 5 V dc, zero to 10 V dc, or 4 to 20 mA.
b. Digital Outputs:

1) Form C dry contacts rated for 3 A at 24 V ac/V dc for high and low alarms.
2) Dual Form A dry contacts rated for 3 A at 24 V ac/V dc for auto-purge activation and acknowledgment.

6. Network Communication: [**BACnet**][**or**][**Modbus TCP/IP**].
7. Enclosure:

a. Circuit Protection. Power input isolated, fused, and reverse polarity protected.
b. Display:

1) Integral backlit LCD digital display on face of enclosure with [**two**][**four**] lines of data display, with each line individually scalable in user-selectable format and units of measure. For high visibility, display flow has easy-to-read, oversized digits and other

variables with standard-size digits.
2) LEDs indicate CPU activated, auto-zero in progress, auto-zero over-ranged, auto purge in progress, and auxiliary alarm "on" status.

c. Noise Filter. Adjustable response time to reach 98 percent of a step change from 2 to 250 seconds.
d. Rating: NEMA 250, [**Type 1**][**or**][**Type 4**].
e. Wiring Connections: Labeled screw terminals concealed within enclosure.
f. Conduit Connections: Two trade-size conduit connections for connection to field-installed conduit.
g. Process Connections: Total (high) pressure and static (low) pressure ports with [**1/8-inch (3-mm)**] [**1/4-inch (6-mm)**]<**Insert size**> metal compression fittings for field connection to tubing.

8. Operator Interface: Transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling performed digitally in the onboard microprocessor via input pushbuttons on face of enclosure.
9. Power: 24 V ac or V dc or 120 V ac via external transformer.

B. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. [**ONICON Incorporated**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. [**ONICON Incorporated**]
c. <**Insert manufacturer's name**>

3. Description: Smart transmitter receives total- and static-pressure signals from a sensor (primary element), amplifies signals, extracts the square root, and scales the signals to produce 4 to 20 mA dc output signals linear to airflow.

a. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals to re-zero transmitter to within 0.1 percent of true zero.

4. Performance:

a. Range: As required by application and at least [**10**]<**Insert number**> percent below minimum airflow and [**10**]<**Insert number**> percent greater than design airflow.
b. Calibrated Span: Field adjustable, minus 40 percent of range.
c. Accuracy: Within 0.25 percent of natural span.
d. Repeatability: Within 0.15 percent of calibrated span.
e. Linearity: Within 0.2 percent of calibrated span.
f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.

g. Pressure: Surges of up to **25 psig (172 kPa)** will not harm transmitter.
h. Relative Humidity: Zero to 95 percent, noncondensing.
i. Temperature: **40 to 140 deg F (4 to 60 deg C)**.
j. Turndown: Flow and velocity turndown of 10 to 1; velocity pressure turndown of 100 to 1.
k. Vibration: Shock and vibration will neither harm transmitter, nor affect its performance.

5. Output Signals:

a. Analog Outputs. One output configurable for zero to 5 V dc, zero to 10 V dc, or 4 to 20 mA.

6. Enclosure:

a. Circuit Protection. Power input isolated, fused, and reverse polarity protected.
b. Display: Integral backlit LCD digital display on face of enclosure for continuous indication of airflow.
c. Noise Filter. Adjustable response time to reach 98 percent of a step change from 2 to 250 seconds.
d. Rating: NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 12**].
e. Wiring Connections: Labeled screw terminals concealed within enclosure.
f. Conduit Connections: Trade size conduit connections to field-installed connection.
g. Process Connections: Total (high) pressure and static (low) pressure ports with [**1/8-inch (3-mm)**] [**1/4-inch (6-mm)**][**3/8-inch (9-mm)**] <**Insert size**> metal compression fittings for field connection to tubing.

7. Power: 24 V ac or V dc.

C. Pressure Differential Transmitters for Airflow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. [**Paragon Controls Incorporated**]
c. [**Setra Systems Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. [**Paragon Controls Incorporated**]
c. [**Setra Systems Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all pressure differential transmitters for airflow measurement from a single manufacturer.
4. Description: Transmitter receives total- and static-pressure signals from a sensor (primary element) and sends output signal(s) for airflow.
5. Performance:

a. Range: As required by application and at least [**10**]<**Insert number**> percent below minimum airflow and [**10**]<**Insert number**> percent greater than design airflow.
b. Accuracy: Within [**0.5**][**0.4**][**0.25**] percent of the full-scale range.

c. Hysteresis: Within [**0.10**]<**Insert number**> percent of full scale.
d. Repeatability: Within [**0.05**]<**Insert number**> percent of full scale.
e. Stability: Within [**1.0**]<**Insert number**> percent of span per year.
f. Overpressure: [**10 psig (69 kPa)**]<**Insert pressure**>.
g. Temperature Limits: [**0 to 150 deg F (Minus 18 to plus 66 deg C)**]<**Insert temperature range**>.
h. Compensate Temperature Limits: [**40 to 150 deg F (4 to 66 deg C)**]<**Insert temperature range**>.
i. Thermal Effects: [**0.033**]<**Insert number**> percent of full scale per **deg F (deg C)**.
j. Vibration: Shock and vibration will not harm the transmitter.

6. Output Signals:

a. Analog Current Signal:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into [**800**]<**Insert value**>-ohm load.

b. Analog Voltage Signal:

1) Three wire, zero to [**5**][**10**] V.
2) Minimum Load Resistance: [**1000**]<**Insert value**> ohms.

7. Display: Digital display with minimum **0.4-inch- (10-mm-)** high numeric characters.
8. Operator Interface:

a. Zero and span adjustments located behind cover.

9. Construction:

a. Enclosure Material: Plastic casing with removable plastic cover.
b. Enclosure Rating: NEMA 250, [**Type 4**]<**Insert type**>.
c. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing.
d. Mounting: Vertical plane mounting.
e. Mounting Bracket: Appropriate for installation.
f. Wiring Connections: Labeled screw terminals.
g. Conduit Connections: Trade-size conduit connections to field-installed connection

D. Pressure Differential Indicating Transmitter, Switch, and Controller for Airflow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Description:

   a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.
   b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
   c. Select instrument range based on application.

4. Performance:

   a. Accuracy including hysteresis and repeatability:

      1) Within 1.5 percent for range of **0.25 inch wg (63 Pa)**.
      2) Within 1 percent for ranges of **0.5 to 5-inch wg (125 to 1250 Pa)**.
      3) Within 0.5 percent for ranges greater than **5 inch wg (1250 Pa)**.

   b. Stability: Within 1 percent per year.
   c. Response Time: 250 ms.
   d. Overpressure:

      1) Ranges less than **50 inch wg (12.5 kPa)** with overpressure of **9 psi (62 kPa)**.
      2) Range of **50 inch wg (12.5 kPa)** with overpressure of **15 psi (103 kPa)**.
      3) Range of **100 inch wg (25 kPa)** with overpressure of **20 psi (138 kPa)**.

   e. Temperature Limits: **32 to 140 deg F (0 to 60 deg C)**.
   f. Thermal Effects: 0.020 percent of full scale per **deg F (deg C)**.
   g. Warmup Period: One hour.

5. Controller: Programming through menu keys to access five menus.

   a. Security level.
   b. Pressure, velocity, or flow application.
   c. Engineering units.
   d. K-factor for use with flow application.
   e. Set-point control only; set-point and alarm operation; alarm operation as high, low, or high/low with manual; or automatic reset and delay.
   f. View high and low readings.
   g. Digital dampening for smoothing erratic applications.
   h. Scaling of analog output to fit range and field calibration.

6. Display:

   a. Four-digit digital, with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
   b. Four LED indicators; two LEDs for set point and two LEDs for alarm status.

7. Operator Interface:

   a. Set-point adjustment through keypad on face of instrument.
   b. Zero and span adjustments accessible through menu.
   c. Programming through keypad.

8. Output Analog Signal: Two-wire, 4 to 20 mA dc current source; capable of operating into a 900-ohm load.
9. Output Digital Signal: Two, SPDT relays; each rated for 1 A at 30 V ac or 30 V dc.
10. Construction:

a. Enclosure Rating: NEMA 250, Type 1.
b. Face Size: Nominal **4-inch- (100-mm-)** diameter.
c. Materials: Die-cast aluminum casing and [**stainless steel**]bezel.
d. Mounting: Vertical plane mounting.
e. Mounting Bracket: Appropriate for installation.
f. Process Connections:**1/8-inch- (3-mm-)** NPT, on side and back.

2.6 LIQUID FLOW METERS

A. General Requirements for Liquid Flow Meters:

1. Adjustable for changes in system operational parameters.
2. Liquid Sensors, Meters, and Transmitters: Extended range of [**10**][**20**]<**Insert number**> percent above Project design flow and [**10**][**20**]<**Insert number**> percent below Project minimum flow to signal abnormal flow conditions.
3. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
4. Product certificates are required.

B. Insertion Impeller Liquid Flow Meters with Accuracy of 1 Percent of Full Scale:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Insertion-type meter with a non-magnetic spinning impeller (paddle wheel).
4. Meter Size Range: [**NPS 3 through NPS 36 (DN 80 through DN 900)**]<**Insert pipe size range**>.
5. Process Pipe Connection: **NPS 2 (DN 50)**.
6. Performance:

   a. Ambient Temperature: **14 to 150 deg F (Minus 10 to plus 66 deg C)**.
   b. Flow Velocity Range: **0.3 to 30 fps (0.09 to 9.1 m/s)**.
   c. Flow Accuracy: Within 1 percent of full scale over flow range.
   d. Linearity: Within 0.2 percent of full scale over flow range.
   e. Repeatability: Within 0.3 percent of full scale over flow range.
   f. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: **400 psig at 100 deg F (2758 kPa at 38 deg C)**.
      2) Minimum Temperature Range: Up to [**221 deg F (105 deg C)**][**285 deg F (141 deg C)**].

7. Output Signal: Frequency pulse.

8. Construction:

    a. Wetted Metal Parts, Including Sensor Sleeve, Mounting Adapter, and Isolation Valve: [**Brass**][**or**][**Type 316 stainless steel**].
    b. Shaft: [**Tungsten carbide**][**or**][**Type 316 stainless steel**].
    c. Impeller: [**Nylon**][**or**][**ETFE**].
    d. Process Connection: **NPS 2 (DN 50)**.
    e. Instrument Isolation Valve: [**Gate**][**Full port ball**] valve for system isolation.
    f. Insertion Depth: Threaded positioning nut for accurate sensor depth in the pipe.
    g. Electronics Enclosure:

        1) Polyphenylene sulfide (PPS) with Viton seal.
        2) Electrical Connection: Cable furnished with sensor.

9. Transmitter:

    a. User-adjustable scale to refine resolution of flow range of over 4 to 20 mA signal.
    b. Enclosure Material: Polycarbonate with tongue and groove, with neoprene-sealed cover.
    c. Enclosure Rating: NEMA 250, Type 4X.
    d. Electrical Connection: Labeled screw terminals.
    e. Linearity of less than 1 percent.
    f. Output Response Time: 6 seconds for 10 to 90 percent step.
    g. Load resistance of 650 ohms at 24 V dc.
    h. Digital display of flow rate.

C. Insertion Impeller Liquid Flow Meters with 0.5 Percent Accuracy:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Badger Meter, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Badger Meter, Inc.**]
    b. <**Insert manufacturer's name**>

3. Description: Insertion-type flow meter with a non-magnetic spinning impeller (paddle wheel).

    a. Include programming kit with cable connector and Microsoft-Windows-compatible software.
    b. Where indicated, provide meter with bidirectional flow measurement.

4. Factory Calibration: Wet calibrate each meter to standards traceable to NIST. Tag each meter and provide each meter with a certificate of calibration.
5. Meter Size Range: [**NPS 1-1/2 through NPS 36 (DN 40 through DN 900)**]<**Insert pipe size range**>.
6. Process Pipe Connection: **NPS 1 (DN 25)**.
7. Performance:

    a. Ambient Temperature: **14 to 150 deg F (Minus 10 to plus 66 deg C)**.
    b. Flow Velocity Range: **0.5 to 20 fps (0.15 to 6.1 m/s)**.

c. Flow Accuracy: Within 0.5 percent of flow rate.
d. Repeatability: Within 0.5 percent.
e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Minimum Pressure: **350 psig (2413 kPa)** with PEEK sensor tip.
2) Minimum Temperature Range: Up to **300 deg F (149 deg C)** with PEEK sensor tip.

f. Pressure Drop: Up to **0.5 psig at 10 fps (3.5 kPa at 3 m/s)** for pipe sizes **NPS 1-1/2 (DN 40)** and larger.

8. Output Signal:

a. Unidirectional Flow Meter:

1) Frequency pulse.
2) Analog, two-wire, loop-powered, 4 to 20 mA signal.
3) Scaled pulse.

b. Bidirectional Flow Meter:

1) Provide analog 4 to 20 mA signal plus direction.
2) Scaled pulse.

9. Operator Interface:

a. Programming: Instrument programming through computer and programming kit.
b. Digital Display: Eight-character digital display of flow rate, flow totalization, input, output, and flow direction for bidirectional meters.

10. Construction:

a. Wetted Metal Parts (Including Sensor Stem, Mounting Adapter, and Isolation Valve): Type 316 stainless steel[**or brass**].
b. Sensor Tip: PPS or PEEK.
c. Shaft: Tungsten carbide.
d. Impeller: Stainless steel.
e. Process Connection: **NPS 1 (DN 25)**.
f. Instrument Isolation Valve: Full port ball valve for system isolation.
g. Insertion Depth: Threaded positioning nut for accurate sensor depth in pipe.
h. Electronics Enclosure:

1) Material: Polypropylene with Viton-sealed acrylic cover.
2) Removable cover.
3) Rating: NEMA 250, Type 4X.
4) Electrical Connection: Labeled screw terminals.
5) Conduit Connection: **1/2-inch (16-mm)** trade size.

D. Insertion Turbine Liquid Flow Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**ONICON Incorporated**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**ONICON Incorporated**]
   c. [**Spirax Sarco Limited**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all insertion turbine flow meters from a single manufacturer.
4. Description: Turbine rotational sensing accomplished electronically by sensing electronic impedance change (non-magnetic and non-photoelectric).
5. Factory Calibration: Wet calibrate each meter to standards traceable to NIST. Tag each meter and provide each meter with a certificate of calibration.
6. Meter Size Range: [**NPS 1-1/4 through NPS 72 (DN 32 through DN 1800)**]<**Insert pipe size range**>.
7. Process Pipe Connection: [**NPS 1 (DN 25)**]<**Insert pipe size**>.
8. Performance:

   a. Ambient Temperature: [**Minus 5 to plus 160 deg F (Minus 21 to plus 71 deg C)**]<**Insert temperature range**>.
   b. Conductivity: Suitable for flow measurement of fluids with electrical conductivity of greater than [**5**][**100**]<**Insert conductivity**> microseimens per centimeter.
   c. Flow Velocity Range: [**0.1 to 30 fps (0.03 to 9.1 m/s)**]<**Insert flow velocity range**>.
   d. Flow Accuracy: Within [**1**]<**Insert number**> percent of reading for flow velocities between [**3 to 30 fps (0.9 to 9.1 m/s)**]<**Insert flow velocity range**> and within [**2**]<**Insert number**> percent of reading for flow velocities between [**0.4 to 20 fps (0.12 to 6.1 m/s)**]<**Insert flow velocity range**>.
   e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: [**400 psig (2758 kPa)**]<**Insert value**>.
      2) Minimum Temperature Range:

         a) Chilled and Condenser Water Systems: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature range**>.
         b) Heating Water Systems: Within [**minus 20 to plus 280 deg F (minus 29 to plus 138 deg C)**]<**Insert temperature range**>.

   f. Pressure Drop: [**Less than 0.16 psig (1.1 kPa) at 8 fps (2.4 m/s) and decreasing at lower velocities**]<**Insert pressure drop**>.

9. Meter Construction:

   a. Installation Hardware: Include installation hardware necessary to enable insertion and removal from pipe without system shutdown.

      1) Isolation Valve: Full-port [**Type 316 stainless steel**]ball valve.

   b. Turbines:

1) Single turbines for pipe sizes **NPS 2 (DN 50)** and smaller.
2) Dual turbines for pipe sizes **NPS 2-1/2 (DN 65)** and larger.
3) Dual turbines for bidirectional flow applications.
4) Dual turbines with dual, contra-rotating turbine elements; each turbine element with its own rotational sensing system and an averaging circuit.
5) Materials: Polypropylene with sapphire jewel bearings and tungsten carbide shafts.

c. Wetted Metal Components: Type 316 stainless steel[**or bronze- and nickel-plated brass**], including installation hardware.
d. Enclosure:

1) Rating: NEMA 250, Type 4 enclosure; Type 6 for submersible applications.
2) Wiring Connections: Labeled terminal strip.
3) Conduit Connections: Suitable for mating to field-installed conduit.

10. Meter Cable: As required by manufacturer for field application.
11. Output Signals:

a. Frequency: Frequency output linear with flow rate. Meter has dual turbines, with individual top and bottom outputs for diagnostic purposes.
b. Digital, Scaled Pulse: Isolated solid-state dry contacts with a contact rating of 100 mA at 50 V with programmable contact duration.
c. Analog: Field programmable, 4 to 20 mA, zero to 5 V, or zero to 10 V.
d. Isolated Analog: Field programmable, 4 to 20 mA, zero to 5 V, or zero to 10 V.

12. Bluetooth Connectivity:

a. Version: 5.1 or later; low energy (BLE).
b. Mode: Single.
c. Connectivity Range: 50 ft.

13. Remote Display Unit:

a. Enclosure Rating: NEMA 250, Type 4 or 4X.
b. Wiring Connections: Labeled terminal strip.
c. Conduit Connections: **1/2-inch (16-mm)** trade size.
d. Remote Signal Interface:

1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero to 10 V dc.
2) Outputs linear to within 0.1 percent of calibrated span.
3) Serial Communication Interface: Compatible with host to share flow rate and totalized flow data.

e. Digital Display: Backlit, LCD display of flow rate and totalized flow.

1) At least eight display digits for totalization; local reset of flow totalization.
2) Bidirectional units with separate digital display for flow and totalization in each direction.
3) Bidirectional units with display of flow direction (contacts open or closed).

14. Memory: Store program and data in nonvolatile memory.
15. Power: 120 to 240 V ac; 50 to 60 Hz power supply with 24 V dc output to power the flow sensor.

E. In-Line Body Turbine Liquid Flow Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Badger Meter, Inc.**]
    b. [**ONICON Incorporated**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Badger Meter, Inc.**]
    b. [**ONICON Incorporated**]
    c. <**Insert manufacturer's name**>

3. Description: Turbine rotational sensing accomplished electronically by sensing electronic impedance change (non-magnetic and non-photoelectric).
4. Factory Calibration: Wet calibrate each meter to standards traceable to NIST. Tag each meter and provide each meter with a certificate of calibration.
5. Meter Size Range: **NPS 3/4 through NPS 1 (DN 20 through DN 25)**.
6. Performance:

    a. Ambient Temperature: **Minus 5 to plus 160 deg F** .
    b. Flow Accuracy:

        1) Within 2 percent of actual flow between flow range of **0.8 to 38 gpm (0.05 to 2.4 L/s)**.
        2) Within 0.5 percent of actual reading at calibrated velocity.

    c. Process Pressure and Temperature: Suitable for maximum system pressure and temperature.

        1) Minimum Pressure: **400 psig (2758 kPa)**.
        2) Minimum Temperature: **250 deg F (121 deg C)**.

    d. Pressure Drop: Not to exceed **0.48 psig (21 kPa at 2.4 L/s)** at maximum flow.

7. Construction:

    a. Sensor is to have an integral frequency output linear with flow rate.
    b. Body End Connections: Threaded union on each end.
    c. Turbine Materials: Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts.
    d. Wetted Metal Parts Material: Brass or stainless steel.
    e. Electronics Enclosure Rating: NEMA 250, Type 4; Type 6 for submersible applications.
    f. Enclosure with conduit connection(s) for field-installed conduit.
    g. Sensor cable of length sufficient to connect to display module.

8. Display Module:

    a. Remote from meter.
    b. Enclosure Rating: NEMA 250, Type 4 or 4X.
    c. Electrical Connections: Labeled terminal strip.
    d. Conduit Connections: Two, **1/2-inch (16-mm)** trade size.

e. Remote Interface:

1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero to 10 V dc.
2) Serial Communication Interface: Compatible with host to share flow rate and totalized flow data.
3) Outputs linear to within 0.1 percent of calibrated span.

f. Digital display of flow rate and totalized flow.
g. At least eight display digits for totalization.
h. Local reset of flow totalization.

9. Memory: Store program and data in nonvolatile memory.
10. Power: 120 to 240 V ac; 50 or 60 Hz power supply with 24 V dc output to power the flow sensor.

F. In-line Body Electromagnetic Liquid Flow Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Badger Meter, Inc.**]
c. [**ONICON Incorporated**]
d. [**Spirax Sarco Limited**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Badger Meter, Inc.**]
c. [**ONICON Incorporated**]
d. [**Spirax Sarco Limited**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all in-line body electromagnetic flow meters from a single manufacturer.
4. Description: In-line body flow meter using electromagnetic technology.

a. No moving parts.
b. Continuous auto-zero function.
c. Inherent bidirectional flow measurement.
d. Flow-measurement applications with [**three**]<**Insert number**> pipe diameters upstream and [**two**]<**Insert number**> pipe diameters downstream.

5. Factory Calibration: Wet calibrate each meter to standards traceable to NIST. Tag each meter and provide each meter with a certificate of calibration.
6. Meter Size Range: [**NPS 1 through NPS 48 (DN 25 through DN 1200)**]<**Insert pipe size range**>.
7. Performance:

a. Ambient Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert**

temperature range>.

b. Conductivity: Suitable for flow measurement of fluids with electrical conductivity greater than [**5**]<**Insert conductivity**> microseimens per centimeter.

c. Flow Velocity Range: [**0.1 to 33 fps (0.03 to 10.1 m/s)**]<**Insert flow velocity range**>.

d. Flow Accuracy: Within [**0.2**]<**Insert number**> percent of reading for flow velocities between [**1.6 to 33 fps (0.5 to 10.1 m/s)**]<**Insert flow velocity range**> and within [**0.0033 fps (0.001 m/s)**]<**Insert flow velocity**> of reading for flow velocities [**1.6 fps (0.5 m/s)**]<**Insert flow velocity**> and less.

e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Minimum Pressure: [**225 psig (1551 kPa)**][**580 psig (3999 kPa)**]<**Insert value**>.

2) Minimum Temperature Range: Within [**0 to 250 deg F (minus 18 to plus 121 deg C)**]<**Insert temperature range**>.

f. Pressure Drop: No permanent pressure drop.

8. Analog Output Current Signal:

a. Two-wire, 4 to 20 mA dc current source.

b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

c. Isolated.

9. Digital Output Signal: Two, programmable, digital/pulse outputs configurable for frequency, pulse, or directional flow.

10. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.

11. Operator Interface: Keypad with backlit digital display.

a. Multiple-line digital display of alphanumerical characters.

b. LED for normal and alarm operation.

12. Construction:

a. Body Material: [**Epoxy-coated carbon steel**][**or**][**Type 316 stainless steel**].

b. Body Liner Material: [**PTFE**]<**Insert material**>.

c. Flow Tube Material: Type 304 or 316 stainless steel.

d. Body End Connections: ASME B16.5, Class 150 or 300 as required by pressure and temperature.

e. Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.

f. Electronics Enclosure:

1) Location: [**Integral**][**or**][**remote**] from meter body.

2) Material: Painted aluminum.

3) Removable cover.

4) Rating: NEMA 250, Type 4, 4X, or 6.

13. Memory: Store program and data in nonvolatile memory.

G. Insertion Electromagnetic Liquid Flow Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. [**ONICON Incorporated**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. [**ONICON Incorporated**]
   c. [**Spirax Sarco Limited**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all insertion electromagnetic flow meters from a single manufacturer.
4. Description: Insertion-style flow meter using electromagnetic technology.

   a. No moving parts.
   b. Continuous auto-zero function.
   c. Transmitter integral to meter.

5. Factory Calibration: Wet calibrate each meter to standards traceable to NIST. Tag each meter and provide each meter with a certificate of calibration.
6. Meter Size Range: [**NPS 1-1/4 through NPS 72 (DN 32 through DN 1800)**]<**Insert pipe size range**>.
7. Process Pipe Connection: [**NPS 1 (DN 25)**]<**Insert pipe size**>.
8. Performance:

   a. Ambient Temperature: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature range**>.
   b. Conductivity: Suitable for flow measurement of fluids with electrical conductivity between [**20 to 60,000**]<**Insert conductivity range**> microseimens per centimeter.
   c. Flow Velocity Range: [**0.1 to 20 fps (0.03 to 6.1 m/s)**]<**Insert flow velocity range**>.
   d. Flow Accuracy: Within [**1**]<**Insert number**> percent of reading for flow velocities between [**2 to 20 fps (0.6 to 6.1 m/s)**]<**Insert flow velocity range**> and within [**0.02 fps (0.006 m/s)**]<**Insert flow velocity**> of reading for flow velocities [**2 fps (0.6 m/s)**]<**Insert flow velocity**> and less.
   e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: [**400 psig (2758 kPa)**]<**Insert value**>.
      2) Minimum Temperature Range: Within [**15 to 250 deg F (minus 9 to plus 121 deg C)**]<**Insert temperature range**>.

   f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

9. Output Signals:

   a. Field-selectable analog signals.

      1) Current Signal (Isolated): 4 to 20 mA.
      2) Voltage Signal (Isolated): Zero to [**5**][**10**] V dc.

   b. Digital Signal: Dry-contact closure signaling fault condition.
   c. Frequency Signal: Zero to 15 V peak pulse; zero to 500 Hz.

d. Scalable Pulse Output:

1) Isolated solid-state dry contact.
2) Contact Rating: [**100 mA at 50 V dc**]<**Insert contact rating**>.
3) Pulse Duration: [**0.5, 1, 2, or 6**]<**Insert duration**> seconds.

10. Construction:

a. Wetted Metal Parts: Type 316 stainless steel.
b. Sensor Head: [**XAREC**][**Polysulfone**]<**Insert material**>.
c. Process Connection: **1 inch (25 mm)**.
d. Instrument Isolation Valve: Full port Type 316 stainless steel ball valve for system isolation.
e. Electrodes: Type 316 stainless steel.
f. Electronics Enclosure:

1) Material: Painted aluminum.
2) Removable cover.
3) Rating: NEMA 250, Type 4.
4) Electrical Connections: PVC-jacketed cable, [**10 ft. (3 m)**]<**Insert length**> long.
5) Conduit Connections: **1/2-inch (16-mm)** trade size.

11. Display Module:

a. Location: Remote from meter.
b. Enclosure Rating: NEMA 250, Type 4X.
c. Wiring Connections: Labeled terminal strip.
d. Power: 24, 120, or 240 V ac; 50 or 60 Hz power supply, unless otherwise required by application, with 24 V dc output to power the flow sensor.
e. Input Signal from Meter: Zero to 15 V pulse output.
f. Output Signals: Additional output signals furnished with flow meter connected to display module terminal strip.
g. Auxiliary Output Signals:

1) Analog Current Output (Isolated): 4 to 20 mA.
2) Analog Voltage Output (Isolated): Zero to [**5**][**10**] V.
3) Digital output (isolated): Solid-state dry contacts rated for 100 mA at 50 V.

h. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
i. Digital Display: Flow rate and totalized flow with local reset of flow totalization.

1) At least six display digits for flow rate and eight display digits for totalization.
2) Bidirectional units with separate digital display for flow and totalization in each direction.
3) Bidirectional units with LED display of flow direction (contacts open or closed).

12. Memory: Store program and data in nonvolatile memory.

H. In-Line Body Thermal Mass Liquid Flow Meters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ONICON Incorporated**]
b. [**Spirax Sarco Limited**]

c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ONICON Incorporated**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all in-line body thermal mass flow meters from a single manufacturer.
4. Description:

   a. Application: Intended for flow measurement of natural gas, propane, and compressed air.
   b. Direct measurement of mass flow from a pair of encapsulated platinum sensors without need for additional pressure and temperature compensation.
   c. Program each meter using project-specific application data.
   d. Meter with integral diagnostics to verify installation conditions and proper operation.

5. Factory Calibration: Factory calibrate each meter at not less than [**five**]<**Insert number**> points across meter flow range against manufacturer's flow standards. Tag meter and provide a certificate of calibration.
6. Meter Size Range: [**NPS 1/2 through NPS 6 (DN 15 through DN 150)**]<**Insert pipe size range**>.
7. Performance:

   a. Ambient Temperature: [**Minus 40 to plus 150 deg F (Minus 40 to plus 66 deg C)**]<**Insert temperature range**>.
   b. Mass Flow Accuracy: Within [**1**]<**Insert number**> percent of reading for flow range of [**500 to 7000 sfpm (2.54 to 35.6 sm/s)**]<**Insert flow range**> and within [**2**]<**Insert number**> percent of reading for flow range of [**100 to 500 sfpm (0.51 to 2.54 sm/s)**]<**Insert flow range**>.
   c. Repeatability: Within [**0.1**]<**Insert number**> percent.
   d. Long-Term Stability: Within [**0.1**]<**Insert number**> percent per year.
   e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: [**200 psig (1379 kPa)**]<**Insert value**>.
      2) Minimum Temperature Range: Within [**minus 40 to plus 250 deg F (minus 40 to plus 121 deg C)**]<**Insert temperature range**>.

   f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

8. Output Signals:

   a. Analog Current Signal of Flow Rate:

      1) Two-wire, 4 to 20 mA dc current source.
      2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

   b. Digital Signal:

      1) Pulse Output for Flow Totalization: Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.

9. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
10. Operator Interface:

    a. Keypad with field programming of all parameters; local reset of flow totalization.
    b. Digital Display: Two-line digital display of alphanumerical characters; displaying flow rate, flow totalization, and temperature.

11. Construction:

    a. Enclosure:

        1) Material: Epoxy-painted cast aluminum.
        2) Removable screw-on cover.
        3) Mounting: [**Integral**][**or**][**remote**]
        4) Rating: NEMA 250, Type 4X.
        5) Electrical Connections: Labeled screw terminals.
        6) Conduit Connections: Two, **3/4-inch (21-mm)** trade size.

    b. Meter Body: In-line body for field installation in piping.
    c. Meter Body End Connections: ASME B16.5 flanges, Class 150.
    d. Meter Materials: Type 316L stainless steel.
    e. Flow Conditioner: Integral to meter body.
    f. Memory: Store program and data in nonvolatile memory.

12. Power: [**120 or 240 V ac; 50 or 60 Hz field power source with field-installed ac-to-dc power supply to convert alternating current source (V ac) to direct current source (V dc) to power the meter**]<**Insert power requirements**> unless otherwise required by application.

I. Vortex-Shedding Liquid Flow Meters with Integral Temperature Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong International, Inc**]
    b. [**ONICON Incorporated**]
    c. [**Spirax Sarco Limited**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong International, Inc**]
    b. [**ONICON Incorporated**]
    c. [**Spirax Sarco Limited**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters with integral temperature measurement from a single manufacturer.
4. Description:

    a. Flow measurement using vortex shedder body with integral 1000-ohm platinum RTD.
    b. Program each meter using project-specific application data.
    c. Meter with integral diagnostics to verify installation conditions and proper operation.

5. Factory Calibration: Factory calibrate each meter at not less than [**five**]<**Insert number**> points across meter flow range against manufacturer's flow standards. Tag meter and provide a certificate of calibration.
6. Meter Size Range: [**NPS 1/2 through NPS 8 (DN 15 through DN 200)**]<**Insert pipe size range**>.
7. Performance:

    a. Ambient Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
    b. Volumetric Flow Accuracy: Within [**0.7**]<**Insert number**> percent of reading for Reynolds numbers [**10,000**]<**Insert value**> and larger.
    c. Repeatability: Within [**0.2**]<**Insert number**> percent.
    d. Long-Term Stability: Within [**0.2**]<**Insert number**> percent per year.
    e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

        1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
        2) Minimum Temperature Range: Within [**minus 330 to plus 500 deg F (minus 201 to plus 260 deg C)**]<**Insert temperature range**>.

    f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

8. Output Signals:

    a. Analog Current Signal of Flow Rate:

        1) Two-wire, 4 to 20 mA dc current source.
        2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

    b. Analog Current Signals for Temperature: 4 to 20 mA.
    c. Digital Signal:

        1) Pulse Output for Flow Totalization: Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.

9. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
10. Operator Interface:

    a. Keypad with field programming of all parameters; local reset of flow totalization.
    b. Digital Display: Two-line digital display of alphanumerical characters; displaying flow rate, flow totalization.

11. Construction:

    a. Enclosure:

        1) Material: Epoxy-painted cast aluminum.
        2) Removable screw-on cover.
        3) Mounting: Integral to meter.
        4) Rating: NEMA 250, Type 4X.
        5) Electrical Connections: Labeled screw terminals.
        6) Conduit Connection: Two, **1/2-inch (16-mm)** trade size.

    b. Meter End Connections: ASME B16.5 flanges; class required by performance.
    c. Meter Material: Type 316L stainless steel.

d. Memory: Store program and data in nonvolatile memory.

12. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.
13. Upstream Flow Straightener:

    a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
    b. Material: Type 316 stainless steel.
    c. Size: Match meter.
    d. Type: Flanged, or wafer designed for installation between field-installed flanges.

J. Vortex-Shedding Liquid Flow Meters with Integral Pressure and Temperature Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong International, Inc**]
    b. [**Badger Meter, Inc.**]
    c. [**ONICON Incorporated**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong International, Inc**]
    b. [**Badger Meter, Inc.**]
    c. [**ONICON Incorporated**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters with integral pressure and temperature measurements from a single manufacturer.
4. Description:

    a. Mass flow measurement corrected for density using vortex shedder body with integral piezoelectric pressure sensors and 1000-ohm platinum RTD.
    b. Program each meter using project-specific application data.
    c. Meter with integral diagnostics to verify installation conditions and proper operation.

5. Factory Calibration: Factory calibrate each meter at not less than [**five**]<**Insert number**> points across meter flow range against the manufacturer's flow standards. Tag meter and provide a certificate of calibration.
6. Meter Size Range: [**NPS 1/2 through NPS 8 (DN 15 through DN 200)**]<**Insert pipe size range**>.
7. Performance:

    a. Ambient Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
    b. Volumetric Flow Accuracy: Within [**0.7**]<**Insert number**> percent of reading for Reynolds numbers [**10,000**]<**Insert value**> and larger.
    c. Repeatability: Within [**0.2**]<**Insert number**> percent.
    d. Long-Term Stability: Within [**0.2**]<**Insert number**> percent per year.
    e. Process Pressure and Temperature: Suitable for system maximum operating pressure and

temperature.

1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
2) Minimum Temperature Range: Within [**minus 330 to plus 500 deg F (minus 201 to plus 260 deg C)**]<**Insert temperature range**>.

f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

8. Output Signals:

a. Analog Current Signal of Flow Rate:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

b. Analog Current Signals for Pressure and Temperature: Separate 4 to 20 mA signals for gage pressure and temperature.
c. Digital Signal:

1) Pulse Output for Flow Totalization: Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.

9. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
10. Operator Interface:

a. Keypad with field programming of all parameters; local reset of flow totalization.
b. Digital Display: Two-line digital display of alphanumerical characters; displaying flow rate, flow totalization, pressure, and temperature.

11. Meter Construction:

a. Enclosure:

1) Material: Epoxy-painted cast aluminum.
2) Removable screw-on cover.
3) Mounting: [**Integral**][**or**][**remote**].
4) Rating: NEMA 250, Type 4X.
5) Electrical Connection: Labeled screw terminals.
6) Conduit Connection: Two, **1/2-inch (16-mm)** trade size.

b. Meter End Connections: ASME B16.5 flanges; class required by performance.
c. Meter Material: Type 316L stainless steel.
d. Memory: Store program and data in nonvolatile memory.

12. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.
13. Upstream Flow Straightener:

a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
b. Material: Type 316 stainless steel.
c. Size: Match meter.
d. Type: Flanged, or wafer designed for installation between field-installed flanges.

K. Vortex-Shedding Liquid Flow Meters for Hazardous Environments:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters for hazardous environments from a single manufacturer.
4. Standard: ASME MFC-6.
5. Description:

   a. FM Approved for hazardous environments.

      1) Intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II and III, Division 1, Groups E, F, and G.
      2) Explosion proof for Class I, Division 1, Groups B, C, and D.
      3) Dust ignition proof for Class II and III, Division 1, Groups E, F, and G.

   b. Sensor isolated from process and replaceable without breaking process seals.
   c. Clog-free design eliminates gaskets and ports.
   d. Each meter furnished with a permanently attached stainless steel tag.
   e. Meter with integral diagnostics to verify proper operation.

6. Factory Calibration: Factory calibrate each meter and provide with a certificate of calibration.
7. Meter Size Range: [**NPS 1/2 through NPS 12 (DN 15 through DN 300)**]<**Insert pipe size range**>.
8. Performance:

   a. Ambient Temperature: [**Minus 4 to plus 185 deg F (Minus 20 to plus 85 deg C)**]<**Insert temperature range**>.
   b. Ambient Humidity: Zero to 95 percent noncondensing.
   c. Flow Accuracy: Within [**0.65**]<**Insert number**> percent of reading plus 0.025 percent of span for Reynolds numbers 20000 and larger.
   d. Repeatability: Within [**0.1**]<**Insert number**> percent of flow rate.
   e. Long-Term Stability: Within [**0.1**]<**Insert number**> percent of flow rate per year.
   f. Response Time: Greater of three vortex-shedding cycles or [**0.2**]<**Insert value**> seconds.
   g. Dampening: Adjustable between [**0.2 to 255**]<**Insert value**> seconds.
   h. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
      2) Minimum Temperature Range: Within [**minus 40 to plus 450 deg F (minus 40 to plus 232 deg C)**]<**Insert temperature range**>.

i. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.
j. Vibration: Meter immune to vibration.

9. Output Signals:

a. Analog Current Signal of Flow Rate:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

b. Digital Signal:

1) Pulse output for flow totalization.
2) HART protocol.

10. Digital Display: Digital display of alphanumerical characters; displaying flow rate, flow totalization, percent of range, and current output.
11. Body and Flanges:

a. Material: Type 316L stainless steel.
b. Connections: ASME B16.5, class required by performance.

12. Enclosure:

a. Materials: Polyurethane-painted cast aluminum.
b. Removable screw-on cover.
c. Rating: NEMA 250, Type 4X.
d. Electrical Connections: Labeled screw terminals.
e. Conduit Connections: **1/2-inch (16-mm)** trade size.

13. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.
14. Upstream Flow Straightener:

a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
b. Material: Type 316 stainless steel
c. Size: Match meter.
d. Type: Flanged, or wafer designed for installation between field-installed flanges.

L. Compact In-Line Body Ultrasonic Liquid Flow Sensor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Dwyer Instruments, Inc**]
c. [**ONICON Incorporated**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Dwyer Instruments, Inc**]
c. [**ONICON Incorporated**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all compact in-line body ultrasonic flow sensors from a single manufacturer.
4. Description:

a. Flow Sensing Method: No moving parts; direct beam path wetted ultrasonic sensors utilizing differential transit time velocity measurement.
b. Programming:

1) Configure and program each meter at factory for specific application without need for field programming. Field programming is to be available through user interface or serial interface using an operator workstation.
2) Store program parameters and totalized values in nonvolatile memory.

c. Battery: Back-up real-time clock and calendar with lithium battery.
d. Approvals: BTL certified to ASHRAE 135.

5. Factory Calibration: Factory calibrate each meter against manufacturer's NIST-traceable flow standards and provide a certificate of calibration for each meter.
6. Meter Size Range: [**NPS 1/2 through NPS 2-1/2 (DN 13 through DN 65)**]<**Insert pipe size range**>.
7. Performance:

a. Ambient Temperature: [**Minus 10 to plus 130 deg F (Minus 23 to plus 54 deg C)**]<**Insert value**>.
b. Ambient Humidity: 5 to 90 percent relative humidity, noncondensing.
c. Flow accuracy of 1 percent for flow range:

1) NPS 1/2 (DN 13): [**0.6 to 15 gpm (0.038 to 0.95 L/s)**]<**Insert flow range**>.
2) NPS 3/4 (DN 20): [**0.6 and 15 gpm (0.038 and 0.95 L/s)**]<**Insert flow range**>.
3) NPS 1 (DN 25): [**1 to 25 gpm (0.063 to 1.58 L/s)**]<**Insert flow range**>.
4) NPS 1-1/4 (DN 32): [**3 to 60 gpm (0.189 to 3.78 L/s)**]<**Insert flow range**>.
5) NPS 1-1/2 (DN 40): [**5 to 100 gpm (0.315 to 6.31 L/s)**]<**Insert flow range**>.
6) NPS 2 (DN 50): [**8 to 150 gpm (0.505 to 9.46 L/s)**]<**Insert flow range**>.
7) NPS 2-1/2 (DN 65): [**12 to 225 gpm (0.757 to 14.19 L/s)**]<**Insert flow range**>.

d. Flow accuracy of 2 percent for flow range:

1) NPS 1/2 (DN 13): [**0.15 and 0.6 gpm (0.0009 and 0.038 L/s)**]<**Insert flow range**>.
2) NPS 3/4 (DN 20): [**0.15 and 0.6 gpm (0.009 and 0.038 L/s)**]<**Insert flow range**>.
3) NPS 1 (DN 25): [**0.25 and 1.0 gpm (0.016 and 0.063 L/s)**]<**Insert flow range**>.
4) NPS 1-1/4 (DN 32): [**0.6 and 3.0 gpm (0.038 and 0.189 L/s)**]<**Insert flow range**>.
5) NPS 1-1/2 (DN 40): [**1.0 and 5.0 gpm (0.063 and 0.315 L/s)**]<**Insert flow range**>.
6) NPS 2 (DN 50): [**1.5 and 8.0 gpm (0.095 and 0.505 L/s)**]<**Insert flow range**>.
7) NPS 2-1/2 (DN 65): [**2.5 and 12 gpm (0.158 and 0.758 L/s)**]<**Insert flow range**>.

e. Minimum Flow Rate:

1) NPS 1/2 (DN 13): [**0.03 gpm (0.002 L/s)**]<**Insert value**>.
2) NPS 3/4 (DN 20): [**0.03 gpm (0.002 L/s)**]<**Insert value**>.
3) NPS 1 (DN 25): [**0.05 gpm (0.003 L/s)**]<**Insert value**>.
4) NPS 1-1/4 (DN 32): [**0.12 gpm (0.008 L/s)**]<**Insert value**>.

5) NPS 1-1/2 (DN 40): [**0.20 gpm (0.013 L/s)**]<**Insert value**>.
6) NPS 2 (DN 50): [**0.30 gpm (0.019 L/s)**]<**Insert value**>.
7) NPS 2-1/2 (DN 65): [**0.50 gpm (0.032 L/s)**]<**Insert value**>.

f. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

1) Minimum Pressure: [**400 psig (2758 kPa)**]<**Insert value**>.
2) Minimum Temperature Range: [**32 to 250 deg F (0 to 121 deg C)**]<**Insert temperature range**>.

g. Pressure Drop: [**1.5 psig (10 kPa)**]<**Insert value**> or less at following flow rate:

1) NPS 1/2 (DN 13): [**6.6 gpm (0.42 L/s)**]<**Insert value**>.
2) NPS 3/4 (DN 20): [**6.6 gpm (0.42 L/s)**]<**Insert value**>.
3) NPS 1 (DN 25): [**11 gpm (0.69 L/s)**]<**Insert value**>.
4) NPS 1-1/4 (DN 32): [**26 gpm (1.64 L/s)**]<**Insert value**>.
5) NPS 1-1/2 (DN 40): [**44 gpm (2.78 L/s)**]<**Insert value**>.
6) NPS 2 (DN 50): [**66 gpm (4.16 L/s)**]<**Insert value**>.
7) NPS 2-1/2 (DN 65): [**110 gpm (6.94 L/s)**]<**Insert value**>.

8. Network Connection:

a. TIA RS-485 serial interface.
b. ASHRAE 135, native BACnet MS/TP protocol.
c. Communicates flow rate, interval data and network status.

9. Input Signals:

a. Three isolated totalizing pulse inputs for use with sinking open collector or dry contacts.
b. Rating: 30 V dc, 10 mA maximum.
c. Pulse duration of 50 ms.
d. Totals accumulated at meter, displayed locally and remotely through network connection.

10. Analog Output Signal: 4 to 20 mA flow rate signal.
11. Digital Output Signals:

a. Indicating: Volume or alarm.
b. Rating: 30 V dc, 50 mA.
c. Pulse Duration: [**50**][**100**][**500**][**1000**] ms.

12. Display:

a. Integral to meter and detachable for remote field mounting.
b. Backlight alphanumeric display and operator interface.
c. Same information communicated to network available on display.

13. Meter:

a. Enclosure:

1) Polycarbonate with removable screw-on cover.
2) Rating: IEC 60529 IP65 or NEMA 250, Type 4.
3) Electrical Connections: Labeled screw terminals.
4) Conduit Connections: Two; trade size.

b. End Connections:

1) Sizes through NPS 2 (DN 50): Threaded, MNPT.
2) NPS 2-1/2 (DN 65): Flange face for mating to ASME B16.5, Class 150 raised face flange.

c. Wetted Materials: Lead-free brass, containing not more than 15 percent zinc (DZR and corrosion resistant), and PEEK.

14. Power Supply:

a. Field Power: 24 V ac; 50 or 60 Hz unless otherwise required by application.

M. Clamp-On Ultrasonic Liquid Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Badger Meter, Inc.**]
c. [**Dwyer Instruments, Inc**]
d. [**ONICON Incorporated**]
e. [**Spirax Sarco Limited**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Badger Meter, Inc.**]
c. [**Dwyer Instruments, Inc**]
d. [**ONICON Incorporated**]
e. [**Spirax Sarco Limited**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all clamp-on ultrasonic flow sensors from a single manufacturer.
4. Description:

a. Flow-Sensing Method: Non-invasive with no moving parts; ultrasonic differential transit time velocity measurement using nonwetted transducers. Method is suitable for use with clear fluids in pressurized metallic and nonmetallic pipes that are full.
b. Programming:

1) Configure and program each meter at factory for specific application without need for field programming. Field programming is available through user interface or serial interface using an operator workstation.
2) Store program parameters and totalized values in nonvolatile memory.

c. Battery: Back-up real-time clock and calendar with lithium battery.
d. Data Logger: Integral data log with minimum [**128**]<**Insert value**> megabytes of storage.

5. Factory Calibration: Factory calibrate each meter against manufacturer's NIST-traceable flow standards and provide a certificate of calibration for each meter

6. Performance:

    a. Ambient Humidity: 5 to 90 percent relative humidity, noncondensing.
    b. Ambient Operating Temperature: [**Minus 5 to plus 140 deg F (Minus 21 to plus 60 deg C)**]<**Insert temperature range**>.
    c. Flow Sensor Accuracy:

        1) Accuracy for Velocities between [**1 and 20 fps (0.3 to 6.1 m/s)**]<**Insert velocity range**>: Within [**1**]<**Insert number**> percent of reading.
        2) Accuracy for Velocities Less than [**1 fps (0.3 m/s)**]<**Insert velocity**>: Within [**0.01 fps (0.003 m/s)**]<**Insert velocity**>.

    d. Flow Sensor Pressure Drop: No permanent pressure drop.
    e. Flow Sensor Velocity Range: [**0.07 to 40 fps (0.02 to 12.2 m/s)**]<**Insert flow velocity range**>.
    f. Process Pipe Sizes: [**NPS 1/2 (DN 13)**]<**Insert pipe size**> through [**NPS 48 (DN 1200)**]<**Insert pipe size**>.
    g. Process Temperature: Suitable for system maximum operating temperature.

7. Meter Display and Operator Interface: Backlit, LCD alphanumeric display of the following on face of meter enclosure:

    a. Flow rate.
    b. Power status (on/off).

8. Meter Enclosure:

    a. Remote mounted from temperature and flow sensors.
    b. Rating: IEC 60529 IP67 or NEMA 250, Type 4X.
    c. Construction: Polycarbonate with hinged cover.
    d. Electrical and Control Cable Connections: Labeled screw terminals.
    e. Conduit Connections: Manufacturer standard; trade size suitable for mating to field-installed conduit.

9. Input Signals:

    a. Three isolated totalizing pulse inputs for use with sinking open collector or dry contacts.
    b. Rating: 30 V dc, 10 mA maximum.
    c. Pulse duration of 50 ms.
    d. For use in totalizing pulses from external devices.
    e. Totals accumulated at meter, displayed locally and remotely through network connection.

10. Output Signals:

    a. Flow Rate: 4 to 20 mA or zero to 10 V dc.

11. Serial Network Interface:

    a. TIA RS-485 serial interface for remoted monitoring.
    b. ASHRAE 135, native BACnet MS/TP protocol.
    c. Communicate energy consumption and rate, flow rate, supply and return temperature, peak and average values, interval data, and network status.

12. Power Supply:

a. Field Power: 24, 120, or 240 V ac; 50 or 60 Hz as required by the application.
b. Internal Power: As required by flow meter.

13. Transducers:

a. Housing: Type 316 stainless steel; NEMA 250, Type 4 with trade-size conduit connections.
b. Mounting Kit: Type 304 or 316 stainless steel brackets and miscellaneous hardware; option to use 200 series stainless steel clamps.
c. Sensor Cable: As required by manufacturer for application.

2.7 STEAM FLOW METERS

A. General Requirements for Steam Flow Meters:

1. Adjustable for changes in system operational parameters.
2. Steam Sensors, Meters, and Transmitters: Extended range of [**10**][**20**]<**Insert number**> percent above Project design flow and [**10**][**20**]<**Insert number**> percent below Project minimum flow to signal abnormal flow conditions.
3. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
4. Product certificates are required.

B. Vortex-Shedding Steam Flow Meters with Integral Temperature Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**ONICON Incorporated**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**ONICON Incorporated**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters with integral temperature measurement from a single manufacturer.
4. Description:

a. Flow measurement using vortex-shedder body with integral 1000-ohm platinum RTD.
b. Program each meter using project-specific application data.
c. Meter with integral diagnostics to verify installation conditions and proper operation.

5. Factory Calibration: Factory calibrate each meter at not less than [**five**]<**Insert number**> points across meter flow range against manufacturer's flow standards. Tag meter and provide a certificate of calibration.
6. Meter Size Range: [**NPS 1/2 through NPS 8 (DN 15 through DN 200)**]<**Insert pipe size**

range>.

7. Performance:

    a. Ambient Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
    b. Mass Flow Accuracy: Within [**1.5**]<**Insert number**> percent of reading for Reynolds numbers [**10,000**]<**Insert value**> and larger.
    c. Repeatability: Within [**0.2**]<**Insert number**> percent.
    d. Long-Term Stability: Within [**0.2**]<**Insert number**> percent per year.
    e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

        1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
        2) Minimum Temperature Range: Within [**minus 330 to plus 500 deg F (minus 201 to plus 260 deg C)**]<**Insert temperature range**>.

    f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

8. Output Signals:

    a. Analog Current Signal of Flow Rate:

        1) Two-wire, 4 to 20 mA dc current source.
        2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

    b. Analog Current Signals for Temperature: 4 to 20 mA.
    c. Digital Signal:

        1) Pulse Output for Flow Totalization: Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.

9. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
10. Operator Interface:

    a. Keypad with field programming of all parameters; local reset of flow totalization.
    b. Digital Display: Two-line digital display of alphanumerical characters, displaying flow rate and flow totalization.

11. Construction:

    a. Enclosure:

        1) Material: Epoxy-painted cast aluminum.
        2) Removable screw-on cover.
        3) Mounting: Integral to meter.
        4) Rating: NEMA 250, Type 4X.
        5) Electrical Connections: Labeled screw terminals.
        6) Conduit Connection: Two, **1/2-inch (16-mm)** trade size.

    b. Meter End Connections: ASME B16.5 flanges; class required by performance.
    c. Meter Material: Type 316L stainless steel.
    d. Memory: Store program and data in nonvolatile memory.

12. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.

13. Upstream Flow Straightener:

    a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
    b. Material: Type 316 stainless steel.
    c. Size: Match meter.
    d. Type: Flanged or wafer designed for installation between field-installed flanges.

C. Vortex-Shedding Steam Flow Meters with Integral Pressure and Temperature Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong International, Inc**]
    b. [**ONICON Incorporated**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong International, Inc**]
    b. [**ONICON Incorporated**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters with integral pressure and temperature measurements from a single manufacturer.
4. Description:

    a. Mass flow measurement corrected for density using vortex-shedder body with integral piezoelectric pressure sensors and 1000-ohm platinum RTD.
    b. Program each meter using project-specific application data.
    c. Meter with integral diagnostics to verify installation conditions and proper operation.

5. Factory Calibration: Factory calibrate each meter at not less than [**five**]<**Insert number**> points across meter flow range against the manufacturer's flow standards. Tag meter and provide a certificate of calibration.
6. Meter Size Range: [**NPS 1/2 through NPS 8 (DN 15 through DN 200)**]<**Insert pipe size range**>.
7. Performance:

    a. Ambient Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
    b. Mass Flow Accuracy: Within [**1.5**]<**Insert number**> percent of reading for Reynolds numbers [**10,000**]<**Insert value**> and larger.
    c. Repeatability: Within [**0.2**]<**Insert number**> percent.
    d. Long-Term Stability: Within [**0.2**]<**Insert number**> percent per year.
    e. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

        1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
        2) Minimum Temperature Range: Within [**minus 330 to plus 500 deg F (minus 201 to plus 260 deg C)**]<**Insert temperature range**>.

f. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.

8. Output Signals:

a. Analog Current Signal of Flow Rate:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

b. Analog Current Signals for Pressure and Temperature: Separate 4 to 20 mA signals for gage pressure and temperature.
c. Digital Signal:

1) Pulse Output for Flow Totalization: Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.

9. Serial Communication: RS-485, two wire; [**BACnet**][**or**][**Modbus RTU**] protocol.
10. Operator Interface:

a. Keypad with field programming of all parameters; local reset of flow totalization.
b. Digital Display: Two-line digital display of alphanumerical characters, displaying flow rate, flow totalization, pressure, and temperature.

11. Meter Construction:

a. Enclosure:

1) Material: Epoxy-painted cast aluminum.
2) Removable screw-on cover.
3) Mounting: [**Integral**][**or**][**remote**].
4) Rating: NEMA 250, Type 4X.
5) Electrical Connection: Labeled screw terminals.
6) Conduit Connection: Two, **1/2-inch** **(16-mm)** trade size.

b. Meter End Connections: ASME B16.5 flanges; class required by performance.
c. Meter Material: Type 316L stainless steel.
d. Memory: Store program and data in nonvolatile memory.

12. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.
13. Upstream Flow Straightener:

a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
b. Material: Type 316 stainless steel.
c. Size: Match meter.
d. Type: Flanged or wafer designed for installation between field-installed flanges.

D. Vortex-Shedding Steam Flow Meters for Hazardous Environments:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. [**Spirax Sarco Limited**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all vortex-shedding flow meters for hazardous environments from a single manufacturer.
4. Standard: ASME MFC-6.
5. Description:

   a. FM Approved for hazardous environments.

      1) Intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II and III, Division 1, Groups E, F, and G.
      2) Explosion proof for Class I, Division 1, Groups B, C, and D.
      3) Dust ignition proof for Class II and III, Division 1, Groups E, F, and G.

   b. Sensor isolated from process and replaceable without breaking process seals.
   c. Clog-free design eliminates gaskets and ports.
   d. Each meter furnished with a permanently attached stainless steel tag.
   e. Meter with integral diagnostics to verify proper operation.

6. Factory Calibration: Factory calibrate each meter and provide with a certificate of calibration.
7. Meter Size Range: [**NPS 1/2 through NPS 12 (DN 15 through DN 300)**]<**Insert pipe size range**>.
8. Performance:

   a. Ambient Temperature: [**Minus 4 to plus 185 deg F (Minus 20 to plus 85 deg C)**]<**Insert temperature range**>.
   b. Ambient Humidity: Zero to 95 percent noncondensing.
   c. Flow Accuracy: Within [**0.65**]<**Insert number**> percent of reading plus 0.025 percent of span for Reynolds numbers 20000 and larger.
   d. Repeatability: Within [**0.1**]<**Insert number**> percent of flow rate.
   e. Long-Term Stability: Within [**0.1**]<**Insert number**> percent of flow rate per year.
   f. Response Time: Greater of three vortex-shedding cycles or [**0.2**]<**Insert value**> seconds.
   g. Dampening: Adjustable between [**0.2 to 255**]<**Insert value**> seconds.
   h. Process Pressure and Temperature: Suitable for system maximum operating pressure and temperature.

      1) Minimum Pressure: [**200 psig (1379 kPa)**][**400 psig (2758 kPa)**]<**Insert value**>.
      2) Minimum Temperature Range: Within [**minus 40 to plus 450 deg F (minus 40 to plus 232 deg C)**]<**Insert temperature range**>.

   i. Pressure Drop: [**See Drawings**]<**Insert pressure drop**>.
   j. Vibration: Meter immune to vibration.

9. Output Signals:

   a. Analog Current Signal of Flow Rate:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

b. Digital Signal:

1) Pulse output for flow totalization.
2) HART protocol.

10. Digital Display: Digital display of alphanumerical characters, displaying flow rate, flow totalization, percentage of range, and current output.
11. Body and Flanges:

a. Material: Type 316L stainless steel.
b. Connections: ASME B16.5, class required by performance.

12. Enclosure:

a. Materials: Polyurethane-painted cast aluminum.
b. Removable screw-on cover.
c. Rating: NEMA 250, Type 4X.
d. Electrical Connections: Labeled screw terminals.
e. Conduit Connections: **1/2-inch** **(16-mm)** trade size.

13. Power: [**120 or 240 V ac; 50 or 60 Hz**]<**Insert power requirements**> unless otherwise required by application.
14. Upstream Flow Straightener:

a. Application: Include meter with flow straightener where required by meter manufacturer for specific installation.
b. Material: Type 316 stainless steel.
c. Size: Match meter.
d. Type: Flanged or wafer designed for installation between field-installed flanges.

2.8 LIQUID FLOW SENSORS (PRIMARY ELEMENTS)

A. Averaging Pitot-Tube Liquid Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]

d. **<Insert manufacturer's name>**

3. Source Limitations: Obtain all averaging pitot-tube liquid flow sensors from a single manufacturer.
4. Standard: ASME MFC-12M.
5. Description:

   a. Sensor cross-sectional shape to provide a flow separation at a fixed point independent of flow rate, pressure, or temperature with a stable flow coefficient maintained over a wide range of Reynolds numbers.
   b. Sensor shape to promote less-turbulent zones on backside of sensor. Locate individual sensing ports in less-turbulent region to measure low pressure. Number of sensing ports is a function of pipe size.
   c. Sensor high pressure measured by a frontal slot extending full length of sensor or a comparable design. Number of slots is a function of pipe size.
   d. Manufacturer to submit on request independent testing documentation (product test reports), demonstrating compliance with specified performance.
   e. Include sensor with flow signal isolation valves and connections that are suitable for connecting to a remote transmitter.

6. Performance:[**Product test reports are required.**]

   a. Accuracy: Within [**0.75**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.
   b. Discharge Coefficient Factor: Within [**0.75**]<**Insert number**> percent of flow rate.
   c. Repeatability: Within [**0.1**]<**Insert number**> percent.
   d. Flow Range: [**10**][**17**]<**Insert value**> to 1 turndown.
   e. Pressure and Temperature: Suitable for system pressure and temperature.
   f. Pressure Drop: Up to [**3**]<**Insert number**> percent of full flow range pressure differential signal.
   g. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
   h. Size Range: [**NPS 2 through NPS 48 (DN 50 through DN 1200)**]<**Insert pipe size range**>.

7. Construction:

   a. Sensor Surface Finish: Front surface textured for high-Reynolds-number applications if required to create a more turbulent boundary layer on front surface of sensor and produce a more predictable and repeatable separation of flow at edge of sensor.
   b. Sensor Material: Type 316 stainless steel.
   c. Packing Gland:

      1) Wetted Parts: Type 316 stainless steel.
      2) Packing Material: Graphite.

   d. Isolation Valve: Type 316 stainless steel full port ball valve configured to remove sensor while isolating process.
   e. Flanged In-line Pipe Spool:

      1) Factory mount sensor in a flanged section of pipe.
      2) Pipe material to match adjacent pipe.
      3) Flanges to match adjacent pipe.

   f. Flow Signal Connections: **NPS 1/2 (DN 15)** NPT with Type 316 stainless steel needle valves.

g. Identification: Attach tag to each averaging pitot-tube sensor with a chain and label indicating pipe size, sensor series, sensor reading at flow rate, and pressure differential.

8. Factory Calibration: Factory calibrate each averaging pitot-tube sensor specific to application.
9. Flow Signal: Mate averaging pitot-tube sensor in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

B. Venturi Liquid Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**HCI; Hydronics Components Inc.**]
   c. [**Preso Meters; Badger Meter Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**HCI; Hydronics Components Inc.**]
   c. [**Preso Meters; Badger Meter Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all venturi liquid flow sensors from a single manufacturer.
4. On request, submit independent testing documentation (product test reports), demonstrating compliance with specified performance.
5. Standard: ASME MFC-3M.
6. Performance:

   a. Accuracy: Within [**0.25**][**0.5**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

      1) Accuracy with [**five**]<**Insert number**> pipe diameters of straight pipe upstream and [**two**]<**Insert number**> pipe diameters downstream.

   b. Repeatability: Within [**0.1**][**0.2**]<**Insert number**> percent over the flow range.
   c. Beta Ratio: Select between 0.30 and 0.75 to achieve performance indicated. Match venturi with transmitter to provide performance of entire assembly.
   d. Flow Range: [**10**]<**Insert value**> to 1 turndown.
   e. Pressure and Temperature: Suitable for system pressure and temperature.
   f. Pressure Drop: Up to [**6**][**20**]<**Insert number**> percent of full flow range pressure differential signal.
   g. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
   h. Size Range: [**NPS 1/2 through NPS 48 (DN 15 through DN 1200)**]<**Insert pipe size range**>.

7. Construction:

a. Body End Connections: Flanged[**or threaded (NPT) for sizes NPS 1/2 through NPS 2 (DN 15 through DN 50)**].

1) Flanges: Suitable for mating to ASME B16.5 Class 150 or 300 pipe flanges as required by system pressure; [**welding neck**][**raised faces**]; material to match body.

b. Body Length: Length determined by manufacturer to comply with performance indicated.
c. Body Material: [**Carbon steel**][**or**] Type 316 or 316L stainless steel with inside diameter to match adjacent pipe.

1) Optional Materials: Option to use one-piece bronze or brass construction with threaded FNPT end connections for pipe sizes **NPS 1/2 through NPS 2 (DN 15 to DN 50)**.

d. Throat Material: Type 316 stainless steel.
e. Flow Signal Connections: Two accurately located built-in sensing taps, nipples, and shut-off valves for field connection to transmitter; minimum size **NPS 1/2 (DN 15)** NPT.
f. Identification: Attach tag to each venturi with a chain and label indicating pipe size, venturi series, station identification, and reading at flow rate and pressure differential.

8. Factory Calibration: Factory calibrate each venturi specific to application.
9. Flow Signal: Mate venturi in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

C. Orifice Plate Liquid Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all orifice plates from a single manufacturer.
4. Description: Concentric with sharp, square-edge orifice plate with handle and adjoining matching companion flanges[**factory installed in a meter run**].
5. Standards: ASME MFC-3M or ASME MFC-14M.
6. Performance:

a. Accuracy: Within [**1**][**2**][**5**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

1) Accuracy with [**10**]<**Insert number**> pipe diameters of straight pipe upstream and [**5**]<**Insert number**> pipe diameters downstream.

b. Repeatability: Within [**0.2**]<**Insert number**> percent over flow range.
c. Flow Range: [**5**][**10**]<**Insert value**> to 1 turndown.
d. Pressure and Temperature: Suitable for system pressure and temperature.
e. Pressure Drop: See Drawings.
f. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
g. Beta Ratio: Select ratio of orifice diameter to actual internal pipe diameter d/B (beta) between 0.30 and 0.70.
h. Size Range: [**NPS 1/2 through NPS 24 (DN 15 through DN 600)**]<**Insert pipe size range**>.

7. Construction:

a. End Connections: Matching companion flanges suitable for mating to ASME B16.5, Class 150 or 300 pipe flanges as required by system pressure. [**Flanges with welding neck**][**Flanges with welding neck and raised faces**].
b. Material: Fabricate orifice plate and matching companion flanges of Type 316 stainless steel [**or**]<**Insert material**>.
c. Flow Signal Connections: **NPS 1/2 (DN 15)** NPT.
d. Identification: Stamp orifice plates with number and orifice bore on handle of orifice plate.

8. Calibration: Include information and calculations for each orifice plate, showing compliance with ASME MFC-3M or ASME MFC-14M.
9. Flow Signal: Mate orifice plate assembly in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

D. Segmented-Wedge Liquid Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all segmented-wedge liquid flow sensors from a single manufacturer.
4. Description: Pressure differential design using a segmented or segmental wedge installed in a straight section of pipe. Design sensors for solids and particulates to be swept through the opening and for measurements with Reynolds Numbers down to 500 as a minimum.
5. Performance:[**Product test reports are required.**]

a. Accuracy: Within 0.5 percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

1) Accuracy with 10 pipe diameters of straight pipe upstream and five pipe diameters downstream.

b. Repeatability: Within 0.2 percent over flow range.
c. Flow Range: 10 to 1 turndown.
d. Discharge Coefficient: Linear and stable throughout flow range.
e. Manufacturer to determine H/ID ratios to meet specified performance.
f. Pressure and Temperature: Suitable for system pressure and temperature.
g. Bidirectional Flow: Where required by application, sensor suitable for bidirectional flow measurement with no degradation of performance, with flow in either direction.
h. Size Range: [**NPS 1/2 through NPS 16 (DN 15 through DN 400)**]<**Insert pipe size range**>.

6. Construction:

a. Body End Connections: Flanged[**or threaded (MNPT) for sizes NPS 1/2 through NPS 2 (DN 15 through DN 50)**].

1) Flanges: Suitable for mating to ASME B16.5, Class 150 or 300 pipe flanges as required by system pressure; [**welding neck**][**raised faces**]; material to match body.

b. Body Material: [**Carbon steel**][**Type 304 stainless steel**][**or**] Type 316 or 316L stainless steel with ID to match adjacent pipe. Length is determined by manufacturer.
c. Wedge: Type 316 stainless steel segmented angled wedge equal on both sides.
d. Instrument Connections: **NPS 1/2 (DN 15)** FNPT using Class 3000 half couplings; material to match body.
e. Identification Tag: Stamped or engraved stainless steel.

7. Factory Calibration: Factory calibrate each sensor specific to application.
8. Flow Signal: Mate sensor in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

E. Portable Meter Package for Liquid Flow Sensors:

1. Metal-reinforced-plastic carrying case.
2. Waterproof meter with nominal **6-inch (150-mm)** round dial face.
3. Meter with dual rupture-proof liquid-filled bellows having integral temperature compensation.
4. Meter with external range and zero adjustment.
5. Multiple meters in package, if required to accommodate flow sensors with a wide range of pressure signals.
6. Two connecting hoses, [**10 ft. (3 m)**]<**Insert dimension**> long, with quick-connect couplings compatible with flow sensor couplings.
7. Two brass, bronze, or stainless steel blowdown valves with Buna-N seals and blowdown hoses.
8. Instruction book with flow versus pressure differential curves.
9. Suitable for system working pressure and temperature.
10. Portable meter package to connect to flow sensor without disturbing connection to pressure differential transmitter. Provide tees with isolation valves at flow signal connections to sensors.
11. Turn over to Owner at Project completion.

2.9 STEAM FLOW SENSORS (PRIMARY ELEMENTS)

A. Averaging Pitot-Tube Steam Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all averaging pitot-tube steam flow sensors from a single manufacturer.
4. Standard: ASME MFC-12M.
5. Description:

a. Sensor cross-sectional shape to provide a flow separation at a fixed point independent of flow rate, pressure, or temperature with a stable flow coefficient maintained over a wide range of Reynolds numbers.
b. Sensor shape to promote less-turbulent zones on backside of sensor. Locate individual sensing ports in less-turbulent region to measure low pressure. Number of sensing ports is a function of pipe size.
c. Sensor high pressure measured by a frontal slot extending full length of sensor or a comparable design. Number of slots is a function of pipe size.
d. Manufacturer to submit on request independent testing documentation (product test reports), demonstrating compliance with specified performance.
e. Include sensor with flow signal isolation valves and connections that are suitable for connecting to a remote transmitter.

6. Performance:[**Product test reports are required.**]

a. Accuracy: Within [**0.75**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.
b. Discharge Coefficient Factor: Within [**0.75**]<**Insert number**> percent of flow rate.
c. Repeatability: Within [**0.1**]<**Insert number**> percent.
d. Flow Range: [**10**][**17**]<**Insert value**> to 1 turndown.
e. Pressure and Temperature: Suitable for system pressure and temperature.
f. Pressure Drop: Up to [**3**]<**Insert number**> percent of full flow range pressure differential signal.
g. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
h. Size Range: [**NPS 2 through NPS 48 (DN 50 through DN 1200)**]<**Insert pipe size range**>.

7. Construction:

a. Sensor Surface Finish: Front surface textured for high-Reynolds-number applications if required to create a more turbulent boundary layer on front surface of sensor and produce

a more predictable and repeatable separation of flow at edge of sensor.

b. Sensor Material: Type 316 stainless steel.

c. Packing Gland:

1) Wetted Parts: Type 316 stainless steel.
2) Packing Material: Graphite.

d. Isolation Valve: Type 316 stainless steel full port ball valve configured to remove sensor while isolating process.

e. Flanged In-line Pipe Spool:

1) Factory mount sensor in a flanged section of pipe.
2) Pipe material to match adjacent pipe.
3) Flanges to match adjacent pipe.

f. Flow Signal Connections: **NPS 1/2 (DN 15)** NPT with Type 316 stainless steel needle valves.

g. Identification: Attach tag to each averaging pitot-tube sensor with a chain and label indicating pipe size, sensor series, sensor reading at flow rate, and pressure differential.

8. Factory Calibration: Factory calibrate each averaging pitot-tube sensor specific to application.
9. Flow Signal: Mate averaging pitot-tube sensor in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

B. Venturi Steam Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**HCI; Hydronics Components Inc.**]
c. [**Preso Meters; Badger Meter Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**HCI; Hydronics Components Inc.**]
c. [**Preso Meters; Badger Meter Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all venturi steam flow sensors from a single manufacturer.
4. On request, submit independent testing documentation (product test reports), demonstrating compliance with specified performance.
5. Standard: ASME MFC-3M.
6. Performance:

a. Accuracy: Within [**0.25**][**0.5**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

1) Accuracy with [**five**]<**Insert number**> pipe diameters of straight pipe upstream and [**two**]<**Insert number**> pipe diameters downstream.

b. Repeatability: Within [**0.1**][**0.2**]<**Insert number**> percent over the flow range.
c. Beta Ratio: Select between 0.30 and 0.75 to achieve performance indicated. Match venturi with transmitter to provide performance of entire assembly.
d. Flow Range: [**10**]<**Insert value**> to 1 turndown.
e. Pressure and Temperature: Suitable for system pressure and temperature.
f. Pressure Drop: Up to [**6**][**20**]<**Insert number**> percent of full flow range pressure differential signal.
g. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
h. Size Range: [**NPS 1/2 through NPS 48 (DN 15 through DN 1200)**]<**Insert pipe size range**>.

7. Construction:

a. Body End Connections: Flanged[**or threaded (NPT) for sizes NPS 1/2 through NPS 2 (DN 15 through DN 50)**].

1) Flanges: Suitable for mating to ASME B16.5 Class 150 or 300 pipe flanges as required by system pressure; [**welding neck**][**raised faces**]; material to match body.

b. Body Length: Length determined by manufacturer to comply with performance indicated.
c. Body Material: [**Carbon steel**][**or**][**Type 316 or 316L stainless steel**] with inside diameter to match adjacent pipe.

1) Optional Materials: Option to use one-piece bronze or brass construction with threaded FNPT end connections for pipe sizes **NPS 1/2 through NPS 2 (DN 15 through DN 50)**.

d. Throat Material: Type 316 stainless steel.
e. Flow Signal Connections: Two accurately located built-in sensing taps, nipples, and shut-off valves for field connection to transmitter; minimum size **NPS 1/2 (DN 15)** NPT.
f. Identification: Attach tag to each venturi with a chain and label indicating pipe size, venturi series, station identification, and reading at flow rate and pressure differential.

8. Factory Calibration: Factory calibrate each venturi specific to application.
9. Flow Signal: Mate venturi in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

C. Orifice Plate Steam Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all orifice plate steam flow sensors from a single manufacturer.
4. Description: Concentric with sharp, square-edge orifice plate with handle and adjoining matching companion flanges[**; factory installed in a meter run**].
5. Standards: ASME MFC-3M or ASME MFC-14M.
6. Performance:

a. Accuracy: Within [**1**][**2**][**5**]<**Insert number**> percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

1) Accuracy with [**10**]<**Insert number**> pipe diameters of straight pipe upstream and [**5**]<**Insert number**> pipe diameters downstream.

b. Repeatability: Within [**0.2**]<**Insert number**> percent over flow range.
c. Flow Range: [**5**][**10**]<**Insert value**> to 1 turndown.
d. Pressure and Temperature: Suitable for system pressure and temperature.
e. Pressure Drop: See Drawings.
f. Pressure Differential Signal for Flow Measurement: Size orifice plates for approximately [**100 inch wg (24.9 kPa)**]<**Insert pressure**> pressure differential, except absolute value of meter range not to exceed absolute value of flowing pressure.
g. Beta Ratio: Select ratio of orifice diameter to actual internal pipe diameter d/B (beta) between 0.30 and 0.70.
h. Size Range: [**NPS 1/2 through NPS 24 (DN 15 through DN 600)**]<**Insert pipe size range**>.

7. Construction:

a. End Connections: Matching companion flanges suitable for mating to ASME B16.5, Class 150 or 300 pipe flanges as required by system pressure. [**Flanges with welding neck**][**Flanges with welding neck and raised faces**].
b. Material: Fabricate orifice plate and matching companion flanges of [**Type 316 stainless steel**][**or**]<**Insert material**>.
c. Flow Signal Connections: **NPS 1/2 (DN 15)** NPT.
d. Identification: Stamp orifice plates with number and orifice bore on handle of orifice plate.

8. Calibration: Include information and calculations for each orifice plate, showing compliance with ASME MFC-3M or ASME MFC-14M.
9. Flow Signal: Mate orifice plate assembly in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

D. Segmented-Wedge Steam Flow Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Preso Meters; Badger Meter Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all segmented-wedge steam flow sensors from a single manufacturer.
4. Description: Pressure differential design using a segmented or segmental wedge installed in a straight section of pipe. Design sensors for solids and particulates to be swept through the opening and for measurements with Reynolds Numbers down to 500 as a minimum.
5. Performance:[**Product test reports are required.**]

   a. Accuracy: Within 0.5 percent of measured flow over flow range from design flow to [**10**]<**Insert number**> percent of design flow.

      1) Accuracy with 10 pipe diameters of straight pipe upstream and five pipe diameters downstream.

   b. Repeatability: Within 0.2 percent over flow range.
   c. Flow Range: 10 to 1 turndown.
   d. Discharge Coefficient: Linear and stable throughout flow range.
   e. Manufacturer to determine H/ID ratios to meet specified performance.
   f. Pressure and Temperature: Suitable for system pressure and temperature.
   g. Bidirectional Flow: Where required by application, sensor suitable for bidirectional flow measurement with no degradation of performance, with flow in either direction.
   h. Size Range: [**NPS 1/2 through NPS 16 (DN 15 through DN 400)**]<**Insert pipe size range**>.

6. Construction:

   a. Body End Connections: Flanged[**or threaded (MNPT) for sizes NPS 1/2 through NPS 2 (DN 15 through DN 50)**].

      1) Flanges: Suitable for mating to ASME B16.5, Class 150 or 300 pipe flanges as required by system pressure; [**welding neck**][**raised faces**]; material to match body.

   b. Body Material: [**Carbon steel**][**Type 304 stainless steel**][**or**][**Type 316 or 316L stainless steel**] with ID to match adjacent pipe. Length is to be determined by manufacturer.
   c. Wedge: Type 316 stainless steel segmented angled wedge equal on both sides.
   d. Instrument Connections: **NPS 1/2 (DN 15)** FNPT using Class 3000 half couplings; material to match body.
   e. Identification Tag: Stamped or engraved stainless steel.

7. Factory Calibration: Factory calibrate each sensor specific to application.
8. Flow Signal: Mate sensor in field to a pressure differential transmitter[**with high accuracy**] for flow measurement.

E. Portable Meter Package for Steam Flow Sensors:

1. Metal-reinforced-plastic carrying case.
2. Waterproof meter with nominal **6-inch (150-mm)** round dial face.
3. Meter with dual rupture-proof liquid-filled bellows having integral temperature compensation.
4. Meter with external range and zero adjustment.
5. Multiple meters in package, if required to accommodate flow sensors with a wide range of

pressure signals.
6. Two connecting hoses, [**10 ft. (3 m)**]<**Insert dimension**> long, with quick-connect couplings compatible with flow sensor couplings.
7. Two brass, bronze, or stainless steel blowdown valves with Buna-N seals and blowdown hoses.
8. Instruction book with flow versus pressure differential curves.
9. Suitable for system working pressure and temperature.
10. Portable meter package to connect to flow sensor without disturbing connection to pressure differential transmitter. Provide tees with isolation valves at flow signal connections to sensors.
11. Turn over to Owner at Project completion.

2.10 LIQUID FLOW SWITCHES

A. Liquid Flow Switch (Bellows Type):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Johnson Controls, Inc.**]
   b. [**Penn Controls**]
   c. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johnson Controls, Inc.**]
   b. [**Penn Controls**]
   c. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all bellows-type liquid flow switches from a single manufacturer.
4. Description:

   a. Field-adjustable four-vane combinations.
   b. Field-adjustable set-point adjustment screw.
   c. Suitable for pipe sizes **NPS 1 through NPS 8 (DN 25 through DN 200)**.
   d. Switch mounted vertically in horizontal pipe.

5. Performance:

   a. Flow Rate Actuation and De-actuation: Varies with vane combination and set-point adjustment.
   b. Pressure Limit: [**145 psig (1000 kPa)**]<**Insert pressure**>.
   c. Temperature Limit: [**230 deg F (110 deg C)**]<**Insert temperature**>.
   d. Electrical Rating: [**10 A resistive, 3 A conductive at 250 V ac**]<**Insert electrical rating**>.
   e. Switch Type: [**SPDT**]<**Insert switch type**> snap switch.

6. Wetted Parts Construction:

   a. Bellows: Tin-bronze.
   b. Vanes: Stainless steel.
   c. Body: Forged brass.

d. Process Connection: [**NPS 1 (DN 25)**]<**Insert pipe size**>.

7. Enclosure:

a. Material: Die-cast aluminum alloy.
b. Rating: NEMA 250, Type 4.
c. Electrical Connection: Cable gland with attached wire leads.

B. Liquid Flow Switch (Magnetic Type):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
b. <**Insert manufacturer's name**>

3. Description:

a. Field-adjustable five-vane combinations.
b. Suitable for pipe sizes **NPS 1-1/2 through NPS 20 (DN 40 to DN 500)**.
c. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency[**, and marked for hazardous-environment Class I, Groups C, and D; Class II, Groups E, F, and G**].

4. Performance:

a. Flow Rate Actuation and De-actuation: Varies with vane combination.
b. Pressure Limit: [**1000 psig (6895 kPa) for brass**][**and**][**2000 psig (13 790 kPa) for Type 316 stainless steel**]<**Insert pressure**> body.
c. Temperature Range: [**Minus 4 to plus 275 deg F (Minus 20 to plus 135 deg C)**]<**Insert temperature range**>.
d. Electrical Rating: [**10 A at 125/250 V ac**]<**Insert electrical rating**>.
e. Switch Type: [**SPDT**][**or**][**DPDT**] snap switch.

5. Wetted Parts Construction:

a. Vanes: Type 316 stainless steel.
b. Body: [**Brass**][**or**][**Type 316 stainless steel**].
c. Magnetic Keeper: [**Type 430 stainless steel**][**or**][**Type 316 stainless steel**].
d. Process Connection: [**NPS 1-1/2 (DN 40)**]<**Insert pipe size**>.

6. Enclosure:

a. Material: Die-cast aluminum alloy.
b. Threaded cover.

c. Rating: NEMA 250, Type 4.
d. Electrical Connection: Labeled terminal block.
e. Conduit Connection: [**3/4-inch (21-mm)**]<**Insert size**> trade size.

C. Liquid Flow Switch (Magnetic Type) for Small-Diameter Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**W.E. Anderson; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description:

   a. Suitable for pipe sizes [**NPS 1/2 through NPS 1-1/4 (DN 15 through DN 32)**][**NPS 1/2 through NPS 2 (DN 15 through DN 50)**]<**Insert pipe size range**>.
   b. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
   c. Listed and labeled as defined in NFPA 70, by a qualified testing agency[**, and marked for hazardous-environment Class I, Groups A, B, C, and D; Class II, Groups E, F, and G**].

4. Performance:

   a. Flow Rate Actuation and De-actuation: Not adjustable.
   b. Pressure Limit of Body: [**1000 psig (6895 kPa) for brass**][**and**][**2000 psig (13 790 kPa) for Type 303 stainless steel**]<**Insert pressure**>.
   c. Pressure Limit of Tee: [**250 psig (1724 kPa) for brass**][**1000 psig (6895 kPa) for malleable iron**][**and**][**2000 psig (13 790 kPa) for forged carbon steel and stainless steel**]<**Insert pressure**>.
   d. Temperature Range: [**Minus 4 to plus 220 deg F (Minus 20 to plus 104 deg C)**]<**Insert temperature range**>.
   e. Electrical Rating: [**5 A at 125/250 V ac**]<**Insert electrical rating**>.
   f. Switch Type: [**SPDT**][**or**][**DPDT**] snap switch.

5. Wetted Parts Construction (Lower Body):

   a. Vanes: Type 301 stainless steel.
   b. Body Material: [**Brass**][**or**][**Type 303 stainless steel**].
   c. Magnet: [**Ceramic**]<**Insert material**>.
   d. Process Connection: [**NPS 1/2 (DN 15)**]<**Insert pipe size**>.

6. Enclosure (Upper Body):

   a. Material: [**Brass**][**or**][**Type 303 stainless steel**].
   b. Rating: NEMA 250, Type 4.
   c. Electrical Connection: Labeled terminal block.
   d. Conduit Connection: [**3/4-inch (21-mm)**]<**Insert size**> trade size.

7. Integral Mounting Tee Furnished with Switch:

   a. Material: [**Brass**][**Forged carbon steel**][**Malleable iron**][**or**][**stainless steel**].
   b. Size: [**Match adjacent pipe**]<**Insert size**>.
   c. Connection: Threaded pipe.

2.11 LIQUID FLOW TRANSMITTERS

A. Pressure Differential Transmitters with High Accuracy for Liquid Flow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. <**Insert manufacturer's name**>

3. For Applications in Hazardous Environments:

   a. FM Approved for hazardous environments.
   b. Intrinsically safe for Classes I, II, and III; Divisions 1 and 2; and Groups A through H.
   c. Explosion-proof for Class I, Division 1, Groups B, C, and D.
   d. Dust-ignition-proof for Class II, Division 1, Groups E, F, and G.
   e. Dust-ignition-proof for Class III, Division 1.

4. Performance:

   a. Pressure Range: [**Minus 250 to plus 250 inches wg (Minus 62.5 to plus 62.5 kPa)**]<**Insert pressure range**>.
   b. Span: Field adjustable.
   c. Minimum Span: [**2.5 inches wg (500 Pa)**]<**Insert pressure**>.
   d. Accuracy: Within [**0.07**]<**Insert number**> percent of span or better.
   e. Stability: Within [**0.125**]<**Insert number**> percent of upper range limit for [**5**]<**Insert value**> years.
   f. Overpressure Limits: [**3626 psig (25 000 kPa)**]<**Insert pressure**>.
   g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
   h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
   i. Temperature Effect: Within [**0.025**]<**Insert number**> percent of upper range limit plus [**0.125**]<**Insert number**> percent of span.
   j. Shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.

b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
c. Digital signal based on HART protocol carried with current signal.
d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

6. Operator Interface: Zero and span adjustments located behind removable cover.
7. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
8. Construction:

a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
b. Nonwetted Parts: Aluminum or stainless steel.
c. Wetted Parts: Type 316 stainless steel.
d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert pipe size**>.
e. Drain/vent valve on low- and high-pressure connections.
f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
g. Wiring Connections: Labeled screw terminal block.
h. Mounting: Include mounting brackets suitable for installation.

9. Valve Manifold:

a. Furnish each transmitter with integrally mounted five-valve manifold.
b. Construction: Type 316 stainless steel.
c. Process Connections: **NPS 1/2 (DN 15)**.

B. Pressure Differential Transmitters for Liquid Flow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. [**Setra Systems Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. [**Setra Systems Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all pressure differential transmitters for liquid flow measurement from a single manufacturer.
4. Performance:

a. Range: [**Approximately 2 times set point**]<**Insert range**>.
b. Span: Adjustable; [**plus or minus 1 mA, non-interactive**]<**Insert range**>.
c. Accuracy: Within [**0.25**]<**Insert number**> percent of full scale.
d. Maximum Operating Pressure: Suitable for system pressure; not less than [**2.5**]<**Insert value**> times range.
e. Temperature Limits: [**0 to 175 deg F (Minus 18 to plus 79 deg C)**]<**Insert temperature range**>.
f. Compensation Temperature Limits: [**30 to 150 deg F (Minus 1 to plus 66 deg C)**]<**Insert**

temperature range>.
g. Thermal Effects: [**0.02**]<**Insert number**> percent of full scale per **deg F (deg C)**.
h. Response Time: 30 to 50 ms.
i. Shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

a. Two-wire, 4 to 20 mA or zero to 10 V dc current source.
b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

6. Operator Interface:

a. Zero and span adjustments located behind removable cover.
b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

7. Construction:

a. Enclosure: NEMA 250, Type 4 or 4X; aluminum and stainless steel with removable cover.
b. Process Connections: [**NPS 1/4 (DN 8)**]<**Insert pipe size**>.
c. Conduit Connections: Knock out for **1/2-inch (15-mm)** trade-size conduit connection on side of enclosure.
d. Wire Connections: Labeled screw terminal block.
e. Wetted Parts: 17-4 PH or 300 series stainless steel.
f. Mounting: Include mounting brackets suitable for installation.

8. Valve Manifolds:

a. Include [**three**][**or**][**five**]-valve manifold with each transmitter.
b. Construction: Brass, bronze, or stainless steel.
c. Process Connections: [**NPS 1/4 (DN 8)**]<**Insert pipe size**>.

2.12 STEAM FLOW TRANSMITTERS

A. Pressure Differential Transmitters with High Accuracy for Steam Flow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

3. For Applications in Hazardous Environments:

a. FM Approved for hazardous environments.
b. Intrinsically safe for Classes I, II, and III; Divisions 1 and 2; and Groups A through H.
c. Explosion-proof for Class I, Division 1, Groups B, C, and D.
d. Dust-ignition-proof for Class II, Division 1, Groups E, F, and G.
e. Dust-ignition-proof for Class III, Division 1.

4. Performance:

a. Pressure Range: [**Minus 250 to plus 250 inches wg (Minus 62.5 to plus 62.5 kPa)**]<**Insert pressure range**>.
b. Span: Field adjustable.
c. Minimum Span: [**2.5 inches wg (500 Pa)**]<**Insert pressure**>.
d. Accuracy: Within [**0.07**]<**Insert number**> percent of span or better.
e. Stability: Within [**0.125**]<**Insert number**> percent of upper range limit for [**5**]<**Insert value**> years.
f. Overpressure Limits: [**3626 psig (25 000 kPa)**]<**Insert pressure**>.
g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
i. Temperature Effect: Within [**0.025**]<**Insert number**> percent of upper range limit plus [**0.125**]<**Insert number**> percent of span.
j. Shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

a. Two-wire, 4 to 20 mA dc current source.
b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
c. Digital signal based on HART protocol carried with current signal.
d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

6. Operator Interface: Zero and span adjustments located behind removable cover.
7. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
8. Construction:

a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
b. Nonwetted Parts: Aluminum or stainless steel.
c. Wetted Parts: Type 316 stainless steel.
d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert pipe size**>.
e. Drain/vent valve on low- and high-pressure connections.
f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
g. Wiring Connections: Labeled screw terminal block.
h. Mounting: Include mounting brackets suitable for installation.

9. Valve Manifold:

a. Furnish each transmitter with integrally mounted five-valve manifold.
b. Construction: Type 316 stainless steel.
c. Process Connections: **NPS 1/2 (DN 15)**.

B. Pressure Differential Transmitters for Steam Flow Measurement:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Dwyer Instruments, Inc**]
b. [**Setra Systems Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. [**Setra Systems Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all liquid pressure differential transmitters for flow measurement from a single manufacturer.
4. Performance:

a. Range: [**Approximately 2 times set point**]<**Insert range**>.
b. Span: Field adjustable; [**plus or minus 1 mA, non-interactive**]<**Insert range**>.
c. Accuracy: Within [**0.25**]<**Insert number**> percent of full scale.
d. Maximum Operating Pressure: Suitable for system pressure; not less than [**2.5**]<**Insert value**> times range.
e. Temperature Limits: [**0 to 175 deg F (Minus 18 to plus 79 deg C)**]<**Insert temperature range**>.
f. Compensation Temperature Limits: [**30 to 150 deg F (Minus 1 to plus 66 deg C)**]<**Insert temperature range**>.
g. Thermal Effects: [**0.02**]<**Insert number**> percent of full scale per **deg F (deg C)**.
h. Response Time: 30 to 50 ms.
i. Shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

a. Two-wire, 4 to 20 mA or zero to 10 V dc current source.
b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.

6. Operator Interface:

a. Zero and span adjustments located behind removable cover.
b. Bleed screws on side of body - two screws on low-pressure side, and one screw on high-pressure side - for air in line and pressure cavity.

7. Construction:

a. Enclosure: NEMA 250, Type 4 or 4X; aluminum and stainless steel with removable cover.
b. Process Connections: [**NPS 1/4 (DN 8)**]<**Insert pipe size**>.
c. Conduit Connections: Knock out for **1/2-inch (15-mm)** trade-size conduit connection on side of enclosure.
d. Wire Connections: Labeled screw terminal block.
e. Wetted Parts: 17-4 PH or 300 series stainless steel.
f. Mounting: Include mounting brackets suitable for installation.

8. Valve Manifolds:

a. Include [**three**][**or**][**five**]-valve manifold with each transmitter.
b. Construction: Brass, bronze, or stainless steel.
c. Process Connections: [**NPS 1/4 (DN 8)**]<**Insert pipe size**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on Shop Drawings.
2. Do not begin installation without submittal approval of mounting location.

E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Thermal Airflow-Measurement Stations:

1. For Ducts/Plenums: [**All applications**]<**Insert applications**>.
2. For Small Ducts/Plenums: [**All applications**]<**Insert applications**>.
3. For Fan Arrays: [**All applications**]<**Insert applications**>.
4. For Single-Width Single-Inlet (SWSI) or Double-Width Double-Inlet (DWDI) Fans: [**All applications**]<**Insert applications**>.
5. For Air Terminal Units: [**All applications**]<**Insert applications**>.
6. For Packaged HVAC Units: [**All applications**]<**Insert applications**>.
7. For Data Center Server Rack Airflow/Pressure and Temperature Monitoring: [**All applications**]<**Insert applications**>.

C. Velocity Pressure Duct-Mounted Airflow Sensors:

1. Measured Velocities Greater Than 500 fpm (2.5 m/s): [**Velocity pressure pitot-tube airflow sensor stations for duct applications**][**Velocity pressure probe-type airflow sensor stations**

for duct applications][**velocity pressure probe-type airflow sensors for duct applications**].

D. Fan-Mounted Airflow Sensors:

1. Measured Velocities Greater Than 500 fpm (2.5 m/s): [**Velocity pressure probe-type fan inlet airflow traverse sensors**][**Piezometer ring fan inlet airflow sensor**].

E. Outdoor Airflow Measurement: [**Outdoor airflow-measurement system using differential static pressure**][**Thermal airflow-measurement stations**].

F. Airflow Switches:

1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless steel single-vane switch.

G. Airflow Transmitters for Use with Velocity Pressure-Type Sensors:

1. Exhaust Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**][**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**][**Pressure differential transmitter for airflow measurement**][**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].
2. Outdoor Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**][**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**][**Pressure differential transmitter for airflow measurement**][**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].
3. Return Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**][**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**][**Pressure differential transmitter for airflow measurement**][**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].
4. Supply Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**][**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**][**Pressure differential transmitter for airflow measurement**][**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].

H. Liquid Flow Sensors (Primary Elements):

1. Averaging Pitot Tubes: <**Insert system**><**Insert unique application**>.
2. Venturis: <**Insert system**><**Insert unique application**>.
3. Orifice Plates: <**Insert system**><**Insert unique application**>.
4. Segmented Wedge: <**Insert system**><**Insert unique application**>.

I. Steam Flow Sensors (Primary Elements):

1. Averaging Pitot Tubes: <**Insert system**><**Insert unique application**>.
2. Venturis: <**Insert system**><**Insert unique application**>.
3. Orifice Plates: <**Insert system**><**Insert unique application**>.
4. Segmented Wedge: <**Insert system**><**Insert unique application**>.

J. Liquid Flow Meters:

1. Insertion Impeller Flow Meters with Accuracy of One Percent of Full Scale: <**Insert system**><**Insert unique application**>.
2. Insertion Impeller Flow Meters with 0.5 Percent Accuracy: <**Insert system**><**Insert unique application**>.
3. Insertion Turbine Flow Meters: <**Insert system**><**Insert unique application**>.

4. In-Line Body Turbine Flow Meters: <**Insert system**><**Insert unique application**>.
5. In-Line Body Electromagnetic Flow Meters: <**Insert system**><**Insert unique application**>.
6. Insertion Electromagnetic Flow Meter: <**Insert system**><**Insert unique application**>.
7. In-Line Body Thermal Mass Flow Meters: <**Insert system**><**Insert unique application**>.
8. Vortex-Shedding Flow Meter with Integral Temperature Measurement: <**Insert system**><**Insert unique application**>.
9. Vortex-Shedding Flow Meter with Integral Pressure and Temperature Measurement: <**Insert system**><**Insert unique application**>.
10. Vortex-Shedding Flow Meter for Hazardous Environments: <**Insert system**><**Insert unique application**>.
11. Compact In-Line Body Ultrasonic Flow Meters: <**Insert system**><**Insert unique application**>.
12. Clamp-On Ultrasonic Flow Meters: <**Insert system**><**Insert unique application**>.

K. Steam Flow Meters:

1. Vortex-Shedding Flow Meter with Integral Temperature Measurement: <**Insert system**><**Insert unique application**>.
2. Vortex-Shedding Flow Meter with Integral Pressure and Temperature Measurement: <**Insert system**><**Insert unique application**>.
3. Vortex-Shedding Flow Meter for Hazardous Environments: <**Insert system**><**Insert unique application**>.

L. Liquid Flow Switches:

1. Bellows Type: <**Insert system**><**Insert unique application**>.
2. Magnetic Type: <**Insert system**><**Insert unique application**>.
3. Magnetic Type for Small Diameter Pipe: <**Insert system**><**Insert unique application**>.

M. Liquid Flow Transmitters:

1. Pressure Differential Transmitter with High Accuracy for Liquid Flow Measurement: <**Insert system**><**Insert unique application**>.
2. Pressure Differential Transmitter for Liquid Flow Measurement: <**Insert system**><**Insert unique application**>.

N. Steam Flow Transmitters:

1. Pressure Differential Transmitter with High Accuracy for Steam Flow Measurement: <**Insert system**><**Insert unique application**>.
2. Pressure Differential Transmitter for Steam Flow Measurement: <**Insert system**><**Insert unique application**>.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert lbf (kgf)**>.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

   a. Laboratory exhaust airstreams.
   b. Process exhaust airstreams.
   c. <**Insert requirement**>.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of [**2**][**3**]<**Insert number**> percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of [**2**][**3**]<**Insert number**> percent.

B. Mounting Height:

1. Mount remote displays, switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of **42 to 72 inches (1050 to 1800 mm)** above the adjacent floor, grade, or service catwalk or platform.

   a. Make every effort to mount at **60 inches (1500 mm)**.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5 INSTALLATION OF FLOW INSTRUMENTS

A. Airflow Sensors and Stations:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Install sensors so they are accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to handle clean sensors.

B. Liquid and Steam Sensors:

1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.
5. Isolation Without System Interruption: Where indicated, install isolation valves upstream and downstream of in-line sensors and a piping bypass, with isolation valve placed around the isolation valves to allow for sensor removal and replacement without system interruption.

C. Liquid and Steam Flow Meters:

1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Isolation Without System Interruption: Where indicated on Drawings, install isolation valves upstream and downstream of in-line meters and a piping bypass, with isolation valve placed around the isolation valves to allow for meter removal and replacement without system interruption.
5. Insertion Meters:

   a. Install system process connections full size of meter connection and meter manufacturer requirements, but not less than [**NPS 1 (DN 25)**][**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**]<**Insert pipe size**>. Provide [**stainless steel**]NPT threaded bushing if required by installation.
   b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
   c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

6. Orifice Plates:

   a. Meter run piping or tubing is to be uniform internal surface, which is free of internal grooves and striations, but is not polished. Out of roundness is not to exceed 0.5 percent. A reduction of the pipe diameter or distortion caused by welding is unacceptable.

b. Locate orifice plates in horizontal or vertical piping following good metering practice.
c. Maintain minimum upstream and downstream straight pipe to comply with ASME's "Fluid Meters: Their Theory and Application" and manufacturer requirements.

D. Liquid Switches:

1. Install system process connection full size of switch connection, but not less than [**NPS 1 (DN 25)**][**NPS 1-1/2 (DN 40)**][**NPS 2 (DN 50)**]<**Insert pipe size**>. Install [**stainless steel**]bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:

1. Install airflow transmitters serving an air system in a single location [**adjacent to**][**or**][**within**] system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.6 INSTALLATION OF ELECTRICAL POWER CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 INSTALLATION OF CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.9 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.10 CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.11 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to meet instrument manufacturer's instructions.

5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent needs to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11 in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.[**Field calibration is not required for instruments that have been factory calibrated and provided with certificates.**]
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 14

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Task	Specification	Specification Description
23 09 23 14	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 14	23 09 23 00a	Leak Detection Instruments
23 09 23 14	23 09 23 00b	Position Instruments
23 09 23 14	23 09 00 00	Speed Instruments
23 09 23 14	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 16 - GAS INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carbon dioxide sensors and transmitters.
2. Carbon dioxide and VOC combination sensors and transmitters.
3. Carbon monoxide sensors and transmitters.
4. Carbon monoxide monitoring system, multipoint air sampling.
5. Oxygen monitoring system, single point continuous.
6. VOC sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, cable, and other requirements that relate to this Section.
2. Section 230923.27 "Temperature Instruments" for temperature sensors that combine gas detection into a single device.
3. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 DEFINITIONS

A. NDIR: Nondispersive infrared.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Carbon dioxide sensors and transmitters,
2. Carbon dioxide and VOC combination sensors and transmitters.
3. Carbon monoxide sensors and transmitters.
4. Carbon monoxide monitoring system, multipoint air-sampling.
5. Oxygen monitoring system, single point continuous.
6. VOC sensors and transmitters.

B. Product Data Submittals: For each product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Installation instructions, including factor affecting performance.
3. Product description with complete technical data, performance curves, product specification sheets.
4. Product data indicating ASHRAE 62.1 compliance.

C. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**]details.
2. Diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

D. Samples: For each exposed product installed in finished space.

E. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, or BIM, drawn to scale, on which wall-mounted instruments located in finished space are shown and coordinated with each other, showing relationship to light switches, fire-alarm devices, and other installed devices using input from installers of items involved.

B. Product Test Reports: For [**carbon dioxide sensors and transmitters,**][**combination carbon dioxide and VOC sensors and transmitters,**][**carbon monoxide sensors and transmitters,**][**multipoint air-sampling carbon monoxide monitoring system,**][**single-point oxygen monitoring system,**][**VOC sensors and transmitters,**] for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas instruments.

PART 2 - PRODUCTS

2.1 CARBON DIOXIDE SENSORS AND TRANSMITTERS

A. Carbon Dioxide Sensors and Transmitters, Duct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Building Automation Products Inc.; BAPI**]
b. [**Dwyer Instruments, Inc**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
g. [**Vaisala**]
h. [**Veris Industries**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
   g. [**Vaisala**]
   h. [**Veris Industries**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Provide carbon dioxide sensors and transmitters, duct mounted, from single manufacturer.
4. Description:

   a. NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.

5. Performance:

   a. Air Velocity Range: [**0 to 2000 fpm (0 to 10.2 m/s)**]<**Insert flow velocity range**>.
   b. Carbon Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
   c. Accuracy: Within [**2**][**3**]<**Insert number**> percent of reading, plus or minus [**30**]<**Insert value**> ppm.
   d. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
   e. Long-Term Stability: Within [**5**]<**Insert number**> percent of full scale after more than [**5**]<**Insert number**> years.
   f. Response Time: Within [**60**]<**Insert number**> seconds.
   g. Warm-up Time: Within [**1**]<**Insert number**> minute(s).
   h. Ambient Relative Humidity: [**Zero to 85**][**Zero to 95**]<**Insert numbers**> percent noncondensing.
   i. Ambient Temperature: [**23 to 113 deg F (minus 5 to plus 45 deg C)**][**or**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

6. Output Signals:

   a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**> output signal, linearized to carbon dioxide concentration in parts per million (ppm).
   b. Digital Output Signal: [**SPST**][**or**][**SPDT**]<**Insert requirement**>.

7. Serial Communication: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert signal**>.
8. Construction:

   a. Enclosure: Painted metal or plastic; equivalent to NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.
   b. Electrical Connections: Screw terminals.
   c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration[**only where indicated on Drawings**].

9. Calibration Kit: Provide kit and turnover to Owner at start of warranty period.

B. Carbon Dioxide Sensors and Transmitters, Wall Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Dwyer Instruments, Inc**]
    d. [**Greystone Energy Systems, Inc.**]
    e. [**Honeywell Building Solutions; Honeywell International, Inc.**]
    f. [**Johnson Controls, Inc.**]
    g. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    h. [**Vaisala**]
    i. [**Veris Industries**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Dwyer Instruments, Inc**]
    d. [**Greystone Energy Systems, Inc.**]
    e. [**Honeywell Building Solutions; Honeywell International, Inc.**]
    f. [**Johnson Controls, Inc.**]
    g. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    h. [**Vaisala**]
    i. [**Veris Industries**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Provide carbon dioxide sensors and transmitters, wall mounted, from single manufacturer.
4. Description:

    a. NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.

5. Performance:

    a. Carbon Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
    b. Accuracy: Within [**2**]<**Insert number**> percent of reading, plus or minus [**30**]<**Insert value**> ppm.
    c. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
    d. Long-Term Stability: Within [**5**]<**Insert number**> percent of full scale after more than [**5**]<**Insert number**> years.
    e. Response Time: Within [**60**]<**Insert number**> seconds.
    f. Warm-up Time: Within [**5**]<**Insert number**> minutes.
    g. Ambient Relative Humidity: [**Zero to 95**]<**Insert numbers**> percent noncondensing.
    h. Ambient Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

6. Output Signals:

    a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**> output signal, linearized to carbon dioxide concentration in parts per million (ppm).

b. Digital Output Signal: [**SPST**][**or**][**SPDT**]<**Insert requirement**>.

7. Serial Communication: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert signal**>.
8. Construction:

a. Enclosure: White plastic; equivalent to NEMA 250, Type 1.
b. Electrical Connections: Screw terminals.
c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration[**only where indicated on Drawings**].

9. Calibration Kit: Provide to Owner at start of warranty period.

2.2 CARBON DIOXIDE AND VOC COMBINATION SENSORS AND TRANSMITTERS

A. Carbon Dioxide and VOC Combination Sensors and Transmitters, Duct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Dwyer Instruments, Inc**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Dwyer Instruments, Inc**]
c. [**Siemens Industry, Inc., Building Technologies Division**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Provide carbon dioxide and VOC combination sensors and transmitters, duct mounted, from single manufacturer.
4. Description:

a. Carbon Dioxide Measurement: NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.
b. VOC Measurement:

1) Technology: [**Metal-oxide semiconductor**]<**Insert type**> or equivalent technology that provides performance, long-term stability, and reliability.
2) Senses and responds to combined concentration of more than [**30**]<**Insert number**> contaminants commonly found in indoor environments.

5. Performance:

a. Carbon Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
b. Carbon Dioxide Accuracy: Within [**40**][**50**]<**Insert value**> ppm, plus [**2**][**3**]<**number**> percent of reading.
c. VOC Range: Zero to [**2000**]<**Insert value**> ppm correlated to carbon dioxide concentration.
d. VOC Sensitivity Ranges: Field selectable; low, normal, or high.

e. Ambient Relative Humidity: [**Zero to 95**][**or**][**10 to 90**]<**Insert numbers**> percent noncondensing.
f. Ambient Temperature: [**32 to 122 deg F (0 to 50 deg C)**][**or**][**32 to 120 deg F (0 to 48 deg C)**]<**Insert temperature range**>.

6. Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**>.
7. Construction:

a. Enclosure: Painted metal or plastic; equivalent to NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.
b. Electrical Connections: Screw terminals.
c. Visual Display: Equip with digital display for continuous indication of carbon dioxide and VOC concentration[**only where indicated on Drawings**].

B. Carbon Dioxide and VOC Combination Sensors and Transmitters, Wall Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. [**Siemens Industry, Inc., Building Technologies Division**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. [**Siemens Industry, Inc., Building Technologies Division**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Provide carbon dioxide and VOC combination sensors and transmitters, wall mounted, from single manufacturer.
4. Description:

a. Carbon Dioxide Measurement: NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.
b. VOC Measurement:

1) Technology: [**Metal-oxide semiconductor**]<**Insert type**> or equivalent technology that provides performance, long-term stability, and reliability.
2) Senses and responds to combined concentration of more than [**30**]<**Insert number**> contaminants commonly found in indoor environments.

5. Performance:

a. Carbon Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
b. Carbon Dioxide Accuracy: Within [**50**]<**Insert value**> ppm, plus [**2**]<**number**> percent measured value.
c. VOC Range: Zero to [**2000**]<**Insert value**> ppm correlated to carbon dioxide concentration.
d. VOC Sensitivity Ranges: Field selectable; low, normal, or high.
e. Ambient Relative Humidity: [**5 to 95**]<**Insert number**> percent noncondensing.
f. Ambient Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

6. Output Signals: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**>.
7. Construction:

   a. Enclosure: White plastic; equivalent to NEMA 250, Type 1.
   b. Electrical Connections: Screw terminals.
   c. Visual Display: Equip with digital display for continuous indication of carbon dioxide and VOC concentration[**only where indicated on Drawings**].

2.3 CARBON MONOXIDE SENSORS AND TRANSMITTERS

A. Carbon Monoxide Sensors and Transmitters, Duct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Analytics; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Analytics; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. <**Insert manufacturer's name**>

3. Description: Electrochemical measurement technology or equivalent technology that provides performance indicated, long-term stability, and reliability.
4. Performance:

   a. Carbon Monoxide Concentration Range: Zero to [**100**]<**Insert value**> ppm.
   b. Accuracy: Within [**3**][**5**]<**Insert number**> percent of full-scale range.
   c. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
   d. Long-Term Stability: Within [**5**]<**Insert number**> percent of full scale per year.
   e. Response Time: Within [**30**]<**Insert number**> seconds.
   f. Warm-up Time: Within [**1**]<**Insert number**> minute(s).
   g. Ambient Relative Humidity: <**Insert number**> percent noncondensing.
   h. Ambient Temperature: [**Minus 4 to plus 122 deg F (Minus 16 to plus 50 deg C)**]<**Insert temperature range**>.

5. Output Signals:

   a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**>.
   b. Digital Output Signal: [**SPST**][**or**][**SPDT**]<**Insert requirement**>.

6. Serial Communication: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert signal**>.

7. Construction:

   a. Enclosure: Painted metal or plastic; equivalent to NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.
   b. Electrical Connections: Screw terminals.
   c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration[**only where indicated on Drawings**].

8. Calibration Kit: Provide and turn over to Owner at start of warranty period.

B. Carbon Monoxide Sensors and Transmitters, Wall Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Analytics; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**MSA Safety, Inc.**]
   g. [**Veris Industries**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Analytics; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**MSA Safety, Inc.**]
   g. [**Veris Industries**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Provide carbon monoxide sensors and transmitters, wall mounted, from single manufacturer.
4. Description: Electrochemical measurement technology or equivalent technology that provides performance indicated, long-term stability, and reliability.

   a. Individual Sensor/Transmitter Applications: Each sensor/transmitter connected directly to DDC system.
   b. Multiple Sensor/Transmitters for Zoned Applications: Multiple sensor/transmitters arranged in zones as indicated on Drawings and directly connected to carbon monoxide monitoring system controller; furnished with sensors and transmitters as part of a complete system furnished by single manufacturer.

5. Performance:

   a. Carbon Monoxide Concentration Range: Zero to [**100**]<**Insert value**> ppm.
   b. Accuracy: Within [**5**]<**Insert number**> percent of full-scale range.

c. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
d. Long-Term Stability: Within [**5**]<**Insert number**> percent of full scale after more than [**5**]<**Insert number**> years.
e. Response Time: Within [**30**]<**Insert number**> seconds.
f. Warm-up Time: Within [**1**]<**Insert number**> minute(s).
g. Ambient Relative Humidity: <**Insert number**> percent noncondensing.
h. Ambient Temperature: [**Minus 4 to plus 122 deg F (Minus 20 to plus 50 deg C)**]<**Insert temperature range**>.

6. Sensor and Transmitter Output Signals:

a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**>.
b. Digital Output Signal: [**SPDT**]<**Insert requirement**>.

7. Sensor and Transmitter Serial Communication: [**BACnet MS/TP**][**or**][**Modbus RTU**].
8. Sensor and Transmitter Construction:

a. Enclosure: Painted metal or plastic; equivalent to NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.
b. Electrical Connections: Screw terminals.
c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration[**only where indicated on Drawings**].

9. Carbon Monoxide System Controller:

a. Configuration:

1) Quantity of Sensors Connected to Each Controller: See Drawings.
2) Arrangement and Quantity of Zones per Controller: See Drawings.

b. Signals:

1) Sensor Signal to Controller: [**Analog**][**or**][**BACnet MS/TP**][**Modbus RTU**][**See Drawings**].
2) Controller Output Signal: [**Analog**][**Digital signal, through control relays, for each sensor connected to controller to indicated alarm status,**][**BACnet MS/TP**][**or**][**Modbus RTU**][**See Drawings**].

c. Enclosure: Painted metal or plastic; equivalent to NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.
d. Electrical Connections: Screw terminals.
e. Operator Interface: Keypad or touch sensitive digital display, located on front of enclosure; access protected by password.
f. Visual Display: Multiple lines, backlit LCD.
g. Alarms:

1) Audible Alarm: Audible alarm with local silence reset; <**Insert sound level**>.
2) Visual Alarms: Faults or failures, individual sensor readings in alarm.

10. Calibration Kit: Provide kit and turn over to Owner at start of warranty period.

2.4 CARBON MONOXIDE MONITORING SYSTEM, MULTIPOINT AIR SAMPLING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**ACI Automation; Automation Components Inc**]
2. [**MSA Safety, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ACI Automation; Automation Components Inc**]
2. [**MSA Safety, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Provide carbon monoxide monitoring system, multipoint air sampling, from single manufacturer.

D. Description: Multipoint air-sampling system with integral air-sampling pumps, gas analyzer(s), and microprocessor.

1. System Sampling Point Quantity: [**8**][**16**][**24**][**32**][**See Drawings**]<**Insert quantity**>.
2. Monitors and reports carbon monoxide concentration level, warnings, and alarms for each sampling point, system operation failures, and faults.
3. Each sampling point is to be individually piped in field to external connection on monitoring system enclosure.

E. Performance:

1. Concentration Range: Zero to [**100**]<**Insert value**> ppm.
2. Accuracy: Within [**5**]<**Insert number**> percent of full-scale range.
3. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
4. Long-Term Stability: Within [**5**]<**Insert number**> percent of full scale after more than [**5**]<**Insert number**> years.
5. Sampling Rate: Within [**10**]<**Insert number**> seconds; adjustable in 1 second increments from zero to [**5**]<**Insert number**> minutes.
6. Response Time: Within [**10**]<**Insert number**> seconds.
7. Warm-up Time: Within [**1**]<**Insert number**> minute(s).
8. Ambient Relative Humidity: [**5 to 90**]<**Insert number**> percent noncondensing.
9. Ambient Temperature: [**32 to 95 deg F (0 to 35 deg C)**]<**Insert temperature range**>.
10. Air Sample Temperature: [**0 to 140 deg F (Minus 17 to plus 60 deg C)**]<**Insert temperature range**>.
11. Zero and Span Drift: Within [**1**]<**Insert number**> percent of full scale within a [**24**]<**Insert number**>-hour period.

F. Analyzer:

1. [**Single**][**Two**][**Three**][**Four**] analyzer(s) arranged for discrete gas measurement across all sampling points.
2. Analyzer Technology: [**Electrochemical**]<**Insert type**> or equivalent technology that provides performance indicated, long-term stability, and reliability.
3. Temperature-compensate readings over operating range as required by performance.

G. Control and Display:

1. Backlight alphanumeric visual display and operator interface located on face of enclosure.
2. Visual indication for sample analyzing, sample concentration, sample high-concentration alarm,

analyzer malfunction, flow failure, and calibration.
3. Operator configurable order of sample points.
4. Each sample point is capable of being manually sampled through an override feature.
5. System data with internal battery backup for at least an [**two years**]<**Insert time**>.
6. Security: Password-protected system parameters.

H. Network Communication Interface: [**BACnet IP**][**or**][**Modbus TCP**].

I. Output Signals:

1. Analog Output Signals: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**> signal for each sample point; proportional with gas concentration.
2. Digital Output Signals: Operator-configurable, [**SPDT**]<**Insert requirement**> control relays, one for each sample point alarm[**and fault**].

J. Enclosure:

1. NEMA 250, [**Type 1**]<**Insert type**>.
2. Hinged[**and locking**] door, full size of front face.
3. Size enclosure to house all system components. Multiple adjoining enclosures are acceptable if interconnected and joined to a common support structure.

K. Filters: Provide each air-sampling point with a 0.3-micron filter located [**at sampling point air inlet**][**or**][**inline at enclosure**].

L. Air-Sampling Pump: Dual-head diaphragm pump draws an air sample from each sampling point through field-installed tubing, and a microprocessor-controlled sequencer feeds the air sample to an analyzer(s) with a new sample at the frequency (sample rate) indicated.

M. Calibration Equipment:

1. Span and zero calibration automatically initiated by microprocessor.
2. Operator is to be also able to manually initiate span and zero calibration through operator interface.
3. Provide equipment necessary to automatically and manually calibrate the system, including, but not be limited to, the following:

a. Regulator assemblies.
b. Zero cap.
c. Calibration cap.
d. Two cylinders filled with calibration gas.

N. Manufacturer Startup: Final adjustment; calibration, testing, and startup of system is performed by a trained manufacturer representative.

2.5 OXYGEN MONITORING SYSTEM, SINGLE POINT CONTINUOUS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**MSA Safety, Inc.**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**MSA Safety, Inc.**]
2. <**Insert manufacturer's name**>

C. Source Limitations: Provide oxygen monitoring system, single point continuous, from single manufacturer.

D. Description:

1. System measures and displays a single gas concentration, provides local audio and visual alarms when preset limits are exceeded, and send output signals of gas concentration and detected alarms.
2. System requires no periodic maintenance other than periodic checking of sensor response to a known concentration of gas.
3. System is to be designed to provide for installation, setup, and startup from outside of unit enclosure without need to open the enclosure door.
4. Factory calibrated and ready for operation after installation.
5. Internally wired to accommodate a single-point field power connection.

E. Performance:

1. Range: Full scale, zero to [**25**]<**Insert number**> percent oxygen.
2. Zero Drift: Within [**1**]<**Insert number**> percent per year.
3. Span Drift: Within [**10**]<**Insert number**> percent per year.
4. Repeatability: Within [**1**]<**Insert number**> percent of full scale.
5. Linearity: Within [**2**]<**Insert number**> percent of full scale.
6. Step Change Response Time: Within [**12**]<**Insert number**> seconds.

F. Enclosure:

1. NEMA 250, [**Type 4X**]<**Insert type**>.
2. Access to inside of enclosure, as well as to controller, display, and wiring connections, through full-length door on front of enclosure[**that requires key access**].
3. Door with [**shatterproof**]window for viewing of visual display and indicator lights.
4. Equip enclosure with mounting brackets to attach unit to a flat surface.

G. Controller:

1. Password-protected access through full-function keypad.
2. Set:

    a. Real-time clock.
    b. Alarm levels.
    c. Change span-gas values.
    d. Display date of last calibration.
    e. Display minimum, maximum, and average gas values.
    f. Change address, future calibration time, and date.

3. Automatic return-to-normal-operation feature after calibration.
4. Date stamps last successful calibration.
5. Time and date stamps events.
6. Selectable lockout of output signals during calibration.
7. Logs minimum, maximum, and average gas concentrations over selected time intervals.

H. Visual Display:

1. Four-digit LED or backlight LCD display visible from front face of enclosure.
2. Display direct reading of gas concentration.
3. Displays system status indicators.
4. Visual Alarm Indication:

   a. Three Separate Alarm Levels: Caution, Warning, and Alarm.
   b. Separate Strobes for Warning and Alarm Conditions: Externally mount the two strobes on top of enclosure.

5. Indicate sensor nearing end of its useful life based on the sensor output, not on the time the sensor was in service.
6. Display average, minimum, and maximum gas concentrations of the sensor over selected time.
7. Malfunction Indication Alarm: Displays a separate unique character when an over-range or under-range condition exists, a sensor signal sensor is lost, or a set-point error or memory failure occurs.

I. Audible Alarm:

1. Activate audible horn when an alarm condition occurs.
2. Rate for [**70**][**95**] dB with selectable output tones.
3. Mount horn inside or on exterior of enclosure.
4. Activate horn through contact relay and set as normally open and common.

J. Operator Interface:

1. Audible Alarm Acknowledge Switch:

   a. Push-button switch located on front door to silence audible alarm.
   b. Switch is to reset latched alarms if normal gas conditions exist. Visual alarms are to remain on as long as alarms are exceeded.

2. Operating Modes and Parameters Selection: Selections listed are to be accomplished by use of switches, jumpers, or remote control not involving use of tools.

   a. Display range value.
   b. Latching or nonlatching mode for alarm set points.
   c. Upscale or downscale acting alarms.

K. Output Signal:

1. Control Relays:

   a. Provide one relay for each set-point level for each of three alarm levels.
   b. Provide one relay for fault conditions.
   c. Alarm and Fault Relays: Form "C," SPDT, rated for 5 A resistive at 250 V ac or 30 V dc.
   d. Contacts are to be capable of being selected normally open or normally closed.
   e. Alarm Relays: Normally de-energized.
   f. Fault Relay: Normally energized.

2. Analog Output:

   a. Two-wire, 4 to 20 mA, [**isolated**][**or**][**nonisolated**] current source.
   b. Signal capable of operating into a [**600**]<**Insert value**> ohm load.

L. Sensor:

1. Electrochemical fuel-cell type that does not require periodic addition of reagents or equivalent technology that provides performance indicated, long-term stability, and reliability.
2. Replaceable without need for tools.
3. Minimum useful life of [**two**]<**Insert number**> years.
4. Mount sensor externally on side or bottom of enclosure, except where indicated on Drawings, mount sensor remote from enclosure.

   a. Remote-Mounted Sensors:

      1) Provide sensor in a separate NEMA 250, Type 4X enclosure, except when sensor is installed in a hazardous location, then enclosure is to be explosion-proof type suitable for application.
      2) Provide sensor with cable for connecting to monitor.
      3) Provide sensor with mounting hardware suitable for application.
      4) For duct-mounted applications, provide sensor with kit for calibrating the sensor without removing sensor from duct.

M. Gas Sampling Pump:

1. Where required by application, provide a pump mounted inside the enclosure to provide a motive force to induce flow of gas sample across the sensor.
2. Signal to the sensor from the pump is to be in digital communication format to eliminate radio-frequency interference (RFI) and electromagnetic interference (EMI).
3. A flow sensor is to activate a relay when the gas sample falls below the acceptable flow rate to the sensor and is to indicate a loss of gas flow on the display.
4. Introduction of a calibration gas to the gas sensor is to be through an integral push-button valve. This push-button valve is to return to monitoring the sampled area when released.

N. Battery Backup:

1. Provide battery backup power supply to continue normal operation if normal power source is interrupted.
2. Transfer to battery backup is to be automatic and is to be indicated on the display.
3. Mount battery backup power supply inside enclosure.
4. Battery backup is to be continuously charged during normal operation.
5. Battery life is to be at least 0.5 hours with strobes flashing, alarm conditions asserted, and horn sounding.

O. Calibration:

1. Calibrate and adjust functions through nonintrusive handheld wireless remote control without opening enclosure door.
2. Enter calibration mode through handheld wireless remote control unit. The display of the monitor is to instruct operator on when to apply zero and span gas. System is to automatically adjust its internal settings to the proper calibration values without further intervention by operator. On completion of a successful calibration, system is to exit the calibration mode. Date stamp of last successful calibration is retained in the system internal memory, with capability to be indicated on display. If calibration is unsuccessful for any reason, the display is to show an unsuccessful calibration attempt and revert to its previous calibration settings.
3. Wireless method is to employ a digitally encoded infrared light beam.
4. Handheld wireless remote control is to let operator perform sensor zeroing and calibration.
5. Handheld wireless remote control is to let operator perform sensor zeroing and calibration, as well as activate all functions and features of the monitor.

6. Monitor infrared link is not to be affected by natural and fabricated low-level ambient light.

P. Automatic Calibration System:

1. Provide automatic calibration of all oxygen monitors installed. Number of automatic calibration systems is to be determined by supplier based on location and quantity of oxygen monitors.
2. Automatic calibration system is to, without manual intervention, periodically perform a complete calibration of the sensors.
3. System to exchange digital signals with sensors.
4. Automatic calibration is to be adjustable from as many as [**three**]<**Insert number**> times per day to only once every [**30**]<**Insert number**> days.
5. Suppress or disable sensor alarms until automatic calibration cycle is completed.
6. Initiate manual calibration of the sensor at any time with a handheld infrared remote control without the need to disable or turn off the automatic calibration system.
7. House the system in a separate NEMA 250, [**Type 4X**]<**Insert type**> enclosure from the oxygen monitoring system. Enclosure is to have provisions for wall mounting.
8. Digital displays are to indicate zero and when span gas is being applied to the sensor, status, and any fault condition.
9. Monitor calibration cylinders attached to the calibration system and light a fault indicator of insufficient gas pressure.

2.6 VOC SENSORS AND TRANSMITTERS

A. VOC Sensors and Transmitters, Duct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Senva Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Senva Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Provide VOC sensors and transmitters from single manufacturer.
4. Description:

   a. VOC sensor with metal-oxidizing element that varies resistance with contaminant gases.
   b. Senses and responds to combined concentration of more than [**30**]<**Insert quantity**> contaminants commonly found in indoor environments.

5. Performance:

   a. Measurement Range: Zero to [**100 percent**][**or**][**1000 ppb isobutene**][**1000 ppm ethanol**]<**Insert range**>.

b. Ambient Relative Humidity: [**Zero to 90**][**5 to 95**]<**Insert humidity range**> percent noncondensing.
c. Ambient Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

6. Output Signals:

a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**> output signal, linearized to concentration.
b. Digital Output Signal: [**SPDT**]<**Insert requirement**>.

7. Serial Communication: [**Modbus RTU**]<**Insert signal**>.
8. Enclosure: ABS plastic or Lexan.

B. VOC Sensors and Transmitters, Wall Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Senva Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Senva Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Provide VOC sensors and transmitters, wall mounted, from single manufacturer.
4. Description:

a. VOC sensor with metal-oxidizing element that varies resistance with contaminant gases.
b. Senses and responds to combined concentration of more than [**30**]<**Insert quantity**> contaminants commonly found in indoor environments.

5. Performance:

a. Measurement Range: Zero to [**100 percent**][**or**][**1000 ppb isobutene**][**1000 ppm ethanol**]<**Insert range**>.
b. Ambient Relative Humidity: [**Zero to 90**][**5 to 95**][**or**][**10 to 95**]<**Insert humidity range**> percent noncondensing.
c. Ambient Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

6. Output Signals:

a. Analog Output Signal: [**4 to 20 mA**][**or**][**zero to 10 V dc**]<**Insert signal**> output signal, linearized to concentration.
b. Digital Output Signal: [**SPDT**]<**Insert requirement**>.

7. Serial Communication: [**Modbus RTU**]<**Insert signal**>.
8. Enclosure: ABS plastic or Lexan.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to [**seismic**][**or**][**external**] loads.

D. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.

a. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure[**constructed of Type 316L stainless steel**].
b. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

3.3 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Mount duct-mounted instruments at locations indicated on Drawings.
2. Mount wall-mounted instruments in user-occupied space at locations indicated on Drawings.
3. Mount instruments intended for wall-mounting using floor-supported freestanding pipe stands, or floor-supported structural support frames where direct-to-wall mounting is not possible. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height is to comply with codes and accessibility requirements.
2. Mount instruments located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements within a range of **42 to 72 inches (1.1 to 1.6 m)** above the adjacent floor, grade, or service catwalk or platform.

   a. Make every effort to mount at **60 inches (1.5 m)**.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.4 INSTALLATION OF CARBON MONOXIDE MONITORING SYSTEM, MULTIPOINT AIR SAMPLING

A. Install sample points in monitored area to provide accurate measurement of gas concentration.

B. Install exposed sampling points with a finished appearance consistent with other materials in space. Submit proposed products to be installed for review and approval.

C. Individually install each sample point to the carbon monoxide monitoring system using tubing.

1. Material: [**Copper**][**stainless steel**][**or**][**polyethylene installed in conduit**].
2. Size: As recommended by carbon monoxide system manufacturer for specific application; minimum size [**NPS 3/8 (DN 10)**]<**Insert pipe size**>.
3. Use compression fittings at tubing connections.
4. Comply with additional requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. If not indicated on Drawings, locate carbon monoxide monitoring system in a secured and serviceable location accessible to authorized personnel.

E. Support carbon monoxide monitoring system enclosure from floor or wall. Support floor-mounted systems using a structural channel frame. Provide mounting brackets.

3.5 INSTALLATION OF OXYGEN MONITORING SYSTEM, SINGLE POINT CONTINUOUS

A. Install monitor in space to provide an accurate measurement of gas concentration.

B. Support oxygen monitoring system from wall.

3.6 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.7 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification on face[**and on face of ceiling directly below instruments concealed above ceilings**].

3.9 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.10 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation that impacts performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.11 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration are to comply with instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE's Guideline 11, in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Transmitters: Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.[**Field calibration is not required for instruments that have been factory calibrated and provided with certificates.**]

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**]

months' full maintenance by [**skilled employees of gas system and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 16

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Task	Specification	Specification Description
23 09 23 16	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 16	23 09 23 00a	Leak Detection Instruments
23 09 23 16	23 09 23 00b	Position Instruments
23 09 23 16	23 09 00 00	Speed Instruments
23 09 23 16	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 19 - MOISTURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Moisture switches.
2. Moisture sensors and transmitters.
3. Moisture and temperature sensors and transmitters.
4. Multifunction moisture and temperature sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, cable, and other requirements that relate to this Section.
2. Section 230923.27 "Temperature Instruments" for temperature sensors that combine moisture, gas, and other measurements into a single device.
3. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Moisture switches.
2. Moisture sensors and transmitters.
3. Moisture and temperature sensors and transmitters.
4. Multifunction moisture and temperature sensors and transmitters.

B. Product Data Submittals: For each product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Product description with complete technical data, performance curves, and product specification sheets.

C. Shop Drawings:

1. Details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For moisture instruments.

PART 2 - PRODUCTS

2.1 MOISTURE SWITCHES

A. Humidistats for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   b. [**Johnson Controls, Inc.**]
   c. [**Schneider Electric USA, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   b. [**Johnson Controls, Inc.**]
   c. [**Schneider Electric USA, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain humidistats for duct applications from single manufacturer.
4. Description:

   a. Two-position control.
   b. Field-adjustable set point.
   c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Performance:

   a. Ambient Relative Humidity: [**Zero to 100**][**5 to 95**]<**Insert numbers**> percent.
   b. Relative Humidity Control Range: [**15 to 95**][**30 to 90**][**35 to 100**]<**Insert numbers**> percent.
   c. Relative Humidity Differential: [**4**][**5**]<**Insert number**> percent.
   d. Ambient Temperature: [**40 to 125 deg F (4 to 52 deg C)**]<**Insert temperature range**>.
   e. Voltage: [**24**][**120**][**or**][**240**]<**Insert value**> V ac.
   f. Current: [**3.6**][**7.2**]<**Insert value**> FLA.
   g. Switch Type: [**SPDT**]<**Insert type**> snap switch.

6. Construction:

   a. Enclosure: Plastic or painted metal; NEMA 250, Type 1[**, 4, or 4X**].
   b. Electrical Connections: Screw terminals.

B. Humidistats for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   b. [**Johnson Controls, Inc.**]
   c. [**Schneider Electric USA, Inc.**]
   d. [**Siemens Industry, Inc., Building Technologies Division**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   b. [**Johnson Controls, Inc.**]
   c. [**Schneider Electric USA, Inc.**]
   d. [**Siemens Industry, Inc., Building Technologies Division**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain humidistats for space applications from single manufacturer.
4. Description:

   a. Two-position control.
   b. Field-adjustable set point.
   c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Performance:

   a. Ambient Relative Humidity: [**Zero to 100**][**5 to 95**]<**Insert numbers**> percent.
   b. Relative Humidity Control Range: [**Zero to 70**][**10 to 90**]<**Insert numbers**> percent.
   c. Relative Humidity Differential: [**4**][**5**][**6**]<**Insert number**> percent.
   d. Ambient Temperature: [**40 to 100 deg F (4 to 38 deg C)**][**40 to 125 deg F (4 to 52 deg C)**]<**Insert temperature range**>.
   e. Voltage: [**24**][**120**][**or**][**240**]<**Insert value**> V ac.
   f. Switch Type: SPDT snap switch.

6. Construction:

   a. Enclosure: Plastic or painted metal; NEMA 250, Type 1.
   b. Electrical Connections: Cable or screw terminals.

2.2 MOISTURE SENSORS AND TRANSMITTERS

A. Moisture Sensors and Transmitters for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**MAMAC Systems, Inc.**]
f. [**Minco**]
g. [**Siemens Industry, Inc., Building Technologies Division**]
h. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**MAMAC Systems, Inc.**]
f. [**Minco**]
g. [**Siemens Industry, Inc., Building Technologies Division**]
h. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain moisture sensors and transmitters for duct applications from single manufacturer.
4. Description: Moisture measurement transmitter for use in duct and equipment applications.
5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

1) Operating Temperature Range between 32 to 122 Deg F (0 to 50 Deg C):

a) Within [**1.5**][**2**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
b) Within [**2**][**2.5**][**3**][**4**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

b. Relative Humidity Operating Stability: [**Within 0.25 percent/year**][**Within 0.5 percent/year**]<**Insert requirement**>.
c. Relative Humidity Range: [**Zero to 100**]<**Insert numbers**> percent.
d. Response Time: Within [**10**][**20**][**50**]<**Insert number**> seconds.
e. Operating Temperature Range: Select for application, but not less than [**minus 40 to plus 140 deg F (minus 40 to plus 60 deg C)**]<**Insert temperature range**>.
f. Maximum Air Velocity: As required by application, but not less than [**0 to 4000 fpm (0 to 20.3 m/s)**]<**Insert velocity range**>.

7. Display:

a. Application: Include transmitters with integral [**backlit**]LCD display[**where indicated on Drawings**]<**Insert application requiring display**>.
b. Display percent relative humidity and temperature in units indicated.

8. Duct Probe: [**Plastic material listed for use in airstream with filter**][**or**][**stainless steel with sintered filter**]<**Insert requirement**>.
9. Transmitter Enclosure:

    a. Enclosure Mounting: [**Integral to**][**or**][**remote from**] duct probe.
    b. Enclosure Material: [**Cast aluminum**][**Plastic**][**or**][**painted metal**].
    c. Enclosure Rating: NEMA 250, [**Type 1**][**or**][**Type 3R**][**Type 4**][**Type 4X**]<**Insert type**>.

10. Analog Output Signal: [**4 to 20 mA**][**or**][**0 to 5 V dc**][**0 to 10 V dc**]<**Insert signal requirements**>.
11. Communication Network Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
12. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
13. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity sensors.

B. Moisture Sensors and Transmitters for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Johnson Controls, Inc.**]
    e. [**MAMAC Systems, Inc.**]
    f. [**Minco**]
    g. [**Schneider Electric USA, Inc.**]
    h. [**Siemens Industry, Inc., Building Technologies Division**]
    i. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Johnson Controls, Inc.**]
    e. [**MAMAC Systems, Inc.**]
    f. [**Minco**]
    g. [**Schneider Electric USA, Inc.**]
    h. [**Siemens Industry, Inc., Building Technologies Division**]
    i. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain moisture sensors and transmitters for space applications from single manufacturer.
4. Description: Moisture measurement transmitter for use in space applications.
5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

    a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):

a) Within [**1.5**][**2**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
b) Within [**2**][**2.5**][**3**][**4**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

b. Relative Humidity Operating Stability: [**Within 0.5 percent/year**]<**Insert requirement**>.
c. Relative Humidity Range: [**Zero to 100**]<**Insert numbers**> percent.
d. Response Time: Within [**10**][**20**]<**Insert number**> seconds.
e. Operating Temperature Range: Select for application, but not less than [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

7. Display:

a. Application: Include transmitters with integral [**backlit**]LCD display[**where indicated on Drawings**]<**Insert application requiring display**>.

8. Transmitter Enclosure:

a. Enclosure Mounting: [**Integral to**][**or**][**remote from**] humidity sensor.
b. Enclosure Material: [**Plastic**][**or**][**painted carbon steel or stainless steel**].
c. Enclosure Rating: NEMA 250, [**Type 1**]<**Insert type**>.

9. Analog Output Signals: [**4 to 20 mA**][**or**][**0 to 5 V dc**][**0 to 10 V dc**]<**Insert signal requirements**>.
10. Communication Network Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
11. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
12. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity sensors.

2.3 MOISTURE AND TEMPERATURE SENSORS AND TRANSMITTERS

A. Moisture and Temperature Sensors and Transmitters for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**MAMAC Systems, Inc.**]
g. [**Minco**]
h. [**Rotronic Instrument Corporation; A PST Brand**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
l. [**Vaisala**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**MAMAC Systems, Inc.**]
   g. [**Minco**]
   h. [**Rotronic Instrument Corporation; A PST Brand**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain moisture and temperature sensors and transmitters for duct applications from single manufacturer.
4. Description: Moisture and temperature measurements combined in a single transmitter for use in duct and equipment applications.
5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

   a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

      1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):

         a) Within [**1.5**][**2**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
         b) Within [**2**][**2.5**][**3**][**4**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

      2) Operating Temperature Range within the Remainder of the Temperature Range Indicated:

         a) Within [**2**][**2.5**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
         b) Within [**2**][**3**][**3.5**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

   b. Relative Humidity Operating Stability: [**Within 0.25 percent/year**][**Within 0.5 percent/year**]<**Insert requirement**>.
   c. Relative Humidity Range: [**Zero to 100**]<**Insert numbers**> percent.
   d. Response Time: Within [**10**][**20**]<**Insert number**> seconds.
   e. Temperature Accuracy:

      1) Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>accuracy over the temperature range of [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature range**>.
      2) Within [**1 deg F (0.6 deg C)**]<**Insert temperature**> when operating within the remainder of the temperature range.

   f. Temperature Range: Select for application, but not less than [**minus 40 to plus 140 deg F (minus 40 to plus 60 deg C)**]<**Insert temperature range**>.

g. Maximum Air Velocity: As required by application, but not less than [**0 to 4000 fpm (0 to 20.3 m/s)**]<**Insert velocity range**>.

7. Display:

a. Application: Include transmitters with integral [**backlit**]LCD display[**where indicated on Drawings**]<**Insert application requiring display**>.
b. Display percent relative humidity and temperature in units indicated.

8. Duct Probe: [**Plastic material listed for use in airstream with filter**][**or**][**stainless steel with sintered filter**]<**Insert requirement**>.
9. Transmitter Enclosure:

a. Enclosure Mounting: [**Integral to**][**or**][**remote from**] duct probe.
b. Enclosure Material: [**Cast aluminum**][**Plastic**][**or**][**painted metal**].
c. Enclosure Rating: NEMA 250, [**Type 1**][**or**][**Type 3R**][**Type 4**][**Type 4X**]<**Insert type**>.

10. Analog Output Signals: Two separate signals; [**4 to 20 mA**][**or**][**0 to 5 V dc**][**0 to 10 V dc**]<**Insert signal requirements**>. Include analog output signal for relative humidity and dry-bulb temperature.
11. Communication Network Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
12. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
13. Temperature Sensor: [**100-ohm platinum RTD**][**or**][**1000-ohm platinum RTD**][**10000-ohm Type II NTC thermistor**][**10000-ohm Type III NTC thermistor**][**20000-ohm NTC thermistor**]<**Insert requirement**>.
14. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.

B. Moisture and Temperature Sensors and Transmitters for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**MAMAC Systems, Inc.**]
g. [**Minco**]
h. [**Rotronic Instrument Corporation; A PST Brand**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
l. [**Vaisala**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]

b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**MAMAC Systems, Inc.**]
g. [**Minco**]
h. [**Rotronic Instrument Corporation; A PST Brand**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
l. [**Vaisala**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain moisture and temperature sensors and transmitters for space applications from single manufacturer.
4. Description: Moisture and temperature measurements combined in a single transmitter for use in space applications.
5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):

a) Within [**1.5**][**2**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
b) Within [**2**][**2.5**][**3**][**4**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

2) Operating Temperature Range within the Remainder of the Temperature Range Indicated:

a) Within [**2**][**2.5**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
b) Within [**2**][**3**][**3.5**][**5**]<**Insert number**> percent from [**90 to 95**][**90 to 100**]<**Insert numbers**> percent relative humidity.

b. Relative Humidity Operating Stability: [**Within 0.5 percent/year**]<**Insert requirement**>.
c. Relative Humidity Range: [**Zero to 100**]<**Insert numbers**> percent.
d. Response Time: Within [**10**][**20**]<**Insert number**> seconds.
e. Temperature Accuracy:

1) Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>accuracy over the temperature range of [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature range**>.
2) Within [**1 deg F (0.6 deg C)**]<**Insert temperature**> when operating within the remainder of the temperature range.

f. Temperature Range: Select for application, but not less than [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

7. Display:

a. Application: Include transmitters with integral [**backlit**]LCD display[**where indicated on Drawings**]<**Insert application requiring display**>.
b. Display percent relative humidity and temperature in units indicated.

8. Transmitter Enclosure:

   a. Enclosure Mounting: [**Integral to**][**or**][**remote from**] humidity and temperature sensor.
   b. Enclosure Material: [**Cast aluminum**][**or**][**plastic**][**painted metal**].
   c. Enclosure Rating: NEMA 250, [**Type 1**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.

9. Analog Output Signals: Two separate signals; [**4 to 20 mA**][**or**][**0 to 5 V dc**][**0 to 10 V dc**]<**Insert signal requirements**>. Include analog output signal for relative humidity and dry-bulb temperature.
10. Communication Network Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
11. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
12. Temperature Sensor: [**100-ohm platinum RTD**][**or**][**1000-ohm platinum RTD**][**10000-ohm Type II NTC thermistor**][**10000-ohm Type III NTC thermistor**][**20000-ohm NTC thermistor**]<**Insert requirement**>.
13. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.

C. Moisture and Temperature Sensors and Transmitters for Outdoor Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**MAMAC Systems, Inc.**]
   g. [**Minco**]
   h. [**Rotronic Instrument Corporation; A PST Brand**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Greystone Energy Systems, Inc.**]
   d. [**Honeywell Building Solutions; Honeywell International, Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**MAMAC Systems, Inc.**]
   g. [**Minco**]
   h. [**Rotronic Instrument Corporation; A PST Brand**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
   l. [**Vaisala**]

m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain moisture and temperature sensors and transmitters for outdoor applications from single manufacturer.
4. Description: Moisture and temperature measurements combined in a single transmitter for use in outdoor applications.
5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

   a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

      1) When operating within the temperature range indicated:

         a) Within [**2**][**3**][**5**]<**Insert number**> percent from [**zero to 90**]<**Insert numbers**> percent relative humidity.
         b) Within [**5**]<**Insert number**> percent from [**90 to 100**]<**Insert numbers**> percent relative humidity.

   b. Relative Humidity Operating Stability: [**Within 1 percent/year**]<**Insert requirement**>.
   c. Relative Humidity Range: [**Zero to 100**]<**Insert numbers**> percent.
   d. Response Time: Within [**20**][**50**]<**Insert number**> seconds.
   e. Temperature Accuracy:

      1) Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>accuracy over the temperature range of [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature range**>.
      2) Within [**1 deg F (0.6 deg C)**]<**Insert temperature**> when operating within the remainder of the temperature range.

   f. Temperature Range: Select for application, but not less than [**minus 40 to plus 140 deg F (minus 40 to plus 60 deg C)**]<**Insert temperature range**>.

7. Transmitter Enclosure:

   a. Enclosure Mounting: [**Integral to**][**or**][**remote from**] humidity and temperature sensors.
   b. Enclosure Material: [**Cast aluminum**][**Plastic**][**or**][**painted metal**].
   c. Enclosure Rating: NEMA 250, [**Type 3R**][**or**][**Type 4**][**Type 4X**]<**Insert type**>.

8. Analog Output Signals: Two separate signals; [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>. Include analog output signal for relative humidity and dry-bulb temperature.
9. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
10. Temperature Sensor: [**Platinum RTD**][**or**][**NTC thermistor**]<**Insert requirement**>.
11. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.
12. Accessories: Include transmitter assembly with weather (solar radiation and precipitation) shield and mounting kit suitable for application.

2.4 MULTIFUNCTION MOISTURE AND TEMPERATURE SENSORS AND TRANSMITTERS

A. Multifunction Moisture and Temperature Sensors and Transmitters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**E+E Elektronik Corporation**]
b. [**Rotronic Instrument Corporation; A PST Brand**]
c. [**Vaisala**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**E+E Elektronik Corporation**]
   b. [**Rotronic Instrument Corporation; A PST Brand**]
   c. [**Vaisala**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain multifunction moisture and temperature sensors and transmitters from single manufacturer.
4. Description:

   a. Factory package consisting of humidity and temperature sensors and transmitter, digital display, keypad or touchscreen display operator interface, installation hardware, interconnecting sensor cabling, installation instructions, and operating manual.
   b. Temperature-compensated relative humidity measurement.
   c. Interchangeable sensors.
   d. Include signal conditioning and analog to digital conversion either at sensors, if offering smart sensors, or at transmitter to achieve performance indicated.
   e. Provide a service cable for connecting to a notebook computer and Microsoft Windows-compatible software.

5. Factory Calibration: Factory calibrate each transmitter to [**NIST**]traceable standards and include transmitter with calibration certificate.
6. Performance:

   a. Ambient Operating Temperature-Transmitter: [**32 to 140 deg F (0 to 60 deg C)**]<**Insert temperature range**>.
   b. Relative Humidity Measurement Range: Zero to 100 percent.
   c. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:

      1) For Temperature Range between 59 to 77 Deg F (15 to 25 Deg C):

         a) Relative Humidity between Zero to 90 Percent: Within [**0.8**][**1**]<**Insert number**> percent.
         b) Relative Humidity between 90 to 100 Percent: Within [**1.7**]<**Insert number**> percent.

      2) For Temperature Range between Minus 4 to Plus 104 Deg F (Minus 20 to Plus 40 Deg C): Within [**1 percent plus 0.008 times relative humidity reading**]<**Insert accuracy**>.
      3) For Temperature between Minus 40 to 356 Deg F (Minus 40 to Plus 180 Deg C): [**Within 1.5 percent plus 0.015 times the relative humidity reading**]<**Insert accuracy**>.

   d. Relative Humidity Operating Stability: [**Within 0.5 percent/year**]<**Insert requirement**>.
   e. Response Time: Within [**20**][**40**][**60**]<**Insert value**> seconds[**in still air**].
   f. Temperature Accuracy:

1) Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>accuracy over the temperature range of [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature range**>.
2) Within [**1 deg F (0.6 deg C)**]<**Insert temperature**> when operating within the remainder of the temperature range.

g. Temperature Range: Select for application, but not less than [**minus 40 to plus 140 deg F (minus 40 to plus 60 deg C)**]<**Insert temperature range**>.

7. Integral Data Logger with Real-Time Clock:

a. Parameters Logged: Up to [**four**]<**Insert number**> operator selectable parameters with measurement trend, minimum value and maximum value over time.
b. Measurement Interval: [**10 seconds**][**Manufacturer's standard offering**]<**Insert requirement**>.
c. Logged Measurement Storage: Up to [**13 million measurements per parameter**]<**Insert requirement**>.
d. Data History: Up to [**one**][**four**]<**Insert number**>-year period.
e. Include display with graphic of measurement trends, and minimum and maximum values over data history indicated.

8. Display:

a. Alphanumeric display of the following parameters on the face of the enclosure:

1) Percent relative humidity.
2) Absolute humidity.
3) Mixing ratio.
4) Dry-bulb temperature.
5) Wet-bulb temperature.
6) Dew point temperature.
7) Enthalpy.

b. LCD display with backlight.

9. Transmitter Electronics Enclosure:

a. Enclosure Mounting: Integral to sensors for space-mounted applications unless otherwise indicated on Drawings. Install remote from temperature and humidity sensors for duct and equipment applications.
b. Material: Aluminum or aluminum alloy.
c. Rating: NEMA 250, Type 4 or 4X.
d. Electrical Connections: Labeled terminal strip for field wiring connections.
e. Conduit Connections: Minimum**1/2-inch (16-mm)** trade size, threaded.
f. Mounting Kit: Suitable for specific field mounting application; wall, DIN rail, pipe stand.

10. Programming:

a. Parameters are field programmable through keypad on the face of the enclosure.
b. Store programmed parameters in nonvolatile memory (EEPROM).

11. Output Signals:

a. Analog Output Signals: [**Two**][**Three**] separate signals; [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>. Include analog output signal for each of the following variables: [**Relative humidity**][**Dry-bulb temperature**]<**Insert variable**>.
b. Digital Output Signals: [**One**][**Two**][**Three**][**Four**] separate relay signals; [**0.5**]<**Insert**

value> A at [**240**]<**Insert value**> V ac. Include digital output signal for each of the following variables: <**Insert variable**>.

12. Communication Network Interface: [**Modbus RTU**][**or**][**Modbus TCP/IP**]<**Insert network protocol**>.
13. Humidity Sensor:

    a. Capacitive thin-film polymer or manufacturer's choice to comply with requirements indicated.
    b. Stainless steel sheath.
    c. Sintered, stainless steel filter, protecting sensor.
    d. Provide duct installation kit for duct and equipment applications.

14. Temperature Sensor:

    a. Platinum RTD; [**100 ohms**][**or**][**1000 ohms**]<**Insert resistance value**>.
    b. Provide duct installation kit for duct and equipment applications.

15. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.
16. Power Supply:

    a. Field Power: [**24**][**120**][**or**][**240**] V ac, 60 Hz, as required by the application.
    b. Internal Power: Manufacturer's standard, as required by transmitter and sensors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MOISTURE INSTRUMENT APPLICATIONS

A. Humidistat for Duct Applications: <**Insert application**>.

B. Humidistat for Space Applications: <**Insert application**>.

C. Moisture Transmitter for Duct Applications: <**Insert application**>.

D. Moisture Transmitter for Space Applications: <**Insert application**>.

E. Moisture and Temperature Transmitter for Duct Applications: <**Insert application**>.

F. Moisture and Temperature Transmitter for Space Applications: <**Insert application**>.

G. Moisture and Temperature Transmitter for Outdoor Applications: <**Insert application**>.

H. Multifunction Moisture and Temperature Transmitter: <**Insert application**>.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to [**seismic**][**or**][**external**] loads.

C. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, verify that unrestricted ladder placement is possible during occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. Where possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 INSTALLATION OF MOISTURE INSTRUMENTS

A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height to comply with codes and accessibility requirements.
2. Mount instruments located in mechanical equipment rooms and other similar space not subject to code, state, and Federal accessibility requirements within a range of **42 to 72 inches (1.1 to 1.6 m)** above the adjacent floor, grade, or service catwalk or platform.

   a. Make every effort to mount at **60 inches (1.5 m)**.

C. Seal penetrations to ductwork, plenums, and equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.5 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.9 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation that impacts performance.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE's Guideline 11, in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Switches: Calibrate switches to make or break contact at set points indicated.

E. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.[**Field calibration is not required for instruments that have been factory calibrated and provided with certificates.**]

3.11 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include

[**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper <**Insert equipment**> operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 19

Task	Specification	Specification Description
23 09 23 19	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 19	23 09 23 00a	Leak Detection Instruments
23 09 23 19	23 09 23 00b	Position Instruments
23 09 23 19	23 09 00 00	Speed Instruments
23 09 23 19	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 21 - MOTION INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motion sensors - passive infrared.
2. Motion sensors - ultrasonic.
3. Motion sensors - dual technology.
4. Motion sensors - switchbox mounted.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, cable, and other requirements that relate to this Section.
2. Section 230923.27 "Temperature Instruments" for temperature sensors that combine motion detection into a single device.
3. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.
4. Section 260923 "Lighting Control Devices" for occupancy and vacancy detectors used to control lighting[**and serve a dual purpose to also control HVAC systems**].

1.2 ACTION SUBMITTALS

A. Product Data:

1. Motion sensors - passive infrared.
2. Motion sensors - ultrasonic.
3. Motion sensors - dual technology.
4. Motion sensors - switchbox mounted.

B. Product Data Submittals: For each product.

1. Include operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Include product description with complete technical data, performance curves, and product specification sheets.

C. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to visual range and obstructions.
2. Wall- and ceiling-mounted instruments located in finished space showing relationship to other installed devices.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For motion instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MOTION SENSORS - INDOOR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
2. [**Eaton**]
3. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Leviton Manufacturing Co., Inc.**]
5. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
6. [**Lutron Electronics Co., Inc**]
7. [**NSi Industries LLC**]
8. [**Philips; Signify North America; Signify Holding**]
9. [**RAB Lighting**]
10. [**Sensor Switch, Inc**]
11. [**Square D; Schneider Electric USA**]
12. [**WattStopper; Legrand North America, LLC**]
13. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
2. [**Eaton**]
3. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Leviton Manufacturing Co., Inc.**]
5. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
6. [**Lutron Electronics Co., Inc**]
7. [**NSi Industries LLC**]
8. [**Philips; Signify North America; Signify Holding**]
9. [**RAB Lighting**]
10. [**Sensor Switch, Inc**]

11. [**Square D; Schneider Electric USA**]
12. [**WattStopper; Legrand North America, LLC**]
13. <**Insert manufacturer's name**>

C. Description: Wall- or ceiling-mounted, solid-state units with a separate relay unit.

D. General Requirements for Sensors:

1. Sensor Operation: Unless otherwise indicated, operate HVAC according to occupied mode when covered area is occupied and operate HVAC according to unoccupied mode when unoccupied; with a time delay for turning off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A load at 120 and 277 V ac. Power supply to sensor is to be 24 V dc, 150 mA, Class 2 power source as defined by NFPA 70.
4. DDC System Connection: [**Hardwired**]<**Insert requirement**>.
5. Mounting:

   a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
   b. Relay: Externally mounted through a **1/2-inch (13-mm)** knock out in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is being detected during testing and normal operation of the sensor.
7. Bypass Switch: Override the on function in case of sensor failure.
8. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

E. Motion Sensors - Passive Infrared: [**Ceiling**][**or**][**wall**] mounting; detect occupancy by sensing a combination of heat and movement in coverage area.

1. Detector Sensitivity: Detect occurrences of **6-inch- (150-mm-)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. in. (232 sq. cm)**.
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of **1000 sq. ft. (93 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
3. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft. (110 sq. m)**][**2000 sq. ft. (220 sq. m)**][**3000 sq. ft. (330 sq. m)**] when mounted **48 inches (1200 mm)** above finished floor.
4. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within **90 ft. (27.4 m)** when mounted on a **10-foot- (3-m-)** high ceiling.

F. Motion Sensors - Ultrasonic: [**Ceiling**][**or**][**wall**] mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in coverage area.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than **12 inches (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inches/s (305 mm/s)**.
2. Detection Coverage (Small Room, Ceiling Mounted): Detect occupancy anywhere within a circular area of **600 sq. ft. (56 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
3. Detection Coverage (Standard Room, Ceiling Mounted): Detect occupancy anywhere within a circular area of **1000 sq. ft. (93 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
4. Detection Coverage (Large Room, Ceiling Mounted): Detect occupancy anywhere within a circular area of **2000 sq. ft. (186 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
5. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy anywhere within **90 ft. (27.4 m)** when mounted on a **10-foot- (3-m-)** high ceiling in a corridor not wider than **14 ft.**

(4.3 m).
6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 sq. ft. (110 sq. m)][2000 sq. ft. (220 sq. m)][3000 sq. ft. (330 sq. m)] when mounted 84 inches (2100 mm) above finished floor.

G. Motion Sensors - Dual Technology: [**Ceiling**][**or**][**wall**] mounting; detect occupancy by using a combination of passive-infrared and ultrasonic detection methods in coverage area. A particular technology or combination of technologies that controls on-off functions is to be field selectable by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room, Ceiling Mounted): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling. Apply occupancy detectors where indicated.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 sq. ft. (110 sq. m)][2000 sq. ft. (220 sq. m)][3000 sq. ft. (330 sq. m)] when mounted 48 inches (1200 mm) above finished floor.

H. Color: [**White**]<**Insert color**>.

2.2 MOTION SENSORS - SWITCHBOX MOUNTED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
2. [**Eaton**]
3. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Leviton Manufacturing Co., Inc.**]
5. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
6. [**Lutron Electronics Co., Inc**]
7. [**NSi Industries LLC**]
8. [**Philips; Signify North America; Signify Holding**]
9. [**RAB Lighting**]
10. [**Sensor Switch, Inc**]
11. [**Square D; Schneider Electric USA**]
12. [**WattStopper; Legrand North America, LLC**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
2. [**Eaton**]
3. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Leviton Manufacturing Co., Inc.**]
5. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
6. [**Lutron Electronics Co., Inc**]
7. [**NSi Industries LLC**]

8. [**Philips; Signify North America; Signify Holding**]
9. [**RAB Lighting**]
10. [**Sensor Switch, Inc**]
11. [**Square D; Schneider Electric USA**]
12. [**WattStopper; Legrand North America, LLC**]
13. <**Insert manufacturer's name**>

C. Description: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.

D. General Requirements for Wall-Switch Motion Sensors:

1. Sensor Operation: Unless otherwise indicated, operate HVAC according to occupied mode when covered area is occupied and operate HVAC according to unoccupied mode when unoccupied; with a time delay for turning off, adjustable over a minimum range of 1 to 15 minutes.
2. Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
3. Switch Rating: Not less than 800 VA and 800 W.
4. DDC System Connection: [**Hardwired**]<**Insert requirement**>.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

E. Wall-Switch Motion Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of [**900 sq. ft. (84 sq. m)**][**2100 sq. ft (196 sq. m)**].
2. Sensing Technology: [**Passive infrared**][**Dual technology - passive infrared and ultrasonic**].
3. Switch Type: [**SP.**][**SP, dual circuit.**][**SP, manual "on," automatic "off."**][**SP, field-selectable, automatic "on," or manual "on," automatic "off."**]
4. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage, 120 and 277 V**].
5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
6. Concealed "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
8. Color: [**White**][**Match color of room light switch**]<**Insert color**>.
9. Faceplate: Color matched to switch.

F. Wall-Switch Motion Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of **900 sq. ft. (84 sq. m)**.
2. Sensing Technology: Passive infrared.
3. Switch Type: [**SP.**][**SP, dual circuit.**][**SP, manual "on," automatic "off."**][**SP, field-selectable, automatic "on," or manual "on," automatic "off."**]
4. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage, 120 and 277 V**].
5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
6. Concealed "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
8. Color: [**White**][**Match color of room light switch**]<**Insert color**>.
9. Faceplate: Color matched to switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MOTION SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Coordinate layout and installation of wall-mounted devices with other wall-mounted devices. Align centerline with adjacent devices. Align centerline with devices above.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.4 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Motion instruments will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for direct-digital control systems specified in Section 230923 "Direct-Digital Control (DDC) System for HVAC."

B. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain motion instruments.

C. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record Owner training and submit digital files with closeout documents for Owner's future use.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

1. Verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

END OF SECTION 23 09 23 21

Task	Specification	Specification Description
23 09 23 21	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 21	23 09 23 00a	Leak Detection Instruments
23 09 23 21	23 09 23 00b	Position Instruments
23 09 23 21	23 09 00 00	Speed Instruments
23 09 23 21	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 23 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.
4. Air-pressure differential indicating transmitter, switch, and controller.
5. Liquid-pressure switches.
6. Liquid-pressure transmitters.
7. Room pressure monitors.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for sequences of operation requirements that relate to this Section.

1.2 DEFINITIONS

A. HART: Highway addressable remote transducer protocol.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over the instrument operating range, control signal over the instrument operating range, default control signal to be used by controller with loss of power to instrument, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**]details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
3. Size and location of wall access panels for instruments installed behind walls.
4. Size and location of ceiling access panels for instruments installed in accessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each product requiring test performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Source quality-control reports.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments must operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure is to be internally insulated, electrically heated[**and cooled**], filtered, and ventilated as required by instrument and application.

2. Protect instruments and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated are to be housed in protective secondary enclosures. Base NEMA 250 enclosure requirements on instrument-installed locations as follows:

a. Outdoors, Protected: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
b. Outdoors, Unprotected: [**Type 4**][**Type 4X**]<**Insert type**>.
c. Indoors, Heated with Filtered Ventilation: [**Type 1**][**Type 2**]<**Insert type**>.
d. Indoors, Heated with Nonfiltered Ventilation: [**Type 2**][**Type 12**]<**Insert type**>.
e. Indoors, Heated and Air-Conditioned: [**Type 1**]<**Insert type**>.

f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: [**Type 12**][**Type 4**][**Type 4X**]<**Insert type**>.
2) Air-Moving Equipment Rooms: [**Type 1**][**Type 2**][**Type 12**]<**Insert type**>.

g. Localized Areas Exposed to Washdown: [**Type 4**][**Type 4X**]<**Insert type**>.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**][**Type 3**][**Type 12**]<**Insert type**>.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**][**Type 4X**]<**Insert type**>.
j. Hazardous Locations: Explosion-proof rating for condition.
k. <**Insert location and enclosure requirements**>.

2.2 AIR-PRESSURE SENSORS

A. Air-Pressure Sensor, Static Pressure Duct Insertion Type - 90-Degree Probe Design with Compression Fitting Tubing Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Process Connection: Compression fitting.
4. Construction Materials: [**Brass**][**or**][**stainless steel**].
5. Insertion Length: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**][**or**][**12 inches (300 mm)**].
6. Mounting: Sensor with threaded end support, sealing washers and nuts.
7. Pressure Measurement: Tip of sensor facing direction of airstream with four radial holes of **0.04-inch (1-mm)** diameter.
8. Pressure Signal Dampener: Provide sensor assembly with dampener designed to minimize erratic and rapid fluctuations in pressure signal.
9. Duct Types: Suitable for flat oval, rectangular, and round duct configurations.

B. Air-Pressure Sensor, Static Pressure Duct Insertion Type - 90-Degree Probe Design with Barb Tubing Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

3. Process Connection: Barb connection for use with polyethylene tubing.
4. Construction Materials: [**Brass**][**or**][**stainless steel**].
5. Insertion Length: [**4 inches (100 mm)**][**or**][**6 inches (150 mm)**].
6. Mounting: Sensor with threaded end support, sealing washers and nuts.
7. Pressure Measurement: Tip of sensor facing direction of airstream with four radial holes of **0.04-inch (1-mm)** diameter.
8. Pressure Signal Dampener: Provide sensor assembly with dampener designed to minimize erratic and rapid fluctuations in pressure signal.
9. Duct Types: Suitable for flat oval, rectangular, and round duct configurations.

C. Air-Pressure Sensor, Static Pressure Duct Insertion Type - Straight Probe with Barb Tubing Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Cleveland Controls Inc.**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Greystone Energy Systems, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Cleveland Controls Inc.**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Greystone Energy Systems, Inc.**]
   e. <**Insert manufacturer's name**>

3. Process Connection: Barb connection for use with polyethylene tubing.
4. Construction Materials: [**Aluminum**][**or**][**Stainless steel**].
5. Insertion Length: [**None required**][**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**][**or**][**12 inches (300 mm)**]<**Insert length requirement**>.
6. Mounting: Sensor with duct-mounting flange and sealing gasket.
7. Pressure Measurement: Single orifice located at open end of straight probe.
8. Pressure Signal Dampener: Provide sensor assembly with dampener to minimize erratic and rapid fluctuations in pressure signal.
9. Duct Types: Suitable for flat oval, rectangular, and round duct configurations.

D. Air-Pressure Sensor, Static Pressure Duct Insertion Type - Dual-Orifice Design:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**MAMAC Systems, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MAMAC Systems, Inc.**]
b. <**Insert manufacturer's name**>

3. Process Connection: Barb fitting for connection to polyethylene tubing.
4. Construction Material: 6061-T6 aluminum alloy.
5. Insertion Length: [**4 inches (100 mm)**][**or**][**8 inches (200 mm)**].
6. Mounting: Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
7. Pressure Measurement: Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
8. Pressure Rating: **10 psig (69 kPa)**.
9. Pressure Signal Dampener: Provide sensor assembly with dampener designed to minimize erratic and rapid fluctuations in pressure signal.
10. Duct Types: Suitable for flat oval, rectangular, and round duct configurations.

E. Air-Pressure Sensor, Static Pressure Duct Traverse Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. [**Paragon Controls Incorporated**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. [**Paragon Controls Incorporated**]
c. <**Insert manufacturer's name**>

3. Description: Sensor to traverse the duct cross section and have at least one pickup point every [**6 inches (150 mm)**]<**Insert distance**> along length of sensor.
4. Design: Dual offset static sensor designed to provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30-degree yaw and pitch.
5. Performance:

a. Accuracy: Within [**1**][**2**]<**Insert value**> percent of actual operating static pressure.
b. Air Resistance (Pressure Drop): Less than [**0.1**]<**Insert value**> times the velocity pressure at probe-operating velocity.
c. Temperature: Up to [**200 deg F (93 deg C)**][**400 deg F (204 deg C)**]<**Insert temperature**>.
d. Velocity: [**0 to 10000 fpm (0 to 51 m/s)**]<**Insert velocity**>.

6. Process Connection: Mounting plate with threaded compression fitting for connection to tubing or

threaded NPT connection.

7. Construction Material: [**Type T6063-T5 extruded and anodized aluminum**][**or**][**Type 316 stainless steel**].
8. Mounting: Sensor supported with noncorrosive threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at opposite end.
9. Pressure Signal Dampener: Provide sensor assembly with dampener to minimize erratic and rapid fluctuations in pressure signal.
10. Duct Type: Suitable for flat oval, rectangular, and round duct configurations.

F. Air-Pressure Sensor, Static Pressure Outdoor Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. <**Insert manufacturer's name**>

3. Provides average outdoor static pressure signal.
4. Sensor with no moving parts.
5. Kit includes sensor and mounting hardware.

G. Air-Pressure Sensor, Static Pressure Outdoor Type - NEMA 250, Type 4X Enclosure:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Greystone Energy Systems, Inc.**]
   d. <**Insert manufacturer's name**>

3. Provides average outdoor pressure signal.
4. Sensor with no moving parts.
5. NEMA 250, Type 4X enclosure.
6. Process Connection: Barb fitting.
7. Conduit fitting around pressure fitting for sensor support and protection to pressure connection.

H. Air-Pressure Sensor, Static Pressure Outdoor Type - Unaffected/Unimpaired by Rain and Snow:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. **<Insert manufacturer's name>**

3. Description: Shielded static pressure sensor suitable for exterior applications, used as outdoor pressure reference for space static pressure control. Sensor has multiple sensing ports, pressure impulse suppression chamber, and air-velocity shielding but no moving parts.
4. Design: Two parallel pressure-sensing plates with a uniform space between the plates.
5. Performance:

   a. Accuracy, Outdoor Atmospheric Pressure:

      1) Within 1 percent of actual value while subjected to varying horizontal radial wind velocities up to **40 mph (17 m/s)**.
      2) Within 2 percent of actual value while subjected to varying radial wind velocities up to [**40 mph (17 m/s)**][**80 mph (34 m/s)**] with approach angles up to 30 degrees to horizontal.
      3) Within 3 percent of actual value while subjected to varying radial wind velocities up to **40 mph (17 m/s)** with approach angles up to 60 degrees to horizontal.

   b. Operation not affected and impaired by rain and snow.

6. Connection: Threaded female NPT, [**1/2 inch (15 mm)**][**or**][**2 inches (50 mm)**].
7. Construction Materials: [**Type 6061 aluminum**][**Type 304 stainless steel**][**or**][**Type 316 stainless steel**].

I. Air-Pressure Sensor, Static Pressure Space Type for Wall Mounting - Stainless Steel Wall Plate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Building Automation Products Inc.; BAPI**]
   b. [**Dwyer Instruments, Inc**]

c. [**Greystone Energy Systems, Inc.**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Building Automation Products Inc.; BAPI**]
b. [**Dwyer Instruments, Inc**]
c. [**Greystone Energy Systems, Inc.**]
d. **<Insert manufacturer's name>**

3. Sintered stainless steel filter mounted in stainless steel wall plate senses static pressure.
4. Wall plate provided with gasket and screws, and sized to fit standard single-gang electrical box.
5. Back of sensor plate fitted with barb fitting for tubing connection.

J. Air-Pressure Sensor, Static Pressure Space Type for Wall Mounting - ABS Plastic Wall Plate:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Building Automation Products Inc.; BAPI**]
b. [**Dwyer Instruments, Inc**]
c. [**Greystone Energy Systems, Inc.**]
d. [**MAMAC Systems, Inc.**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Building Automation Products Inc.; BAPI**]
b. [**Dwyer Instruments, Inc**]
c. [**Greystone Energy Systems, Inc.**]
d. [**MAMAC Systems, Inc.**]
e. **<Insert manufacturer's name>**

3. White ABS plastic wall plate with integral sensing port to sense static pressure.
4. Wall plate provided with matching colored screws and sized to fit standard single-gang electrical box.
5. Not affected by germicidal or sanitizing cleaning and washdown.
6. Back of sensor plate fitted with union or barb fitting for tubing connection.

K. Air-Pressure Sensor, Static Pressure Space Type - with Published Performance for Wall Mounting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. [**Paragon Controls Incorporated**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. <**Insert manufacturer's name**>

3. Description: Flush-mounted wall plate with multiple sensing ports and pressure impulse suppression chamber.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor[**while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source**].
5. Connection: Barb or NPT fitting for connection to field-installed tubing.
6. Construction:

   a. Material: [**Aluminum**][**or**][**Stainless steel**].
   b. Exposed surfaces with brush finish.
   c. Provide wall plate with matching screws.
   d. Fits a standard single-gang electrical box.

L. Air-Pressure Sensor, Static Pressure Space Type - with Published Performance for Recessed Ceiling Mounting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. [**Paragon Controls Incorporated**]
   c. <**Insert manufacturer's name**>

3. Description: Sensor intended for flush mount sensor face on face of ceiling with sensor pressure chamber recessed in ceiling plenum.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor[**while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source**].
5. Connection: Threaded NPT fitting or compression fitting for concealed connection to field installed tubing.
6. Construction:

   a. Material: [**Aluminum**][**or**][**Stainless steel**] round plate with perforated center arranged to sense space static pressure.
   b. Exposed surfaces with brush finish.
   c. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.

M. Air-Pressure Sensor, Static Pressure Space Type - with Published Performance for Exposed Surface or Suspended Ceiling Mounting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

3. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of **1000 fpm (5.1 m/s)** from a 360-degree radial source.
4. Construction:

   a. Material: [**Aluminum**][**Stainless steel**] with perforations arranged to sense space static pressure.
   b. Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.

5. Exposed Surface-Mounted Sensor:

   a. Solid mounting plate intended for mounting to face of ceiling with sensor pressure chamber exposed to view.
   b. Connection: **0.125-inch (3-mm)** NPT fitting or compression fitting for exposed tubing connection.

6. Suspended Ceiling-Mounted Sensor:

   a. Intended for pendent mount with pressure chamber exposed to view.
   b. Connection: **1/2-inch (15-mm)** NPT fitting for exposed pipe or tubing connection.

2.3 AIR-PRESSURE SWITCHES

A. Air-Pressure Switch, Differential Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cleveland Controls Inc.**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Johnson Controls, Inc.**]
   d. [**Penn Controls**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cleveland Controls Inc.**]
b. [**Dwyer Instruments, Inc**]
c. [**Johnson Controls, Inc.**]
d. [**Penn Controls**]
e. <**Insert manufacturer's name**>

3. Description: Diaphragm operated to actuate an SPDT snap switch.

   a. Fan Safety Shutdown Applications: Switch with manual reset and SPST snap switch.

4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

   a. Accuracy/Repeatability: Within [**3**]<**Insert value**> percent of set point.
   b. Electrical Rating: [**15 A at 120 to 480 V ac**][**15 A at 120 to 277 V ac**]<**Insert electrical rating**>.
   c. Pressure Limits:

      1) Continuous: [**45 inches wg (11 kPa)**]<**Insert pressure**>.
      2) Surge: [**10 psig (69 kPa)**]<**Insert pressure**>.

   d. Pressure Range: Approximately [**2**]<**Insert value**> times set point.
   e. Temperature Limits: [**Minus 30 to plus 180 deg F (Minus 34 to plus 82 deg C)**]<**Insert temperature limits**>.

6. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
7. Process Connections: Threaded NPT or compression fittings.
8. Conduit Connections: Knock out or threaded connection(s) for trade-size conduit.
9. Wiring Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
10. Enclosure Material: Corrosion-resistant metal.
11. Enclosure Rating:

    a. Dry Indoor Installations: NEMA 250, Type 1.
    b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
    c. Hazardous Environments: Explosion proof.

B. Air-Pressure Switch, Differential Type - with Set-Point Indicator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

3. Description: Diaphragm operated to actuate an SPDT snap switch.

4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

    a. Accuracy/Repeatability: Within 1 percent.
    b. Electrical Rating: 15 A at 120 to 480 V ac.
    c. Pressure Limits:

        1) Continuous: **10 psig (69 kPa)**.
        2) Surge: **25 psig (172 kPa)**.

    d. Pressure Range: Approximately [**2**]<**Insert value**> times set point.
    e. Temperature Limits: **Minus 30 to plus 110 deg F (Minus 34 to plus 43 deg C)**.

6. User Interface: Screw-type set-point adjustment with visible enclosed set-point indicator and scale.
7. Process Connections: Threaded NPT, **1/8 inch (3 mm)**.
8. Conduit Connection: Knock out or threaded connection.
9. Wiring Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
10. Enclosure Material: Corrosion-resistant metal.
11. Enclosure Rating:

    a. Dry Indoor Installations: NEMA 250, Type 1.
    b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

C. Air-Pressure Switch, Differential Type - with Dual-Scale Adjustable Set Point:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Belimo Aircontrols (USA), Inc**]
    c. [**Building Automation Products Inc.; BAPI**]
    d. [**Dwyer Instruments, Inc**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Belimo Aircontrols (USA), Inc**]
    c. [**Building Automation Products Inc.; BAPI**]
    d. [**Dwyer Instruments, Inc**]
    e. <**Insert manufacturer's name**>

3. Description: Diaphragm operated to actuate an SPDT snap switch.
4. Performance:

    a. Electrical Rating: [**1.5 A at 250 V ac**]<**Insert electrical rating**>.
    b. Pressure Limits: [**40 inches wg (10 kPa)**]<**Insert pressure**>.
    c. Pressure Range: Approximately [**2**]<**Insert value**> times set point.

d. Temperature Limits: [**Minus 4 to plus 185 deg F (Minus 20 to plus 85 deg C)**]<**Insert pressure**>.

5. User Interface: Dual-scale set-point adjustment knob located inside removable enclosure cover.
6. Process Connections: Slip-on tubing connections.
7. Conduit Connection(s): Knock out or threaded connection(s).
8. Wiring Connections: Push-on screw terminals.
9. Enclosure Material: Plastic.
10. Enclosure Rating:

    a. Dry Indoor Installations: NEMA 250, Type 13.

D. Air-Pressure Switch, Differential Type - with Indicator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dwyer Instruments, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dwyer Instruments, Inc**]
    b. <**Insert manufacturer's name**>

3. Description: Combination gauge with integral low- and high-limit switches.
4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

    a. Accuracy:

        1) 4 percent for ranges through **0.5 in. wg (125 Pa)**.
        2) 2 percent for ranges **1 in. wg (250 Pa)** and greater.

    b. Repeatability: Within 1 percent of full scale.
    c. Switch Deadband: One pointer width and within 1 percent of full scale for each switch set point.
    d. Electrical Rating: 10 A at 120 to 240 V ac.
    e. Pressure Limits: **25 psig (172 kPa)**.
    f. Pressure Range: Approximately [**2**]<**Insert value**> set point unless otherwise required for application.
    g. Temperature Limits: **20 to 120 deg F (Minus 7 to plus 49 deg C)**.

6. User Interface: Switch zero and set-point [**tamperproof**]adjustment screws or knobs on the display face.
7. Display: Nominal **4-inch- (100-mm-)** diameter analog indication with white dial face, graduated black markings, pointer to indicate measured value, and a separate adjustable pointer for each switch set point.
8. Process Connections: Threaded NPT, **1/8 inch (3 mm)**.
9. Conduit Connection(s): **3/4-inch (20-mm)** threaded NPT connection(s).
10. Wiring Connections: Screw terminals.

11. Enclosure Material: Plastic.
12. Enclosure Rating:

    a. Dry Indoor Installations: NEMA 250, Type 1.

13. Power Supply: [**24**][**or**][**120**] V ac, 50/60 Hz.
14. Switches:

    a. Each switch used as a safety limit to have a manual reset button local to switch.
    b. Type: Each switch set point to have two Form C relays, DPDT.

2.4 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Transmitter, Differential Type - with Display:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ashcroft Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Paragon Controls Incorporated**]
    d. [**Setra Systems Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ashcroft Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Paragon Controls Incorporated**]
    d. [**Setra Systems Inc.**]
    e. <**Insert manufacturer's name**>

3. Performance:

    a. Range: Approximately [**2**]<**Insert value**> times set point.
    b. Accuracy: Within [**0.25**][**0.4**][**0.5**][**1**]<**Insert value**> percent of the full-scale range.
    c. Hysteresis: Within [**0.10**]<**Insert value**> percent of full scale.
    d. Repeatability: Within [**0.05**]<**Insert value**> percent of full scale.
    e. Stability: Within [**0.1**]<**Insert value**> percent of full scale range.
    f. Overpressure: [**10 psig (69 kPa)**][**25 psig (172 kPa)**]<**Insert pressure**>.
    g. Temperature Limits: [**Zero to 150 deg F (Minus 18 to plus 66 deg C)**]<**Insert temperature**>.
    h. Compensated Temperature Limits: [**40 to 150 deg F (4 to 66 deg C)**]<**Insert temperature**>.
    i. Thermal Effects: [**0.033**]<**Insert value**> percent of full scale per degree F.
    j. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Output Signals:

    a. Analog Current Signal:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into 800-ohm load.

b. Analog Voltage Signal:

1) Three wire, zero to [**5**][**or**][**10**] V.
2) Minimum Load Resistance: 1000 ohms.

5. Display: Four-digit digital display with minimum **0.4-inch- (10-mm-)** high numeric characters.
6. Operator Interface: Zero and span adjustments located on face or behind cover.
7. Construction:

a. Enclosure Material: Plastic enclosure with removable plastic cover.
b. Enclosure Rating: NEMA 250, [**Type 2**][**Type 4**][**or**][**Type 4X**]<**Insert type**>
c. Process Connections: Threaded, NPT swivel fittings for connection to copper tubing or barb fittings for connection to polyethylene tubing.
d. Wiring Connections: Screw terminal block; reverse wiring protected.
e. Mounting: Vertical plane mounting.
f. Provide mounting bracket suitable for installation.

8. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

B. Air-Pressure Transmitter, Differential Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Dwyer Instruments, Inc**]
c. [**MAMAC Systems, Inc.**]
d. [**Paragon Controls Incorporated**]
e. [**Setra Systems Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Dwyer Instruments, Inc**]
c. [**MAMAC Systems, Inc.**]
d. [**Paragon Controls Incorporated**]
e. [**Setra Systems Inc.**]
f. <**Insert manufacturer's name**>

3. Performance:

a. Range: Approximately [**2**]<**Insert value**> times set point.
b. Accuracy: Within [**0.25**][**0.4**][**0.5**][**1**]<**Insert value**> percent of the span at reference temperature of **70 deg F (21 deg C)**.
c. Hysteresis: Within [**0.02**]<**Insert value**> percent of the span.
d. Repeatability: Within [**0.05**]<**Insert value**> percent of the calibrated span.
e. Stability: Within [**0.25**]<**Insert value**> percent of span per year.

f. Overpressure: [**10 psig (69 kPa)**][**25 psig (172 kPa)**]<**Insert pressure**>.
g. Temperature Limits: [**Minus 20 to plus 160 deg F (Minus 29 to plus 71 deg C)**]<**Insert temperature**>.
h. Compensated Temperature Limits: [**35 to 135 deg F (2 to 57 deg C)**]<**Insert temperature**>.
i. Thermal Effects: [**0.015**]<**Insert value**> percent of full scale per degree F.
j. Warm-up Time: Within [**5**]<**Insert value**> seconds.
k. Response Time: [**5 ms**][**250 ms**][**One second**].
l. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Output Signals:

a. Analog Current Signal:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into 1000 ohm load.

b. Analog Voltage Signal:

1) Three wire, zero to [**5**][**or**][**6**][**10**] V.
2) Minimum Load Resistance: 1000 ohms.

5. Operator Interface:

a. Zero and span adjustments within [**5**][**10**]<**Insert value**> percent of full span.
b. Potentiometer adjustments located on face of transmitter or behind cover.

6. Construction:

a. Enclosure Material: Stainless steel [**or**][**plastic**].
b. Enclosure Rating: NEMA 250, [**Type 2**][**Type 4**][**or**][**Type 4X**].
c. Process Connections: Threaded, NPT swivel fittings for connection to copper tubing or barb fittings for connection to polyethylene tubing.
d. Wiring Connections: Screw terminal block. Reverse wiring protected.
e. Mounting: Vertical plane mounting.
f. Mounting Bracket: Appropriate for installation.

7. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

C. Air-Pressure Transmitter, Differential Type - for Hazardous Environments:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Dwyer Instruments, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Dwyer Instruments, Inc**]
c. <**Insert manufacturer's name**>

3. Hazardous Environments:

a. FM Approved for hazardous environments.
b. Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, and Groups A through H.
c. <**Insert requirements**>.

4. Performance:

a. Range: Approximately [**2**]<**Insert value**> times set point.
b. Accuracy: Within [**0.25**][**0.5**]<**Insert value**> percent of the span at reference temperature of [**70 deg F (21 deg C)**]<**Insert temperature**>.
c. Hysteresis: Within [**0.02**]<**Insert value**> percent of the span.
d. Repeatability: Within [**0.05**]<**Insert value**> percent of the calibrated span.
e. Stability: Within [**0.25**]<**Insert value**> percent of span per year.
f. Overpressure: [**20 psig (138 kPa)**]<**Insert pressure**>.
g. Temperature Limits: [**Minus 20 to plus 185 deg F (Minus 29 to plus 85 deg C)**]<**Insert temperature**>.
h. Compensated Temperature Limits: [**0 to 160 deg F (Minus 18 to plus 71 deg C)**]<**Insert temperature**>.
i. Thermal Effects: [**0.01**]<**Insert value**> percent of full scale per degree F.
j. Warm-up Time: Within [**5**]<**Insert value**> seconds.
k. Response Time: [**250**]<**Insert value**> ms.
l. Transmitter is to be shock and vibration tolerant without impacting performance.

5. Output Signals:

a. Analog Current Signal:

1) Two-wire, 4 to 20 mA dc current source.
2) Signal capable of operating into 1000-ohm load.

b. Analog Voltage Signal:

1) Three wire, zero to [**5**][**or**][**6**][**10**] V.
2) Minimum Load Resistance: 1000 ohms.

6. Operator Interface:

a. Zero and span adjustments within [**10**]<**Insert value**> percent of full span.
b. Potentiometer adjustments located on face of transmitter.

7. Construction:

a. Enclosure Material: Plastic.
b. Enclosure Rating: NEMA 250, Type 4X.
c. Process Connections: Threaded NPT connections for connection to tubing. Fittings are to be on bottom of instrument enclosure.
d. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections isolated from electronics.
e. Wiring Connections: Screw terminal block; reverse wiring protected.
f. Mounting: Vertical plane mounting.
g. Mounting Bracket: Appropriate for installation.

8. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

D. Air-Pressure Transmitter, Differential Type - with Indicator and Round Face:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

3. Performance:

   a. Range: Approximately [**2**]<**Insert value**> times set point.
   b. Accuracy Including Hysteresis and Repeatability: Within 1 percent of full scale at **77 deg F (25 deg C)**.
   c. Stability: Within 1 percent of full scale per year.
   d. Overpressure: **10 psig (69 kPa)**.
   e. Temperature Limits: **20 to 120 deg F (Minus 7 to plus 49 deg C)**.
   f. Thermal Effects: 0.055 percent of full scale per degree F.

4. Display: Four-digit digital display with minimum **0.7-inch- (18-mm-)** high numeric characters.
5. Operator Interface:

   a. Zero and span adjustments.
   b. Selectable engineering units.

6. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into a 1200-ohm load.

7. Construction:

   a. Enclosure Face: Nominal **4-inch (100-mm)** diameter face.
   b. Enclosure Material: Plastic casing with clear plastic cover.
   c. Enclosure Rating: NEMA 250, Type 1.
   d. Process Connections: Integral fittings for plastic tubing connections.
   e. Wiring Connections: Terminal block.
   f. Mounting: Vertical plane mounting.
   g. Mounting Bracket: Appropriate for installation.

8. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

E. Air-Pressure Transmitter, Differential Type - with Indicator and Rectangular Face:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dwyer Instruments, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dwyer Instruments, Inc**]
    b. <**Insert manufacturer's name**>

3. Performance:

    a. Range: Approximately [**2**]<**Insert value**> times set point.
    b. Accuracy including hysteresis and repeatability: Within 0.25 percent of full scale.
    c. Stability: Within 1 percent of full scale per year.
    d. Overpressure: Varies with range; at least 1.5 times range.
    e. Temperature Limits: **Minus 4 to plus 158 deg F (Minus 20 to plus 70 deg C)**.

4. Display: Digital with minimum **0.4-inch- (10-mm-)** high numeric characters.
5. Operator Interface: Zero and span adjustments.
6. Analog Output Current Signal:

    a. Two-wire, 4 to 20 mA dc current source.
    b. Signal capable of operating into a 1200-ohm load.

7. Construction:

    a. Enclosure Material: Plastic.
    b. Enclosure Rating: NEMA 250, Type 4X.
    c. Process Connections: Integral barb fittings for plastic tubing connections.
    d. Wiring Connections: Screw terminal block.
    e. Mounting: Vertical plane mounting.
    f. Mounting Bracket: Appropriate for installation.

8. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

F. Air-Pressure Transmitter, Differential Type - with Indicator and Field-Selectable Features:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dwyer Instruments, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Field-Selectable Features:

   a. Field configurable for pressure and velocity applications through user interface.
   b. Field selectable from one of three pressure ranges both in SI (metric) and inch-pound (IP) units of measure.
   c. Select range based on application. Range to be approximately [**2**]<**Insert value**> times set point.

4. Performance:

   a. Accuracy Including Hysteresis and Repeatability:

      1) Within 2 percent for **0.10 in. wg (25 Pa)**, **1.0 in. wg (250 Pa)** and all bidirectional ranges.
      2) Within 1 percent for other ranges.

   b. Stability: Within 1 percent of full scale per year.
   c. Response Time: Adjustable 0.5- to 15-second time constant with 95 percent response within 1.5 to 45 seconds.
   d. Overpressure: **1 psig (6.9 kPa)** maximum operating; **10 psig (69 kPa)** burst pressure.
   e. Temperature Limits: **Zero to 150 deg F (Minus 18 to plus 66 deg C)**.

5. Display: Four-digit digital display with minimum **0.4-inch- (10-mm-)** high numeric characters.
6. Operator Interface:

   a. Selectable pressure ranges, where indicated.
   b. Zero and span adjustments.
   c. Selectable air velocity mode with square root function.
   d. Adjustable signal dampening

7. Output Signal:

   a. Analog Current Signal:

      1) Two-wire, 4 to 20 mA dc current source.
      2) Signal capable of operating into a 1200-ohm load.

   b. Analog Voltage Signal:

      1) Three wire, zero to 10 V.
      2) Minimum Load Resistance: 1000 ohms.

8. Construction:

   a. Enclosure Face: Nominal **4-inch- (100-mm-)** diameter face.
   b. Enclosure Material: Plastic.
   c. Enclosure Rating: NEMA 250, Type 4X.
   d. Process Connections: Plastic tubing connections on side of instrument case.
   e. Conduit Connections: **1/2-inch (15-mm)** threaded connection for conduit.
   f. Wiring Connections: Terminal block for wire connections.
   g. Mounting: Vertical plane mounting.
   h. Mounting Bracket: Appropriate for installation.

9. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

G. Air-Pressure Transmitter, Differential Type - with 0.10 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Air Monitor; an ONICON Brand**]
   b. <**Insert manufacturer's name**>

3. Description: Smart transmitter receives static-pressure signals from a sensor (primary element), amplifies signals, and scales the signal to produce an output signal linear to pressure.

   a. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals to re-zero transmitter to within 0.1 percent of true zero.

4. Performance:

   a. Range: As required by application with range approximately [**2**]<**Insert value**> times set point.
   b. Calibrated Span: Field adjustable, minus 40 percent of the range.
   c. Accuracy: Within 0.10 percent of natural span.
   d. Repeatability: Within 0.15 percent of calibrated span.
   e. Linearity: Within 0.2 percent of calibrated span.
   f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
   g. Pressure: Surges of up to **25 psig (172 kPa)** will not harm transmitter.
   h. Relative Humidity: 0 to 95 percent, noncondensing.
   i. Temperature: **40 to 140 deg F (4 to 60 deg C)**.
   j. Transmitter is to be shock and vibration tolerant without impacting performance.

5. Output Signals:

   a. Analog Outputs: Two outputs, individually configurable for 0 to 5 V dc, 0 to 10 V dc, or 4 to 20 mA.
   b. Digital Outputs:

      1) Form C dry contacts rated for 3 A at 24 V ac/V dc for high and low alarms.
      2) Dual Form A dry contacts rated for 3 A at 24 V ac/V dc for auto-purge activation and acknowledgment.

6. Network Communication: [**BACnet**][**or**][**Modbus TCP/IP**].
7. Construction:

   a. Circuit Protection: Power input isolated, fused, and reverse polarity protected.
   b. Display:

1) Integral backlit LCD digital display on face of enclosure; [**two**][**four**] lines of data display, with each line individually scalable in user selectable format and units of measure.
2) LED's indicate CPU activated, auto-zero in progress, auto-zero over-ranged, auto purge in progress, and auxiliary alarm "on" status.

c. Noise Filter: Adjustable response time to reach 98 percent of a step change from 2 to 250 seconds.
d. Enclosure Rating: NEMA 250, [**Type 1**][**or**][**Type 4**].
e. Process Connections: [**1/8-inch (3-mm)**][**1/4-inch (6-mm)**]<**Insert size**> metal compression fittings for field connection to tubing.
f. Conduit Connections: Two trade-size conduit connections for connection to field-installed conduit.
g. Wiring Connections: Labeled screw terminals concealed within enclosure.

8. Operator Interface: Transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling performed digitally in the onboard microprocessor via input pushbuttons on face of enclosure.
9. Power: 24 V ac or V dc or 120 V ac via external transformer.
10. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

H. Air-Pressure Transmitter, Differential Type - with 0.25 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Monitor; an ONICON Brand**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Monitor; an ONICON Brand**]
b. <**Insert manufacturer's name**>

3. Description: Smart transmitter receives static-pressure signals from a sensor (primary element), amplifies signals, and scales the signal to produce an output signal linear to pressure.

a. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals to re-zero transmitter to within 0.1 percent of true zero.

4. Performance:

a. Range: As required by application with range approximately [**2**]<**Insert value**> times set point.
b. Calibrated Span: Field adjustable, minus 40 percent of the range.
c. Accuracy: Within 0.25 percent of natural span.
d. Repeatability: Within 0.15 percent of calibrated span.
e. Linearity: Within 0.2 percent of calibrated span.
f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.

g. Pressure: Surges of up to **25 psig (172 kPa)** will not harm transmitter.
h. Relative Humidity: 0 to 95 percent, noncondensing.
i. Temperature: **40 to 140 deg F (4 to 60 deg C)**.
j. Transmitter is to be shock and vibration tolerant without impacting performance.

5. Output Signals:

a. Analog Outputs: One output configurable for 0 to 5 V dc, 0 to 10 V dc, or 4 to 20 mA.

6. Construction:

a. Circuit Protection: Power input isolated, fused, and reverse polarity protected.
b. Display: Integral backlit LCD digital display on face of enclosure for continuous indication of airflow.
c. Noise Filter: Adjustable response time to reach 98 percent of a step change from 2 to 250 seconds.
d. Enclosure Rating: NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 12**].
e. Process Connections: [**1/8-inch (3-mm)**][**1/4-inch (6-mm)**][**or**][**3/8-inch (9-mm)**]<**Insert size**> metal compression fittings for field connection to tubing.
f. Conduit Connections: Trade-size conduit connections to field-installed connection.
g. Wiring Connections: Labeled screw terminals concealed within enclosure.

7. Power: 24 V ac or V dc.
8. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

2.5 AIR-PRESSURE DIFFERENTIAL INDICATING TRANSMITTER, SWITCH, AND CONTROLLER

A. Air-Pressure Differential Indicating Transmitter, Switch, and Controller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Description:

a. Three-in-one instrument, including digital display, controller, control relay switches, and a transmitter with a current output.
b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
c. Select instrument range based on application. Range to be approximately [**2**]<**Insert value**> times set point.

4. Performance:

a. Accuracy Including Hysteresis and Repeatability:

1) Within 1.5 percent for ranges **0.25 in. wg (68 Pa)** and less.
2) Within 1 percent for ranges **0.5 in. wg (125 Pa)** to **5 in. wg (1250 Pa)**.
3) Within 0.5 percent at **77 deg F (25 deg C)** for other ranges.

b. Stability: Within 1 percent per year.
c. Response Time: 250 ms.
d. Overpressure: Varies with range; at least [**5**]<**Insert value**> times pressure range and not less than **1.5 psig (10 kPa)**.
e. Temperature Limits: **32 to 140 deg F (Zero to 60 deg C)**.
f. Compensated Temperature Limits: **32 to 140 deg F (Zero to 60 deg C)**.
g. Thermal Effects: 0.020 percent per degree F.
h. Warm-up Period: One hour.

5. Controller Programming through Menu Keys to Access Five Menus:

a. Security level.
b. Pressure, velocity, or flow application.
c. Engineering units.
d. K-factor for use with flow application.
e. Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.
f. View high and low readings.
g. Digital dampening for smoothing erratic applications.
h. Scaling of analog output to fit range and field calibration.

6. Display:

a. Digital, four-digit display with backlight, with **0.4-inch- (10-mm-)** high alphanumeric characters.
b. Four indicators; two for set point and two for alarm status.

7. Operator Interface:

a. Set-point adjustment through keypad on face of instrument.
b. Zero and span adjustments accessible through menu.
c. Programming through keypad.

8. Analog Output Signal:

a. Two-wire, 4 to 20 mA dc current source.
b. Signal capable of operating into a 900-ohm load.

9. Digital Output Signal: Two SPDT relays, each rated for one amp at 30 V ac or dc.
10. Construction:

a. Enclosure Face: Nominal **5-inch- (125-mm-)** diameter face.
b. Enclosure Material: Die-cast-aluminum casing and [**brushed Type 304 stainless steel**]bezel.
c. Enclosure Rating: NEMA 250, Type 1.
d. Process Connections: Threaded, **1/8-inch (3-mm)** NPT connections on side or back as required by application.
e. Mounting: Vertical plane mounting.
f. Mounting Bracket: Appropriate for installation.

11. Factory Calibration: Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

2.6 LIQUID-PRESSURE SWITCHES

A. Liquid-Pressure Switch, Gauge-Pressure Type - Diaphragm Operated, Low Pressure:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Mercoid Controls; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Mercoid Controls; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Diaphragm operates to actuate an SPDT snap switch.
4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

   a. Deadband: Fixed.
   b. Operating Pressure Range: [**1 to 30 psig (7 to 207 kPa)**][**10 to 125 psig (69 to 862 kPa)**].
   c. Pressure Limits:

      1) Range 1 to 30 psig (7 to 207 kPa): **60 psig (414 kPa)**.
      2) Range 10 to 125 psig (69 to 862 kPa): **160 psig (1103 kPa)**.

   d. Temperature Limits: **Minus 30 to plus 150 deg F (Minus 35 to plus 66 deg C)**.
   e. Electrical Rating: 15 A at 120 V ac.

6. Operator Interface: External screw with visual set-point adjustment.
7. Construction:

   a. Deadband: Fixed.
   b. Enclosure:

      1) Dry Indoor Installations: NEMA 250, Type 1.
      2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
      3) Hazardous Environments: Explosion proof.

   c. Diaphragm Material: [**Nylon reinforced Buna-N**][**or**][**PTFE**].
   d. Pressure Chamber Material: [**Steel**][**or**][**Stainless steel**].
   e. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.
   f. Conduit Connections: Knock out or threaded connection.
   g. Wiring Connections: Screw terminal.

B. Liquid-Pressure Switch, Gauge-Pressure Type - Diaphragm Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Mercoid Controls; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Mercoid Controls; a division of Dwyer Instruments, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description: Diaphragm operates to actuate a [**SPDT**][**or**][**DPDT**] snap switch.
4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

   a. Adjustable Operating Pressure Range: [**10 to 150 psig (69 to 1034 kPa)**][**20 to 250 psig (138 to 1724 kPa)**][**30 to 500 psig (207 to 3447 kPa)**].
   b. Pressure Limits: **1200 psig (8274 kPa)**.
   c. Ambient Temperature Limits: **Minus 30 to plus 180 deg F (Minus 35 to plus 82 deg C)**.
   d. Process Temperature Limits: **Minus 4 to plus 167 deg F (Minus 20 to plus 75 deg C)**.
   e. Electrical Rating: 15 A at 120, 240, and 480 V ac.

6. Operator Interface: Internal hex nut set-point adjustment with enclosed and visible set-point indicator and scale.
7. Construction:

   a. Deadband: Adjustable.
   b. Enclosure:

      1) Dry Indoor Installations: NEMA 250, Type 4X.
      2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4X.
      3) Hazardous Environments: Explosion proof.

   c. Pressure Chamber Material: [**Aluminum**][**or**][**stainless steel**].
   d. Diaphragm Material: [**Buna-N**][**or**][**fluorocarbon**].
   e. Process Connections: Threaded NPT, **1/2 inch (15 mm)**.
   f. Conduit Connections: Threaded NPT, **3/4 inch (20 mm)**.
   g. Wiring Connections: Screw terminal.

C. Liquid-Pressure Switch, Gauge-Pressure Type - Bourdon Tube Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dwyer Instruments, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Description:

a. Bourdon tube operates to actuate a [**SPDT**][**or**][**DPDT**] snap switch as required for auto reset applications and SPST for manual reset applications.
b. Provide switches used in safety limiting applications with [**auto**][**manual**] reset.

4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

a. Operating Pressure Range: Not less than system design pressure rating.
b. Pressure Limits: Equal to maximum pressure in full-scale range, but not less than system design pressure rating.
c. Temperature Limits: **180 deg F (82 deg C)**.
d. Electrical Rating: Minimum 10 A at 120/240 V ac.

6. Operator Interface: Thumbscrew set-point adjustment with visible enclosed set-point indicator and scale.
7. Construction:

a. Deadband: [**Adjustable**][**Fixed**][**Adjustable or fixed as required by application**].
b. Enclosure:

1) Dry Indoor Installations: NEMA 250, Type 1.
2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
3) Hazardous Environments: Explosion proof.

c. Wetted Parts: [**Brass**][**Type 403 stainless steel**][**or**][**Type 316 stainless steel**].
d. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.
e. Conduit Connections: Knock out or threaded connection.
f. Wiring Connections: Screw terminal.

D. Liquid-Pressure Switch, Differential Type - with Set-Point Indicator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. <**Insert manufacturer's name**>

3. Description: Double opposing bellows operate to actuate a SPDT snap switch

4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

    a. Operating Pressure Range: Approximately [**2**]<**Insert value**> times set point.
    b. Pressure Limits: At least [**5**]<**Insert value**> times full-scale range, but not less than system design pressure rating.
    c. Temperature Limits: **Minus 10 to plus 180 deg F (Minus 23 to plus 82 deg C)**.
    d. Electrical Rating: 15 A at 120 to 240 V ac.

6. Operator Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
7. Construction:

    a. Deadband: [**Adjustable**][**Fixed**][**Adjustable or fixed as required by application**].
    b. Bellows: [**Brass**][**or**][**Type 316 stainless steel**].
    c. Enclosure:

        1) Dry Indoor Installations: NEMA 250, Type 1.
        2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
        3) Hazardous Environments: Explosion proof.

    d. Process Connections: Threaded NPT, **1/8 inch (3 mm)**.
    e. Conduit Connections: Knock out or threaded connection.
    f. Wiring Connections: Screw terminal.

E. Liquid-Pressure Switch, Differential Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ashcroft Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ashcroft Inc**]
    b. <**Insert manufacturer's name**>

3. Description: Diaphragm operates to actuate an SPDT snap switch for auto reset applications and SPST for manual reset applications.

    a. Provide switches used in safety limiting applications with [**auto**][**manual**] reset.

4. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Performance:

    a. Pressure Range: Approximately [**2**]<**Insert value**> times set point, unless otherwise required by application.
    b. Pressure Limits: **Zero to 500 psig (Zero to 3447 kPa)**.
    c. Ambient Temperature Limits: **Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**.

d. Process Temperature Limits: [**20 to 150 deg F (Minus 7 to plus 66 deg C)**][**20 to 300 deg F (Minus 7 to plus 149 deg C)**].
e. Electrical Rating: 10 A at 120 to 240 V ac.

6. Operator Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
7. Construction:

a. Deadband: [**Adjustable**][**Fixed**][**Adjustable or fixed as required by application**].
b. Enclosure Material: [**Aluminum**][**or**][**Stainless steel**]
c. Enclosure Rating: NEMA 250, Type 4 or 4X.
d. Seals: [**Buna-N**][**or**][**Viton**].
e. Wetted Parts: Type 316 stainless steel.
f. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.
g. Conduit Connections: Threaded connection.
h. Wiring Connections: Screw terminals.

2.7 LIQUID-PRESSURE TRANSMITTERS

A. Liquid Gauge Pressure Transmitter with Adjustable Span:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

3. Performance:

a. Pressure Range: [**Minus 300 to plus 300 psig (Minus 2068 to plus 2068 kPa)**]<**Insert pressure range**>.
b. Span: Field adjustable.
c. Minimum Span: [**2 psig (14 kPa)**]<**Insert pressure**>.
d. Accuracy: Within [**0.07**]<**Insert value**> percent of span or better.
e. Stability: Within [**0.125**]<**Insert value**> percent of upper range limit for [**5**]<**Insert value**> years.
f. Overpressure Limits: [**3626 psig (25000 kPa)**]<**Insert pressure**>.
g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
i. Temperature Effect: Within [**0.025**]<**Insert value**> percent of upper range limit plus [**0.125**]<**Insert value**> percent of span.
j. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Analog Output Current Signal:

a. Two-wire, 4 to 20 mA dc current source.
b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
c. Digital signal based on HART protocol carried with current signal.
d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

5. Operator Interface: Zero and span adjustments located behind removable cover.
6. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
7. Construction:

a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
b. Nonwetted Parts: Aluminum or stainless steel.
c. Wetted Parts: Type 316 stainless steel.
d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert size**>.
e. Drain/vent valve on low- and high-pressure connections.
f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
g. Wiring Connections: Labeled screw terminal block.
h. Mounting Backets: Include mounting brackets suitable for installation.

8. Valve Manifold:

a. Furnish each transmitter with integrally mounted three-valve manifold.
b. Construction: Type 316 stainless steel.
c. Process Connections: Threaded NPT, **1/2 inch (16 mm)**.

9. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide a certificate of calibration for each transmitter.

B. Liquid-Pressure Transmitter, Gauge-Pressure Type - with High Accuracy and Adjustable Span for Hazardous Environments:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

3. Hazardous Classification:

a. FM Approved for hazardous environments.
b. Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, and Groups A through H.
c. Explosion-proof for Class I, Division 1, and Groups B, C, and D.
d. Dust-ignition-proof for Class II, Division 1, and Groups E, F, and G.
e. Dust-ignition-proof for Class III, Division 1.
f. <**Insert requirements**>.

4. Performance:

    a. Pressure Range: [**Minus 300 to plus 300 psig (Minus 2068 to plus 2068 kPa)**]<**Insert pressure range**>.
    b. Span: Field adjustable.
    c. Minimum Span: [**2 psig (14 kPa)**]<**Insert pressure**>.
    d. Accuracy: Within [**0.07**]<**Insert value**> percent of span or better.
    e. Stability: Within [**0.125**]<**Insert value**> percent of upper range limit for [**5**]<**Insert value**> years.
    f. Overpressure Limits: [**3626 psig (25000 kPa)**]<**Insert pressure**>.
    g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
    h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
    i. Temperature Effect: Within [**0.025**]<**Insert value**> percent of upper range limit plus [**0.125**]<**Insert value**> percent of span.
    j. Transmitter is to be shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

    a. Two-wire, 4 to 20 mA dc current source.
    b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
    c. Digital signal based on HART protocol carried with current signal.
    d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

6. Operator Interface: Zero and span adjustments located behind removable cover.
7. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
8. Construction:

    a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
    b. Nonwetted Parts: Aluminum or stainless steel.
    c. Wetted Parts: Type 316 stainless steel.
    d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert size**>.
    e. Drain/vent valve on low- and high-pressure connections.
    f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
    g. Wiring Connections: Labeled screw terminal block.
    h. Mounting Bracket: Include mounting brackets suitable for installation.

9. Valve Manifold:

    a. Furnish each transmitter with integrally mounted three-valve manifold.
    b. Construction: Type 316 stainless steel.
    c. Process Connections: Threaded NPT, **1/2 inch (16 mm)**.

10. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide a certificate of calibration for each transmitter.

C. Liquid-Pressure Transmitter, Differential Type - with High Accuracy and Adjustable Span:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. <**Insert manufacturer's name**>

3. Performance:

   a. Pressure Range: [**Minus 300 to plus 300 psig (Minus 2068 to plus 2068 kPa)**]<**Insert pressure range**>.
   b. Span: Field adjustable.
   c. Minimum Span: [**2 psig (14 kPa)**]<**Insert pressure**>.
   d. Accuracy: Within [**0.07**]<**Insert value**> percent of span or better.
   e. Stability: Within [**0.125**]<**Insert value**> percent of upper range limit for [**5**]<**Insert value**> years.
   f. Overpressure Limits: [**3626 psig (25000 kPa)**]<**Insert pressure**>.
   g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
   h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
   i. Temperature Effect: Within [**0.025**]<**Insert value**> percent of upper range limit plus [**0.125**]<**Insert value**> percent of span.
   j. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
   c. Digital signal based on HART protocol carried with current signal.
   d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

5. Operator Interface: Zero and span adjustments located behind removable cover.
6. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
7. Construction:

   a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
   b. Nonwetted Parts: Aluminum or stainless steel.
   c. Wetted Parts: Type 316 stainless steel.
   d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert size**>.
   e. Drain/vent valve on low- and high-pressure connections.
   f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
   g. Wiring Connections: Labeled screw terminal block.
   h. Mounting Bracket: Include mounting brackets suitable for installation.

8. Valve Manifold:

   a. Furnish each transmitter with integrally mounted five-valve manifold.
   b. Construction: Type 316 stainless steel.
   c. Process Connections: Threaded NPT, **1/2 inch (16 mm)**.

9. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide a certificate of calibration for each transmitter.

D. Liquid-Pressure Transmitter, Differential Type - with High Accuracy and Adjustable Span for Hazardous Environments:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   b. <**Insert manufacturer's name**>

3. Hazardous Classification:

   a. FM Approved for hazardous environments.
   b. Intrinsically safe for Classes I, II, and III, Divisions 1 and 2, and Groups A through H.
   c. Explosion-proof for Class I, Division 1, and Groups B, C, and D.
   d. Dust-ignition-proof for Class II, Division 1, and Groups E, F, and G.
   e. Dust-ignition-proof for Class III, Division 1.
   f. <**Insert requirements**>.

4. Performance:

   a. Pressure Range: [**Minus 300 to plus 300 psig (Minus 2068 to plus 2068 kPa)**]<**Insert pressure range**>.
   b. Span: Field adjustable.
   c. Minimum Span: [**2 psig (14 kPa)**]<**Insert pressure**>.
   d. Accuracy: Within [**0.07**]<**Insert value**> percent of span or better.
   e. Stability: Within [**0.125**]<**Insert value**> percent of upper range limit for [**5**]<**Insert value**> years.
   f. Overpressure Limits: [**3626 psig (25000 kPa)**]<**Insert pressure**>.
   g. Ambient Temperature Limits: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
   h. Process Temperature Limits: [**Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**]<**Insert temperature range**>.
   i. Temperature Effect: Within [**0.025**]<**Insert value**> percent of upper range limit plus [**0.125**]<**Insert value**> percent of span.
   j. Transmitter is to be shock and vibration tolerant without impacting performance.

5. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into [**1000**]<**Insert value**>-ohm load.
   c. Digital signal based on HART protocol carried with current signal.
   d. Dampening: Field-selectable zero to [**30**]<**Insert value**> seconds.

6. Operator Interface: Zero and span adjustments located behind removable cover.

7. Display: Five-digit, two-line digital display with minimum **0.4-inch- (10-mm-)** high alphanumeric characters.
8. Construction:

    a. Enclosure: NEMA 250, Type 4X with removable cover on each side.
    b. Nonwetted Parts: Aluminum or stainless steel.
    c. Wetted Parts: Type 316 stainless steel.
    d. Process Connections: [**NPS 1/2 (DN 15)**]<**Insert size**>.
    e. Drain/vent valve on low- and high-pressure connections.
    f. Conduit Connections: Two **1/2-inch (16-mm)** trade-size conduit connections with plugs on side of instrument enclosure.
    g. Wiring Connections: Labeled screw terminal block.
    h. Mounting Bracket: Include mounting brackets suitable for installation.

9. Valve Manifold:

    a. Furnish each transmitter with integrally mounted five-valve manifold.
    b. Construction: Type 316 stainless steel.
    c. Process Connections: Threaded NPT, **1/2 inch (16 mm)**.

10. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide a certificate of calibration for each transmitter.

E. Liquid-Pressure Transmitter, Differential Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Dwyer Instruments, Inc**]
    b. [**Setra Systems Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Dwyer Instruments, Inc**]
    b. [**Setra Systems Inc.**]
    c. <**Insert manufacturer's name**>

3. Performance:

    a. Range: Approximately [**2**]<**Insert value**> times set point.
    b. Span: Adjustable plus or minus one milliamp, noninteractive.
    c. Accuracy: Within 0.25 percent of full-scale range.
    d. Pressure: Maximum operating pressure [**2.5**]<**Insert value**> times range, but not less than system design pressure.
    e. Temperature Limits: **Zero to 175 deg F (Minus 18 to plus 79 deg C)**.
    f. Compensated Temperature Limits: **30 to 150 deg F (Minus 1 to plus 66 deg C)**.
    g. Thermal Effects: 0.02 percent of full scale range per degree F.
    h. Response Time: 30 to 50 ms.
    i. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into 1000-ohm load.

5. Operator Interface:

   a. Zero and span adjustments located on face or behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

6. Construction:

   a. Enclosure: Aluminum and stainless steel enclosure with removable cover.
   b. Enclosure NEMA Rating: NEMA 250, Type 4 or 4X.
   c. Wetted Parts: Constructed of 17-4 PH or 300 Series stainless steel.
   d. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.
   e. Conduit Connections: Knock out for **1/2-inch (16-mm)** nominal connections on side of instrument enclosure.
   f. Wiring Connections: Screw terminal block.
   g. Mounting Bracket: Appropriate for installation.

7. Three-Valve Manifold:

   a. Construction Materials: Brass, bronze, or stainless steel.
   b. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.

8. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide each transmitter with a certificate of calibration.

F. Liquid-Pressure Transmitter, Differential Type - Single-Diaphragm Design:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Setra Systems Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Setra Systems Inc.**]
   b. <**Insert manufacturer's name**>

3. Performance:

   a. Range: Approximately [**2**]<**Insert value**> times the set point.
   b. Span: Adjustable within one milliamp, noninteractive.
   c. Accuracy: Within 0.25 percent of full scale.
   d. Hysteresis: Within 0.1 percent of full scale.
   e. Repeatability: Within 0.05 percent of full scale.
   f. Maximum Working Pressure: **250 psig (1724 kPa)**.
   g. Temperature Limits: **Zero to plus 175 deg F (Minus 18 to plus 79 deg C)**.

h. Compensated Temperature Limits: **30 to 150 deg F (Minus 1 to plus 66 deg C)**.
i. Thermal Effects: 0.02 percent of full scale per degree F.
j. Response Time: 30 to 50 ms.
k. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into 1000-ohm load.

5. Analog Output Voltage Signal:

   a. Three wire, zero to [**5**][**or**][**10**] V.
   b. Minimum Load Resistance: 1000 ohms.

6. Operator Interface:

   a. Zero and span adjustments located behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.

7. Construction:

   a. Enclosure: Aluminum and stainless steel with removable cover.
   b. Enclosure NEMA Rating: NEMA 250, Type 4.
   c. Wetted Parts: Constructed of 17-4 PH or 300 Series stainless steel.
   d. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.
   e. Conduit Connections: Knock out for **1/2-inch (15-mm)** nominal conduit connection on side of instrument enclosure.
   f. Wiring Connections: Screw terminal block.
   g. Mounting Bracket: Appropriate for installation.

8. Valve Manifold: [**Three-**][**or**][**Five-**] valve design.

   a. Construct manifold of brass, bronze, or stainless steel.
   b. Process Connections: Threaded NPT, **1/4 inch (6 mm)**.

9. Factory Calibration: Calibrate each transmitter to NIST or other industry recognized traceable standards and provide a certificate of calibration for each transmitter.

G. Liquid-Pressure Transmitter, Differential Type - with Field-Selectable Range and Display:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dwyer Instruments, Inc**]
   b. [**Greystone Energy Systems, Inc.**]
   c. [**Setra Systems Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dwyer Instruments, Inc**]
b. [**Greystone Energy Systems, Inc.**]
c. [**Setra Systems Inc.**]
d. **<Insert manufacturer's name>**

3. Performance:

a. Field-Selectable Range:

1) **5, 10, 25, and 50 psig (34, 69, 172, and 345 kPa)**.
2) **10, 20, 50, and 100 psig (69, 138, 345, and 689 kPa)**.
3) **25, 50, 125, and 250 psig (172, 345, 862, and 1724 kPa)**.

b. Field-selectable unidirectional or bidirectional range.
c. Accuracy: Within 1 percent of the full-scale range, except lowest selectable range within 2 percent.
d. Stability: Within 0.5 percent of span per year.
e. Pressure: Maximum operating pressure equal to highest pressure in range, but not less than system design pressure.
f. Overpressure: Proof pressure 2 times full scale range; burst pressure [**20**][**40**] times full-scale range.
g. Ambient Temperature Limits: [**Minus 4 to plus 185 deg F (Minus 20 to plus 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**].
h. Compensated Temperature Limits: **32 to 130 deg F (Zero to 54 deg C)**.
i. Thermal Effects: 2 percent of full scale per **100 deg F (56 deg C)**.
j. Response Time: Field selectable from 1 to [**5**][**60**] seconds.
k. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Configurable Analog Output Current Signal:

a. Two-wire, 4 to 20 mA dc current source.
b. Signal capable of operating into [**550**][**1000**]-ohm load.

5. Configurable Analog Output Voltage Signals:

a. Three wire, zero to 5 V, zero to 10 V[**, and 1 to 5 V**].
b. Minimum Load Resistance: 1000 ohms.

6. Display: Four-digit LCD with minimum **0.4-inch- (10-mm-)** high numeric characters.
7. Operator Interface:

a. Digital zero button located behind cover.
b. Range selector located behind cover.

8. Construction:

a. Enclosure: Cast-aluminum enclosure with removable cover.
b. Enclosure NEMA Rating: NEMA 250, Type 4 or 4X.
c. Wetted Parts: Constructed of 17-4 PH stainless steel.
d. Process Connections: Threaded NPT, **1/8 inch (3 mm)**.
e. Conduit Connections: **1/2-inch (16-mm)** trade-size connection.
f. Wiring Connections: Screw terminal block.
g. Mounting: Vertical plane mounting.
h. Mounting Bracket: Appropriate for installation.

9. Three-Valve Manifold:

a. Construction Materials: Brass, bronze, or stainless steel.
b. Process Connections: Threaded NPT.

10. Factory Calibration: Calibrate each transmitter to NIST-traceable standards and provide a certificate of calibration for each transmitter.

H. Liquid-Pressure Transmitter, Differential Type - 1 Percent Accuracy:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**MAMAC Systems, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MAMAC Systems, Inc.**]
   b. <**Insert manufacturer's name**>

3. Performance:

   a. Range: Approximately [**2**]<**Insert value**> times set point.
   b. Accuracy: Within 1 percent of the full-scale range.
   c. Overpressure: Proof pressure 3 times full-scale range, burst pressure 5 times full-scale range.
   d. Compensated Temperature Limits: **Zero to 180 deg F (Minus 18 to plus 82 deg C)**.
   e. Thermal Effects: 0.025 percent of full scale per degree F.
   f. Transmitter is to be shock and vibration tolerant without impacting performance.

4. Analog Output Current Signal:

   a. Two-wire, 4 to 20 mA dc current source.
   b. Signal capable of operating into 1000-ohm load.

5. Analog Output Voltage Signals:

   a. Three wire, field selectable from zero to 5 V or zero to 10 V.
   b. Minimum Load Resistance: 1000 ohms.

6. Construction:

   a. Enclosure: Corrosion-resistant steel with baked-enamel finish and removable front cover.
   b. Enclosure NEMA Rating: NEMA 250, Type 1.
   c. Wetted Parts: Constructed of stainless steel.
   d. Process Connections: Threaded NPT, **1/8-inch (3-mm)**.
   e. Conduit Connections: **1/2-inch (16 mm)** trade-size conduit on side of instrument enclosure.
   f. Wiring Connections: Screw terminal block.
   g. Vertical plane mounting.
   h. Mounting Bracket: Appropriate for installation.

2.8 ROOM PRESSURE MONITORS

A. Room Pressure Monitor, Multifunction - Isolated Pressure Measurement Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Critical Room Control**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Setra Systems Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Critical Room Control**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Setra Systems Inc.**]
   d. <**Insert manufacturer's name**>

3. General:

   a. Integral self-diagnostics to ensure unit is operating properly.
   b. Save parameters and settings in nonvolatile memory.
   c. Field configurable, without need for commissioning tools, through easy-to-use and intuitive display menus.
   d. Positive, negative, no (neutral) and vacant (stand-by) pressurization modes set using touchscreen display.
   e. Pressurization modes remotely switchable through remote control system interface.
   f. Multiple levels of password protection to provide secure access to functions.

4. Mounting: Recessed in wall, unless otherwise indicated.
5. Monitoring and Control:

   a. Field configurable for monitoring and display only, or for monitoring, display and integral control.

      1) Monitoring and Display: Room pressure differential, temperature, relative humidity[**, room air-change rate**][**and**][**operator (user)-defined parameters indicated**].
      2) Control: Room pressure differential, room temperature[**, room relative humidity**].

   b. Pressure Differential:

      1) Inputs: 0 to 5 V, 0 to 10 V, or 4 to 20 mA or serial communication signal from network.
      2) Output: 0 to 5 V or 0 to 10 V analog signal for remote monitoring by control system.
      3) Integral and field-tunable [**PI**][**or**][**PID**] control function where standalone operation is indicated.

   c. Temperature:

      1) Inputs: 0 to 5 V, 0 to 10 V, or 4 to 20 mA or serial communication signal from control system.

2) Output: 0 to 5 V or 0 to 10 V analog signal for temperature control.
3) Integral and field-tunable [**PI**][**or**][**PID**] control function where standalone operation is indicated.

d. Relative Humidity:

1) Inputs: 0 to 5 V, 0 to 10 V, or 4 to 20 mA or serial communication signal from control system.
2) Output: 0 to 5 V, 0 to 10 V analog signal for humidity control.
3) Integral and field-tunable [**PI**][**or**][**PID**] control function where standalone operation is indicated.

e. Room Air-Change Rate (ACH):

1) Inputs: 0 to 5 V, 0 to 10 V, or 4 to 20 mA or serial communication signal from control system for ACH or perform ACH calculation from input signal of room airflow.

f. Operator (User)-Defined Parameter(s).

1) <**Insert requirements**>.

6. Color Touchscreen Display:

a. Screen Size: Nominal [**6-inch (150-mm)**][**or**][**7-inch (175-mm)**]<**Insert size**>.
b. Complete word text with graphics and color indication of pressure differential operating condition and room status. Colors indicated are preferred. Other colors are acceptable so long as a unique color is used for each different condition/status.

1) Green for "Normal" status.
2) Orange for "Warning" status.
3) Red for "Alarm" status.
4) Blue for "Vacant" or "Stand-by" status.

c. Highly visible and readable in direct sunlight.
d. Operator interaction with screen through bare finger, gloved finger, or stylus.
e. Two separate levels of field-changeable password-protected operator access.
f. Alphanumeric display of room name and number.
g. Pressure differential display with resolution to at least four decimal places.
h. Onscreen ability to:

1) Silence audible alarms.
2) Manually zero calibrate pressure measurement with a single touch.
3) Display and hide room temperature and temperature set point.
4) Display and hide room relative humidity and relative humidity set point.
5) Change temperature set point.
6) Change relative humidity set point.
7) Display and hide room air-change rate.
8) Change display units of measure between IP and SI.

7. Pressure Differential Transducer:

a. Room monitor to house a pressure differential transducer with two pressure ports for connection to remotely mounted space pressure sensors.

1) Install one space pressure sensor in room being monitored and the other space

pressure sensor in the reference space.
2) Maintain complete isolation of each room pressure measurement to prevent possible contamination between the two spaces.

b. High-end, industrial-grade instrument with long-term accuracy and stability.
c. Accuracy: Within [**0.1**][**0.25**]<**Insert value**> percent of the full-scale range.
d. Full Scale Pressure Range: Select for specific application with bidirectional full-scale range approximately [**2**]<**Insert value**> times room pressure differential control set point.
e. Overpressure: Up to [**1 psig (7 kPa)**][**5 psig (35 kPa)**]<**Insert pressure**> without damage.
f. Factory Calibration: Provide NIST-traceable calibration certificate for each transducer.

8. Digital Inputs:

a. Door position contacts.
b. Room occupancy contacts.
c. Remote silence of audible alarm.
d. Airflow alarm.
e. Operator (User)-Defined Parameter(s): <**Insert requirement**>.

9. Digital Outputs:

a. Normally open relays rated for up to 12 V at 500 mA.
b. Separate output signals:

1) Pressure alarm indication.
2) Temperature alarm indication.
3) Airflow alarm indication.
4) Audible alarm indication.

10. Control System Communication Interface:

a. Interface to Any of following: BACnet IP, BACnet MS/TP, LON, or Modbus.
b. Provide interface required by control system.

11. Alarming:

a. Independent high and low audible and visual alarms.
b. Adjustable time delay for audible and visual alarms.
c. Unique and distinct sound for pressure and remote alarms.

B. Room Pressure Monitor, Multifunction Thermal Measurement Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**TSI Incorporated**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**TSI Incorporated**]
b. <**Insert manufacturer's name**>

3. General:

    a. Integral self-diagnostics to ensure unit is operating properly.
    b. Save parameters and settings in nonvolatile memory.
    c. Field configurable, without need for commissioning tools, through easy-to-use and intuitive display menus.
    d. Positive, negative, no (neutral), and vacant (stand-by) pressurization modes set using touchscreen display.
    e. Pressurization modes remotely switchable through remote control system interface.
    f. Multiple levels of password protection to provide secure access to functions.

4. Mounting: Recessed in wall, unless otherwise indicated.
5. Monitoring and Control:

    a. Field configurable for monitoring and display only, or for monitoring, display and integral control.

        1) Monitoring and Display: Room pressure differential, temperature, relative humidity[**and room air-change rate**].
        2) Control: Room pressure differential, room temperature[**and room relative humidity**].

    b. Pressure Differential:

        1) Inputs: 0 to 10 V or 4 to 20 mA or serial communication signal from network.
        2) Output: 0 to 10 V analog signal for remote monitoring by control system.
        3) Integral and field-tunable [**PI**][**or**][**PID**] control function where standalone operation is indicated.

    c. Temperature:

        1) Inputs: 0 to 10 V or 4 to 20 mA or serial communication signal from control system.
        2) Output: 0 to 10 V analog signal for temperature control.
        3) Integral and field-tunable [**PI**][**or**][**PID**] control function where standalone operation is indicated.

    d. Relative Humidity:

        1) Inputs: 0 to 10 V or 4 to 20 mA or serial communication signal from control system.

    e. Room Air-Change Rate (ACH):

        1) Inputs: 0 to 10 V or 4 to 20 mA or serial communication signal from control system for ACH or perform ACH calculation from input signal of room airflow.

6. Color Touchscreen Display:

    a. Screen Size: Nominal **5-inch (125-mm)**.
    b. Complete word text with graphics and color indication of pressure differential operating condition and room status. Colors indicated are preferred. Other colors are acceptable so long as a discreet color is used for each different condition.

        1) Green for "Normal" status.
        2) Orange for "Warning" status.
        3) Red for "Alarm" status.

4) Blue for "Vacant" or "Stand-by" status.

c. Highly visible and readable in direct sunlight.
d. Operator interaction with screen through bare finger, gloved finger, or stylus.
e. Alphanumeric display of room name and number.
f. Pressure differential display with resolution to at least four decimal places.
g. Onscreen ability to:

1) Silence audible alarms.
2) Manually zero calibrate pressure measurement with a single touch.
3) Display and hide room temperature and temperature set point.
4) Display and hide room relative humidity and relative humidity set point.
5) Change temperature set point.
6) Change relative humidity set point.
7) Display and hide room air-change rate.
8) Change display units of measure between IP and SI.

7. Pressure Differential Measurement:

a. Bidirectional through-the-sensor using thermal measurement technology.
b. Performance:

1) Accuracy: Within 10 percent of actual pressure reading over a range of **negative 0.2 to positive 0.2 inch wg (negative 50 to positive 50 Pa)**.
2) Resolution: Within 5 percent of actual reading.
3) Temperature Compensation: **55 to 95 deg F (13 to 35 deg C)**.

c. Factory Calibration: Provide sensor with a NIST-traceable calibration certificate.

8. Digital Inputs:

a. Door position contacts.
b. Room occupancy contacts.
c. Remote silence of audible alarm.
d. Airflow alarm.

9. Digital Outputs:

a. Normally open relays.
b. Separate output signals:

1) High-pressure alarm indication.
2) Low-pressure alarm indication.

10. Control System Communication Interface:

a. Interface to Any of following: BACnet MS/TP, LONworks, or Modbus.
b. Provide interface required by control system.

11. Alarming:

a. Independent high and low audible and visual alarms.
b. Adjustable time delay for audible and visual alarms.
c. Unique and distinct sound for pressure and remote alarms.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping systems to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PRESSURE INSTRUMENT APPLICATIONS

A. Air-Pressure Sensors:

1. Air-Pressure Sensor, Static Pressure Duct Insertion Type - 90-Degree Probe Design with Compression Fitting Connection: <**Insert system**><**Insert unique application**>.
2. Air-Pressure Sensor, Static Pressure Duct Insertion Type - 90-Degree Probe Design with Barb Connection: <**Insert system**><**Insert unique application**>.
3. Air-Pressure Sensor, Static Pressure Duct Insertion Type - Straight Probe with Barb Connection: <**Insert system**><**Insert unique application**>.
4. Air-Pressure Sensor, Static Pressure Duct Insertion Type - Dual-Orifice Design: <**Insert system**><**Insert unique application**>.
5. Air-Pressure Sensor, Static Pressure Duct Traverse Type: <**Insert system**><**Insert unique application**>.
6. Air-Pressure Sensor, Static Pressure, Outdoor Type : <**Insert system**><**Insert unique application**>.
7. Air-Pressure Sensor, Static Pressure Outdoor Type - NEMA 250, Type 4X Enclosure: <**Insert system**><**Insert unique application**>.
8. Air-Pressure Sensor, Static Pressure Outdoor Type - Unaffected/Unimpaired by Rain and Snow: <**Insert system**><**Insert unique application**>.
9. Air-Pressure Sensor, Static Pressure Space Type for Wall Mounting - Stainless Steel Wall Plate: <**Insert system**><**Insert unique application**>.
10. Air-Pressure Sensor, Static Pressure Space Type for Wall Mounting - ABS Plastic Wall Plate: <**Insert system**><**Insert unique application**>.
11. Air-Pressure Sensor, Static Pressure Space Type with Published Performance for Wall Mounting: <**Insert system**><**Insert unique application**>.
12. Air-Pressure Sensor, Static Pressure Space Type with Published Performance for Recessed Ceiling Mounting: <**Insert system**><**Insert unique application**>.

13. Air-Pressure Sensor, Static Pressure Space Type with Published Performance for Exposed or Suspended Ceiling Mounting: <**Insert system**><**Insert unique application**>.

B. Air-Pressure Switches:

1. Air-Pressure Switch, Differential Type: <**Insert system**><**Insert unique application**>.
2. Air-Pressure Switch, Differential Type - with Set-Point Indicator: <**Insert system**><**Insert unique application**>.
3. Air-Pressure Switch, Differential Type - with Dual-Scale Adjustable Set Point: <**Insert system**><**Insert unique application**>.
4. Air-Pressure Switch, Differential Type - with Indicator: <**Insert system**><**Insert unique application**>.

C. Air-Pressure Transmitters:

1. Air-Pressure Transmitter, Differential Type - with Display: <**Insert system**><**Insert unique application**>.
2. Air-Pressure Transmitter, Differential Type: <**Insert system**><**Insert unique application**>.
3. Air-Pressure Transmitter, Differential Type - for Hazardous Environments: <**Insert system**><**Insert unique application**>.
4. Air-Pressure Transmitter, Differential Type - with Indicator and Round Face: <**Insert system**><**Insert unique application**>.
5. Air-Pressure Transmitter, Differential Type - with Indicator and Rectangular Face: <**Insert system**><**Insert unique application**>.
6. Air-Pressure Transmitter, Differential Type - with Field-Selectable Features: <**Insert system**><**Insert unique application**>.
7. Air-Pressure Transmitter, Differential Type - with 0.10 Percent Accuracy and Auto-Zero Feature: <**Insert system**><**Insert unique application**>.
8. Air-Pressure Transmitter, Differential Type - with 0.25 Percent Accuracy and Auto-Zero Feature: <**Insert system**><**Insert unique application**>.

D. Air-Pressure Three-in-One Combination Controller/Switch/Transmitters:

1. Air-Pressure Three-in-One Combination Controller/Switch/Transmitter, Differential Type - with Indicator: <**Insert system**><**Insert unique application**>.

E. Liquid-Pressure Switches:

1. Liquid-Pressure Switch, Gauge-Pressure Type - Diaphragm Operated, Low Pressure: <**Insert system**><**Insert unique application**>.
2. Liquid-Pressure Switch, Gauge-Pressure Type - Diaphragm Operated: <**Insert system**><**Insert unique application**>.
3. Liquid-Pressure Switch, Gauge-Pressure Type - Bourdon Tube Operated: <**Insert system**><**Insert unique application**>.
4. Liquid-Pressure Switch, Differential Type - with Set-Point Indicator: <**Insert system**><**Insert unique application**>.
5. Liquid-Pressure Switch, Differential Type: <**Insert system**><**Insert unique application**>.
6. Liquid-Pressure Transmitter, Gauge-Pressure Type - with High Accuracy and Adjustable Span: <**Insert system**><**Insert unique application**>.
7. Liquid-Pressure Transmitter, Gauge-Pressure Type - with High Accuracy and Adjustable Span for Hazardous Environments: <**Insert system**><**Insert unique application**>.
8. Liquid-Pressure Transmitter, Differential Type - with High Accuracy and Adjustable Span: <**Insert system**><**Insert unique application**>.
9. Liquid-Pressure Transmitter, Differential Type - with High Accuracy and Adjustable Span for Hazardous Environments: <**Insert system**><**Insert unique application**>.
10. Liquid-Pressure Transmitter, Differential Type: <**Insert system**><**Insert unique application**>.

11. Liquid-Pressure Transmitter, Differential Type - Single-Diaphragm Design: <**Insert system**><**Insert unique application**>.
12. Liquid-Pressure Transmitter, Differential Type with Field-Selectable Range and Display: <**Insert system**><**Insert unique application**>.
13. Liquid-Pressure Transmitter, Differential Type - 1 Percent Accuracy: <**Insert system**><**Insert unique application**>.

F. Room Pressure Monitors:

1. Room Pressure Monitors, Multifunction - Isolated Pressure Measurement Type: <**Insert unique application**>.
2. Room Pressure Monitors, Multifunction - Thermal Measurement Type: <**Insert unique application**>.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause damage to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. Avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 INSTALLATION OF PRESSURE INSTRUMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments (except pressure gauges) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of [**2**][**3**]<**Insert value**> percent.
7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of [**2**][**3**]<**Insert value**> percent.

B. Mounting Height:

1. Mount remote displays, switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of **42 to 72 inches (1050 to 1800 mm)** above the adjacent floor, grade, or service catwalk or platform.

   a. Mount at **60 inches (1500 mm)**.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

D. Duct Pressure Sensors:

1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately [**50**][**67**][**75**] percent of distance of longest hydraulic run. Location of sensors is to be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

E. Outdoor Pressure Sensors:

1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
2. Locate wall-mounted sensor in an inconspicuous location.
3. Submit sensor location for approval before installation.
4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.

6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

F. Air-Pressure Differential Switches:

1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route **NPS 3/8 (DN 12)** tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within [**50 ft. (15 m)**]<**Insert distance**>; otherwise, locate switch in vicinity of system connection.

G. Liquid-Pressure Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single location for inspection and service.
4. System process tubing connection to be full size of switch connection, but not less than [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**]<**Insert option**>. Install[**stainless steel**] bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

H. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection to be full size of switch connection, but not less than [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**]<**Insert option**>. Install[**stainless steel**] bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage

and hinder accurate operation.

3.5 ELECTRIC POWER

A. Provide electrical power to products requiring electrical connections.

B. Provide power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Provide raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Provide circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by instrument manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate at each instrument electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates are to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplates are to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Provide raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials

from exposed interior and exterior surfaces.

3.9 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Submit a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration must comply with instrument manufacturer's recommendations.
5. Furnish diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.[**Field calibration is not required for instruments that have been factory calibrated and provided with certificates.**]

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, lubrication and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 23

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Task	Specification	Specification Description
23 09 23 23	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 23	23 09 23 00a	Leak Detection Instruments
23 09 23 23	23 09 23 00b	Position Instruments
23 09 23 23	23 09 00 00	Speed Instruments
23 09 23 23	23 09 23 00c	Sequence of Operations for HVAC DDC

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SECTION 23 09 23 27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air temperature sensors.
2. Air temperature sensors with network communication signal.
3. Multivariable air temperature sensors and transmitters.
4. Wireless air temperature sensors.
5. Combination air temperature sensors and switches.
6. Air temperature switches.
7. Air temperature RTD transmitters.
8. Liquid and steam temperature sensors.
9. Strap-on temperature sensors for piping.
10. Liquid temperature switches.
11. Liquid and steam temperature transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.2 DEFINITIONS

A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

B. PIR: Passive infrared.

C. RTD: Resistance temperature detector.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For the following:

a. Air temperature sensors.
b. Air temperature sensors with network communication signal.
c. Multi-variable air temperature sensors and transmitters.
d. Wireless air temperature sensors.

e. Combination air temperature sensors and switches.
f. Air temperature switches.
g. Air temperature RTD transmitters.
h. Liquid and steam temperature sensors.
i. Strap-on temperature sensors for piping.
j. Liquid temperature switches.
k. Liquid and steam temperature transmitters.

2. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
3. Operating and performance characteristics, electrical characteristics, functional characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including pressure, temperature, and humidity.
4. Product description with complete technical data, performance curves, and product specification sheets.
5. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and[**mounting**] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

C. Samples: For each exposed product installed in finished space.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
3. Sizes and locations of wall access panels for instruments installed behind walls.
4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For [**air temperature sensors**][**air temperature sensors with network communication signal**][**multivariable air temperature sensors**][**wireless air temperature sensors**][**combination air temperature sensors and switches**][**air temperature switches**][**air temperature RTD transmitters**][**liquid and steam temperature sensors, commercial grade**][**liquid and steam temperature sensors, high-end commercial grade**][**liquid and steam temperature switches, industrial grade**][**liquid temperature switches, commercial grade**][**liquid temperature switches, high-end commercial grade**][**liquid temperature switches, industrial grade**], for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Source quality-control reports.

E. Field quality-control reports.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide [**one**][**two**]<**Insert quantity**> matching product(s) in Project inventory for each unique type of the following:

1. <**Insert product**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments are to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure is to be internally insulated, electrically heated[**and cooled**], filtered, and ventilated as required by instrument and application.

2. Instruments and accessories are to be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated are to be housed in protective secondary enclosures. Instrument's installed location is to dictate NEMA 250 enclosure requirements:

a. Outdoors, Protected: [**Type 2**][**Type 3**][**or**][**Type 12**]<**Insert type**>.
b. Outdoors, Unprotected: [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
c. Indoors, Heated with Filtered Ventilation: [**Type 1**][**or**][**Type 2**]<**Insert type**>.
d. Indoors, Heated with Nonfiltered Ventilation: [**Type 2**][**or**][**Type 12**]<**Insert type**>.
e. Indoors, Heated and Air Conditioned: [**Type 1**]<**Insert type**>.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: [**Type 12**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
2) Air-Moving Equipment Rooms: [**Type 1**][**Type 2**][**or**][**Type 12**]<**Insert type**>.

g. Localized Areas Exposed to Washdown: [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
h. Within Duct Systems and Air-Moving Equipment not Exposed to Possible Condensation: [**Type 2**][**Type 3**][**Type 4**][**or**][**Type 12**]<**Insert type**>.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
j. Hazardous Locations: Explosion-proof rating for condition.
k. <**Insert location and enclosure requirements**>.

2.2 AIR TEMPERATURE SENSORS

A. Platinum RTD, Single-Point Duct Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD single-point air temperature duct sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Performance:

   a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   b. Self-Heating: Negligible.
   c. Two- or three-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
   d. Resistance: [**100 ohms**][**or**][**1000 oms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**].
   e. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
   f. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 45 to 85 deg C)**][**Minus 50 to 275 deg F**

(Minus 45 to 135 deg C)][Minus 40 to 392 deg F (Minus 40 to 200 deg C)]<**Insert temperature range**>.

g. Accuracy: At 32 deg F (0 deg C) within [0.27 deg F (0.15 deg C)][0.54 deg F (0.3 deg C)][0.27 deg F (0.15 deg C) **or** 0.54 deg F (0.3 deg C) **as required by application**]<**Insert temperature**>.

6. Output Signal: Resistance in ohms.
7. Sensor Assembly:

   a. Probe: Single-point RTD wired within a rigid stainless steel sheath.
   b. Length: As required by application to achieve probe tip near midpoint of air tunnel, up to 18 inches (450 mm) long.

8. Enclosure:

   a. Material: Metal[**or plastic**] box with removable cover.
   b. Rating: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**or**][**Type 4X**]<**Insert type**> for indoor applications and [**Type 4**][**or**][**Type 4X**]<**Insert type**> for outdoor applications.
   c. Field Wiring Connection: Terminal block.
   d. Conduit Connection: 1/2-inch (16-mm)[**or** 3/4-inch (20-mm)] trade size.

9. Gasket: For attachment to duct or equipment to seal penetration airtight.

B. Platinum RTD, Averaging Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]

j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD air temperature averaging sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description: Multiple internal RTDs located across length of sensor probe and internally wired to signal a single average temperature reading.
6. Two- or three-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
7. Performance:

   a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   b. Self-Heating: Negligible.
   c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**].
   d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
   e. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**Minus 50 to 275 deg F (Minus 45 to 135 deg C)**]<**Insert temperature range**>.
   f. Accuracy: At **32 deg F (0 deg C)** within [**0.54 deg F (0.3 deg C)**]<**Insert temperature**>.

8. Output Signal: Resistance in ohms.
9. Sensor Probe:

   a. Type: Flexible probes; option to use averaging rigid probe sensors for air tunnels up to [**20 inches (500 mm)**][**36 inches (900 mm)**]<**Insert distance**>.
   b. Material:

      1) Flexible Probe: [**Aluminum**][**Brass**][**Copper**][**or**][**stainless steel**]<**Insert material**>.
      2) Rigid Probe: [**Stainless steel**]<**Insert material**>

   c. Flexible probes formable to a minimum [**4-inch (100-mm)**]<**Insert distance**> radius.
   d. Length: As required by application to account for temperature variations across entire cross section of air tunnel.

10. Enclosure:

    a. Material: Metal[**or plastic**] box with removable cover.
    b. Rating: NEMA 250, [**Type 1**][**Type 4**][**or**] Type 4X <**Insert type**> for indoor applications and [**Type 1**][**Type 4**][**or**] Type 4X <**Insert type**> for outdoor applications.
    c. Field Wiring Connection: Terminal block.
    d. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

11. Gasket: For attachment to duct or equipment to seal penetration airtight.
12. Mounting Clips: [**Copper**][**Plastic**][**Material to match probe**]<**Insert material**>; specifically designed for flexible probes to achieve radius ends when installed in serpentine arrangements.

C. Platinum RTD Outdoor Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Minco**]
j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Minco**]
j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD outdoor air temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Two- or three-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
6. Performance:

a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
b. Self-Heating: Negligible.
c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**] ohms.
d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
e. Temperature Range: As required by application, not less than [**Minus 30 to 120 deg F (Minus 34 to 49 deg C)**][**Minus 40 to 158 deg F (Minus 45 to 70 deg C)**][**Minus 50 to 275 deg F (Minus 45 to 135 deg C)**]<**Insert temperature range**>.
f. Accuracy: At **32 deg F (0 deg C)** within [**0.54 deg F (0.3 deg C)**]<**Insert temperature**>.

7. Output Signal: Resistance in ohms.
8. Sensor Assembly:

a. Probe: Single-point RTD wired within a stainless steel[**or plastic**] sheath.
b. Solar Shield: Stainless steel[**or plastic**].

9. Enclosure:

a. Material: Metal[**or plastic**] box or combination conduit and outlet box; removable cover and gasket.
b. Rating: NEMA 250, [**Type 3R**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
c. Field Wiring Connection: Terminal block.
d. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

D. Platinum RTD Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. [**Vaisala**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD space air temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Two- or three-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
6. Performance:

   a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   b. Self-Heating: Negligible.
   c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each**

application under Part 3 or on the Drawings].

d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.

e. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**35 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**>.

f. Accuracy: At **32 deg F (0 deg C)** within [**0.27 deg F (0.15 deg C)**][**0.54 deg F (0.3 deg C)**][**0.27 deg F (0.15 deg C) or 0.54 deg F (0.3 deg C) as required by application**]<**Insert temperature**>.

7. Output Signal: Resistance in ohms.

8. Sensor Assembly:

a. Mount temperature sensing element under a bright-white, non-yellowing, plastic enclosure.

b. Enclosure Rating: NEMA 250, Type 1.

c. Mounting: Provide mounting compatible with surface mounted to and electrical box used.

d. Wiring Connection: Concealed wiring connection.

1) Terminal block.

2) Multi-conductor modular connector.

E. Platinum RTD Space Air Temperature Sensors-Flush-Mount, Flat-Face Cover:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]

b. [**Belimo Aircontrols (USA), Inc**]

c. [**Building Automation Products Inc.; BAPI**]

d. [**Greystone Energy Systems, Inc.**]

e. [**Honeywell International Inc.**]

f. [**Johnson Controls, Inc.**]

g. [**MAMAC Systems, Inc.**]

h. [**Minco**]

i. [**Schneider Electric USA, Inc.**]

j. [**Siemens Industry, Inc., Building Technologies Division**]

k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]

b. [**Belimo Aircontrols (USA), Inc**]

c. [**Building Automation Products Inc.; BAPI**]

d. [**Greystone Energy Systems, Inc.**]

e. [**Honeywell International Inc.**]

f. [**Johnson Controls, Inc.**]

g. [**MAMAC Systems, Inc.**]

h. [**Minco**]

i. [**Schneider Electric USA, Inc.**]

j. [**Siemens Industry, Inc., Building Technologies Division**]

k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD space air temperature sensors with flush-mount, flat-face cover from a single manufacturer.

4. Factory Calibration: Factory calibrate each instrument to [**NIST**]traceable standards and include instrument with a calibration certificate.
5. Two- or three-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
6. Description: Sensor with flush-mounted, flat-face brushed-metal cover, intended to provide a finished appearance in areas where aesthetics is a high priority.
7. Performance:

    a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
    b. Self-Heating: Negligible.
    c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**].
    d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
    e. Temperature Range: As required by application, not less than [**Minus 40 to 160 deg F (Minus 40 to 71 deg C)**][**Minus 4 to 140 deg F (Minus 20 to 60 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
    f. Accuracy: At **32 deg F (0 deg C)** within [**0.27 deg F (0.15 deg C)**][**0.54 deg F (0.3 deg C)**][**0.27 deg F (0.15 deg C) or 0.54 deg F (0.3 deg C) as required by application**]<**Insert temperature**>.

8. Output Signal: Resistance in ohms.
9. Sensor Assembly:

    a. Mount temperature-sensing element under a flush, brushed stainless steel[**or aluminum**] flat cover plate.
    b. Enclosure Rating: NEMA 250, Type 1.
    c. Mounting: Provide mounting compatible with surface mounted to and electrical box used.
    d. Wiring Connection: Concealed wiring connection.

F. Platinum RTD Space Air Temperature Sensors, Button Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD space air temperature sensors with button-style from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description: Flush-mount, button style, sensor intended to provide a discreet, nonobtrusive, and highly finished appearance in areas where aesthetics is a high priority.
6. Performance:

    a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
    b. Self-Heating: Negligible.
    c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**].
    d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
    e. Temperature Range: As required by application, not less than [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**][**Minus 40 to 185 deg F (Minus 45 to 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
    f. Accuracy: At **32 deg F (0 deg C)** within [**0.27 deg F (0.15 deg C)**][**0.54 deg F (0.3 deg C)**][**0.27 deg F (0.15 deg C) or 0.54 deg F (0.3 deg C) as required by application**]<**Insert temperature**>.

7. Output Signal: Resistance in ohms.
8. Sensor Assembly:

    a. Conceal temperature-sensing element under a [**brushed-brass**][**brushed stainless steel**][**paintable plastic**][**black plastic**][**bright-white plastic**] flush-mount, button-style cover.

        1) Metal sensor assemblies with threaded shaft and backnut to secure sensor to mounting substrate.
        2) Plastic sensor assemblies with ribbed shafts to secure sensor to mounting substrate.

    b. Enclosure Rating: NEMA 250, Type 1.
    c. Two-[**or three-**] wire, PTFE-insulated, minimum 22-gauge stranded copper leads. Each application determines length of leads.

9. Mounting Kit: Include a mounting kit with each sensor.

G. Platinum RTD Space Air Temperature Sensors with Occupant Interface Features:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Belimo Aircontrols (USA), Inc**]
    c. [**Building Automation Products Inc.; BAPI**]
    d. [**Greystone Energy Systems, Inc.**]
    e. [**Honeywell International Inc.**]
    f. [**Johnson Controls, Inc.**]
    g. [**MAMAC Systems, Inc.**]
    h. [**Schneider Electric USA, Inc.**]
    i. [**Siemens Industry, Inc., Building Technologies Division**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Greystone Energy Systems, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Johnson Controls, Inc.**]
g. [**MAMAC Systems, Inc.**]
h. [**Schneider Electric USA, Inc.**]
i. [**Siemens Industry, Inc., Building Technologies Division**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD space air temperature sensors with occupant interface features from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description: Sensor with integral occupant interface features
6. Performance:

a. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
b. Self-Heating: Negligible.
c. Resistance: [**100 ohms**][**or**][**1000 ohms**][**100 or 1000 ohms as indicated for each application under Part 3 or on the Drawings**].
d. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/deg C.
e. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**35 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**>.
f. Accuracy: At **32 deg F (0 deg C)** within [**0.27 deg F (0.15 deg C)**][**0.54 deg F (0.3 deg C)**][**0.27 deg F (0.15 deg C) or 0.54 deg F (0.3 deg C) as required by application**]<**Insert temperature**>.

7. Output Signal: Resistance in ohms.
8. Sensor Assembly:

a. Mount temperature-sensing element under a bright-white, non-yellowing, plastic cover.
b. Enclosure Rating: NEMA 250, Type 1.
c. Mounting: Provide mounting compatible with surface shape mounted to and electrical box used.
d. Wiring Connection: Concealed wiring connection.

1) Terminal block.
2) Multi-conductor modular connector.

9. Occupant Interface Features: Where indicated, include instrument with the following features:

a. Display: Backlit LCD display of temperature in [**degrees F**][**degrees C**][**degrees that is switchable between either degree C or degree F**].
b. Operation Override: Local adjustment on face of enclosure for occupant to initiate HVAC zone "On" operation.
c. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
d. Fan Speed: Multispeed adjustment.
e. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
f. <**Insert feature**>.

H. Thermistor Single-Point Duct Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor single-point duct air temperature sensors from a single manufacturer.
4. Performance:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: [**Minus 50 to 275 deg F (Minus 46 to 135 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   e. Self-Heating: Negligible.
   f. Two-wire, PTFE-insulated, 22-gauge stranded copper leads.

5. Output Signal: Resistance in ohms.
6. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative-temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit

encased in epoxy.

7. Sensor Assembly:

   a. Probe: Single-point thermistor in a stainless steel sheath.
   b. Probe Length: As required by application to achieve tip at midpoint of air tunnel, up to **18 inches (450 mm)** long.

8. Enclosure:

   a. Material: Metal[**or plastic**] junction box with removable cover.
   b. Rating: NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.

9. Gasket: For attachment to duct or equipment to seal penetration airtight.
10. Conduit Connection: **1/2-inch (16-mm)** [**or 3/4-inch (20-mm)**] trade size.

I. Thermistor Averaging Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. **<Insert manufacturer's name>**

3. Source Limitations: Obtain all thermistor averaging air temperature sensors from a single manufacturer.
4. Description: Multiple internal thermistors located across length of sensor probe and internally wired to signal a single average temperature reading.

5. Performance:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: As required by application, not less than [**Minus 50 to 275 deg F (Minus 45 to 135 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   e. Self-Heating: Negligible.

6. Output Signal: Resistance in ohms.
7. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

8. Sensor Probe:

   a. Type: Flexible probes; option to use rigid probes for air tunnels up to [**20 inches (500 mm)**][**36 inches (900 mm)**]<**Insert distance**>.
   b. Material:

      1) Flexible: [**Aluminum**][**Brass**][**Copper**][**or**][**stainless steel**]<**Insert material**>.
      2) Rigid: Flexible: [**Stainless steel**]<**Insert material**>.

   c. Flexible probes formable to a minimum [**4-inch (100-mm)**]<**Insert distance**> radius.
   d. Length: As required by application to account for temperature variations across entire cross section of air tunnel.

9. Enclosure:

   a. Material: Metal[**or plastic**] box with removable cover.
   b. Rating: NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 4X**]<**Insert type**> for indoor applications and [**Type 4**][**or**][**Type 4X**]<**Insert type**> for outdoor applications.
   c. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

10. Gasket: For attachment to duct or equipment to seal penetration airtight.
11. Mounting Clips: [**Copper**][**Plastic**][**Material to match probe**]<**Insert material**>; specifically designed for flexible probes to achieve radius ends when installed in serpentine arrangements.

J. Thermistor Outdoor Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]

h. [**MAMAC Systems, Inc.**]
i. [**Minco**]
j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Minco**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Building Technologies Division**]
   l. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor outdoor air temperature sensors from a single manufacturer.
4. Performance:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: As required by application, not less than [**Minus 50 to 275 deg F (Minus 45 to 135 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   e. Self-Heating: Negligible.

5. Output Signal: Resistance in ohms.
6. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

7. Sensor Assembly:

   a. Probe: Single-point thermistor wired within a stainless steel[**or plastic**] sheath.
   b. Solar Shield: Stainless steel[**or plastic**].

8. Enclosure:

   a. Material: Metal[**or plastic**] box or combination conduit and outlet box; removable cover and gasket.
   b. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.

9. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

K. Thermistor Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Greystone Energy Systems, Inc.**]
   e. [**Honeywell International Inc.**]
   f. [**Johnson Controls, Inc.**]
   g. [**MAMAC Systems, Inc.**]
   h. [**Minco**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Greystone Energy Systems, Inc.**]
   e. [**Honeywell International Inc.**]
   f. [**Johnson Controls, Inc.**]
   g. [**MAMAC Systems, Inc.**]
   h. [**Minco**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor space air temperature sensors from a single manufacturer.
4. Performance:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   e. Self-Heating: Negligible.

5. Output Signal: Resistance in ohms.
6. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

7. Sensor Assembly:

a. Mount temperature-sensing element under a bright-white, non-yellowing, plastic enclosure.
b. Enclosure Rating: NEMA 250, Type 1.
c. Mounting: Provide mounting compatible with surface mounted to and electrical box used.
d. Wiring Connection: Concealed wiring connection.

1) Terminal block.
2) Multiconductor modular connector.

L. Thermistor Space Air Temperature Sensors - Flush-Mount, Flat-Face Cover:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**MAMAC Systems, Inc.**]
g. [**Minco**]
h. [**Schneider Electric USA, Inc.**]
i. [**Siemens Industry, Inc., Building Technologies Division**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**MAMAC Systems, Inc.**]
g. [**Minco**]
h. [**Schneider Electric USA, Inc.**]
i. [**Siemens Industry, Inc., Building Technologies Division**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor space air temperature sensors with flush-mount, flat-face cover from a single manufacturer.
4. Description: Sensor with flush-mounted, flat-face brushed-metal cover, intended to provide a finished appearance in areas where aesthetics is a high priority.
5. Performance:

a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
b. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
e. Self-Heating: Negligible.

6. Output Signal: Resistance in ohms.
7. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

    a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

8. Sensor Assembly:

    a. Mount temperature-sensing element under a flush, [**brushed-aluminum**][**or**][**brushed stainless steel**] flat cover plate.
    b. Enclosure Rating: NEMA 250, Type 1.
    c. Mounting: Provide mounting compatible with surface mounted to and electrical box used.
    d. Wiring Connection: Concealed wiring connection.

M. Thermistor Space Air Temperature Sensors - Button Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Schneider Electric USA, Inc.**]
    g. [**Siemens Industry, Inc., Building Technologies Division**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Building Automation Products Inc.; BAPI**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Schneider Electric USA, Inc.**]
    g. [**Siemens Industry, Inc., Building Technologies Division**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor space air temperature sensors with button style from a single manufacturer.
4. Description: Flush-mounted, button-style sensor intended to provide a discreet, nonobtrusive, and highly finished appearance in areas where aesthetics is a high priority.
5. Performance:

    a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
    b. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
    c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.

d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
e. Self-Heating: Negligible.

6. Output Signal: Resistance in ohms.
7. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

8. Sensor Assembly:

   a. Conceal temperature sensing element under a [**brushed-brass**][**brushed stainless steel**][**paintable plastic**][**black plastic**][**bright-white plastic**] flush-mount, button-style cover.

      1) Metal sensor assemblies with threaded shaft and backnut to secure sensor to mounting substrate.
      2) Plastic sensor assemblies with ribbed shafts to secure sensor to mounting substrate.

   b. Enclosure Rating: NEMA 250, Type 1.
   c. Wiring Connection: Two-wire, PTFE-insulated, minimum 22-gauge stranded copper leads. Length of leads as required by application.

9. Mounting Kit: Include a mounting kit with each sensor.

N. Thermistor Space Air Temperature Sensors with Occupant Interface Features:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]

g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor space air temperature sensors with occupant override features from a single manufacturer.
4. Description: Sensor with integral occupant interface features.
5. Performance:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: At **77 deg F (25 deg C)** within [**0.18 deg F (0.1 deg C)**][**0.36 deg F (0.2 deg C)**][**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   d. Repeatability: Within [**0.5 deg F (0.3 deg C)**]<**Insert temperature**>.
   e. Self-Heating: Negligible.

6. Output Signal: Resistance in ohms.
7. Thermistor: 10000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

8. Sensor Assembly:

   a. Mount temperature sensing element under a bright-white, non-yellowing, plastic cover.
   b. Enclosure Rating: NEMA 250, Type 1.
   c. Mounting: Provide mounting compatible with surface shape mounted to and electrical box used.
   d. Wiring Connection: Concealed wiring connection.

      1) Terminal block.
      2) Multiconductor modular connector.

9. Occupant Interface Features: Where indicated, include instrument with the following features:

   a. Display: Backlit LCD display of temperature in [**degrees F**][**degrees C**][**degrees that is switchable between either degree C or degree F**].
   b. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
   c. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
   d. Fan Speed: Multispeed adjustment.
   e. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
   f. <**Insert feature**>.

2.3 AIR TEMPERATURE SENSORS WITH NETWORK COMMUNICATION SIGNAL

A. Air Temperature Sensors with Network Communication Signal for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Greystone Energy Systems, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Johnson Controls, Inc.**]
g. [**Schneider Electric USA, Inc.**]
h. [**Siemens Industry, Inc., Building Technologies Division**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Greystone Energy Systems, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Johnson Controls, Inc.**]
g. [**Schneider Electric USA, Inc.**]
h. [**Siemens Industry, Inc., Building Technologies Division**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all air temperature sensors with network communication signal for space applications from a single manufacturer.
4. Description: Air temperature sensors with network communication signal for wired connection to DDC network.
5. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
6. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
7. Performance:

a. Temperature:

1) Accuracy: [**0.5 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
2) Measured Range: [**55 to 85 deg F (13 to 29 deg C)**][**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.
3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

8. Network Communication Interface: [**BACnet IP**][**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
9. Temperature Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability**].
10. Enclosure:

a. Material: Plastic; bright white, non-yellowing.
b. Rating: NEMA 250, Type 1.

11. Additional Features: Where indicated, include instrument with the following features:

    a. Display: Backlit LCD display of temperature in [**degrees F**][**degrees C**][**degrees that is switchable between either degree C or degree F**].
    b. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
    c. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
    d. Fan Speed: Multispeed adjustment.
    e. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
    f. <**Insert feature**>.

12. Mounting: Concealed screw mount; compatible with mounting surface.

2.4 MULTIVARIABLE AIR TEMPERATURE SENSORS AND TRANSMITTERS

A. Combination Carbon-Dioxide and Air Temperature Sensors and Transmitters for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Honeywell International Inc.**]
    d. [**Johnson Controls, Inc.**]
    e. [**Schneider Electric USA, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Honeywell International Inc.**]
    d. [**Johnson Controls, Inc.**]
    e. [**Schneider Electric USA, Inc.**]
    f. [**Siemens Industry, Inc., Building Technologies Division**]
    g. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all combination carbon-dioxide and air temperature sensors and transmitters for duct applications from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description:

    a. Carbon-dioxide and air temperature sensors and transmitters combined into a single instrument for wired connection to DDC controllers.
    b. Intended for use in duct applications.

6. Factory Calibration: Factory calibrate each instrument and include instrument with a calibration

certificate.

7. Performance:

   a. Carbon Dioxide:

      1) Carbon-Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
      2) Accuracy: Within [**2**][**3**][**4**]<**Insert value**> percent of reading, plus or minus [**30**][**40**][**50**]<**Insert value**> ppm.
      3) Repeatability: Within [**1**]<**Insert value**> percent of full scale.
      4) Long-Term Stability: Within [**5**]<**Insert value**> percent of full scale after more than [**5**]<**Insert value**> years.
      5) Response Time: Within [**60**]<**Insert value**> seconds.
      6) Warm-up Time: Within [**5**]<**Insert value**> minutes.

   b. Temperature:

      1) Accuracy: [**0.54 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
      2) Measured Range: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
      3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

8. Analog Output Signal:

   a. Carbon Dioxide: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**> output signal, linearized to carbon-dioxide concentration in parts per million (ppm).
   b. Temperature: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.

9. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
10. Carbon-Dioxide Sensor Type: Nondispersive infrared or equivalent technology providing performance indicated, long-term stability, and reliability.
11. Temperature Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability**].
12. Enclosure: Plastic; NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
13. Display: Backlit LCD display of caron dioxide concentration in parts per million (ppm), relative humidity in percent relative humidity, and temperature in [**degrees F**][**degrees C**].
14. Mounting: Screw mount; compatible with mounting surface.

B. Combination Carbon-Dioxide and Air Temperature Sensors and Transmitters for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Honeywell International Inc.**]
   f. [**Johnson Controls, Inc.**]
   g. [**Schneider Electric USA, Inc.**]
   h. [**Siemens Industry, Inc., Building Technologies Division**]

i. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
j. [**Vaisala**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Honeywell International Inc.**]
   f. [**Johnson Controls, Inc.**]
   g. [**Schneider Electric USA, Inc.**]
   h. [**Siemens Industry, Inc., Building Technologies Division**]
   i. [**Telaire; a brand of Amphenol Thermometrics Inc.**]
   j. [**Vaisala**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all combination carbon-dioxide and air temperature sensors and transmitters for space applications from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description:

   a. Carbon-dioxide and air temperature sensors and transmitters combined into a single instrument for wired connection to DDC controllers.
   b. Intended for use in applications controlling indoor, conditioned space.

6. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
7. Performance:

   a. Carbon Dioxide:

      1) Carbon-Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
      2) Accuracy: Within [**2**][**3**][**4**]<**Insert value**> percent of reading, plus or minus [**30**][**40**][**50**]<**Insert value**> ppm.
      3) Repeatability: Within [**1**]<**Insert value**> percent of full scale.
      4) Long-Term Stability: Within [**5**]<**Insert value**> percent of full scale after more than [**5**]<**Insert value**> years.
      5) Response Time: Within [**60**]<**Insert value**> seconds.
      6) Warm-up Time: Within [**5**]<**Insert value**> minutes.

   b. Temperature:

      1) Accuracy: [**0.5 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
      2) Measured Range: [**55 to 85 deg F (13 to 29 deg C)**][**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.
      3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

8. Analog Output Signal:

   a. Carbon Dioxide: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**> output signal, linearized to carbon-dioxide concentration in parts per million (ppm).

b. Temperature: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.

9. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
10. Carbon-Dioxide Sensor Type: Nondispersive infrared or equivalent technology providing performance indicated, long-term stability, and reliability.
11. Temperature Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability**].
12. Enclosure:

    a. Material: Plastic; bright white, non-yellowing.
    b. Rating: NEMA 250, Type 1.

13. Additional Features: Where indicated, include instrument with the following features:

    a. Display: Backlit LCD display of caron-dioxide concentration in parts per million (ppm), relative humidity in percent relative humidity, and temperature in [**degrees F**][**degrees C**][**degrees that is switchable between either degree C or degree F**].
    b. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
    c. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
    d. Fan Speed: Multispeed adjustment.
    e. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
    f. <**Insert feature**>.

14. Mounting: Concealed screw mount; compatible with mounting surface.

C. Combination Carbon-Dioxide, Relative Humidity, and Air Temperature Sensors and Transmitters for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Honeywell International Inc.**]
    d. [**Schneider Electric USA, Inc.**]
    e. [**Siemens Industry, Inc., Building Technologies Division**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Dwyer Instruments, Inc**]
    c. [**Honeywell International Inc.**]
    d. [**Schneider Electric USA, Inc.**]
    e. [**Siemens Industry, Inc., Building Technologies Division**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all combination carbon-dioxide, relative humidity, and air temperature sensors and transmitters for duct applications from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description:

    a. Carbon-dioxide, relative humidity, and air temperature sensors and transmitters combined into a single instrument for wired connection to DDC controllers.
    b. Intended for use in duct applications.

6. Factory Calibration: Factory calibrate each instrument and include instrument with a calibration certificate.
7. Performance:

    a. Carbon Dioxide:

        1) Carbon-Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
        2) Accuracy: Within [**2**][**3**][**4**]<**Insert value**> percent of reading, plus or minus [**30**][**40**][**50**]<**Insert value**> ppm.
        3) Repeatability: Within [**1**]<**Insert value**> percent of full scale.
        4) Long-Term Stability: Within [**5**]<**Insert value**> percent of full scale after more than [**5**]<**Insert value**> years.
        5) Response Time: Within [**60**]<**Insert value**> seconds.
        6) Warm-up Time: Within [**5**]<**Insert value**> minutes.

    b. Relative Humidity:

        1) Accuracy: [**2**][**3**][**4**]<**Insert value**>percent relative humidity.
        2) Calibrated Range: [**5 to 65**][**20 to 80**][**10 to 90**][**0 to 100**]<**Insert value**> percent relative humidity.
        3) Operating Stability: [**Within 0.5 percent/year**]<**Insert requirement**>.
        4) Response Time: Within [**10**][**20**]<**Insert value**> seconds.

    c. Temperature:

        1) Accuracy: [**0.54 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
        2) Measured Range: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
        3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

8. Analog Output Signal:

    a. Carbon Dioxide: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**> output signal, linearized to carbon-dioxide concentration in parts per million (ppm).
    b. Relative Humidity: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.
    c. Temperature: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.

9. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
10. Carbon-Dioxide Sensor Type: Nondispersive infrared or equivalent technology providing performance indicated, long-term stability, and reliability.
11. Relative Humidity Sensor Type: Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability.
12. Temperature Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability**].

13. Enclosure: Plastic; NEMA 250, [**Type 1**][**or**][**Type 4**]<**Insert type**>.
14. Display: Backlit LCD display of caron-dioxide concentration in parts per million (ppm), relative humidity in percent relative humidity, and temperature in [**degrees F**][**degrees C**].
15. Mounting: Screw mount; compatible with mounting surface.

D. Combination Carbon-Dioxide, Relative Humidity, and Temperature Sensors and Transmitters for Space Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Belimo Aircontrols (USA), Inc**]
    c. [**Building Automation Products Inc.; BAPI**]
    d. [**Dwyer Instruments, Inc**]
    e. [**Greystone Energy Systems, Inc.**]
    f. [**Honeywell International Inc.**]
    g. [**Johnson Controls, Inc.**]
    h. [**Schneider Electric USA, Inc.**]
    i. [**Siemens Industry, Inc., Building Technologies Division**]
    j. [**Vaisala**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ACI Automation; Automation Components Inc**]
    b. [**Belimo Aircontrols (USA), Inc**]
    c. [**Building Automation Products Inc.; BAPI**]
    d. [**Dwyer Instruments, Inc**]
    e. [**Greystone Energy Systems, Inc.**]
    f. [**Honeywell International Inc.**]
    g. [**Johnson Controls, Inc.**]
    h. [**Schneider Electric USA, Inc.**]
    i. [**Siemens Industry, Inc., Building Technologies Division**]
    j. [**Vaisala**]
    k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all combination carbon-dioxide, relative humidity, and air temperature sensors and transmitters for space applications from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description:

    a. Carbon-dioxide, relative humidity, and air temperature sensors and transmitters combined into a single instrument for wired connection to DDC controllers.
    b. Intended for use in applications controlling indoor, conditioned space.

6. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
7. Performance:

    a. Carbon Dioxide:

1) Carbon-Dioxide Concentration Range: Zero to [**2000**]<**Insert value**> ppm.
2) Accuracy: Within [**2**][**3**][**4**]<**Insert value**> percent of reading, plus or minus [**30**][**40**][**50**]<**Insert value**> ppm.
3) Repeatability: Within [**1**]<**Insert value**> percent of full scale.
4) Long-Term Stability: Within [**5**]<**Insert value**> percent of full scale after more than [**5**]<**Insert value**> years.
5) Response Time: Within [**60**]<**Insert value**> seconds.
6) Warm-up Time: Within [**5**]<**Insert value**> minutes.

b. Relative Humidity:

1) Accuracy: [**2**][**3**][**5**]<**Insert value**>percent relative humidity.
2) Calibrated Range: [**5 to 65**][**20 to 80**][**10 to 90**][**0 to 100**]<**Insert value**> percent relative humidity.
3) Operating Stability: [**Within 0.5 percent/year**]<**Insert requirement**>.
4) Response Time: Within [**10**][**20**]<**Insert value**> seconds.

c. Temperature:

1) Accuracy: [**0.54 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
2) Measured Range: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

8. Analog Output Signal:

a. Carbon Dioxide: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**> output signal, linearized to carbon-dioxide concentration in parts per million (ppm).
b. Relative Humidity: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.
c. Temperature: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.

9. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
10. Carbon-Dioxide Sensor Type: Nondispersive infrared or equivalent technology providing performance indicated, long-term stability, and reliability.
11. Relative Humidity Sensor Type: Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability.
12. Temperature Sensor Type: [**100-ohm platinum RTD**][**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated, long-term stability, and reliability**].
13. Enclosure:

a. Material: Plastic; bright white, non-yellowing.
b. Rating: NEMA 250, Type 1.

14. Additional Features: Where indicated, include instrument with the following features:

a. Display: Backlit LCD display of caron-dioxide concentration in parts per million (ppm), relative humidity in percent relative humidity, and temperature in [**degrees F**][**degrees C**][**degrees that is switchable between either degree C or degree F**].
b. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
c. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
d. Fan Speed: Multispeed adjustment.

e. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
f. <**Insert feature**>.

15. Mounting: Concealed screw mount; compatible with mounting surface.

2.5 WIRELESS AIR TEMPERATURE SENSORS

A. Wireless Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Honeywell International Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**Schneider Electric USA, Inc.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Building Automation Products Inc.; BAPI**]
   c. [**Dwyer Instruments, Inc**]
   d. [**Honeywell International Inc.**]
   e. [**Johnson Controls, Inc.**]
   f. [**Schneider Electric USA, Inc.**]
   g. [**Siemens Industry, Inc., Building Technologies Division**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all wireless air temperature sensors from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description: Wireless temperature sensors communicating with associated receivers, transceivers, or repeaters for wired connection to DDC controllers.
6. Performance:

   a. Battery Life: [**1**][**3**][**5**]<**Insert value**> years when operating under planned use.
   b. Temperature:

      1) Accuracy: [**0.54 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
      2) Measured Range:

         a) Duct Applications: [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**]<**Insert temperature span**>
         b) Outdoor applications: [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**]<**Insert temperature span**>.
         c) Space Applications: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.

3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**][**45 to 100 deg F (7 to 38 deg C)**]<**Insert temperature range**>.

c. Radio Frequency (RF) Transmission:

1) Frequency: Nominal [**400 MHz**][**900 MHz**][**or**][**2.4 GHz**].
2) Interval: Maximum of [**90**][**150**]<**Insert value**> seconds between individual temperature sensor signals sent to DDC controllers.
3) Range: Horizontal line of sight not less than [**100 ft. (30 m)**][**200 ft. (60 m)**][**300 ft. (90 m)**]<**Insert distance**>.
4) Regulations: Comply with FCC regulations for low-power unlicensed transmitters.

7. Analog Output Signal: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.
8. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
9. Temperature Sensor Type: [**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated**].
10. Enclosure:

a. Material:

1) Duct and Outdoor Applications: Plastic.
2) Space Applications: Plastic; bright white, non-yellowing.

b. Rating:

1) Duct: NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
2) Outdoor: NEMA 250, Type 4X
3) Space: NEMA 250, Type 1.

11. Additional Features: Where indicated for space applications, include temperature sensor with the following features:

a. Battery Level Display: LED to indicated need for replacement.
b. Transmission Signal Display: LED to indicate signal trouble.
c. Temperature Display: Backlit LCD display of temperature with toggle between Metric (SI) and Imperial (IP) units.
d. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
e. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
f. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
g. <**Insert feature**>.

12. Mounting:

a. Duct and Outdoor Applications: Screw mount, magnets; compatible with mounting surface.
b. Space Applications: [**Screw mount**][**magnets, double-sided foam back tape or Velcro**]; compatible with mounting surface.

B. Wireless Air Temperature and Relative Humidity Sensors and Transmitters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Johnson Controls, Inc.**]
d. [**Schneider Electric USA, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Building Automation Products Inc.; BAPI**]
c. [**Johnson Controls, Inc.**]
d. [**Schneider Electric USA, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all wireless air temperature and relative humidity sensors and transmitters from a single manufacturer.
4. Certifications: [**BACnet Testing Lab (BTL) certification**]<**Insert certification**>.
5. Description:

a. Wireless temperature and relative humidity sensors and transmitters communicating with associated receivers, transceivers, or repeaters for wired connection to DDC controllers.
b. Intended for use in applications controlling indoor, conditioned space.

6. Performance:

a. Battery Life: [**3**][**5**] years when operating under planned use.
b. Relative Humidity:

1) Accuracy: [**2**][**3**]<**Insert value**> percent relative humidity.
2) Calibrated Range: [**20 to 80**][**10 to 90**]<**Insert range**> percent relative humidity.

c. Temperature:

1) Accuracy: [**0.54 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**>.
2) Measured Range: [**32 to 104 deg F (0 to 40 deg C)**][**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature range**>.
3) Ambient Operating Range: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature range**>.

d. Radio Frequency (RF) Transmission:

1) Frequency: Nominal [**900 MHz**][**or**][**2.4 GHz**].
2) Interval: Maximum of [**90**]<**Insert value**> seconds between individual temperature sensor signals sent to DDC controllers.
3) Range: Horizontal line of sight not less than [**100 ft. (30 m)**][**200 ft. (60 m)**][**300 ft. (90 m)**]<**Insert distance**>.
4) Regulations: Comply with FCC regulations for low power unlicensed transmitters.

7. Analog Output Signal:

a. Relative Humidity: [**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.
b. Temperature: [**Temperature sensor resistance (ohms)**][**4 to 20 mA**][**or**][**0 to 10 V dc**]<**Insert signal requirements**>.

8. Network Communication Interface: [**BACnet MS/TP**][**or**][**Modbus RTU**]<**Insert network protocol**>.
9. Relative Humidity Sensor Type: Manufacturer's choice of sensor type to achieve performance indicated.
10. Temperature Sensor Type: [**1000-ohm platinum RTD**][**or**][**10000-ohm, Type II negative temperature coefficient (NTC) thermistor**][**Manufacturer's choice of sensor type to achieve performance indicated**].
11. Enclosure:

    a. Material: Plastic; bright white, non-yellowing.
    b. Rating: NEMA 250, Type 1.

12. Additional Features: Where indicated for space applications, include temperature and relative humidity sensor with the following features:

    a. Battery Level Display: LED to indicate need for replacement.
    b. Transmission Signal Display: LED to indicate signal trouble.
    c. Relative Humidity Display: Backlit LCD display of percent relative humidity.
    d. Temperature Display: Backlit LCD display of temperature in metric (SI) or imperial (IP) units.
    e. Occupancy Override: Local adjustment on face of enclosure for occupant to initiate zone HVAC operation.
    f. Temperature Set Point: Local adjustment on face of enclosure for occupant to adjust zone temperature set point.
    g. Occupancy Detector: Sensor with integral PIR-type occupancy detector.
    h. <**Insert feature**>.

13. Mounting: [**Screw mount**][**magnets, double-sided foam back tape or Velcro**]; compatible with mounting surface.

2.6 COMBINATION AIR TEMPERATURE SENSORS AND SWITCHES

A. Combination Platinum RTD Air Temperature Sensors and Switches:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Minco**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Minco**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all combination air temperature sensors and switches from a single manufacturer.

4. Description: Combination air temperature sensor and low-temperature switch in same instrument.
5. Standards: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Air Temperature Switch:

    a. Factory preset set point of **38 deg F (3 deg C)**. Field-adjustable set point from **30 to 44 deg F (minus 1 to 7 deg C)**.
    b. Responsive to coldest **12-inch (300-mm)** section of sensor length.
    c. Accuracy: Within **0.9 deg F (0.5 deg C)**.
    d. DPDT latching relay rated at 6 A and 120 V ac, with powered controller, coil, and local manual rest.[**Wire one leg to fan start circuit and other leg to signal a remote alarm.**]

7. Air Temperature Sensor:

    a. Temperature-averaging type over sensor length. Length to be determined by installing trade to provide uniform coverage over air tunnel. Consult manufacturer for recommendations.
    b. Platinum RTDs with a resistance of 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
    c. Temperature Range: **Minus 50 to 176 deg F (Minus 46 to 80 deg C)**.
    d. Accuracy: At **32 deg F (0 deg C)** within **0.54 deg F (0.3 deg C)**.
    e. Encase RTDs in a flexible nominal **0.375-inch- (9-mm-)** diameter sheath constructed of aluminum[**or galvanized steel armor with PVC coating**].

8. Analog Output Signal: Include integral transmitter with 4 to 20 mA signal for connection to remote monitoring.
9. Enclosure:

    a. Material: Plastic with removable or hinged clear plastic cover.
    b. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
    c. Wiring Connection: Terminal block.

10. Status LEDs: LEDs to indicate status of electrical power and fault.

2.7 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low-Temperature Control in Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belimo Aircontrols (USA), Inc**]
    b. [**Dynacon Inc.**]
    c. [**Greystone Energy Systems, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Schneider Electric USA, Inc.**]
    g. [**Siemens Industry, Inc., Building Technologies Division**]
    h. [**Veris Industries**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Belimo Aircontrols (USA), Inc**]
b. [**Dynacon Inc.**]
c. [**Greystone Energy Systems, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Schneider Electric USA, Inc.**]
g. [**Siemens Industry, Inc., Building Technologies Division**]
h. [**Veris Industries**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermostat and switch for low-temperature control in duct applications from a single manufacturer.
4. Description:

a. Two-position control to open control circuit when temperature is below set point.
b. Field-adjustable set point.
c. Reset: [**Automatic**][**or**][**Manual**].
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Performance:

a. Operating Temperature Range: [**15 to 55 deg F (Minus 9 to 13 deg C)**]<**Insert temperature range**>.
b. Temperature Differential: [**2 deg F (1 deg C)**][**5 deg F (2.8 deg C)**]<**Insert temperature**>, nonadjustable and additive.
c. Enclosure Ambient Temperature: [**Minus 20 to 140 deg F (Minus 11 to 60 deg C)**][**20 to 140 deg F (Minus 7 to 60 deg C)**]<**Insert temperature range**>.
d. Sensing Element Maximum Temperature: [**140 deg F (60 deg C)**][**250 deg F (121 deg C)**]<**Insert temperature**>.
e. Voltage: 120 V ac.
f. Current: [**10**][**16**]<**Insert value**> FLA.
g. Switch Type: Two SPDT snap switches operate on coldest **12-inch (300-mm)** section along element length.

6. Construction:

a. Vapor-Filled Sensing Element: Nominal [**10 ft. (3 m)**][**20 ft. (6 m)**][**or**][**50 ft. (15 m)**] long; quantity and length of elements as required by application to account for temperature variations across entire cross section of air tunnel.
b. Temperature Scale: [**Fahrenheit**][**and**][**Celsius**] visible on face.
c. Set-Point Adjustment: Screw.
d. Enclosure: Painted metal or plastic, NEMA 250, [**Type 1**][**or**][**Type 4**]<**Insert type**>.
e. Electrical Connections: Screw terminals.
f. Conduit Connection: **1/2-inch (16-mm)** trade size.
g. Mounting Clips: Copper-clad mounting clips with formed radius intended for serpentine coverage across coil face area.

B. Thermostat and Switch for High-Temperature Control in Duct Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Greystone Energy Systems, Inc.**]
b. [**Schneider Electric USA, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Greystone Energy Systems, Inc.**]
b. [**Schneider Electric USA, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermostat and switches for high-temperature control from a single manufacturer.
4. Description:

a. Two-position control to open control circuit when temperature rises above set point.
b. Field-adjustable set point.
c. [**Automatic**][**or**][**manual**] reset.
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Performance:

a. Temperature Range: [**100 to 140 deg F (38 to 60 deg C)**][**100 to 160 deg F (38 to 71 deg C)**][**100 to 212 deg F (38 to 100 deg C)**]<**Insert temperature range**>.
b. Temperature Differential: [**5 deg F (2.8 deg C)**][**10 deg F (5.6 deg C)**]<**Insert temperature**>.
c. Ambient Temperature: [**14 to 122 deg F (Minus 10 to 50 deg C)**][**0 to 260 deg F (Minus 18 to 127 deg C)**]<**Insert temperature range**>.
d. Voltage: [**120 V ac**][**240 V ac**]<**Insert voltage**>.
e. Current: [**5 FLA**][**16 FLA**]<**Insert current**>.

6. Construction:

a. Sensing Element: [**Helical bimetal**][**or**][**10000-ohm, Type II, NTC thermistor**].
b. Switch Type: SPDT snap switch.
c. Enclosure Material: Metal or plastic.
d. Enclosure Rating: NEMA 250, [**Type 1**][**or**][**Type 4X**]<**Insert type**>.
e. Electrical Connections: Screw terminals.
f. Conduit Connection: **1/2-inch (16-mm)** trade size.

2.8 AIR TEMPERATURE RTD TRANSMITTERS

A. Air Temperature RTD Transmitters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Minco**]
j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Vaisala**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Minco**]
j. [**Schneider Electric USA, Inc.**]
k. [**Siemens Industry, Inc., Building Technologies Division**]
l. [**Vaisala**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air temperature RTD transmitters from same manufacturer as air temperature RTD sensors.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. If transmitter is not integral with sensor enclosure, house transmitter electronics in NEMA 250 enclosure based on physical location and application.

a. Duct: [**Type 1**][**Type 2**][**Type 3**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
b. Outdoor: [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
c. Space: Type 1.

6. Conduit Connection: **1/2-inch (16-mm)** trade size.
7. Functional Characteristics:

a. Input:

1) 100-ohm platinum RTD with a temperature coefficient of resistance (TCR) of 0.00385 ohm/ohm/deg C, two-wire sensors.
2) 1000-ohm platinum RTD with a temperature coefficient of resistance (TCR) of 0.00385 ohm/ohm/deg C, two-wire sensors.

b. Span (Adjustable):

1) Space: [**40 to 90 deg F (4 to 32 deg C)**]<**Insert temperature span**>.

2) Supply Air Cooling and Heating: [**40 to 120 deg F (4 to 49 deg C)**]<**Insert temperature span**>.
3) Supply Air Cooling Only: [**40 to 90 deg F (4 to 32 deg C)**]<**Insert temperature span**>.
4) Supply Air Heating Only: [**40 to 120 deg F (4 to 49 deg C)**]<**Insert temperature span**>.
5) Exhaust Air from Conditioned Space: [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature span**>.
6) Exhaust Air from Unconditioned Space: [**40 to 120 deg F (4 to 49 deg C)**]<**Insert temperature span**>.
7) Return Air: [**50 to 100 deg F (10 to 38 deg C)**]<**Insert temperature span**>.
8) Mixed Air: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**]<**Insert temperature span**>.
9) Outdoor: [**Minus 40 to 140 deg F (Minus 40 to 60 deg C)**]<**Insert temperature span**>.
10) <**Insert application with temperature span**>.

c. Minimum Span: [**50 deg F (28 deg C)**]<**Insert temperature**>.
d. Field Adjustments: Zero and span, plus or minus [**5**]<**Insert value**> percent of span.
e. Transmitter required for each 100-ohm RTD.
f. Transmitter optional for 1000-ohm RTD, contingent on compliance with system end-to-end control accuracy.
g. Analog Output Signal:

1) Current: 4 to 20 mA dc, linear with temperature; radio-frequency-interference insensitive; minimum drive load of [**600**]<**Insert value**> ohms at 24 V dc.
2) Voltage: [**0 to 5**][**0 to 10**] V dc, linear with temperature.

8. Performance Characteristics:

a. Calibration Accuracy: Within [**0.1**][**0.2**]<**Insert value**> percent of the span.
b. Stability: Within [**0.2**]<**Insert value**> percent of the span for at least six months.
c. Combined Accuracy: Within [**0.5**]<**Insert value**> percent.

9. Factory Match: Match sensor with temperature transmitter and factory calibrate together.

2.9 LIQUID AND STEAM TEMPERATURE SENSORS

A. Platinum RTD Immersion Temperature Sensors, Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]

j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD immersion commercial-grade temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Performance Characteristics:

   a. Resistance: [**100**][**or**][**1000**] ohms.
   b. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/ohm/deg C.
   c. Temperature Range: [**Minus 40 to 210 deg F (Minus 40 to 99 deg C)**]<**Insert temperature range**>.
   d. Interchangeable Accuracy: Within [**0.54 deg F (0.3 deg C) at 32 deg F (0 deg C)**]<**Insert temperatures**>.
   e. Rated for system pressure, temperature, and velocity.

6. Output Signal: Resistance in ohms.
7. Sensor Assembly:

   a. Probe: Single RTD wired within a rigid stainless steel sheath with a **0.25-inch (6-mm)** OD.
   b. Immersion Depth: **2, 2-1/2, 4, 6, or 8 inches (50, 65, 100, 150, or 200 mm)** as required by application.
   c. Process Connection: Threaded, **NPS 1/2 (DN 15)**.
   d. Two- or three-stranded copper lead wires.

8. Enclosure:

   a. Material: Metal[**or plastic**] box with removable cover.
   b. Rating: NEMA 250, [**Type 3R**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
   c. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

B. Thermistor Immersion Temperature Sensors, Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]

b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermistor immersion commercial-grade temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description:
6. Performance Characteristics:

   a. Temperature Drift: Within [**0.5 deg F (0.3 deg C)**][**1.0 deg F (0.6 deg C)**]<**Insert temperature**> over [**10**]<**Insert value**> years.
   b. Temperature Range: [**32 to 158 deg F (0 to 99 deg C)**][**Minus 40 to 210 deg F (Minus 40 to 99 deg C)**]<**Insert temperature range**>.
   c. Interchangeable Accuracy: Within [**0.18 deg F (0.1 deg C) at 77 deg F (25 deg C)**][**0.36 deg F (0.2 deg C) at 77 deg F (25 deg C)**]<**Insert temperatures**>.
   d. Rated for system pressure, temperature and velocity.

7. Output Signal: Resistance in ohms.
8. Thermistor: 10000-ohm, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

9. Sensor Assembly:

   a. Probe: Single thermistor wired within a rigid stainless steel sheath with a **0.25-inch (6-mm)** OD.
   b. Immersion Depth: **2, 2-1/2, 4, 6, or 8 inches (50, 65, 100, 150, or 200 mm)** as required by application.
   c. Process Connection: Threaded, **NPS 1/2 (DN 15)**.

d. Two- or three-stranded copper lead wires.

10. Enclosure:

a. Material: Metal[**or plastic**] box with removable cover.
b. Rating: NEMA 250, [**Type 3R**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.
c. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.

C. Thermowells, Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain thermowells from same manufacturer as liquid and steam commercial-grade temperature sensors.
4. Performance: Rated for system pressure, temperature and velocity.
5. Thermowell:

a. Material: [**Brass**][**or**][**stainless steel**].
b. Process Connection: Threaded, **NPS 1/2 (DN 15)** or**NPS 3/4 (DN 20)**.
c. Sensor Connection: Threaded, **NPS 1/2 (DN 15)**.
d. Stem: [**Straight**][**or**][**stepped**] shank formed from solid bar stock.
e. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
f. Extended Neck: Furnish thermowells installed in insulated pipes and equipment with an extended neck.
g. Immersion Length: **2, 2-1/2, 4 , 6, or 8 inches (50, 65 , 100, 150, or 200 mm)** as required

by application.

6. Furnish thermowells with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.
7. Factory Assembly: Sensor manufacturer is to furnish sensor and thermowell to provide a matched assembly.

D. Platinum RTD Immersion Temperature Sensors, High-End Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD immersion high-end commercial-grade temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to traceable standards and include instrument with a calibration certificate.
5. Standards: Comply with IEC 60751, Class [**A**][**or**][**B**] requirements.
6. Performance Characteristics:

   a. Temperature Range: **Minus 58 to 500 deg F (Minus 50 to 260 deg C)**.
   b. Interchangeable Accuracy: Within [**0.27 deg F (0.15 deg C)**][**0.54 deg F (0.3 deg C)**] at **32 deg F (0 deg C)**.
   c. Time Constant: 1.5 seconds with water flowing across sensor.

7. Sensor Assembly:

   a. RTD: Platinum with a value of 100 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
   b. Probe: Encase RTD in a Type 316 stainless steel sheath with a **0.25-inch (8-mm)** OD.
   c. Wire: [**two**][**three**][**four**]-wire, PTFE-insulated, nickel-coated, 22-gauge, stranded copper leads.
   d. Provide spring-loaded RTDs for thermowell installations.

E. Thermowells, High-End Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain high-end commercial-grade thermowells from same manufacturer as liquid and steam high-end commercial-grade temperature sensors.
4. Performance: Rated for system pressure, temperature, and velocity.
5. Thermowell:

   a. Material: [**Type 304**][**or**][**Type 316**] stainless steel.
   b. Process Connection: Threaded, **NPS 1/2 (DN 15)** or **NPS 3/4 (DN 20)**.
   c. Sensor Connection: Threaded, **NPS 1/2 (DN 15)**.
   d. Stem: [**Straight**][**Stepped**][**or**][**tapered**] shank formed from solid bar stock.
   e. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
   f. Extended Neck: Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends the threaded sensor connection beyond the face of the insulation covering.
   g. Immersion Length: As required by application and pipe size.
   h. Furnish thermowells with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

F. Connection Heads, High-End Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain high-end commercial-grade connection heads from same manufacturer as liquid and steam high-end commercial-grade temperature sensors.
4. Housing: Low-copper cast-aluminum alloy or Type 316 stainless steel, complying with NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
5. Terminals: Six or eight as required by sensor.
6. Conduit Connection: **1/2-inch (16-mm)** trade size.
7. Sensor Connection: **NPS 1/2 (DN 15)**.
8. Factory Assembly: Sensor manufacturer is to furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

G. Platinum RTD Immersion Temperature Sensor, Industrial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Burns Engineering**]
b. [**Honeywell Process Solutions**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. [**Siemens**]
e. [**Yokogawa**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Burns Engineering**]
b. [**Honeywell Process Solutions**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. [**Siemens**]
e. [**Yokogawa**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD immersion industrial-grade temperature sensors from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to traceable standards and include instrument with a calibration certificate.
5. Standards: Comply with IEC 60751, Class A requirements.
6. Performance:

a. Temperature Range: [**Minus 58 to 500 deg F (Minus 50 to 260 deg C)**][**Minus 58 to 842 deg F (Minus 50 to 450 deg C)**]<**Insert temperature range**>.
b. Interchangeable Accuracy: Within [**0.27 deg F (0.15 deg C) at 32 deg F (0 deg C)**]<**Insert temperature**>.
c. Hysteresis: Within [**0.04**]<**Insert value**> percent of range.
d. Stability: [**Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F (400 deg C)**]<**Insert requirement**>.
e. Response Time: [**62.8 percent of change in four seconds with water flowing across sensor at 3 fps (0.9 m/s)**]<**Insert requirement**>.
f. Self-Heating: [**18 mW minimum power dissipation required to cause a 1.8 deg F (1 deg C) temperature measurement error in water flowing at 3 fps (0.9 m/s)**]<**Insert requirement**>.

7. Sensor Assembly:

a. RTD: Platinum with a value of 100 ohms at 0 deg C and a temperature coefficient of resistance (TCR) of 0.00385 ohm/ohm/deg C.
b. Probe: Encase RTD in a Type 316, Type 316L, or Type 321 stainless steel sheath with a **0.25-inch (8-mm)** OD.
c. Wire: Provide [**two**][**three**][**four**]-wire, PTFE-insulated, nickel-coated, 22-gauge, stranded copper leads.
d. Provide sensor assembly with spring-loaded tip for thermowell installations.

H. Thermowells, Industrial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Burns Engineering**]
b. [**Honeywell Process Solutions**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. [**Siemens**]
e. [**Yokogawa**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Burns Engineering**]
b. [**Honeywell Process Solutions**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. [**Siemens**]
e. [**Yokogawa**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain industrial-grade thermowells from same manufacturer as liquid and steam industrial-grade temperature sensors.
4. Performance: Rated for system pressure, temperature, and velocity.
5. Thermowell Construction:

a. Stem: [**Straight**][**stepped**][**or**][**tapered**] shank formed from solid bar stock.
b. Material: [**Type 304**][**Type 304L**][**Type 316**][**or**][**Type 316L**]<**Insert type**> stainless steel.
c. Process Connection:

1) Threaded: **NPS 3/4 (DN 20)**.
2) Flange-face, where indicated: [**NPS 1 (DN 25)**][**NPS 1-1/2 (DN 38)**][**NPS 2 (DN 50)**], ASME B16.5, [**Class 150**][**Class 300**].

d. Sensor Connection: Threaded, **NPS 1/2 (DN 15)**.
e. Bore: Size to accommodate sensor stem OD with tight tolerance between sensor and well.
f. Head (Neck) Extension: Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends the threaded sensor connection beyond the face of the insulation covering.
g. Immersion Length: As required by application and pipe size.
h. Furnish thermowells with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

I. Connection Heads, Industrial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Burns Engineering**]
b. [**Honeywell Process Solutions**]
c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
d. [**Siemens**]
e. [**Yokogawa**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burns Engineering**]
   b. [**Honeywell Process Solutions**]
   c. [**Rosemount; Emerson Electric Co., Automation Solutions**]
   d. [**Siemens**]
   e. [**Yokogawa**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain industrial-grade connection heads from same manufacturer as liquid and steam industrial-grade temperature sensors.
4. Housing: Low-copper cast-aluminum alloy or stainless steel, complying with NEMA 250, [**Type 4**][**or**][**Type 4X**]<**Insert type**>.
5. Terminals: Six or eight as required by sensor, nickel-plated brass.
6. Conduit Connection: **1/2-inch (16-mm)** trade size.
7. Sensor Connection: Threaded, **NPS 1/2 (DN 15)**.
8. Factory Assembly: Sensor manufacturer is to furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

2.10 STRAP-ON TEMPERATURE SENSORS FOR PIPING

A. Platinum RTD Strap-on Temperature Sensors for Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]

i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum RTD strap-on temperature sensors for piping from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description: Nonintrusive temperature sensor for pipe applications.
6. Performance:

   a. Accuracy: Within [**0.27 deg F (0.15 deg C) at 32 deg F (0 deg C)**]<**Insert temperatures**>.
   b. Resistance: [**100**][**or**][**1000**]<**Insert value**> ohms.
   c. Response Time: Within [**30**]<**Insert value**> seconds for a [**60**]<**Insert value**> percent step change.
   d. Self-Heating: 18 mW minimum power dissipation
   e. Stability: Within [**0.03**]<**Insert value**> percent after 1000 hours at maximum temperature in range.
   f. Temperature Coefficient of Resistance (TCR): 0.00385 ohm/ohm/deg C.
   g. Fluid Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 45 to 85 deg C)**]<**Insert temperature range**>.
   h. Ambient Temperature Range: As required by application, not less than [**Minus 40 to 122 deg F (Minus 40 to 50 deg C)**]<**Insert temperature range**>.

7. Output Signal: Resistance in ohms.
8. Sensor Assembly:

   a. Sensing Plate: RTD bonded or encapsulated to the back side of [**an aluminum**][**a brass**][**or**][**copper**] heat sink for direct contact with outside surface of pipe.
   b. Clamp: Adjustable stainless steel hose clamp with quick-release worm gear.
   c. Pipe Size Range: [**NPS 3/4 (DN 20)**]<**Insert pipe size**> through [**NPS 10 (DN 250)**]<**Insert pipe size**>.

9. Enclosure:

   a. Material: Painted or galvanized metal[**or plastic**] box with removable cover.
   b. Rating: NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.

10. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.
11. Wiring Connection:

    a. Two-[**or three-**] wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
    b. Terminal Strip: Labeled terminal strip for connection to field wiring.

12. Heat-Transfer Paste: Include each temperature sensor with heat-transfer paste.

B. Thermistor Strap-on Temperature Sensors for Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]

d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ACI Automation; Automation Components Inc**]
   b. [**Belimo Aircontrols (USA), Inc**]
   c. [**Building Automation Products Inc.; BAPI**]
   d. [**Dwyer Instruments, Inc**]
   e. [**Greystone Energy Systems, Inc.**]
   f. [**Honeywell International Inc.**]
   g. [**Johnson Controls, Inc.**]
   h. [**MAMAC Systems, Inc.**]
   i. [**Schneider Electric USA, Inc.**]
   j. [**Siemens Industry, Inc., Building Technologies Division**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all platinum thermistor strap-on temperature sensors for piping from a single manufacturer.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Description: Nonintrusive temperature sensor for pipe applications.
6. Performance:

   a. Accuracy: Within [**0.36 deg F (0.20 deg C) at 32 deg F (0 deg C)**]<**Insert temperatures**>.
   b. Response Time: Within [**30**]<**Insert value**> seconds for a [**60**]<**Insert value**> percent step change.
   c. Self-Heating: Negligible.
   d. Stability: Within [**0.03**]<**Insert value**> percent after 1000 hours at maximum temperature in range.
   e. Fluid Temperature Range: As required by application, not less than [**Minus 40 to 185 deg F (Minus 45 to 85 deg C)**]<**Insert temperature range**>.
   f. Ambient Temperature Range: As required by application, not less than [**Minus 40 to 122 deg F (Minus 40 to 50 deg C)**]<**Insert temperature range**>.

7. Output Signal: Resistance in ohms.
8. Thermistor: 10000-ohm, Type II, negative temperature coefficient (NTC).

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.

9. Sensor Assembly:

   a. Sensing Plate: Thermistor bonded or encapsulated to the back side of [**an aluminum**][**a brass**][**or**][**copper**] heat sink for direct contact with outside surface of pipe.
   b. Clamp: Adjustable stainless steel hose clamp with quick-release worm gear.
   c. Pipe Size Range: [**NPS 3/4 (DN 20)**]<**Insert pipe size**> through [**NPS 10 (DN 250)**]<**Insert**

pipe size>.

10. Enclosure:

    a. Material: Painted or galvanized metal[**or plastic**] box with removable cover.
    b. Rating: NEMA 250, [**Type 1**][**Type 4**][**or**][**Type 4X**]<**Insert type**>.

11. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.
12. Wiring Connection:

    a. Two-wire, PTFE-insulated, minimum 22-gauge stranded copper leads.
    b. Terminal Strip: Labeled terminal strip for connection to field wiring.

13. Heat-Transfer Paste: Include each temperature sensor with heat-transfer paste.

2.11 LIQUID TEMPERATURE SWITCHES

A. Thermostat and Switch for Temperature Control in Pipe Applications:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Honeywell International Inc.**]
    b. [**Penn Controls**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Honeywell International Inc.**]
    b. [**Penn Controls**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain all thermostats and switches for temperature control in piping applications from a single manufacturer.
4. Description:

    a. Two-position control.
    b. Field-adjustable set point.
    c. Manual reset.
    d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Performance:

    a. Operating Temperature Range: [**65 to 200 deg F (18 to 93 deg C)**][**100 to 240 deg F (40 to 120 deg C)**].
    b. Temperature Differential Deadband: [**5 to 30 deg F (3 to 17 deg C)**] [**6 to 24 deg F (3.3 to 13 deg C)**], adjustable.
    c. Enclosure Ambient Temperature: [**140 deg F (60 deg C)**][**150 deg F (66 deg C)**].

d. Sensing Element Pressure Rating: **200 psig (1379 kPa)**.
e. Voltage: 120 V ac.
f. Current: [**8**][**10**]<**Insert value**> FLA.
g. Switch Type: SPDT snap switch.

6. Construction:

a. Vapor-filled immersion element.
b. Temperature Scale: Fahrenheit, visible on face.
c. Set-Point Adjustment: Screw or rotary knob.
d. Enclosure: Painted metal, NEMA 250, Type 1.
e. Electrical Connections: Screw terminals.
f. Conduit Connection: **1/2-inch (16-mm)** or **3/4-inch (20-mm)** trade size.

2.12 LIQUID AND STEAM TEMPERATURE TRANSMITTERS

A. Liquid and Steam Temperature Transmitters, Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACI Automation; Automation Components Inc**]
b. [**Belimo Aircontrols (USA), Inc**]
c. [**Building Automation Products Inc.; BAPI**]
d. [**Dwyer Instruments, Inc**]
e. [**Greystone Energy Systems, Inc.**]
f. [**Honeywell International Inc.**]
g. [**Johnson Controls, Inc.**]
h. [**MAMAC Systems, Inc.**]
i. [**Schneider Electric USA, Inc.**]
j. [**Siemens Industry, Inc., Building Technologies Division**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain liquid and steam temperature transmitters from same manufacturer as liquid and steam temperature RTD sensors.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include

instrument with a calibration certificate.

5. Performance Characteristics:

   a. Calibration Accuracy: Within [**0.2**]<**Insert value**> percent of the span.

6. Functional Characteristics:

   a. Input: 100-ohm platinum RTD with temperature coefficient of 0.00385 ohm/ohm/deg C; [**two-**][**or**][**three-**]wire sensors.
   b. Default Span (Adjustable):

      1) Chilled Water: [**0 to 100 deg F (Minus 18 to 38 deg C)**]<**Insert temperature range**>.
      2) Condenser Water: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
      3) Heating Hot Water: [**32 to 212 deg F (0 to 100 deg C)**]<**Insert temperature range**>.
      4) Heat Recovery: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
      5) <**Insert system and span**>.

   c. Minimum Span: [**50 deg F (28 deg C)**]<**Insert temperature**>.
   d. Field Adjustments: Span.

7. Analog Output Signal: 4 to 20 mA dc, linear with temperature; radio-frequency-interference insensitive; minimum drive load of [**600**]<**Insert value**> ohms at 24 V dc.
8. Electronics Enclosure:

   a. Rating: NEMA 250, [**Type 3R**][**Type 4**][**or**][**Type 4X**].
   b. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.
   c. Wiring Connection: Labeled terminals.

9. Factory Match: Factory match sensor with temperature transmitter.

B. Liquid and Steam Temperature Transmitters, High-End Commercial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Minco**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain liquid and steam temperature transmitters from same manufacturer as liquid and steam temperature RTD sensors.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Performance Characteristics:

a. Calibration Accuracy: Within [**0.1**]<**Insert value**> percent of the span.

6. Functional Characteristics:

a. Input: 100-ohm platinum RTD with temperature coefficient of 0.00385 ohm/ohm/deg C; [**two-**][**or**][**three-**]wire sensors.
b. Default Span (Adjustable):

1) Chilled Water: [**0 to 100 deg F (Minus 18 to 38 deg C)**]<**Insert temperature range**>.
2) Condenser Water: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
3) Heating Hot Water: [**32 to 212 deg F (0 to 100 deg C)**]<**Insert temperature range**>.
4) Heat Recovery: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
5) <**Insert system and span**>.

c. Minimum Span: [**18 deg F (10 deg C)**]<**Insert temperature**>
d. Field Adjustments: Zero and span adjustments, plus or minus [**5**]<**Insert value**> percent of span.

7. Analog Output Signal: 4 to 20 mA dc, linear with temperature; radio-frequency-interference insensitive; minimum drive load of [**600**]<**Insert value**> ohms at 24 V dc.
8. Electronics Enclosure:

a. Material: Painted aluminum alloy.
b. Rating: NEMA 250, [**Type 4**][**or**][**Type 4X**].
c. Conduit Connection: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.
d. Wiring Connection: Labeled terminals.
e. Display: Head mounted; display of temperature in [**degrees C**][**degrees F**].

9. Factory Match: Factory match sensor with temperature transmitter.

C. Liquid and Steam Temperature Transmitters, Industrial Grade:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell Process Solutions**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Siemens**]
d. [**Yokogawa**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell Process Solutions**]
b. [**Rosemount; Emerson Electric Co., Automation Solutions**]
c. [**Siemens**]
d. [**Yokogawa**]

e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain liquid and steam temperature transmitters from same manufacturer as liquid and steam temperature RTD sensors.
4. Factory Calibration: Factory calibrate each instrument to [**NIST-**]traceable standards and include instrument with a calibration certificate.
5. Hazard Classification: Where indicated, provide instrument that is FM Approved for hazardous environments.

   a. Intrinsically safe for Classes I, II, and III; Division 1; Groups A through G.
   b. Explosion proof for Class I; Division 1; Groups B, C, and D.
   c. Dust-ignition proof for Classes II and III; Division 1; Groups E, F, and G.

6. Performance:

   a. Digital Accuracy: Within **0.18 deg F (0.1 deg C)** <**Insert temperature**>.
   b. Digital to Analog Accuracy: Within [**0.005**][**0.03**]<**Insert value**> percent of span.
   c. Total Accuracy: Within [**0.23 deg F (0.18 deg C)**][**0.32 deg F (0.18 deg C)**]<**Insert temperature**> with a [**180 deg F (82 deg C)**]<**Insert temperature**>.
   d. Stability: Within [**0.15**]<**Insert value**> percent of output reading for [**24**]<**Insert value**> months.
   e. Ambient Temperature Limits: [**Minus 40 to 185 deg F (Minus 40 to 85 deg C)**]<**Insert temperature range**>.
   f. Humidity Limits: Zero to [**99**]<**Insert value**> percent.

7. Functional Characteristics:

   a. Range: [**Minus 328 to 1562 deg F (Minus 200 to 850 deg C)**]<**Insert temperature range**>.
   b. Field-Adjustable Span: [**1 deg F (0.6 deg C)**][**18 deg F (10 deg C)**]<**Insert temperature**> minimum.
   c. Default Spans:

      1) Chilled Water: [**0 to 100 deg F (Minus 18 to 38 deg C)**]<**Insert temperature range**>.
      2) Condenser Water: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
      3) Heating Hot Water: [**32 to 212 deg F (0 to 100 deg C)**]<**Insert temperature range**>.
      4) Heat Recovery: [**0 to 120 deg F (Minus 18 to 49 deg C)**]<**Insert temperature range**>.
      5) <**Insert system and span**>.

   d. Output Signal:

      1) 4 to 20 mA dc, linear with temperature.
      2) Digital signal based on HART protocol carried with current signal.
      3) Radio-frequency-interference insensitive.
      4) Minimum drive load of [**600**]<**Insert value**> ohms at 24 V dc.

   e. Self-Calibration: The analog-to-digital measurement circuitry automatically self-calibrates for each temperature update by comparing the dynamic measurement to extremely stable and accurate internal reference elements.

8. Electronics Enclosure:

a. Materials: [**Aluminum alloy**][**or**][**stainless steel**].
b. Rating: NEMA 250, Type 4X.
c. Conduit Connections: **1/2-inch (16-mm)**[**or 3/4-inch (20-mm)**] trade size.
d. Wiring Terminals: As required by sensor.
e. Digital Display: Display of engineering units.
f. Mounting kit to suit application.

9. Factory Match: Factory match sensor with temperature transmitter.

2.13 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:

1. 100-ohm Platinum RTD, Single-Point Air Temperature Duct Sensors: <**Insert application**>.
2. 1000-ohm Platinum RTD, Single-Point Air Temperature Duct Sensors: <**Insert application**>.
3. 100-ohm Platinum RTD, Air Temperature Averaging Sensors: <**Insert application**>.
4. 1000-ohm Platinum RTD, Air Temperature Averaging Sensors: <**Insert application**>.
5. 100-ohm Platinum RTD Outdoor Air Temperature Sensors: <**Insert application**>.
6. 1000-ohm Platinum RTD Outdoor Air Temperature Sensors: <**Insert application**>.
7. 100-ohm Platinum RTD Space Air Temperature Sensors: <**Insert application**>.
8. 1000-ohm Platinum RTD Space Air Temperature Sensors: <**Insert application**>.
9. 100-ohm Platinum RTD Space Air Temperature Sensors, Flush-Mount, Flat-Face Cover: <**Insert application**>.
10. 1000-ohm Platinum RTD Space Air Temperature Sensors, Flush-Mount, Flat-Face Cover: <**Insert application**>.
11. 100-ohm Platinum RTD Space Air Temperature Sensors, Button Style: <**Insert application**>.

12. 1000-ohm Platinum RTD Space Air Temperature Sensors, Button Style: <**Insert application**>.
13. 100-ohm Platinum RTD Space Air Temperature Sensors with Occupant Interface Features: <**Insert application**>.
14. 1000-ohm Platinum RTD Space Air Temperature Sensors with Occupant Interface Features: <**Insert application**>.
15. Thermistor Single-Point Air Temperature Duct Sensors: <**Insert application**>.
16. Thermistor Air Temperature Averaging Sensors: <**Insert application**>.
17. Thermistor Outdoor Air Temperature Sensors: <**Insert application**>.
18. Thermistor Space Air Temperature Sensors: <**Insert application**>.
19. Thermistor Space Air Temperature Sensors, Flush-Mount, Flat-Face Cover: <**Insert application**>.
20. Thermistor Space Air Temperature Sensors, Button Style: <**Insert application**>.
21. Thermistor Space Air Temperature Sensors with Occupant Interface Features: <**Insert application**>.

B. Air Temperature Sensors with Network Communication Signal for Space Applications: <**Insert application**>.

C. Multivariable Air Temperature Sensors and Transmitters:

1. Combination Carbon-Dioxide and Air Temperature Sensors and Transmitters for Duct Applications: <**Insert application**>.
2. Combination Carbon-Dioxide and Air Temperature Sensors and Transmitters for Space Applications: <**Insert application**>.
3. Combination Carbon-Dioxide, Relative Humidity, and Air Temperature Sensors and Transmitters for Duct Applications: <**Insert application**>.
4. Combination Carbon-Dioxide, Relative Humidity, and Temperature Sensors and Transmitters for Space Applications: <**Insert application**>.

D. Wireless Air Temperature Sensors:

1. Wireless Air Temperature Sensors: <**Insert application**>.
2. Wireless Air Temperature and Relative Humidity Sensors and Transmitters: <**Insert application**>.

E. Combination Air Temperature Sensors and Switches: <**Insert application**>.

F. Air Temperature Switches:

1. Thermostat and Switch for Low-Temperature Control in Duct Applications: <**Insert application**>.
2. Thermostat and Switch for High-Temperature Control in Duct Applications: <**Insert application**>.

G. Air Temperature RTD Transmitters: <**Insert application**>.

H. Liquid and Steam Temperature Sensors, Commercial Grade:

1. 100-ohm Platinum RTD Immersion Temperature Sensors, Commercial Grade: <**Insert application**>.
2. 1000-ohm Platinum RTD Immersion Temperature Sensors, Commercial Grade: <**Insert application**>.
3. Thermistor Immersion Temperature Sensors, Commercial Grade: <**Insert application**>.
4. 100-ohm Platinum RTD Immersion Temperature Sensors, High-End Commercial Grade: <**Insert application**>.

I. Liquid and Steam Temperature Sensors, High-End Commercial Grade:

1. Platinum RTD Immersion Temperature Sensors, High-End Commercial Grade: <**Insert application**>.

J. Liquid and Steam Temperature Sensors, Industrial Grade:

1. Platinum RTD Immersion Temperature Sensors, Industrial Grade: <**Insert application**>.

K. Strap-on Temperature Sensors for Piping:

1. Platinum RTD Strap-on Temperature Sensors for Piping: <**Insert application**>.
2. Thermistor Strap-on Temperature Sensors for Piping: <**Insert application**>.

L. Liquid Temperature Switches:

1. Thermostat and Switch for Temperature Control in Pipe Applications: <**Insert application**>.
2. <**Insert system**> System, <**Insert unique application**>: [**Liquid and steam temperature sensor, Commercial Grade**][**Liquid and steam temperature sensor, High-End Commercial Grade**][**Liquid and steam temperature sensor, Industrial Grade**].

M. Liquid and Steam Temperature Transmitters, Commercial Grade: <**Insert application**>.

N. Liquid and Steam Temperature Transmitters, High-End Commercial Grade: <**Insert application**>.

O. Liquid and Steam Temperature Transmitters, Industrial Grade: <**Insert application**>.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

C. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of [**Type 316L**

stainless steel]<**Insert material**>.

3.4 INSTALLATION OF TEMPERATURE INSTRUMENTS

A. Mounting Location:

1. Roughing In:

a. Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
2) Do not begin installation without submittal approval of mounting location.

c. Complete installation rough-in only after confirmation by independent inspector is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual HVAC equipment and associated connected ductwork and piping near HVAC equipment co-located in HVAC equipment system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation and building and wind effect with stand-offs and shields constructed of [**Type 316 stainless steel**]<**Insert material**>.
2. Isolate temperature instruments having performance impacted by temperature of mounting substrate with an insulating barrier located between instrument and substrate to eliminate effect on performance. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height is to comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of **42 to 72 inches (1.1 to 1.6 m)** above the adjacent floor, grade, or service catwalk or platform.

a. Make every effort to mount at **60 inches (1500 mm)**.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Installation of Space Temperature Sensors:

1. Conceal assembly and field wiring connections in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Installation of Outdoor Air Temperature Sensors:

1. Mount sensor in an accessible and discrete location facing north.
2. Protect installed sensor from solar radiation and other environmental influences that could impact performance.
3. If required to have a transmitter, mount transmitter remotely from sensor in an accessible and serviceable location indoors that is not readily accessible by building occupants.

G. Installation of Single-Point Duct Temperature Sensors:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed near center of duct cross section and located to sense near average temperature. Do not exceed **18 inches (450 mm)** in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remotely from sensor at accessible and serviceable location indoors that is not readily accessible by building occupants.
5. Install duct access doors of sufficient size for inspection, removal, and replacement of single-point duct temperature sensors. Comply with Section 233300 "Air Duct Accessories" for access doors.

H. Installation of Averaging Duct Temperature Sensors:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar HVAC equipment, and large ducts with air tunnel cross-sectional area of [**10 sq. ft. (0.9 sq. m)**][**20 sq. ft. (1.86 sq. m)**]<**Insert area**> and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area and measure an average temperature. Install multiple sensors where required to maintain coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor properly supported and taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location indoors that is not readily accessible by building occupants.
5. Install duct access doors of sufficient size for inspection, removal, and replacement of averaging duct temperature sensors. Comply with Section 233300 "Air Duct Accessories" for access doors.

I. Installation of Multivariable Air Temperature Sensors and Transmitters: Comply with requirements indicated for air temperature sensors.

J. Installation of Wireless Air Temperature Sensors:

1. Mount sensors to substrate at height indicated, using mounting kits furnished with sensors.

2. In areas with ceilings, conceal mounting of receivers, transceivers, or repeaters above ceilings.
3. Test communication signal to ensure a strong and uninterrupted signal to all connected devices and for proper coverage. Add additional receivers, transceivers, or repeaters if required.

K. Installation of Combination Air Temperature Sensors and Switches:

1. Install combination air temperature sensors and switches to maintain coverage over entire cross-sectional area of air tunnel and to account for stratification. Install multiple instruments if required to maintain coverage over entire cross-sectional area of air tunnel and to account for stratification.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element properly supported and taut throughout entire length.
3. Mount instrument enclosure outside of airstream at a location and mounting height to provide easy access for set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.
5. Install duct access doors of sufficient size for inspection, removal, and replacement of combination air temperature sensors and switches. Comply with Section 233300 "Air Duct Accessories" for access doors.

L. Installation of Low-Limit Air Temperature Switches:

1. Install low-limit switches to maintain coverage over entire cross-sectional area of air tunnel and to account for stratification. Install multiple switches if required to maintain coverage over entire cross-sectional area of air tunnel and to account for stratification.
2. Fasten and support sensing element with manufacturer-furnished clips to keep sensor properly supported and taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.
5. Install duct access doors of sufficient size for inspection, removal, and replacement of low-limit air temperature switches. Comply with Section 233300 "Air Duct Accessories" for access doors.

M. Installation of Liquid and Steam Temperature Sensors:

1. Install all sensors in a matching thermowell.
2. For pipe **NPS 4 (DN 100)** and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than **NPS 4 (DN 100)**:

    a. Install reducers to increase pipe size to **NPS 4 (DN 100)** at point of thermowell installation.
    b. For pipe sizes **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
    c. Minimum insertion depth is to be **2-1/2 inches (65 mm)**.

4. Fill thermowell with heat-transfer compound before inserting sensor.
5. Install tip of spring-loaded sensors to contact inside of thermowell.
6. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
7. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
8. Install sensors and thermowells to provide a leak-free installation when subjected to system, pressures, temperatures, and velocities encountered.
9. Install high-end commercial and industrial grade liquid and steam temperature sensors with a connection head.
10. For applications with transmitters, mount transmitter remotely from sensor in an accessible and serviceable location from floor[**service platform or catwalk**]. Avoid locations that are readily

accessible by building occupants.

3.5 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.9 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Check instruments for proper installation with respect to location, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

E. Verify that wiring is correct and secure.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.[**Field calibration is not required for instruments that have been factory calibrated and provided with certificates.**]
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform in accordance with manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.12 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.13 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.14 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 23 09 23 27

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Task	Specification	Specification Description
23 09 23 27	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 27	23 09 23 00a	Leak Detection Instruments
23 09 23 27	23 09 23 00b	Position Instruments
23 09 23 27	23 09 00 00	Speed Instruments
23 09 23 27	23 09 23 00c	Sequence of Operations for HVAC DDC
23 09 23 53	23 09 23 00	Direct Digital Control (DDC) System for HVAC
23 09 23 53	23 09 23 12	Control Dampers
23 09 23 53	23 09 23 00a	Leak Detection Instruments
23 09 23 53	23 09 23 00b	Position Instruments
23 09 23 53	23 09 00 00	Speed Instruments
23 09 23 53	23 09 23 00c	Sequence of Operations for HVAC DDC
23 09 43 00	23 09 00 00	Speed Instruments
23 11 00 00	23 11 23 00	Facility Natural-Gas Piping
23 11 00 00	23 11 26 00	Facility Liquefied-Petroleum Gas Piping

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SECTION 23 11 23 00 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. CSST and fittings.
3. Aluminum tubing, piping, and fittings.
4. Copper tubing and fittings.
5. PE pipe, tubing, and fittings.
6. Mechanical couplings.
7. Piping specialties.
8. Manual gas shutoff valve.
9. Manual gas shutoff ball valve.
10. Automatic gas shutoff valve.
11. Earthquake valve.
12. Pressure regulators.
13. Service meters.
14. Dielectric fittings.
15. Detectable warning tape.

B. Related Requirements:

1. Section 231126 "Facility Liquified-Petroleum Gas Piping."

1.2 DEFINITIONS

A. CSST: Corrugated stainless steel tubing.

B. CWP: Cold working pressure.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. PE: Polyethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Provide plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**> .
2. Detail mounting, supports, and valve arrangements for [**service-meter assembly and**] pressure regulator assembly.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Seismic Qualification Data: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Welding Certificates: For piping.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**automatic gas shutoff valves**][**pressure regulators**][**and**][**service meters**] .

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and

Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes, tubing, and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 230553 "Identification of HVAC Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with [**NFPA 54**][**and**][**the International Fuel Gas Code**] for natural-gas distribution system, including materials, installation, and testing.

B. Comply with requirements of authorities having jurisdiction.

C. Comply with requirements of utility company supplying natural-gas.

D. Minimum Operating-Pressure Ratings:

1. Piping and Valves: [**100 psig (690 kPa)**]<**Insert pressure**> minimum.
2. Service Regulators: [**65 psig (450 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> minimum.
3. Service Meter: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**][**65 psig (450 kPa)**]<**Insert value**> .

E. Natural-Gas System Pressure within Buildings:

1. Single Pressure: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**]<**Insert pressure range**> .
2. Two Pressure Ranges, Not More Than 2 psig (13.8 kPa): Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
3. Two Pressure Ranges, Not More Than 5 psig (34.5 kPa): Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** and is reduced to secondary pressure of more than **0.5 psig (3.45 kPa)**, but not more than **2 psig (13.8 kPa)**.
4. Three Pressure Ranges: Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** is reduced to secondary pressures of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced again to pressures of **0.5 psig (3.45 kPa)** or less.

F. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> . See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the piping system will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Component Amplification Factor: <**Insert requirement**> .
4. Component Response Modification Factor: <**Insert requirement**> .

2.2 PIPE, TUBES, AND FITTINGS

A. Steel Pipe and Fittings:

1. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
3. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
5. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.

c. Lapped Face: Unacceptable for underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

6. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. CSST and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
c. [**Tru-Flex Metal Hose Corp**]
d. [**Ward Manufacturing LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
c. [**Tru-Flex Metal Hose Corp**]
d. [**Ward Manufacturing LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain CSST and fittings from single manufacturer.
4. Standard: CSA/ANSI LC 1/CSA 6.26.
5. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
6. Jacket: Electrically insulative and UV-resistant polymer with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

7. Jacket with Fully Vent-Capable PE Sleeve: Include associated fittings suitable for locations requiring vented containment.
8. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with CSST and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
9. Striker Plates: Steel, designed to protect tubing from penetrations.
10. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
11. Operating-Pressure Rating: **5 psig (34.5 kPa)**.

C. Aluminum Tubing, Piping, and Fittings:

1. Aluminum Tubing and Piping:

   a. Standards:

      1) ASTM B210/B210M.
      2) ASTM B241/B241M.

   b. Material: Aluminum Alloy 5456 is prohibited by NFPA 54.

2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
3. Flare Fittings: ASME B16.26 and SAE J513.

   a. Copper-alloy fittings.
   b. Metal-to-metal compression seal without gasket.
   c. Dryseal threads complying with ASME B1.20.3.

D. Copper Tubing and Fittings:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
2. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
3. Coating: Factory-applied, extruded PE a minimum of **0.025 inch (0.64 mm)** thick. Continuously marked with size, specification information, manufacturing code, and footage every **2 ft. (610 mm)**.
4. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
5. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
6. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

   a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
   b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

7. Flare Fittings: Comply with ASME B16.26 and SAE J513.

   a. Copper fittings with long nuts.
   b. Metal-to-metal compression seal without gasket.
   c. Dryseal threads complying with ASME B1.20.3.

8. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of **0.022 inch (0.56 mm)** thick.

E. PE Pipe, Tubing, and Fittings:

1. PE Pipe and Tubing: ASTM D2513, SDR 11.
2. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type.
3. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
4. Anodeless Service-Line Risers: Factory fabricated and leak tested.

   a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.

b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. [**Vent casing aboveground.**]
c. Aboveground Portion: PE transition fitting.
d. Provide outlet threaded or flanged or suitable for welded connection.
e. Provide tracer wire connection.
f. Provide UV shield.

5. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Provide outlet threaded or flanged or suitable for welded connection.
c. Provide bridging sleeve over mechanical coupling.
d. Provide factory-connected anode.
e. Provide tracer wire connection.
f. Provide UV shield.

2.3 MECHANICAL COUPLINGS

A. Mechanical Coupling - Plastic, NPS 1-1/2 (DN 40) and Smaller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Continental Industries; brand of Hubbell Incorporated**]
b. [**Elster Perfection; Honeywell**]
c. [**Lyall; brand of Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Continental Industries; brand of Hubbell Incorporated**]
b. [**Elster Perfection; Honeywell**]
c. [**Lyall; brand of Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. PE body.
6. Elastomeric seals.
7. Independent gripping collets.
8. Suitable for joining PE pipe to PE pipe.

B. Mechanical Coupling - Plastic, NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elster Perfection; Honeywell**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elster Perfection; Honeywell**]
b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. Stainless steel bolts, nuts, and washers.
6. Suitable for joining PE pipe to PE pipe.

C. Mechanical Coupling - Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Smith-Blair, a Xylem brand.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Smith-Blair, a Xylem brand.**]
b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Flanges and Tube: [**Stainless steel**][**Steel**] with epoxy finish.
5. Seals: NBR.
6. Bolts, Washers, and Nuts: [**Stainless steel**][**Steel**] bolts, washers, and nuts.
7. Factory-installed anode for steel-body couplings installed underground.
8. Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

2.4 PIPING SPECIALTIES

A. Appliance Flexible Connector:

1. Indoor, Fixed-Appliance Flexible Connectors: ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: ANSI Z21.75.
4. CSST with polymer coating.
5. Operating-Pressure Rating: **0.5 psig (3.45 kPa)**.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: **72 inches (1830 mm)**.

B. Quick-Disconnect Device:

1. Standard: ANSI Z21.41/CSA 6.9.
2. Copper-alloy convenience outlet and matching plug connector.
3. Nitrile seals.
4. Hand operated with automatic shutoff when disconnected.
5. For indoor or outdoor applications.
6. Adjustable, retractable restraining cable.

C. Y-Pattern Strainer:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

D. Basket Strainer:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

E. T-Pattern Strainer:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer, and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: **750 psig (5170 kPa)**.

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 Steel Pressure-Seal Fittings

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.6 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: AWS D10.12/D10.12M.

C. Brazing Filler Metals: AWS A5.8/A5.8M alloy with melting point greater than **1000 deg F (540 deg C)**. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.7 GAS VALVES

A. Manual Gas Shutoff Valve - Metallic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain metallic manual gas shutoff valves from single manufacturer.
4. Description: Metallic ball valve or metallic plug valve of type indicated in schedules under Part 3.
5. Standards:

   a. CSA/ANSI Z21.15/CSA 9.1.
   b. ASME B16.33.
   c. ASME B16.44.

6. System Pressure Rating: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**][**More than 5 psig (34.5 kPa) but not more than 125 psig (862 kPa)**]<**Insert pressure**> .
7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service Mark: Initials "WOG" permanently marked on valve body.
9. End Connections:

   a. Threaded Ends: ASME B1.20.1.
   b. Dryseal Threads on Flare Ends: ASME B1.20.3.
   c. Flanged Ends: ASME B16.5 for steel flanges.

10. Tamperproof locking feature.

B. Manual Gas Shutoff Ball Valve - PE:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain PE manual gas shutoff valves from single manufacturer.
4. Standard: ASME B16.40.
5. Body: PE.
6. Ball: Polypropylene.
7. Stem: Acetal.
8. Seats and Seals: NBR.
9. Ends: Plain or fusible to match piping.
10. CWP Rating: [**80 psig (552 kPa)**]<**Insert pressure**> .
11. Operating Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**> .
12. Operator: Nut or flat head for key operation.
13. Plastic valve extension.
14. Tamperproof locking feature.

C. Valve Box:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of **5 inches (125 mm)** in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

D. Automatic Gas Shutoff Valve - Electrically Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Gas Safety, LLC.**]
    b. [**ASCO; an Emerson company**]
    c. [**BASO Gas Products, LLC**]
    d. [**Magnatrol Valve Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain electrically operated automatic gas shutoff valves from single manufacturer.
4. Description: Electrically operated automatic valve, solenoid type, used in natural-gas piping for automatic shutoff of service when interlocked with a hazard-condition initiating device.
5. Standards:

a. CSA/ANSI Z21.21/CSA 6.5.
b. UL 429.
c. FM Global approved.

6. Body: Brass or aluminum.
7. Seats and Disc: NBR.
8. Springs and Valve Trim: Stainless steel.
9. Coil: Continuous-duty, molded coil, replaceable.
10. Normally closed.
11. Visual position indicator.
12. Electrical Characteristics: [**120 V ac, 60 Hz**][**24 V ac, 60 Hz**][**24 V dc**]<**Insert value**> .

E. Earthquake Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Firefighter Gas Safety Products**]
b. [**Pacific Seismic Products, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Firefighter Gas Safety Products**]
b. [**Pacific Seismic Products, Inc**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain earthquake valves from same manufacturer.
4. Description: Seismically activated automatic gas shutoff valve.
5. Standard: ANSI/ASCE/SEI 25.
6. Maximum Operating Pressure: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**60 psig (414 kPa)**]<**Insert pressure**> .
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Threaded for valves **NPS 4 (DN 100)** and smaller; or flanged for valves **NPS 2 (DN 50)** and larger.
10. Wall-mounting bracket with bubble level indicator.

2.8 PRESSURE REGULATORS

A. Service Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. [**Fairview Ltd.**]
   d. [**Fischer; Emerson Electric Co., Automation Solutions**]
   e. [**Marshall Excelsior Company**]
   f. [**Maxitrol Company**]
   g. [**RegO Products; a brand of Engineered Controls International, LLC**]
   h. [**Richards Industrials**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. [**Fairview Ltd.**]
   d. [**Fischer; Emerson Electric Co., Automation Solutions**]
   e. [**Marshall Excelsior Company**]
   f. [**Maxitrol Company**]
   g. [**RegO Products; a brand of Engineered Controls International, LLC**]
   h. [**Richards Industrials**]
   i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain service pressure regulators from single manufacturer.
4. Standards:

   a. NFPA 54.
   b. ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
6. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

B. Line Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain line-pressure regulators from single manufacturer.
4. Standards:

a. NFPA 54.
b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
6. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]

c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain appliance pressure regulators from single manufacturer.
4. Standards:

a. NFPA 54.
b. CSA/ANSI Z21.18/CSA 6.3.

5. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
6. Maximum Inlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
7. Maximum Outlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**]<**Insert pressure**> .
8. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.

2.9 SERVICE METERS

A. Diaphragm-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]

c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain diaphragm-type service meters from single manufacturer.
4. Standard: [**ANSI B109.1**][**ANSI B109.2**] .
5. Case: Die-cast aluminum.
6. Connections: Steel threads.
7. Diaphragm: Synthetic fabric.
8. Diaphragm Support Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Meter Case and Index: Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Pressure Loss: Maximum [**0.5 inch wg (124 Pa)**][**2.0 inch wg (498 Pa)**]<**Insert pressure differential**> .
15. Accuracy: Maximum plus or minus [**1.0**]<**Insert number**> percent.

B. Rotary-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain rotary-type service meters from single manufacturer.
4. Standard: ANSI B109.3.
5. Case: Extruded aluminum.
6. Connection: Flange.
7. Impellers: Polished aluminum.
8. Rotor Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

C. Turbine Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain turbine meters from single manufacturer.
4. Standard: ASME MFC.4M.
5. Housing: Cast iron or welded steel.
6. Connection Threads or Flanges: Steel.
7. Turbine: Aluminum or plastic.
8. Turbine Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

D. Service-Meter Bar:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
c. <**Insert manufacturer's name**>

3. Malleable- or cast-iron frame for supporting service meter.
4. Include offset swivel pipes, meter nuts with O-ring seal, and factory- or field-installed dielectric unions.
5. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. <**Insert manufacturer's name**>

3. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
4. Integral ball-check bypass valve.

2.10 DIELECTRIC FITTINGS

A. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Union:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A.Y. McDonald Mfg. Co.**]
b. [**HART Industrial Unions, LLC**]
c. [**Jomar Valve**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**HART Industrial Unions, LLC**]
c. [**Jomar Valve**]
d. [**Matco-Norca**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**]<**Insert pressure rating at temperature**> .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flange:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Matco-Norca**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Matco-Norca**]
b. [**WATTS; A Watts Water Technologies Company**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Standard: ASSE 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 180 deg F (82 deg C)**]<**Insert pressure at temperature**> .
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT Industries, LLC.**]
d. <**Insert manufacturer's name**>

3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> .
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

2.11 DETECTABLE WARNING TAPE

A. Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for preventing accidental ignition.

3.4 INSTALLATION OF PIPE, TUBES, AND FITTINGS

A. Outdoor Piping: Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for installation and purging of natural-gas piping.

1. Install underground, natural-gas piping buried at least [**18 inches (460 mm)**]<**Insert value**> below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

   a. If natural-gas piping is installed less than **12 inches (300 mm)** below finished grade, install it in containment conduit.

2. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
3. Steel Piping with Protective Coating:

   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating

manufacturer.
c. Replace pipe having damaged PE coating with new pipe.

4. Copper Tubing with Protective Coating:

a. Apply joint cover kits over tubing to cover, seal, and protect joints.
b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

5. Install fittings for changes in direction and branch connections.
6. Joints for connection to inlets and outlets on regulators, and valves may be flanged or threaded to match the equipment.
7. Install pressure gauge [**downstream**][**upstream and downstream**] from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

B. Indoor Piping: Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for installation and purging of natural-gas piping.

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
3. Install piping in concealed locations unless otherwise indicated on Drawings. Piping in equipment rooms and service areas may be installed exposed. Piping is not to be installed in inaccessible locations.

a. Conceal piping in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
b. Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit in accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1) Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

a) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

2) In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of **1-1/2 inches (38 mm)** of concrete. Piping may not be in physical contact with other metallic structures, such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3) In Floor Channels: Channels must have cover and be open to space above cover for ventilation.
4) In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a) Exception: Tubing passing through partitions or walls does not require striker barriers.

5) Prohibited Locations:

a) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
b) Do not install natural-gas piping in return-air plenums.
c) Do not install natural-gas piping in solid walls or partitions.

6) Under the Building: Install in vented containment conduit or CSST with integral vented sleeve and associated fittings.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise on Drawings.
5. Locate valves for easy access from a standing position. Do not locate valves within return air plenums.
6. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Comply with requirements in Sections specifying gas-fired appliances and equipment, and verify final appliance and equipment locations for roughing-in requirements.
10. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three pipe diameters, but not less than **3 inches (75 mm)** long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
    b. Install sediment trap on both sides of regulators for gas reduction to **2 psig (13.8 kPa)** with valve and cap.

11. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors, and terminate with weatherproof vent cap.
12. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
13. Connect branch piping from top or side of horizontal piping.
14. Install unions in pipes **NPS 2 (DN 50)** and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
15. Do not use natural-gas piping as grounding electrode.
16. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve. Remove and replace startup strainer with new strainer prior to final acceptance tests.
17. Install pressure gauge [**downstream**][**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."
18. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
19. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
20. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF SERVICE METERS

A. Install service-meter assemblies aboveground [**, on concrete bases**] .

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 INSTALLATION OF PRESSURE REGULATORS

A. Ensure the gas supply is completely shut off at the main valve and that the line is fully depressurized.

B. Remove any shipping plugs from the inlet, outlet, and vent connections. Ensure the pipe interior and regulator are free of dirt, debris, and contaminants.

C. Apply pipe joint sealant or Teflon tape rated for gas use to the male threads of the pipe. Avoid getting sealant on the female threads or inside the regulator.

D. Mount the regulator in the correct orientation, aligning the flow arrow on the body with the direction of gas flow. The piping must be properly aligned and supported to avoid stressing the regulator.

E. If the pressure regulator is installed inside of a building, install a dedicated vent line directly from the regulator to the outdoors. The vent terminal must be insect resistant and rain resistant. The regulator should be at least **3 ft. (914 mm)** horizontally from any building opening below the vent opening, and positioned so that gas can disperse freely.

3.7 INSTALLATION OF GAS VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of CSST, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**steel piping**][**and**][**copper tubing**] , with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

F. Support vertical runs of [**steel piping**][**and**][**copper tubing**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.10 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Install piping adjacent to appliances to allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas-shutoff valves and unions. Install valve within **72 inches (1800 mm)** of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.11 INSTALLATION OF LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, **12 inches (300 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

C. Label and identify gas piping and pressure outside a multitenant building by tenant.

3.12 CONCRETE BASES

A. Anchor equipment to concrete base [**.**][**in accordance with seismic codes of Project. See Section 230548 "Vibration and Seismic Controls for HVAC."**]

B. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on [**18-inch (450-mm)**]<**Insert dimension**> centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Use [**3000 psig (20.7 MPa)**]<**Insert value**> , 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction requirements for testing, inspection, and purging of natural-gas installation.
2. Natural-gas installation will be considered defective if it does not pass tests and inspections. Defective products are to be replaced. Retest installation after defective products have been replaced for code compliance.

B. Prepare test and inspection reports.

3.14 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.15 OUTDOOR NATURAL-GAS PIPING SCHEDULE

A. Underground Natural-Gas Piping: To be one of the following:

1. PE Pipe, Tubing and Fittings: Terminate service-line risers with tracer wire in an accessible location.
2. Steel Pipe: With wrought-steel welding fittings or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
3. Drawn-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
6. CSST and Fittings: With integral vented sleeve terminated in an accessible location.

B. Aboveground Natural-Gas Piping: To be one of the following:

1. CSST and fittings.
2. Steel pipe with malleable-iron threaded fittings.
3. Steel pipe with wrought-steel welded fittings.
4. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Annealed-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

3.16 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground Branch Piping NPS 1 (DN 25) and Smaller: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.

4. Aluminum Tube: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.

B. Aboveground Distribution Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

C. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.17 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground Branch Piping NPS 1 (DN 25) and Smaller: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tubing and Piping: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.

B. Aboveground Distribution Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

C. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.18 INDOOR NATURAL-GAS PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than [**5 psig (34.5 kPa)**]<**Insert pressure**> .

B. Aboveground, Branch Piping:

1. Steel Pipe: With wrought-steel welding fittings.

C. Aboveground Distribution Piping: To be one of the following:

1. Steel Pipe: With wrought-steel welding fittings.
2. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

D. Underground Below-Building Piping: To be one of the following:

1. Steel pipe with malleable-iron threaded fittings.
2. Steel pipe with wrought-steel welding fittings.
3. Containment Conduit: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.
4. Containment Conduit Vent Piping: In accordance with [**NFPA 54,**][**the International Fuel Gas Code,**] and authorities having jurisdiction.

3.19 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. Manual gas shutoff ball valve - PE.
2. Manual gas shutoff valve - metallic.

3.20 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Natural-Gas Piping: Manual gas shutoff valve - metallic.

END OF SECTION 23 11 23 00

Task	Specification	Specification Description
23 11 23 00	21 05 00 00	Common Work Results for Fire Suppression
23 11 23 00	22 05 00 00	Common Work Results for Plumbing
23 11 23 00	23 05 00 00	Common Work Results for HVAC
23 11 23 00	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 11 23 00	33 11 13 00a	Potable Water Supply Wells

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SECTION 23 11 26 00 - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. CSST and fittings.
3. Aluminum tubing, piping, and fittings.
4. Copper tubing and fittings.
5. PE pipe, tubing, and fittings.
6. Polyamide pipe, tubing, and fittings.
7. Mechanical couplings.
8. Piping specialties.
9. Manual gas shutoff valve.
10. Manual gas shutoff ball valve.
11. Valve boxes.
12. Automatic gas shutoff valve.
13. Earthquake valve.
14. Pressure regulators.
15. Service meters.
16. Dielectric fittings.
17. Storage containers.
18. Transport truck unloading facility.
19. Vaporizers.
20. Detectable warning tape.

B. Related Requirements:

1. Section 231123 Facility Natural-Gas Piping.

1.2 DEFINITIONS

A. CSST: Corrugated stainless steel tubing.

B. CWP: Cold working pressure.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. LPG: Liquefied-petroleum gas.

G. PE: Polyethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Provide plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawings Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**> .
2. Detail mounting, supports, and valve arrangements for [**service meter assembly and**] pressure regulator assembly.

C. Delegated Design Submittals: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is indicated and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.

C. Seismic Qualification Data: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Welding Certificates: For piping.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**automatic gas shutoff valves**][**pressure regulators**][**and**][**service meters**] .

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes with factory-applied protective coating to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes, tubing, and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of LPG service.
2. Do not proceed with interruption of LPG service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 230553 "Identification of HVAC Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of [**NFPA 58**][**and**][**the International Fuel Gas Code**] for LPG distribution

system, including materials, installation, and testing.

B. Comply with requirements of authorities having jurisdiction.

C. Comply with requirements of utility company supplying LPG.

D. Minimum Operating-Pressure Ratings:

1. Piping and Valves: [**125 psig (862 kPa)**]<**Insert pressure**> minimum.
2. Service Regulators: [**65 psig (450 kPa)**][**100 psig (690 kPa)**]<**Insert pressure**> minimum.
3. Service Meter: [**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**][**65 psig (450 kPa)**]<**Insert pressure**> .

E. LPG System Pressure within Buildings:

1. Single Pressure: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**]<**Insert pressure range**> .
2. Two Pressure Ranges, Not More Than 2 psig (13.8 kPa): Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
3. Two Pressure Ranges, Not More Than 5 psig (34.5 kPa): Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)** and is reduced to secondary pressure of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)**.
4. Three Pressure Ranges: Primary pressure is more than **2 psig (13.8 kPa)** but not more than **5 psig (34.5 kPa)**, is reduced to secondary pressures of more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)** and is reduced again to pressures of **0.5 psig (3.45 kPa)** or less.

F. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Seismic Performance: LPG piping system, vaporizers, and storage container supports are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> . See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. The term "withstand" means "the piping/unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the piping system will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Component Amplification Factor: <**Insert requirement**>
4. Component Response Modification Factor: <**Insert requirement**>

2.2 PIPE, TUBING, AND FITTINGS

A. Steel Pipe and Fittings:

1. Steel Pipe: ASTM A53/A53M black steel, Schedules 40 and 80, Type E or S, Grade B.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
3. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and

threaded ends.

5. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Unacceptable for underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.

6. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. CSST and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
    b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
    c. [**Tru-Flex Metal Hose Corp**]
    d. [**Ward Manufacturing LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**FlashShield Products; Gastite, a division of Titeflex Corp.**]
    b. [**TracPipe CounterStrike; OmegaFlex, Inc.**]
    c. [**Tru-Flex Metal Hose Corp**]
    d. [**Ward Manufacturing LLC**]
    e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain CSST and fittings from single manufacturer.
4. Standard: CSA/ANSI LC 1/CSA 6.26.
5. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
6. Jacket: Electrically Insulative and UV-Resistant Polymer with Flame Retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

7. Jacket with Fully Vent-Capable PE Sleeve: Include associated fittings suitable for locations requiring vented containment.
8. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with CSST and suitable for metal-to-metal seal without gaskets. Include brazing socket or threaded ends

complying with ASME B1.20.1.
9. Striker Plates: Steel, designed to protect tubing from penetrations.
10. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
11. Operating-Pressure Rating: **5 psig (34.5 kPa)**.

C. Aluminum Tubing, Piping, and Fittings:

1. Aluminum Tubing:

a. Standards:

1) ASTM B210/B210M.
2) ASTM B241/B241M.

b. Material: Aluminum Alloy 5456 is prohibited per NFPA 54.

2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
3. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper-alloy fittings.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads are to comply with ASME B1.20.3.

D. Copper Tubing and Fittings:

1. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
2. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B280, Type ACR**][**ASTM B837, Type G**] .
3. Coating: Factory-applied, extruded PE a minimum of **0.025 inch (0.64 mm)** thick. Continuously marked with size, specification information, manufacturing code, and footage every **2 ft. (610 mm)**.
4. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
5. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
6. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

a. Gasket Material: ASME B16.20, metallic, flat, asbestos-free, aluminum o-rings and spiral-wound metal gaskets.
b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

7. Flare Fittings: ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

8. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of **0.022 inch (0.56 mm)** thick.

E. PE Pipe, Tubing, and Fittings:

1. PE Pipe and Tubing: ASTM D2513, SDR 11.
2. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type.

3. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11, and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
4. Anodeless Service-Line Riser: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. [**Vent casing aboveground.**]
    c. Aboveground Portion: PE transition fitting.
    d. Provide outlet threaded or flanged or suitable for welded connection.
    e. Provide tracer wire connection.
    f. Provide UV shield.

5. Transition Service-Line Riser: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Provide outlet threaded or flanged or suitable for welded connection.
    c. Provide bridging sleeve over mechanical coupling.
    d. Provide factory-connected anode.
    e. Provide tracer wire connection.
    f. Provide UV shield.

F. Polyamide Pipe, Tubing, and Fittings: ASTM F2945.

2.3 MECHANICAL COUPLINGS

A. Mechanical Coupling - Plastic, NPS 1-1/2 (DN 40) and Smaller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Continental Industries; brand of Hubbell Incorporated**]
    b. [**Elster Perfection; Honeywell**]
    c. [**Lyall; brand of Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Continental Industries; brand of Hubbell Incorporated**]
    b. [**Elster Perfection; Honeywell**]
    c. [**Lyall; brand of Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. PE body.
6. Elastomeric seals.
7. Independent gripping collets.
8. Couplings are to be suitable for joining PE pipe to PE pipe.

B. Mechanical Coupling - Plastic, NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Elster Perfection; Honeywell**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Elster Perfection; Honeywell**]
   b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Standard: ASTM D2513.
5. Stainless steel bolts, nuts, and washers.
6. Couplings are to be suitable for joining PE pipe to PE pipe.

C. Mechanical Coupling - Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Smith-Blair, a Xylem brand.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Smith-Blair, a Xylem brand.**]
   b. <**Insert manufacturer's name**>

3. Source Limitation: Obtain couplings from single manufacturer.
4. Flanges and Tube: [**Stainless steel**][**Steel**] with epoxy finish.
5. Seals: NBR.
6. Bolts, Washers, and Nuts: [**Stainless steel**][**Steel**] bolts, washers, and nuts.
7. Factory-installed anode for steel-body couplings installed underground.
8. Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

2.4 PIPING SPECIALTIES

A. Flexible Piping Joint:

1. Approved for LPG service.
2. Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. Minimum working pressure of **250 psig (1723 kPa)** and **250 deg F (121 deg C)** operating temperature.

4. Flanged- or threaded-end connections to match equipment connected and to be capable of minimum **3/4-inch (20-mm)** misalignment.
5. Maximum **36-inch (914-mm)** length for liquid LPG lines.

B. Appliance Flexible Connector:

1. Indoor, Fixed-Appliance Flexible Connectors: CSA/ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: CSA/ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: CSA/ANSI Z21.75.
4. CSST with polymer coating.
5. Operating-Pressure Rating: **0.5 psig (3.45 kPa)**.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: ASME B1.20.1.
8. Maximum Length: **72 inches (1830 mm)**.

C. Quick-Disconnect Device:

1. Standard: CSA/ANSI Z21.41/CSA 6.9.
2. Copper-alloy convenience outlet and matching plug connector.
3. Nitrile seals.
4. Hand operated with automatic shutoff when disconnected.
5. For indoor or outdoor applications.
6. Adjustable, retractable restraining cable.

D. Y-Pattern Strainer:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

E. Basket Strainer:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

F. T-Pattern Strainer:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: **750 psig (5170 kPa)**.

G. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

B. Welding Filler Metals: AWS D10.12/D10.12M.

C. Brazing Filler Metals: AWS A5.8/A5.8M alloy with melting point greater than **1000 deg F (540 deg C)**. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.6 GAS VALVES

A. Manual Gas Shutoff Valve - Metallic:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**BrassCraft Manufacturing Co.; a Masco company**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**Jomar Valve**]
   f. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   g. [**NIBCO INC.**]
   h. [**Stockham; a Crane Co. brand**]
   i. **<Insert manufacturer's name>**

3. Source Limitation: Obtain metallic manual gas shutoff valves from single manufacturer.
4. Description: Metallic ball valve or metallic plug valve of type indicated in schedules under Part 3.
5. Standards:

   a. CSA/ANSI Z21.15/CSA 9.1.
   b. ASME B16.33.
   c. ASME B16.44.

6. System Pressure Rating: [**0.5 psig (3.45 kPa) or less**][**More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa)**][**More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa)**][**More than 5 psig (34.5 kPa) but not more than 125 psig (862 kPa)**]**<Insert pressure>** .
7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service Mark: Initials "WOG" permanently marked on valve body.
9. End Connections:

    a. Threaded Ends: ASME B1.20.1.
    b. Dryseal Threads on Flare Ends: ASME B1.20.3.
    c. Flanged Ends: ASME B16.5 for steel flanges.

10. Tamperproof locking feature.

B. Manual Gas Shutoff Ball Valve - PE:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Elster Perfection; Honeywell**]
    b. [**Kerotest Manufacturing Corp**]
    c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain PE manual gas shutoff valves from single manufacturer.
4. Standard: ASME B16.40.
5. Body: PE.
6. Ball: Polypropylene.
7. Stem: Acetal.
8. Seats and Seals: NBR.
9. Ends: Plain or fusible to match piping.
10. CWP Rating: [**80 psig (552 kPa)**]<**Insert pressure**> .
11. Operating Temperature: [**Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C)**]<**Insert temperature range**> .
12. Operator: Nut or flat head for key operation.
13. Plastic valve extension.
14. Tamperproof locking feature.

C. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of **5 inches (125 mm)** in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

D. Automatic Gas Shutoff Valve - Hydrostatic Relief:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Marshall Excelsior Company**]
c. [**RegO Products; a brand of Engineered Controls International, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fischer; Emerson Electric Co., Automation Solutions**]
b. [**Marshall Excelsior Company**]
c. [**RegO Products; a brand of Engineered Controls International, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitation: Obtain hydrostatic relief valves from single manufacturer.
4. Standard: NFPA 58.
5. Operating Pressure: [**350 psig (2413 kPa)**]<**Insert pressure**> .
6. Body: Brass.
7. Spring: Stainless steel.
8. Disc and Seat: NBR.
9. Brass body and stainless steel, spring-operated valve with resilient rubber disc seat and protective cap.
10. Factory set and tested.
11. Valve is to automatically reseat after relieving pressure.

E. Automatic Gas Shutoff Valve - Electrically Operated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gas Safety, LLC.**]
b. [**ASCO; an Emerson company**]
c. [**BASO Gas Products, LLC**]
d. [**Magnatrol Valve Corporation**]
e. <**Insert manufacturer's name**>

3. Source Limitation: Obtain electrically operated automatic gas shutoff valves from single manufacturer.
4. Description: Electrically operated automatic valve, solenoid type, used in LPG piping for automatic shutoff of service when interlocked with a hazard-condition initiating device.

5. Standards:

   a. CSA/ANSI Z21.21/CSA 6.5.
   b. UL 429.
   c. FM Global approved.

6. Body: Brass or aluminum.
7. Seats and Disc: NBR.
8. Springs and Valve Trim: Stainless steel.
9. Coil: Continuous-duty, molded enclosure, replaceable.
10. Normally closed.
11. Visual position indicator.
12. Electrical Characteristics: [**120 V ac, 60 Hz**][**24 V ac, 60 Hz**][**24 V dc**]<**Insert value**> .

F. Earthquake Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Firefighter Gas Safety Products**]
   b. [**Pacific Seismic Products, Inc**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Firefighter Gas Safety Products**]
   b. [**Pacific Seismic Products, Inc**]
   c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain earthquake valves from single manufacturer.
4. Description: Seismically activated automatic gas shutoff valve.
5. Standard: ANSI/ASCE/SEI 25.
6. Maximum Operating Pressure: [**10 psig (69 kPa)**][**60 psig (414 kPa)**]<**Insert pressure**> .
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Threaded for valves **NPS 4 (DN 100)** and smaller; or flanged for valves **NPS 2 (DN 50)** and larger.
10. Wall-mounting bracket with bubble level indicator.

2.7 PRESSURE REGULATORS

A. Service Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cavagna North America**]
   b. [**Dresser Utility Solutions**]
   c. [**Elster-American Meter**]

d. [**Fairview Ltd.**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. [**Richards Industrials**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cavagna North America**]
   b. [**Dresser Utility Solutions**]
   c. [**Elster-American Meter**]
   d. [**Fairview Ltd.**]
   e. [**Fischer; Emerson Electric Co., Automation Solutions**]
   f. [**Marshall Excelsior Company**]
   g. [**Maxitrol Company**]
   h. [**RegO Products; a brand of Engineered Controls International, LLC**]
   i. [**Richards Industrials**]
   j. <**Insert manufacturer's name**>

3. Source Limitation: Obtain service pressure regulators from single manufacturer.
4. Standards:

   a. NFPA 58.
   b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
6. Pressure regulator is to maintain discharge pressure-setting downstream and is not to exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**][**20 psig (138 kPa)**]<**Insert pressure**> .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

B. Line-Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Cavagna North America**]
   b. [**Dormont; A Watts Water Technologies Company**]
   c. [**Dresser Utility Solutions**]
   d. [**Elster-American Meter**]
   e. [**Fischer; Emerson Electric Co., Automation Solutions**]
   f. [**Marshall Excelsior Company**]

g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fischer; Emerson Electric Co., Automation Solutions**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. **<Insert manufacturer's name>**

3. Source Limitation: Obtain line-pressure regulators from single manufacturer.
4. Standards:

a. NFPA 58.
b. CSA/ANSI Z21.80/CSA 6.22.

5. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure-sensing piping external to the regulator.
6. Pressure regulator is to maintain discharge pressure-setting downstream and is not exceed 150 percent of design discharge pressure at shutoff.
7. Maximum Inlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**][**10 psig (69 kPa)**]**<Insert pressure>** .
8. Maximum Outlet Pressure: [**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]**<Insert pressure>** .
9. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**Cavagna North America**]
b. [**Dormont; A Watts Water Technologies Company**]
c. [**Dresser Utility Solutions**]
d. [**Elster-American Meter**]
e. [**Fairview Ltd.**]
f. [**Marshall Excelsior Company**]
g. [**Maxitrol Company**]
h. [**RegO Products; a brand of Engineered Controls International, LLC**]
i. <**Insert manufacturer's name**>

3. Source Limitation: Obtain appliance pressure regulators from single manufacturer.
4. Standards:

a. NFPA 58.
b. CSA/ANSI Z21.18/CSA 6.3.

5. Regulator may include vent-limiting device, instead of vent connection, if approved by authorities having jurisdiction.
6. Maximum Inlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**][**5 psig (34.5 kPa)**]<**Insert pressure**> .
7. Maximum Outlet Pressure: [**1 psig (6.9 kPa)**][**2 psig (13.8 kPa)**]<**Insert pressure**> .
8. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.

2.8 SERVICE METERS

A. Diaphragm-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dresser Utility Solutions**]
b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain diaphragm-type service meters from single manufacturer.
4. Standard: [**ANSI B109.1**][**ANSI B109.2**] .
5. Case: Die-cast aluminum.
6. Connections: Steel threads.
7. Diaphragm: Synthetic fabric.
8. Diaphragm Support Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .

10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Meter Case and Index: Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Pressure Loss: Maximum [**0.5 inch wg (124 Pa)**][**2.0 inch wg (498 Pa)**]<**Insert pressure differential**> .
15. Accuracy: Maximum plus or minus [**1.0**]<**Insert number**> percent.

B. Rotary-Type Service Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain rotary-type service meters from single manufacturer.
4. Standard: ANSI B109.3.
5. Case: Extruded aluminum.
6. Connection: Flange.
7. Impellers: Polished aluminum.
8. Rotor Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

C. Turbine Meter:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Dresser Utility Solutions**]
   b. [**Elster-American Meter**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]

b. [**Elster-American Meter**]
c. <**Insert manufacturer's name**>

3. Source Limitation: Obtain turbine meters from single manufacturer.
4. Standard: ASME MFC.4M.
5. Housing: Cast iron or welded steel.
6. Connection Threads or Flanges: Steel.
7. Turbine: Aluminum or plastic.
8. Turbine Bearings: Self-lubricating.
9. Compensation: Continuous temperature [**and pressure**] .
10. Meter Index: [**Cubic feet**][**Liters**][**Cubic feet and liters**] .
11. Tamper resistant.
12. Remote meter reader compatible.
13. Maximum Inlet Pressure: [**100 psig (690 kPa)**]<**Insert pressure**> .
14. Accuracy: Maximum plus or minus [**2.0**]<**Insert number**> percent.

D. Service-Meter Bar:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Mueller Co.; Gas Products Division; a subsidiary of Mueller Gas Products Inc.**]
   c. <**Insert manufacturer's name**>

3. Malleable- or cast-iron frame for supporting service meter.
4. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
5. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]

b. **<Insert manufacturer's name>**

3. Ferrous, tee, pipe fitting with capped side inlet for temporary LPG supply.
4. Integral ball-check bypass valve.

2.9 DIELECTRIC FITTINGS

A. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Union:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**HART Industrial Unions, LLC**]
   c. [**Jomar Valve**]
   d. [**Matco-Norca**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**HART Industrial Unions, LLC**]
   c. [**Jomar Valve**]
   d. [**Matco-Norca**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**250 psig (1725 kPa) minimum at 180 deg F (82 deg C)**]**<Insert pressure rating at temperature>** .
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flange:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Matco-Norca**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Matco-Norca**]
   b. [**WATTS; A Watts Water Technologies Company**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

3. Standard: ASSE/IAMPO/ANSI/CAN 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa) minimum at 180 deg F (82 deg C)**][**175 psig (1200 kPa) minimum at 180 deg F (82 deg C)**][**300 psig (2070 kPa) minimum at 250 deg F (282 deg C)**]<**Insert pressure**> .
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT Industries, LLC.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT Industries, LLC.**]
   d. <**Insert manufacturer's name**>

3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure**> .
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or PE.
7. Washers: Phenolic with steel backing washers.

2.10 STORAGE CONTAINERS

A. Storage Container:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Roy E. Hanson Jr. Mfg.**]

b. [**TransTech Energy, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Roy E. Hanson Jr. Mfg.**]
   b. [**TransTech Energy, LLC**]
   c. <**Insert manufacturer's name**>

3. Description: Factory-designed, -fabricated, and -tested container.
4. Standards:

   a. NFPA 58.
   b. ASME BPVC-VIII-1.
   c. ANSI/CAN/UL/ULC 125.
   d. ANSI/CAN/UL/ULC 842.
   e. Department of Transportation (DOT) Regulations.
   f. Provide all appurtenances as required by NFPA 58, qualified to ANSI/CAN/UL/ULC 125.
   g. Vapor-shutoff valve.
   h. Liquid-shutoff valve.
   i. Pressure-relief valve.
   j. Fixed maximum liquid level gauge.
   k. Filler valve.
   l. Overfilling protection device.
   m. Actuated liquid withdrawal excess-flow valve.
   n. Provide container appurtenances with a minimum service pressure rating of **250 psig (1724 kPa)**.

5. Provide exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion for outdoor installation.
6. Provide ladders for access to valves more than **72 inches (1830 mm)** aboveground.
7. Stainless Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.

   a. Name and address of supplier or trade name of container.
   b. Water capacity in gallons and liters.
   c. Design pressure in psig and kPa.

      1) Statement: "This container does not contain a product having a vapor pressure in excess of <**Insert maximum pressure in psig (kPa) at 100 deg F (37.8 deg C)**> ."
      2) Outside surface area in square feet and square meters.
      3) Year of manufacture.
      4) Shell thickness in inches and millimeters.
      5) Overall length in feet and meters.
      6) OD in feet and meters.
      7) Manufacturer's serial number.
      8) ASME code label.

   d. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
   e. Tie straps for each saddle.
   f. Straps and anchors for tie-down slab.
   g. Asphalt-based coating for corrosion protection.
   h. Container connections and valves protected in manway at top of storage container.

i. Manway equipped with ventilation louvers.

2.11 TRANSPORT TRUCK UNLOADING FACILITY

A. Transport Truck Unloading Facility: Provide in accordance with the requirements in NFPA 58.

1. Support structure consisting of a minimum **6-inch (150-mm)** steel channel or **6-by-4-inch (150-by-100-mm)** rectangular steel tubing, a minimum of **36 inches (914 mm)** above and below grade.
2. Liquid-fill and vapor-return, quick-disconnect fittings.
3. Liquid- and vapor-shutoff valves with hydrostatic relief valves mounted between the quick-disconnect fittings and shutoff valves.
4. Excess-flow safety shutoff valve in vapor-return line.
5. Backflow check valve in liquid-fill line.
6. Remote emergency shutoff valve station with underground cable to the vapor emergency shutoff valve.

2.12 VAPORIZERS

A. Vaporizer - Direct-Type, Direct-Fired Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Algas-SDI**]
   b. [**Ransome Manufacturing**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Algas-SDI**]
   b. [**Ransome Manufacturing**]
   c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

   a. NFPA 58.
   b. ASME BPVC-VIII-1.
   c. NFPA 70.
   d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer coil contained in an insulated enclosure insulated with a burner.
6. Burner Tubes and Orifices: Stainless steel.
7. Gas Train: Control devices and burner-control sequence are to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
8. Burner Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
c. Operating Vapor-Pressure Control: Factory piped and mounted to control burner.

B. Vaporizer - Indirect-Type, Direct-Fired Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Algas-SDI**]
b. [**Ransome Manufacturing**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Algas-SDI**]
b. [**Ransome Manufacturing**]
c. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

a. NFPA 58.
b. ASME BPVC-VIII-1.
c. NFPA 70.
d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer vessel with a replaceable, immersion-type, electric heating element.
6. Heating Element Operating Controls:

a. Controls are to maintain safe operating conditions.
b. Operating Vapor-Pressure Control: Factory wired and mounted to control heating element.
c. High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
e. Control Transformer: 115 V maximum control voltage.

C. Vaporizer - Direct-Type, Water-Bath Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Algas-SDI**]
b. [**Alternate Energy Systems, Inc**]
c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Algas-SDI**]
    b. [**Alternate Energy Systems, Inc**]
    c. [**Ransome Manufacturing**]
    d. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

    a. NFPA 58.
    b. ASME BPVC-VIII-1.
    c. NFPA 70.
    d. FM Global labeled.

5. ASME-Rated and -Stamped: Helical LPG vaporizer coil submerged in water bath. Straight, steel fire tubes welded into steel headers.
6. Water Bath:

    a. Water bath filled with water/glycol solution designed to prevent freezing at [**minus 30 deg F (minus 34 deg C)**]<**Insert temperature**> .
    b. Water-bath, high- and low-level sight glasses.
    c. Low-water cutoff to stop burner and annunciate alarm.
    d. Water/glycol fill and vent fitting.
    e. Minimum **NPS 3/4 (DN 20)** hose-end drain valves.
    f. Operating high- and low-limit aquastat controllers.
    g. Water-bath temperature gauge; a minimum of **2-1/2 inches (63 mm)** in diameter. Gauges are to have operating-temperature ranges, so normal operating range is at approximately 50 percent of full range.

7. Burner Tubes and Orifices: Stainless steel.
8. Gas Train: Control devices and burner-modulation control sequence is to be FM Global labeled. Provide shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
9. Burner Operating Controls:

    a. Operating controls are to maintain safe operating conditions.
    b. Operating Water-Bath Temperature Control: Factory wired and mounted to control burner.
    c. High-Temperature and High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design temperature or vapor pressure.
    d. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; is to sound alarm for out-of-normal conditions.
    e. Control Transformer: 115 V maximum control voltage.

D. Vaporizer - Indirect-Type, Heat Exchanger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Algas-SDI**]
    b. [**Alternate Energy Systems, Inc**]

c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Algas-SDI**]
b. [**Alternate Energy Systems, Inc**]
c. [**Ransome Manufacturing**]
d. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, -assembled, -calibrated, and -tested vaporizer.
4. Standards:

a. NFPA 58.
b. ASME BPVC-VIII-1.
c. NFPA 70.
d. FM Global labeled.

5. ASME-Rated and -Stamped: LPG vaporizer with immersion tubes containing [**steam**][**hot water**] and LPG in surrounding shell.
6. Operating Controls:

a. Controls are to maintain safe operating conditions.
b. High-Temperature and High-Pressure Cutoff: Manual reset if operating conditions rise above maximum design temperature or pressure.
c. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; sound alarm for out-of-normal conditions.
d. Control Transformer: 115 V maximum control voltage.

E. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control set points and display vaporizer status and alarms.

F. Capacities and Characteristics:

1. Heating Fuel: [**Propane**][**Butane**][**Electric**] .
2. Vaporization Heat Exchanger:

a. Minimum Working-Pressure Rating: [**250 psig (1723 kPa)**]<**Insert value**> .
b. Test Pressure: [**375 psig (2586 kPa)**]<**Insert value**> .

3. LPG Vaporization Rate: <**Insert gph (mL/s)**> .
4. Entering-LPG Temperature: [**Minus 30 deg F (Minus 34 deg C)**]<**Insert temperature**> .
5. Leaving-LPG Temperature: [**80 deg F (26.7 deg C)**]<**Insert temperature**> .
6. Discharge-LPG Pressure: [**90 psig (621 kPa)**]<**Insert value**> .
7. Burner Gas Input: <**Insert Btu/h (kW)**> .
8. Electric Burner Input: <**Insert kilowatts**> .
9. Water-Bath Vaporizers:

a. Operating Pressure: [**Atmospheric**]<**Insert psig (kPa)**> .
b. Operating Temperature: [**160 deg F (71 deg C)**]<**Insert temperature**> .

10. Electrical Characteristics:

a. Volts: [**120**][**240**][**480**]<**Insert number**> V.

b. Phase: [**Single**][**Three**] .
c. Hertz: 60.
d. Minimum Circuit Ampacity: <**Insert number**> A.
e. Maximum Overcurrent Protection: <**Insert number**> A.

2.13 DETECTABLE WARNING TAPE

A. Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment-shutoff valves before turning off LPG to premises or piping section.

B. Inspect LPG piping in accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction to determine that LPG utilization devices are turned off in piping section affected.

C. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for prevention of accidental ignition.

3.4 INSTALLATION OF PIPE, TUBING, AND FITTINGS

A. Outdoor Pipe:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for installation and purging of LPG piping.
2. Install underground, LPG piping buried a minimum of [**12 inches (300 mm)**]<**Insert dimension**> below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

a. If LPG piping is installed less than **12 inches (300 mm)** below finished grade, install it in

containment conduit.

3. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
4. Steel Piping with Protective Coating:

   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
   c. Replace pipe having damaged PE coating with new pipe.

B. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Install fittings for changes in direction and branch connections.
4. Joints for connection to inlets and outlets on vaporizers, regulators, and valves may be flanged or threaded to match the equipment.
5. Install pressure gauge [**downstream**][**upstream and downstream**] from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

C. Indoor Pipe:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for installation and purging of LPG piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated on Drawings. Piping in equipment rooms and service areas may be installed exposed. Piping is not to be installed in inaccessible locations.

   a. Conceal piping in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
   b. Except as specified below, install concealed piping and piping installed under the building in containment conduit in accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

      1) Above Accessible Ceilings: Piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

         a) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

      2) In Floors: Install piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of **1-1/2 inches (38 mm)** of concrete. Piping may not be in physical contact with other metallic structures, such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
      3) In Floor Channels: Channels must have cover and be open to space above cover for ventilation.
      4) In Walls or Partitions: Protect piping installed inside partitions or hollow walls from

physical damage using steel striker barriers at rigid supports.

a) Exception: Piping passing through partitions or walls does not require striker barriers.

c. Prohibited Locations:

1) Do not install piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2) Do not install piping in return-air plenums.
3) Do not install piping in solid walls or partitions.

d. Under the Building: Install in vented containment conduit or CSST with integral vented sleeve and associated fittings.

5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise on Drawings.
6. Locate valves for easy access from a standing position. Do not locate valves within return air plenums.
7. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Comply with requirements in Sections specifying gas-fired appliances and equipment, and verify final appliance and equipment locations for roughing-in requirements.
11. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three pipe diameters, but not less than **3 inches (75 mm)** long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

12. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors, and terminate with weatherproof vent cap.
13. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
14. Connect branch piping from top or side of horizontal piping.
15. Install unions in pipes **NPS 2 (DN 50)** and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
16. Do not use LPG piping as grounding electrode.
17. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve. Remove and replace startup strainer with new strainer prior to final acceptance tests.
18. Install pressure gauge [**downstream**][**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."
19. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
20. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
21. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF SERVICE METERS

A. Install service-meter assemblies aboveground [**, on concrete bases**] .

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 INSTALLATION OF PRESSURE REGULATORS

A. Ensure the gas supply is completely shut off at the main valve and that the line is fully depressurized.

B. Remove any shipping plugs from the inlet, outlet, and vent connections. Ensure the pipe interior and regulator are free of dirt, debris, and contaminants.

C. Apply pipe joint sealant or Teflon tape rated for gas use to the male threads of the pipe. Avoid getting sealant on the female threads or inside the regulator.

D. Mount the regulator in the correct orientation, aligning the flow arrow on the body with the direction of gas flow. The piping must be properly aligned and supported to avoid stressing the regulator.

E. If the pressure regulator is installed inside of a building, install a dedicated vent line directly from the regulator to the outdoors. The vent terminal must be insect resistant and rain resistant. The regulator should be at least **3 ft. (914 mm)** horizontally from any building opening below the vent opening and positioned so that gas can disperse freely.

3.7 INSTALLATION OF GAS VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of CSST, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for [**steel piping**][**and**][**copper tubing**] , with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and requirements

of authorities having jurisdiction, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

F. Support vertical runs of [**steel piping**][**and**][**copper tubing**] to comply with MSS SP-58, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and requirements of authorities having jurisdiction, whichever are most stringent.

3.10 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas-shutoff valves and unions. Install valve within **72 inches (1830 mm)** of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

3.11 INSTALLATION OF TRANSPORT TRUCK UNLOADING FACILITY

A. Install transport truck unloading in a cast-in-place concrete base, **48 inches (1220 mm)** square by **36 inches (914 mm)** deep. Set top of concrete base at least **6 inches (150 mm)** above finished grade.

B. Install remote emergency shutoff station with cable release in an accessible location, a minimum of **25 ft. (7.6 m)** and a maximum of **100 ft. (30 m)** away from transport truck unloading.

C. Install at least two **6-inch- (150-mm-)** diameter metal bollards set in and filled with concrete on both sides of transport truck unloading. Bollard length is to be at least **48 inches (1220 mm)** above and below grade, with concrete encasement a minimum of **12 inches (300 mm)** in diameter.

3.12 INSTALLATION OF STORAGE CONTAINER

A. Do not install storage containers in a pit.

B. Fill storage container to at least 80 percent capacity with [**butane**][**propane**] .

C. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.

D. Ground containers in accordance with NFPA 780. Grounding is specified in Section 264113 "Lightning Protection for Structures."

E. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.

F. Install tie-downs over storage containers on saddles with proper tension.

G. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

H. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.

I. Install tie-down straps over container anchored in ballast base, and repair damaged coating.

J. Backfill with a minimum coverage for underground or mounded storage containers in accordance with NFPA 58.

K. Backfill with pea gravel as required in Section 312000 "Earth Moving."

L. Install cathodic protection for storage container. Cathodic protection is specified in Section 134713 "Cathodic Protection."

3.13 INSTALLATION OF VAPORIZER

A. Install vaporizer with access space for periodic maintenance.

B. Set vaporizers on and anchor to concrete base.

C. Connect liquid line from pump set, and connect vapor supply to distribution piping.

D. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass the vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

3.14 INSTALLATION OF LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, **12 inches (305 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

C. Label and identify gas piping and pressure outside a multitenant building by tenant.

3.15 CONCRETE BASES

A. Anchor equipment to concrete base [.][**in accordance with seismic codes of Project. See Section 230548 "Vibration and Seismic Controls for HVAC."**]

B. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on [**18-inch (451-mm)**]<**Insert dimension**> centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Use [**3000 psig (20.7 MPa)**]<**Insert value**> , 28-day, compressive-strength concrete and reinforcement, as specified in Section 033000 "Cast-in-Place Concrete."

3.16 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction for testing, inspection, and purging of LPG installation.
2. LPG installation will be considered defective if it does not pass tests and inspections. Defective products are to be replaced. Retest installation after defective products have been replaced for code compliance.

B. Prepare test and inspection reports.

3.17 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain LPG equipment.

3.18 OUTDOOR LPG PIPING SCHEDULE

A. Underground LPG Piping: To be one of the following:

1. PE Pipe, Tubing, and Fittings: Terminate service-line risers with tracer wire in an accessible location.
2. Polyamide Pipe, Tubing, and Fittings: Terminate in an accessible location.
3. Steel Pipe: With wrought-steel welding fittings or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
4. Drawn-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
6. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
7. CSST and Fittings: With integral vented sleeve terminated in an accessible location.

B. Aboveground LPG Piping: To be one of the following:

1. CSST and fittings.
2. Steel Pipe: With [**malleable-iron threaded fittings**][**wrought-steel welded fittings or mechanical couplings**] .
3. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Annealed-Temper Copper Tube: With copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance:

1. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints. Install piping embedded in concrete with no joints in concrete. Coat pipe and fittings with protective coating for copper tubing.

3.19 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground Piping: To be one of the following:

1. CSST and Fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tube: With flared fittings and joints.
5. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
6. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be one of the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code**] and requirements of authorities having jurisdiction.

3.20 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: To be one of the following:

1. CSST and fittings.
2. Tin-Lined Copper Tube: With flared joints and fittings.
3. Annealed-Temper Copper Tube: With wrought-copper fittings and [**brazed**][**flared**] joints.
4. Aluminum Tubing and Piping: With flared fittings and joints.
5. Steel Pipe: With malleable-iron threaded fittings.
6. Schedule 40, steel pipe with steel welding fittings.
7. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be one of the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.

3.21 INDOOR LPG PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than [**5 psig (34.5 kPa)**]<**Insert pressure**> .

1. Steel Pipe: With wrought-steel welding fittings.

2. Drawn-Temper Copper Tube: With wrought-copper fittings and brazed joints.

B. Underground (Below Building) Piping: To be the following:

1. Steel Pipe: With [**malleable-iron threaded**][**wrought-steel welding**] fittings.
2. Containment Conduit: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.
3. Containment Conduit Vent Piping: In accordance with [**NFPA 58,**][**the International Fuel Gas Code,**] and requirements of authorities having jurisdiction.

3.22 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground Vapor Piping:

1. Manual gas shutoff ball valve - PE.
2. Manual gas shutoff valve - metallic.

3.23 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground LPG Piping: Manual gas shutoff valve - metallic.

END OF SECTION 23 11 26 00

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Task	Specification	Specification Description
23 11 26 00	21 05 00 00	Common Work Results for Fire Suppression
23 11 26 00	22 05 00 00	Common Work Results for Plumbing
23 11 26 00	22 13 16 00	Sanitary Waste And Vent Piping
23 11 26 00	23 05 00 00	Common Work Results for HVAC
23 11 26 00	23 11 23 00	Facility Natural-Gas Piping
23 11 26 00	33 11 13 00a	Potable Water Supply Wells

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SECTION 23 12 13 00 - FACILITY FUEL-OIL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible fuel-oil storage tank pumps.
2. Fuel-oil pumps - simplex.
3. Fuel-oil pumps - multiplex.
4. Fuel-oil polishing systems.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Submersible fuel-oil storage tank pumps.
2. Fuel-oil pumps - simplex.
3. Fuel-oil pumps - multiplex.
4. Fuel-oil polishing systems.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For fuel-oil pumps[**and fuel-oil polishing systems**].

1. Include construction details and dimensions of individual components for fuel-oil pumps.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**>.

D. Delegated Design Submittals: For vibration isolation[**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data[**signed and sealed by the qualified professional engineer responsible for their preparation**].

1. Detail fabrication and assembly of anchors[**and seismic restraints**].
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication and assembly of hangers, supports, and attachments of the same to building structure.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, or Building Information Model (BIM), drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For fuel-oil pumps[**, and fuel-oil polishing systems,**] from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Qualification Statements: For professional engineer.

E. Sample Warranties: For [**fuel-oil pumps**][**fuel-oil polishing system**].

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil pumps[**and fuel-oil polishing systems**].

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[**, from the same production run,**] to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Drive Belt: [**One**]<**Insert number**> for each belt-driven pump.

1.6 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.

1.7 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and installer agree**] to repair or replace fuel-oil pumps[**and fuel-oil polishing systems**] that fail in materials or workmanship within specific warranty period.

B. Warranty Period for Fuel-Oil Pumps: <**Insert number**> year(s) from date of Substantial Completion.

C. Warranty Period for Fuel-Oil Polishing Systems: <**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Maximum Operating-Pressure Ratings: [**3 psig (21 kPa)**]<**Insert pressure**> fuel-oil supply pressure at oil-fired appliances.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for fuel-oil pumps[**and fuel-oil polishing systems**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Seismic Performance: Factory-installed support attachments for pumps [**and fuel-oil polishing systems**]are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

E. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

2.2 SUBMERSIBLE FUEL-OIL STORAGE TANK PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Franklin Fueling Systems**]
2. [**Red Jacket Pumps**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Franklin Fueling Systems**]
2. [**Red Jacket Pumps**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain submersible fuel-oil storage tank pumps from single manufacturer.

D. Comply with UL 79, UL 87, and UL 343.

1. Impeller: Turbine.
2. Housing and Volute: Cast iron.
3. Bearings: Bronze, self-lubricating.
4. Seals: Mechanical.

5. Shaft: Polished steel.
6. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.
7. Base: Steel.
8. Pressure Relief: Built in.
9. Discharge Check Valve: Built in.
10. Drive: Direct, close coupled.

E. Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to fuel-oil-burning equipment.

1. Maintain minimum manifold pressure with outdoor-air temperature less than [**60 deg F (16 deg C)**]<**Insert temperature**>.
2. Seven-day schedule.
3. Stage multiple pumps to maintain pressure at a common supply manifold.
4. Alternate pumps to equalize run time.
5. Alarm motor failure.
6. Manual reset dry-run protection.
7. Stop pumps if fuel level falls below pump suction.
8. De-energize and sound alarm for pump, locked-rotor condition.
9. Sound alarm for open circuit and for high and low voltage.
10. Lights indicate normal power on, run, and off conditions.
11. Interface with automatic control system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" to control and indicate the following:

    a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
    b. Operating status.
    c. Alarm off-normal status.

F. Capacities and Characteristics:

1. Number of Stages: <**Insert number**>.
2. Capacity: <**Insert gph (L/s)**>.
3. Discharge Pressure: <**Insert psig (kPa)**>.
4. Outlet Size: <**Insert NPS (DN)**>.
5. Motor Speed: <**Insert rpm**>.
6. Motor Horsepower: <**Insert value**>.
7. Electrical Characteristics:

    a. Volts: [**120**][**208**][**240**]<**Insert value**>.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 FUEL-OIL PUMPS - SIMPLEX

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**DESMI INC./Rotan Pumps**]
2. [**Earthsafe Systems, Inc.**]

3. [**Haight Pumps; a division of Baker Mfg.**]
4. [**Preferred Utilities Manufacturing Corporation**]
5. [**Suntec Industries Incorporated**]
6. [**Tuthill Corporation**]
7. [**Viking Pump Inc.; a unit of IDEX Corporation**]
8. [**Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**DESMI INC./Rotan Pumps**]
2. [**Earthsafe Systems, Inc.**]
3. [**Haight Pumps; a division of Baker Mfg.**]
4. [**Preferred Utilities Manufacturing Corporation**]
5. [**Suntec Industries Incorporated**]
6. [**Tuthill Corporation**]
7. [**Viking Pump Inc.; a unit of IDEX Corporation**]
8. [**Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fuel-oil pumps - simplex, from single manufacturer.

D. Description: Comply with UL 343 and HI 3.1-3.5.

1. Type: Positive-displacement, rotary type.
2. Impeller: [**Steel gear with crescent**][**Carbon vane**].
3. Housing: Cast-iron foot mounted.
4. Bearings: Bronze, self-lubricating.
5. Shaft: Polished steel.
6. Seals: Mechanical.
7. Base: Steel.
8. Pressure Relief: Built in.
9. Discharge Check Valve: Built in.

E. Drive: [**V-belt with guard; gear reducer; or direct, close coupled**][**V-belt with guard**][**Gear reducer**][**Direct, close coupled**].

F. Controls:

1. Maintain minimum manifold pressure with outdoor-air temperature less than [**60 deg F (16 deg C)**]<**Insert temperature**>.
2. Seven-day schedule.
3. Alarm motor failure.
4. Manual reset dry-run protection.
5. Stop pump if fuel level falls below pump suction.
6. De-energize and sound alarm for pump, locked-rotor condition.
7. Sound alarm for open circuit and for high and low voltage.
8. Lights are to indicate normal power on, run, and off conditions.
9. Interface with automatic control system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" to control and indicate the following:

   a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
   b. Operating status.
   c. Alarm off-normal status.

G. Capacities and Characteristics:

1. Number of Stages: <**Insert number**>.
2. Capacity: <**Insert gph (L/s)**>.
3. Inlet Vacuum: <**Insert inches Hg (kPa)**>.
4. Discharge Pressure: <**Insert psig (kPa)**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Motor Speed: <**Insert rpm**>.
7. Motor Horsepower: <**Insert value**>.
8. Electrical Characteristics:

   a. Volts: [**120**][**208**][**240**]<**Insert value**>.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 FUEL-OIL PUMP SETS - MULTIPLEX

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alyan Pump Company**]
2. [**Earthsafe Systems, Inc.**]
3. [**Flo Fab Inc**]
4. [**Hydronic Modules Company**]
5. [**Preferred Utilities Manufacturing Corporation**]
6. [**Smith-Koch, Inc**]
7. [**Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alyan Pump Company**]
2. [**Earthsafe Systems, Inc.**]
3. [**Flo Fab Inc**]
4. [**Hydronic Modules Company**]
5. [**Preferred Utilities Manufacturing Corporation**]
6. [**Smith-Koch, Inc**]
7. [**Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fuel-oil pump sets - multiplex, from single manufacturer.

D. Description: Comply with HI 3.1-3.5.

1. Type: Positive-displacement, rotary type.
2. Configuration: [**Duplex**][**Triplex**].
3. Impeller: [**Steel gear with crescent**][**Carbon vane**].
4. Housing: Cast-iron foot mounted.
5. Bearings: Bronze, self-lubricating.

6. Shaft: Polished steel.
7. Seals: Mechanical.
8. Base: Steel.
9. Pressure Relief: Built in.
10. Discharge Check Valve: Built in.

E. Drive: [**V-belt with guard, gear reducer, or direct close coupled**][**V-belt with guard**][**Gear reducer**][**Direct close coupled**].

F. Controls:

1. Maintain minimum manifold pressure with outdoor-air temperature less than [**60 deg F (16 deg C)**]<**Insert temperature**>.
2. Seven-day schedule.
3. Stage multiple pumps to maintain pressure at a common supply manifold.
4. Alternate pumps to equalize run time.
5. Alarm motor failure.
6. Manual reset dry-run protection.
7. Stop pumps if fuel level falls below pump suction.
8. De-energize and sound alarm for pump, locked-rotor condition.
9. Sound alarm for open circuit and for high and low voltage.
10. Lights indicate normal power on, run, and off conditions.
11. Interface with automatic control system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" to control and indicate the following:

    a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
    b. Operating status.
    c. Alarm off-normal status.

G. Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.

H. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.

I. Capacities and Characteristics:

1. Number of Stages: <**Insert number**>.
2. Capacity (Each Pump): <**Insert gph (L/s)**>.
3. Inlet Vacuum: <**Insert inches Hg (kPa)**>.
4. Discharge Pressure: <**Insert psig (kPa)**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Motor Speed: <**Insert rpm**>.
7. Motor Horsepower (Each Pump): <**Insert value**>.
8. Electrical Characteristics (Pump Set):

    a. Volts: [**120**][**208**][**240**]<**Insert value**>.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 FUEL-OIL POLISHING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Earthsafe Systems, Inc.**]
2. [**Fuel Technologies International**]
3. [**Fuel-Vu, a division of Unified Services of Texas, Inc.**]
4. [**Fueltec Systems, LLC**]
5. [**Preferred Utilities Manufacturing Corporation**]
6. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Earthsafe Systems, Inc.**]
2. [**Fuel Technologies International**]
3. [**Fuel-Vu, a division of Unified Services of Texas, Inc.**]
4. [**Fueltec Systems, LLC**]
5. [**Preferred Utilities Manufacturing Corporation**]
6. **<Insert manufacturer's name>**

C. Source Limitations: Obtain fuel-oil polishing system from single manufacturer.

D. Description: Factory-fabricated and -wired, fuel-oil polishing system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls.

1. System to be FM Global approved and be listed and labeled an NRTL acceptable to authorities having jurisdiction.
2. Enclosure: NEMA 250, Type 3R, painted steel containing pumps, filters, accessories, and controls. Hinged door on the front of enclosure.
3. Pump: Comply with HI 3.1-3.5, steel gear with crescent, positive-displacement, direct-coupled, rotary type.
4. Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-in, pressure relief bypass valve.
5. Piping: Steel with malleable-iron fittings and threaded joints or wrought-steel fittings and welded joints.
6. Spin-on, Replaceable, Multistage Filters:

    a. Stage 1: 100-mesh strainer.
    b. Stage 2: Centrifuge to separate particulates and water from oil.
    c. Stage 3: Coalescing water and particulate filter.
    d. Stage 4: 30-micron particulate removal.
    e. Stage 5: 10-micron particulate removal.
    f. Stage 6: Minimum 99.5 percent water removal with see-through bowl and water-sensor probe.
    g. Stage 7: Minimum 99 percent [**1.5**][**3**][**5**]-micron particulate removal.

7. Multiple-Tank Manifolds:

    a. Manifold fabricated of Schedule 80, black steel pipe and threaded nipples for [**two**][**three**][**four**] tanks.
    b. Solenoid valves for supply and return piping to each tank.
    c. Strainers for each tank supply connection.

8. Programmable Logic Controller:

a. Provide fully automatic operation of system.
b. Alarm on maximum **15 in. Hg (51 kPa)** vacuum at pump suction indicating plugged filter.
c. Alarm on high water level in filter.
d. Alarm on leak in enclosure.
e. Touchscreen; with minimum 2-line, 20-character, illuminated digital display.
f. Display pressure differential across filter.
g. Display pressure differential across coalescer.
h. Controller strip heater with thermostat.

9. Fuel-Quality Analyzer: Continuously monitors fuel quality to detect and record particulate contamination and presence of water.
10. Interface with automatic control system is specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" to control and indicate the following:

a. Start/stop system when required by schedule.
b. Operating status.
c. Alarm off-normal status.

E. Pump Capacities and Characteristics:

1. Capacity (Each Pump): [**3 gpm (0.19 L/s)**][**8 gpm (0.50 L/s)**][**24 gpm (1.5 L/s)**]<**Insert value**>.
2. Maximum Suction Lift: [**15 ft. (4.6 m)**]<**Insert value**>.
3. Inlet and Outlet Size: <**Insert NPS (DN)**>.
4. Motor Horsepower (Each Pump): <**Insert value**>.
5. Electrical Characteristics (Pump Set):

a. Volts: [**120**][**208**][**240**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
2. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
3. Motor Bearings: <**Insert requirements**>.
4. Unusual Service Conditions:

a. Ambient Temperature: <**Insert deg C**>.
b. Altitude: <**Insert feet (m)**> above sea level.
c. High humidity.
d. <**Insert conditions**>.

5. Efficiency: Premium efficient.
6. NEMA Design: <**Insert designation**>.
7. Service Factor: <**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.4 INSTALLATION OF FUEL-OIL PUMPS

A. Submersible Fuel-Oil Storage Tank Pumps:

1. Suspend pumps from supply piping and anchor to bottom of tank.

B. Simplex and Multiplex Fuel-Oil Pumps:

1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchor to concrete base.
3. Pump Mounting:

   a. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   b. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   c. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

4. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of in-line pumps.

   a. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   b. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install two-piece, full-port ball valves at suction and discharge of pumps. Comply with requirements in

Section 230523.12 "Ball Valves for HVAC Piping."

D. Install mechanical leak-detector valves at pump discharge.

E. Install [**Y-pattern**][**basket**][**T-pattern**] strainer on inlet side of all fuel-oil pumps.

F. Install check valve on discharge of all fuel-oil pumps unless provided with built-in check valve.

G. Install suction piping with minimum fittings and change of direction.

H. Install vacuum and pressure gauge, upstream and downstream, respectively, at each pump to measure the differential pressure across the pump. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF FUEL-OIL POLISHING SYSTEMS

A. Polishing System Mounting:

1. Install equipment cabinet on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install suction line, with foot valve, at one end of storage tank, **1 inch (25 mm)** from the bottom of tank.

C. Install return line at the opposite end of storage tank from suction line.

3.6 LABELING AND IDENTIFYING

A. Install nameplates and signs on each fuel-oil pump. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

C. Tests and Inspections:

1. Start fuel-oil transfer pumps [**and fuel-oil polishing system pumps**]to verify for proper operation of pump, and check for leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Fuel-oil pumps[**and fuel-oil polishing systems**] will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**fuel-oil pumps**][**and fuel-oil polishing system**]<**Insert other**>.

END OF SECTION 23 12 13 00

SECTION 23 13 13 00 - FACILITY UNDERGROUND FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underground fuel-oil storage tanks, double-wall steel, with STI-P3.
2. Underground fuel-oil storage tanks, composite, double-wall steel.
3. Underground fuel-oil storage tanks, double wall, jacketed, steel.
4. Underground fuel-oil storage tanks, double-wall FRP.
5. Underground fuel-oil storage tank accessories.
6. Fuel-oil-level gauge system.
7. Fuel-oil leak-detection and monitoring system.
8. Fuel oil.
9. Manholes, concrete.
10. Labels and identification.

1.2 DEFINITIONS

A. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

B. FRP: Glass-fiber-reinforced plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Fuel-oil storage tank accessories.
4. Fuel-oil leak-detection and monitoring system.

B. Shop Drawings: For underground fuel-oil storage tanks.

1. Include plans, elevations, sections, concrete ballast pads and anchors, and lifting or supporting points.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Shop Drawing Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**>.

1.4 INFORMATIONAL SUBMITTALS

A. Site Survey: Plans, drawn to scale, on which underground fuel-oil storage tanks are indicated and coordinated with other services and utilities.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: For FRP tanks, installers are to be trained and certified by tank manufacturer.

B. EPA Compliance: Comply with requirements of the EPA and of state and local authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as indicated on Shop Drawings. Do not move or lift tanks unless empty.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding [**150 deg F (66 deg C)**]<**Insert temperature**>:

1) Structural failures including cracking, breakup, and collapse.
2) Corrosion failure including external and internal corrosion of steel tanks.

b. Warranty Period: [**30**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNDERGROUND FUEL-OIL STORAGE TANKS, DOUBLE-WALL STEEL, WITH STI-P3

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Highland Tank & Manufacturing Company, Inc.**]
4. [**Kennedy Tank and Manufacturing Company, Inc.**]
5. [**Modern Welding Company, Inc.**]

6. [**Palmer Manufacturing and Tank Company**]
7. [**Steel Tank and Fabricating Corporation (STAFCO)**]
8. [**Watco Tanks, Inc**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Highland Tank & Manufacturing Company, Inc.**]
4. [**Kennedy Tank and Manufacturing Company, Inc.**]
5. [**Modern Welding Company, Inc.**]
6. [**Palmer Manufacturing and Tank Company**]
7. [**Steel Tank and Fabricating Corporation (STAFCO)**]
8. [**Watco Tanks, Inc**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain double-wall, steel, STI-P3 underground fuel-oil storage tanks from single manufacturer.

D. Description: UL 58 and STI-P3, double-wall, horizontal steel tank; with cathodic protection and electrical isolation.

1. Containment Method: STI-P3, [**Type I, with primary and secondary walls in contact**][**Type II, with interstitial space**].

E. Construction: Fabricated with welded carbon steel; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:

1. Depth of Bury: **36 inches (900 mm)** from top of tank to finished surface.
2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of **32,000 lb (14 515 kg)**.

F. Corrosion-Protection System: Protect tank and factory-installed piping by engineered and installed corrosion-protection system in accordance with STI-P3, with means of monitoring cathodic protection.

G. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel-Oil Grade Number: [**Grade No. 1**][**Grade No. 2**][**Diesel**][**Low-Sulfur Diesel**][**Ultra-Low Sulfur Diesel**]<**Insert grade**>.

2.2 UNDERGROUND FUEL-OIL STORAGE TANKS, COMPOSITE, DOUBLE-WALL STEEL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Lannon Tank Corporation**]
4. [**Modern Welding Company, Inc.**]
5. [**Palmer Manufacturing and Tank Company**]
6. [**Watco Tanks, Inc**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Lannon Tank Corporation**]
4. [**Modern Welding Company, Inc.**]
5. [**Palmer Manufacturing and Tank Company**]
6. [**Watco Tanks, Inc**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain double-wall, steel, composite underground fuel-oil storage tanks from single manufacturer.

D. Description: UL 58, double-wall, horizontal, composite tank; with FRP or urethane coating complying with UL 1746 and STI F894.

1. Containment Method: STI F894, [**Type I, with primary and secondary walls in contact**][**Type II, with interstitial space**].

E. Construction: Fabricated with welded carbon steel and factory FRP or urethane coating in accordance with UL 1746 and STI F894; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:

1. Depth of Bury: **36 inches (900 mm)** from top of tank to finished surface.
2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of **32,000 lb (14 515 kg)**.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

a. Fill Line: <**Insert NPS (DN)**>.
b. Vent Line: <**Insert NPS (DN)**>.
c. Outlet: <**Insert NPS (DN)**>.
d. Return: <**Insert NPS (DN)**>.
e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

a. Number Required: <**Insert number**>.
b. Diameter: <**Insert inches (mm)**>.

6. Fuel-Oil Grade Number: [**Grade No. 1**][**Grade No. 2**][**Diesel**][**Low-Sulfur Diesel**][**Ultra-Low Sulfur Diesel**]<**Insert grade**>.

2.3 UNDERGROUND FUEL-OIL STORAGE TANKS, DOUBLE WALL, JACKETED, STEEL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Highland Tank & Manufacturing Company, Inc.**]
4. [**Kennedy Tank and Manufacturing Company, Inc.**]
5. [**Lannon Tank Corporation**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Watco Tanks, Inc**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hall Tank Co**]
2. [**Hamilton Tanks**]
3. [**Highland Tank & Manufacturing Company, Inc.**]
4. [**Kennedy Tank and Manufacturing Company, Inc.**]
5. [**Lannon Tank Corporation**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Watco Tanks, Inc**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain double-wall, jacketed, steel underground fuel-oil storage tanks from single manufacturer.

D. Description: Double-wall, jacketed, horizontal steel tank; complying with UL 58, and with plastic or fiberglass jacket and corrosion-protection system in accordance with UL 1746[**and STI F922**].

E. Construction: Tank fabricated with welded carbon steel, and jacket fabricated with plastic or fiberglass and vacuum-sealed interstitial space; suitable for operation at atmospheric pressure and with integral leak-detection device. Tank fabricated for the following loads:

1. Depth of Bury: **36 inches (900 mm)** from top of tank to finished surface.
2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is

fully flooded.

3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of **32,000 lb (14 515 kg)**.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel-Oil Grade Number: [**Grade No. 1**][**Grade No. 2**][**Diesel**][**Low-Sulfur Diesel**][**Ultra-Low Sulfur Diesel**]<**Insert grade**>.

2.4 UNDERGROUND FUEL-OIL STORAGE TANKS, DOUBLE-WALL FRP

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Containment Solutions, Inc**]
2. [**Palmer Manufacturing and Tank Company**]
3. [**Xerxes by Shawcor Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Containment Solutions, Inc**]
2. [**Palmer Manufacturing and Tank Company**]
3. [**Xerxes by Shawcor Ltd.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain double-wall, FRP underground fuel-oil storage tanks from single manufacturer.

D. Description: Horizontal, FRP underground fuel-oil storage tank; UL 1316, double wall, with interstitial space[**and integral, hydrostatic, leak-detection and monitoring system**].

E. Construction: Fabricated with fiberglass-reinforced polyester resins; suitable for operation at atmospheric pressure; fabricated for the following loads:

1. Depth of Bury: **36 inches (900 mm)** from top of tank to finished surface.
2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.
3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of **32,000 lb (14 515 kg)**.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel-Oil Grade Number: [**Grade No. 1**][**Grade No. 2**][**Diesel**][**Low-Sulfur Diesel**][**Ultra-Low Sulfur Diesel**]<**Insert grade**>.

2.5 UNDERGROUND FUEL-OIL STORAGE TANK ACCESSORIES

A. Tank Manholes: **22-inch- (560-mm-)** minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank.

B. Steel Tank Masonry Supports: Two [**6-by-6-by-3/8-inch (150-by-150-by-10-mm)**]<**Insert dimensions**> steel angles, [**72 inches (1800 mm)**]<**Insert dimension**> long, located longitudinally on tank on each side of manholes and continuously welded in place.

C. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, and gauging; in locations and of sizes indicated. Include cast-iron plugs for shipping.

D. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gauge, and other tube openings.

E. Lifting Lugs: For handling and installation.

F. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom. Include reinforcement of tank at bottom of ladder.

G. Supply Tube: Extension of supply piping fitting into tank, terminating **6 inches (150 mm)** above tank bottom and cut at a **45-degree angle- (1:1 slope)**.

H. Sounding and Gauge Tubes: Extension of fitting into tank, terminating **6 inches (150 mm)** above tank bottom and cut at a **45-degree angle (1:1 slope)**.

I. Containment Sumps: [**Fiberglass**][**PE**] with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.

J. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.

K. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables, and turnbuckles; of strength at least one-and-one-half times maximum uplift force of empty tank without backfill in place.

L. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of [**3 oz./sq. yd. (101.7 g/sq. m)**]<**Insert dimension**>.

M. Overfill Prevention Valves: Factory fabricated or shop or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 95 percent of tank capacity and to provide complete shutoff of filling at [**98**][**99**]<**Insert number**> percent of tank capacity.

2.6 FUEL-OIL-LEVEL GAUGE SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caldwell Systems Corporation**]
2. [**Clawson Tank Company**]
3. [**Franklin Fueling Systems**]
4. [**Gems Sensors & Controls Inc.**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**In-Situ, Inc**]
7. [**King Engineering Corp**]
8. [**Krueger Sentry Gauge**]
9. [**Pneumercator Inc**]
10. [**Preferred Utilities Manufacturing Corporation**]
11. [**Rochester Sensors**]
12. [**Tuthill Corporation**]
13. [**Uehling Instrument Company**]
14. [**Venture Measurement Company, LLC**]
15. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caldwell Systems Corporation**]
2. [**Clawson Tank Company**]
3. [**Franklin Fueling Systems**]
4. [**Gems Sensors & Controls Inc.**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**In-Situ, Inc**]
7. [**King Engineering Corp**]
8. [**Krueger Sentry Gauge**]
9. [**Pneumercator Inc**]
10. [**Preferred Utilities Manufacturing Corporation**]
11. [**Rochester Sensors**]
12. [**Tuthill Corporation**]
13. [**Uehling Instrument Company**]

14. [**Venture Measurement Company, LLC**]
15. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fuel-oil-level gauge system from single manufacturer.

D. Description: Calibrated, fuel-oil-level gauge system complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.

E. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in **gallons (liters)**, and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.

F. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

2.7 FUEL-OIL LEAK-DETECTION AND MONITORING SYSTEM

A. Fuel-Oil Leak-Detection and Monitoring, Cable and Sensor System: Comply with UL 1238.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Caldwell Systems Corporation**]
   b. [**Containment Solutions, Inc**]
   c. [**Franklin Fueling Systems**]
   d. [**Gems Sensors & Controls Inc.**]
   e. [**Highland Tank & Manufacturing Company, Inc.**]
   f. [**In-Situ, Inc**]
   g. [**PermAlert**]
   h. [**Pneumercator Inc**]
   i. [**Veeder-Root Company (The)**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Caldwell Systems Corporation**]
   b. [**Containment Solutions, Inc**]
   c. [**Franklin Fueling Systems**]
   d. [**Gems Sensors & Controls Inc.**]
   e. [**Highland Tank & Manufacturing Company, Inc.**]
   f. [**In-Situ, Inc**]
   g. [**PermAlert**]
   h. [**Pneumercator Inc**]
   i. [**Veeder-Root Company (The)**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cable and sensor fuel-oil leak-detection and monitoring system from single manufacturer.
4. Calibrated fuel-oil leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
5. Include fittings and devices required for testing.
6. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

7. Calibrated fuel-oil-level gauge complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.
8. Remote annunciator panel with visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in **gallons (liters)**, and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.
9. Remote Annunciator Panel Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

B. Fuel-Oil Leak Detection and Monitoring, Hydrostatic System: Comply with UL 1238.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Caldwell Systems Corporation**]
   b. [**Containment Solutions, Inc**]
   c. [**Franklin Fueling Systems**]
   d. [**Gems Sensors & Controls Inc.**]
   e. [**Highland Tank & Manufacturing Company, Inc.**]
   f. [**In-Situ, Inc**]
   g. [**PermAlert**]
   h. [**Pneumercator Inc**]
   i. [**Veeder-Root Company (The)**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Caldwell Systems Corporation**]
   b. [**Containment Solutions, Inc**]
   c. [**Franklin Fueling Systems**]
   d. [**Gems Sensors & Controls Inc.**]
   e. [**Highland Tank & Manufacturing Company, Inc.**]
   f. [**In-Situ, Inc**]
   g. [**PermAlert**]
   h. [**Pneumercator Inc**]
   i. [**Veeder-Root Company (The)**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain hydrostatic fuel-oil leak-detection and monitoring system from single manufacturer.
4. Calibrated fuel-oil leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
5. Include fittings and devices required for testing.
6. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.
7. Calibrated fuel-oil-level gauge complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.
8. Remote annunciator panel with visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in **gallons (liters)**, and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.
9. Remote Annunciator Panel Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

2.8 FUEL OIL

A. Fuel Oil: ASTM D396, [**Grade No. 1**][**Grade No. 2**].

B. Diesel Fuel Oil: ASTM D975, [**Grade Low Sulfur**][**Grade Ultra-Low Diesel**][**Grade No. 1-D, special purpose**][**Grade No. 2-D, general purpose**], high volatility.

2.9 MANHOLES, CONCRETE

A. Precast Concrete Manhole Sections: ASTM C478/C478M, base and [**concentric-cone**][**eccentric-cone**] sections with integral ladder or steps.

B. Cast-Iron Frame and Cover: Heavy-duty, water-resistant, cast-iron manhole frame, gasket, and bolted cover; [**24-inch- (609-mm-)**]<**Insert dimension**> diameter, inside opening dimension; [**8-inch (203-mm)**]<**Insert dimension**> frame riser height.

2.10 LABELS AND IDENTIFICATION

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (152 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (762 mm)** deep; colored yellow.

2.11 SOURCE QUALITY CONTROL

A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, in accordance with ASME and the following:

1. Horizontal, Steel, Underground Fuel-Oil Storage Tanks with the STI-P3 Corrosion-Protection System: UL 58 and STI-P3.
2. Composite, Steel, Underground Fuel-Oil Storage Tanks: UL 58.
3. Composite and Jacketed, Steel, Underground Fuel-Oil Storage Tanks: UL 58.
4. Jacketed, Steel, Underground Fuel-Oil Storage Tanks: UL 58.
5. FRP Underground Fuel-Oil Storage Tanks: UL 1316.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for underground fuel-oil storage tanks to verify actual locations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

B. Excavate to sufficient depth for a minimum of **36 inches (900 mm)** of earth cover from top of tank to finished grade. Allow for cast-in-place, concrete-ballast base plus **6 inches (150 mm)** of sand or pea gravel between ballast base and tank. Extend excavation at least **12 inches (300 mm)** around perimeter of tank.

C. Backfill excavation with clean sand or pea gravel in **12-inch (305-mm)** lifts and tamp backfill lift to consolidate.

D. Install filter mat between top of backfill material and earth fill.

3.3 INSTALLATION OF UNDERGROUND FUEL-OIL STORAGE TANK

A. Install tank in accordance with NFPA 30 and 31 by a contractor trained and certified by tank manufacturer.

B. Set tie-down eyelets for hold-down straps in concrete-ballast base and tie to reinforcing steel.

C. Place **6 inches (152 mm)** of clean sand or pea gravel on top of concrete-ballast base.

D. Set tank on fill materials and install hold-down straps.

E. Connect piping.

F. Install tank leak-detection and monitoring devices.

G. Install containment sumps.

H. Install steel underground fuel-oil storage tank with the STI-P3 corrosion-protection system in accordance with STI R821 and STI R891. Protect anodes during tank placement and backfilling operations.

I. Install composite, steel, underground fuel-oil storage tank in accordance with STI R913 and STI R891.

J. Install jacketed, steel, underground fuel-oil storage tank in accordance with STI R923 and STI R891.

K. Install FRP underground fuel-oil storage tank with FRP hold-down straps, manhole extensions, and manhole risers.

L. Fill storage tank with specified fuel oil.

3.4 INSTALLATION OF LIQUID-LEVEL GAUGE SYSTEM

A. Install liquid-level gauge system. Install panel inside building at location indicated on Drawings.

3.5 INSTALLATION OF FUEL-OIL LEAK-DETECTION AND MONITORING SYSTEM

A. Install fuel-oil leak-detection and monitoring system. Install alarm panel inside building at location indicated.

1. Double-Wall, Fuel-Oil Storage Tanks: [**Install probes**][**Install probes or use factory-installed integral probes**][**Use factory-installed integral probes**] in interstitial space.

2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated on Drawings.
3. Double-Containment, Fuel-Oil Piping: Install fuel-oil leak-detection sensor [**probes in fuel-oil storage tank containment sumps and at low points in piping**][**cable probes in interstitial space of double-containment piping**].
4. Install liquid-level gauge.

3.6 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Install detectable warning tape directly above underground fuel-oil storage tank, [**12 inches (304 mm)**]<**Insert dimension**> below finished grade, except [**6 inches (152 mm)**]<**Insert dimension**> below subgrade under pavements and slabs.

1. Terminate tracer wire in an accessible area and identify as "tracer wire" for future use with plastic-laminate sign.
2. Install over edges of each underground fuel-oil storage tank.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

a. Double-Wall Tanks:

1) Inner Tanks: Minimum [**3 psig (20.7 kPa)**]<**Insert pressure**> and maximum [**5 psig (34.5 kPa)**]<**Insert pressure**>.
2) Interstitial Space: Minimum [**3 psig (20.7 kPa)**]<**Insert pressure**> and maximum [**5 psig (34.5 kPa)**]<**Insert pressure**>, or [**5.3 in. Hg (18 kPa)**]<**Insert negative pressure**> vacuum.

b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than **10 psig (69 kPa)**, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
c. Maintain the test pressure for one hour.

C. Underground fuel-oil storage tanks will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 23 13 13 00

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Task	Specification	Specification Description
23 13 13 13	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 13 13 13	23 13 13 00	Facility Underground Fuel-Oil Storage Tanks
23 13 13 23	23 13 13 00	Facility Underground Fuel-Oil Storage Tanks

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SECTION 23 13 23 00 - FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground fuel-oil storage tanks, vertical, steel.
2. Aboveground fuel-oil storage tanks, horizontal, steel.
3. Aboveground fuel-oil storage tanks, steel, with containment dike.
4. Aboveground fuel-oil storage tanks, insulated, steel.
5. Aboveground fuel-oil storage tanks, steel, with concrete vault.
6. Aboveground fuel-oil storage tank, shop painting.
7. Aboveground fuel-oil storage tank accessories.
8. Fuel-oil-level gauge system.
9. Fuel-oil leak-detection and monitoring systems.
10. Fuel oil.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Fuel-oil storage tank accessories.
4. Fuel-oil leak-detection and monitoring system.

B. Shop Drawings: For aboveground fuel-oil storage tanks.

1. Include plans, elevations, sections, concrete bases, anchors, and lifting or supporting points.
2. Indicate details of equipment assemblies. Indicate dimensions, components, and location and size of each field connection.
3. Shop Drawing Scale: [**1/4 inch per foot (1:50)**]<**Insert scale**>.

1.3 INFORMATIONAL SUBMITTALS

A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are indicated and coordinated with other services and utilities.

Retain "Seismic Qualification Data" Paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

B. Seismic Qualification Data: Certificates for aboveground fuel oil storage tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of

assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Retain "Welding certificates" Paragraph below if retaining procedures for welder certification in "Quality Assurance" Article.

C. Welding certificates.

Retain "Field quality-control reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

EPA Compliance: Comply with requirements of the EPA and of state and local authorities having jurisdiction. Retain "Steel Support Welding Qualifications" Paragraph for welded supports. Also retain "Welding certificates" Paragraph in "Informational Submittals" Article.

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

1.7 WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding [**150 deg F (66 deg C)**]<**Insert temperature**>:

1) Structural failures including cracking, breakup, and collapse.

Retain first subparagraph below for steel tanks.

2) Corrosion failure including external and internal corrosion of steel tanks.

Verify available warranties and warranty periods for units and components with manufacturers listed in Part 2 articles.

b. Warranty Period: [**30**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for aboveground fuel-oil storage tanks and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

Retain "Seismic Performance" Paragraph below with "Seismic Qualification Data" Paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

B. Seismic Performance: Factory-installed support attachments for aboveground fuel-oil storage tanks are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, system components serving critical healthcare functions, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

2. Component Importance Factor: [**1.5**][**1.0**].

Retain "Wind Performance" Paragraph below with "Product Certificates" Paragraph in "Informational Submittals" Article for project requiring wind-restraint design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for building equipment subject to wind effects. Coordinate requirements with structural engineer.

C. Wind Performance: Aboveground fuel-oil storage tanks are to withstand the effects of wind determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**].

2.2 ABOVEGROUND FUEL-OIL STORAGE TANKS, VERTICAL, STEEL

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brown Tank, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Steel Tank and Fabricating Corporation (STAFCO)**]
9. [**Watco Tanks, Inc**]
10. [**We-Mac Manufacturing, Inc.**]
11. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Brown Tank, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Steel Tank and Fabricating Corporation (STAFCO)**]
9. [**Watco Tanks, Inc**]
10. [**We-Mac Manufacturing, Inc.**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain vertical, steel, aboveground fuel-oil storage tanks from single manufacturer.

D. Description:

Retain one of two subparagraphs below. Double-wall tanks may be required if tanks are not diked. Dikes may be required when single-wall tanks are used. Consult applicable codes and authorities having jurisdiction. If retaining both single-wall and double-wall tanks, include drawing designation for each type of tank.

1. UL 142, single-wall, vertical steel tank.

Not all manufacturers are members of the Steel Tank Institute and therefore may not use the STI F921

designation. Retaining the option below will restrict tank products to STI member manufacturers. Consult manufacturers.

2. UL 142[**and STI F921**], double-wall, vertical steel tank; with primary- and secondary-containment walls and interstitial space.

E. Construction: Fabricated with welded carbon steel suitable for operation at atmospheric pressure, for storing fuel oil with specific gravity up to 1.1, and for maintained temperature up to **150 deg F (66 deg C)**.

If Project has more than one type or configuration of vertical, steel, aboveground fuel-oil storage tanks, delete "Capacities and Characteristics" Paragraph below and schedule tanks on Drawings.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel: [**Fuel oil**][**Diesel**].

2.3 ABOVEGROUND FUEL-OIL STORAGE TANKS, HORIZONTAL, STEEL

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brown Tank, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Safe-T-Tank Corp**]
9. [**Steel Tank and Fabricating Corporation (STAFCO)**]
10. [**Watco Tanks, Inc**]
11. [**We-Mac Manufacturing, Inc.**]
12. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Brown Tank, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Modern Welding Company, Inc.**]
7. [**Palmer Manufacturing and Tank Company**]
8. [**Safe-T-Tank Corp**]
9. [**Steel Tank and Fabricating Corporation (STAFCO)**]
10. [**Watco Tanks, Inc**]
11. [**We-Mac Manufacturing, Inc.**]
12. **<Insert manufacturer's name>**

C. Source Limitations: Obtain horizontal, steel, aboveground fuel-oil storage tanks from single manufacturer.

D. Description:

Retain one of two subparagraphs below. Double-wall tanks may be required if tanks are not diked. Dikes may be required when single-wall tanks are used. Consult applicable codes and authorities having jurisdiction. If retaining both single-wall and double-wall tanks, include drawing designation for each type of tank.

1. UL 142, single-wall, horizontal steel tank.

Not all manufacturers are members of the Steel Tank Institute and therefore may not use the STI F921 designation. Retaining the option below will restrict tank products to STI member manufacturers. Consult manufacturers.

2. UL 142[**and STI F921**], double-wall, horizontal steel tank; with primary- and secondary-containment walls and interstitial space.

E. Construction: Fabricated with welded carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to **150 deg F (66 deg C)**.

F. Supports:

Retain one of first two subparagraphs below.

1. Manufacturer's standard structural steel welded to tank.
2. Manufacturer's standard type[**and number**], steel or cast-iron cradles, for field installation.
3. Number of Supports: **<Insert number>**.

Concrete or steel supports for off-the-ground mounting must be specified or detailed on Drawings.

If Project has more than one type or configuration of horizontal, steel, aboveground fuel-oil storage tanks, delete "Capacities and Characteristics" Paragraph below and schedule tanks on Drawings.

G. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

    a. Fill Line: <**Insert NPS (DN)**>.
    b. Vent Line: <**Insert NPS (DN)**>.
    c. Outlet: <**Insert NPS (DN)**>.
    d. Return: <**Insert NPS (DN)**>.
    e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

    a. Number Required: <**Insert number**>.
    b. Diameter: <**Insert inches (mm)**>.

6. Fuel: [**Fuel il**][**Diesel**].

2.4 ABOVEGROUND FUEL-OIL STORAGE TANKS, HORIZONTAL, STEEL, WITH CONTAINMENT DIKE

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Areo Power Tanks, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Kennedy Tank and Manufacturing Company, Inc.**]
7. [**Modern Welding Company, Inc.**]
8. [**Watco Tanks, Inc**]
9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Areo Power Tanks, LLC**]
2. [**Buffalo Tank Company, Inc**]
3. [**Hall Tank Co**]
4. [**Hamilton Tanks**]
5. [**Highland Tank & Manufacturing Company, Inc.**]
6. [**Kennedy Tank and Manufacturing Company, Inc.**]
7. [**Modern Welding Company, Inc.**]
8. [**Watco Tanks, Inc**]
9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

C. Source Limitations: Obtain horizontal, steel, aboveground fuel-oil storage tanks with containment dike from single manufacturer.

Not all manufacturers are members of the Steel Tank Institute and therefore may not use the STI F911 designation. Retaining the option below will restrict tank products to STI member manufacturers. Consult manufacturers.

D. Description: UL 142[**and STI F911**], single-wall, horizontal steel tank; with [**open or enclosed**][**enclosed**] secondary-containment dike with capacity greater than tank capacity.

E. Construction: Fabricated with welded carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to **150 deg F (66 deg C)**.

If Project has more than one type or configuration of containment-dike, steel, aboveground fuel-oil storage tanks, delete "Capacities and Characteristics" Paragraph below and schedule tanks on Drawings.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel: [**Fuel oil**][**Diesel**].

2.5 ABOVEGROUND FUEL-OIL STORAGE TANKS, INSULATED, STEEL

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ace Tank & Fueling Equipment, LLC**]
2. [**Areo Power Tanks, LLC**]
3. [**Brown Tank, LLC**]
4. [**Clark Welding Service**]
5. [**Hamilton Tanks**]
6. [**Highland Tank & Manufacturing Company, Inc.**]
7. [**Modern Welding Company, Inc.**]
8. [**Steel Tank and Fabricating Corporation (STAFCO)**]

9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ace Tank & Fueling Equipment, LLC**]
2. [**Areo Power Tanks, LLC**]
3. [**Brown Tank, LLC**]
4. [**Clark Welding Service**]
5. [**Hamilton Tanks**]
6. [**Highland Tank & Manufacturing Company, Inc.**]
7. [**Modern Welding Company, Inc.**]
8. [**Steel Tank and Fabricating Corporation (STAFCO)**]
9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

C. Source Limitations: Obtain insulated, steel, aboveground fuel-oil storage tanks from single manufacturer.

Not all manufacturers are members of the Steel Tank Institute and therefore may not use the STI F941 designation. Retaining the option below will restrict tank products to STI member manufacturers. Consult manufacturers.

D. Description: [**UL 142 and UL 2085**][**UL 142, UL 2085, and STI F941**], thermally insulated and fire resistant as defined in NFPA 30, double-wall, [**horizontal**][**vertical**] steel tank; with primary- and secondary-containment walls and insulation in the interstitial space.

E. Construction: Fabricated with welded carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature in accordance with UL 2085.

If Project has more than one type or configuration of insulated, steel, aboveground fuel-oil storage tanks, delete "Capacities and Characteristics" Paragraph below and schedule tanks on Drawings.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel: [**Fuel oil**][**Diesel**].

2.6 ABOVEGROUND FUEL-OIL STORAGE TANKS, STEEL, WITH CONCRETE VAULT

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ConVault, Inc**]
2. [**Hall Tank Co**]
3. [**Hamilton Tanks**]
4. [**Highland Tank & Manufacturing Company, Inc.**]
5. [**Modern Welding Company, Inc.**]
6. [**Palmer Manufacturing and Tank Company**]
7. [**Steel Tank and Fabricating Corporation (STAFCO)**]
8. [**Watco Tanks, Inc**]
9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ConVault, Inc**]
2. [**Hall Tank Co**]
3. [**Hamilton Tanks**]
4. [**Highland Tank & Manufacturing Company, Inc.**]
5. [**Modern Welding Company, Inc.**]
6. [**Palmer Manufacturing and Tank Company**]
7. [**Steel Tank and Fabricating Corporation (STAFCO)**]
8. [**Watco Tanks, Inc**]
9. [**We-Mac Manufacturing, Inc.**]
10. <**Insert manufacturer's name**>

C. Source Limitations: Obtain steel, aboveground fuel-oil storage tanks with concrete vault from single manufacturer.

Not all manufacturers are members of the Steel Tank Institute and therefore may not use the STI F941 designation. Retaining the option below will restrict tank products to STI member manufacturers. Consult manufacturers.

D. Description: [**UL 142 and UL 2085**][**UL 142, UL 2085, and STI F941**]; thermally insulated, fire-resistant and protected, double-wall, horizontal steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.

E. Construction: Fabricated with welded carbon steel and insulation and encased in concrete that will protect from bullets; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature in accordance with UL 2085.

If Project has more than one type or configuration of concrete-vaulted, steel, aboveground fuel-oil storage tanks, delete "Capacities and Characteristics" Paragraph below and schedule tanks on Drawings.

F. Capacities and Characteristics:

1. Capacity: <**Insert gal. (L)**>.
2. Diameter: <**Insert feet (m)**>.
3. Length: <**Insert feet (m)**>.
4. Connection Sizes:

   a. Fill Line: <**Insert NPS (DN)**>.
   b. Vent Line: <**Insert NPS (DN)**>.
   c. Outlet: <**Insert NPS (DN)**>.
   d. Return: <**Insert NPS (DN)**>.
   e. Gauge: <**Insert NPS (DN)**>.

5. Manholes:

   a. Number Required: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.

6. Fuel: [**Fuel oil**][**Diesel**].

2.7 ABOVEGROUND FUEL-OIL STORAGE TANK, SHOP PAINTING

Retain only first paragraph below if field painting aboveground fuel-oil storage tank.

A. Apply manufacturer's standard prime coat to exterior steel surface of aboveground fuel-oil storage tank[**and tank supports**].

Retain remainder of this article if shop painting aboveground fuel-oil storage tank.

B. Prepare exterior steel surface of aboveground fuel-oil storage tank[**and tank supports**].

Retain first option in "Shop Cleaning" Paragraph below for "Commercial Blast Cleaning"; retain second option for "Near-White Blast Cleaning."

C. Shop Cleaning: After fabrication, blast clean in accordance with [**SSPC-SP 6/NACE No. 3**][**SSPC-SP 10/NACE No. 2**].

D. After cleaning, remove dust or residue from cleaned surfaces.

E. If surface develops rust before prime coat is applied, repeat surface preparation.

F. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.

G. Apply manufacturer's standard two-component, epoxy finish coats.

2.8 ABOVEGROUND FUEL-OIL STORAGE TANK ACCESSORIES

Show fittings and accessories on plans, details, and piping schematics.

A. Tank Manholes:

Retain one of two subparagraphs below. Retain first subparagraph for horizontal tanks and some vertical tanks; retain second subparagraph for vertical tanks.

1. [**22-inch- (560-mm-)**]<**Insert dimension**> minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
2. [**22-inch- (560-mm-)**]<**Insert dimension**> minimum diameter; bolted, flanged, and gasketed; on top and at side of tank.

Retain one of first two paragraphs below. Retain first paragraph for horizontal tanks; retain second for vertical tanks.

B. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gauging. Include cast-iron plugs for shipping.

C. Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gauging. Include cast-iron plugs for shipping.

D. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gauge, and other tube openings.

E. Lifting Lugs: For handling and installation.

F. Ladders:

Retain one of first two subparagraphs below. Retain first subparagraph for horizontal tanks and some vertical tanks; retain second subparagraph for vertical tanks.

1. Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
2. Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Section 055000 "Metal Fabrications" for exterior steel ladder.

    a. Cage: Include welded steel cage around ladders for tanks [**20 feet (6 m)**]<**Insert dimension**> high or higher.

G. Supply Tube: Extension of supply piping fitting into tank, terminating **6 inches (150 mm)** above tank bottom and cut at a **45-degree angle (1:1 slope)**.

H. Sounding and Gauge Tubes: Extension of fitting into tank, terminating **6 inches (150 mm)** above tank bottom and cut at a **45-degree angle (1:1 slope)**.

2.9 FUEL-OIL-LEVEL GAUGE SYSTEM

Retain this article if fuel-oil-level gauge system is not specified in "Leak-Detection and Monitoring System" Article. Delete this article if fuel-oil-level gauge system is included in the leak-detection and monitoring system.

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caldwell Systems Corporation**]
2. [**Franklin Fueling Systems**]
3. [**Gems Sensors & Controls Inc.**]
4. [**Highland Tank & Manufacturing Company, Inc.**]
5. [**In-Situ, Inc**]
6. [**Pneumercator Inc**]
7. [**Preferred Utilities Manufacturing Corporation**]
8. [**Rochester Sensors**]
9. [**Veeder-Root Company (The)**]
10. [**Venture Measurement Company, LLC**]
11. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caldwell Systems Corporation**]
2. [**Franklin Fueling Systems**]
3. [**Gems Sensors & Controls Inc.**]
4. [**Highland Tank & Manufacturing Company, Inc.**]
5. [**In-Situ, Inc**]
6. [**Pneumercator Inc**]
7. [**Preferred Utilities Manufacturing Corporation**]
8. [**Rochester Sensors**]
9. [**Veeder-Root Company (The)**]
10. [**Venture Measurement Company, LLC**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fuel-oil-level gauge system from single manufacturer.

D. Description: Calibrated fuel-oil-level gauge system complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.

Alarms specified in "Annunciator Panel" Paragraph below may be used as part of fuel-oil leak-detection system.

E. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in **gallons (liters)**; and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.

F. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

2.10 FUEL-OIL LEAK-DETECTION AND MONITORING SYSTEMS

Retain one of two paragraphs in this article.

A. Fuel-Oil Leak Detection and Monitoring, Cable and Sensor System: Comply with UL 1238.

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Caldwell Systems Corporation**]
b. [**Containment Solutions, Inc**]
c. [**Franklin Fueling Systems**]
d. [**Gems Sensors & Controls Inc.**]
e. [**Highland Tank & Manufacturing Company, Inc.**]
f. [**In-Situ, Inc**]
g. [**PermAlert**]
h. [**Pneumercator Inc**]
i. [**Veeder-Root Company (The)**]
j. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Caldwell Systems Corporation**]
b. [**Containment Solutions, Inc**]
c. [**Franklin Fueling Systems**]
d. [**Gems Sensors & Controls Inc.**]
e. [**Highland Tank & Manufacturing Company, Inc.**]
f. [**In-Situ, Inc**]
g. [**PermAlert**]
h. [**Pneumercator Inc**]
i. [**Veeder-Root Company (The)**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cable-and-sensor fuel-oil leak-detection and monitoring system from single manufacturer.

Visual and audible alarms in "Fuel-Oil-Level Gauge System" Article may be used as part of leak-detection system.

4. Calibrated fuel-oil leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
5. Include fittings and devices required for testing.
6. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

Retain subparagraphs below for an optional feature that replaces system described in "Fuel-Oil-Level Gauge System" Article.

7. Calibrated fuel-oil-level gauge complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.
8. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in **gallons (liters)**; and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.
9. Remote Annunciator Panel Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

B. Fuel-Oil Leak Detection and Monitoring, Hydrostatic System: Comply with UL 1238.

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Caldwell Systems Corporation**]
    b. [**Containment Solutions, Inc**]
    c. [**Franklin Fueling Systems**]
    d. [**Gems Sensors & Controls Inc.**]
    e. [**Highland Tank & Manufacturing Company, Inc.**]
    f. [**In-Situ, Inc**]
    g. [**PermAlert**]
    h. [**Pneumercator Inc**]
    i. [**Veeder-Root Company (The)**]
    j. <**Insert manufacturer's name**>

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Caldwell Systems Corporation**]
    b. [**Containment Solutions, Inc**]
    c. [**Franklin Fueling Systems**]
    d. [**Gems Sensors & Controls Inc.**]
    e. [**Highland Tank & Manufacturing Company, Inc.**]
    f. [**In-Situ, Inc**]
    g. [**PermAlert**]
    h. [**Pneumercator Inc**]
    i. [**Veeder-Root Company (The)**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain hydrostatic fuel-oil leak-detection and monitoring system from single manufacturer.

Visual and audible alarms in "Fuel-Oil-Level Gauge System" Article may be used as part of leak-detection system.

4. Calibrated fuel-oil leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.
5. Include fittings and devices required for testing.
6. Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

Retain subparagraphs below for an optional feature that replaces system described in "Fuel-Oil-Level Gauge System" Article.

7. Calibrated fuel-oil-level gauge complying with [**UL 180 with floats**][**UL 1238 with probes**] or other sensors and remote annunciator panel.
8. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in **gallons (liters)**; and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.
9. Remote Annunciator Panel Controls: Electrical, operating on [**120**]<**Insert voltage**> V ac.

2.11 FUEL OIL

Second option in "Fuel Oil" Paragraph below is grade typically used for fuel-oil-burning equipment.

A. Fuel Oil: ASTM D396, [**Grade No. 1**][**Grade No. 2**].

Last option in "Diesel Fuel Oil" Paragraph below is typically used for automotive or other diesel engines such as emergency generators.

B. Diesel Fuel Oil: ASTM D975, [**Grade Low Sulfur**][**Grade Ultra-Low Sulfur**][**Grade No. 1-D, special purpose**][**Grade No. 2-D, general purpose**], high volatility.

2.12 SOURCE QUALITY CONTROL

Coordinate standards for tests in this article with those referenced in Part 2 Aboveground Fuel-Oil Storage Tanks articles. Do not include STI tests if tanks are not STI type.

A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, in accordance with ASME and the following:

Retain one or more of 10 subparagraphs below.

1. Vertical, Single-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142.
2. Vertical or Horizontal, Single-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142.
3. Horizontal, Single-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142.
4. Vertical, Double-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142, STI F921, and STI R931.
5. Vertical or Horizontal, Double-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142, STI F921, and STI R931.
6. Horizontal, Double-Wall Steel Aboveground Fuel-Oil Storage Tanks: UL 142, STI F921, and STI R931.
7. Horizontal, Containment-Dike, Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and STI F911.
8. Horizontal, Concrete-Vaulted, Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and UL 2085.
9. Horizontal, Concrete-Vaulted and Insulated, Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and UL 2085.
10. Horizontal, Insulated, Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and UL 2085.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF ABOVEGROUND FUEL-OIL STORAGE TANKS

Indicate size and location of concrete base on Drawings, including reinforcing steel.

A. Install tank in accordance with NFPA 30 and 31 by a tank-manufacturer-trained and -certified contractor.

B. Install tank bases and supports.

Coordinate concrete work in this article with Section 033000 "Cast-in-Place Concrete."

C. Concrete Bases: Anchor aboveground fuel oil storage tank to concrete base in accordance with equipment manufacturer's written instructions and in accordance with seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on [**18-inch (457-mm)**]<**Insert dimension**> centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use [**3000-psig (20.7-MPa)**]<**Insert dimension**>, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

D. Connect piping and vent fittings.

E. Install ground connections.

F. Install tank leak-detection and monitoring devices.

G. Install steel aboveground fuel-oil storage tanks in accordance with STI R912.

H. Install insulated and concrete-vaulted, steel, aboveground fuel-oil storage tanks in accordance with STI R942.

I. Fill storage tanks with fuel oil.

3.4 INSTALLATION OF FUEL-OIL-LEVEL GAUGE SYSTEM

A. Install liquid-level gauge system. Install panel where indicated on Drawings.

3.5 INSTALLATION OF LEAK-DETECTION AND MONITORING SYSTEM

A. Install leak-detection and monitoring system. Install alarm panel where indicated on Drawings.

1. Double-Wall, Fuel-Oil Storage Tanks: [**Install probes**][**Install probes or use factory-installed integral probes**][**Use factory-installed integral probes**] in interstitial space.

System in "Single-Wall, Fuel-Oil Storage Tanks" Subparagraph below requires extensive description here or layout and details on Drawings.

2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated on Drawings.

Float-type probes in tank containment sumps and at piping low points, if required, are most often used. Cable sensors are also available.

3. Double-Containment Fuel-Oil Piping: Install leak-detection sensor [**probes in fuel-oil storage tank containment sumps and at low points in piping**][**cable probes in interstitial space of double-containment piping**].

Retain "Install liquid-level gauge" Subparagraph below for liquid-level gauge that is part of leak-detection and monitoring system.

4. Install liquid-level gauge.

3.6 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 ABOVEGROUND FUEL-OIL STORAGE TANK, FIELD PAINTING

Retain this article only for aboveground fuel-oil tank with steel exterior surface.

Retain only first paragraph below if shop painting aboveground fuel-oil storage tank.

A. Prepare and touch up damaged exterior surface of aboveground fuel-oil storage tank[**and supports**] as specified in "Aboveground Fuel-Oil Storage Tank, Shop Painting" Article.

Retain remainder of this article if field painting aboveground fuel-oil storage tank.

B. Prepare exterior steel surface of aboveground fuel-oil storage tank[**and tank supports**].

Retain first option in "Field Cleaning" Paragraph below for "Commercial Blast Cleaning"; retain second option for "Near-White Blast Cleaning."

C. Field Cleaning: After fabrication, blast clean in accordance with [**SSPC-SP 6/NACE No. 3**][**SSPC-SP 10/NACE No. 2**].

D. After cleaning, remove dust or residue from cleaned surfaces.

E. If surfaces develop rust before prime coat is applied, repeat surface preparation.

F. Prepare surface of aboveground fuel-oil storage tank[**and supports**] and apply painting systems in accordance with specifications in Section 099600 "High-Performance Coatings" for [**severe**][**moderate**][**mild**] environment [**high-gloss**][**semigloss**] finish for ferrous metal.

3.8 FIELD QUALITY CONTROL

Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform tests and inspections.

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

Tank and pipe test pressures in this article are required by NFPA 31. Verify requirements with authorities having jurisdiction.

Retain "Tanks" Subparagraph below if storage tanks do not bear the ASME code stamp as required in "Source Quality Control" Article.

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

   a. Single-Wall Tanks: Minimum **3 psig (20.7 kPa)** and maximum **5 psig (34.5 kPa)**.
   b. Double-Wall Tanks:

      1) Inner Tanks: Minimum **3 psig (20.7 kPa)** and maximum **5 psig (34.5 kPa)**.
      2) Interstitial Space: Minimum **3 psig (20.7 kPa)** and maximum **5 psig (34.5 kPa)**, or **5.3-in. Hg (18-kPa)** vacuum.

   c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than **10 psig (69 kPa)**, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
   d. Maintain the test pressure for one hour.

C. Aboveground fuel-oil storage tanks will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 23 13 23 00

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Task	Specification	Specification Description
23 13 23 13	23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks
23 13 23 16	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 13 23 16	23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks
23 13 23 19	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 13 23 19	23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks
23 13 23 26	23 13 23 00	Facility Aboveground Fuel-Oil Storage Tanks

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SECTION 23 21 13 00 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Stainless steel pipe and fittings.
4. Plastic pipe and fittings.
5. Fiberglass pipe and fittings.
6. Piping joining materials.
7. Transition fittings.
8. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings:

1. Show hydronic piping layouts, sizes and elevations, including connecting equipment, valves, specialty valves, fittings, strainers, air vents, expansion tanks, air/dirt separators/purgers, meters, expansion loops/expansion joints/anchors, and low point drains.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 foot (1:50)**] .

C. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors, alignment guides, and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

D. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Welding Certificates: For [**steel support**][**and**][**pipe**] welding.

C. Field Quality Control Reports: For specified tests and inspections.

D. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP are to be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

C. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9 for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.5 WARRANTY

A. PP-R and PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Hot-Water Heating Piping: [**100 psig (689 kPa)**] at [**200 deg F (93 deg C)**][**180 deg F (82 deg C)**].
2. Chilled-Water Piping: [**150 psig (1034 kPa)**] at [**73 deg F (22 deg C)**].
3. Dual-Temperature Heating- and Cooling-Water Piping: [**100 psig (1034 kPa)**] at [**180 deg F (82**

deg C)].
4. Condenser-Water Piping: [150 psig (1034 kPa)] at [73 deg F (66 deg C)].
5. Glycol Cooling-Water Piping: [150 psig (1034 kPa)] at [150 deg F (66 deg C)].
6. Makeup-Water Piping: [80 psig (552 kPa)][150 psig (1034 kPa)] at [73 deg F (22 deg C)][150 deg F (66 deg C)].
7. Condensate-Drain Piping: [150 deg F (66 deg C)][180 deg F (82 deg C)].
8. Air-Vent Piping: [180 deg F (82 deg C)][200 deg F (93 deg C)].
9. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cambridge-Lee Industries, LLC**]
b. [**Cerro Flow Products, LLC**]
c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [ASTM B88, Type K (ASTM B88M, Type A)][**and**][ASTM B88, Type L (ASTM B88M, Type B)] .

B. Annealed-Temper Copper Tube:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cambridge-Lee Industries, LLC**]
b. [**Cerro Flow Products, LLC**]
c. [**Mueller Streamline Co.; a company of Mueller Industries**]

2. Standard: [ASTM B88, Type K (ASTM B88M, Type A)][**and**][ASTM B88, Type L (ASTM B88M, Type B)] .

C. DWV Copper Tube: ASTM B306, Type DWV.

D. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).

E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
b. [**Mueller Streamline Co.; a company of Mueller Industries**]
c. [**NIBCO INC.**]

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

H. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than **NPS 4 (DN 100)**.

I. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**T-DRILL Industries Inc**]

2. Description: Tee formed in copper tube in accordance with ASTM F2014.

J. Grooved, Mechanical-Joint, Copper Tube Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**SCI; an ASC Engineered Solution**]
d. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
e. [**Star Pipe Products**]
f. [**Victaulic Company**]

2. Source Limitations: Obtain grooved mechanical-joint copper tube appurtenances from single manufacturer.
3. Grooved-End Copper Fittings: **ASTM B75 (ASTM B75M)** copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM gasket rated for minimum [**230 deg F (110 deg C)**] for use with ferrous housing, and steel bolts and nuts; **300 psig (2060 kPa)** minimum CWP pressure rating.

K. Copper-Tube, Pressure-Seal-Joint Fittings - Copper or Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Copper Press Brand; Merit Brass Company**]
c. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
d. [**FNW; Ferguson Enterprises, Inc.**]
e. [**Mueller Streamline Co.; a company of Mueller Industries**]
f. [**NIBCO INC.**]
g. [**Victaulic Company**]
h. [**Viega LLC**]

2. Source Limitations: Obtain copper-tube pressure-seal-joint fittings from single manufacturer.
3. Housing: Copper or bronze.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum **200 psig (1370 kPa)** working pressure rating at **250 deg F (121 deg C)**.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3,"Hydronic Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3, "Hydronic Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Hydronic Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Hydronic Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Hydronic Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.

G. Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**ASC Engineered Solutions**]
d. [**GroovJoint**]
e. [**National Fittings, Inc**]
f. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]

g. [**SCI; an ASC Engineered Solution**]
h. [**Star Pipe Products**]
i. [**Victaulic Company**]

2. Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
3. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Couplings: Ductile- or malleable-iron housing and [**EPDM**][**nitrile**] gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Plain-End Mechanical-Joint Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**NormaGroup**]
c. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
d. [**Victaulic Company**]

2. Source Limitations: Obtain plain-end mechanical-joint couplings from single manufacturer.
3. Housing: ASTM A536, Grade 65-45-12 segmented ductile iron or Type 304 stainless steel.
4. Housing coating: [**None**].
5. Gasket: [**EPDM**][**NBR**] .
6. Sealing Mechanism: Double-lip sealing system or carbon steel case-hardened jaws.
7. Bolts, hex nuts, washers, or lock bars based on manufacturer's design.
8. Minimum Pressure Rating: Equal to that of the joined pipes.

J. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe, Plain Ends: ASTM A312/A312M plain ends, seamless; stainless steel of types and schedules as indicated in Part 3 "Hydronic Piping Applications" Article.

B. Appurtenances for Grooved-End, Stainless Steel Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**ASC Engineered Solutions**]
c. [**National Fittings, Inc**]
d. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]

e. [**SCI; an ASC Engineered Solution**]
f. [**Shurjoint; a brand of Aalbert Integrated Piping Systems (Aalberts Industries)**]
g. [**Star Pipe Products**]
h. [**Victaulic Company**]

2. Source Limitations: Obtain appurtenances for grooved-end stainless steel pipe from single manufacturer.
3. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

a. AWWA C606 for stainless steel pipe dimensions.
b. Stainless steel housing sections.
c. Stainless steel bolts and nuts.
d. EPDM gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: [**600 psig (4137 kPa)**].
2) NPS 10 to NPS 12 (DN 250 to DN 300): [**400 psig (2758 kPa)**].
3) NPS 14 to NPS 24 (DN 350 to DN 600): [**250 psig (1725 kPa)**].

C. Stainless Steel Piping, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**GroovJoint**]
c. [**Merit Brass Company**]
d. [**SCI; an ASC Engineered Solution**]
e. [**Victaulic Company**]
f. [**Viega LLC**]

2. Source Limitations: Obtain stainless steel piping pressure-seal-joint fittings from single manufacturer.
3. Material: ASTM A312/A312M, Type 316, stainless steel, Schedule 10.
4. Fittings: Type O-Rings and Pipe Stop: EPDM.
5. Tools: Manufacturer's special tool.
6. Minimum **300 psig (2070 kPa)** working-pressure rating at **230 deg F (110 deg C)**.

2.5 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F441/F441M, with wall thickness as indicated in "Hydronic Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]
d. [**Uponor Inc.**]

2. Source Limitations: Obtain CPVC plastic pipe from single manufacturer.

3. CPVC Socket Fittings: [**ASTM F438 for Schedule 40**][**and**][**ASTM F439 for Schedule 80**] .

4. CPVC Threaded Fittings: ASTM F437, Schedule 80.

5. CPVC Piping System: ASTM D2846/D2846M, SDR, pipe and socket fittings.

6. CPVC Tubing System: ASTM D2846/D2846M, SDR, tube and socket fittings.

B. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Hydronic Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain PVC plastic pipe from single manufacturer.

3. PVC Socket Fittings: [**ASTM D2466 for Schedule 40**][**and**][**ASTM D2467 for Schedule 80**] .

4. PVC Schedule 80 Threaded Fittings: ASTM D2464.

C. Polypropylene (PP-R and PP-RCT) Pipe:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**aquatherm**]
b. [**Asahi/America**]
c. [**IPEX USA LLC**]
d. [**Nupi Americas**]
e. [**Uponor Inc.**]

2. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe from single manufacturer.
3. Description: ASTM F2389; pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.

a. Polypropylene Fittings: ASTM F2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings to be used for fusion-welded joints between pipe and fittings.
b. Mechanical fittings and transition fittings to be used where transitions are made to other

piping materials or to valves and appurtenances.

c. Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is required.

D. Smoke and Fire Ratings:

1. Where indicated on Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation; field installed.

a. The system is to have a flame-spread classification of less than 25 and smoke-developed rating of less than 50.

b. Pipe, wrap, or insulation as a system to comply with the requirements of CAN/ULC-S102.2, ASTM E84, or UL 2846.

c. For insulation required for thermal and condensation conditions, see Section 230719 "HVAC Piping Insulation."

2.6 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D4024; full-face gaskets suitable for the service, minimum **1/8-inch (3.2-mm)** thick, 60-70 durometer. Provide ASTM A307, Grade B, hex head bolts with washers.

2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Flux: ASTM B813, water flushable.

G. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for CPVC Piping: ASTM F493.

1. Product Data: Verify CPVC welding solvent cement has a VOC content of 490 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

I. Solvent Cements for PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

1. Product Data:

   a. Verify PVC welding solvent cement has a VOC content of 510 g/L or less.
   b. Verify adhesive primer has a VOC content of 550 g/L or less.

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

6. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

7. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

8. Product Data: Verify adhesive primer complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended

exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

J. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the recommended indoor exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

5. Verify adhesive complies with VOC emissions evaluation criteria.

2.8 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Charlotte Pipe and Foundry Company**]
b. [**IPEX USA LLC**]
c. [**Uponor Inc.**]
d. [**Viega LLC**]

2. Source Limitations: Obtain plastic-to-metal transition fittings from single manufacturer.
3. Description: [**CPVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

a. End Connections: One end with threaded brass insert and one solvent-cement-socket [**or threaded**] end.

4. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

D. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**aquatherm**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**IPEX USA LLC**]
   d. [**NIBCO INC.**]
   e. [**Spears Manufacturing Company**]

2. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
3. Brass or copper end and solvent-cement-joint end of union to match pipe in size and material.
4. Description: [**CPVC**][**PVC**] four-part union.

   a. Threaded End: Brass [**or stainless steel**] .
   b. End Connections: Solvent-cement-joint [**or threaded**] plastic end.
   c. Gasket: Rubber O-ring.
   d. Union nut.

2.9 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A.Y. McDonald Mfg. Co.**]
   b. [**Capitol Manufacturing Company**]
   c. [**GF Piping Systems**]
   d. [**HART Industrial Unions, LLC**]
   e. [**Jomar Valve**]
   f. [**Matco-Norca**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. [**Wilkins**]
   i. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE 1079.

4. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**].
5. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used

on pipe sizes greater than **NPS 4 (DN 100)**.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASC Engineered Solutions**]
   b. [**GF Piping Systems**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Wilkins**]
   e. [**Zurn; Zurn Elkay**]

2. Source Limitations: Obtain dielectric flanges from single manufacturer.
3. Standard: ASSE 1079.
4. Description: Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**].
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GF Piping Systems**]
   d. [**GPT Industries, LLC.**]

2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
3. Description: Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: [**150 psig (1035 kPa)**].
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]

c. [**Elster Perfection; Honeywell**]
d. [**GPT Industries, LLC.**]
e. [**Matco-Norca**]
f. [**Precision Plumbing Products**]
g. [**Sioux Chief Manufacturing Company, Inc.**]
h. [**Victaulic Company**]

2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Standard: IAPMO PS 66.
4. Description: Electroplated steel nipple, complying with ASTM F1545.

5. Pressure Rating: Minimum [**300 psig (2070 kPa) at 225 deg F (107 deg C)**].
6. End Connections: Male threaded or grooved.
7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS

A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**], wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

   a. Schedule 5, [**Type 304**]; [**Type 316**]; stainless steel pressure-seal fittings; and pressure-seal joints.
   b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

   a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges, flange-fittings, and flanged joints.
   b. Grooved mechanical joint coupling and fittings; and grooved mechanical joints.
   c. Plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

C. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**]; stainless steel pressure-seal fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

D. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings; and welded and flanged joints**][**grooved mechanical joint coupling and fittings; and grooved mechanical joints**][**plain-end mechanical joint coupling and fittings; and plain-end mechanical joints**] .
3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved, mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

E. Dual-Temperature Heating- and Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**] stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

F. Dual-Temperature Heating and Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and

[**soldered**][**brazed**][**grooved mechanical**] joints.

2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

   a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
   b. Grooved mechanical joint coupling and fittings; and grooved mechanical joints.
   c. Plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

G. Condenser-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**], drawn-temper copper tubing, wrought-copper fittings, and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B, steel pipe; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] , fittings; and [**threaded**][**grooved mechanical**] joints.
3. Stainless Steel Pipe, Plain Ends:

   a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
   b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

H. Condenser-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; fittings and joints as follows:

   a. [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250 cast-iron**][**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
   b. Grooved, mechanical joint coupling and fittings; and grooved mechanical joints.
   c. Plain-end mechanical joint coupling and fittings; and plain-end mechanical joints.

3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] piping and fittings with heat fusion joints.

I. Glycol Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Steel Pipe: [**Schedule 40**]; [**Class 125, cast-iron**][**Class 150, malleable-iron**][**Class 250, cast-iron**][**Class 300, malleable-iron**] fittings; and threaded joints.
3. Stainless Steel Pipe, Plain Ends:

    a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe: [**Schedule 40**], CPVC plastic pipe and fittings and solvent-welded joints.
5. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
6. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.

J. Glycol Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**grooved mechanical**] joints.
2. Steel Pipe: [**Schedule 40**], Grade B; [**wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings; and welded and flanged joints**][**grooved, mechanical joint coupling and fittings; and grooved mechanical joints**][**plain-end mechanical joint coupling and fittings; and plain-end mechanical joints**] .
3. Stainless Steel Pipe, Plain Ends: [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

4. CPVC Plastic Pipe.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive or flanged joints.
6. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

K. Makeup-Water Piping Installed Aboveground to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**mechanical grooved**][**mechanically formed tee**] joints.
2. Stainless Steel Pipe:

    a. Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.
    b. [**Schedule 10**][**Schedule 40**], [**Type 304**]; [**Type 304**], grooved mechanical joint coupling and fittings; and grooved mechanical joints.

3. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.
5. Fiberglass Pipe and Fittings: RTRP and RTRF with adhesive joints.

L. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

1. Drawn-Temper Copper Tube: [**Type K (Type A)**][**Type L (Type B)**][**Type DWV**]; wrought-copper fittings; and [**soldered**][**brazed**][**pressure-seal**][**grooved mechanical**][**mechanically formed tee**] joints.
2. Stainless Steel Pipe, Plain Ends: Schedule 5, [**Type 304**]; [**Type 316**], stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

3. CPVC Plastic Pipe: [**Schedule 40**]; CPVC plastic fittings; and solvent-welded joints.
4. Polypropylene (PP-R and PP-RCT) Pipe: [**PP-R**][**PP-RCP**] plastic piping and fittings with heat fusion joints.

M. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, in accordance with piping manufacturer's written instructions.
2. Outlet: **Type K (Type A)**, annealed-temper copper tubing with soldered or flared joints.

N. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, in accordance with piping manufacturer's written instructions.

3.2 INSTALLATION OF HYDRONIC PIPING

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles below.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, **NPS 3/4 (DN 20)** ball valve, and short **NPS 3/4 (DN 20)** threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install hydronic closed-loop piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Install cooling coil condensate-drain piping at a minimum one percent downward slope, **1/8 inch per foot (10.4 mm per m)** horizontal run or as required by code whichever is more stringent.

P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Q. Install branch connections to mains using [**mechanically formed**] tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

R. Install valves in accordance with Section 230523 "General-Duty Valves for HVAC Piping."

S. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."

T. Install unions in piping, [**NPS 2 (DN 50)**] and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

U. Install flanges in piping, [**NPS 2-1/2 (DN 65)**] and larger, at final connections of equipment and elsewhere as indicated.

V. Install shutoff valve immediately upstream of each dielectric fitting.

W. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

X. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

BB. Joint Construction, General:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3.3 INSTALLATION OF COPPER TUBE AND FITTINGS

A. Joint Construction:

1. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
2. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves

in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings

4. Mechanically Formed Tee Fittings: Use manufacturer-recommended tools, procedure, and brazed joints.

5. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF STEEL PIPE AND FITTINGS

A. Joint Construction:

1. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

2. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
3. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

4. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings

5. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions

3.5 INSTALLATION OF STAINLESS STEEL PIPE AND FITTINGS

A. Joint Construction:

1. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

2. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.6 INSTALLATION OF PLASTIC PIPE AND FITTINGS

A. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe, and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
4. PVC Nonpressure Piping: Join in accordance with ASTM D2855.

3.7 INSTALLATION OF FIBERGLASS PIPE AND FITTINGS

A. Joint Construction:

1. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
2. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

3.8 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

1. Dielectric Unions: For [**NPS 2 (DN 50) and smaller**][**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] .
2. Dielectric Flanges: For **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**.
3. Dielectric-Flange Insulating Kits: For [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**][**NPS 5 (DN 125) and larger**] .

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Metal Tube or Pipe:

1. Install hangers for with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of metal tube or pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Plastic Pipe:

1. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
2. Support vertical runs of plastic piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Fiberglass Pipe:

1. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and

authorities having jurisdiction requirements, whichever are most stringent.

2. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within [**12 inches (300 mm)**] of each fitting and coupling.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.12 SYSTEM STARTUP

A. System Startup Preparation: Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.13 FIELD QUALITY CONTROL

A. Test Preparation: Prepare hydronic piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to

protect against damage by expanding liquid or other source of overpressure during test.

B. Piping Tests: Perform the following tests on hydronic piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

END OF SECTION 23 21 13 00

Task	Specification	Specification Description
23 21 13 23	21 05 00 00	Common Work Results for Fire Suppression
23 21 13 23	22 05 00 00	Common Work Results for Plumbing
23 21 13 23	22 11 16 00	Domestic Water Piping
23 21 13 23	22 13 16 00	Sanitary Waste And Vent Piping
23 21 13 23	22 14 13 00	Storm Drainage Piping
23 21 13 23	22 15 13 00	General-Service Compressed-Air Piping
23 21 13 23	22 63 13 00	Gas Piping For Laboratory And Healthcare Facilities
23 21 13 23	23 05 00 00	Common Work Results for HVAC
23 21 13 23	23 11 23 00	Facility Natural-Gas Piping
23 21 13 23	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
23 21 13 23	23 21 13 00	Hydronic Piping
23 21 13 23	22 11 16 00a	Steam And Condensate Piping
23 21 13 23	23 23 00 00	Refrigerant Piping
23 21 13 23	33 05 00 00	Common Work Results For Utilities
23 21 13 23	33 11 13 00a	Potable Water Supply Wells
23 21 13 23	33 31 00 00	Site Sanitary Sewerage Piping
23 21 13 23	33 32 00 00	Site Packaged Sewage Pumping Stations

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SECTION 23 21 16 00 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air vents.
3. Expansion tanks and fittings.
4. Air/dirt separators and purgers.
5. Strainers.
6. Flexible connectors.

B. Related Requirements:

1. Section 230500 "Common Work Results for HVAC" for expansion fittings and loops.
2. Section 230523 "General-Duty Valves for HVAC Piping" for specification and installation requirements for general-duty valves common to most piping systems.
3. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII,

Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   c. [**Armstrong Fluid Technology**]
   d. [**Bell & Gossett; a Xylem brand**]
   e. [**Flamco; a division of AALBERTS Ind.**]
   f. [**Gerand Engineering Co**]
   g. [**Griswold Controls, LLC**]
   h. [**Hays Fluid Controls**]
   i. [**HCI; Hydronics Components Inc.**]
   j. [**IMI Flow Design, Inc.**]
   k. [**Jenkins Valves; a Crane Co. brand**]
   l. [**Jomar Valve**]
   m. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
   n. [**NIBCO INC.**]
   o. [**NuTech Hydronic Specialty Products**]
   p. [**Oventrop Corporation**]
   q. [**Red-White Valve Corp.**]
   r. [**Taco Comfort Solutions**]
   s. [**Tour & Andersson; available through Victaulic Company**]
   t. [**Tunstall Corporation**]
   u. [**Victaulic Company**]
   v. [**WATTS; A Watts Water Technologies Company**]

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum **125 psig (860 kPa)**.
10. Maximum Operating Temperature: **250 deg F (121 deg C)**.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**Armstrong Fluid Technology**]
d. [**ASC Engineered Solutions**]
e. [**Bell & Gossett; a Xylem brand**]
f. [**Flamco; a division of AALBERTS Ind.**]
g. [**Gerand Engineering Co**]
h. [**Griswold Controls, LLC**]
i. [**Hammond Valve**]
j. [**Hays Fluid Controls**]
k. [**HCI; Hydronics Components Inc.**]
l. [**IMI**]
m. [**IMI Flow Design, Inc.**]
n. [**Jenkins Valves; a Crane Co. brand**]
o. [**Jomar Valve**]
p. [**KITZ Corporation**]
q. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
r. [**NIBCO INC.**]
s. [**NuTech Hydronic Specialty Products**]
t. [**Oventrop Corporation**]
u. [**Red-White Valve Corp.**]
v. [**Tour & Andersson; available through Victaulic Company**]
w. [**Tunstall Corporation**]
x. [**Victaulic Company**]
y. [**WATTS; A Watts Water Technologies Company**]

2. Body: Cast-iron or steel body, ball, butterfly, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass- and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum **125 psig (860 kPa)**.
11. Maximum Operating Temperature: **250 deg F (121 deg C)**.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**Caleffi North America**]
d. [**Jenkins Valves; a Crane Co. brand**]
e. [**Keckley Company**]
f. [**NIBCO INC.**]
g. [**Oventrop Corporation**]
h. [**Spence Engineering Company, Inc**]
i. [**Taco Comfort Solutions**]
j. [**Victaulic Company**]

k. [**WATTS; A Watts Water Technologies Company**]
l. [**Zurn; Zurn Elkay**]

2. Body: Bronze or brass.
3. Disc: [**Brass**][**EPDM**] .
4. Seat: [**Brass**][**Steel**] .
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPDM.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size and Capacity: As indicated on Drawings.
11. Operating Pressure: Factory set and field adjustable.

D. Diaphragm-Operated Pressure-Relief Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**Flamco; a division of AALBERTS Ind.**]
d. [**Keckley Company**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn; Zurn Elkay**]

2. Body: Bronze or brass.
3. Disc: [**Brass**][**Steel**] .
4. Seat: [**Brass**][**Steel**] .
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPDM.
7. Valve Seat and Stem: Noncorrosive.
8. Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC, Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anvil; an ASC Engineered Solution**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Caleffi North America**]
e. [**Flamco; a division of AALBERTS Ind.**]
f. [**Flowcon Americas LLC**]
g. [**Griswold Controls, LLC**]
h. [**Hays Fluid Controls**]

i. [**HCI; Hydronics Components Inc.**]
j. [**IMI**]
k. [**IMI Flow Design, Inc.**]
l. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
m. [**NIBCO INC.**]
n. [**NuTech Hydronic Specialty Products**]
o. [**Oventrop Corporation**]
p. [**Red-White Valve Corp.**]
q. [**Spence Engineering Company, Inc**]
r. [**Tunstall Corporation**]
s. [**Victaulic Company**]
t. [**WATTS; A Watts Water Technologies Company**]

2. Body: Brass or ferrous metal.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than capacity of device being served.
6. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
7. Minimum CWP Rating: [**175 psig (1207 kPa)**][**300 psig (2070 kPa)**] .
8. Maximum Operating Temperature: [**200 deg F (93 deg C)**][**250 deg F (121 deg C)**] .

2.2 AIR VENTS

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**Caleffi North America**]
d. [**Flamco; a division of AALBERTS Ind.**]
e. [**HCI; Hydronics Components Inc.**]
f. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
g. [**NuTech Hydronic Specialty Products**]
h. [**Taco Comfort Solutions**]
i. [**WATTS; A Watts Water Technologies Company**]

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: **NPS 1/2 (DN 15)**.
6. Discharge Connection: **NPS 1/8 (DN 6)**.
7. CWP Rating: **150 psig (1035 kPa)**.
8. Maximum Operating Temperature: **225 deg F (107 deg C)**.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
b. [**Bell & Gossett; a Xylem brand**]
c. [**Caleffi North America**]
d. [**Flamco; a division of AALBERTS Ind.**]
e. [**Flo Fab Inc**]
f. [**Metraflex Company (The)**]
g. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
h. [**NuTech Hydronic Specialty Products**]
i. [**Oventrop Corporation**]
j. [**Spirotherm, Inc.**]
k. [**Taco Comfort Solutions**]
l. [**WATTS; A Watts Water Technologies Company**]

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: **NPS 1/2 (DN 15)**.
6. Discharge Connection: **NPS 1/4 (DN 8)**.
7. CWP Rating: **150 psig (1035 kPa)**.
8. Maximum Operating Temperature: **240 deg F (116 deg C)**.

2.3 EXPANSION TANKS AND FITTINGS

A. Expansion Tanks with Direct Air/Water Interface:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AMTROL, Inc.**]
b. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
c. [**Armstrong Fluid Technology**]
d. [**Bell & Gossett; a Xylem brand**]
e. [**Flo Fab Inc**]
f. [**Taco Comfort Solutions**]
g. [**WATTS; A Watts Water Technologies Company**]

2. Tank: Welded steel, rated for **125 psig (860 kPa)** working pressure and **375 deg F (191 deg C)** maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gauge glass. Tanks are factory tested after taps are fabricated and labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless steel ball check, **100 gal. (379 L)** unit only; sized for expansion tank diameter. Provide tank fittings for **125 psig (860 kPa)** working pressure and **250 deg F (121 deg C)** maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; **125 psig (860 kPa)** working pressure and **240 deg F (116 deg C)** maximum operating temperature; constructed to admit air to

expansion tank, drain water, and close off system.

5. Gauge Glass: Full height with dual manual shutoff valves, [**3/4-inch- (20-mm-)**] diameter gauge glass, and slotted-metal glass guard.

B. Diaphragm-Type ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**AMTROL, Inc.**]
   b. [**Armstrong Fluid Technology**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]
   e. [**Taco Comfort Solutions**]
   f. [**WATTS; A Watts Water Technologies Company**]

2. Tank: Welded steel, rated for **125 psig (860 kPa)** working pressure and **375 deg F (191 deg C)** maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

C. Bladder-Type ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**AMTROL, Inc.**]
   b. [**Armstrong Fluid Technology**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Flo Fab Inc**]
   e. [**Taco Comfort Solutions**]
   f. [**WATTS; A Watts Water Technologies Company**]

2. Tank: Welded steel, rated for **125 psig (860 kPa)** working pressure and **240 deg F (116 deg C)** maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. [**Field-replaceable bladder.**]
4. Accessory: Sight glass.
5. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Diaphragm-Type Non-ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**AMTROL, Inc.**]
   b. [**Armstrong Fluid Technology**]

c. [**Bell & Gossett; a Xylem brand**]
d. [**Caleffi North America**]
e. [**Flamco; a division of AALBERTS Ind.**]
f. [**Flo Fab Inc**]
g. [**Taco Comfort Solutions**]
h. [**WATTS; A Watts Water Technologies Company**]
i. [**Zurn; Zurn Elkay**]

2. Tank: Carbon steel, non-ASME constructed, rated for minimum **100 psig (690 kPa)** working pressure at minimum **200 deg F (93 deg C)** maximum operating temperature.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR/DIRT SEPARATORS AND PURGERS

A. Coalescing-Type Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AMTROL, Inc.**]
b. [**Armstrong Fluid Technology**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Caleffi North America**]
e. [**Flamco; a division of AALBERTS Ind.**]
f. [**Flo Fab Inc**]
g. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
h. [**Spirotherm, Inc.**]
i. [**Taco Comfort Solutions**]

2. Tank: Fabricated steel tank; ASME constructed and stamped for **125 psig (862 kPa)** working pressure and **270 deg F (130 deg C)** maximum operating temperature.

3. Coalescing Medium: [**Copper**][**Stainless steel**].
4. Air Vent: Threaded to top of separator.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for **NPS 2-1/2 (DN 65)** and larger.
6. Blowdown Connection: Threaded to bottom of separator.
7. Size: Match system flow capacity.

B. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AMTROL, Inc.**]
b. [**Armstrong Fluid Technology**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Flamco; a division of AALBERTS Ind.**]

e. [**Flo Fab Inc**]
f. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
g. [**Spirotherm, Inc.**]
h. [**Taco Comfort Solutions**]

2. Tank: Welded steel; ASME constructed and labeled for **125 psig (860 kPa)** minimum working pressure and **375 deg F (191 deg C)** maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged connections for **NPS 2-1/2 (DN 65)** and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

C. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**AMTROL, Inc.**]
b. [**Armstrong Fluid Technology**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Caleffi North America**]
e. [**Flamco; a division of AALBERTS Ind.**]
f. [**Flo Fab Inc**]
g. [**Spirotherm, Inc.**]
h. [**Taco Comfort Solutions**]
i. [**WATTS; A Watts Water Technologies Company**]

2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Working Pressure: Up to **175 psig (1207 kPa)**.
4. Maximum Operating Temperature: Up to **300 deg F (149 deg C)**.

D. Air Purgers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bell & Gossett; a Xylem brand**]
b. [**Griswold Controls, LLC**]
c. [**Spirotherm, Inc.**]
d. [**Taco Comfort Solutions**]
e. [**WATTS; A Watts Water Technologies Company**]

2. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
3. Maximum Working Pressure: **150 psig (1035 kPa)**.
4. Maximum Operating Temperature: **250 deg F (121 deg C)**.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**ASC Engineered Solutions**]
   c. [**Caleffi North America**]
   d. [**Flexicraft Industries**]
   e. [**Flo Fab Inc**]
   f. [**FNW; Ferguson Enterprises, Inc.**]
   g. [**Griswold Controls, LLC**]
   h. [**Hays Fluid Controls**]
   i. [**Keckley Company**]
   j. [**Metraflex Company (The)**]
   k. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
   l. [**Titan Flow Control, Inc.**]
   m. [**Victaulic Company**]
   n. [**WATTS; A Watts Water Technologies Company**]
   o. [**Zurn; Zurn Elkay**]

2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.

4. Strainer Screen: Stainless steel, [**20**][**40**][**60**] -mesh strainer, or perforated stainless steel basket.
5. CWP Rating: **125 psig (860 kPa)**.

B. Basket Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexicraft Industries**]
   b. [**Flo Fab Inc**]
   c. [**Keckley Company**]
   d. [**Metraflex Company (The)**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn; Zurn Elkay**]

2. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for **NPS 2 (DN 50)** and smaller; flanged ends for **NPS 2-1/2 (DN 65)** and larger.
4. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 50 percent free area.
5. CWP Rating: **125 psig (860 kPa)**.

C. T-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Apollo Valves; a brand of Aalberts Integrated Piping Systems (Aalberts Industries)**]
   b. [**ASC Engineered Solutions**]
   c. [**Keckley Company**]
   d. [**WATTS; A Watts Water Technologies Company**]

2. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
3. End Connections: Grooved ends.
4. Strainer Screen: [**40**][**60**] -mesh startup strainer and perforated stainless steel basket with 57 percent free area.
5. CWP Rating: **750 psig (5170 kPa)**.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ASC Engineered Solutions**]
   b. [**Flexicraft Industries**]
   c. [**Flo Fab Inc**]
   d. [**Metraflex Company (The)**]

2. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of **3/4-inch (20-mm)** misalignment.
5. CWP Rating: **150 psig (1035 kPa)**.
6. Maximum Operating Temperature: **250 deg F (121 deg C)**.

B. Spherical, Rubber, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexicraft Industries**]
   b. [**Flo Fab Inc**]
   c. [**Metraflex Company (The)**]

2. Body: Fiber-reinforced rubber body.
3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

4. Performance: Capable of misalignment.
5. CWP Rating: **150 psig (1035 kPa)**.
6. Maximum Operating Temperature: **250 deg F (121 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads on all devices for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Install at each branch connection to return main.
2. Install in the return pipe of each heating and cooling terminal.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Install at each branch connection to return main.
2. Install in the return pipe of each heating and cooling terminal.

C. Automatic Flow-Control Valves:

1. Install at each branch connection to return main.
2. Install in the return pipe of each heating and cooling terminal.

D. Diaphragm-Operated, Pressure-Reducing Valves: Install at makeup-water connection to regulate system fill pressure.

E. Diaphragm-Operated Pressure-Relief Valves: Install at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 INSTALLATION OF AIR VENTS

A. Manual Air Vents: Install at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Automatic Air Vents: Install at high points of system piping in mechanical equipment rooms only.

1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.

3.4 INSTALLATION OF AIR/DIRT SEPARATORS AND PURGERS

A. Coalescing-Type Air and Dirt Separators: Install in pump suction piping.

B. Tangential-Type Air Separators: Install in pump suction piping. Install blowdown piping with gate or full-port ball valve full size of separator outlet; extend full size to nearest floor drain.

C. In-Line Air Separators: Install in pump suction piping. Install drain valve on air separators **NPS 2 (DN 50)** and larger.

D. Air Purgers: Install in pump suction piping.

3.5 INSTALLATION OF EXPANSION TANKS AND FITTINGS

A. Expansion Tanks with Direct Air/Water Interface: Install above the air separator or air purger. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus tank full of water. Do not overload building components and structural members.
3. Install piping from air separator or air purger to expansion tank with a 2 percent upward slope toward tank to avoid air entrapment.

B. Diaphragm-Type ASME Expansion Tanks: Install on concrete pad on the floor.

C. Bladder-Type ASME Expansion Tanks: Install on concrete pad on the floor.

D. Diaphragm-Type Non-ASME Expansion Tanks: Install on concrete pad on the floor.

E. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 23 21 16 00

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Task	Specification	Specification Description
23 21 16 00	21 05 00 00	Common Work Results for Fire Suppression
23 21 16 00	22 05 00 00	Common Work Results for Plumbing
23 21 16 00	22 15 13 00	General-Service Compressed-Air Piping
23 21 16 00	23 05 00 00	Common Work Results for HVAC
23 21 16 00	23 21 13 00	Hydronic Piping
23 21 16 00	23 21 23 00	Hydronic Pumps
23 21 16 00	22 11 16 00a	Steam And Condensate Piping
23 21 16 00	23 23 00 00	Refrigerant Piping
23 21 16 00	23 43 00 00	Electronic Air Cleaners

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SECTION 23 21 23 00 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
4. Separately coupled, vertically mounted, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
6. Separately coupled, base-mounted, double-suction centrifugal pumps.
7. Separately coupled, vertically mounted, double-suction centrifugal pumps.
8. Separately coupled, vertically mounted, turbine centrifugal pumps.
9. Wet-rotor pumps.
10. Automatic condensate pump units.

1.2 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For each pump.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

    a. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
    b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: [**One**]<**Insert number**> mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**].

C. Seismic Performance: Pumps shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Crane Pumps & Systems**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Crane Pumps & Systems**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet[**, replaceable**

bronze wear rings,] and threaded [**companion-flange**][**union-end**] connections.

2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: [**Bronze**][**Type 304 stainless steel**].
4. Pump Stub Shaft: [**Type 304**][**Type 316**] stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> rubber bellows and gasket. Include water slinger on shaft between motor and seal.
6. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.

F. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure : [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

   a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**Lancaster Pump**]
10. [**Mepco, LLC**]
11. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
12. [**Patterson Pump Company; a Gorman-Rupp company**]
13. [**Peerless Pump Company**]
14. [**Scot Pump; a division of Ardox Corporation**]
15. [**Taco Comfort Solutions**]
16. [**Thrush Co. Inc.**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**Lancaster Pump**]
10. [**Mepco, LLC**]
11. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
12. [**Patterson Pump Company; a Gorman-Rupp company**]
13. [**Peerless Pump Company**]
14. [**Scot Pump; a division of Ardox Corporation**]
15. [**Taco Comfort Solutions**]
16. [**Thrush Co. Inc.**]
17. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and [**threaded companion-flange**][**flanged**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: [**Bronze**][**Type 304 stainless steel**].
4. Pump Stub Shaft: [**Type 304**][**Type 316**] stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a

stainless steel spring, and [**NBR**][**EPDM**][**FKM**] bellows and gasket. Include water slinger on shaft between motor and seal.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

G. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

   a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Flowserve Corporation**]
4. [**ITT Corporation**]
5. [**Mepco, LLC**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Scot Pump; a division of Ardox Corporation**]
8. [**Taco Comfort Solutions**]
9. [**Thrush Co. Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Flowserve Corporation**]
4. [**ITT Corporation**]
5. [**Mepco, LLC**]
6. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
7. [**Scot Pump; a division of Ardox Corporation**]
8. [**Taco Comfort Solutions**]
9. [**Thrush Co. Inc.**]
10. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, and threaded [**companion-flange**][**union-end**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Pump Bearings: [**Permanently lubricated ball bearings**][**Grease lubricated ball bearings**].

F. Shaft Coupling: [**Molded-rubber insert with interlocking spider**][**Interlocking frame with interconnecting springs**] capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure Type: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.

7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Crane Pumps & Systems**]
4. [**Flowserve Corporation**]
5. [**ITT Corporation**]
6. [**Mepco, LLC**]
7. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
8. [**Patterson Pump Company; a Gorman-Rupp company**]
9. [**Peerless Pump Company**]
10. [**Taco Comfort Solutions**]
11. [**Thrush Co. Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**Crane Pumps & Systems**]
4. [**Flowserve Corporation**]
5. [**ITT Corporation**]
6. [**Mepco, LLC**]
7. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
8. [**Patterson Pump Company; a Gorman-Rupp company**]
9. [**Peerless Pump Company**]
10. [**Taco Comfort Solutions**]
11. [**Thrush Co. Inc.**]
12. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet[**, replaceable bronze wear rings,**] and threaded [**companion-flange**][**union-end**] connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.

F. Shaft Coupling: [**Molded-rubber insert with interlocking spider**][**Interlocking frame with interconnecting springs**] capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

   a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.6 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]

4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Scot Pump; a division of Ardox Corporation**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Scot Pump; a division of Ardox Corporation**]
12. [**Taco Comfort Solutions**]
13. [**Thrush Co. Inc.**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and [**threaded companion-flange**][**flanged**] connections.[**Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon steel, with copper-alloy shaft sleeve**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. [**Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor**][**EPDM coupling sleeve for variable-speed applications**].

G. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

H. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

I. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

J. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.7 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]

7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Scot Pump; a division of Ardox Corporation**]
13. [**Taco Comfort Solutions**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Crane Pumps & Systems**]
6. [**Flowserve Corporation**]
7. [**GRUNDFOS CBS Inc.**]
8. [**ITT Corporation**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Patterson Pump Company; a Gorman-Rupp company**]
11. [**Peerless Pump Company**]
12. [**Scot Pump; a division of Ardox Corporation**]
13. [**Taco Comfort Solutions**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

E. Pump Construction:

1. Casing: [**Radially**][**Horizontally**] split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, [**Class 125**][**Class 250**] flanges.[**Casing supports shall allow removal and replacement of impeller without disconnecting piping.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Type 304**][**Type 316**] stainless steel.
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. [**Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor**][**EPDM coupling sleeve for variable-speed applications**].

G. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

H. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

I. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

J. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

   a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.8 SEPARATELY COUPLED, VERTICALLY MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Pentair Water Commercial Pool and Aquatics**]
12. [**Taco Comfort Solutions**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Armstrong Fluid Technology**]
3. [**Aurora Pump; Pentair Ltd.**]
4. [**Buffalo Pumps, Inc**]
5. [**Flowserve Corporation**]
6. [**GRUNDFOS CBS Inc.**]
7. [**ITT Corporation**]
8. [**Mepco, LLC**]
9. [**PACO Pumps; Grundfos Pumps Corporation, USA**]
10. [**Peerless Pump Company**]
11. [**Pentair Water Commercial Pool and Aquatics**]
12. [**Taco Comfort Solutions**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

E. Pump Construction:

1. Casing: Radially split, cast iron, with[**replaceable bronze wear rings,**] threaded gauge tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, [**Class 125**][**Class 250**] flanges.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Type 304 stainless steel**][**Type 316 stainless steel**]<**Insert material**>.
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**]<**Insert material**> bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

F. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**175 psig (1204 kPa)**][**250 psig (1720 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**250 deg F (120 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.9 SEPARATELY COUPLED, VERTICALLY MOUNTED, TURBINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American-Marsh Pumps**]
2. [**Flowserve Corporation**]
3. [**Peerless Pump Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American-Marsh Pumps**]
2. [**Flowserve Corporation**]
3. [**Peerless Pump Company**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, [**single-stage**][**multistage**], centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump.

E. Pump Construction:

1. Pump Bowl: Cast iron, with [**cone**][**basket**] strainer[**, replaceable bronze wear ring,**] and suction bell.[**Water passages of intermediate bowls shall be coated with porcelain enamel.**]
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: [**Carbon**][**Type 304 stainless**][**Type 316 stainless**] steel sized in accordance with manufacturer's written instructions.
4. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings in cast-iron housing.
5. Pump Column: ASTM A53/A53M, Grade B steel pipe.
6. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and [**NBR**][**EPDM**][**FKM**] bellows and gasket. Include water

slinger on shaft between motor and seal.

7. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

F. Shaft Coupling: Keyed with locking collets.

G. Discharge Head: ASME B16.1, [**Class 125**][**Class 250**] discharge flange with threaded gauge tapping. Top of discharge head shall have a registered fit to accurately locate the driver.

H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: [**Totally enclosed, fan cooled**]<**Insert enclosure type**>.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. [**Single**][**Variable**]-speed motor.
6. Provide integral pump motor variable-speed controller.
7. <**Insert unique motor characteristics**>.

I. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Minimum Static Head: <**Insert feet (kPa)**>.
4. Maximum Operating Pressure: [**175 psig (1204 kPa)**]<**Insert value**>.
5. Maximum Continuous Operating Temperature: [**200 deg F (93 deg C)**]<**Insert temperature**>.
6. Outlet Size: <**Insert NPS (DN)**>.
7. Impeller Size: <**Insert inches (mm)**>.
8. Motor Speed: <**Insert rpm**>.
9. Motor Horsepower: <**Insert value**>.
10. Electrical Characteristics:

    a. Volts: [**120**][**240**][**208**][**460**]<**Insert value**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: <**Insert value**> A.
    e. Minimum Circuit Ampacity: <**Insert value**> A.
    f. Maximum Overcurrent Protection: <**Insert value**> A.

2.10 WET-ROTOR PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Fluid Technology**]
2. [**Flowserve Corporation**]
3. [**GRUNDFOS CBS Inc.**]
4. [**ITT Corporation**]
5. [**Taco Comfort Solutions**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Fluid Technology**]
2. [**Flowserve Corporation**]
3. [**GRUNDFOS CBS Inc.**]
4. [**ITT Corporation**]
5. [**Taco Comfort Solutions**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pumps from single source from single manufacturer.

D. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.

E. Pump Construction:

1. Body: [**100 percent lead-free bronze**][**Type 304 stainless steel**][**Cast iron**].
2. Impeller: [**Polypropylene**][**Noryl**][**Type 304 stainless steel**].
3. Pump Shaft: [**Ceramic**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Bearings. Double-sintered carbon.

F. Motor: [**Single**][**Three**][**Variable**] speed.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Efficiency: Premium Efficiency.
   b. NEMA Design: <**Insert designation**>.
   c. Service Factor: <**Insert value**>.

3. Integral pump motor variable-speed control.
4. ECM.

G. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Total Dynamic Head: <**Insert feet (kPa)**>.
3. Maximum Operating Pressure: [**150 psig (1132 kPa)**]<**Insert value**>.
4. Maximum Continuous Operating Temperature: [**225 deg F (107 deg C)**][**230 deg F (111 deg C)**]<**Insert temperature**>.
5. Inlet and Outlet Size: <**Insert NPS (DN)**>.
6. Impeller Size: <**Insert inches (mm)**>.
7. Motor Speed: <**Insert rpm**>.
8. Motor Horsepower: <**Insert value**>.
9. Electrical Characteristics:

   a. Volts: [**120**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.

f. Maximum Overcurrent Protection: <**Insert value**> A.

2.11 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Beckett Corporation**]
2. [**Crane Pumps & Systems**]
3. [**GRUNDFOS CBS Inc.**]
4. [**Hartell Pumps; Milton Roy**]
5. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Beckett Corporation**]
2. [**Crane Pumps & Systems**]
3. [**GRUNDFOS CBS Inc.**]
4. [**Hartell Pumps; Milton Roy**]
5. [**Little Giant; a brand of Franklin Electric Co., Inc.**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pump units from single source from single manufacturer.

D. Description: Packaged units with corrosion-resistant pump, [**aluminum**][**plastic**] tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and **72-inch- (1800-mm-)** minimum, electrical power cord with plug.

E. Capacities and Characteristics:

1. Tank Capacity: <**Insert gal (L)**>.
2. Pump Capacity: <**Insert gpm (L/s)**>.
3. Maximum Lift: <**Insert feet (m)**>.
4. Motor Horsepower: <**Insert value**>.
5. Electrical Characteristics:

a. Volts: [**120**]<**Insert value**> V.
b. Phase: Single.
c. Hertz: 60 Hz.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.12 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. [**175-psig (1204-kPa)**][**300-psig (2060-kPa)**] pressure rating, [**cast**][**ductile**]-iron body and end

cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and [**bronze**][**Type 304 stainless steel**] permanent strainers with **3/16-inch (4.8-mm) perforations and 51 percent open area)**.
4. [**Bronze**][**Carbon steel**][**Type 304 stainless steel**] straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. [**175-psig (1204-kPa)**][**300-psig (2060-kPa)**] pressure rating, [**cast**][**ductile**]-iron body, pump-discharge fitting.
3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
4. Brass valve disc with EPDM rubber seat.
5. Type 304 stainless steel valve stem.
6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
7. Brass gauge ports with integral check valve and orifice for flow measurement.

2.13 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.

1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: [**Modbus RTU**][**BACnet MS/TP**][**Metasys N2**].
3. Commissioning and pump set up access to pump controls via the following:

   a. A web interface (data exchange).
   b. A user interface located on the face of speed controller to adjust modes and mode values.
   c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.

4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:

   a. Manual (via user interface or HTML).
   b. Remote via 0 to 10 V dc.
   c. Data protocol communications with the BMS.

5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.
7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
8. Pump capable of being monitored continuously via integrated Internet link.
9. Integrated pump controller system to have the following features:

   a. Controller software shall be capable of sensorless control in variable-volume systems without need for pump-mounted (internal/external) or remotely mounted differential

pressure sensor.

b. Integrated Pump Controller Sensorless Control: Operates under Quadratic Pressure Control (QPC) to ensure that head reduction with reducing flow conforms to quadratic control curve.

c. Controller:

1) Minimum head of 40 percent of design duty head.
2) User-adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

d. Controller Integrated Control Software:

1) Capable of controlling pump performance for non-overloading power at every point of operation.
2) Capable of maintaining flow rate data.

2.14 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Provide pumps so they are specified or scheduled with ECM.

1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with [**HI 1.4**][**and**][**HI 2.4**].

B. Install pumps to provide access for periodic maintenance including removing motors, impellers,

couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Equipment Mounting for In-Line Pumps Suspended from Structure: Install in-line pumps with continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install [**check, shutoff, and throttling valves**][**check valve and throttling valve with memory stop**][**triple-duty valve**] on discharge side of pumps.

F. Install [**Y-type strainer**][**suction diffuser**] and shutoff valve on suction side of pumps.

1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

I. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Hydronic pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23 00

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Task	Specification	Specification Description
23 21 23 13	23 21 23 00	Hydronic Pumps
23 21 23 16	23 21 23 00	Hydronic Pumps
23 21 23 23	23 21 23 00	Hydronic Pumps
23 21 29 00	23 21 23 00	Hydronic Pumps

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SECTION 23 22 00 00 - UNDERGROUND STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. Fiberglass pipe and fittings.
3. Preengineered conduit piping system.
4. Loose-fill insulation.

1.2 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than **15 psig (104 kPa)** as defined by ASME B31.1.

B. Invert: Vertical distance from Project datum reference point to bottom of interior pipe surface.

C. LP Systems: Low-pressure piping operating at **15 psig (104 kPa)** or less as defined by ASME B31.1.

D. Reinforced, Thermosetting Resin Fitting (RTRF): Fittings fabricated of composite materials, largely consisting of a reinforcement material embedded in, or surrounded by, cured thermosetting resin. Most common form of reinforced thermosetting resin pipe is one in which fiberglass strands form reinforcement.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: For underground steam and condensate distribution piping. Signed and sealed by a qualified professional engineer.

1. Include calculations showing requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
3. Show pipe sizes, locations, inverts, and pitch. Show piping in trench and piping in conduit, with details showing clearances between piping.
4. Show insulation thickness.

C. Delegated Design Submittals: For underground steam and condensate piping systems indicated to comply with performance requirements and design criteria, including analysis data and design drawings signed and sealed by the professional engineer responsible for their preparation.

1. Include design calculations and details for selecting thermal expansion and thrust restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from steam distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and at vertical scale of not less than **1 inch equals 5 feet (1:50)**.

1. Show locations and inverts of utility system manholes and piping. Show types, sizes, materials, and inverts of other utilities crossing steam distribution piping.
2. Show depth of cover from top of steam distribution system piping to finished grade.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Material Test Reports: For conduit piping, by a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Fiberglass Pipe and Fitting Installers: Provide RTRF and RTRP pipe installation by technicians certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in [**ASME B31.9**][**ASME B31.1**].
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance:

1. Comply with [**ASME B31.9**][**ASME B31.1**] for materials, products, and installation.
2. Provide safety valves and pressure vessels bearing appropriate ASME labels.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.7 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing steam and condensate piping systems with the following minimum working-pressure ratings:

1. HP Steam Piping: <**Insert psig (kPa)**>.
2. LP Steam Piping: <**Insert psig (kPa)**>.
3. Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design underground steam and condensate piping systems, including restraints and anchors.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, black with plain ends; wall thickness as indicated in "Piping Application" Article.

B. Cast-Iron, Threaded Fittings: ASME B16.4, standard pattern, with threads in accordance with ASME B1.20.1; Classes 125, 150, and 300 as indicated in "Piping Application" Article.

C. Malleable-Iron, Threaded Fittings: ASME B16.3, ASME B1.20.1; Classes 150 and 300 as indicated in "Piping Application" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Application" Article.

E. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

F. Steel Welding Fittings: [**ASME B16.9**][**and**][**ASTM A234/A234M**], seamless or welded.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Nipples: ASTM A733, standard weight, seamless, carbon-steel pipe complying with ASTM A53/A53M.

H. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised face, Class 250, cast-iron and steel flanges.

I. Flange Bolts and Nuts: ASME B18.2.1 carbon steel, unless otherwise indicated.

2.3 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D2996, filament-wound pipe with tapered bell-and-spigot ends for adhesive joints.

B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.

C. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

D. Flanges: ASTM D4024. Full-face gaskets suitable for service, minimum **1/8-inch- (3.2-mm-)** thick, 60-70 durometer. ASTM A307, Grade B, hex-head bolts with washers.

2.4 PREENGINEERED CONDUIT PIPING SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Insul-Tek Piping Systems, Inc**]
2. [**PermAlert**]
3. [**Rovanco Piping Systems, Inc**]
4. [**Thermacor Process, L.P.**]
5. [**Tricon Piping Systems, Inc.**]
6. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Insul-Tek Piping Systems, Inc**]
2. [**PermAlert**]
3. [**Rovanco Piping Systems, Inc**]
4. [**Thermacor Process, L.P.**]
5. [**Tricon Piping Systems, Inc.**]
6. **<Insert manufacturer's name>**

C. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.

D. Source Limitations: Obtain piping system from single source from single manufacturer.

E. Carrier Pipe: Material as indicated in "Piping Application" Article. See Part 3 articles in this Section for required carrier pipe.

F. Carrier Pipe Insulation:

1. Mineral-Wool Pipe Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply

with ASTM C547, [**Type I, 850 deg F (454 deg C)**][**Type II, 1200 deg F (649 deg C)**], Grade A.

a. Bands: ASTM A666, Type 304, stainless steel, **3/4 inch (19 mm)** wide, **0.020 inch (0.5 mm)** thick.

2. Calcium Silicate Pipe Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C533, Type I.

a. Bands: ASTM A666, Type 304, stainless steel, **3/4 inch (19 mm)** wide, **0.020 inch (0.5 mm)** thick.

3. Polyisocyanurate Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

a. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) to not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
b. Flame-spread index to be 25 or less and smoke-developed index to be 50 or less for thickness up to **1-1/2 inches (38 mm)**, as tested in accordance with ASTM E84.
c. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

4. Polyurethane Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyurethane material intended for use as thermal insulation.

a. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) to not exceed **0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K)** at **75 deg F (24 deg C)** after 180 days of aging.
b. Flame-spread index to be 25 or less and smoke-developed index to be 50 or less for thickness up to **1-1/2 inches (38 mm)**, as tested in accordance with ASTM E84.
c. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

G. Minimum Clearance:

1. Between Carrier Pipe Insulation and Conduit: **1 inch (25 mm)**.
2. Between Insulation of Multiple Carrier Pipes: **3/16 inch (4.75 mm)**.
3. Between Bottom of Carrier Pipe Insulation and Conduit: **1 inch (25 mm)**.

H. Conduit: [**Spiral wound, steel**]<**Insert conduit material**>.

1. Finish: With two coats of fusion-bonded epoxy, minimum **20 mils (0.50 mm)** thick.
2. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
3. Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of **10 feet (3 m)**.
4. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees to be factory fabricated and insulated, and compatible with carrier pipe.
5. Expansion Offsets and Loops: Provide directional changes to permit piping expansion without exceeding allowable pipe stress.
6. Accessories include the following:

a. Water Shed: Terminal end protector for carrier pipes entering building through floor, **3 inches (75 mm)** deep and **2 inches (50 mm)** larger than conduit; terminate conduit **20 inches (500 mm)** above the floor level.
b. Guides and Anchors: Steel plate welded to carrier pipes and to conduit, complete with vent and drainage openings inside conduit.

c. End Seals: Steel plate welded to carrier pipes and to conduit, complete with drain and vent openings on vertical centerline.
d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of conduit, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.

I. Manholes: Black steel with lifting eyes.

1. Finish: Spray-applied urethane, minimum **30 mils (0.75 mm)** thick.
2. Access: **30-inch- (750-mm-)** diameter waterproof cover with gasket, ladder, and two **6-inch (150-mm)** vents, one high and one low, extending above grade with rain caps.
3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
4. Sump: **12 inches (300 mm)** in diameter; **12 inches (300 mm)** deep.
5. Flotation Anchor: Oversized bottom keyed into concrete base.

J. Source Quality Control: Factory test conduit to **15 psig (105 kPa)** for a minimum of two minutes with no change in pressure. Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

2.5 LOOSE-FILL INSULATION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**DriTherm International Inc.**]
2. [**Gilsulate International, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**DriTherm International Inc.**]
2. [**Gilsulate International, Inc.**]
3. <**Insert manufacturer's name**>

C. Description: Inorganic, nontoxic, nonflammable, hydrophobic, pour-in-place insulation.

D. Source Limitations: Obtain insulation from single source from single manufacturer.

E. Thermal Conductivity (k-Value): [**0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C)**]<**Insert values at rated temperatures**>.

1. Application Temperature Range: [**35 to 800 deg F (2 to 426 deg C)**]<**Insert range**>.

F. Dry Density, Minimum: [**40 to 42 lb/cu. ft. (640 to 672 kg/cu. m)**]<**Insert range**>.

G. Strength: [**12,000 lb/sq. ft. (58 600 kg/sq. m)**]<**Insert range**>.

H. Insulation at Pipe Joints and Fittings:

1. Provide pipe system manufacturer's recommended joint and fitting seals, with formed, spray, or

loose-fill insulation. Provide pipe system manufacturer's recommended sealants and adhesives required to form watertight boundaries at outer conduit.

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 APPLICATION OF PIPING

A. LP Steam Piping:

1. NPS 2 (DN 50) and Smaller: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Conduit Piping: [**Standard weight**][**Schedule 40**][**Schedule 80**] steel carrier pipe, with [**mineral-wool**][**calcium silicate**][**polyisocyanurate**] carrier-pipe insulation and with [**coated**][**coated and insulated**] conduit.

   a. Piping Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.
   b. Conduit Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

      1) Insulation: [**Polyisocyanurate**][**Polyurethane**].
      2) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

6. Piping with loose-fill insulation.

B. HP Steam Piping:

1. NPS 2 (DN 50) and Smaller: [**Schedule 40**][**Schedule 80**], Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): [**Schedule 40**][**Schedule 80**], Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Conduit Piping: [**Standard weight**][**Schedule 40**][**Schedule 80**] steel carrier pipe, with [**mineral-wool**][**calcium silicate**][**polyisocyanurate**] carrier-pipe insulation and with [**coated**][**coated and insulated**] conduit.

   a. Piping Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.
   b. Conduit Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

      1) Insulation: [**Polyisocyanurate**][**Polyurethane**].

2) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

6. Piping with loose-fill insulation.

C. Condensate Piping:

1. [**NPS 2 (DN 50)**]<**Insert pipe size**> and smaller to be[**either of**] the following:

   a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
   b. RTRP and RTRF with adhesive or flanged joints.

2. [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**> and larger to be[**either of**] the following:

   a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   b. RTRP and RTRF with adhesive or flanged joints.

3. Conduit Piping: [**Standard weight, steel pipe and fittings**][**Schedule 40, steel pipe and fittings**][**Schedule 80, steel pipe and fittings**][**Fiberglass pipe and fittings**] with [**mineral-wool**][**calcium silicate**][**polyisocyanurate**][**polyurethane**] carrier-pipe insulation and with [**coated**][**coated and insulated**] conduit.

   a. Piping Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.
   b. Conduit Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

4. Piping with loose-fill insulation.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Show piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Remove standing water in the bottom of trench.

C. Bed the pipe on a minimum **6-inch (150-mm)** layer of pipe system manufacturer's recommended granular fill material with a minimum **6-inch (150-mm)** clearance between pipes.

D. Do not backfill piping trench or insulate piping until field quality-control testing has been completed and results approved.

E. Install piping at uniform grade of 0.2 percent downward in direction of flow or as indicated.

1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

F. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.

1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

G. In conduit pipes, install drain valves at low points and manual air vents at high points.

H. Install components with pressure rating equal to or greater than system operating pressure.

I. Install piping in straight lines. Do not bend pipe.

J. Install fittings for changes in direction and branch connections.

K. See Section 230500 "Common Work Results for HVAC" for sleeves and mechanical sleeve seals through exterior building walls.

L. Connect to steam and condensate piping where it passes through the building wall. Steam and condensate piping inside the building is specified in Section 232213 "Steam and Condensate Heating Piping."

M. See Section 230523.13 "Butterfly Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

N. See Section 230523.15 "Gate Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

O. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

P. See Section 134713 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.

Q. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 033000 "Cast-in-Place Concrete" for concrete and reinforcement.

R. After field quality-control testing is complete, backfill with **6 inches (150 mm)** of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to **12 inches (300 mm)** before using mechanical-compaction equipment.

3.4 INSTALLATION OF LOOSE-FILL INSULATION

A. Compact and stabilize bottom of trench and bedding to ensure continuous pipe support.

B. Remove standing water in the bottom of trench before installing pipe.

C. Bed pipe on minimum **6-inch (150-mm)** layer of pipe system manufacturer's recommended granular fill material with minimum **6-inch (150-mm)** clearance between pipes.

D. See Section 312000 "Earth Moving" for requirements of trench backfill materials.

E. Form insulation trench by excavation or by installing gypsum board side forms to establish required height and width of insulation.

F. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after backfilling with insulation.

G. Place insulation and backfill after field quality-control testing has been completed and results approved.

H. Insulate piping joints at fittings, expansion loops, and offsets with manufacturer-supplied joint insulation kit. Install insulation of thickness appropriate for calculated expansion amount.

I. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.

J. Maintain pipe system manufacturer's recommended separation between adjacent and crossing pipes and other utilities.

K. Remove temporary hangers and supports.

L. Cover loose-fill insulation with polyethylene sheet minimum of **4 mils (0.10 mm)** thick, and empty loose-fill insulation bags on top.

M. Manually backfill **6 inches (150 mm)** of clean fill. If mechanical compaction is required, manually backfill to **12 inches (300 mm)** before using mechanical-compaction equipment. Do not compact fill with excavating machinery buckets, wheels, or treads.

3.5 JOINT CONSTRUCTION

A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Join pipe and fittings in accordance with the following requirements and Section 232213 "Steam and Condensate Heating Piping":

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1 or ISO 7-1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Apply suitable lubricants on bolt threads.

F. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

G. Conduit Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

3.6 IDENTIFICATION

A. Install continuous plastic underground warning tapes during backfilling of trenches for underground steam and condensate distribution piping. Locate tapes **6 to 8 inches (150 to 200 mm)** below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Prepare steam and condensate piping for testing in accordance with [**ASME B31.9**][**and**][**ASME B31.1**] and as follows:

   a. Leave joints, including welds, uninsulated and exposed for examination during test.
   b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
   c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
   d. Fill system with ambient temperature water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
   e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid through drip legs installed at accessible low points.

2. Test steam and condensate piping as follows:

   a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1.5 times system design pressure. Disconnect connections to equipment and instrumentation during hydrostatic test.
   b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
   c. Do not pressurize carrier pipe with air.
   d. Maintain test pressure for [**two**][**four**]<**Insert number**> hours with no loss of pressure.

3. Test conduit as follows:

   a. Seal vents and drains and subject conduit to **15 psig (105 kPa)** compressed air for four hours with no loss of pressure. Repair leaks and retest.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.

H. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END OF SECTION 23 22 00 00

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Task	Specification	Specification Description
23 22 00 00	22 11 16 00a	Steam And Condensate Piping

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SECTION 23 22 16 00 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Strainers.
2. Flash tanks.
3. Stop-check valves.
4. Steam safety valves.
5. Steam pressure-reducing valves.
6. Steam traps.
7. Thermostatic air vents and steam vacuum breakers.
8. Flexible connectors.
9. Steam meters.
10. Steam condensate meters.

B. Related Requirements:

1. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with the following:

1. ASME Compliance: Safety valves and pressure vessels to bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. High-Pressure Steam Piping: <**Insert psig (kPa)**>.
2. Low-Pressure Steam Piping: <**Insert psig (kPa)**>.
3. Steam Condensate Piping: <**Insert psig (kPa)**> at [**250 deg F (121 deg C)**]<**Insert temperature**>.
4. Makeup-Water Piping: [**80 psig (552 kPa)**][**150 psig (1034 kPa)**]<**Insert value**> at [**73 deg F (22 deg C)**][**150 deg F (66 deg C)**]<**Insert temperature**>.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STRAINERS

A. Y-Pattern Strainers, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Keckley Company**]
   c. [**Metraflex Company (The)**]
   d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   e. [**Spirax Sarco Limited**]
   f. [**Titan Flow Control, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Keckley Company**]
   c. [**Metraflex Company (The)**]
   d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   e. [**Spirax Sarco Limited**]
   f. [**Titan Flow Control, Inc.**]
   g. <**Insert manufacturer's name**>

3. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
4. End Connections: Threaded ends for strainers **NPS 2 (DN 50)** and smaller; flanged ends for strainers **NPS 2-1/2 (DN 65)** and larger.
5. Strainer Screen: Stainless steel, [**20**][**40**][**60**]<**Insert number**>-mesh strainer or perforated stainless steel basket.
6. Tapped blowoff plug.
7. Rating: **250 psig (1725 kPa)** working steam pressure.

B. Y-Pattern Strainers, Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Keckley Company**]
c. [**Metraflex Company (The)**]
d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
e. [**Spirax Sarco Limited**]
f. [**Titan Flow Control, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Keckley Company**]
c. [**Metraflex Company (The)**]
d. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
e. [**Spirax Sarco Limited**]
f. [**Titan Flow Control, Inc.**]
g. <**Insert manufacturer's name**>

3. Body: ASTM A351/A351M <**Insert type**> stainless steel, with bolted cover and bottom drain connection.
4. End Connections: [**Socket weld**][**Threaded**] for strainers **NPS 2 (DN 50)** and smaller; flanged ends for strainers **NPS 2-1/2 (DN 65)** and larger.
5. Strainer Screen: [**1/32 inch (1 mm)**][**1/16 inch (1.6 mm)**]<**Insert dimension**> perforations in <**Insert type**> stainless steel strainer screen.
6. Tapped blowoff plug.
7. Rating: [**Class 600**]<**Insert class**> for [**socket weld**][**threaded**]; [**Class 150**][**Class 300**] for flanged.

C. Basket Strainers, Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Keckley Company**]
b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
c. [**Titan Flow Control, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Keckley Company**]
b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
c. [**Titan Flow Control, Inc.**]
d. <**Insert manufacturer's name**>

3. Body and cover: ASTM A216/A216M Grade WCB carbon steel body and bolted cover; bottom drain connection.
4. End Connections: Threaded ends for strainers **NPS 3 inch (DN 80)** and smaller.

5. Strainer Screen: Stainless steel, [**20**]<**Insert number**>-mesh strainer and perforated stainless steel basket with [**50**]<**Insert number**> percent free area.
6. Rating: Minimum **150 psig (1034 kPa)** working steam pressure.

D. Basket Strainers, Aluminum Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   c. [**Titan Flow Control, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Keckley Company**]
   b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   c. [**Titan Flow Control, Inc.**]
   d. <**Insert manufacturer's name**>

3. Body and Cover: ASTM B148, cast aluminum bronze body and bolted cover; bottom drain connection.
4. End Connections: Flanged ends.
5. Strainer Screen: Stainless steel, [**20**]<**Insert number**>-mesh strainer and perforated stainless steel basket with [**50**]<**Insert number**> percent free area.
6. Rating: Minimum **150 psig (1172 kPa)** working steam pressure

E. Basket Strainers, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Metraflex Company (The)**]
   c. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   d. [**Spirax Sarco Limited**]
   e. [**Titan Flow Control, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Keckley Company**]
   b. [**Metraflex Company (The)**]
   c. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   d. [**Spirax Sarco Limited**]
   e. [**Titan Flow Control, Inc.**]

f. **<Insert manufacturer's name>**

3. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
4. End Connections: Threaded ends for strainers **NPS 2 (DN 50)** and smaller; flanged ends for strainers **NPS 2-1/2 (DN 65)** and larger.
5. Strainer Screen: Stainless steel, [**20**]<**Insert number**>-mesh strainer and perforated stainless steel basket with 50 percent free area.
6. Rating: **250 psig (1725 kPa)** working steam pressure.

F. Basket Strainers, Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Metraflex Company (The)**]
   c. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   d. [**Spirax Sarco Limited**]
   e. [**Titan Flow Control, Inc.**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Keckley Company**]
   b. [**Metraflex Company (The)**]
   c. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   d. [**Spirax Sarco Limited**]
   e. [**Titan Flow Control, Inc.**]
   f. **<Insert manufacturer's name>**

3. Body: ASTM A351/A351M <**Insert type**> stainless steel, with bolted cover and bottom drain connection.
4. End Connections: [**Socket weld**][**Threaded**] for strainers **NPS 2 (DN 50)** and smaller; flanged ends for strainers **NPS 2-1/2 (DN 65)** and larger.
5. Strainer Screen: [**1/32 inch (1 mm)**][**1/16 inch (1.6 mm)**]<**Insert dimension**> perforations in <**Insert type**> stainless steel strainer screen.
6. Rating: [**Class 600**]<**Insert class**> for [**socket weld**][**threaded**]; [**Class 150**][**Class 300**] for flanged.

G. Basket Strainers, Fabricated Flanged Ends:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Keckley Company**]
   b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
   c. [**Titan Flow Control, Inc.**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Keckley Company**]
b. [**Mueller Steam Specialty; A Watts Water Technologies Company**]
c. [**Titan Flow Control, Inc.**]
d. <**Insert manufacturer's name**>

3. Description: Fabricated, custom engineered, flanged-end basket strainer.
4. Body Material: [**ASTM A106 Gr. B carbon steel**][**ASTM A312/A312M Type 304 stainless steel**][**ASTM A312/A312M Type 316 stainless steel**]<**Insert body material**>.
5. Cover Material: [**ASTM A106 Gr. B carbon steel**][**ASTM A312/A312M Type 316 stainless steel**]<**Insert cover material**>.
6. Cover Type: [**Bolted**][**Quick-open**][**Davited**]<**Insert cover type**>.
7. Inlet/Outlet Flange: [**Slip-on flanged,**][**Butt-welded flanged,**][**ASTM A105/A105M carbon steel**][**ASTM A182/A182M Type 316 stainless steel**].
8. Straining Element Material: [**Type 304 stainless steel**][**Type 316 stainless steel**]<**Insert straining element material**>
9. Straining element screen: [**50 mesh**]<**Insert screen size/configuration**>.
10. Strainer Open Area: [**50 percent**]<**Insert percent open area**>.
11. Drain: [**ASTM A105/A105M carbon steel**][**ASTM A182/A182M Type 316 stainless steel**]<**Insert drain material**>.
12. Vent with Plug: [**ASTM A105/A105M carbon steel**][**ASTM A182/A182M Type 316 stainless steel**]<**Insert vent and plug material**>.
13. Steam Working Pressure: <**Insert minimum steam working pressure**>.
14. Temperature Rating: <**Insert temperature rating**>.
15. <**Insert additional features**>.

2.3 FLASH TANKS

A. Shop or factory fabricated of welded steel in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 for [**150 psig (1035 kPa)**]<**Insert pressure**> rating and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.4 Basket Strainers, Aluminum Bronze, Duplex

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Titan Flow Control, Inc.**]
2. <**Insert manufacturer's name**>

2.5 STOP-CHECK VALVES

A. Stop-Check Valves - Malleable Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves**]
d. [**Lunkenheier Valves; CVC Valves, USA licensed manufacturer.**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Crane Fluid Systems; Crane Co.**]
c. [**Jenkins Valves**]
d. [**Lunkenheier Valves; CVC Valves, USA licensed manufacturer.**]
e. **<Insert manufacturer's name>**

3. Body and Bonnet: Malleable iron.
4. End Connections: Flanged.
5. Disc: Cylindrical with removable liner and machined seat.
6. Stem: Brass alloy.
7. Operator: Outside screw and yoke with cast-iron handwheel.
8. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
9. Pressure Class: 250.

2.6 Basket Strainers, Cast Iron, Duplex

A. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Titan Flow Control, Inc.**]
2. **<Insert manufacturer's name>**

2.7 STEAM SAFETY VALVES

A. Steam Safety Valves - Bronze or Brass:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Armstrong International, Inc**]
c. [**Kunkle Valve**]
d. [**Nabic Valves - a division of Crane Co.**]
e. [**Spirax Sarco Limited**]
f. [**WATTS; A Watts Water Technologies Company**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]

b. [**Armstrong International, Inc**]
c. [**Kunkle Valve**]
d. [**Nabic Valves - a division of Crane Co.**]
e. [**Spirax Sarco Limited**]
f. [**WATTS; A Watts Water Technologies Company**]
g. <**Insert manufacturer's name**>

3. Standard: [**ASME Section I Certified Capacity, National Board V stamp**][**ASME Section VIII Certified Capacity, National Board UV stamp**].
4. Valve Body Material: [**Bronze**][**or**][**brass**], ASTM B584.
5. Disc Material: Forged copper alloy.
6. End Connections: Threaded inlet and outlet.
7. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
8. Pressure Class: 250.
9. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet, with threads complying with ASME B1.20.1.
10. Size and Capacity: As required for equipment in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Steam Safety Valves - Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Armstrong International, Inc**]
c. [**Kunkle Valve**]
d. [**Spirax Sarco Limited**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Armstrong International, Inc**]
c. [**Kunkle Valve**]
d. [**Spirax Sarco Limited**]
e. <**Insert manufacturer's name**>

3. Standard: [**ASME Section I Certified Capacity, National Board V stamp**][**ASME Section VIII Certified Capacity, National Board UV stamp**].
4. Valve Body Material: Cast iron, ASTM A126.
5. Disc Material: Forged copper alloy with bronze nozzle.
6. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
7. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
8. Pressure Class: 250.
9. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
10. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

11. Size and Capacity: As required for equipment in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2.8 Basket Strainers, Carbon Steel, Duplex

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Titan Flow Control, Inc.**]
2. <**Insert manufacturer's name**>

2.9 STEAM PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Cashco, Inc.**]
3. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
4. [**Leslie Controls, Inc**]
5. [**Spence Engineering Company, Inc**]
6. [**Spirax Sarco Limited**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Cashco, Inc.**]
3. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
4. [**Leslie Controls, Inc**]
5. [**Spence Engineering Company, Inc**]
6. [**Spirax Sarco Limited**]
7. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Steam Flow Rate: <**Insert lb/h (kg/s)**>.
2. Inlet Pressure: <**Insert psig (kPa)**>.
3. Outlet Set Pressure: <**Insert psig (kPa)**>.
4. Pressure Loss (Wide Open): <**Insert psig (kPa)**>.

D. Standard: ASME labeled.

E. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

F. Description: Pilot-actuated diaphragm type, with adjustable pressure range and positive shutoff.

G. Body: [**Cast iron**][**Stainless steel**].

H. End Connections: Threaded connections for valves **NPS 2 (DN 50)** and smaller and flanged connections for valves **NPS 2-1/2 (DN 65)** and larger.

I. Trim: Hardened stainless steel.

J. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

K. Gaskets: Non-asbestos materials.

2.10 Basket Strainers, Stainless Steel, Duplex

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Titan Flow Control, Inc.**]
2. <**Insert manufacturer's name**>

2.11 STEAM TRAPS

A. Steam Traps, Thermostatic Type - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Sterling**]
   f. [**Tunstall Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Sterling**]
   f. [**Tunstall Corporation**]
   g. <**Insert manufacturer's name**>

3. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
4. Trap Type: Balanced pressure.
5. Bellows: Stainless steel or monel.
6. Head and Seat: Replaceable, hardened stainless steel.
7. Pressure Class: 125.

B. Steam Traps, Thermostatic Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Spence Engineering Company, Inc**]
   c. [**Spirax Sarco Limited**]
   d. [**Steriflow; a division of Richards Industrial**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**Spence Engineering Company, Inc**]
   c. [**Spirax Sarco Limited**]
   d. [**Steriflow; a division of Richards Industrial**]
   e. <**Insert manufacturer's name**>

3. Body: Type 316L or Type 316 stainless steel.
4. Trap Type: Balanced pressure.
5. Bellows: Type 316L or Type 316 stainless steel.
6. Maximum Operating Pressure: At least [**100 psig (689 kPa)**]<**Insert pressure**> at saturated steam temperature.

C. Steam Traps, Thermodynamic Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Tunstall Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Tunstall Corporation**]
   f. <**Insert manufacturer's name**>

3. Body: <**Insert type**> stainless steel with screw-in cap.
4. End Connections: [**Threaded**]<**Insert connection type**>.
5. Disc and Seat: <**Insert type**> stainless steel.
6. Maximum Operating Pressure: [**600 psig (4140 kPa)**]<**Insert pressure**>.

D. Steam Traps, Float and Thermostatic Type - Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Sterling**]
   f. [**Tunstall Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   d. [**Spirax Sarco Limited**]
   e. [**Sterling**]
   f. [**Tunstall Corporation**]
   g. <**Insert manufacturer's name**>

3. Body and Bolted Cap: ASTM A126 cast iron.
4. End Connections: Threaded.
5. Float Mechanism: Replaceable, stainless steel.
6. Seat: Hardened stainless steel.
7. Trap Type: Balanced pressure.
8. Thermostatic Bellows: Stainless steel or monel.
9. Thermostatic air vent capable of withstanding **45 deg F (25 deg C)** of superheat and resisting water hammer without sustaining damage.
10. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
11. Maximum Operating Pressure: **125 psig (860 kPa)**.

E. Steam Traps, Float and Thermostatic Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armstrong International, Inc**]

b. [**Spirax Sarco Limited**]
c. <**Insert manufacturer's name**>

3. Body and Bolted Cover: <**Insert type**> stainless steel.
4. End Connections: [**Threaded**]<**Insert end connection type**>.
5. Float Mechanism: <**Insert type**> stainless steel.
6. Seat: <**Insert type**> stainless steel.
7. Strainer: Integral, stainless steel[**, with blowdown valve**].
8. Trap Type: Balanced pressure.
9. Thermostatic air vent.
10. Maximum Operating Pressure: <**Insert pressure**>.

F. Steam Traps, Inverted Bucket Type - Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Barnes & Jones, Inc**]
c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
d. [**Spirax Sarco Limited**]
e. [**Sterling**]
f. [**Tunstall Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Barnes & Jones, Inc**]
c. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
d. [**Spirax Sarco Limited**]
e. [**Sterling**]
f. [**Tunstall Corporation**]
g. <**Insert manufacturer's name**>

3. Body and Cap: Cast iron.
4. End Connections: Threaded.
5. Head and Seat: Stainless steel.
6. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
7. Bucket: Brass or stainless steel.
8. Strainer: Integral stainless steel inlet strainer within the trap body.
9. Air Vent: Stainless steel thermostatic vent.
10. Pressure Rating: **250 psig (1725 kPa)**.

G. Steam Traps, Inverted Bucket Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]

b. [**Spence Engineering Company, Inc**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Spence Engineering Company, Inc**]
c. [**Spirax Sarco Limited**]
d. <**Insert manufacturer's name**>

3. Body and Cap: <**Insert type**> stainless steel.
4. End Connections: [**Threaded**]<**Insert connection type**>.
5. Head and Seat: Stainless steel.
6. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
7. Bucket: Stainless steel.
8. Strainer: Integral stainless steel inlet strainer within the trap body.
9. Air Vent: Stainless steel thermostatic vent.
10. Pressure Rating: Minimum [**200 psig at 450 deg F (1379 kPa at 232 deg C)**]<**Insert pressure at temperature**>.

2.12 THERMOSTATIC AIR VENTS AND STEAM VACUUM BREAKERS

A. Air Vents, Thermostatic Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong International, Inc**]
b. [**Barnes & Jones, Inc**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
e. [**Johnson Corporation (The)**]
f. [**Spirax Sarco Limited**]
g. [**Sterling**]
h. [**Tunstall Corporation**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong International, Inc**]
b. [**Barnes & Jones, Inc**]
c. [**Bell & Gossett; a Xylem brand**]
d. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
e. [**Johnson Corporation (The)**]
f. [**Spirax Sarco Limited**]
g. [**Sterling**]
h. [**Tunstall Corporation**]

i. **<Insert manufacturer's name>**

3. Body: Cast iron, bronze, or stainless steel.
4. End Connections: Threaded.
5. Float, Valve, and Seat: Stainless steel.
6. Thermostatic Element: Phosphor bronze bellows in a stainless steel cage.
7. Pressure Rating: [**125 psig (861 kPa)**][**300 psig (2068 kPa)**]**<Insert value>**.
8. Maximum Temperature Rating: [**350 deg F (177 deg C)**]**<Insert temperature>**.

B. Steam Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   e. [**Kadant Johnson LLC**]
   f. [**Spirax Sarco Limited**]
   g. [**Tunstall Corporation**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Armstrong International, Inc**]
   b. [**Barnes & Jones, Inc**]
   c. [**Bell & Gossett; a Xylem brand**]
   d. [**Hoffman Specialty; Bell & Gossett, a xylem brand**]
   e. [**Kadant Johnson LLC**]
   f. [**Spirax Sarco Limited**]
   g. [**Tunstall Corporation**]
   h. **<Insert manufacturer's name>**

3. Body: Cast iron, bronze, or stainless steel.
4. End Connections: Threaded.
5. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
6. O-Ring Seal: Ethylene propylene rubber.
7. Pressure Rating: [**125 psig (861 kPa)**][**300 psig (2068 kPa)**]**<Insert value>**.
8. Maximum Temperature Rating: [**350 deg F (177 deg C)**]**<Insert temperature>**.

2.13 FLEXIBLE CONNECTORS

A. Flexible Connectors, Bellows Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Duraflex, Inc.**]

b. [**Flexicraft Industries**]
c. [**Hyspan Precision Products, Inc**]
d. [**Mason Industries, Inc.**]
e. [**Metraflex Company (The)**]
f. [**Twin City Hose, Inc.**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Duraflex, Inc.**]
b. [**Flexicraft Industries**]
c. [**Hyspan Precision Products, Inc**]
d. [**Mason Industries, Inc.**]
e. [**Metraflex Company (The)**]
f. [**Twin City Hose, Inc.**]
g. **<Insert manufacturer's name>**

3. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
4. End Connections: Threaded or flanged to match equipment connected.
5. Performance: Capable of **3/4-inch (20-mm)** misalignment.
6. CWP Rating: **150 psig (1035 kPa)**.
7. Maximum Operating Temperature: **250 deg F (121 deg C)**.

2.14 STEAM METERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Badger Meter, Inc.**]
2. [**ISTEC Corporation**]
3. [**Preso Meters; Badger Meter Inc.**]
4. [**Spirax Sarco Limited**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Badger Meter, Inc.**]
2. [**ISTEC Corporation**]
3. [**Preso Meters; Badger Meter Inc.**]
4. [**Spirax Sarco Limited**]
5. **<Insert manufacturer's name>**

C. Meters to have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

1. Computer to have 4 to 20 mA or 2 to 10 V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation described in Section 230923 "Direct Digital Control (DDC) System for HVAC."

4. Microprocessor Enclosure: NEMA 250, Type 4.

D. Sensor:

1. Venturi, of [**stainless steel**][**carbon steel**] construction, for insertion in pipeline between flanges. Sensor has at least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
2. Vortex type with stainless steel wetted parts and [**wafer**][**flange**] connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. Sensor has at least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
3. Spring-loaded, variable-area flowmeter type; density compensated with stainless steel wetted parts and [**wafer**][**flange**] connections. Sensor is to have at least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

2.15 STEAM CONDENSATE METERS

A. Steam Condensate Meter - Magnetic Flow Velocity Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Central Station Steam Co.**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Central Station Steam Co.**]
   b. [**Spirax Sarco Limited**]
   c. <**Insert manufacturer's name**>

3. Flow Element: Magnetic flow velocity type.

   a. In-line pipe installation utilizing electronically generated magnetic field to measure water velocity.
   b. Wetted liner: Teflon or ceramic.
   c. Maximum Fluid Temperature Rating: [**220 deg F (104 deg C)**]<**Insert temperature**>.

4. Body: [**Manufacturer's standard material**]<**Insert material**>.
5. Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 (DN 65)**.
6. Totalizer: Meters to have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

   a. Computer to have 4 to 20 mA or 2 to 10 V output for temperature, pressure, and contact closure for flow increments.
   b. Independent timers to store four peak flow rates and total flow.
   c. Interface compatible with central workstation specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   d. Microprocessor Enclosure: NEMA 250, Type 4.

7. Pressure Rating: [**Atmospheric**]<**Insert pressure**>.
8. Maximum Body Temperature Rating: [**220 deg F (104 deg C)**]<**Insert temperature**>.

B. Steam Condensate Meter - Gravity Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Central Station Steam Co.**]
   b. [**Lincoln Meter Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Central Station Steam Co.**]
   b. [**Lincoln Meter Company**]
   c. <**Insert manufacturer's name**>

3. Flow Element: Gravity type.

   a. Flow measured by rotating, compartmented drum.
   b. Casing: Stainless steel.
   c. Metering drum: Stainless steel.
   d. Maximum Fluid Temperature Rating: [**220 deg F (104 deg C)**]<**Insert temperature**>.

4. Body: [**Manufacturer's standard material**]<**Insert material**>.
5. Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 (DN 65)**.
6. Totalizer: Meters to have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

   a. Computer to have 4 to 20 mA or 2 to 10 V output for temperature, pressure, and contact closure for flow increments.
   b. Independent timers to store four peak flow rates and total flow.
   c. Interface compatible with central workstation specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   d. Microprocessor Enclosure: NEMA 250, Type 4.

7. Pressure Rating: [**Atmospheric**]<**Insert pressure**>.
8. Maximum Body Temperature Rating: [**220 deg F (104 deg C)**]<**Insert temperature**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF STRAINERS

A. Install strainers on inlet side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install **NPS 3/4 (DN 20)** nipple and full-port ball valve in blowdown connection of strainers, **NPS 2 (DN 50)** and larger. Match size of strainer blowoff connection for strainers smaller than **NPS 2 (DN 50)**.

3.2 INSTALLATION OF FLASH TANKS

A. Pitch steam condensate piping downward no less than **1/4 in./ft. (21 mm/meter)** toward flash tank.

B. If more than one steam condensate pipe discharges into flash tank, install a check valve in each line.

C. Install thermostatic air vent at tank top.

D. Install steam safety valve at tank top.

E. Install full-port ball valve and swing check valve on condensate outlet.

F. Install inverted bucket or float and thermostatic trap at low-pressure steam condensate outlet, sized for three times the calculated heat load.

G. Install pressure gauge on low-pressure steam outlet in accordance with Section 230500 "Common Work Results for HVAC."

3.3 INSTALLATION OF STOP-CHECK VALVES

A. Install stop-check valves at locations detailed on the Drawings.

3.4 INSTALLATION OF STEAM SAFETY VALVES

A. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

B. Install safety valves in accordance with [**ASME B31.1.**][**ASME B31.9.**][**ASME B31.1 and ASME B31.9.**]

C. Install safety valve downstream from pressure-reducing valve station as detailed on the Drawings.

D. Pipe steam safety-valve discharge without valves to atmosphere outside the building.

E. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

F. Install exhaust head with drain to waste, on vents equal to or larger than **NPS 2-1/2 (DN 65)**.

3.5 INSTALLATION OF STEAM PRESSURE-REDUCING VALVES

A. Install steam pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise detailed on the Drawings.

C. Install shutoff valves on upstream and downstream sides of pressure-reducing valves or as otherwise detailed on the Drawings.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

E. Install pressure gauges on low-pressure side of steam pressure-reducing valves after the bypass connection in accordance with Section 230500 "Common Work Results for HVAC"

F. Install strainers upstream of steam pressure-reducing valve.

3.6 INSTALLATION OF STEAM TRAPS

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

C. Install in accessible locations close to connected equipment.

3.7 INSTALLATION OF THERMOSTATIC AIR VENTS AND STEAM VACUUM BREAKERS

A. Install air vent and vacuum breakers downstream from control valve, close to coil inlet connection or as otherwise detailed on the Drawings.

3.8 INSTALLATION OF FLEXIBLE CONNECTORS

A. Install flexible connectors at locations detailed on the Drawings.

3.9 INSTALLATION OF STEAM METERS

A. Install steam meters with lengths of straight pipe upstream and downstream in accordance with meter manufacturer's written instructions.

B. See Section 230923 "Direct Digital Control (DDC) System for HVAC" for data acquisition wiring.

3.10 INSTALLATION OF STEAM CONDENSATE METERS

A. Install steam condensate meters with lengths of straight pipe upstream and downstream in accordance with meter manufacturer's written instructions.

B. See Section 230923 "Direct Digital Control (DDC) System for HVAC" for data acquisition wiring.

END OF SECTION 23 22 16 00

Task	Specification	Specification Description
23 22 16 00	22 15 13 00	General-Service Compressed-Air Piping
23 22 16 00	22 11 16 00a	Steam And Condensate Piping
23 22 16 00	23 22 00 00	Underground Steam and Condensate Heating Piping
23 22 16 00	23 23 00 00	Refrigerant Piping

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SECTION 23 22 23 00 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-stage, centrifugal steam condensate pumps with floor-mounted receiver.
2. Multistage, centrifugal steam condensate pumps with elevated receiver.
3. Single-stage, centrifugal steam condensate pumps with elevated receiver.
4. Vertical, wet-pit-mounted steam condensate pumps.
5. Pressure-powered steam condensate pumps.

1.2 DEFINITIONS

A. PPE: Polyphenylene ether.

B. PPO: Polyphenylene oxide.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of steam condensate pump.

   a. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories.
   b. Indicate pump's operating point on curves.
   c. Include receiver capacity and material.

B. Shop Drawings: For each pump/receiver.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for steam condensate pumps/receivers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps.

1. Indicate actual installed items by marking submittals with an arrow or box.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

D. Seismic Performance: Steam condensate pumps/receivers to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.3 SINGLE-STAGE, CENTRIFUGAL STEAM CONDENSATE PUMPS WITH FLOOR-MOUNTED RECEIVER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**ITT Corporation**]
3. [**Roth Pump Company**]
4. [**Skidmore Pump**]
5. [**Spirax Sarco Limited**]
6. [**Sterling**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**ITT Corporation**]
3. [**Roth Pump Company**]
4. [**Skidmore Pump**]
5. [**Spirax Sarco Limited**]
6. [**Sterling**]
7. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, packaged, [**simplex**][**duplex**]<**Insert number of pumps**>, electric-driven pumps; with receiver, float switch(es), [**control panel and controls,**] and accessories suitable for operation with steam condensate up to **200 deg F (93 deg C)**.

D. Receiver:

1. Floor mounted.
2. Material: [**Cast iron**][**Carbon steel**][**Stainless steel**].
3. Externally adjustable float switch for each pump.
4. Flanges for pump mounting.
5. Water-level gauge and dial thermometer.
6. Pressure gauge at each pump discharge.
7. Isolation valve between pump and receiver.
8. Lifting eyebolts.
9. Vent and overflow.
10. Inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.

E. Pumps:

1. Centrifugal, close-coupled, vertical design.
2. Permanently aligned.
3. Impeller: [**Bronze**][**stainless steel**][**or**][**modified PPO/PPE blend thermoplastic**].
4. Mechanical seals rated at **250 deg F (120 deg C)**.
5. Mounted on receiver flange.

F. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
3. Enclosure Materials: Cast iron, cast aluminum, or rolled steel.
4. Motor Bearings: [**Permanently lubricated**][**Grease-lubricated**] ball bearings.
5. Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (meters)**> above sea level.
   c. High Humidity: <**Insert wet bulb deg F (deg C)**>.
   d. <**Insert conditions**>.

6. Efficiency: Premium efficient.
7. NEMA Design: <**Insert designation**>.
8. Service Factor: <**Insert value**>.

G. Control Panel:

1. NEMA 250, [**Type 1**][**Type 12**]<**Insert type**> enclosure with hinged door and grounding lug, mounted on receiver.
2. Combination magnetic starter with fused disconnect[**for each pump,**] and cover interlock.

3. Factory wired between pump(s) and float switches, for single external electrical connection.
4. Provide fused, control-power transformer if panel exceeds 120 V ac.
5. Automatic electrical pump alternator to operate pumps in [**lead-lag**]<**Insert sequence**> sequence and allow [**both**][**all**] pumps to operate upon receiver high-level signal.
6. Manual control to override electrical pump alternator and manually select the lead pump.
7. Hand-off-auto selector switch for each pump.
8. Momentary-contact "TEST" push-button on cover for each pump.
9. All power and control wiring prewired for single external electrical connection.
10. Numbered terminal strip.
11. Disconnect switch.

H. Capacities and Characteristics:

1. Number of Pumps: <**Insert number**>.
2. Capacity, Each Pump:

   a. Flow: <**Insert gpm (L/s)**>.
   b. Discharge Head: <**Insert psig (kPa)**>.
   c. Discharge Size: <**Insert NPS (DN)**>.
   d. Speed: <**Insert rpm**>.
   e. Motor Horsepower: <**Insert value**>.

3. Receiver:

   a. Capacity: <**Insert gal. (L)**>.
   b. Inlet Size: <**Insert NPS (DN)**>.
   c. Height to Inlet: <**Insert inches (mm)**>.

4. Electrical Characteristics:

   a. Volts: [**120**][**230**][**240**]<**Insert value**>.
   b. Phase: Single.
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 MULTISTAGE CENTRIFUGAL STEAM CONDENSATE PUMPS WITH ELEVATED RECEIVER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Skidmore Pump**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Skidmore Pump**]
2. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, packaged, [**simplex**][**duplex**][**triplex**][**quadraplex**], electric-driven pumps; with receiver, pumps, float switch(es), [**control panel and controls,**] and accessories suitable

for operation with steam condensate up to **200 deg F (93 deg C)**.

D. Receiver:

1. Elevated, mounted on fabricated-steel supports.
2. Material: Carbon steel.
3. Externally adjustable float switch for each pump.
4. Water-level gauge and dial thermometer.
5. Pressure gauge at each pump discharge.
6. Isolation valves between pump and receiver.
7. Lifting eyebolts.
8. Vent and overflow connections.
9. Inlet cascade baffle and convex heads.
10. Inlet strainer with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.

E. Pumps:

1. Centrifugal, [**two-stage**][**multistage**], close coupled.
2. Vertical design, permanently aligned.
3. Impeller: [**Bronze**][**Type 304 stainless steel**][**Type 316 stainless steel**].
4. Stainless steel shafts.
5. Mechanical seals rated at **250 deg F (120 deg C)**.
6. Mounted on base below the receiver.
7. Rated to operate with a minimum of **2 ft. (610 mm)** of NPSH.

F. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Enclosure: [**Open, dripproof**][**Totally enclosed fan cooled**]<**Insert type**>.
3. Enclosure Materials: Cast iron, cast aluminum, or rolled steel.
4. Motor Bearings: [**Permanently lubricated**][**Grease-lubricated**] ball bearings.
5. Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (meters)**> above sea level.
   c. High Humidity: <**Insert wet bulb deg F (deg C)**>.
   d. <**Insert conditions**>.

6. Efficiency: Premium efficient.
7. NEMA Design: <**Insert designation**>.
8. Service Factor: <**Insert value**>.

G. Pipe: [**ASTM A53/A53M, Type S, Grade B**][**ASTM A106/A106M; Schedule 80; seamless steel**].

H. Fittings NPS 2 (DN 50) and Smaller: ASME B16.1, Class 125 [**cast iron**][**stainless steel**], threaded.

I. Fittings NPS 2-1/2 (DN 65) and Larger: ASTM A234/A234M, steel, for welded connections.

J. Control Panel:

1. NEMA 250, [**Type 1**][**Type 12**]<**Insert type**> enclosure with hinged door and grounding lug, mounted on receiver.
2. Combination magnetic starter with fused disconnect[**for each pump,**] and cover interlock.
3. Factory wired between pumps and float switches, for single external electrical connection.
4. Provide fused, control-power transformer if panel exceeds 120 V ac.

5. Automatic electrical pump alternator to operate pumps in [**lead-lag**]<**Insert sequence**> sequence and allow [**both**][**all**] pumps to operate upon receiver high-level signal.
6. Manual control to override electrical pump alternator and manually select the lead pump.
7. Hand-off-auto selector switch for each pump.
8. Momentary-contact "TEST" push-button on cover for each pump.
9. All power and control wiring prewired for single external electrical connection.
10. Numbered terminal strip.
11. Disconnect switch.

K. Capacities and Characteristics:

1. Number of Pumps: <**Insert number**>.
2. Capacity, Each Pump:

   a. Flow: <**Insert gpm (L/s)**>.
   b. Discharge Head: <**Insert psig (kPa)**>.
   c. Discharge Size: <**Insert NPS (DN)**>.
   d. Speed: <**Insert rpm**>.
   e. Motor Horsepower: <**Insert value**>.

3. Receiver:

   a. Capacity: <**Insert gal. (L)**>.
   b. Inlet Size: <**Insert NPS (DN)**>.
   c. Height to Inlet: <**Insert inches (mm)**>.

4. Electrical Characteristics:

   a. Volts: [**120**][**208**][**230**][**240**][**480**]<**Insert value**>.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.5 SINGLE-STAGE, CENTRIFUGAL STEAM CONDENSATE PUMPS WITH ELEVATED RECEIVER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ITT Corporation**]
2. [**Skidmore Pump**]
3. [**Spirax Sarco Limited**]
4. [**Sterling**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ITT Corporation**]
2. [**Skidmore Pump**]
3. [**Spirax Sarco Limited**]
4. [**Sterling**]

5. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, packaged, [**simplex**][**duplex**]<**Insert number of pumps**>, electric-driven pumps; with elevated receiver, pumps, float switch(es), controls, [**control panel,**] and accessories suitable for operation with steam condensate up to **200 deg F (93 deg C)**.

D. Receiver:

1. Elevated, mounted on fabricated-steel supports.
2. Material: [**Cast iron**][**Welded steel**][**Stainless steel**].
3. Externally adjustable float switch for each pump.
4. Water-level gauge and dial thermometer.
5. Pressure gauge at each pump discharge.
6. Isolation valves between receiver and pumps.
7. Lifting eyebolts.
8. Vent and overflow connections.
9. Inlet cascade baffle and convex heads.
10. Inlet strainer with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.

E. Pumps:

1. Centrifugal, close coupled.
2. Permanently aligned.
3. Impeller: [**Bronze**][**stainless steel**][**or**][**modified PPO/PPE blend thermoplastic**].
4. Stainless steel shafts.
5. Mechanical seals rated at **250 deg F (120 deg C)**.
6. Mounted on base below the receiver.
7. Rated to operate with a minimum of **2 ft. (610 mm)** of NPSH.

F. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
3. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
4. Motor Bearings: [**Permanently lubricated**][**Grease-lubricated**] ball bearings.
5. Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (meters)**> above sea level.
   c. High Humidity: <**Insert wet bulb deg F (deg C)**>.
   d. <**Insert conditions**>.

6. Efficiency: Premium efficient.
7. NEMA Design: <**Insert designation**>.
8. Service Factor: <**Insert value**>.

G. Pipe: [**ASTM A53/A53M, Type S, Grade B**][**ASTM A106/A106M; Schedule 80; seamless steel**].

H. Fittings NPS 2 (DN 50) and Smaller: ASME B16.1, Class 125 [**cast iron**][**stainless steel**], threaded.

I. Fittings NPS 2-1/2 (DN 65) and Larger: ASTM A234/A234M, steel, for welded connections.

J. Control Panel:

1. NEMA 250, [**Type 1**][**Type 12**]<**Insert type**> enclosure with hinged door and grounding lug,

mounted on pump.
2. Combination magnetic starter with fused disconnect[**for each pump,**] and cover interlock.
3. Factory wired between pumps and float switches, for single external electrical connection.
4. Provide fused, control-power transformer if panel exceeds 120 V ac.
5. Automatic electrical pump alternator to operate pumps in [**lead-lag**]<**Insert sequence**> sequence and allow [**both**][**all**] pumps to operate upon receiver high-level signal.
6. Manual control to override electrical pump alternator and manually select the lead pump.
7. Hand-off-auto selector switch for each pump.
8. Momentary-contact "TEST" push-button on cover for each pump.
9. All power and control wiring prewired for single external electrical connection.
10. Numbered terminal strip.
11. Disconnect switch.

K. Capacities and Characteristics:

1. Number of Pumps: <**Insert number**>.
2. Capacity, Each Pump:

   a. Flow: <**Insert gpm (L/s).**>
   b. Discharge Head: <**Insert psig (kPa)**>.
   c. Discharge Size: <**Insert NPS (DN)**>.
   d. Speed: <**Insert rpm**>.
   e. Motor Horsepower: <**Insert value**>.

3. Receiver:

   a. Capacity: <**Insert gal. (L)**>.
   b. Inlet Size: <**Insert NPS (DN)**>.
   c. Height to Inlet: <**Insert inches (mm)**>.

4. Electrical Characteristics:

   a. Volts: [**120**][**208**][**230**][**240**][**480**]<**Insert value**>.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**> A.
   e. Minimum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Overcurrent Protection: <**Insert value**> A.

2.6 VERTICAL, WET-PIT-MOUNTED STEAM CONDENSATE PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ITT Corporation**]
2. [**Roth Pump Company**]
3. [**Skidmore Pump**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ITT Corporation**]

2. [**Roth Pump Company**]
3. [**Skidmore Pump**]
4. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, packaged, [**simplex**][**duplex**], electric-driven pumps; with float switch(es), [**control panel and controls,**] and accessories suitable for operation with steam condensate up to **200 deg F (93 deg C)**.

D. Basin: Cast iron, with hub-type inlets.

1. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.
2. Discharge pressure gauges.
3. Float switch(es): One float switch for each pump or a single float with operating contacts for each pump.
4. Anchor Flange: Cast iron, attached to basin, in location and of size required to anchor basin to concrete slab.

E. Basin Cover: Cast-iron or steel cover for each pump with gasketed openings for access to pumps, pump shafts, control rods, discharge piping, and vent connections.

F. Pumps:

1. Vertical, wet-pit mounted, flexible coupled, and suspended.
2. Cast-iron casing with open inlet.
3. Stainless steel shaft with oil-lubricated, bronze, intermediate sleeve bearings; **48-inch (1200-mm)** maximum intervals where basin depth is more than **48 inches (1200 mm)**; and grease-lubricated, ball-type, thrust bearings.
4. Shaft Couplings: Flexible, capable of absorbing vibration.
5. Impeller: [**Bronze**][**Stainless steel**].
6. Mechanical seals rated at **250 deg F (120 deg C)**, with carbon rotating ring bearing on a ceramic seat held by a stainless steel spring and enclosed by a flexible bellows and gasket.

G. Motors:

1. Vertically mounted on cast-iron pedestal.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
3. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
4. Enclosure Materials: Cast iron, cast aluminum, or rolled steel.
5. Motor Bearings: [**Permanently lubricated**][**Grease-lubricated**] ball bearings.
6. Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (meters)**> above sea level.
   c. High Humidity: <**Insert wet bulb deg F (deg C)**>.
   d. <**Insert conditions**>.

7. Efficiency: Premium efficient.
8. NEMA Design: <**Insert designation**>.
9. Service Factor: <**Insert value**>.

H. Pump Discharge Piping: Manufacturer's standard steel or bronze pipe unless otherwise indicated.

I. Control Panel:

1. NEMA 250, [**Type 1**][**Type 12**]<**Insert type**> enclosure with hinged door and grounding lug,

mounted on pump.
2. Combination magnetic starter with fused disconnect for each pump and cover interlock.
3. Factory wired between pumps and float switches, for single external electrical connection.
4. Provide fused, control-power transformer if panel exceeds 120 V ac.
5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate upon receiver high-level signal.
6. Manual control to override electrical pump alternator and manually select the lead pump.
7. Hand-off-auto selector switch for each pump.
8. Momentary-contact "TEST" push-button on cover for each pump.
9. Numbered terminal strip.
10. Disconnect switch.

J. Capacities and Characteristics:

1. Capacity, Each of Two Pumps:

a. Flow: <**Insert gpm (L/s)**>.
b. Discharge Head: <**Insert psig (kPa)**>.
c. Discharge Size: <**Insert NPS (DN)**>.
d. Speed: <**Insert rpm**>.
e. Motor Horsepower: <**Insert value**>.

2. Underground Basin:

a. Diameter: <**Insert inches (mm)**>.
b. Depth: <**Insert inches (mm)**>.
c. Inlet Size: <**Insert NPS (DN)**>.
d. Bottom to Centerline of Inlet: <**Insert inches (mm)**>.

3. Electrical Characteristics:

a. Volts: [**120**][**208**][**230**][**480**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**> A.
e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.7 PRESSURE-POWERED STEAM CONDENSATE PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Cemline Corporation**]
3. [**Kadant Johnson LLC**]
4. [**Spence Engineering Company, Inc**]
5. [**Spirax Sarco Limited**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Cemline Corporation**]
3. [**Kadant Johnson LLC**]
4. [**Spence Engineering Company, Inc**]
5. [**Spirax Sarco Limited**]
6. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, [**simplex**][**duplex**], pressure-powered pumps with float-operated valve controls, valves, piping connections, and accessories suitable for pumping steam condensate using [**steam**][**compressed air**].

D. Pump Body: [**Cast iron**][**Welded steel**], ASME rated to **125 psig (860 kPa)**.

E. Piping Connections: Threaded or flanged; for steam condensate inlet, outlet, operating medium, vent, and indicated accessories.

F. Level Gauge: Glass site gauge with shutoff cocks.

G. Valves: Manufacturer's standard check valves on inlet and outlet.

H. Internal Parts: Stainless steel float, springs, and actuating mechanism.

I. Valve Seals: Replaceable from exterior.

J. Receiver:

1. Factory skid-mounted on steel supports.
2. Material; [**Cast iron**][**Welded steel**][**Type 316 stainless steel**].
3. Threaded or flanged piping connections.
4. Water-level gauge and dial thermometer.
5. Pressure gauge at pump discharge.
6. Bronze fitting isolation valve between pump and receiver.
7. Lifting eyebolts.
8. Inlet vent and an overflow.
9. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.

K. Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M; Schedule 80; seamless steel.

L. Fittings: Wrought steel, ASTM A234/A234M with wall thickness to match adjacent pipe or wrought cast- and forged-steel flanges and flanged fittings, ASME B16.5.

M. Capacities and Characteristics:

1. Number of Pumps: <**Insert number**>.
2. Capacity, Each Pump:

   a. Flow: <**Insert gpm (L/s)**>.
   b. Discharge Head: <**Insert psig (kPa)**>.
   c. Discharge Size: <**Insert NPS (DN)**>.

3. Operating Steam Pressure: <**Insert psig (kPa)**>.
4. Steam Consumption Rate: <**Insert lb/1000 lb (kg/1000 kg)**> of steam condensate.
5. Operating Compressed-Air Pressure: <**Insert psig (kPa)**>.
6. Compressed-Air Consumption Rate: <**Insert cu. ft./1000 lb (L/1000 kg)**> of steam condensate.
7. Receiver:

a. Capacity: <**Insert gal. (L)**>.
b. Inlet Size: <**Insert NPS (DN)**>.
c. Height to Inlet: <**Insert inches (mm)**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STEAM CONDENSATE PUMPS

A. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

B. Support pumps and piping separately so piping is not supported by pumps.

C. Install thermometers and pressure gauges.

D. Equipment Mounting:

1. Install pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

B. Where installing piping adjacent to machine, allow space for service and maintenance.

C. Install compressed-air supply for pressure-powered pumps as required in Section 221513 "General-Service Compressed-Air Piping."

D. Install a globe and check valve at inlet of each pump and a gate and check valve at pump outlet.

E. Install pressure gauge at each pump discharge.

F. Pipe drain to nearest floor drain for overflow and drain piping connections.

G. Install full-size vent piping to outdoors, terminating in 180-degree elbow.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. For units with single-phase motors and without control panel, wire float switch in series with each motor.

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Clean strainers.
3. Adjust steam condensate pump controls.
4. Adjust pump controls for automatic start, stop, and alarm operation.
5. Perform the following operational checks before starting:

   a. Set float switches to operate at proper levels.
   b. Check motors for proper rotation.
   c. Test pump controls and demonstrate compliance with requirements.
   d. Replace damaged or malfunctioning pump controls and equipment.
   e. Verify that pump controls are correct for required application.

6. Start steam condensate pumps in accordance with manufacturer's written startup instructions.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

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Task	Specification	Specification Description
23 22 23 00	22 11 16 00a	Steam And Condensate Piping
23 22 23 00	23 22 00 00	Underground Steam and Condensate Heating Piping
23 22 23 13	22 11 16 00a	Steam And Condensate Piping
23 22 23 13	23 22 00 00	Underground Steam and Condensate Heating Piping
23 22 23 13	23 22 23 00	Steam Condensate Pumps

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SECTION 23 23 00 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Valves and specialties.
4. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

B. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, at a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [**1/4 inch equals 1 ft. (1:50)**]<**Insert value**> .

C. Delegated Design Submittals: For refrigerant piping design, including sizing and layout, oil traps, double risers, specialties, and pipe and tube sizes to accommodate, at a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Provide plans, piping schematics, and details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Welding Certificates: For each welder performing shop or field welding on Project.

C. Field Quality Control Reports: For each specified field quality-control test and inspection.

D. Delegated Design Engineer Qualification Statement: For refrigerant piping design.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use precautions during storage as follows:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15 and ASHRAE 34.

C. Comply with ASME B31.5.

D. Test Pressure for Refrigerant R-32:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [**300 psig (2068 kPa)**]<**Insert pressure**> .
2. Suction Tubing for Heat-Pump Applications: [**535 psig (3689 kPa)**]<**Insert pressure**> .
3. Hot-Gas and Liquid Tubing: [**535 psig (3689 kPa)**]<**Insert pressure**> .

E. Test Pressure for Refrigerant R-454B:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [**300 psig (2068 kPa)**]<**Insert pressure**> .
2. Suction Tubing for Heat-Pump Applications: [**535 psig (3689 kPa)**]<**Insert pressure**> .
3. Hot-Gas and Liquid Tubing: [**535 psig (3689 kPa)**]<**Insert pressure**> .

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube, for Refrigerant Piping: [**ASTM B280, Type ACR,**][**drawn-temper**][**and**][**annealed-temper**]<**Insert ASTM standard and type**> .

B. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8M/A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
4. Working Pressure Rating: Factory test at minimum [**500 psig (3450 kPa)**]<**Insert pressure rating**> .
5. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

F. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Conex Bänninger; a part of IBP Group LLC**]
   b. [**Mueller Streamline Co.; a company of Mueller Industries**]
   c. [**Parker Hannifin; Sporlan Division**]
   d. [**RLS LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Conex Bänninger; a part of IBP Group LLC**]
   b. [**Mueller Streamline Co.; a company of Mueller Industries**]
   c. [**Parker Hannifin; Sporlan Division**]
   d. [**RLS LLC**]
   e. <**Insert manufacturer's name**>

3. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
4. Housing: Copper.
5. O-Rings: [**HNBR**]<**Insert material type**> compatible with specific refrigerant.
6. Tools: Manufacturer's approved special tools.
7. Minimum Rated Pressure: [**700 psig (48 bar)**]<**Insert pressure**> .

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and pipe schedule as selected in "Piping Application Schedules" Article.

B. Wrought-Steel Fittings: ASTM A234/A234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5 steel, including bolts, nuts, gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 and ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for **NPS 1 to NPS 1-1/2 (DN 25 to DN 40)** and ductile iron for **NPS 2 to NPS 3 (DN 50 to DN 80)**. Factory apply rust-resistant finish.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Factory apply rust-resistant finish.
4. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
5. Pressure Rating: Factory test at minimum [**400 psig (2760 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: **330 deg F (165 deg C)**.

F. Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, stainless steel-wire-reinforced protective jacket.
2. End Connections:

   a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
   b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.

3. Offset Performance: Capable of minimum **3/4-inch (20-mm)** misalignment in minimum **7-inch-(180-mm-)** long assembly.
4. Pressure Rating: Factory test at minimum [**500 psig (3450 kPa)**]<**Insert pressure**> .
5. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

2.4 Copper-Tube, Solder Fittings for Refrigerant

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.5 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
4. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
5. Operator: Rising stem and hand wheel.
6. Seat: Nylon.
7. End Connections: Socket, union, or flanged.
8. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Forged brass or cast bronze.
4. Packing: Molded stem, back seating, and replaceable under pressure.
5. Operator: Rising stem.
6. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
7. Seal Cap: Forged-brass or valox hex cap.
8. End Connections: Socket, union, threaded, or flanged.
9. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
10. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Danfoss, Inc.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker (Parker Hannifin)**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    b. [**Danfoss, Inc.**]
    c. [**Henry Technologies Inc.; The Henry Group**]
    d. [**Parker (Parker Hannifin)**]
    e. <**Insert manufacturer's name**>

3. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
4. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
5. Piston: Removable polytetrafluoroethylene seat.
6. Closing Spring: Stainless steel.
7. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
8. End Connections: Socket, union, threaded, or flanged.
9. Maximum Opening Pressure: **0.50 psig (3.4 kPa)**.
10. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
11. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**JB Industries**]
    d. [**Parker (Parker Hannifin)**]
    e. [**RectorSeal HVAC; a CSW Industrials Company**]
    f. [**Refrigeration Sales, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**JB Industries**]
    d. [**Parker (Parker Hannifin)**]
    e. [**RectorSeal HVAC; a CSW Industrials Company**]

f. [**Refrigeration Sales, Inc.**]
g. <**Insert manufacturer's name**>

3. Body: Forged brass with brass cap, including key end to remove core.
4. Core: Removable ball-type check valve with stainless steel spring.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Copper spring.
7. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

E. Refrigerant Locking Caps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**C & D Valve, LLC**]
   b. [**JB Industries**]
   c. [**RectorSeal HVAC; a CSW Industrials Company**]
   d. [**Refrigeration Sales, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**C & D Valve, LLC**]
   b. [**JB Industries**]
   c. [**RectorSeal HVAC; a CSW Industrials Company**]
   d. [**Refrigeration Sales, Inc.**]
   e. <**Insert manufacturer's name**>

3. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
4. Material: Brass, with protective shroud or sleeve.
5. Refrigerant Identification: [**Color-coded, refrigerant specific based on AHRI Guideline N**][**or**][**Universal**] design.
6. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with **AHRI 760 I-P (AHRI 761 SI)** and UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Plated steel.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Threaded.
7. Electrical: Molded, watertight coil in ANSI/NEMA 250 enclosure of type required by location with **1/2-inch (16-mm)** conduit adapter, and [**24**][**115**][**208**] V ac coil.
8. Working Pressure Rating: [**400 psig (2760 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
4. Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. End Connections: Threaded.
7. Working Pressure Rating: [**400 psig (2760 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

H. Thermostatic Expansion Valves: Comply with **AHRI 750 I-P (AHRI 751 SI)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Danfoss, Inc.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker Hannifin; Sporlan Division**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker Hannifin; Sporlan Division**]
   d. <**Insert manufacturer's name**>

3. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Packing and Gaskets: Non-asbestos.
6. Capillary and Bulb: Copper tubing filled with refrigerant charge.
7. Suction Temperature: [**40 deg F (4.4 deg C)**]<**Insert temperature**> .
8. Superheat: [**Adjustable**][**Nonadjustable**] .
9. Design: Reverse-flow option (for heat-pump applications).
10. End Connections: Socket, flare, or threaded union.
11. Working Pressure Rating: [**700 psig (4820 kPa)**][**450 psig (3100 kPa)**]<**Insert value**> .

I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. <**Insert manufacturer's name**>

3. Body, Bonnet, and Seal Cap: Ductile iron or steel.
4. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
5. Packing and Gaskets: Non-asbestos.
6. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
7. Seat: Polytetrafluoroethylene.
8. Equalizer: [**Internal**][**External**] .
9. Electrical: Molded, watertight coil in ANSI/NEMA 250 enclosure of type required by location with **1/2-inch (16-GRC)** conduit adapter and [**24**][**115**][**208**] V ac coil.
10. End Connections: Socket.
11. Set Pressure: <**Insert psig (kPa)**> .
12. Throttling Range: Maximum **5 psig (34 kPa)**.
13. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
14. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

J. Straight-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. Screen: 100-mesh stainless steel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
7. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

K. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body: Forged brass or cast bronze.
4. Drain Plug: Brass hex plug.
5. Screen: 100-mesh monel.
6. End Connections: Socket or flare.
7. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
8. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

L. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. [**RLS LLC**]
    e. <**Insert manufacturer's name**>

3. Body: Forged brass.
4. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
5. Indicator: Color-coded to show moisture content in parts per million (ppm).
6. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
7. End Connections: Socket or flare.
8. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

M. Replaceable-Core Filter Dryers: Comply with **AHRI 730 I-P (AHRI 731 SI)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Danfoss, Inc.**]
    b. [**Henry Technologies Inc.; The Henry Group**]
    c. [**Parker (Parker Hannifin)**]
    d. <**Insert manufacturer's name**>

3. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
4. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
5. Desiccant Media: Activated [**alumina**][**charcoal**] .
6. Design: Reverse flow (for heat-pump applications).

7. End Connections: Socket.
8. Access Ports: **NPS 1/4 (DN 8)** connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**> .
10. Rated Flow: <**Insert tons (kW)**> .
11. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
12. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

N. Permanent Filter Dryers: Comply with **AHRI 730 I-P (AHRI 731 SI)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. [**RLS LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Danfoss, Inc.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. [**RLS LLC**]
   e. <**Insert manufacturer's name**>

3. Body and Cover: Painted-steel shell.
4. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
5. Desiccant Media: Activated [**alumina**][**charcoal**] .
6. Design: Reverse flow (for heat-pump applications).
7. End Connections: Socket.
8. Access Ports: **NPS 1/4 (DN 8)** connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**> .
10. Rated Flow: <**Insert tons (kW)**> .
11. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
12. Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**> .

O. Mufflers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Danfoss, Inc.**]
   b. [**Emerson Climate Technologies; Emerson Electric Co.**]
   c. [**Henry Technologies Inc.; The Henry Group**]
   d. [**Parker Hannifin; Sporlan Division**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Danfoss, Inc.**]
   b. [**Emerson Climate Technologies; Emerson Electric Co.**]
   c. [**Henry Technologies Inc.; The Henry Group**]
   d. [**Parker Hannifin; Sporlan Division**]
   e. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. End Connections: Socket or flare.
5. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

P. Receivers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Henry Technologies Inc.; The Henry Group**]
   b. [**Parker Hannifin; Sporlan Division**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Henry Technologies Inc.; The Henry Group**]
   b. [**Parker Hannifin; Sporlan Division**]
   c. <**Insert manufacturer's name**>

3. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
4. Comply with UL 207; listed and labeled by an NRTL.
5. Body: Welded steel with corrosion-resistant coating.
6. Tappings: Inlet, outlet, liquid-level indicator, and safety-relief valve.
7. End Connections: Socket or threaded.
8. Working Pressure Rating: [**450 psig (3100 kPa)**]<**Insert pressure**> .
9. Maximum Operating Temperature: [**250 deg F (121 deg C)**]<**Insert temperature**> .

Q. Liquid Accumulators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Emerson Climate Technologies; Emerson Electric Co.**]
   b. [**Henry Technologies Inc.; The Henry Group**]
   c. [**Parker (Parker Hannifin)**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Emerson Climate Technologies; Emerson Electric Co.**]
b. [**Henry Technologies Inc.; The Henry Group**]
c. [**Parker (Parker Hannifin)**]
d. <**Insert manufacturer's name**>

3. Body: Welded steel with corrosion-resistant coating.
4. End Connections: Socket or threaded.
5. Working Pressure Rating: [**500 psig (3450 kPa)**]<**Insert pressure**> .
6. Maximum Operating Temperature: [**275 deg F (135 deg C)**]<**Insert temperature**> .

2.6 REFRIGERANTS

A. R-32, ASHRAE 34: Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

B. R-454B, ASHRAE 34: R-32 (68.9 percent by mass) and R-1234yf (31.1 percent by mass).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arkema Inc.**]
b. [**Honeywell International Inc.**]
c. [**Mexichem Fluor, Inc. (Koura)**]
d. [**The Chemours Company**]
e. **<Insert manufacturer's name>**

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: [**R-454B**][**R-32**]**<Insert refrigerant>** .

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller, Annealed-Temper: Copper, Type ACR, annealed-temper tubing and [**wrought-copper fittings with brazed joints**][**ACR copper fittings with pressure-seal joints**] .

C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller, Drawn-Temper: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100), Drawn-Temper: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

E. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

F. Safety-Relief-Valve Discharge Piping for Conventional Air-Conditioning (Cooling-Only) Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

G. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller, Annealed-Temper: Copper, Type ACR, annealed-temper tubing and [**wrought-copper fittings with brazed joints**][**ACR copper fittings with pressure-seal joints**] .

H. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 (DN 100) and Smaller, Drawn-Temper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

I. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 2 to NPS 4 (DN 50 to DN 100), Drawn-Temper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

J. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

K. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

L. Refrigerant Tubing for Variable Refrigerant Flow System Applications:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings, Brazed Joints: ASME B16.50.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

M. Safety-Relief-Valve Discharge Tubing for VRF Applications, Copper: Type ACR, [**drawn-temper**][**or**][**annealed-temper**] tubing and wrought-copper fittings with brazed joints.

N. Safety-Relief-Valve Discharge Piping for VRF Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 INSTALLATION OF VALVES AND SPECIALTIES

A. Install [**diaphragm packless**][**packed-angle**] valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install [**diaphragm packless**][**packed-angle**] valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Strainers: Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve [**, and in the suction line at the compressor**] .

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF REFRIGERANT PIPING, GENERAL

A. Requirements in this article apply to all piping materials, except where more specific requirements are specified in various pipe and fittings installation articles below.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

C. Install refrigerant piping in accordance with ASHRAE 15.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping adjacent to machines to allow service and maintenance.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. See Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

L. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

M. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

N. Install refrigerant piping in protective conduit where installed belowground.

O. Install refrigerant piping in rigid or flexible conduit in locations where exposed to potential mechanical injury.

P. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 INSTALLATION OF COPPER TUBE AND FITTINGS

A. When brazing copper tubing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

B. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

    a. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
    b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

4. Copper-tube, Pressure-Seal-Joint Fittings: Construct joints in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF STEEL PIPE AND FITTINGS

A. Pre-Installation Cleaning: Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

B. Joint Construction:

1. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
4. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

5. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
6. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.
7. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Piping Attachments: Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than **20 ft. (6 m)** long.
2. Roller hangers and spring hangers for individual horizontal runs **20 ft. (6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper tube.

D. Install hangers for metal tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting.

F. Support vertical runs of metal tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System must maintain test pressure at the manifold gauge throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

4. Prepare test and inspection reports.

3.8 SYSTEM CHARGING

A. Procedures: Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to **500 micrometers (67 Pa)**. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to **2 psig (14 kPa)**.
4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Adjustments: Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00 00

Task	Specification	Specification Description
23 23 13 00	23 23 00 00	Refrigerant Piping
23 23 16 00	21 05 00 00	Common Work Results for Fire Suppression
23 23 16 00	22 05 00 00	Common Work Results for Plumbing
23 23 16 00	22 13 16 00	Sanitary Waste And Vent Piping
23 23 16 00	22 14 13 00	Storm Drainage Piping
23 23 16 00	23 05 00 00	Common Work Results for HVAC
23 23 16 00	23 21 13 00	Hydronic Piping
23 23 16 00	23 23 00 00	Refrigerant Piping
23 23 16 00	23 62 00 00	Packaged Compressor and Condenser Units
23 23 23 00	23 23 00 00	Refrigerant Piping
23 23 23 00	23 62 00 00	Packaged Compressor and Condenser Units

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SECTION 23 25 00 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC water treatment.
2. Manual chemical-feed equipment.
3. Automatic chemical-feed equipment.
4. Ozone-generator biocide equipment.
5. Stainless steel pipes and fittings.
6. UV biocide equipment.
7. Chemical-treatment test equipment.
8. Chemicals.
9. Inhibited ethylene glycol and propylene glycol.
10. HVAC makeup-water softener.
11. RO equipment for HVAC makeup water.
12. Filtration equipment.

1.2 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. PPM: Parts per million.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

E. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TDS controllers.
6. TSS controllers.
7. Biocide feeder timers.
8. Chemical solution tanks.
9. Injection pumps.
10. Ozone generators.
11. UV-irradiation units.

12. Chemical test equipment.
13. Chemical material safety data sheets.
14. Inhibited ethylene glycol.
15. Inhibited propylene glycol.
16. Water softeners.
17. RO units.
18. Multimedia filters.
19. Self-cleaning strainers.
20. Replaceable bag- or cartridge-type filters.
21. Centrifugal separators.

B. Shop Drawings: Pretreatment equipment and chemical- [**and ozone-generator-biocide-**][**and UV-irradiation-biocide-**] treatment equipment, showing tanks, maintenance space required, and piping connections to HVAC systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For [**chemical-treatment equipment**][**water softeners**][**RO equipment**][**water-filtration units**] and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

F. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, [**water softeners,**][**RO equipment,**][**water-filtration units,**] and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 HVAC WATER TREATMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**LiquiTech, Inc.**]
9. [**Metro Group, Inc. (The)**]
10. [**Nalco; an Ecolab company**]
11. [**Sonitec-Vortisand Inc.**]
12. [**Suez Water Technologies (Formerly GE Water)**]
13. [**Watcon, Inc**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**LiquiTech, Inc.**]
9. [**Metro Group, Inc. (The)**]
10. [**Nalco; an Ecolab company**]
11. [**Sonitec-Vortisand Inc.**]
12. [**Suez Water Technologies (Formerly GE Water)**]
13. [**Watcon, Inc**]
14. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [**hot-water heating below 250 deg F (120 deg C)**][**chilled water**][**dual-temperature water**][**glycol heating**][**and**][**glycol cooling**] shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a value within <**Insert range**> mg/L as CaCO(3).
3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert number**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
5. Scale Control: Provide softened water for initial fill and makeup. [**Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
7. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.

8. <**Insert other applicable requirements**>.

D. Open hydronic systems, including [**condenser**][**and**][**fluid-cooler spray**] water, shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a maximum value of <**Insert range**> mg/L as CaCO(3).
3. Silica in Cooling Towers: Maintain a value no higher than <**Insert number**> mg/L.
4. Silica in Evaporative Condensers: Maintain a value no higher than <**Insert number**> mg/L.
5. Hardness in Cooling Towers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
6. Hardness in Evaporative Condensers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
7. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
8. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
9. Scale Control: [**Provide softened water for initial fill and makeup.**][**Provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]
10. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.

d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.

12. <**Insert other applicable requirements**>.

E. Passivation for Galvanized Steel:

1. Passivation of all galvanized-steel cooling towers and other system components must be conducted strictly in accordance with manufacturer's instructions in order to validate warranties. During the required passivation period, all water-quality parameters must be maintained in accordance with manufacturer's specifications, and all other requirements must be observed.

F. Steam Boiler and Steam Condensate:

1. Steam Condensate:

a. pH: Maintain a value within <**Insert range**>.
b. Alkalinity: Maintain a value no higher than <**Insert range**> mg/L as CaCO(3).
c. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
d. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
e. Ammonia: Maintain a value of <**Insert number**> mg/L.
f. <**Insert other requirements if necessary**>.

2. Steam boiler operating at **100 psig (690 kPa)** and less shall have the following water qualities:

a. Silica: Maintain a value no higher than <**Insert value**> mg/L as SiO(2).
b. TSS: Maintain a value no higher than <**Insert value**> mg/L.
c. TDS: Maintain a value no higher than <**Insert value**> mg/L.
d. Total Alkalinity: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
e. pH: Maintain a value within <**Insert range**> pH.
f. <**Insert other applicable requirements**>.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum **3-1/2-inch (89-mm)** fill opening in the top, and **NPS 3/4 (DN 20)** bottom inlet and top side outlet. Provide quarter- turn or threaded fill cap with gasket seal and diaphragm arranged to lock the top onto the feeder when exposed to system pressure in the vessel. Provide a **NPS 3/4 IN (DN 20)** quarter-turn valve on inlet and outlet.

1. Capacity: [**2 gal. (7.6 L)**][**5 gal. (19 L)**]<**Insert value**>.
2. Minimum Working Pressure: [**125 psig (860 kPa)**][**175 psig (1210 kPa)**]<**Insert value**>.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Oscillating Piston:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.

5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

B. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

C. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Provide and electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Programmable timers with infinite adjustment over full range, mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.

5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

E. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

F. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

   a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
   b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

G. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from 0.001 mg/L to 50 g/L. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 4X enclosure.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. [**Forms of digital communication:**][**MODBUS RS-232**][**MODBUS RS-485**][**Profibus DP**].
3. Digital display and touch pad for input.
4. Sensor probe adaptable to sample stream manifold.
5. High- or low-value-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.

H. Biocide Feeder Timer:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with

gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup, so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

I. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

J. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints, except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

L. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.5 OZONE-GENERATOR BIOCIDE EQUIPMENT

A. Corona discharge generator with stainless steel generating cells and transformer housed in a NEMA 250, Type 4 enclosure. Assembly shall be suitable for continuous duty. Provide site glasses to verify proper operation of generator.

B. Water-cooled generators shall be provided with cooling water at maximum [**70 deg F (21 deg C)**]<**Insert value**> and [**35 psig (241 kPa)**]<**Insert value**>.

C. Generator vessels exposed to system pressure shall be constructed in accordance with 2017 ASME Boiler and Pressure Vessel Code and be equipped with pressure-relief valve.

D. External air compressor or induced airflow through a cleanable prefilter supplies concentrated oxygen through a molecular sieve, with **minus 62 deg F (minus 52 deg C)** dew point to avoid the formation of nitric acid.

E. Microprocessor-based control with software in EEPROM, surge protection, high-temperature cutout, and operational status lights.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

F. Ozone Contactors:

1. Bubble diffusers.
2. Induction injection nozzle.
3. Injectors with static mixers.

G. Ozone Detector and Alarm Devices:

1. Detector:

a. Sensor: Metal dioxide semiconductor.
b. Concentration Range: [**0 to 10**]<**Insert range**> ppm.
c. Accuracy: Plus or minus 0.01 ppm.
d. Sensitivity: 0.01 ppm.
e. Response Time: Maximum 10 seconds.
f. Operating Temperature: **50 to 100 deg F (10 to 38 deg C)**.
g. Relative Humidity: 15 to 90 percent, noncondensing over the operating temperature range.

2. Horns:

a. Electric-vibrating-polarized type.
b. 24-V dc, with provision for housing the operating mechanism behind a grille.
c. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn.
d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Visible Alarm Devices:

a. Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
b. Rated Light Output: [**75**][**110**]<**Insert number**> candela.
c. Strobe Leads: Factory connected to screw terminals.

H. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.

1. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO(2) buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
2. Backplate: Orthopedically designed of [**chemical and impact-resistant, glass-fiber composite**][**aluminum**].

3. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps; modular in design, detachable components, and easy to clean and maintain. Shoulder straps are padded with flame-resistant material, reinforced with stainless steel cable, and attached with T-nuts, washers, and screws.
4. Air Cylinder: [**30**][**45**][**60**]-minute, low-pressure, air-supply-loaded [**fiberglass**][**aluminum**][**steel**] cylinders fitted with quick-fill assembly for refilling and air transfer.
5. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.
6. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, in accordance with 42 CFR 84, Subpart H.

2.6 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.

B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** steam working pressure and **600-psig (4140-kPa)** cold working pressure ratings.

D. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** steam working pressure and **600-psig (4140-kPa)** cold working pressure rating.

2.7 UV BIOCIDE EQUIPMENT

A. Target Irradiation: Minimum [**5,000 microWxs/sq. cm**]<**Insert value**>.

B. Light Source Vessels:

1. ASTM A666, Type 304 stainless steel.
2. Construct for minimum [**150 psig (1035 kPa)**]<**Insert value**> at [**150 deg F (65 deg C)**]<**Insert value**> in accordance with ASME Boiler and Pressure Vessel Code, and equipped with pressure-relief valve.
3. Light Source Sleeve: Quartz, with EPDM O-ring seals.
4. Light Source: Replaceable UV lamp producing minimum target irradiation of 254-nm wavelength light.

C. Controls: Interlock with pumps to operate when water is circulating.

2.8 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers; and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.

a. Size: **NPS 1/4 (DN 8)** tubing.
b. Material: ASTM A666, Type 316 stainless steel.
c. Pressure Rating: Minimum **2000 psig (13 790 kPa)**.
d. Temperature Rating: Minimum **850 deg F (454 deg C)**.

2. Shell: Cooling water.

a. Material: ASTM A666, Type 304 stainless steel.
b. Pressure Rating: Minimum **250 psig (1725 kPa)**.
c. Temperature Rating: Minimum **450 deg F (232 deg C)**.

3. Capacities and Characteristics:

a. Tube: Sample.

1) Flow Rate: [**0.25 gpm (0.016 L/s)**]<**Insert value**>.
2) Entering Temperature: [**400 deg F (204 deg C)**]<**Insert value**>.
3) Leaving Temperature: [**88 deg F (31 deg C)**]<**Insert value**>.
4) Pressure Loss: [**6.5 psig (44.8 kPa)**]<**Insert value**>.

b. Shell: Cooling water.

1) Flow Rate: [**3 gpm (0.19 L/s)**]<**Insert value**>.
2) Entering Temperature: [**70 deg F (21 deg C)**]<**Insert value**>.
3) Pressure Loss: [**1.0 psig (6.89 kPa)**]<**Insert value**>.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Two**]<**Insert number**>-station rack for closed-loop systems.
2. [**Four**]<**Insert number**>-station rack for open-loop systems.

2.9 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

B. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.

C. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range, with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum <**Insert grains/cu. ft. (kg/cu. m)**> of calcium carbonate of resin when regenerated with <**Insert lb (kg)**> of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

2.10 INHIBITED ETHYLENE GLYCOL AND PROPYLENE GLYCOL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CORECHEM**]
2. [**Dynalene**]
3. [**Fremont Industries**]
4. [**Houghton Chemical Corp.**]
5. [**The Dow Chemical Company**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CORECHEM**]
2. [**Dynalene**]
3. [**Fremont Industries**]
4. [**Houghton Chemical Corp.**]
5. [**The Dow Chemical Company**]
6. <**Insert manufacturer's name**>

C. Inhibited Ethylene Glycol:

1. Ethylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact ethylene glycol to prevent corrosion by stabilizing fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.
4. Operating Temperature Range: [**Minus 60 deg F (minus 51 deg C) to 250 deg F (121 deg C)**]<**Insert range**>.
5. Concentrated inhibited ethylene glycol is to be 95.5 percent ethylene glycol by weight and 4.5 percent performance additives.
6. Concentrated inhibited ethylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at time of installation. Use only deionized water for mixing.
7. Provide only ethylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

D. Inhibited Propylene Glycol:

1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.
4. Operating Temperature Range: [**Minus 50 deg F (minus 46 deg C) to 250 deg F (121 deg C)**]<**Insert range**>.
5. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5

percent performance additives.

6. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
7. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

2.11 HVAC MAKEUP-WATER SOFTENER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Pentair, Inc.**]
11. [**RainSoft**]
12. [**Water King**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Hungerford & Terry, Inc**]
7. [**Kinetico Incorporated**]
8. [**Marlo Incorporated**]
9. [**Parker Boiler**]
10. [**Pentair, Inc.**]
11. [**RainSoft**]
12. [**Water King**]
13. <**Insert manufacturer's name**>

C. Description: Twin mineral tanks and one brine tank, factory mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event, when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Mineral Tanks:

1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Fabricate and label fiber-reinforced plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
3. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
4. Wetted Components: Suitable for water temperatures from [**40 to at least 100 deg F (5 to at least 38 deg C)**]<**Insert range**>.
5. Freeboard: 50 percent minimum, for backwash expansion above the normal resin bed level.
6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.

G. Controls: Automatic; factory mounted on mineral tanks and factory wired.

1. Adjustable duration of regeneration steps.
2. Push-button start and complete manual operation override.
3. Pointer on pilot-control valve shall indicate cycle of operation.
4. Means of manual operation of pilot-control valve if power fails.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    e. Float-operated brine valve to automatically measure the correct amount of brine to the softener, and refill with fresh water.
    f. Sampling cocks for soft water.

6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in **gallons (liters)** and that automatically resets after regeneration to preset total in **gallons (liters)** for next service run. Include alternator to regenerate one mineral tank with the other in service.

H. Brine Tank: Combination measuring and wet-salt storing system.

1. Tank and Cover Material: Fiberglass a minimum of **3/16 inch (4.8 mm)** thick; or molded polyethylene a minimum of **3/8 inch (9.5 mm)** thick.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
3. Size: Large enough for at least four regenerations at full salting.

I. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meters.

J. Water Test Kit: Include in wall-mounted enclosure for water softener.

K. Capacities and Characteristics:

1. Continuous Service Flow Rate: <**Insert gpm (L/s)**> at **15-psig (104-kPa)** pressure loss.
2. Peak Service Flow Rate: <**Insert gpm (L/s)**> at **25-psig (173-kPa)** pressure loss.
3. Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase: <**Insert value**>.
   c. Hertz: <**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.
   g. Interrupting Capacity: <**Insert amperage**>.

2.12 RO EQUIPMENT FOR HVAC MAKEUP WATER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Marlo Incorporated**]
7. [**Pentair, Inc.**]
8. [**Water & Power Technologies Incorporated**]
9. [**Water King**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**Marlo Incorporated**]
7. [**Pentair, Inc.**]
8. [**Water & Power Technologies Incorporated**]
9. [**Water King**]
10. <**Insert manufacturer's name**>

C. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Skid Assembly: Welded-steel frame coated with epoxy protective finish.

G. RO Membrane and Housing:

1. Element: Thin-film composite with U-cup brine seal, with minimum 98 percent salt rejection based on 2000-ppm water supplied at **225 psig (1551 kPa)** and **77 deg F (25 deg C)**.
2. Housing: ASTM A666, Type 304 stainless steel, with PVC end caps held in place with stainless steel straps.

H. High-Pressure Pumps and Motors:

1. Pump:

a. Vertical, multistage, centrifugal pump, operating at 3500 rpm, with ASTM A666, Type 304 stainless steel casing, shaft, impellers, and inlet and discharge casting.
b. Bearings shall be tungsten carbide and ceramic.
c. Cast-iron frame and flanged suction and discharge connections.
d. Motor: NEMA-standard, C-faced, totally enclosed, fan-cooled motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

I. Controls:

1. Microprocessor-based controller with digital display.
2. Interlock for remote start/stop control.
3. Membrane flush sequence when pumps shut down.
4. Run time indicator.
5. Low-pressure safety cutoff.
6. Panel-mounted gages as follows:

a. Product and concentrate.
b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
c. Product conductivity monitor.

J. Valves:

1. Stainless steel pump, concentrate, and recycle throttling valves rated for minimum **300 psig (2068 kPa)**.
2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Install sample valves at cartridge filter outlet, concentrate, and product outlet.

K. Prefilter:

1. Housing: Polypropylene with built-in relief or vent valve.
2. Element: Spun-wound polypropylene.

L. Inlet Water-Tempering Valve: Thermostatic water-tempering valve to maintain [**77 deg F (25 deg C)**]<**Insert value**> inlet water temperature to RO unit.

M. Activated Carbon Filter:

1. Media Tank: Fiberglass-reinforced polyester rated for minimum **150 psig (1035 kPa)** with internal backwash distributor and filtered water collector.
2. Media: 12-by-40-mesh, bituminous coal-based activated carbon.
3. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
4. Backwash Control: Seven-day time clock.

N. Atmospheric Storage Tank:

1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.
2. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps and signal an alarm.

O. Repressurization Pumps:

1. Pumps: Two close-coupled, single-stage centrifugal pumps with mechanical seals. Wetted components are made of ASTM A666, Type 316 stainless steel.
2. Controls: NEMA 250, Type 4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.
3. Motor: Open, drip-proof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

P. Water Test Kit: Include in wall-mounting cabinet for RO unit.

Q. Capacities and Characteristics:

1. RO Product Flow Rate: <**Insert gpm (L/s)**>.
2. Total Water-Flow Rate: <**Insert gpm (L/s)**>.
3. Daily Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Storage Tank Size: <**Insert gal. (L)**>.
6. RO Inlet Operating Temperature: [**77 deg F (25 deg C)**]<**Insert value**>.
7. High-Pressure Pump:

    a. Discharge Pressure: <**Insert psig (kPa)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Horsepower: <**Insert value**>.
    d. Motor Speed: [**3500**]<**Insert number**> rpm.

8. Repressure Pumps:

    a. Discharge Pressure: <**Insert psig (kPa)**>.
    b. Flow Rate: <**Insert gpm (L/s)**>.
    c. Horsepower: <**Insert value**>.
    d. Motor Speed: [**3500**]<**Insert number**> rpm.

9. Prefilter Design (at Total Water-Flow Rate):

    a. Filter Efficiency: [**98**]<**Insert number**> percent.
    b. Particle Size: [**5**]<**Insert number**> microns and larger.
    c. Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.

d. Replacement Pressure Loss: [**6 psig (41 kPa)**]<**Insert value**>.

10. Electrical Characteristics (Single-Point Connection):

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.
g. Interrupting Capacity: <**Insert amperage**>.

2.13 FILTRATION EQUIPMENT

A. Multimedia Filters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond Water Conditioning; a Griesbach company**]
b. [**Everfilt**]
c. [**LAKOS Filtration Solutions**]
d. [**Miami Filter, Inc.**]
e. [**PEP Filters, Inc.**]
f. [**Puroflux Corporation**]
g. [**Sonitec-Vortisand Inc.**]
h. [**United Industries, Inc; Tower-flo Water Systems**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Diamond Water Conditioning; a Griesbach company**]
b. [**Everfilt**]
c. [**LAKOS Filtration Solutions**]
d. [**Miami Filter, Inc.**]
e. [**PEP Filters, Inc.**]
f. [**Puroflux Corporation**]
g. [**Sonitec-Vortisand Inc.**]
h. [**United Industries, Inc; Tower-flo Water Systems**]
i. <**Insert manufacturer's name**>

3. Description: Factory-fabricated and -tested, simplex, multimedia filter system, consisting of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.

a. Filter Tank: Corrosion resistant with distribution system and media.

4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel

Code: Section VIII, Division 1.

b. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.

c. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.

d. Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

e. FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125-psig (0.862-MPa)**][**or**][**Designation F, 150-psig (1.034-MPa)**] pressure category flanges of grade same as tank material, in accordance with ASTM D5421.

f. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

g. Strainer: Basket type mounted on pump suction.

h. Piping:

1) ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.

2) **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

i. Safety Valves: Automatic pressure relief.

j. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1) Casing: Radially split, cast iron.

2) Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.

3) Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.

5) Seal: Mechanical.

6) Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

k. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.

1) Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.

2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.

3) Backwash: Automatic; with time clock and differential pressure switch.

4) Backwash Valve: Tank mounted with valves interlocked to single actuator.

l. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event, when filter base is anchored to building structure.**]

5. Capacities and Characteristics:

a. Filter Design:

1) Water Flow: <**Insert gpm (L/s)**>.

2) Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.

3) Maximum Media-Flow Rate: [**15 gpm/sq. ft. (10.2 L/s per sq. m)**]<**Insert value**>.

4) Filtration Efficiency: [**98**]<**Insert number**> percent.
5) Particle-Specific Gravity: [**1.8**]<**Insert number**>.
6) Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

b. Filter Tank: With internal distribution piping.

1) Pressure Rating: <**Insert psig (kPa)**>.
2) Diameter: <**Insert inches (mm)**>.
3) Inlet and Outlet Size: <**Insert NPS (DN)**>.
4) Blowdown Piping Outlet Size: <**Insert NPS (DN)**>.

c. Filter Media: <**Insert material**>.
d. Start Backwash Pressure Loss: [**13 psig (90 kPa)**]<**Insert value**>.
e. Backwash Period: [**10**]<**Insert number**> minutes.
f. Circulating Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Motor Speed: <**Insert number**> rpm.
4) Inlet Size: <**Insert NPS (DN)**>.
5) Outlet Size: <**Insert NPS (DN)**>.

g. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.

h. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.
4) Interrupting Capacity: <**Insert amperage**>.

B. Self-Cleaning Strainers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Everfilt**]
b. [**Hayward Flow Control; Hayward Industries, Inc.**]
c. [**Islip Flow Controls Inc.**]
d. [**Orival, Inc.**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Everfilt**]

b. [**Hayward Flow Control; Hayward Industries, Inc.**]
c. [**Islip Flow Controls Inc.**]
d. [**Orival, Inc.**]
e. [**Sure Flow Equipment Inc**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated and -tested, ASTM A126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.

   a. Fabricate and label ASTM A126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Pipe Connections:

      1) NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

4. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.
5. Strainer: ASTM A666, Type 316 stainless steel.
6. Piping: ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
7. Safety Valves: Automatic pressure relief.
8. Backwash Arm Drive:

   a. Drive Casing: Cast iron.
   b. Worm Gears: Immersed in oil.
   c. Motor: Open, dripproof motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

9. Controls: Automatic control of backwash; factory wired for single electrical connection.

   a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.
   b. Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
   c. Backwash: Automatic; with time clock and differential pressure switch.
   d. Backwash Valve: Electric actuator.

10. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event, when strainer base is anchored to building structure.**]
11. Capacities and Characteristics:

    a. Strainer Design:

       1) Water Flow: <**Insert gpm (L/s)**>.
       2) Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
       3) Strainer Mesh: [**40**][**60**][**80**]<**Insert number**>.

    b. Strainer Tank: With internal distribution piping.

       1) Material: [**Cast iron**][**Steel**]<**Insert material**>.
       2) Pressure Rating: [**150 psig (1034 kPa)**]<**Insert value**>.
       3) Inlet and Outlet Size: <**Insert NPS (DN)**>.

4) Backwash Piping Outlet Size: <**Insert NPS (DN)**>.

c. Start Backwash: [**10 psig (69 kPa)**]<**Insert value**>.
d. Backwash Period: [**5**]<**Insert number**> minutes.
e. Drive Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.

f. Unit Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.
4) Interrupting Capacity: <**Insert amperage**>.

C. Bag- or Cartridge-Type Filters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eden Equipment Company**]
b. [**Filtration Systems; Mechanical Mfg. Corporation**]
c. [**Hayward Flow Control; Hayward Industries, Inc.**]
d. [**Parker Hannifin Corp.; Process Filtration Div**]
e. [**Pentair, Inc.**]
f. [**PEP Filters, Inc.**]
g. [**Rosedale Products, Inc.**]
h. [**Shelco Filters**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eden Equipment Company**]
b. [**Filtration Systems; Mechanical Mfg. Corporation**]
c. [**Hayward Flow Control; Hayward Industries, Inc.**]
d. [**Parker Hannifin Corp.; Process Filtration Div**]
e. [**Pentair, Inc.**]
f. [**PEP Filters, Inc.**]
g. [**Rosedale Products, Inc.**]
h. [**Shelco Filters**]
i. <**Insert manufacturer's name**>

3. Description: [**Floor-mounted housing**][**Housing**] with filter [**bags**][**cartridges**] for removing particles from water.

a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through [**bag**][**cartridge**]-type water filter; with [**bag support and**]base, feet, or skirt.

1) Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
2) Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
3) Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150-psig (1035-kPa)** plastic flanges.

b. Bag or Cartridge, Replaceable: Of shape to fit housing.

4. Capacities and Characteristics:

a. Filter Design:

1) Water-Flow Rate: <**Insert gpm (L/s)**>.
2) Filtration Efficiency: [**98**]<**Insert number**> percent.
3) Particle Size: [**10**][**20**]<**Insert number**> microns and larger.
4) Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.
5) Pressure Loss at Replacement: [**6 psig (41 kPa)**]<**Insert value**>.

b. Housing:

1) Material: [**Carbon steel**][**Plastic**].
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Seal Material: [**Nitrile rubber**]<**Insert material**>.
4) Diameter: <**Insert inches (mm)**>.
5) Height or Length: <**Insert inches (mm)**>.
6) Inlet and Outlet Size: <**Insert NPS (DN)**>.
7) Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.
8) Bag Support Basket Material: [**Stainless steel**]<**Insert material**>.

c. Bag or Cartridge:

1) Number Required: <**Insert number**>.
2) Nominal Diameter: <**Insert inches (mm)**>.
3) Nominal Length: <**Insert inches (mm)**>.
4) Media Material: [**Cotton**][**Polyester**][**Polypropylene**]<**Insert material**>.

D. Centrifugal Separators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Culligan International Company**]
b. [**Griswold Water Systems**]
c. [**LAKOS Filtration Solutions**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**Rosedale Products, Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Culligan International Company**]
b. [**Griswold Water Systems**]
c. [**LAKOS Filtration Solutions**]
d. [**PEP Filters, Inc.**]
e. [**Puroflux Corporation**]
f. [**Rosedale Products, Inc.**]
g. **<Insert manufacturer's name>**

3. Description: Simplex separator housing, with baffles and chambers for removing particles from water by centrifugal action and gravity.
4. Housing: With manufacturer's proprietary system of baffles and chambers.

   a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
   c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
   d. Collection Chamber: Designed to hold separated particles.
   e. Outlet: Near top of unit.
   f. Purge: At bottom of collection chamber.
   g. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
   h. Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.

5. Motorized Purge Valve: Gate or plug pattern valve.

   a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with [**EPDM**]**<Insert material>** valve seat and stem seal; with ASTM B148 aluminum bronze disc.
   b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Strainer: Stainless steel basket type mounted on pump suction.
7. Piping, Steel: ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
8. Piping, Copper: **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
9. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

   a. Casing: Radially split, cast iron.
   b. Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
   c. Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeve.
   e. Seal: Mechanical.
   f. Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
   g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

10. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.

a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure.
b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
c. Separator Purge: Automatic and manual.
d. TSS Controller Interlock: Open separator purge valve with bleed-off control.

11. Support: Skid mounting.[**Fabricate supports, base, and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event, when separator base is anchored to building structure.**]
12. Capacities and Characteristics:

a. Separator Design:

1) Water-Flow Rate: <**Insert gpm (L/s)**>.
2) Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
3) Separator Efficiency: [**98**]<**Insert number**> percent.
4) Particle-Specific Gravity: [**1.8**]<**Insert number**>.
5) Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

b. Housing:

1) Material: [**Steel**][**Stainless steel**][**Plastic**][**Fiberglass**]<**Insert material**>.
2) Pressure Rating: <**Insert psig (kPa)**>.
3) Diameter: <**Insert inches (mm)**>.
4) Height: <**Insert inches (mm)**>.
5) Inlet and Outlet Size: <**Insert NPS (DN)**>.
6) Purge Size: <**Insert NPS (DN)**>.

c. Circulating Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Motor Speed: <**Insert number**> rpm.
4) Inlet Size: <**Insert NPS (DN)**>.
5) Outlet Size: <**Insert NPS (DN)**>.

d. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <**Insert value**>.
2) Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: [**60**]<**Insert number**> Hz.
5) Full-Load Amperes: <**Insert value**>.
6) Minimum Circuit Ampacity: <**Insert value**>.
7) Maximum Overcurrent Protection: <**Insert amperage**>.
8) Interrupting Capacity: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including[**hot-water heating,**][**chilled water,**][**dual-temperature water,**][**glycol heating,**][**and**][**glycol cooling**], and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install water meter in makeup-water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

G. Install automatic fluid make-up equipment for glycol water system and include the following:

1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.
4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

H. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup-water softener.
2. Install water meter in makeup-water supply.
3. Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

    a. Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection.

4. Install test equipment and furnish test-kit to Owner.
5. Install RO unit for makeup water.
6. Install TDS controller with sensor and bleed valves.

    a. Bleed valves to cycle, to maintain maximum TDS concentration.

7. Install TSS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TSS concentration.

8. Install inhibitor injection timer with injection pumps and solution tanks.

a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into main steam supply header.

I. Install automatic chemical-feed equipment for open [**condenser**][**fluid-cooler spray**] water and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

3. Install test equipment, and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install TDS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TDS concentration.

5. Install TSS controller with sensor and bleed valves.

a. Bleed valves to cycle, to maintain maximum TSS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

a. Injection pumps shall operate to feed biocide on an alternating basis.

8. Install ozone generator with diffusers in condenser-water piping.

a. Ozone generator shall operate continuously with condenser-water flow.

9. Install UV-irradiation lamps in condenser-water piping.

a. UV lights shall operate continuously with condenser-water flow.

3.3 INSTALLATION OF OZONE GENERATOR

A. Install ozone generator and equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Pipe ozone from ozone generator to condenser water with stainless steel pipe and fittings with welded

joints.

D. Install [**two**][**three**]-piece, stainless steel ball valve in ozone supply to condenser water.

E. Pipe cooling water to ozone generator and to air-gap drain fitting with stainless steel pipe and fittings with welded joints where enclosed in ozone-generator room.

F. Install [**two**][**three**]-piece, stainless steel ball valve in cooling water supply to ozone generator.

G. Mounting supports for ozone generator shall be ASTM A666, Type 316 stainless steel.

H. Mount breathing apparatus outside ozone-generator room.

I. Mount and install ozone detector, warning lights, and audible alarm inside ozone-generator room. Mount another set of warning lights and audible alarm just outside the main entrance to ozone-generator room.

3.4 INSTALLATION OF UV-IRRADIATION UNIT

A. Install UV-irradiation units on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for UV-irradiation units and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.5 INSTALLATION OF WATER SOFTENER

A. Install water softener equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals, and place specified mineral into mineral tanks.

E. Install water-testing sets on wall adjacent to water softeners.

3.6 INSTALLATION OF RO UNIT

A. Install RO unit and storage tank on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.

D. Install water-testing sets on wall adjacent to RO unit.

3.7 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. See Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.8 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.9 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

E. Equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report, advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at [**four**][**six**][**eight**]<**Insert number**>-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

H. At [**four**][**six**][**eight**]<**Insert number**>-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

I. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.10 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for [**cooling, chilled-water piping**][**heating, hot-water piping**][**heating, steam and condensate piping**][**steam and condensate system for humidifier and cooking appliance applications**][**condenser-water piping**] and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment. When training is complete, turn over video to Owner for future use.

END OF SECTION 23 25 00 00

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SECTION 23 25 00 00A - WATER TREATMENT FOR OPEN-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for open-loop hydronic systems.
2. Automatic chemical-feed equipment.
3. Ozone-generator biocide equipment.
4. Stainless steel pipes and fittings.
5. UV biocide equipment.
6. Chemical-treatment test equipment.
7. Chemicals.
8. TDS controllers.
9. TSS controllers.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water treatment of water softeners, RO equipment, and filtration equipment.

1.2 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. PPM: Parts per million.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

E. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Water meters.
2. Inhibitor injection timers.
3. pH controllers.
4. TDS controllers.
5. Biocide feeder timers.
6. Chemical solution tanks.
7. Injection pumps.
8. Ozone generators.
9. UV-irradiation units.

10. Chemical-treatment test equipment.
11. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment equipment and chemical- [**and ozone-generator-biocide-**][**and UV-irradiation-biocide-**]treatment equipment, showing tanks, maintenance space required, and piping connections to HVAC systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

F. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR OPEN-LOOP HYDRONIC SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]
11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]
11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Open hydronic systems, including [**condenser**][**and**][**fluid-cooler spray**] water, shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a maximum value of <**Insert range**> mg/L as CaCO(3).
3. Silica in Cooling Towers: Maintain a value no higher than <**Insert number**> mg/L.

4. Silica in Evaporative Condensers: Maintain a value no higher than <**Insert number**> mg/L.
5. Hardness in Cooling Towers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
6. Hardness in Evaporative Condensers: Maintain a value no higher than <**Insert value**> mg/L as CaCO(3).
7. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
8. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert number**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
9. Scale Control: [**Provide softened water for initial fill and makeup.**][**Provide sufficient scale inhibitors to prevent formation of scale, and maintain all scale-forming material in solution.**]
10. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.

12. <**Insert other applicable requirements**>.

D. Passivation for Galvanized Steel:

1. Passivation of all galvanized-steel cooling towers and other system components must be conducted strictly in accordance with manufacturer's instructions in order to validate warranties. During the required passivation period, all water-quality parameters must be maintained in accordance with manufacturer's specifications, and all other requirements must be observed.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Oscillating Piston:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

B. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.

4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flowrate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

C. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Programmable timers, with infinite adjustment over full range, mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High- or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.

7. Internal adjustable hysteresis or deadband.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

    a. Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

G. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from 0.001 mg/L to 50 g/L. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 4X enclosure.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. [**Forms of Digital Communication:**][**MODBUS RS-232**][**MODBUS RS-485**][**Profibus DP**].
3. Digital display and touch pad for input.
4. Sensor probe adaptable to sample stream manifold.
5. High- or low-value-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.

H. Biocide Feeder Timer:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup, so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

I. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

J. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints, except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

L. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.4 OZONE-GENERATOR BIOCIDE EQUIPMENT

A. Corona discharge generator with stainless steel generating cells, and transformer housed in a NEMA 250, Type 4 enclosure. Assembly shall be suitable for continuous duty. Include factory-mounted site glasses to verify proper operation of generator.

B. Water-cooled generators shall be provided with cooling water at maximum [**70 deg F (21 deg C)**]<**Insert value**> and [**35 psig (241 kPa)**]<**Insert value**>.

C. Generator vessels shall be constructed in accordance with 2017 ASME Boiler and Pressure Vessel Code, bear an ASME label, and be equipped with pressure relief valve.

D. External air compressor or induced airflow through a cleanable prefilter shall supply concentrated oxygen through a molecular sieve, with **minus 62 deg F (minus 52 deg C)** dew point to avoid the formation of nitric acid.

E. Controls: Microprocessor based with software in EEPROM, surge protection, high-temperature cutout, and operational status lights.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

F. Ozone Contactors:

1. Bubble diffusers.
2. Induction injection nozzle.

3. Injectors with static mixers.

G. Ozone Detector and Alarm Devices:

1. Detector:

a. Sensor: Metal dioxide semiconductor.
b. Concentration Range: [**0 to 10**]<**Insert range**> ppm.
c. Accuracy: Plus or minus 0.01 ppm.
d. Sensitivity: 0.01 ppm.
e. Response Time: Maximum 10 seconds.
f. Operating Temperature: **50 to 100 deg F (10 to 38 deg C)**.
g. Relative Humidity: 15 to 90 percent, noncondensing over the operating temperature range.

2. Horns:

a. Electric-vibrating-polarized type.
b. 24-V dc, with provision for housing the operating mechanism behind a grille.
c. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn.
d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Visible Alarm Devices:

a. Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
b. Rated Light Output: [**75**][**110**]<**Insert number**> candela.
c. Strobe Leads: Factory connected to screw terminals.
d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand, compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.

1. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO(2) buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
2. Backplate: Orthopedically designed of [**chemical and impact-resistant, glass-fiber composite**][**aluminum**].
3. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps; modular in design, detachable components, and easy to clean and maintain. Shoulder straps are padded with flame-resistant material, reinforced with stainless steel cable, and attached with T-nuts, washers, and screws.
4. Air Cylinder: [**30**][**45**][**60**]-minute, low-pressure, air-supply-loaded [**fiberglass**][**aluminum**][**steel**] cylinders fitted with quick-fill assembly for refilling and air transfer.
5. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.
6. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, in accordance with 42 CFR 84, Subpart H.

2.5 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.

B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** steam working-pressure rating and **600-psig (4140-kPa)** cold working-pressure rating.

D. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** steam working pressure and **600-psig (4140-kPa)** cold working pressure rating.

2.6 UV BIOCIDE EQUIPMENT

A. Target Irradiation: Minimum 30 mJ x s/sq. cm.

B. Light Source Vessels:

1. ASTM A666, Type 304 stainless steel.
2. Construct for minimum [**150 psig (1035 kPa)**]<**Insert value**> at [**150 deg F (65 deg C)**]<**Insert value**> in accordance with 2017 ASME Boiler and Pressure Vessel Code, and equip with pressure-relief valve.
3. Light Source Sleeve: Quartz, with EPDM O-ring seals.
4. Light Source: Replaceable UV lamp producing a minimum target irradiation of 254-nm wavelength light.

C. Controls: Interlock with pumps to operate when water is circulating.

2.7 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Four**]<**Insert number**>-station rack for open systems.

2.8 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Install automatic chemical-feed equipment for open [**condenser**][**fluid-cooler spray**] water, and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection.

3. Install test equipment and provide test kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install TDS controller with sensor and bleed valves.

    a. Bleed valves to cycle, to maintain maximum TDS concentration.

5. Install TSS controller with sensor and bleed valves.

    a. Bleed valves to cycle, to maintain maximum TSS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

8. Install ozone generator with diffusers in condenser-water piping.

a. Ozone generator shall operate continuously with condenser-water flow.

9. Install UV-irradiation lamps in condenser-water piping.

a. UV lights shall operate continuously with condenser-water flow.

3.3 INSTALLATION OF OZONE GENERATOR

A. Install ozone generator and equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Pipe ozone from ozone generator to condenser water with stainless steel pipe and fittings with welded joints.

D. Install [**two**][**three**]-piece, stainless steel ball valve in ozone supply to condenser water.

E. Pipe cooling water to ozone generator and to air-gap drain fitting with stainless steel pipe and fittings with welded joints where enclosed in ozone-generator room.

F. Install [**two**][**three**]-piece, stainless steel ball valve in cooling water supply to ozone generator.

G. Mounting supports for ozone generator shall be ASTM A666, Type 316 stainless steel.

H. Mount breathing apparatus outside ozone-generator room.

I. Mount and install ozone detector, warning lights, and audible alarm inside ozone-generator room. Mount another set of warning lights and audible alarm just outside the main entrance to ozone-generator room.

3.4 INSTALLATION OF UV-IRRADIATION UNIT

A. Install UV-irradiation units on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for UV-irradiation units and floor-mounting accessories, and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.5 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for dielectric fittings.

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate

Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

3.6 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. At [**four**][**six**][**eight**]<**Insert number**>-week intervals following Substantial Completion, perform separate water analyses on HVAC systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

F. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for [**condenser-water piping**]and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and hydronic water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

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SECTION 23 25 00 00B - WATER TREATMENT FOR STEAM SYSTEM FEEDWATER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for steam system feedwater.
2. Automatic chemical-feed equipment.
3. Stainless steel pipes and fittings.
4. Chemical-treatment test equipment.
5. Chemicals.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water treatment of water softeners, RO equipment, and filtration equipment.

1.2 DEFINITIONS

A. RO: Reverse osmosis.

B. TDS: Total dissolved solids.

C. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Water meters.
2. Inhibitor injection timers.
3. pH controllers.
4. TDS controllers.
5. TSS controllers.
6. Chemical solution tanks.
7. Injection pumps.
8. Chemical-treatment test equipment.
9. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to steam systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steam System Water-Treatment Service Provider Qualifications: An experienced steam system water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR STEAM SYSTEM FEEDWATER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]

11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]
11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for steam systems shall minimize corrosion and scale buildup for optimum efficiency of steam and condensate equipment without creating a hazard to operating personnel or the environment.

B. Base steam system feedwater treatment on quality of water available at Project site, steam and condensate system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1. Steam Condensate:

   a. pH: Maintain a value within <**Insert range**>.
   b. Alkalinity: Maintain a value no higher than <**Insert range**> mg/L as CaCO(3).
   c. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
   d. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
   e. Ammonia: Maintain a value of <**Insert number**> mg/L.
   f. <**Insert other requirements if necessary**>.

2. Steam boiler operating at **100 psig (690 kPa)** and less shall have the following water qualities:

   a. Silica: Maintain a value no higher than <**Insert value**> mg/L as SiO(2).
   b. TSS: Maintain a value no higher than <**Insert value**> mg/L.
   c. TDS: Maintain a value no higher than <**Insert value**> mg/L.
   d. Total Alkalinity: Maintain a value no higher than <**Insert value**>mg/L as CaCO(3).
   e. pH: Maintain a value within <**Insert range**> pH.
   f. <**Insert other applicable requirements**>.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Oscillating Piston:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Programmable timers with infinite adjustment over full range, mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

D. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.

7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

E. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

F. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

   a. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

G. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from 0.001 mg/L to 50 g/L. Incorporate solid-state integrated circuits and digital display in NEMA 250 Type 4X enclosure.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. [**Forms of digital communication:**][**MODBUS RS-232**][**MODBUS RS-485**][**Profibus DP**].
3. Digital display and touch pad for input.
4. Sensor probe adaptable to sample stream manifold.
5. High- or low-value-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.

H. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

I. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

K. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.4 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.

B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** steam working-pressure rating and **600-psig (4140-kPa)** cold working-pressure rating.

D. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** steam working-pressure rating and **600-psig (4140-kPa)** cold working-pressure rating.

2.5 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure

boilers, and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.

a. Size: **NPS 1/4 (DN 8)** tubing.
b. Material: ASTM A666, Type 316 stainless steel.
c. Pressure Rating: Minimum **2000 psig (13 790 kPa)**.
d. Temperature Rating: Minimum **850 deg F (454 deg C)**.

2. Shell: Cooling water.

a. Material: ASTM A666, Type 304 stainless steel.
b. Pressure Rating: Minimum **250 psig (1725 kPa)**.
c. Temperature Rating: Minimum **450 deg F (232 deg C)**.

3. Capacities and Characteristics:

a. Tube: Sample.

1) Flow Rate: [**0.25 gpm (0.016 L/s)**]<**Insert value**>.
2) Entering Temperature: [**400 deg F (204 deg C)**]<**Insert value**>.
3) Leaving Temperature: [**88 deg F (31 deg C)**]<**Insert value**>.
4) Pressure Loss: [**6.5 psig (44.8 kPa)**]<**Insert value**>.

b. Shell: Cooling water.

1) Flow Rate: [**3 gpm (0.19 L/s)**]<**Insert value**>.
2) Entering Temperature: [**70 deg F (21 deg C)**]<**Insert value**>.
3) Pressure Loss: [**1.0 psig (6.89 kPa)**]<**Insert value**>.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Two**]<**Insert number**>-station rack for closed-loop systems.
2. [**Four**]<**Insert number**>-station rack for open-loop systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Install automatic chemical-feed equipment for steam boiler and steam condensate systems, and include the following:

1. Install makeup-water softener.
2. Install water meter in makeup-water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and furnish test kit to Owner.
5. Install RO unit for makeup water.
6. Install TDS controller with sensor and bleed valves.

    a. Bleed valves to cycle, to maintain maximum TDS concentration.

7. Install TSS controller with sensor and bleed valves.

    a. Bleed valves shall cycle, to maintain maximum TSS concentration.

8. Install inhibitor injection timer with injection pumps and solution tanks.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into main steam supply header.

G. Install automatic chemical-feed equipment for [**condenser**][**fluid-cooler spray**] water and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

3. Install test equipment and provide test kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install TSS controller with sensor and bleed valves.

    a. Bleed valves shall cycle, to maintain maximum TSS concentration.

5. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

3.3 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between steam system water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232113 "Hydronic Piping" for dielectric fittings.

C. Install shutoff valves on steam system water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place steam system water-treatment system into operation and calibrate controls during the preliminary phase of steam system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at [**four**][**six**][**eight**]<**Insert number**>-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.6 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for [**heating, steam and condensate piping**][**condenser-water piping**] and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and steam system water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain steam and condensate-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 23 25 00 00B

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SECTION 23 25 00 00C - WATER TREATMENT FOR HUMIDIFICATION STEAM SYSTEM FEEDWATER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for humidification steam system feedwater.
2. Automatic chemical-feed equipment.
3. Stainless steel pipes and fittings.
4. Chemical-treatment test equipment.
5. Chemicals.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water treatment of water softeners, RO equipment, and filtration equipment.

1.2 DEFINITIONS

A. RO: Reverse osmosis.

B. TDS: Total dissolved solids.

C. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Water meters.
2. Inhibitor injection timers.
3. pH controllers.
4. TDS controllers.
5. TSS controllers.
6. Chemical solution tanks.
7. Injection pumps.
8. Chemical-treatment test equipment.
9. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment equipment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to humidification steam feedwater systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For equipment and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Water-Treatment Humidification Steam System Feedwater Service Provider Qualifications: An experienced service provider of HVAC water treatment for humidification steam system feedwater, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR HUMIDIFICATION STEAM SYSTEM FEEDWATER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]

9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]
11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Suez Water Technologies (Formerly GE Water)**]
11. [**Watcon, Inc**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for humidification steam systems shall minimize corrosion and scale buildup for optimum efficiency of humidification steam equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, humidification steam system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1. Steam Condensate:

a. pH: Maintain a value within <**Insert range**>.
b. Alkalinity: Maintain a value no higher than <**Insert range**> mg/L as CaCO(3).
c. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
d. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert value**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
e. Ammonia: Maintain a value of <**Insert number**> mg/L.
f. <**Insert other requirements if necessary**>.

2. Steam boiler operating at 100 psig (690 kPa) and less shall have the following water qualities:

a. Silica: Maintain a value no higher than <**Insert value**> mg/L as SiO(2).
b. TSS: Maintain a value no higher than <**Insert value**> mg/L.
c. TDS: Maintain a value no higher than <**Insert value**> mg/L.
d. Total Alkalinity: Maintain a value no higher than <**Insert value**>mg/L as CaCO(3).
e. pH: Maintain a value within <**Insert range**> pH.
f. <**Insert other applicable requirements**>.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Oscillating Piston:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

B. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

C. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure

with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

    a. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

E. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves: Motorized ball valve, steel body, and TFE seats and seals.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25

percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.4 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269/A269M, Type 316.

B. Stainless Steel Fittings: Comply with ASTM A815/A815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** steam working-pressure rating and **600-psig (4140-kPa)** cold working-pressure rating.

D. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351/A351M, Type 316 stainless steel body; ASTM A276/A276M, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** steam working-pressure rating and **600-psig (4140-kPa)** cold working-pressure rating.

2.5 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, TDS, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Two**]<**Insert number**>-station rack for closed-loop systems.
2. [**Four**]<**Insert number**>-station rack for open-loop systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in "Performance Requirements" Article.

B. Chemicals to be FDA approved and safe for use with direct steam injection humidification and for steam used in direct contact with food.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

B. Install water-testing equipment on wall near water-chemical-application equipment.

C. Install interconnecting control wiring for chemical-treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Install automatic chemical-feed equipment for water, and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

   a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

3. Install test equipment and provide test kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install TDS controller with sensor and bleed valves.

   a. Bleed valves to cycle, to maintain maximum TDS concentration.

5. Install TSS controller with sensor and bleed valves.

   a. Bleed valves to cycle, to maintain maximum TSS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

   a. Injector pumps shall operate to maintain required pH.

3.3 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, to allow service and maintenance.

B. Make piping connections between steam system water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232113 "Hydronic Piping" for dielectric fittings.

C. Install shutoff valves on humidifier steam system water-treatment equipment inlet and outlet. Metal

general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place humidifier steam system water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at [**four**][**six**][**eight**]<**Insert number**>-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water

quality within performance requirements specified in this Section.

F. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.6 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for humidification steam and condensate piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and steam system water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain steam and condensate-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 23 25 00 00C

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SECTION 23 25 00 00D - HVAC MAKEUP-WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following HVAC water-filtration equipment:

1. HVAC makeup-water softeners.
2. RO equipment for HVAC makeup water.
3. Water filters, multimedia type.
4. Self-cleaning strainers.
5. Water filters, bag type.
6. Water filters, cartridge type.
7. Centrifugal separators.
8. Water-softener chemicals.

B. Related Requirements:

1. Section 232513 "Water Treatment for Closed-Loop Hydronic Systems" for hydronic water-treatment equipment.
2. Section 232516 "Water Treatment for Open-Loop Hydronic Systems" for hydronic heating and cooling water-treatment equipment.
3. Section 232519 "Water Treatment for Steam System Feedwater" for water treatment of steam system feedwater.
4. Section 232523 "Water Treatment for Humidification Steam System Feedwater" for water treatment equipment of humidification steam system feedwater.

1.2 DEFINITIONS

A. RO: Reverse osmosis.

B. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Water softeners.
2. RO units.
3. Water filters, multimedia type.
4. Self-cleaning strainers.
5. Water filters, bag type.
6. Water filters, cartridge type.
7. Centrifugal separators.

B. Shop Drawings: Softeners and filtration equipment, maintenance space required, and piping connections to HVAC systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For [**water softeners**][**RO equipment**][**water-filtration units**] and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, [**water softeners,**][**RO equipment,**][**water-filtration units,**] and controllers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 HVAC MAKEUP-WATER SOFTENER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**EVOQUA Water Technologies**]
7. [**Hungerford & Terry, Inc**]
8. [**Hydro Service and Supplies**]
9. [**Kinetico Incorporated**]
10. [**Marlo Incorporated**]
11. [**Parker Boiler**]
12. [**Pentair, Inc.**]
13. [**RainSoft**]
14. [**Water King**]

15. [**WATTS; A Watts Water Technologies Company**]
16. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**EVOQUA Water Technologies**]
7. [**Hungerford & Terry, Inc**]
8. [**Hydro Service and Supplies**]
9. [**Kinetico Incorporated**]
10. [**Marlo Incorporated**]
11. [**Parker Boiler**]
12. [**Pentair, Inc.**]
13. [**RainSoft**]
14. [**Water King**]
15. [**WATTS; A Watts Water Technologies Company**]
16. <**Insert manufacturer's name**>

C. Description: Twin mineral tanks and one brine tank, factory mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure, as recommended in writing by manufacturer.

F. Mineral Tanks:

1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Fabricate and label fiber-reinforced plastic (FRP) filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
3. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
4. Wetted Components: Suitable for water temperatures from [**40 to at least 100 deg F (5 to at least 38 deg C)**]<**Insert range**>.
5. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.

G. Controls: Automatic; factory mounted on mineral tanks and factory wired.

1. Adjustable duration of regeneration steps.
2. Push-button start and complete manual operation override.
3. Pointer on pilot-control valve to indicate cycle of operation.

4. Means of manual operation of pilot-control valve if power fails.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    e. Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
    f. Sampling cocks for soft water.

6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in **gallons (liters)** and that automatically resets after regeneration to preset total in **gallons (liters)** for next service run. Include alternator to regenerate one mineral tank with the other in service.

H. Brine Tank: Combination measuring and wet-salt storing system.

1. Tank and Cover Material: Fiberglass a minimum of **3/16 inch (4.8 mm)** thick; or molded polyethylene a minimum of **3/8 inch (9.5 mm)** thick.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
3. Size: Large enough for at least four regenerations at full salting.

I. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meters.

J. Water Test Kit: Include in wall-mounted enclosure for water softener.

K. Capacities and Characteristics:

1. Continuous Service Flow Rate: <**Insert gpm (L/s)**> at **15-psig (104-kPa)** pressure loss.
2. Peak Service Flow Rate: <**Insert gpm (L/s)**> at **25-psig (173-kPa)** pressure loss.
3. Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
    g. Interrupting Capacity: <**Insert amperage**>.

2.2 RO EQUIPMENT FOR HVAC MAKEUP WATER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**EVOQUA Water Technologies**]
7. [**Hydro Service and Supplies**]
8. [**Marlo Incorporated**]
9. [**Pentair, Inc.**]
10. [**Water & Power Technologies Incorporated**]
11. [**Water King**]
12. [**WATTS; A Watts Water Technologies Company**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**CSI Water Treatment Systems**]
3. [**Culligan International Company**]
4. [**Diamond Water Conditioning; a Griesbach company**]
5. [**Ecodyne Limited**]
6. [**EVOQUA Water Technologies**]
7. [**Hydro Service and Supplies**]
8. [**Marlo Incorporated**]
9. [**Pentair, Inc.**]
10. [**Water & Power Technologies Incorporated**]
11. [**Water King**]
12. [**WATTS; A Watts Water Technologies Company**]
13. <**Insert manufacturer's name**>

C. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Skid Assembly: Welded-steel frame coated with epoxy protective finish.

G. RO Membrane and Housing:

1. Element: Thin-film composite with U-cup brine seal, with minimum 98 percent salt rejection based on 2000-ppm water supplied at **225 psig (1551 kPa)** and **77 deg F (25 deg C)**.
2. Housing: ASTM A666, Type 304 stainless steel, with PVC end caps held in place with stainless steel straps.

H. High-Pressure Pumps and Motors:

1. Pump:

   a. Vertical, multistage, centrifugal pump, operating at 3500 rpm, with ASTM A666, Type 304 stainless steel casing, shaft, impellers, and inlet and discharge casting.
   b. Bearings to be tungsten carbide and ceramic.
   c. Cast-iron frame and flanged suction and discharge connections.

2. Motor: NEMA-standard, C-faced, totally enclosed, fan-cooled motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

I. Controls:

1. Microprocessor-based controller with digital display.
2. Interlock for remote start/stop control.
3. Membrane flush sequence when pumps shut down.
4. Run time indicator.
5. Low-pressure safety cutoff.
6. Panel-mounted gages as follows:

   a. Product and concentrate.
   b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
   c. Product conductivity monitor.

J. Valves:

1. Stainless steel pump, concentrate, and recycle throttling valves rated for minimum **300 psig (2068 kPa)**.
2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Provide sample valves at cartridge filter outlet, concentrate, and product outlet.

K. Prefilter:

1. Housing: Polypropylene with built-in relief or vent valve.
2. Element: Spun-wound polypropylene.

L. Inlet Water-Tempering Valve: Thermostatic water-tempering valve to maintain [**77 deg F (25 deg C)**]<**Insert value**> inlet water temperature to RO unit.

M. Activated Carbon Filter:

1. Media Tank: Fiberglass-reinforced polyester rated for minimum **150 psig (1035 kPa)** with internal backwash distributor and filtered water collector.
2. Media: 12-by-40-mesh, bituminous coal-based activated carbon.
3. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
4. Backwash Control: Seven-day time clock.

N. Atmospheric Storage Tank:

1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron

filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.

2. Control: Level switches start and stop RO unit. Low-level limit to stop repressurization pumps, and signal an alarm.

O. Repressurization Pumps:

1. Pumps: Two close-coupled, single-stage centrifugal pumps, with mechanical seals. Wetted components to be made of ASTM A666, Type 316 stainless steel.
2. Controls: NEMA 250, Type 4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.
3. Motor: Open, drip-proof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

P. Water Test Kit: Include in wall-mounting cabinet for RO unit.

Q. Capacities and Characteristics:

1. RO Product Flow Rate: <**Insert gpm (L/s)**>.
2. Total Water-Flow Rate: <**Insert gpm (L/s)**>.
3. Daily Water Consumption: <**Insert gal./day (cu. m/day)**>.
4. Water Demand: <**Insert number**> hours/day.
5. Storage Tank Size: <**Insert gal. (L)**>.
6. RO Inlet Operating Temperature: [**77 deg F (25 deg C)**]<**Insert value**>.
7. High-Pressure Pump:

   a. Discharge Pressure: <**Insert psig (kPa)**>.
   b. Flow Rate: <**Insert gpm (L/s)**>.
   c. Horsepower: <**Insert value**>.
   d. Motor Speed: [**3500**]<**Insert number**> rpm.

8. Repressure Pumps:

   a. Discharge Pressure: <**Insert psig (kPa)**>.
   b. Flow Rate: <**Insert gpm (L/s)**>.
   c. Horsepower: <**Insert value**>.
   d. Motor Speed: [**3500**]<**Insert number**> rpm.

9. Prefilter Design (at Total Water Flow Rate):

   a. Filter Efficiency: [**98**]<**Insert number**> percent.
   b. Particle Size: [**5**]<**Insert number**> microns and larger.
   c. Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.
   d. Replacement Pressure Loss: [**6 psig (41 kPa)**]<**Insert value**>.

10. Electrical Characteristics (Single-Point Connection):

    a. Volts: <**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
    g. Interrupting Capacity: <**Insert amperage**>.

2.3 WATER FILTERS, MULTIMEDIA TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aqua Pure Water Conditioning**]
2. [**Diamond Water Conditioning; a Griesbach company**]
3. [**Everfilt**]
4. [**LAKOS Filtration Solutions**]
5. [**Miami Filter, Inc.**]
6. [**MWF Metro Water Filter**]
7. [**PEP Filters, Inc.**]
8. [**Puroflux Corporation**]
9. [**Sonitec-Vortisand Inc.**]
10. [**United Industries, Inc; Tower-flo Water Systems**]
11. [**Water Professionals**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aqua Pure Water Conditioning**]
2. [**Diamond Water Conditioning; a Griesbach company**]
3. [**Everfilt**]
4. [**LAKOS Filtration Solutions**]
5. [**Miami Filter, Inc.**]
6. [**MWF Metro Water Filter**]
7. [**PEP Filters, Inc.**]
8. [**Puroflux Corporation**]
9. [**Sonitec-Vortisand Inc.**]
10. [**United Industries, Inc; Tower-flo Water Systems**]
11. [**Water Professionals**]
12. <**Insert manufacturer's name**>

C. Description: Factory-fabricated and -tested, simplex, multimedia filter system, consisting of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.

1. Filter Tank: Corrosion resistant with distribution system and media.

   a. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
   c. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
   d. Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
   e. FRP Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Type A, integral; [**Designation E, 125-psig (0.862-MPa)**][**or**][**Designation F, 150-psig (1.034-MPa)**] pressure category flanges of grade same as tank material in accordance with ASTM D5421.

2. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

3. Strainer: Basket type mounted on pump suction.
4. Piping:

    a. ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
    b. **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

5. Safety Valves: Automatic pressure relief.
6. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

    a. Casing: Radially split, cast iron.
    b. Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
    c. Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
    d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
    e. Seal: Mechanical.
    f. Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

7. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.

    a. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.
    b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
    c. Backwash: Automatic; with time clock and differential pressure switch.
    d. Backwash Valve: Tank mounted with valves interlocked to single actuator.

8. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event, when filter base is anchored to building structure.**]

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Capacities and Characteristics:

1. Filter Design:

    a. Water Flow: <**Insert gpm (L/s)**>.
    b. Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
    c. Maximum Media-Flow Rate: [**15 gpm/sq. ft. (10.2 L/s per sq. m)**]<**Insert value**>.
    d. Filtration Efficiency: [**98**]<**Insert number**> percent.
    e. Particle-Specific Gravity: [**1.8**]<**Insert number**>.
    f. Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

2. Filter Tank: With internal distribution piping.

    a. Pressure Rating: <**Insert psig (kPa)**>.
    b. Diameter: <**Insert inches (mm)**>.
    c. Inlet and Outlet Size: <**Insert NPS (DN)**>.
    d. Blowdown Piping Outlet Size: <**Insert NPS (DN)**>.

3. Filter Media: <**Insert material**>.

4. Start Backwash Pressure Loss: [**13 psig (90 kPa)**]<**Insert value**>.
5. Backwash Period: [**10**]<**Insert number**> minutes.
6. Circulating Pump:

    a. Capacity: <**Insert gpm (L/s)**>.
    b. Total Dynamic Head: <**Insert feet (kPa)**>.
    c. Motor Speed: <**Insert number**> rpm.
    d. Inlet Size: <**Insert NPS (DN)**>.
    e. Outlet Size: <**Insert NPS (DN)**>.

7. Pump Motor Size and Electrical Characteristics:

    a. Horsepower: <**Insert value**>.
    b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
    c. Phase: [**Single**][**Three**].
    d. Hertz: [**60**]<**Insert number**> Hz.

8. Unit Electrical Characteristics:

    a. Full-Load Amperes: <**Insert value**>.
    b. Minimum Circuit Ampacity: <**Insert value**>.
    c. Maximum Overcurrent Protection: <**Insert amperage**>.
    d. Interrupting Capacity: <**Insert amperage**>.

2.4 SELF-CLEANING STRAINERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. Everfilt.
2. Hayward Flow Control; Hayward Industries, Inc.
3. Islip Flow Controls Inc.
4. Orival, Inc.
5. Sure Flow Equipment Inc.
6. <**Insert manufacturer's name**>.

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

C. Description: Factory-fabricated and -tested, ASTM A126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.

1. Fabricate and label ASTM A126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Pipe Connections:

    a. NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
    b. NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with [**EPDM**]<**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

F. Strainer: Stainless steel.

G. Piping: ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.

H. Safety Valves: Automatic pressure relief.

I. Backwash Arm Drive:

1. Drive Casing: Cast iron.
2. Worm Gears: Immersed in oil.
3. Motor: Open, dripproof motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

J. Controls: Automatic control of backwash; factory wired for single electrical connection.

1. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure with time clock and pressure gages.
2. Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
3. Backwash: Automatic; with time clock and differential pressure switch.
4. Backwash Valve: Electric actuator.

K. Support: Skid mounting.[**Fabricate supports, base, and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event, when strainer base is anchored to building structure.**]

L. Capacities and Characteristics:

1. Strainer Design:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Clean Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
c. Strainer Mesh: [**40**][**60**][**80**]<**Insert number**>.

2. Strainer Tank: With internal distribution piping.

a. Material: [**Cast iron**][**Steel**]<**Insert material**>.
b. Pressure Rating: [**150 psig (1034 kPa)**]<**Insert value**>.
c. Inlet and Outlet Size: <**Insert NPS (DN)**>.
d. Backwash Piping Outlet Size: <**Insert NPS (DN)**>.

3. Start Backwash: [**10 psig (69 kPa)**]<**Insert value**>.
4. Backwash Period: [**5**]<**Insert number**> minutes.
5. Drive Motor Size and Electrical Characteristics:

a. Horsepower: <**Insert value**>.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
c. Phase: [**Single**][**Three**].
d. Hertz: [**60**]<**Insert number**> Hz.

6. Unit Electrical Characteristics:

a. Full-Load Amperes: <**Insert value**>.
b. Minimum Circuit Ampacity: <**Insert value**>.
c. Maximum Overcurrent Protection: <**Insert amperage**>.
d. Interrupting Capacity: <**Insert amperage**>.

2.5 WATER FILTERS, BAG TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eden Equipment Company**]
2. [**Filtration Systems; Mechanical Mfg. Corporation**]
3. [**Hayward Flow Control; Hayward Industries, Inc.**]
4. [**Parker Hannifin Corp.; Process Filtration Div**]
5. [**Pentair, Inc.**]
6. [**PEP Filters, Inc.**]
7. [**Rosedale Products, Inc.**]
8. [**Shelco Filters**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eden Equipment Company**]
2. [**Filtration Systems; Mechanical Mfg. Corporation**]
3. [**Hayward Flow Control; Hayward Industries, Inc.**]
4. [**Parker Hannifin Corp.; Process Filtration Div**]
5. [**Pentair, Inc.**]
6. [**PEP Filters, Inc.**]
7. [**Rosedale Products, Inc.**]
8. [**Shelco Filters**]
9. <**Insert manufacturer's name**>

C. Description: [**Floor-mounted housing**][**Housing**] with filter bags for removing particles from water.

1. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through bag-type water filter; with [**bag support and**]base, feet, or skirt.

a. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
b. Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
c. Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150-psig (1035-kPa)** plastic flanges.

2. Bag: Replaceable; of shape to fit housing.

D. Capacities and Characteristics:

1. Filter Design:

a. Water-Flow Rate: <**Insert gpm (L/s)**>.
b. Filtration Efficiency: [**98**]<**Insert number**> percent.

c. Particle Size: [**10**][**20**]<**Insert number**> microns and larger.
d. Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.
e. Pressure Loss at Replacement: [**6 psig (41 kPa)**]<**Insert value**>.

2. Housing:

a. Material: [**Carbon steel**][**Plastic**].
b. Pressure Rating: <**Insert psig (kPa)**>.
c. Seal Material: [**Nitrile rubber**]<**Insert material**>.
d. Diameter: <**Insert inches (mm)**>.
e. Height or Length: <**Insert inches (mm)**>.
f. Inlet and Outlet Size: <**Insert NPS (DN)**>.
g. Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.
h. Bag Support Basket Material: [**Stainless steel**]<**Insert material**>.

3. Bag:

a. Number Required: <**Insert number**>.
b. Nominal Diameter: <**Insert inches (mm)**>.
c. Nominal Length: <**Insert inches (mm)**>.
d. Media Material: [**Cotton**][**Polyester**][**Polypropylene**]<**Insert material**>.

2.6 WATER FILTERS, CARTRIDGE TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eden Equipment Company**]
2. [**Filtration Systems; Mechanical Mfg. Corporation**]
3. [**Hayward Flow Control; Hayward Industries, Inc.**]
4. [**Parker Hannifin Corp.; Process Filtration Div**]
5. [**Pentair, Inc.**]
6. [**PEP Filters, Inc.**]
7. [**Rosedale Products, Inc.**]
8. [**Shelco Filters**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eden Equipment Company**]
2. [**Filtration Systems; Mechanical Mfg. Corporation**]
3. [**Hayward Flow Control; Hayward Industries, Inc.**]
4. [**Parker Hannifin Corp.; Process Filtration Div**]
5. [**Pentair, Inc.**]
6. [**PEP Filters, Inc.**]
7. [**Rosedale Products, Inc.**]
8. [**Shelco Filters**]
9. <**Insert manufacturer's name**>

C. Description: [**Floor-mounted housing**][**Housing**] with filter cartridges for removing particles from water.

1. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through cartridge-type water filter; with base, feet, or skirt.

a. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
b. Steel Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.
c. Plastic Housing Pipe Connections NPS 2-1/2 (DN 65) and Larger: **150-psig (1035-kPa)** plastic flanges.

2. Cartridge: Replaceable; of shape to fit housing.

D. Capacities and Characteristics:

1. Filter Design:

a. Water-Flow Rate: <**Insert gpm (L/s)**>.
b. Filtration Efficiency: [**98**]<**Insert number**> percent.
c. Particle Size: [**10**][**20**]<**Insert number**> microns and larger.
d. Clean Pressure Loss: [**2 psig (14 kPa)**]<**Insert value**>.
e. Pressure Loss at Replacement: [**6 psig (41 kPa)**]<**Insert value**>.

2. Housing:

a. Material: [**Carbon steel**][**Plastic**].
b. Pressure Rating: <**Insert psig (kPa)**>.
c. Seal Material: [**Nitrile rubber**]<**Insert material**>.
d. Diameter: <**Insert inches (mm)**>.
e. Height or Length: <**Insert inches (mm)**>.
f. Inlet and Outlet Size: <**Insert NPS (DN)**>.
g. Drain Size: [**Not applicable**]<**Insert NPS (DN)**>.

3. Cartridge:

a. Number Required: <**Insert number**>.
b. Nominal Diameter: <**Insert inches (mm)**>.
c. Nominal Length: <**Insert inches (mm)**>.
d. Media Material: [**Cotton**][**Polyester**][**Polypropylene**]<**Insert material**>.

2.7 CENTRIFUGAL SEPARATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Culligan International Company**]
2. [**Griswold Water Systems**]
3. [**LAKOS Filtration Solutions**]
4. [**PEP Filters, Inc.**]
5. [**Puroflux Corporation**]
6. [**Rosedale Products, Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Culligan International Company**]

2. [**Griswold Water Systems**]
3. [**LAKOS Filtration Solutions**]
4. [**PEP Filters, Inc.**]
5. [**Puroflux Corporation**]
6. [**Rosedale Products, Inc.**]
7. **<Insert manufacturer's name>**

C. Description: Simplex separator housing, with baffles and chambers for removing particles from water by centrifugal action and gravity.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Housing: With manufacturer's proprietary system of baffles and chambers.

1. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
3. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
4. Collection Chamber: Designed to hold separated particles.
5. Outlet: Near top of unit.
6. Purge: At bottom of collection chamber.
7. Pipe Connections NPS 2 (DN 50) and Smaller: Threaded in accordance with ASME B1.20.1.
8. Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.

F. Motorized Purge Valve: Gate or plug pattern valve.

1. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with [**EPDM**]**<Insert material>** valve seat and stem seal; with ASTM B148 aluminum bronze disc.

G. Strainer: Stainless steel basket type mounted on pump suction.

H. Piping:

1. ASTM A53/A53M; Type S, F, or E; Grade B; Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding or ductile-iron fittings.
2. **ASTM B88, Type L (ASTM B88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

I. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1. Casing: Radially split, cast iron.
2. Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1035 kPa)**] minimum.
3. Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
5. Seal: Mechanical.
6. Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

J. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.

1. Panel: NEMA 250, [**Type 4**]<**Insert type**> enclosure.
2. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
3. Separator Purge: Automatic and manual.
4. TSS Controller Interlock: Open separator purge valve with bleed-off control.

K. Support: Skid mounting.[**Fabricate supports, base, and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event, when separator base is anchored to building structure.**]

L. Capacities and Characteristics:

1. Separator Design:

   a. Water-Flow Rate: <**Insert gpm (L/s)**>.
   b. Pressure Loss: [**5 psig (34.5 kPa)**]<**Insert value**>.
   c. Separator Efficiency: [**98**]<**Insert number**> percent.
   d. Particle-Specific Gravity: [**1.8**]<**Insert number**>.
   e. Particle Size: [**5**][**10**][**20**][**45**]<**Insert number**> microns.

2. Housing:

   a. Material: [**Steel**][**Stainless steel**][**Plastic**][**Fiberglass**]<**Insert material**>.
   b. Pressure Rating: <**Insert psig (kPa)**>.
   c. Diameter: <**Insert inches (mm)**>.
   d. Height: <**Insert inches (mm)**>.
   e. Inlet and Outlet Size: <**Insert NPS (DN)**>.
   f. Purge Size: <**Insert NPS (DN)**>.

3. Circulating Pump:

   a. Capacity: <**Insert gpm (L/s)**>.
   b. Total Dynamic Head: <**Insert feet (kPa)**>.
   c. Motor Speed: <**Insert number**> rpm.
   d. Inlet Size: <**Insert NPS (DN)**>.
   e. Outlet Size: <**Insert NPS (DN)**>.

4. Pump Motor Size and Electrical Characteristics:

   a. Horsepower: <**Insert value**>.
   b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V.
   c. Phase: [**Single**][**Three**].
   d. Hertz: [**60**]<**Insert number**> Hz.
   e. Full-Load Amperes: <**Insert value**>.
   f. Minimum Circuit Ampacity: <**Insert value**>.
   g. Maximum Overcurrent Protection: <**Insert amperage**>.
   h. Interrupting Capacity: <**Insert amperage**>.

2.8 WATER-SOFTENER CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity to be a minimum **30,000 grains/cu. ft. (69 kg/cu. m)** of calcium carbonate of resin when regenerated with **15 lb (6.8 kg)** of salt.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION OF EQUIPMENT

A. Equipment Mounting:

1. Install [**water-softener**][**water-filtration**] equipment on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 INSTALLATION OF WATER SOFTENER

A. Install water-softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.

C. Prepare mineral-tank distribution system and underbed for minerals, and place specified mineral into mineral tanks.

D. Install water-testing sets on wall adjacent to water softeners.

3.4 INSTALLATION OF RO UNIT

A. Install RO unit and storage tank on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.

B. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.

C. Install water-testing sets on wall adjacent to RO unit.

3.5 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC [**water-softener**][**water-filtration**] equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC [**water-softener**][**water-filtration**] equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

3.6 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC [**water-softener**][**water-filtration**] system into operation, and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for equipment. Services and chemicals to be provided for a period of one year from date of Substantial Completion, and to include the following:

1. Periodic field service and consultation.
2. Customer report charts and log sheets.
3. Laboratory technical analysis.
4. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

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SECTION 23 25 13 00 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for closed-loop hydronic systems.
2. Manual chemical-feed equipment.
3. Automatic chemical-feed equipment.
4. Chemicals.
5. Inhibited ethylene glycol and propylene glycol.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water treatment of water softeners, RO equipment, and filtration equipment.

1.2 DEFINITIONS

A. RO: Reverse osmosis.

B. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

C. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. Chemical solution tanks.
6. Injection pumps.
7. Chemical-treatment test equipment.
8. Chemical material safety data sheets.
9. Inhibited ethylene glycol.
10. Inhibited propylene glycol.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Sonitec-Vortisand Inc.**]

11. [**Suez Water Technologies (Formerly GE Water)**]
12. [**Watcon, Inc**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anderson Chemical Company**]
2. [**Aqua-Chem, Inc.**]
3. [**Barclay Water Management, Inc**]
4. [**Boland Trane Services**]
5. [**Cascade Water Services, Inc**]
6. [**Earthwise Environmental Inc**]
7. [**H-O-H Water Technology, Inc**]
8. [**Metro Group, Inc. (The)**]
9. [**Nalco; an Ecolab company**]
10. [**Sonitec-Vortisand Inc.**]
11. [**Suez Water Technologies (Formerly GE Water)**]
12. [**Watcon, Inc**]
13. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [**hot-water heating below 250 deg F (120 deg C)**][**chilled water**][**dual-temperature water**][**glycol heating**][**and**][**glycol cooling**] shall have the following water qualities:

1. pH: Maintain a value within <**Insert range**>.
2. Alkalinity: Maintain a value within <**Insert range**> mg/L as CaCO(3).
3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**Insert number**> mils per year. Maintain soluble iron concentrations at or below <**Insert value**> mg/L.
4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**Insert number**> mils per year. Maintain soluble copper concentrations at or below <**Insert value**> mg/L.
5. Scale Control: Provide softened water for initial fill and makeup. [**Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
7. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <**Insert number**> organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of <**Insert number**> organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of <**Insert number**> organisms/mL.

8. <**Insert other applicable requirements**>.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum **3-1/2-inch (89-mm)** fill opening in the top, and **NPS 3/4 (DN 20)** bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: [**2 gal. (7.6 L)**][**5 gal. (19 L)**]<**Insert value**>.
2. Minimum Working Pressure: [**125 psig (860 kPa)**][**175 psig (1210 kPa)**]<**Insert value**>.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Piston Type, Threaded:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

B. Water Meter, Turbine Type, Threaded:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: **100 psig (690 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.
6. End Connections: Threaded.
7. [**Controls: Flow-control switch with normally open contacts. rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

C. Water Meter, Turbine Type, Flanged:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [**Bronze**][**Epoxy-coated cast iron**].
3. Minimum Working-Pressure Rating: **150 psig (1035 kPa)**.
4. Maximum Pressure Loss at Design Flow: **3 psig (20 kPa)**.
5. Registration: **Gallons (Liters)** or **cubic feet (cubic meters)**.

6. End Connections: Flanged.
7. [**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]
8. [**Electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet (305 m).**]
9. [**Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**]

D. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**][**50 gal. (189 L)**][**120 gal. (454 L)**]<**Insert value**>.

E. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500 "Common Work Results for HVAC."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

G. Injection Assembly:

1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: [**Three**][**Two**]-piece, stainless steel; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.5 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, corrosion inhibitors, alkalinity, hardness, and other properties recommended by manufacturer.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [**Two**]<**Insert number**>-station rack for closed-loop systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

2.7 INHIBITED ETHYLENE GLYCOL AND PROPYLENE GLYCOL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dynalene**]
2. [**Fremont Industries**]
3. [**Houghton Chemical Corp.**]
4. [**The Dow Chemical Company**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dynalene**]
2. [**Fremont Industries**]
3. [**Houghton Chemical Corp.**]
4. [**The Dow Chemical Company**]
5. <**Insert manufacturer's name**>

C. Inhibited Ethylene Glycol:

1. Ethylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact ethylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between [**9.0 and 10.5**]<**Insert range**>, with reserve alkalinity greater than [**12**]<**Insert number**> mL.
4. Concentrated inhibited ethylene glycol is to be 95.5 percent ethylene glycol by weight and 4.5 percent performance additives.
5. Concentrated inhibited ethylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at time of installation. Use only deionized water for mixing.
6. Provide only ethylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

D. Inhibited Propylene Glycol:

1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.

4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F (minus 29 deg C)**]<**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including[**hot-water heating,**][**chilled water,**][**dual-temperature water,**][**glycol heating,**][**and**][**glycol cooling**], and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
2. Install water meter in makeup-water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
5. Install a swing check on the inlet after the isolation valve.

G. Install automatic fluid make-up equipment for glycol water system, and include the following:

1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.
4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

3.3 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.4 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

E. Equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. At [**four**][**six**][**eight**]<**Insert number**>-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

H. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.6 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 13 00

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Task	Specification	Specification Description
23 25 13 00	23 21 13 00	Hydronic Piping
23 25 13 00	23 25 00 00	HVAC Water Treatment
23 25 13 00	23 25 00 00a	Water Treatment for Open-Loop Hydronic Systems
23 25 13 00	23 25 00 00b	Water Treatment for Steam System Feedwater
23 25 13 00	23 25 00 00c	Water Treatment for Humidification Steam System Feedwater
23 25 13 00	23 25 00 00d	HVAC Makeup-Water Filtration Equipment

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SECTION 23 31 13 00 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings - single wall.
2. Rectangular ducts and fittings - double wall.
3. Round ducts and fittings - single wall.
4. Round ducts and fittings - double wall.
5. Flat-oval ducts and fittings - single wall.
6. Flat-oval ducts and fittings - double wall.
7. Sheet metal materials.
8. Duct liner.
9. Sealants and gaskets.
10. Hangers and supports.
11. Strut support system for ductwork - metal, cable type.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
3. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
4. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
5. Section 233119.13 "Shop-Fabricated HVAC Casings" for field-fabricated casings for mechanical equipment.
6. Section 233119.16 "Manufactured HVAC Casings" for factory-fabricated casings for mechanical equipment.
7. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top[**and bottom**] of ducts.
5. Dimensions of [**main**][**all**] duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.
13. <**Insert areas or systems requiring Shop Drawings**>.

C. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations[**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation**] for selecting hangers and supports[**and seismic restraints**].

D. Sustainable Design Submittals:

1. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
3. Laboratory Test Reports:

   a. For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
   b. For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

1.6 MOCKUPS

A. Before installing duct systems, build mockups representing static-pressure classes in excess of [**3-inch wg (750 Pa)**]<**Insert static-pressure class**>. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. [**Five**]<**Insert number**> transverse joints.
2. [**One**]<**Insert number**> access door(s).
3. [**Two**]<**Insert number**> typical branch connections, each with at least one elbow.
4. [**Two**]<**Insert number**> typical flexible duct or flexible-connector connections for each duct and apparatus.
5. [**One**]<**Insert number**> 90-degree turn(s) with turning vanes.
6. [**One**]<**Insert number**> fire damper(s).
7. [**One**]<**Insert number**> smoke damper(s).
8. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

B. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports[**and seismic restraints**] are to withstand the effects of gravity[**and seismic**] loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" [**and**][**ASCE/SEI 7**]<**Insert applicable building code**>. [**Seismically brace duct hangers and supports in accordance with**][**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**][**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**]<**Insert reference document.**>

1. Seismic Hazard Level (SHL): [**AA**][**A**][**B**][**C**][**D**].
2. Connection Level: [**1**][**2**].
3. <**Insert requirement**>.

C. Seismic Performance: Ductwork to withstand the effects of earthquake motions. See Section 018123 "Facility Seismic and Wind Criteria" that specifies basis-of-design seismic and wind criteria for nonstructural components. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. Wind-Restraint Performance: See Section 018123 "Facility Seismic and Wind Criteria" and Section 230548 "Vibration and Seismic Controls for HVAC" for building classification criteria.

E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts and Fittings - Single Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ductmate Industries, Inc; a DMI company**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SHAPE Manufacturing Inc.**]
   e. [**Sheet Metal Connectors, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ductmate Industries, Inc; a DMI company**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SHAPE Manufacturing Inc.**]
   e. [**Sheet Metal Connectors, Inc.**]
   f. <**Insert manufacturer's name**>

3. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.

4. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. For ducts with longest side less than **36 inches (914 mm)**, select joint types in accordance

with Figure 2-1.

b. For ducts with longest side **36 inches (914 mm)** or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

c. Welded Transverse Joints:

1) Provide all welded transverse joints for <**Insert specific systems or applications**>.
2) See Drawings for specific systems or applications.

5. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."[**All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**]

a. Welded Longitudinal Seams:

1) Provide all welded longitudinal seams for <**Insert specific systems or applications**>.
2) See Drawings for specific systems or applications.

6. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Rectangular Ducts and Fittings - Double Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ductmate Industries, Inc; a DMI company**]
b. [**McGill AirFlow LLC**]
c. [**MKT Metal Manufacturing**]
d. [**SHAPE Manufacturing Inc.**]
e. [**Sheet Metal Connectors, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ductmate Industries, Inc; a DMI company**]
b. [**McGill AirFlow LLC**]
c. [**MKT Metal Manufacturing**]
d. [**SHAPE Manufacturing Inc.**]
e. [**Sheet Metal Connectors, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain double-wall, rectangular ducts and fittings from single manufacturer.
4. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.

5. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct outer duct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.

6. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. For ducts with longest side less than **36 inches (914 mm)**, select joint types in accordance with Figure 2-1.
   b. For ducts with longest side **36 inches (914 mm)** or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
   c. Welded Transverse Joints:

      1) Provide all welded transverse joints for <**Insert specific systems or applications**>.
      2) See Drawings for specific systems or applications.

7. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."[**All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**]

   a. Welded Longitudinal Seams:

      1) Provide all welded longitudinal seams for <**Insert specific systems or applications**>.
      2) See Drawings for specific systems or applications.

8. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

   a. Maximum Thermal Conductivity: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.
   b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   c. Coat insulation with antimicrobial coating.
   d. Cover insulation with polyester film complying with UL 181, Class 1.

9. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

   a. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.

10. Inner Duct: Minimum **24-gauge (0.7-mm)** [**perforated galvanized sheet steel having 3/32-inch-(2.4-mm-) diameter perforations, with overall open area of 23 percent**][**solid galvanized sheet steel**].

2.3 ROUND DUCTS AND FITTINGS

A. Round Ducts and Fittings - Single Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Elgen Manufacturing**]
   b. [**GreenSeam**]
   c. [**Linx Industries; a DMI company (formerly Lindab)**]
   d. [**McGill AirFlow LLC**]
   e. [**MKT Metal Manufacturing**]
   f. [**Nordfab Ducting**]
   g. [**SEMCO, LLC; part of FlaktGroup**]
   h. [**Set Duct Manufacturing**]
   i. [**SHAPE Manufacturing Inc.**]
   j. [**Sheet Metal Connectors, Inc.**]
   k. [**Spiral Manufacturing Co., Inc.**]
   l. [**Stamped Fittings Inc**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Elgen Manufacturing**]
   b. [**GreenSeam**]
   c. [**Linx Industries; a DMI company (formerly Lindab)**]
   d. [**McGill AirFlow LLC**]
   e. [**MKT Metal Manufacturing**]
   f. [**Nordfab Ducting**]
   g. [**SEMCO, LLC; part of FlaktGroup**]
   h. [**Set Duct Manufacturing**]
   i. [**SHAPE Manufacturing Inc.**]
   j. [**Sheet Metal Connectors, Inc.**]
   k. [**Spiral Manufacturing Co., Inc.**]
   l. [**Stamped Fittings Inc**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain [**single-wall, round ducts and fittings**][**single-wall, round and flat-oval ducts and fittings**] from single manufacturer.
4. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.

5. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Provide flanged joints for transverse joints in ducts larger than [**60 inches (1524 mm)**]<**Insert dimension**> in diameter.

6. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Fabricate round ducts larger than [**90 inches (2286 mm)**]<**Insert dimension**> in diameter with butt-welded longitudinal seams.

7. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Round Ducts and Fittings - Double Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Linx Industries; a DMI company (formerly Lindab)**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SEMCO, LLC; part of FlaktGroup**]
   e. [**Set Duct Manufacturing**]
   f. [**SHAPE Manufacturing Inc.**]
   g. [**Sheet Metal Connectors, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Linx Industries; a DMI company (formerly Lindab)**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SEMCO, LLC; part of FlaktGroup**]
   e. [**Set Duct Manufacturing**]
   f. [**SHAPE Manufacturing Inc.**]
   g. [**Sheet Metal Connectors, Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain [**double-wall, round ducts and fittings**][**double-wall, round and flat-oval ducts and fittings**] from single manufacturer.
4. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct outer duct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.

1) Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a) Provide flanged joints for transverse joints in ducts larger than [**60 inches (1524 mm)**]<**Insert dimension**> in diameter.

2) Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a) Fabricate round ducts larger than [**90 inches (2286 mm)**]<**Insert dimension**> in diameter with butt-welded longitudinal seams.

c. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

5. Inner Duct: Minimum **24-gauge (0.7-mm)** [**perforated galvanized sheet steel having 3/32-inch-(2.4-mm-) diameter perforations, with overall open area of 23 percent**][**solid galvanized sheet steel**].
6. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

a. Maximum Thermal Conductivity: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.
b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
c. Coat insulation with antimicrobial coating.
d. Cover insulation with polyester film complying with UL 181, Class 1.

7. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

a. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.

2.4 FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts and Fittings - Single Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elgen Manufacturing**]
b. [**GreenSeam**]
c. [**Linx Industries; a DMI company (formerly Lindab)**]

d. [**McGill AirFlow LLC**]
e. [**MKT Metal Manufacturing**]
f. [**Nordfab Ducting**]
g. [**SEMCO, LLC; part of FlaktGroup**]
h. [**Set Duct Manufacturing**]
i. [**SHAPE Manufacturing Inc.**]
j. [**Sheet Metal Connectors, Inc.**]
k. [**Spiral Manufacturing Co., Inc.**]
l. [**Stamped Fittings Inc**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Elgen Manufacturing**]
   b. [**GreenSeam**]
   c. [**Linx Industries; a DMI company (formerly Lindab)**]
   d. [**McGill AirFlow LLC**]
   e. [**MKT Metal Manufacturing**]
   f. [**Nordfab Ducting**]
   g. [**SEMCO, LLC; part of FlaktGroup**]
   h. [**Set Duct Manufacturing**]
   i. [**SHAPE Manufacturing Inc.**]
   j. [**Sheet Metal Connectors, Inc.**]
   k. [**Spiral Manufacturing Co., Inc.**]
   l. [**Stamped Fittings Inc**]
   m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain [**single-wall, flat-oval ducts and fittings**][**single-wall, flat-oval and round ducts and fittings**] from single manufacturer.
4. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.
   c. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible.

      1) Provide flanged joints for transverse joints in ducts larger than [**60 inches (1524 mm)**]<**Insert dimension**> in diameter.

5. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Fabricate round ducts larger than **90 inches (2286 mm)** in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than **72 inches (1830 mm)** in width (major dimension) with

butt-welded longitudinal seams.

6. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Flat-Oval Ducts and Fittings - Double Wall:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Linx Industries; a DMI company (formerly Lindab)**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SEMCO, LLC; part of FlaktGroup**]
   e. [**Set Duct Manufacturing**]
   f. [**SHAPE Manufacturing Inc.**]
   g. [**Sheet Metal Connectors, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Linx Industries; a DMI company (formerly Lindab)**]
   b. [**McGill AirFlow LLC**]
   c. [**MKT Metal Manufacturing**]
   d. [**SEMCO, LLC; part of FlaktGroup**]
   e. [**Set Duct Manufacturing**]
   f. [**SHAPE Manufacturing Inc.**]
   g. [**Sheet Metal Connectors, Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain [**double-wall, flat-oval ducts and fittings**][**double-wall, flat-oval and round ducts and fittings**] from single manufacturer.
4. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class indicated on the Drawings.

   a. Construct ducts of [**galvanized sheet steel**]<**Insert material**>.
   b. For ducts exposed to weather, construct outer duct of [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.
   c. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

      1) Provide flanged joints for transverse joints in ducts larger than [**60 inches (1524 mm)**]<**Insert dimension**> in diameter.

   d. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's

"HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1) Fabricate flat-oval ducts larger than [**72 inches (1830 mm) in width (major dimension)**]<**Insert dimension**> with butt-welded longitudinal seams.

e. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

5. Inner Duct: Minimum **24-gauge (0.7-mm)** [**perforated galvanized sheet steel having 3/32-inch-(2.4-mm-) diameter perforations, with overall open area of 23 percent**][**solid galvanized sheet steel**].
6. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

   a. Maximum Thermal Conductivity: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.
   b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   c. Coat insulation with antimicrobial coating.
   d. Cover insulation with polyester film complying with UL 181, Class 1.

7. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

   a. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60 (Z180)**][**G90 (Z275)**].
2. Finishes for Surfaces Exposed to View: Mill phosphatized.
3. Lockforming Quality: Sheet steel and galvanized coating is to be able to be formed with back-to-back bends in seams such as the Pittsburgh lock at high speed without cracking or flaking of the coating on the outside of the bend.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60 (Z180)**][**G90 (Z275)**].
2. Minimum Thickness for Factory-Applied PVC Coating: **4 mils (0.10 mm)** thick[**on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface**].

3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

F. Aluminum Sheets: Comply with **ASTM B209 (ASTM B209M)** Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: [**Black**][**White**].
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

I. Tie Rods: Galvanized steel, **1/4-inch- (6-mm-)** minimum diameter for lengths **36 inches (900 mm)** or less; **3/8-inch- (10-mm-)** minimum diameter for lengths longer than **36 inches (900 mm)**.

2.6 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]
e. [**Sekisui Voltek, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Johns Manville; a Berkshire Hathaway company**]
c. [**Knauf Insulation**]
d. [**Owens Corning**]
e. [**Sekisui Voltek, LLC**]
f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
4. Maximum Thermal Conductivity:

   a. Type I, Flexible: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**]**<Insert conductivity>** at **75 deg F (24 deg C)** mean temperature.
   b. Type II, Rigid: [**0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K)**]**<Insert conductivity>** at **75 deg F (24 deg C)** mean temperature.

5. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
6. Liner Adhesive: [**Solvent**][**Water**]-based liner adhesive, complying with NFPA 90A or NFPA 90B and with ASTM C916.

   a. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

      1) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
      2) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
      3) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Aeroflex USA**]
      b. [**Armacell LLC**]
      c. [**K-Flex USA**]
      d. [**Sekisui Voltek, LLC**]
      e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aeroflex USA**]
   b. [**Armacell LLC**]
   c. [**K-Flex USA**]
   d. [**Sekisui Voltek, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

   a. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

      1) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
      2) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
      3) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

C. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Acoustical Surfaces, Inc.**]
      b. [**Ductmate Industries, Inc; a DMI company**]
      c. <**Insert manufacturer's name**>

   2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      a. [**Acoustical Surfaces, Inc.**]
      b. [**Ductmate Industries, Inc; a DMI company**]
      c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single manufacturer.
4. Maximum Thermal Conductivity: [**0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature when tested in accordance with ASTM C518.
5. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
6. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

        1) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
        2) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
        3) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

D. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, complying with NFPA 90A or NFPA 90B; sheet (Type II) complying with ASTM C1427.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Sekisui Voltek, LLC**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Sekisui Voltek, LLC**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain polyolefin duct liner from single manufacturer.
4. Foam Core Density: **1.5 pcf (25 kg/cm)**.
5. Maximum Thermal Conductivity: [**0.25 Btu x in./h x sq. ft. x deg F (0.036 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature when tested in accordance with ASTM C518.
6. Minimum Noise Reduction Coefficient (NRC): 0.50 for **3/8-inch (10-mm)** thickness, 0.45 for **5/8-inch (15-mm)** thickness, 0.55 for **1-inch (24-mm)** thickness, and 0.55 for **2-1/8-inch (54-mm)** thickness.

7. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
8. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

        1) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
        2) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
        3) Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch- (2.6-mm-)**][**0.135-inch- (3.5-mm-)**] diameter shank, length to suit depth of insulation indicated with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick [**galvanized steel**][**aluminum**][**stainless steel**]; with beveled edge sized as required to hold insulation securely in place, but not less than **1-1/2 inches (38 mm)** in diameter.

F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of **2500 fpm (12.7 m/s)** or greater.
7. Secure liner with mechanical fasteners **4 inches (100 mm)** from corners and at intervals not exceeding **12 inches (300 mm)** transversely; at **3 inches (75 mm)** from transverse joints and at intervals not exceeding **18 inches (450 mm)** longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.

b. Intervals of lined duct preceding unlined duct.
c. Upstream edges of transverse joints in ducts where air velocities are higher than [**2500 fpm (12.7 m/s)**]<**Insert velocity**>.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

   a. Sheet Metal Inner Duct Perforations: **3/32-inch (2.4-mm)** diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANTS AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: [**3 inches (76 mm)**][**4 inches (100 mm)**][**6 inches (152 mm)**].
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: **10-inch wg (2500 Pa)**, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: **Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C)**.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. Sealant shall have a VOC content of 420 g/L or less.

    a. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    b. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    c. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.

4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: **10-inch wg (2500 Pa)**, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: **10-inch wg (2500 Pa)**, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
11. Sealant shall have a VOC content of 420 g/L or less.
12. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
13. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
14. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single component, acid curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify sealant complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of **3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa)** and is to be rated for **10-inch wg (2500 Pa)** static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," **Table 5-1 (Table 5-1M)**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Strut Support System for Ductwork - Metal, Cable Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CADDY; brand of nVent Electrical plc**]
   b. [**Gripple Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CADDY; brand of nVent Electrical plc**]
b. [**Gripple Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain metal cable type strut support system for ductwork from single manufacturer.
4. Description: Factory-fabricated ductwork support system consisting of cable clamps, slotted channel brackets, wire-rope suspension components, and associated accessories for a complete ductwork suspension system. No tools required for manual assembly in the field to support ductwork routing.
5. Components:

a. Brackets: Slotted steel channels furnished in pre-cut lengths to suit specific system application for Project.
b. Suspension Components: Hanging cables with adjustable fasteners.

1) Wire Rope: High-tensile-steel wire rope, complying with **ASTM A1023 (ASTM 1023M)**; lengths, diameters, and wire construction [**to accommodate design loads**][**indicated on Shop Drawings**].

a) Foot attachment type to suit application.
b) End Fix Type: [**Loop**][**, strap hook**][**, eyelet**][**or**]<**Insert fix type**><**as required to suit application**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of **1 inch (25 mm)**, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same

metal thickness as the duct. Overlap openings on four sides by at least **1-1/2 inches (38 mm)**.

J. Install fire[**, combination fire/smoke,**] and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.[**Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."**]

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.

N. Branch Connections: Use lateral or conical branch connections.

O. Installation of Metal, Cable-Type Strut Support System for Ductwork: Install in accordance with manufacturer's written installation instructions.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines."

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be [**stainless**][**carbon**] steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of [**20 ft. (6 m)**][**12 ft. (3.7 m)**]<**Insert dimension**> in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a **1-inch (25-mm)** trapped copper drain from each drain pocket to open-sight floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 REQUIREMENTS FOR DUCTWORK EXPOSED TO WEATHER

A. All external joints are to [**be welded**][**have secure watertight mechanical connections**]. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork is to be [**Type 304**][**Type 316**] stainless steel.
2. Ductwork is to be galvanized steel.

   a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."

3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section

230713 "Duct Insulation."

D. Double Wall:

1. Ductwork is to comply with requirements in "Rectangular Ducts and Fittings - Double Wall," "Round Ducts and Fittings - Double Wall," or "Flat-Oval Ducts and Fittings - Double Wall" Product Type.
2. Ductwork outer wall is to be [**Type 304**][**Type 316**] stainless steel indicated by manufacturer in writing to be suitable for outdoor installation.
3. Provide interstitial insulation as specified under Part 2.

3.7 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than **4 inches (100 mm)** thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than **4 inches (100 mm)** thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," **Table 5-1 (Table 5-1M)**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within **24 inches (610 mm)** of each elbow and within **48 inches (1220 mm)** of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of **16 ft. (5 m)**.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.9 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.10 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.11 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher than 3-Inch wg (750 Pa): Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts: For pressure class of [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**> or higher; test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.
   c. Return Ducts: For a pressure class of [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg**

(1000 Pa)]<**Insert number**> or higher; test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.

d. Exhaust Ducts: For a pressure class of [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**> or higher; test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.

e. Outdoor-Air Ducts: For a pressure class of [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**> or higher; test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give [**seven**]<**Insert number**> days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning, and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.14 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.15 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

2. Underground Ducts: Concrete-encased, [**galvanized sheet steel**][**PVC-coated, galvanized sheet steel with thicker coating on duct exterior**][**stainless steel**].
3. <**Insert requirements**>.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units: <**Insert equipment**>.

   a. Pressure Class: Positive [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

2. Ducts Connected to Constant-Volume Air-Handling Units: <**Insert equipment**>.

   a. Pressure Class: Positive [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

3. Ducts Connected to Variable-Air-Volume Air-Handling Units: <**Insert equipment**>.

   a. Pressure Class: Positive [**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

4. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units: <**Insert equipment**>.

   a. Pressure Class: Positive or negative [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

2. Ducts Connected to Air-Handling Units: <**Insert equipment**>.

   a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**] if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

2. Ducts Connected to Air-Handling Units: <**Insert equipment**>.

   a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
   b. Minimum SMACNA Seal Class: [**A**][**B**][**C**] if negative pressure, and [**A**][**B**][**C**] if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

   a. Exposed to View: Type 304, stainless steel sheet, [**No. 4**][**No. 3**]<**Insert finish**> finish.
   b. Concealed: [**Type 304, stainless steel sheet, No. 2D finish**][**Carbon-steel sheet**].
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
   e. Airtight/watertight.

4. Ducts Connected to Dishwashers, Dishwasher Hoods, and Other High-Humidity Locations:

   a. Type 304, stainless steel sheet.
   b. Exposed to View: [**No. 4**][**No. 3**]<**Insert finish**> finish.
   c. Concealed: [**No. 2D**]<**Insert finish**> finish.
   d. Welded longitudinal seams; welded or flanged transverse joints with watertight EPDM gaskets.
   e. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
   f. Airtight/watertight.

5. Ducts Connected to Fans Exhausting Fume Hood, Laboratory, and Process (ASHRAE 62.1, Class 3 and Class 4) Air:

   a. [**Type 316**][**Type 304**], stainless steel sheet.

      1) Exposed to View: [**No. 4**][**No. 3**]<**Insert finish**> finish.
      2) Concealed: [**No. 2B**][**No. 2D**]<**Insert finish**> finish.

   b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.

c. Pressure Class: Positive or negative [**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**][**6-inch wg (1500 Pa)**]<**Insert number**>.
d. Seal Class: [**Minimum SMACNA Seal Class A**]<**Insert seal class**>.
e. Joints: [**Welded seams and joints, airtight/watertight**]<**Insert seam and joint types**>.
f. Leakage Class: [**SMACNA Leakage Class 2**]<**Insert leakage class**>.

6. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
b. Minimum SMACNA Seal Class: [**A**][**B**] if negative pressure; A if positive pressure.
c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units <**Insert equipment**>:

a. Pressure Class: Positive or negative [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**]<**Insert number**>.
b. Minimum SMACNA Seal Class: [**A**][**B**][**C**].
c. SMACNA Leakage Class for Rectangular: [**8**][**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**8**][**16**].

2. Ducts Connected to Air-Handling Units <**Insert equipment**>:

a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert number**>.
b. Minimum SMACNA Seal Class: [**A**][**B**].
c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert number**>.
b. Minimum SMACNA Seal Class: [**A**][**B**].
c. SMACNA Leakage Class for Rectangular: [**2**][**4**][**8**][**16**].
d. SMACNA Leakage Class for Round and Flat Oval: [**2**][**4**][**8**][**16**].

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: [**Galvanized steel**][**Carbon steel coated with zinc-chromate primer**][**Galvanized steel or carbon steel coated with zinc-chromate primer**].
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: [**Galvanized**][**Match duct material**].

3. Stainless Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: [**Galvanized**][**Match duct material**].

4. Aluminum Ducts: [**Aluminum**][**or**][**galvanized steel coated with zinc chromate**].

G. Liner:

1. Supply-Air Ducts: [**Fibrous glass, Type I**][**Flexible elastomeric**][**Fibrous-glass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
2. Return-Air Ducts: [**Fibrous glass, Type I**][**Flexible elastomeric**][**Fibrous-glass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
3. Exhaust-Air Ducts: [**Fibrous glass, Type I**][**Flexible elastomeric**][**Fibrous-glass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
4. Supply Fan Plenums: [**Fibrous glass, Type II**][**Flexible elastomeric**][**Fibrous-glass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
5. Return- and Exhaust-Fan Plenums: [**Fibrous glass, Type II**][**Flexible elastomeric**][**Fiberglass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
6. Transfer Ducts: [**Fibrous glass, Type I**][**Flexible elastomeric**][**Fibrous-glass-free, natural fiber**][**Polyolefin**], [**5/8 inch (15 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.

H. Double-Wall Duct Interstitial Insulation:

1. Supply-Air Ducts: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
2. Return-Air Ducts: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.
3. Exhaust-Air Ducts: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**]<**Insert dimension**> thick.

I. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm (5 m/s) or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

   c. Velocity 1500 fpm (7.6 m/s) or Higher:

      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
        4) Radius-to-Diameter Ratio: 1.5.

    b. Round Elbows:

        1) Stamped or pleated for [**12 inches (305 mm)**]<**Insert dimension**> and smaller diameters.
        2) Standing seam for [**14 inches (356 mm)**]<**Insert dimension**> and larger diameter.
        3) Welded for [**14 inches (356 mm)**]<**Insert dimension**> and larger diameter.

J. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
    c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 31 13 00

Task	Specification	Specification Description
23 31 13 13	23 01 30 51	Existing HVAC Air Distribution System Cleaning
23 31 13 13	23 31 13 00	Metal Ducts
23 31 13 16	23 31 13 00	Metal Ducts
23 31 13 19	23 31 13 00	Metal Ducts
23 31 13 19	23 33 00 00	Air Duct Accessories
23 31 13 23	23 31 13 00	Metal Ducts

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SECTION 23 31 16 00 - NONMETAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fibrous-glass ducts and fittings.
2. Phenolic-foam ducts and fittings.
3. Thermoset FRP ducts and fittings.
4. PVC ducts and fittings.
5. CPVC ducts and fittings.
6. HDPE duct and fittings.

B. Related Requirements:

1. Section 230130.52 "Existing HVAC Air-Distribution System Cleaning" for cleaning of existing HVAC air-distribution equipment, ducts, plenums, and system components.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration-isolated and restrained ductwork hangers and supports.
3. Section 230548.13 "Vibration Controls for HVAC" for vibration-isolated ductwork and hangers.
4. Section 233113 "Metal Ducts" for single- and double-wall, rectangular and round ducts.
5. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Fibrous-glass duct materials.
2. Phenolic-foam duct materials.
3. Thermoset FRP duct materials.
4. PVC duct materials.
5. CPVC duct materials.
6. HDPE duct materials.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.
6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevation of top of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated, smoke-rated, and other partitions.
9. Fire and smoke damper locations.
10. Equipment installation based on equipment being used on Project.
11. Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.

D. Delegated-Design Submittal: For nonmetal ducts, signed and sealed by a qualified professional engineer.

1. Duct materials and thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports[**and seismic restraints**].
5. Design calculations for selecting hangers and supports[**and seismic restraints**].[**Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.**]

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for nonmetal ducts, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Hanger and Support Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for steel hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum hangers and supports.

B. Mockups:

1. Before installing duct systems, build mockups representing static-pressure classes [**3-inch wg (750 Pa)**]<**Insert value**> and higher. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

    a. [**Five**]<**Insert number**> transverse joints.
    b. [**One**]<**Insert number**> access door(s).
    c. [**Two**]<**Insert number**> typical branch connections, each with at least one elbow.
    d. [**Two**]<**Insert number**> typical flexible duct or flexible-connector connections for each duct and apparatus.
    e. [**One**]<**Insert number**> 90-degree turn(s) with turning vanes.
    f. [**One**]<**Insert number**> fire damper(s).
    g. [**One**]<**Insert number**> smoke damper(s).
    h. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of ductwork system that fail in material or workmanship within specified warranty period.

1. Warranty Period, HDPE Duct System: [**10**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with the following and with the Works' performance requirements and design criteria:

1. SMACNA's "Fibrous Glass Duct Construction Standards."
2. SMACNA's "Phenolic Duct Construction Standards."
3. SMACNA's "Thermoplastic Duct (PVC) Construction Manual."
4. SMACNA's "Thermoset FRP Duct Construction Manual."
5. Static-Pressure Classes:

    a. Supply Ducts (except in Mechanical Rooms): [**2-inch wg (500 Pa)**]<**Insert value**>.
    b. Supply Ducts (Upstream from Air Terminal Units): [**2-inch wg (500 Pa)**]<**Insert value**>.
    c. Supply Ducts (Downstream from Air Terminal Units): [**1-inch wg (250 Pa)**]<**Insert value**>.
    d. Supply Ducts (in Mechanical Equipment Rooms): [**2-inch wg (500 Pa)**]<**Insert value**>.
    e. Return Ducts (Negative Pressure): [**1-inch wg (250 Pa)**]<**Insert value**>.
    f. Exhaust Ducts (Negative Pressure): [**1-inch wg (250 Pa)**]<**Insert value**>.
    g. <**Insert duct systems and static-pressure class**>.

B. Seismic Performance: Ducts to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.

C. Wind-Restraint Performance:

1. See [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**] for requirements.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1, Section 5.4 - "Airstream Surfaces."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

G. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

2.2 FIBROUS-GLASS DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CertainTeed; SAINT-GOBAIN**]
2. [**Johns Manville; a Berkshire Hathaway company**]
3. [**Knauf Insulation**]
4. [**Owens Corning**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**CertainTeed; SAINT-GOBAIN**]
2. [**Johns Manville; a Berkshire Hathaway company**]
3. [**Knauf Insulation**]
4. [**Owens Corning**]
5. **<Insert manufacturer's name>**

C. Fibrous-Glass Duct Materials: Resin-bonded fiberglass, faced on the outside surface with fire-resistive FSK vapor retarder and with a smooth fiberglass mat finish on the air-side surface.

1. Duct Board: Factory molded into rectangular boards.
2. Temperature Limits: **40 to 250 deg F (5 to 121 deg C)** inside ducts; **150 deg F (66 deg C)** ambient temperature surrounding ducts.
3. Maximum Thermal Conductivity: [**0.24 Btu x in./h x sq. ft. x deg F (0.035 W/m x K)**]**<Insert**

conductivity> at **75 deg F (24 deg C)** mean temperature.

4. Moisture Absorption: Not exceeding 5 percent by weight at **120 deg F (49 deg C)** and 95 percent relative humidity for 96 hours when tested according to ASTM C1104/C1104M.
5. Acoustical Performance: Conform to sound absorption coefficients listed in NAIMA AH116.
6. Permeability: **0.02 perm (1.15 ng/Pa x s x sq. m)** maximum when tested according to ASTM E96/E96M, Procedure A.
7. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
8. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C423, Mounting A.
9. Fire/Smoke Resistance: Duct material shall comply with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E84.
10. Required Markings: EI stiffness rating, UL label, and other markings required by UL 181 on each full sheet of duct board.

D. Closure Materials:

1. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by manufacturer with coding "181A-P," manufacturer's name, and a date code.

   a. Tape: Aluminum foil-scrim tape imprinted with listing information.
   b. Minimum Tape Width: **2-1/2 inches (64 mm)**; **3 inches (76 mm)** for duct board thicker than **1 inch (25 mm)**.
   c. Staples: **1/2-inch (13-mm)** outward clinching, **2 inches (51 mm)** o.c. in tabs, one tab per joint.
   d. Water resistant.
   e. Mold and mildew resistant.

2. Heat-Activated Tape: Comply with UL 181A; imprinted by manufacturer with coding "181A-H," manufacturer's name, and a date code.

   a. Tape: Aluminum foil-scrim tape imprinted with listing information.
   b. Minimum Tape Width: **3 inches (76 mm)**.
   c. Heat-Sensitive Imprint: Printed indicator on tape to show proper heating during application has been achieved.
   d. Water resistant.
   e. Mold and mildew resistant.

3. Two-Part Tape Sealing System: Comply with UL 181A; imprinted by manufacturer with coding "181A-M," manufacturer's name, and a date code.

   a. Tape: Woven glass fiber impregnated with mineral gypsum.
   b. Minimum Tape Width: **3 inches (76 mm)**.
   c. Sealant: Modified styrene acrylic.
   d. Water resistant.
   e. Mold and mildew resistant.
   f. Sealant shall have a VOC content of 420 g/L or less.
   g. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   h. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   i. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

j. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

k. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Fabrication:

1. Comply with: [**SMACNA's "Fibrous Glass Duct Construction Standards," Ch. 3, "Specifications and Closure," and Ch. 4, "Fittings and Connections"**][**NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section II, "Fabrication of Straight Duct Modules," Section III, "Fabrication of Fittings from Modules or Flat Board," and Section IV, "Closure"**] for the following:

   a. Joints, seams, transitions, elbows, and branch connections.
   b. Reinforcements, including channel and tie rod reinforcement materials, spacing, and fabrications.

2. Fabricate 90-degree mitered elbows to include turning vanes.

F. Reinforcements: Comply with requirements in [**SMACNA's "Fibrous Glass Duct Construction Standards," Ch. 5, "Reinforcement"**][**NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section V, "Reinforcement"**] for channel- and tie-rod reinforcement materials, spacing, and fabrication.

2.3 PHENOLIC-FOAM DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AQC Industries, LLC**]
2. [**Kingspan Insulation LLC**]
3. [**PTM Manufacturing, LLC**]
4. [**Thermaduct**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AQC Industries, LLC**]
2. [**Kingspan Insulation LLC**]
3. [**PTM Manufacturing, LLC**]
4. [**Thermaduct**]
5. <**Insert manufacturer's name**>

C. Duct Panel: CFC-free phenolic-foam bonded on both sides with factory-applied, **0.001-inch- (0.025-mm-)** thick, aluminum foil reinforced with fiberglass scrim.

1. Temperature Limits:

a. Maximum **176 deg F (80 deg C)**.
b. Minimum: **Minus 4 deg F (Minus 20 deg C)**.

2. Maximum Thermal Conductivity: [**0.15 Btu x in./h x sq. ft. x deg F (0.021 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.
3. Permeability: **0.0002 perm (0.0115 ng/Pa x s x sq. m)** maximum when tested according to ASTM E96/E96M, Procedure A.
4. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
5. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C423, Mounting A.
6. Fire/Smoke Resistance: Duct material shall comply with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E84.
7. Required Markings: UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for closure materials.

D. Closure Materials:

1. V-Groove Adhesive: Silicone.

a. Sealant shall have a VOC content of 420 g/L or less.
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
f. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by manufacturer with coding "181A-P," manufacturer's name, and a date code.

a. Tape: Aluminum foil tape imprinted with listing information.
b. Minimum Tape Width: **3 inches (76 mm)**.
c. Water resistant.
d. Mold and mildew resistant.

3. Polymeric Sealing System:

a. Structural Membrane: Woven glass fiber.
b. Minimum Tape Width: **3 inches (76 mm)**.
c. Sealant: Water based.
d. Color: White.
e. Water resistant.
f. Mold and mildew resistant.

g. Sealant shall have a VOC content of 420 g/L or less.
h. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
i. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
j. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
k. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
l. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs according manufacturer's written instructions.
2. Fabricate 90-degree mitered elbows to include turning vanes.

2.4 THERMOSET FRP DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Monoxivent Co.**]
2. [**Perry Fiberglass Products, Inc.**]
3. [**Viron International**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Monoxivent Co.**]
2. [**Perry Fiberglass Products, Inc.**]
3. [**Viron International**]
4. <**Insert manufacturer's name**>

C. Duct and Fittings:

1. Thermoset FRP Resin: Comply with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E84.
2. Inner Liner: FSK liner rated by an NRTL to comply with UL 181, Class 1.
3. Round Duct: ASTM D2996, Type I, Grade 2, Class E, filament-wound duct, minimum [**0.125-inch (3.2-mm)**]<**Insert dimension**> wall thickness, with tapered bell-and-spigot ends for adhesive joints or with plain ends with couplings.
4. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and

joining method as duct.

5. Rectangular Fittings: Minimum [**0.125-inch- (3.2-mm-)**]<**Insert dimension**> thick, flat sheet with fiberglass roving and resin-reinforced joints and seams.
6. Double-Wall Insulated Duct: Inner and outer duct complying with requirements in "Round Duct" Subparagraph. Polyurethane foam or isocyanurate insulation with maximum thermal conductivity of [**0.14 Btu x in./h x sq. ft. x deg F (0.020 W/m x K)**]<**Insert conductivity**> at **75 deg F (24 deg C)** mean temperature.

D. Joining Materials: Roving and polyester resin.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Ch. 7, "Requirements."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.

F. Drains: Formed drain pockets with a minimum of **NPS 1 (DN 25)** threaded pipe connections.

2.5 PVC DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**General Plastics, Inc**]
2. [**GPK Products, Inc.**]
3. [**Harrison Machine & Plastic Corporation**]
4. [**Harvel Plastics, Inc.**]
5. [**Kroy Industries, Inc.**]
6. [**Spears Manufacturing Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**General Plastics, Inc**]
2. [**GPK Products, Inc.**]
3. [**Harrison Machine & Plastic Corporation**]
4. [**Harvel Plastics, Inc.**]
5. [**Kroy Industries, Inc.**]
6. [**Spears Manufacturing Company**]
7. **<Insert manufacturer's name>**

C. Duct and Fittings:

1. Material: Rigid, virgin PVC compound complying with ASTM D1784 Cell Classification 12454-B.
2. Flammability: Maximum flame-spread index of not more than 25 without evidence of continued progressive combustion.
3. External Loading Properties: ASTM D2412.
4. Minimum Round Duct Wall Thickness: [**0.187 inch (4.75 mm) for up to 18-inch (450-mm)**][**0.219 inch (5.56 mm) for up to 20-inch (508-mm)**][**0.25 inch (6.35 mm) for up to 24-inch (610-mm)**]<**Insert dimensions**> duct.
5. Round Fittings: Socket end molded of same material, pressure class, and joining method as duct.
6. Rectangular Fittings: Minimum [**0.125-inch- (3.2-mm-)**]<**Insert dimension**> thick, flat sheet with heat-formed corners and continuous welded butt joints.

D. Joining Materials: PVC solvent cement complying with ASTM D2564.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
6. Solvent cement shall have a VOC content of 510 g/L or less.
7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
10. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

11. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Ch. 3, "Standards of Construction for PVC Duct Systems."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.

F. Drains: PVC drain pockets with a minimum of **NPS 1 (DN 25)** threaded PVC pipe connections.

2.6 CPVC DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Harrison Machine & Plastic Corporation**]
2. [**Harvel Plastics, Inc**]
3. [**Spears Manufacturing Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Harrison Machine & Plastic Corporation**]
2. [**Harvel Plastics, Inc**]
3. [**Spears Manufacturing Company**]
4. <**Insert manufacturer's name**>

C. Duct and Fittings:

1. Material: Rigid, virgin CPVC compound complying with ASTM D1784 Cell Classification 23447.
2. Flammability: Maximum flame-spread index of not more than 25 without evidence of continued progressive combustion and a smoke-developed index of not more than 50.
3. Maximum Service Temperature: **200 deg F (93 deg C)**.
4. External Loading Properties: ASTM D2412.
5. Round Fittings: Socket end molded of same material, pressure class, and joining method as duct.
6. Rectangular Fittings: Minimum [**0.125-inch- (3.2-mm-)**]<**Insert dimension**> thick, flat sheet with heat-formed corners and continuous welded butt joints.

D. Joining Materials: CPVC solvent cement complying with ASTM D2564.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive primer shall comply with the testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
6. Solvent cement shall have a VOC content of 490 g/L or less.
7. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
10. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
11. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Ch. 3, "Standards of Construction for PVC Duct Systems."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.

F. Drains: CPVC drain pockets with a minimum of **NPS 1 (DN 25)** threaded CPVC pipe connections.

2.7 HDPE DUCT AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AQC Industries, LLC**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AQC Industries, LLC**]
2. **<Insert manufacturer's name>**

C. Source Limitations: Obtain HDPE duct system components from single manufacturer.

D. Description: Complete HDPE underground duct system consisting of factory-manufactured components to suit duct layout configuration including straight round duct, elbows, [**plenums,**][**run-outs,**][**diffuser boots,**] fitting clamps, gaskets, bolts, sealant, and other components required for a complete underground ductwork system.

E. Duct and Fittings:

1. Material:

a. Closed-cell recyclable HDPE plastic.
b. Does not emit VOCs.
c. Leakage: Air leakage testable, exceeding SMACNA Leakage Class 3 requirements at system design static pressure.
d. Thermal Distribution Efficiency: Inherent R-10 equivalent thermal insulation efficiency without using a separate insulation layer, tested in accordance with NSF P374 protocol and verified by an NSF thermal testing report.
e. Resistant to mildew, mold, and rust.
f. Remains stable, without cracking, when subjected to underground stresses and strains.
g. Rated for maximum **10-inch wg (2.5-kPa)** positive pressure and maximum rated **2-inch wg (0.5-kPa)** negative pressure.
h. Surface-Burning Characteristics: Flame-spread index of 200 or less when tested in accordance with ASTM E84.
i. Flood Plain Elevation: Tested to withstand **8-foot (2.4-m)** water column pressure for seven days with no leakage.

F. Joining Materials:

1. **Flanged Ductwork: Join with stainless steel bolts and water- and UV-resistant copolymer adhesive caulking sealant.**
2. **Unflanged Ductwork:**

a. **Clamps: Polyethylene clamps with stainless steel plates and stainless steel screws.**
b. **Gaskets: Butyl rubber gaskets, minimum 0.25 inch (6 mm)thick.**

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Zinc-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," **Table 5-1 (Table 5-1M)**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables: [**ASTM A603, galvanized**][**ASTM A492, stainless**]-steel cables with end connections made of [**zinc-plated**][**stainless-**]steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct

materials.

F. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.

2.9 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Ductmate Industries, Inc; a DMI company**]
5. [**Hilti, Inc.**]
6. [**Kinetics Noise Control, Inc**]
7. [**Mason Industries, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore Unistrut**]
2. [**CADDY; brand of nVent Electrical plc**]
3. [**Cooper B-line; brand of Eaton, Electrical Sector**]
4. [**Ductmate Industries, Inc; a DMI company**]
5. [**Hilti, Inc.**]
6. [**Kinetics Noise Control, Inc**]
7. [**Mason Industries, Inc.**]
8. <**Insert manufacturer's name**>

C. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by [**an evaluation service member of ICC-ES**][**the Office of Statewide Health Planning and Development for the State of California**][**an agency acceptable to authorities having jurisdiction**].

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least [**four**]<**Insert number**> times the maximum seismic forces to which they will be subjected.

D. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

E. Restraint Cables: [**ASTM A603, galvanized**][**ASTM A492, stainless**]-steel cables with end connections made of [**zinc plated**][**stainless-**]steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

F. Hanger Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**][**Reinforcing steel angle clamped**] to hanger rod.

G. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install duct sections in maximum practical lengths with fewest possible joints.

C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

F. Install ducts with a minimum clearance of **1 inch (25 mm)**, plus allowance for insulation thickness.

G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

H. Where ducts pass through non-fire-rated interior partitions and exterior walls, and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least **1-1/2 inches (38 mm)**.

I. Install fire[**, combination fire/smoke,**] and smoke dampers where indicated on Drawings and as required by code and by authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the fire damper UL listing.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.[**Comply with SMACNA's "IAQ Guidelines for Occupied Buildings under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."**]

L. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.

M. Branch Connections: Use lateral or conical branch connections.

N. Install fibrous-glass ducts and fittings to comply with [**NAIMA AH116, "Fibrous Glass Duct Construction Standards."**][**SMACNA's "Fibrous Glass Duct Construction Standards."**]

O. Install phenolic-foam ducts and fittings to comply with SMACNA's "Phenolic Duct Construction Standards."

P. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

Q. Install PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual."

R. Install CPVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual."

S. Install HDPE ducts, fittings, and components to comply with manufacturer's written installation instructions. Installer to complete manufacturer's installation training prior to installation.

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for fibrous-glass ducts and fittings to comply with [**SMACNA's "Fibrous Glass Duct Construction Standards," Ch. 6, "Hangers and Supports."**][**NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section VI, "Hangers and Supports."**]

B. Install hangers and supports for phenolic-foam ducts and fittings to comply with SMACNA's "Phenolic Duct Construction Standards" Ch. 6, "Hangers and Supports" and with manufacturer's written instructions.

C. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Ch. 7, "Requirements."

D. Install hangers and supports for PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Ch. 3, "Standards of Construction for PVC Duct Systems."

E. Install hangers and supports for CPVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Ch. 3, "Standards of Construction for PVC Duct Systems."

F. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than **4 inches (100 mm)** thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than **4 inches (100 mm)** thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. See Section 230548 "Vibration and Seismic Controls for HVAC." Comply with [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**][**ASCE/SEI 7.**]

1. Space lateral supports a maximum of [**40 feet (12 m)**]<**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet (24 m)**]<**Insert dimension**> o.c.
2. Brace a change of direction longer than **12 feet (3.7 m)**.

B. Select sizes of components so strength will be adequate to carry calculated static and seismic loads within restraint device capacity.

C. Install restraint cables so they do not bend across edges of adjacent equipment or building structure.

D. Install restraint cables where ducts are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by [**an evaluation service member of the ICC Evaluation Service**][**the Office of Statewide Health Planning and Development for the State of California**][**an agency acceptable to authorities having jurisdiction**].

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and water and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.4 PAINTING

A. Paint interior of [**thermoset FRP**][**PVC**][**and**][**CPVC**] ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, acrylic or latex paint that is chemically compatible with duct material. Confirm compatibility information with paint manufacturer. Oil-based paint is not recommended. Paint materials and application requirements are specified in Section 099123 "Interior Painting."

3.5 STARTUP SERVICE

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and

inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Leakage Tests:

a. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
b. Where static pressure and leakage values shown below differ from those in the SMACNA manual, the more stringent values shall apply.
c. Test the following systems:

1) Ducts with a Pressure Class Higher Than **3-Inch wg (750 Pa)**: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than 25 percent of total installed duct area for each designated pressure class.
2) Supply Ducts with a Pressure Class of [**2-Inch wg (500 Pa)**][**3-Inch wg (750 Pa)**][**4-Inch wg (1000 Pa)**]<**Insert value**> or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.
3) Return Ducts with a Pressure Class of [**2-Inch wg (500 Pa)**][**3-Inch wg (750 Pa)**][**4-Inch wg (1000 Pa)**]<**Insert value**> or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.
4) Exhaust Ducts with a Pressure Class of [**2-Inch wg (500 Pa)**][**3-Inch wg (750 Pa)**][**4-Inch wg (1000 Pa)**]<**Insert value**> or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.
5) Outdoor Air Ducts with a Pressure Class of [**2-Inch wg (500 Pa)**][**3-Inch wg (750 Pa)**][**4-Inch wg (1000 Pa)**]<**Insert value**> or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**][**100**]<**Insert number**> percent of total installed duct area for each designated pressure class.

d. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
e. Test for leaks before applying external insulation.
f. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
g. Give [**seven**]<**Insert number**> days' advance notice for testing.

2. Duct System Cleanliness Tests:

a. Test protocols shall be performed according to NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems," "Section 5 - Cleanliness Verification and Documentation."
b. Visually inspect duct system to ensure that no visible contaminants are present.
c. Test sections of fibrous-glass duct system chosen randomly by Owner for cleanliness according to "Method 2 Protocol."

d. Test sections of Phenolic-foam, Thermoset FRP, PVC, and CPVC duct systems chosen randomly by Owner, for cleanliness according to "Method 3 - NADCA Vacuum Test."

1) Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

3. Duct system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. All duct cleaning shall be performed according to NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
4. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for washdown procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removing surface deposits and debris.

3.8 DUCT SCHEDULE

A. Indoor Ducts and Fittings:

1. Fibrous-Glass Rectangular Ducts and Fittings:

a. Minimum Flexural Rigidity: EI-[**475**][**800**][**1400**].
b. Minimum Board Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**].

2. Phenolic-Foam Rectangular Ducts and Fittings:

a. Minimum Panel Thickness: [**7/8 inch (22 mm)**][**1-3/32 inches (30 mm)**].
b. Aluminum Cladding: Minimum **0.025 inch (0.635 mm)** thick.
c. Joints: Secure joints with adhesive or clips according to duct manufacturer's written instructions, then tape joints with aluminum vapor tape.
d. Sealing: All joints shall be sealed with a generous and continuous bead of silicone sealant and pressed into corners using a smooth radius tool.

B. Outdoor Ducts and Fittings:

1. Provide suitable external surface protection as recommended by manufacturer.
2. Phenolic-Foam Rectangular Ducts and Fittings:

a. Minimum Panel Thickness: [**7/8 inch (22 mm)**][**1-3/32 inches (28 mm)**].
b. Aluminum Cladding: Minimum **0.032 inch (0.813 mm)** thick.
c. Joints: Secure joints with adhesive or clips according to duct manufacturer's written instructions, then tape joints with aluminum vapor tape.
d. Sealing: All joints shall be sealed with a generous and continuous bead of silicone sealant and pressed into corners using a smooth radius tool.

3. Thermoset FRP Round Ducts and Fittings:

a. Double-Wall Insulated Ducts: Minimum [**5/8-inch (15.9-mm)**][**7/8-inch (22.2-mm)**][**1-inch (25.4-mm)**] insulation thickness with [**k-factor of 14 (2.02-W/mK)**]<**Insert value**> insulation thickness.

C. Underground Ducts:

1. Provide suitable external surface protection as recommended by manufacturer.
2. Thermoset FRP Round Ducts and Fittings:

a. Double wall.
b. Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
c. Drain: Minimum **NPS 1 (DN 25)** PVC pipe with P-trap to air-gap drain.

3. PVC Round Ducts and Fittings:

a. Drain: Minimum **NPS 1 (DN 25)** PVC pipe with P-trap to air-gap drain.

4. CPVC Round Ducts and Fittings:

a. Drain: Minimum **NPS 1 (DN 25)** CPVC pipe with P-trap to air-gap drain.

5. HDPE Round Ducts and Fittings: Drain as recommended by manufacturer.

D. Fume Exhaust:

1. Thermoset FRP ducts and fittings.
2. Install exhaust ducts without dips and traps that may hold condensate or other liquid, and sloped a minimum of 2 percent to drain. Where indicated on Drawings, install trapped drain piping.
3. Connect duct to fume hood or other equipment where indicated on Drawings.

END OF SECTION 23 31 16 00

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Task	Specification	Specification Description
23 31 16 13	23 31 13 00	Metal Ducts
23 31 16 13	23 31 16 00	Nonmetal Ducts
23 31 16 16	23 31 13 00	Metal Ducts
23 31 16 16	23 31 16 00	Nonmetal Ducts

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SECTION 23 31 16 23 - FABRIC AIR-DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabric air-distribution duct and devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

B. Shop Drawings: For fabric air-distribution devices.

1. Include plans, elevations, sections, and suspension and attachment details.

C. Samples for Initial Selection: Fabric samples for air-distribution devices with factory-applied color finishes.

D. Samples for Verification: Fabric samples for air-distribution devices, in manufacturer's standard sizes to verify color selected.

E. Diffuser Schedule: Use same designations indicated on Drawings. Indicate room location, quantity, model number, size, and accessories furnished.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Source quality control reports.

PART 2 - PRODUCTS

2.1 FABRIC AIR-DISTRIBUTION DUCT AND DEVICES

A. Fabric Air-Distribution Duct and Devices:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Air Distribution Concepts**]
b. [**Airmax International**]
c. [**Berner International**]
d. [**DuctSox Corp.**]
e. [**Durkee America Inc.**]
f. [**Fabric Duct Systems**]
g. [**FabricAir Inc.**]
h. [**KE Fibertec NA, Inc**]
i. [**Prihoda North America**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Air Distribution Concepts**]
b. [**Airmax International**]
c. [**Berner International**]
d. [**DuctSox Corp.**]
e. [**Durkee America Inc.**]
f. [**Fabric Duct Systems**]
g. [**FabricAir Inc.**]
h. [**KE Fibertec NA, Inc**]
i. [**Prihoda North America**]
j. <**Insert manufacturer's name**>

B. Source Limitations: Obtain fabric air duct and distribution devices from a single manufacturer.

C. Performance Requirements:

1. Continuous tubular diffuser materials are to be listed and labeled as complying with [**UL 2518**][**UL 723**][**NFPA 90A**][**NFPA 90B**][**NFPA 701**][**ASTM E84**].
2. Air permeability of fabric is to comply with ASTM D737.

D. Description:

1. Fabric: [**Woven polyethylene**][**Woven, coated polyethylene**][**Polyester**][**Anti-microbial-coated polyester**][**Vinyl-coated polyester**][**Anti-static polyester**][**High-temperature fiberglass**][**Permeable polyester**]<**Insert material**>.
2. Shape: [**Round**][**Oval**][**Half round**]<**Insert shape**>.
3. Air-Outlet Configuration:

a. Permeable fabric.
b. Circumferential hole pattern with diffusion-hole diameter of <**Insert inches (mm)**>, spaced <**Insert inches (mm)**> o.c. circumferentially, and <**Insert inches (mm)**> along the length of the diffusion device.
c. Lengthwise mesh.
d. Lengthwise hole pattern; with diffusion-hole diameter of <**Insert inches (mm)**>.
e. Periodic nozzles.
f. Linear vents.

1) Color: <**Insert color**>.

E. Duct Connection Type: Round [**worm-gear band**][**radial securing clips**][**zipper**].

F. Accessories:

1. Quick-connect joint.
2. Snap hooks.
3. Cleanout zipper.
4. Condensate drain.
5. Fabric damper.
6. End cap.
7. Draw cords.
8. Removable support hoops.
9. Elbows.

PART 3 - EXECUTION

3.1 INSTALLATION OF FABRIC AIR-DISTRIBUTION DUCT AND DEVICES

A. Drawings indicate general arrangement of ducts, fittings, and accessories. Air-outlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. Where architectural features or other items conflict with installation, notify Architect to determine final location.

END OF SECTION 23 31 16 23

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Task	Specification	Specification Description
23 31 16 23	23 31 16 00	Nonmetal Ducts

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SECTION 23 33 00 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling radiation dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Duct-mounted duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Duct access panel assemblies.
16. Duct flexible connectors.
17. Duct security bars.
18. Duct accessory hardware.
19. Flexible ducts.
20. Flexible duct connectors.

B. Related Requirements:

1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

2. Section 284600 "Fire Detection and Alarm" for duct-mounted heat, smoke, and carbon-monoxide detectors.
3. Section 284614 "Single- and Multiple- Station Alarms" for standalone duct-mounted heat, smoke, and carbon-monoxide detectors/alarms.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Construction details, material descriptions, and dimensions of individual components.
2. For dampers, include housings, linkages, and operators.
3. For damper operators, include electrical or pneumatic pressure rating and damper size rating.
4. For duct-mounted duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For air duct accessories.

1. Plans showing locations, elevations, sections, and attachment details.
2. Duct accessories' fabrication and installation in ducts and other construction. Include dimensions,

weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.

f. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product Data: Showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source Quality Control Reports: For duct-mounted duct silencers.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to [**10**] percent of amount installed.

PART 2 - PRODUCTS

2.1 DAMPERS

A. Backdraft and Pressure Relief Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**American Warming and Ventilating (AWV); Mestek, Inc.**]

c. [**Cesco Products; MESTEK, Inc.**]
d. [**Greenheck Fan Corporation**]
e. [**Lloyd Industries, Inc.**]
f. [**Nailor Industries Inc**]
g. [**Pottorff**]
h. [**Safe Air - Dowco**]
i. [**United Enertech Corp.**]
j. [**Vent Products Co., Inc**]

2. Description: Gravity balanced [**with adjustable counterweight**][**with spring**][**with motorized actuator**] .
3. General Requirements:

   a. Maximum Air Velocity: [**1000 fpm (5.1 m/s)**][**1250 fpm (6.4 m/s)**][**2000 fpm (10 m/s)**][**3000 fpm (15 m/s)**].
   b. Maximum System Pressure: [**1 inch wg (0.25 kPa)**][**2 inches wg (0.5 kPa)**][**3 inches wg (0.8 kPa)**][**6 inches wg (1.5 kPa)**].

   c. AMCA Certification: Test and rate in accordance with AMCA 511.
   d. Leakage:

      1) Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      2) Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      3) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      4) Class III: Leakage is not to exceed **40 cfm/sq. ft. (203 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

4. Construction:

   a. Frame: Hat shaped, with welded or mechanically attached corners [**and mounting flange**] .

      1) Material: [**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**10-gauge- (3.5-mm-) thick, galvanized sheet steel**][**0.093-inch- (2.4-mm-) thick extruded aluminum**][**18-gauge- (1.3-mm-) thick stainless steel**].

   b. Blades: Multiple single-piece blades, [**center**][**off-center**][**end**] pivoted, with sealed edges.

      1) Maximum Blade Width: **6-inch (150-mm)**.
      2) Material: [**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**0.050-inch- (1.2-mm-) thick aluminum sheet**][**26-gauge (0.48-mm) Type 304 stainless steel**][**noncombustible, tear-resistant, neoprene-coated fiberglass**].
      3) Action: Parallel.
      4) Seals: [**Felt**][**Vinyl foam**][**Extruded vinyl, mechanically locked**][**Neoprene, mechanically locked**] .
      5) Axles:

         a) Material: [**Nonferrous metal**][**Galvanized steel**][**Plated steel**][**Stainless steel**][**Nonmetallic**][**Aluminum**] .
         b) Diameter: [**0.20 inch (5 mm)**][**0.50 inch (13 mm)**].

   c. Tie Bars and Brackets: [**Aluminum**][**Galvanized steel**] .

d. Counterbalance: [**Adjustable counterweight**][**Adjustable-tension return spring**][**Motorized actuator**] .
e. Bearings: [**Steel ball**][**Brass sleeve**][**synthetic pivot bushings**] .

5. Damper Actuator - Electric:

a. Electrical Voltage: [**120 V ac**][**24 V ac**] .

b. UL Rating: UL 60730-2-14 and UL 2043 plenum rated.
c. Actuator Type: [**Two position**][**Fully modulating**][**with fail-safe spring return**] .

1) Sufficient motor torque [**and spring torque**] to drive damper fully closed with adequate force to achieve required damper seal.
2) Minimum 90-degree drive rotation.

d. Drive Rotation: Clockwise or counterclockwise as required for application.
e. Environmental Operating Range:

1) Temperature: **Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C)**.
2) Humidity: 5 to 95 percent relative humidity noncondensing.

f. Environmental Enclosure: NEMA 2.
g. Actuator to be factory mounted and provided with a single-point wiring connection.

6. Damper Actuator - Pneumatic:

a. Pneumatic Signal: **0 to 20 psig (0 to 138 kPa)**.
b. Actuator Type: [**Two position with**][**Fully modulating with positioner and**] fail-safe spring return.

1) Sufficient power and spring force to drive damper fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.

c. Actuator to be factory mounted.

7. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

a. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**].

8. Accessories:

a. Adjustment Device: To permit setting for varying differential static pressure.
b. Counterweights and Spring-Assist Kits: For vertical airflow installations.
c. Chain pulls.
d. 90-degree stops.
e. Screen:

1) Mounting: [**Front**][**Rear**] mounted in sleeve.

a) Sleeve Thickness: **20 gauge (1.0 mm)** minimum.
b) Sleeve Length: **6 inches (150 mm)** minimum.

2) Material: [**Galvanized steel**][**Aluminum**] .
3) Type: [**Bird**][**Insect**] .

B. Barometric Relief Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
c. [**Cesco Products; MESTEK, Inc.**]
d. [**Greenheck Fan Corporation**]
e. [**Lloyd Industries, Inc.**]
f. [**Nailor Industries Inc**]
g. [**Pottorff**]
h. [**Safe Air - Dowco**]
i. [**United Enertech Corp.**]
j. [**Vent Products Co., Inc**]

2. General Requirements:

a. Suitable for horizontal or vertical applications.
b. Maximum Air Velocity: [**1000 fpm (5.1 m/s)**][**1250 fpm (6.4 m/s)**][**2000 fpm (10 m/s)**][**2500 fpm (13 m/s)**].
c. Maximum System Pressure: [**2 inches wg (0.5 kPa)**][**3 inches wg (0.8 kPa)**][**6 inches wg (1.5 kPa)**][**10 inches wg (2.5 kPa)**] .

3. Construction:

a. Frame: Hat shaped, with welded corners or mechanically attached [**with mounting flange**] .

1) Material: [**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**13-gauge- (2.4-mm-) thick, galvanized sheet steel**][**0.093-inch- (2.4-mm-) thick extruded aluminum**][**18-gauge- (1.3-mm-) thick stainless steel**][**18-gauge- (1.3-mm-) thick stainless steel**].

b. Blades: Multiple blades, [**eccentrically**][**off-center**][**end**] pivoted, with sealed edges.

1) Maximum Blade Width: **6-inch (150-mm)**.
2) Material: [**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**0.050-inch- (1.2-mm-) thick aluminum sheet**][**26-gauge (0.48-mm) Type 304 stainless steel**] .
3) Action: Parallel.
4) Balance: Gravity.
5) Seals: [**Vinyl**][**Neoprene**] .
6) Axles: [**Galvanized steel**][**Nonferrous metal**][**Plated steel**][**Stainless steel**][**Nonmetallic**] .

c. Tie Bars and Brackets:

1) Material: [**Aluminum**][**Galvanized steel**] .
2) Rattle free with 90-degree stop.

d. Bearings: [**Synthetic**][**Stainless steel**][**Ball bearing**] .

4. Pressure Adjustment: Return spring or counter weight with adjustable tension.
5. Accessories:

a. Flange: On intake.
b. Screens: [**Bird**][**Insect**] screen on [**intake**][**discharge**] .
c. Adjustment Device: To permit setting for varying differential static pressures.

C. Control Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
c. [**Arrow United Industries; Mestek, Inc.**]
d. [**Carnes Company**]
e. [**Cesco Products; MESTEK, Inc.**]
f. [**Greenheck Fan Corporation**]
g. [**Lloyd Industries, Inc.**]
h. [**McGill AirFlow LLC**]
i. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
j. [**Nailor Industries Inc**]
k. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
l. [**Pottorff**]
m. [**Safe Air - Dowco**]
n. [**United Enertech Corp.**]
o. [**Vent Products Co., Inc**]

2. General Requirements:

a. Suitable for horizontal or vertical airflow applications.
b. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
c. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

d. AMCA Certification: Test and rate in accordance with AMCA 511.
e. Leakage:

1) Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
2) Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
3) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
4) Class III: Leakage is not to exceed **40 cfm/sq. ft. (203 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

f. Pressure Drop: **0.05 inch wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **24-by-24-inch**

(600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.

g. Velocity: Up to [3000 fpm (15 m/s)].
h. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
i. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

3. Construction:

a. Frames: Hat, U, or angle shaped. Provide flanges for attaching to walls and flangeless frames for installing in ducts.

1) Material: [**0.08-inch- (2.0-mm-) thick extruded aluminum**][**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**18-gauge- (1.3-mm-) thick stainless steel**] .
2) Corners: [**Mitered and welded**][**Interlocking, gusseted**] .

b. Blades: Multiple blades. Vertical blades to have thrust bearings at each end of every blade.

1) Material: [**Galvanized steel**][**Stainless steel**][**Aluminum**] .
2) Material Thickness: [**16-gauge- (1.6-mm-) thick single skin**][**14-gauge- (1.9-mm-) thick air foil dual skin**] .
3) Maximum Blade Width: [**6 inches (150 mm)**][**8 inches (200 mm)**] .
4) Action: [**Parallel**][**Opposed**] blade design.
5) Edging Seals: [**Replaceable closed-cell neoprene**][**Replaceable PVC**][**Inflatable seal blade edging, or replaceable rubber seals**] .
6) Jamb Seals: Flexible stainless steel, compression type.
7) Axles: **1/2-inch (13-mm)** diameter; [**galvanized**][**stainless**] steel.
8) Linkage: Enclosed within the frame and out of airstream.
9) Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.

c. Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

4. Damper Actuator - Electric :

a. Electric - [**120 V ac**][**24 V ac**] .

b. UL Rating: UL 60730-2-14 and UL 2043, plenum rated.
c. Actuator Type: [**Two position**][**Fully modulating**][**with fail-safe spring return**] .

1) Sufficient motor torque [**and spring torque**] to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Minimum 90-degree drive rotation.

d. Clockwise or counterclockwise drive rotation as required for application.
e. Environmental Operating Range:

1) Temperature: Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C).
2) Humidity: 5 to 95 percent relative humidity noncondensing.

f. Environmental Enclosure: NEMA 2.
g. Actuator to be factory mounted and provided with a single-point wiring connection.

5. Damper Actuator - Pneumatic:

a. Operated by **0 to 20 psig (0 to 138 kPa)** pneumatic signal.

b. Actuator Type: [**Two position with**][**Fully modulating with positioner and**][**with fail-safe spring return**] .

1) Sufficient power and spring force to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.

c. Actuator to be factory mounted.

6. Controllers, Electrical Devices, and Wiring:

a. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
b. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**].

D. Manual Volume Dampers:

1. Standard, Steel, Manual Volume Dampers :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Ruskin; Air Distribution Technologies, Inc.**]
2) [**Air Balance; MESTEK, Inc.**]
3) [**Aire Technologies, Inc.; DMI Companies**]
4) [**American Warming and Ventilating (AWV); Mestek, Inc.**]
5) [**Arrow United Industries; Mestek, Inc.**]
6) [**Cesco Products; MESTEK, Inc.**]
7) [**Greenheck Fan Corporation**]
8) [**Lloyd Industries, Inc.**]
9) [**McGill AirFlow LLC**]
10) [**Nailor Industries Inc**]
11) [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
12) [**Pottorff**]
13) [**Safe Air - Dowco**]
14) [**United Enertech Corp.**]
15) [**Vent Products Co., Inc**]

b. General Requirements:

1) Suitable for horizontal or vertical airflow applications.
2) Leakage Rating Class III: Leakage not exceeding **40 cfm/sq. ft. (203 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

c. Construction:

1) Frames: Hat-shaped with mitered and welded corners. Provide flanges for attaching to walls and flangeless frames for installing in ducts.

a) Material: [**16-gauge- (1.6-mm-) thick, galvanized sheet steel**][**18-gauge- (1.3-mm-) thick stainless steel**] .

2) Blades: Multiple or single blade. Stiffen damper blades for stability. Vertical blades to have thrust bearing at each end of every blade.

a) Material: [**Galvanized**][**Stainless**] steel; **16 gauge (1.6 mm)** thick.
b) Action: Parallel- or opposed-blade design.
c) Axles: [**Galvanized steel**][**Stainless steel**][**Nonferrous metal**] .
d) Linkage: Enclosed within the frame and out of airstream.
e) Locking Device: Holds damper blades in fixed position without vibration.

3) Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

a) Tie Bars and Brackets: Galvanized steel.

2. Standard, Aluminum, Manual Volume Dampers :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Ruskin; Air Distribution Technologies, Inc.**]
2) [**American Warming and Ventilating (AWV); Mestek, Inc.**]
3) [**Arrow United Industries; Mestek, Inc.**]
4) [**Cesco Products; MESTEK, Inc.**]
5) [**Linx Industries; a DMI company (formerly Lindab)**]
6) [**Nailor Industries Inc**]
7) [**Pottorff**]
8) [**Safe Air - Dowco**]
9) [**United Enertech Corp.**]

b. General Requirements:

1) Suitable for horizontal or vertical airflow applications.
2) Leakage Rating Class III: Leakage not exceeding **40 cfm/sq. ft. (203 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

c. Construction:

1) Frames: Hat shaped. Provide flanges for attaching to walls and flangeless frames for installing in ducts.

a) Material: **0.10-inch- (2.5-mm-)** thick, aluminum sheet channels.

2) Blades: Multiple or single blade. Stiffen damper blades for stability. Vertical blades to have thrust bearing at each end of every blade.

a) Roll-Formed Aluminum Blades: **0.10-inch- (2.5-mm-)** thick aluminum sheet.
b) Extruded-Aluminum Blades: **0.050-inch- (1.2-mm-)** thick extruded aluminum.
c) Action: Parallel- or opposed-blade design.
d) Axles: [**Galvanized steel**][**Stainless steel**][**Nonferrous metal**] .
e) Linkage: Enclosed within the frame and out of airstream.
f) Locking Device: Holds damper blades in a fixed position without vibration.

3) Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Stainless steel sleeve**] .

a) Tie Bars and Brackets: Aluminum.

3. Low-Leakage, Steel, Manual Volume Dampers :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Ruskin; Air Distribution Technologies, Inc.**]
2) [**Air Balance; MESTEK, Inc.**]
3) [**American Warming and Ventilating (AWV); Mestek, Inc.**]
4) [**Arrow United Industries; Mestek, Inc.**]
5) [**Cesco Products; MESTEK, Inc.**]
6) [**Greenheck Fan Corporation**]
7) [**Nailor Industries Inc**]
8) [**Pottorff**]
9) [**Safe Air - Dowco**]
10) [**Vent Products Co., Inc**]

b. General Requirements:

1) Suitable for horizontal or vertical airflow applications.

2) AMCA Certification: Test and rate in accordance with AMCA 511.
3) Leakage:

a) Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
b) Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
c) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

c. Construction:

1) Frames: Hat, U, or angle shaped with mitered and welded corners. Provide flanges for attaching to walls and flangeless frames for installing in ducts.

a) Material: [**16-gauge (1.6-mm) galvanized sheet steel**][**18-gauge (1.3-mm) stainless steel**] .

2) Blades: Multiple or single blade. Stiffen damper blades for stability. Vertical blades to have thrust bearing at each end of every blade.

a) Material: [**Galvanized**][**Stainless**] , roll-formed steel; **16 gauge (1.6 mm)** thick.
b) Action: Parallel- or opposed-blade design.
c) Edging Seals: [**Closed-cell neoprene**][**PVC**][**Inflatable seal blade edging or replaceable rubber seals**] .
d) Jamb Seals: [**Flexible metal compression type**][**Felt**][**Vinyl**][**Neoprene**] .
e) Axles: [**Galvanized steel**][**Stainless steel**][**Nonferrous metal**] .
f) Locking Device: Holds damper blades in a fixed position without vibration.

3) Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

a) Tie Bars and Brackets: [**Galvanized steel**][**Aluminum**] .

4. Low-Leakage, Aluminum, Manual Volume Dampers :

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**Ruskin; Air Distribution Technologies, Inc.**]
2) [**Air Balance; MESTEK, Inc.**]
3) [**American Warming and Ventilating (AWV); Mestek, Inc.**]
4) [**Arrow United Industries; Mestek, Inc.**]
5) [**Cesco Products; MESTEK, Inc.**]
6) [**Pottorff**]
7) [**Safe Air - Dowco**]
8) [**United Enertech Corp.**]
9) [**Vent Products Co., Inc**]

b. General Requirements:

1) Suitable for horizontal or vertical airflow applications.

2) AMCA Certification: Test and rate in accordance with AMCA 511.
3) Leakage:

a) Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
b) Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
c) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

c. Construction:

1) Frames: Hat, U, or angle shaped. Provide flanges for attaching to walls and flangeless frames for installing in ducts..

a) Material: **0.08-inch (2.0-mm)** aluminum sheet channels.

2) Blades: Multiple or single blade. Vertical blades to have thrust bearings at each end of every blade.

a) Roll-Formed Aluminum Blades: **0.072-inch (1.8-mm-)** thick aluminum sheet.
b) Extruded-Aluminum Blades: **0.050-inch- (1.2-mm-)** thick extruded aluminum.
c) Action: Parallel- or opposed-blade design.
d) Edging Seals: [**Closed-cell neoprene**][**PVC**][**Inflatable seal blade edging or replaceable rubber seals**] .
e) Jamb Seals: [**Flexible metal compression type**][**Felt**][**Vinyl**][**Neoprene**] .
f) Blade Axles: [**Galvanized steel**][**Stainless steel**][**Nonferrous metal**] .
g) Linkage: Enclosed within the frame and out of airstream.
h) Locking Device: Holds damper blades in a fixed position without vibration.

3) Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

a) Tie Bars and Brackets: [**Galvanized steel**][**Aluminum**] .

5. Manual Volume Damper Jackshaft:

a. Size: [**0.5-inch (13-mm)**][**1-inch (25-mm)**] diameter.
b. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
c. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

6. Manual Volume Damper Hardware:

a. Zinc-plated, die-cast core with dial and handle, made of **3/32-inch- (2.4-mm-)** thick zinc-plated steel, and a **3/4-inch (19-mm)** hexagon locking nut.
b. Include center hole to suit damper operating-rod size.
c. Include elevated platform for insulated duct mounting.

2.2 UL-LISTED DAMPERS

A. Fire Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**Air Balance; MESTEK, Inc.**]
c. [**Aire Technologies, Inc.; DMI Companies**]
d. [**Arrow United Industries; Mestek, Inc.**]
e. [**Cesco Products; MESTEK, Inc.**]
f. [**CL WARD & Family Inc.**]
g. [**Greenheck Fan Corporation**]
h. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
i. [**Pottorff**]
j. [**Prefco**]
k. [**Safe Air - Dowco**]
l. [**United Enertech Corp.**]
m. [**Vent Products Co., Inc**]

2. Standards: Comply with NFPA 90A and NFPA 90B.

3. Type: [**Static**][**and**][**dynamic**] ; rated and labeled in accordance with UL 555 by an NRTL.

4. Closing Rating in Ducts: Up to [**4 inch wg (1 kPa)**] static pressure class and minimum [**2000 fpm (1 m/s)**] velocity.

5. Fire Rating: [**1-1/2**][**and**][**3**] hours.
6. Construction:

a. Frame: [**Curtain type with blades inside airstream**][**Curtain type with blades outside airstream**][**Multiple-blade type**][**Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream**] ; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
b. Blades: Roll-formed [**galvanized sheet steel**][**stainless steel**] , [**interlocking**][**full-length steel blade connectors**] . Material gauge is to be in accordance with UL listing.

7. Mounting Sleeve: Factory or field installed.

a. Material: [**Galvanized sheet**][**Stainless**] steel; gauge in accordance with UL listing.
b. Orientation: Vertical or horizontal as indicated.

8. Horizontal Dampers: Include blade lock and stainless steel closure spring.
9. Heat-Responsive Device:

a. Fusible Links: Replaceable, [**165 deg F (74 deg C)**][**212 deg F (100 deg C)**] rated.
b. Link and Switch Package: [**Electric**][**Pneumatic**] , [**resettable**][**replaceable**] , factory installed, [**165 deg F (74 deg C)**][**and**][**212 deg F (100 deg C)**] rated.

B. Ceiling Radiation Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**Air Balance; MESTEK, Inc.**]
c. [**Aire Technologies, Inc.; DMI Companies**]
d. [**Arrow United Industries; Mestek, Inc.**]
e. [**Cesco Products; MESTEK, Inc.**]
f. [**CL WARD & Family Inc.**]
g. [**Greenheck Fan Corporation**]
h. [**Lloyd Industries, Inc.**]
i. [**Nailor Industries Inc**]
j. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
k. [**Pottorff**]
l. [**Prefco**]
m. [**Safe Air - Dowco**]
n. [**United Enertech Corp.**]

2. Standards: Comply with NFPA 90A and NFPA 90B.
3. General Requirements:

a. Labeled according to UL 555C by an NRTL.
b. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

4. Fire Rating: [**1**][**2**][**3**] hour(s).
5. Construction:

a. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction; gauge in accordance with UL listing.
b. Blades: Galvanized sheet steel with refractory insulation; gauge in accordance with UL

listing.

6. Heat-Responsive Device: Replaceable, [**165 deg F (74 deg C)**][**212 deg F (100 deg C)**] rated, fusible links.

C. Smoke Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ruskin; Air Distribution Technologies, Inc.**]
   b. [**Air Balance; MESTEK, Inc.**]
   c. [**Aire Technologies, Inc.; DMI Companies**]
   d. [**Arrow United Industries; Mestek, Inc.**]
   e. [**Cesco Products; MESTEK, Inc.**]
   f. [**CL WARD & Family Inc.**]
   g. [**Greenheck Fan Corporation**]
   h. [**Pottorff**]
   i. [**Safe Air - Dowco**]
   j. [**United Enertech Corp.**]

2. General Requirements:

   a. Suitable for horizontal or vertical airflow applications.
   b. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
   c. Label to indicate conformance to NFPA 80, NFPA 90A, and NFPA 90B by an NRTL.
   d. Unless otherwise indicated, use parallel-blade configuration.
   e. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.
   f. Factory install damper actuator by damper manufacturer as integral part of damper assembly. Coordinate actuator location, mounting, and electrical requirements with damper manufacturer.

   g. AMCA Certification: Test and rate in accordance with AMCA 511.
   h. Leakage:

      1) Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      2) Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s/ per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      3) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

   i. Pressure Drop: **0.05 inch wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **24-by-24-inch (600-by-600-mm)** damper when tested in accordance with AMCA 500-D, Figure 5.3.
   j. Velocity: Up to [**3000 fpm (15 m/s)**].
   k. Temperature: **Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C)**.
   l. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

3. Construction:

a. Frame: Hat shaped.

1) Material: [**Galvanized sheet steel**][**Stainless steel**] .
2) Gauge: In accordance with UL listing.
3) Corners: [**Welded**][**Interlocking, gusseted**][**mechanically attached**] corners [**and mounting flange**] .

b. Blades: Roll-formed, horizontal, [**v-groove**][**airfoil**] .

1) Material: [**Galvanized sheet steel**][**Stainless steel**][**Extruded aluminum**] .
2) Maximum Width and Gauge: In accordance with UL listing.
3) Edging Seals: Silicone rubber.
4) Jamb Seal: Flexible stainless steel, compression type.
5) Axles: **1/2-inch (13-mm)** diameter; [**galvanized steel**][**stainless steel**] ; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage is to be mounted out of airstream.
6) Linkage: Enclosed within frame and out of airstream.

c. Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

4. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application [**with factory-furnished silicone caulking**] ; gauge in accordance with UL listing.

5. Damper Actuator - Electric:

a. Electric - [**120 V ac**][**24 V ac**] .

b. UL Rating: UL 60730-2-14 and UL 2043, plenum rated.
c. Designed to operate in smoke-control systems complying with UL 555S requirements.
d. Actuator Type: [**Two position**][**Fully modulating**][**with fail-safe spring return**] .

1) Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.
3) Minimum 90-degree drive rotation.

e. Drive Rotation: Clockwise or counterclockwise as required for application.
f. Environmental Operating Range:

1) Temperature: **Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C)**.
2) Humidity: 5 to 95 percent relative humidity noncondensing.

g. Environmental Enclosure: NEMA 2.
h. Actuator to be factory mounted and provided with single-point wiring connection.

6. Damper Actuator - Pneumatic:

a. Operated by **0 to 20 psig (0 to 138 kPa)** pneumatic signal.
b. Designed to operate in smoke-control systems complying with UL 555S requirements.
c. Actuator Type: [**Two position with**][**Fully modulating with positioner and**] fail-safe spring return.

1) Sufficient power and spring force to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.

d. Actuator to be factory mounted.

7. Controllers, Electrical Devices, and Wiring:

a. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
b. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**].

8. Accessories:

a. Auxiliary Switches: For [**signaling**][**fan control**][**position indication**] .
b. Switch Type: [**Momentary test switch**][**Test and reset switches**] , [**damper**][**remote**] mounted.

9. Smoke Detector: Integral, factory wired for single-point connection.

D. Combination Fire and Smoke Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**Air Balance; MESTEK, Inc.**]
c. [**Aire Technologies, Inc.; DMI Companies**]
d. [**Arrow United Industries; Mestek, Inc.**]
e. [**Cesco Products; MESTEK, Inc.**]
f. [**CL WARD & Family Inc.**]
g. [**Greenheck Fan Corporation**]
h. [**NCA Manufacturing, Inc.; Metal Industries, Inc.**]
i. [**Pottorff**]
j. [**Safe Air - Dowco**]
k. [**United Enertech Corp.**]

2. General Requirements:

a. Suitable or horizontal or vertical airflow applications.
b. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
c. Label to indicate conformance to NFPA 80, NFPA 90A, and NFPA 90B by an NRTL.
d. Unless otherwise indicated, use parallel-blade configuration.

3. Closing rating in ducts up to [**4 inch wg (1 kPa)**] static pressure class and minimum [**2000 fpm (10 m/s)**] velocity.

4. Fire Rating: [**1-1/2**][**and**][**3**] hours.

5. AMCA Certification: Test and rate in accordance with AMCA 511.
6. Leakage:

a. Class IA: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
b. Class I: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s/ per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

c. Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

7. Pressure Drop: **0.05 in. wg (12.5 Pa)** at **1500 fpm (7.6 m/s)** across a **24-by-24-inch (600-by-600-mm)** damper when tested in accordance with AMCA 500-D, Figure 5.3.
8. Velocity: Up to **3000 fpm (15 m/s)**.
9. Temperature: **Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C)**.
10. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

11. Construction:

    a. Frame: Hat shaped.

        1) Material: [**Galvanized sheet steel**][**Stainless steel**] .
        2) Gauge: In accordance with UL listing.
        3) Corners: [**Welded**][**Interlocking, gusseted**][**mechanically attached**] corners [**and mounting flange**] .

    b. Blades: Roll-formed, horizontal, [**v-groove**][**airfoil**] .

        1) Material: [**Galvanized sheet steel**][**Stainless steel**][**Extruded aluminum**] .
        2) Maximum Width and Gauge: In accordance with UL listing.
        3) Edging Seals: Silicone rubber.
        4) Jamb Seal: Flexible stainless steel, compression type.
        5) Axles: **1/2-inch- (13-mm-)** diameter; [**galvanized steel**][**stainless steel**] ; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
        6) Linkage: Enclosed within frame and out of airstream.

    c. Bearings: [**Oil-impregnated bronze**][**Molded synthetic**][**Oil-impregnated stainless steel sleeve**][**Stainless steel sleeve**] .

12. Mounting Sleeve:

    a. Factory installed, galvanized sheet steel.
    b. Length: To suit wall or floor application [**with factory-furnished silicone caulking**] .
    c. Gauge: In accordance with UL listing.

13. Heat-Responsive Device:

    a. [**Resettable**][**Replaceable**] , [**165 deg F (74 deg C)**][**212 deg F (100 deg C)**] rated, [**fusible links**][**fire-closure device**] .
    b. [**Electric**][**Pneumatic**] resettable [**link**][**device**] and switch package, factory installed, rated.

14. Master control panel for use in dynamic smoke-management systems.

15. Damper Actuator - Electric:

    a. Electric - [**120 V ac**][**24 V ac**] .

    b. UL Rating: UL 60730-2-14 and UL 2043, plenum rated.
    c. Designed to operate in smoke-control systems complying with UL 555S requirements.
    d. Actuator Type: [**Two position**][**Fully modulating**] with fail-safe spring return.

1) Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.
3) Minimum 90-degree drive rotation.

e. Clockwise or counterclockwise drive rotation as required for application.
f. Environmental Operating Range:

1) Temperature: **Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C)**.
2) Humidity: 5 to 95 percent relative humidity noncondensing.

g. Environmental Enclosure: NEMA 2.
h. Actuator to be factory mounted and provided with single-point wiring connection.

16. Damper Actuator - Pneumatic:

a. Operated by **0 to 20 psig (0 to 138 kPa)** pneumatic signal.
b. Designed to operate in smoke control systems complying with UL 555S requirements.
c. Actuator Type: [**Two position with**][**Fully modulating with positioner and**] fail-safe spring return.

1) Sufficient power and spring force to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.

d. Actuator to be factory mounted.

17. Controllers, Electrical Devices, and Wiring:

a. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
b. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**].

18. Accessories:

a. Auxiliary Switches: For [**signaling**][**fan control**][**position indication**] .
b. Switch Type: [**Momentary test switch**][**Test and reset switches**] , [**damper**][**remote**] mounted.

c. Smoke Detector: Integral, factory wired for single-point connection.

E. Corridor Dampers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ruskin; Air Distribution Technologies, Inc.**]
b. [**Aire Technologies, Inc.; DMI Companies**]
c. [**Cesco Products; MESTEK, Inc.**]
d. [**Pottorff**]
e. [**Safe Air - Dowco**]
f. [**United Enertech Corp.**]

2. General Requirements:

   a. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
   b. Label to indicate conformance to NFPA 90A by an NRTL.
   c. Closing rating in ducts up to [**4 inch wg (1 kPa)**] static pressure class and minimum [**2000 fpm (10 m/s)**] velocity.
   d. Fire Rating: [**1**][**1-1/2**][**2**] hour(s).

   e. AMCA Certification: Test and rate in accordance with AMCA 511.
   f. Leakage:

      1) Class 1A: Leakage is not to exceed **3 cfm/sq. ft. (15.2 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      2) Class 1: Leakage is not to exceed **4 cfm/sq. ft. (20 L/s/ per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.
      3) Class II: Leakage is not to exceed **10 cfm/sq. ft. (51 L/s per sq. m)** against **1 inch wg (250 Pa)** differential static pressure.

3. Construction:

   a. Frame: Hat shaped.

      1) Material: Galvanized sheet steel.
      2) Gauge: In accordance with UL listing.
      3) Corners: [**Welded**][**Interlocking, gusseted**][**mechanically attached**] corners [**and mounting flange**] .

   b. Blades: Roll-formed, horizontal, [**interlocking**][**overlapping**] .

      1) Material: Galvanized sheet steel.
      2) Gauge: In accordance with UL listing.

4. Mounting Sleeve:

   a. Factory installed, galvanized sheet steel.
   b. Length: To suit wall or floor application [**with factory-furnished silicone caulking**] .
   c. Gauge: In accordance with UL listing.

5. Heat-Responsive Device:

   a. [**Resettable**][**Replaceable**] , [**165 deg F (74 deg C)**][**212 deg F (100 deg C)**] rated, [**fusible links**][**fire-closure device**] .
   b. [**Electric**][**Pneumatic**] resettable [**link**][**device**] and switch package, factory installed, rated.

6. Damper Actuator - Electric:

   a. Electric - [**120 V ac**][**24 V ac**] .

   b. UL Rating: UL 60730-2-14 and UL 2043, plenum rated.
   c. Designed to operate in smoke-control systems complying with UL 555S requirements.
   d. Actuator Type: Two position with fail-safe spring return.

      1) Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
      2) Maximum 15-second full-stroke closure.

3) Minimum 90-degree drive rotation.

e. Clockwise or counterclockwise drive rotation as required for application.
f. Environmental Operating Range:

1) Temperature: **Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C)**.
2) Humidity: 5 to 95 percent relative humidity noncondensing.

g. Environmental enclosure: NEMA 2.
h. Actuator to be factory mounted and provided with single-point wiring connection.

7. Damper Actuator - Pneumatic:

a. Operated by **0 to 20 psig (0 to 138 kPa)** pneumatic signal.
b. Designed to operate in smoke-control systems complying with UL 555S requirements.
c. Actuator Type: Two position with fail-safe spring return.

1) Sufficient power and spring force to drive damper fully open and fully closed with adequate force to achieve required damper seal.
2) Maximum 15-second full-stroke closure.

d. Actuator to be factory mounted.

8. Controllers, Electrical Devices, and Wiring:

a. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
b. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**].

9. Accessories:

a. Auxiliary Switches: For [**signaling**][**fan control**][**position indication**] .
b. Switch Type: [**Momentary test switch**][**Test and reset switches**] , [**damper**][**remote**] mounted.

c. Smoke Detector: Integral, factory wired for single-point connection.

2.3 FLANGE CONNECTORS

A. Flange Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CL WARD & Family Inc.**]
b. [**Ductmate Industries, Inc; a DMI company**]
c. [**DynAir; a Carlisle Company**]
d. [**Elgen Manufacturing**]
e. [**Ward Industries; a brand of Hart & Cooley, LLC**]

2. Description: [**Add-on**][**roll-formed**] , factory-fabricated, slide-on transverse flange connectors,

gaskets, and components.
3. Material: Galvanized steel.
4. Gauge and Shape: Match connecting ductwork.

2.4 DUCT-MOUNTED DUCT SILENCERS

A. Duct-Mounted Duct Silencer:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ruskin; Air Distribution Technologies, Inc.**]
   b. [**FläktGroup**]
   c. [**Flexmaster U.S.A., Inc**]
   d. [**IAC Acoustics**]
   e. [**McGill AirFlow LLC**]
   f. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
   g. [**Pottorff**]
   h. [**Price Industries Limited**]
   i. [**Vibro-Acoustics**]

2. General Requirements:

   a. Factory fabricated.
   b. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials are to have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
   c. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.

   d. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

3. Shape:

   a. Rectangular straight with splitters or baffles.
   b. Round straight with center bodies or pods.
   c. Rectangular elbow with splitters or baffles.
   d. Round elbow with center bodies or pods.
   e. Rectangular transitional with splitters or baffles.

4. Rectangular Silencer Outer Casing: ASTM A653/A653M, [**G90 (Z275)**][**G60 (Z180)**] , galvanized sheet steel, [**0.034 inch (0.85 mm)**][**0.040 inch (1.02 mm)**] thick.
5. Round Silencer Outer Casing: ASTM A653/A653M, [**G90 (Z275)**][**G60 (Z180)**] , galvanized sheet steel.

   a. Sheet Metal Thickness for Units up to **24 Inches (600 mm)** in Diameter: [**22 gauge (0.85 mm)**] thick.
   b. Sheet Metal Thickness for Units **26 through 40 Inches (660 through 1000 mm)** in Diameter: [**20 gauge (1.02 mm)**] thick.
   c. Sheet Metal Thickness for Units **42 through 52 Inches (1060 through 1300 mm)** in Diameter: [**18 gauge (1.3 mm)**] thick.

d. Sheet Metal Thickness for Units **54 through 60 Inches (1370 through 1500 mm)** in Diameter: [**16 gauge (1.62 mm)**] thick.

6. Inner Casing and Baffles: ASTM A653/A653M, [**G90 (Z275)**][**G60 (Z180)**] galvanized sheet metal, [**22 gauge (0.85 mm)**] thick, and with [**1/8-inch- (3-mm-)**] diameter perforations.
7. Special Construction:

   a. Suitable for outdoor use.
   b. High transmission loss [**to achieve STC 45**].

8. Connection Sizes: Match connecting ductwork unless otherwise indicated.
9. Principal Sound-Absorbing Mechanism:

   a. Controlled impedance membranes and broadly tuned resonators without absorptive media.

10. Type: [**Dissipative**][**Film-lined**] with fill material.

    a. Fill Material: [**Inert and vermin-proof fibrous material, packed under not less than 5 percent compression**][**Inert and vermin-proof fibrous material, packed under not less than 15 percent compression**][**Moisture-proof nonfibrous material**] .
    b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.

    c. Lining: [**None**][**Mylar**][**Tedlar**][**Fiberglas cloth**].

11. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

    a. Joints: [**Lock formed and sealed**][**Continuously welded**][**flanged connections**] .
    b. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
    c. Reinforcement: Cross or trapeze angles for rigid suspension.

12. Accessories:

    a. Fire Damper: Integral [**1-1/2**][**3**] -hour fire damper with access door. [**Access door to be high transmission loss to match silencer.**]
    b. Factory-installed end caps to prevent contamination during shipping.
    c. Removable splitters.
    d. Airflow-measuring devices.

13. Source Quality Control:

    a. Test in accordance with ASTM E477.
    b. Testing [**of mockups**] to be witnessed by [**Architect**][**the Owner**], as directed by the Owner.
    c. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least [**2000 fpm (10 m/s)**] face velocity.
    d. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or [**6-inch wg (1500-Pa)**] static pressure, whichever is greater.

14. Capacities and Characteristics:

    a. Configuration: [**Straight**][**90-degree elbow**].
    b. Shape: [**Rectangular**][**Round**] .
    c. Attenuation Mechanism: [**Acoustical glass fiber**][**Acoustical glass fiber with protective**

film liner][**Helmholtz resonator mechanism with no internal media**] .

d. Maximum Pressure Drop: [**0.35 inch wg (0.09 kPa)**].

e. Casing:

1) Attenuation: [**Standard**][**High transmission loss**] .
2) Outer Material: [**Galvanized steel**][**Stainless steel**][**Aluminum**] .
3) Inner Material: [**Galvanized steel**][**Stainless steel**][**Aluminum**] .

f. End Connection: [**1-inch (25-mm) slip joint**][**Flange**] .

g. Accessories:

1) Access door.
2) Birdscreen.

2.5 TURNING VANES

A. Turning Vane:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Aero-Dyne Sound Control Co.**]
b. [**CL WARD & Family Inc.**]
c. [**Ductmate Industries, Inc; a DMI company**]
d. [**Duro Dyne Inc.**]
e. [**DynAir; a Carlisle Company**]
f. [**Elgen Manufacturing**]
g. [**Ward Industries; a brand of Hart & Cooley, LLC**]

2. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

a. Turning Vanes: Fabricate [**single**][**double**] -wall curved blades of [**galvanized steel**][**stainless steel**][**aluminum**][**extruded aluminum**] .
b. Acoustic Turning Vanes: Fabricate airfoil-shaped [**galvanized steel**][**sheet aluminum**][**extruded aluminum**] with perforated faces and fibrous-glass fill.

3. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
4. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
5. Vane Construction:

a. Wall: [**Single**][**Double**] .
b. Single wall for ducts up to [**48 inches (1200 mm)**] wide and double wall for larger dimensions.

2.6 REMOTE DAMPER OPERATORS

A. Remote Damper Operator:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**DynAir; a Carlisle Company**]
    b. [**METALAIRE, Inc**]
    c. [**United Enertech Corp.**]
    d. [**Young Regulator Company**]

2. Description: Cable system designed for remote manual damper adjustment.
3. Tubing: [**Brass**][**Copper**][**Aluminum**] .
4. Cable: [**Stainless steel**][**Steel**] .
5. Wall-Box Mounting: [**Recessed**][**Surface**] .
6. Wall-Box Cover-Plate Material: [**Steel**][**Stainless steel**] .

2.7 DUCT-MOUNTED ACCESS DOORS, ACCESS PANELS, AND PRESSURE-RELIEF DOORS

A. Duct-Mounted Access Doors and Pressure-Relief Doors:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Ruskin; Air Distribution Technologies, Inc.**]
    b. [**Aire Technologies, Inc.; DMI Companies**]
    c. [**Arrow United Industries; Mestek, Inc.**]
    d. [**Cesco Products; MESTEK, Inc.**]
    e. [**CL WARD & Family Inc.**]
    f. [**Ductmate Industries, Inc; a DMI company**]
    g. [**Duro Dyne Inc.**]
    h. [**Elgen Manufacturing**]
    i. [**Flexmaster U.S.A., Inc**]
    j. [**McGill AirFlow LLC**]
    k. [**United Enertech Corp.**]
    l. [**Ventfabrics, Inc**]
    m. [**Ward Industries; a brand of Hart & Cooley, LLC**]

2. General Requirements: Fabricate [**access doors**][**pressure-relief doors**] in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
3. Access Doors:

    a. Door:

        1) Double wall, rectangular.
        2) Material matching duct material, with insulation fill matching duct insulation type and thickness, and access door wall thickness matching duct pressure class.
        3) Vision panel.
        4) Hinges and Latches: **1-by-1-inch (25-by-25-mm)** butt or piano hinge and cam latches.

5) Fabricate doors airtight and suitable for duct pressure class.

b. Frame: Material matching door material, with bend-over tabs and foam gaskets.
c. Number of Hinges and Locks:

1) Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
2) Access Doors up to 18 Inches (460 mm) Square: [**Two hinges**][**Continuous**] and two sash locks.
3) Access Doors up to 24 by 48 Inches (600 by 1200 mm): [**Three hinges**][**Continuous**] and two compression latches [**with outside and inside handles**] .
4) Access Doors Larger than 24 by 48 Inches (600 by 1200 mm): [**Four hinges**][**Continuous**] and two compression latches with outside and inside handles.

4. Pressure-Relief Doors:

a. Door and Frame Material: [**24-gauge- (0.70-mm-) thick galvanized steel**][**0.032-inch- (0.81-mm-) thick aluminum**][**24-gauge- (0.70-mm-) thick stainless steel**] door panel.
b. Door Wall: [**Single wall**][**Double wall with insulation fill**] with metal thickness applicable for duct pressure class.
c. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

d. Factory set at [**3.0 to 8.0 inches wg (800 to 2000 Pa)**][**10 inches wg (2500 Pa)**].
e. Doors close when pressures are within set-point range.
f. Hinge: Continuous piano.
g. Latches: Cam.
h. Seal: Neoprene or foam rubber.
i. Insulation Fill: [**1-inch- (25-mm-)**] thick, fibrous-glass or polystyrene-foam board.

B. Duct Access Panel Assemblies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CL WARD & Family Inc.**]
b. [**Ductmate Industries, Inc; a DMI company**]
c. [**Flame Gard, Inc**]

2. Access panels used in cooking applications:

a. Labeled compliant to NFPA 96 for grease duct access doors.
b. Labeled in accordance with UL 1978 by an NRTL.

3. Panel and Frame: Minimum thickness [**16-gauge (1.6-mm) carbon**][**16-gauge (1.6-mm) stainless**] steel.
4. Fasteners: [**Carbon**][**Stainless**] steel. Panel fasteners are not to penetrate duct wall.
5. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum **2000 deg F (1093 deg C)**.
6. Minimum Pressure Rating: [**10 inches wg (2500 Pa)**] positive or negative.

2.8 DUCT FLEXIBLE CONNECTORS

A. Duct Flexible Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CL WARD & Family Inc.**]
   b. [**Ductmate Industries, Inc; a DMI company**]
   c. [**Duro Dyne Inc.**]
   d. [**DynAir; a Carlisle Company**]
   e. [**Elgen Manufacturing**]
   f. [**Ventfabrics, Inc**]
   g. [**Ward Industries; a brand of Hart & Cooley, LLC**]

2. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials are to have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.
4. Materials: Flame-retardant or noncombustible fabrics.
5. Coatings and Adhesives: Comply with UL 181, Class 1.

6. Metal-Edged Connectors: Factory fabricated with a fabric strip [**3-1/2 inches (89 mm)**][**5-3/4 inches (146 mm)**] wide attached to two strips of **2-3/4-inch- (70-mm-)** wide, [**0.028-inch- (0.7-mm-)**] thick, galvanized sheet steel or **0.032-inch- (0.8-mm-)** thick aluminum sheets. Provide metal compatible with connected ducts.

7. Indoor System, Duct Flexible Connector Fabric: Glass fabric double coated with neoprene.

   a. Minimum Weight: [**26 oz./sq. yd. (880 g/sq. m)**].
   b. Tensile Strength: **480 lbf/inch (84 N/mm)** in the warp and [**360 lbf/inch (63 N/mm)**] in the filling.
   c. Service Temperature: **Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C)**.

8. Outdoor System, Duct Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   a. Minimum Weight: [**24 oz./sq. yd. (810 g/sq. m)**].
   b. Tensile Strength: **530 lbf/inch (93 N/mm)** in the warp and [**440 lbf/inch (77 N/mm)**] in the filling.
   c. Service Temperature: **Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C)**.

9. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

   a. Minimum Weight: [**16 oz./sq. yd. (542 g/sq. m)**].
   b. Tensile Strength: **285 lbf/inch (50 N/mm)** in the warp and [**185 lbf/inch (32 N/mm)**] in the filling.
   c. Service Temperature: **Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C)**.

10. High-Corrosive-Environment System, Duct Flexible Connectors: Glass fabric with chemical-resistant coating.

a. Minimum Weight: [**14 oz./sq. yd. (474 g/sq. m)**].
b. Tensile Strength: **450 lbf/inch (79 N/mm)** in the warp and [**340 lbf/inch (60 N/mm)**] in the filling.
c. Service Temperature: **Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C)**.

11. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
g. Coil Spring: Factory set and field adjustable for a maximum of [**1/4-inch (6-mm)**] movement at start and stop.

2.9 DUCT SECURITY BARS

A. Duct Security Bar:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carnes Company**]
b. [**Kees, Inc**]
c. [**Lloyd Industries, Inc.**]
d. [**Metal Form Manufacturing LLC; United Enertech Corp.**]
e. [**Price Industries Limited**]
f. [**United Enertech Corp.**]

2. Description: [**Field-fabricated**][**Factory-fabricated and field-installed**][**Field- or factory-fabricated and field-installed**] duct security bars.
3. Configuration:

a. Frame Size: [**Flat frame of 2 by 1/4 inch (50 by 6 mm)**][**Angle frame of 2-1/2 by 2-1/2 by 1/4 inch (64 by 64 by 6 mm)**].
b. Sleeve: [**0.1345-inch (3.4-mm)**][**3/16-inch (4.8-mm)**], [**continuously welded**][**bent**] steel frames with [**1-by-1-by-3/16-inch (25-by-25-by-4.8-mm)**][**1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3-mm)**] angle frame [**factory welded to one end**][**furnished loose for field welding on other end**] . To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
c. Horizontal Bars: [**1/2 inch (13 mm)**][**2 by 1/4 inch (50 by 6 mm)**].
d. Vertical Bars: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 by 1/4 inch (50 by 6 mm)**].
e. Bar Spacing: [**6 inches (150 mm)**].
f. Mounting: [**Metal deck or roofing**][**Bolted or welded**][**Bolted or welded with masonry anchors**][**Ductwork or other framing**][**Poured in place or set with concrete**

block][**Welded or bolted to one wall (one side only)**][**Bar extends 6 inches (150 mm) into wall**] .

2.10 DUCT ACCESSORY HARDWARE

A. Duct Accessory Hardware:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CL WARD & Family Inc.**]
   b. [**Ductmate Industries, Inc; a DMI company**]
   c. [**Duro Dyne Inc.**]
   d. [**DynAir; a Carlisle Company**]
   e. [**Elgen Manufacturing**]
   f. [**Hardcast; Carlisle Construction Materials**]
   g. [**United Enertech Corp.**]
   h. [**Ventfabrics, Inc**]
   i. [**Ward Industries; a brand of Hart & Cooley, LLC**]

2. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
3. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.11 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60 (Z180)**][**G90 (Z275)**] .
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a [**No. 2**] finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209/B209M, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with **ASTM B221 (ASTM B221M)**, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, [**1/4-inch (6-mm)**] minimum diameter for lengths **36 inches (900 mm)** or less; [**3/8-inch (10-mm)**] minimum diameter for lengths longer than **36 inches (900 mm)**.

2.12 FLEXIBLE DUCTS

A. Standard: Product is to be UL 181 listed and bearing the UL label.

B. Flexible Ducts, Noninsulated - Class 1, Two-Ply Vinyl or Polyethylene Film Supported by Helically Wound, Spring-Steel Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flexmaster U.S.A., Inc**]
b. [**JP Lamborn Co.**]

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C)**.

C. Flexible Ducts, Noninsulated - Class 1, Black Polymer Film Supported by Helically Wound, Spring-Steel Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flexmaster U.S.A., Inc**]

2. Pressure Rating: **4 inch wg (1000 Pa)** positive and **0.5 inch wg (125 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C)**.

D. Flexible Ducts, Noninsulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Flexmaster U.S.A., Inc**]

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C)**.

E. Flexible Ducts, Noninsulated - Class 1, Aluminum Laminate and Polyester Film with Latex Adhesive Supported by Helically Wound, Spring-Steel Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Flexmaster U.S.A., Inc**]

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C)**.

F. Flexible Ducts, Noninsulated - Class 0, Interlocking Spiral of Aluminum Foil:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATCO Rubber Products, Inc.**]
   b. [**Flexmaster U.S.A., Inc**]
   c. [**Thermaflex; a Flex-Tek Group company**]

2. Pressure Rating: **8 inch wg (2280 Pa)** positive or negative.
3. Maximum Air Velocity: **5000 fpm (25 m/s)**.
4. Temperature Range: **Minus 100 to plus 435 deg F (Minus 73 to plus 224 deg C)**.

G. Flexible Ducts, Insulated - Class 1, Two-Ply Vinyl Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ATCO Rubber Products, Inc.**]
   b. [**Flexmaster U.S.A., Inc**]
   c. [**JP Lamborn Co.**]

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C)**.
5. Insulation R-Value: [**Comply with ASHRAE/IES 90.1**][**R4.2**][**R6**][**R8**] .
6. Vapor-Barrier Film: [**Polyethylene**][**Aluminized**] , ASTM E96/E96M.

H. Flexible Ducts, Insulated - Class 1, Black Polymer Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CASCO C.A. Schroeder, Inc.**]
   b. [**Flexmaster U.S.A., Inc**]
   c. [**JP Lamborn Co.**]

d. [**Thermaflex; a Flex-Tek Group company**]

2. Pressure Rating: **4 inch wg (1000 Pa)** positive and **0.5 inch wg (125 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C)**.
5. Insulation R-Value: [**Comply with ASHRAE/IES 90.1**][**R4.2**][**R6**][**R8**].
6. Vapor-Barrier Film: [**Polyethylene**][**Aluminized**] , ASTM E96/E96M.

I. Flexible Ducts, Insulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexmaster U.S.A., Inc**]
   b. [**JP Lamborn Co.**]
   c. [**Thermaflex; a Flex-Tek Group company**

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C)**.
5. Insulation R-Value: [**Comply with ASHRAE/IES 90.1**][**R4.2**][**R6**][**R8**].
6. Vapor-Barrier Film: [**Polyethylene**][**Aluminized**] , ASTM E96/E96M.

J. Flexible Ducts, Insulated - Class 1, Aluminum Laminate and Polyester Film with Latex Adhesive Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexmaster U.S.A., Inc**]

2. Pressure Rating: **10 inch wg (2500 Pa)** positive and **1.0 inch wg (250 Pa)** negative.
3. Maximum Air Velocity: **4000 fpm (20 m/s)**.
4. Temperature Range: **Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C)**.
5. Insulation R-Value: [**Comply with ASHRAE/IES 90.1**][**R4.2**][**R6**][**R8**].
6. Vapor-Barrier Film: [**Polyethylene**][**Aluminized**] , ASTM E96/E96M.

K. Flexible Ducts, Insulated - Class 0, Interlocking Spiral of Aluminum Foil; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Flexmaster U.S.A., Inc**]

2. Pressure Rating: **8 inch wg (2280 Pa)** positive or negative.

3. Maximum Air Velocity: **5000 fpm (25 m/s)**.
4. Temperature Range: **Minus 20 to plus 250 deg F (Minus 29 to plus 121 deg C)**.
5. Insulation R-Value: [**Comply with ASHRAE/IES 90.1**][**R4.2**][**R6**][**R8**].
6. Vapor-Barrier Film: [**Polyethylene**][**Aluminized**] , ASTM E96/E96M.

2.13 FLEXIBLE DUCT CONNECTORS

A. Clamps: [**Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action**][**Nylon strap**] in sizes **3 through 18 inches (75 through 460 mm)**, to suit duct size.

B. Non-Clamp Connectors: [**Adhesive**][**Liquid adhesive plus tape**][**Adhesive plus sheet metal screws**] .

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DUCT ACCESSORIES, GENERAL

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install duct test holes where required for testing and balancing.

D. Duct-Mounted Duct Silencers: Connect ducts to duct silencers [**with flexible duct connectors**][**rigidly**] .

E. Remote Damper Operators: Install per manufacturer's written instructions.

3.2 INSTALLATION OF DAMPERS

A. Backdraft and Pressure-Relief Dampers: Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

B. Control Dampers: Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

C. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full-system-design static pressure.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Manual Volume Dampers: Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having a duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

3.3 INSTALLATION OF UL-LISTED DAMPERS

A. Install in accordance with UL listing.

3.4 INSTALLATION OF DUCT-MOUNTED ACCESS DOORS, ACCESS PANELS, AND PRESSURE-RELIEF DOORS

A. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream [**and downstream**] from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links are to be pressure-relief access doors and be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

7. At each change in direction and at maximum [**50 ft. (15 m)**] spacing.
8. Upstream [**and downstream**] from turning vanes.
9. Upstream or downstream from duct silencers.
10. For grease ducts, install at locations and spacing as required by NFPA 96.
11. Control devices requiring inspection.
12. Elsewhere as indicated.

B. Install access doors with swing against duct static pressure.

C. Access Door Sizes:

1. One-Hand or Inspection Access: **8 by 5 inches (200 by 125 mm)**.
2. Two-Hand Access: **12 by 6 inches (300 by 150 mm)**.
3. Head and Hand Access: **18 by 10 inches (460 by 250 mm)**.
4. Head and Shoulders Access: **21 by 14 inches (530 by 355 mm)**.
5. Body Access: **25 by 14 inches (635 by 355 mm)**.
6. Body plus Ladder Access: **25 by 17 inches (635 by 430 mm)**.

D. Duct Access Panel Assemblies: Install in fire-rated duct systems per manufacturer's written instructions.

E. Label access doors in accordance with Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of each access door.

3.5 INSTALLATION OF DUCT FLEXIBLE CONNECTORS

A. Install flexible connectors to connect ducts to equipment.

1. For fans developing static pressures of **5 inches wg (1250 Pa)** and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

B. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of **1/4-inch (6-mm)** movement during start and stop of fans.

3.6 INSTALLATION OF DUCT SECURITY BARS

A. Construct duct security bars from [**0.164 inch (4.18 mm)**] steel sleeve, continuously welded at all joints, and [**1/2-inch- (13-mm)**] diameter steel bars, [**6 inches (150 mm)**] o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld [**2-1/2-by-2-1/2-by-1/4-inch (64-by-64-by-6-mm)**] steel angle to four sides and both ends of sleeve.

B. Connect duct security bars to ducts with flexible connections. Provide **12-by-12-inch (300-by-300-mm)** hinged access panel with cam lock in duct in each side of sleeve.

C. Secure duct security bar assembly to building structure [**as detailed on Drawings**][**as indicated in manufacturer's written installation instructions**] .

3.7 INSTALLATION OF FLEXIBLE DUCTS

A. Install flexible ducts in accordance with applicable details in the following publications:

1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
2. NAIMA AH116.
3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV rays.

C. Where flexible duct is to be installed in locations where it will be exposed to UV rays, install only duct that is specifically made for this use and is has been so marked by the manufacturer.

D. Connect terminal units to supply ducts [**directly or**] with maximum [**12-inch (300-mm)**] lengths of flexible duct. Do not use flexible ducts to change directions.

E. Connect diffusers and light troffer boots to ducts [**directly or**] with maximum [**60-inch (1500-mm)**] lengths of flexible duct clamped or strapped in place.

F. Connect flexible ducts to metal ducts with [**adhesive**][**liquid adhesive plus tape**][**draw bands**][**adhesive plus sheet metal screws**] .

G. Installation of Flexible Ducts:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Install in accordance with ADC instructions.

H. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than **4 ft. (1.2 m)**. Provide sufficient support so that maximum centerline sag is **1/2 inch per ft. (42 mm per meter)** between supports. A connection to rigid duct or equipment may be considered a support joint.
2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of **72 inches (1800 mm)** o.c.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Dampers: Operate dampers to verify full range of movement.
2. Duct-Mounted Access Doors, Access Panels, and Pressure Relief Doors: Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. UL-Listed Dampers: Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Turning Vanes: Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Remote Damper Operators: Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00 00

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Task	Specification	Specification Description
23 33 13 00	23 33 00 00	Air Duct Accessories
23 33 13 13	23 33 00 00	Air Duct Accessories
23 33 13 16	23 33 00 00	Air Duct Accessories
23 33 13 19	23 33 00 00	Air Duct Accessories
23 33 13 23	23 33 00 00	Air Duct Accessories
23 33 13 33	23 33 00 00	Air Duct Accessories
23 33 13 43	23 33 00 00	Air Duct Accessories
23 33 19 00	23 33 00 00	Air Duct Accessories
23 33 23 00	23 33 00 00	Air Duct Accessories
23 33 33 00	23 33 00 00	Air Duct Accessories
23 33 43 00	23 33 00 00	Air Duct Accessories
23 33 46 00	23 31 13 00	Metal Ducts
23 33 46 00	23 33 00 00	Air Duct Accessories
23 33 53 00	23 31 13 00	Metal Ducts
23 33 53 00	23 33 00 00	Air Duct Accessories
23 33 56 00	23 31 13 00	Metal Ducts
23 33 56 00	23 33 00 00	Air Duct Accessories
23 33 59 00	23 33 00 00	Air Duct Accessories

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SECTION 23 34 00 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fans, tubeaxial.
2. Fans, vaneaxial.
3. Fans, mixed flow.
4. Fans, centrifugal - backward-inclined blades.
5. Fans, centrifugal - forward-curved blades.
6. Fans, centrifugal, inline - square.
7. Fans, centrifugal, inline - tubular.
8. Fans, plenum.
9. Fans, plug.
10. Fans, utility set.
11. Ventilators, axial - roof mounted.
12. Ventilators, centrifugal - ceiling mounted.
13. Ventilators, centrifugal - roof-mounted downblast.
14. Ventilators, centrifugal - roof-mounted upblast and sidewall mounted.
15. Fans, propeller - sidewall mounted.
16. Fans, propeller - roof-mounted upblast.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   b. Rated capacities, furnished specialties, and accessories for each fan.
   c. Fans:

      1) Certified fan performance curves with system operating conditions indicated.
      2) Certified fan sound-power ratings.
      3) Fan construction and accessories.
      4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
      5) Fan speed controllers.

   d. Material thickness and finishes, including color charts.
   e. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

4. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**]and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For vibration isolation[**, supports,**][**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**][**, seismic restraints,**][**and for designing vibration isolation bases**].

D. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing fan rooms and fan system layouts, reflected ceiling plans, and other drawings required to illustrate relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Seismic Qualification Data: Certificates, for fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Startup service reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.

1. Belts: [**One**]<**Insert number**> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**][**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

G. Capacities and Characteristics:

1. Fan Type: [**Centrifugal**][**Square, inline, centrifugal**][**Tubular, inline, centrifugal**][**Plenum**][**Plug**][**Utility set**].
2. Blade Type: [**Forward curved**][**Backward inclined, airfoil**][**Backward inclined, curved**][**Backward inclined, flat**].
3. Airflow: <**Insert cfm (L/s)**>.
4. Total Static Pressure: <**Insert inches wg (Pa)**>.
5. Class: AMCA 99, Section 14, [**Class I**][**Class II**][**Class III**].
6. Drive Arrangement: <**Insert AMCA arrangement number**>.
7. Drive Type: [**Belt**][**Direct**].
8. Discharge Arrangement: <**Insert discharge arrangement configuration**>.
9. Housing Material: [**Reinforced steel**][**Shaped fiberglass-reinforced plastic**][**Aluminum**][**Stainless steel**].
10. Housing Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**]<**Insert manufacturer's name and trade name**>.
11. Wheel Size (Diameter): <**Insert inches (mm)**>.
12. Fan Diameter: <**Insert inches (mm)**>.
13. Wheel Material: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**].
14. Wheel Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.
15. Brake Horsepower: <**Insert number**>.
16. Fan rpm: <**Insert value**>.
17. Outlet Velocity: <**Insert fpm (m/s)**>.

18. Motor:

    a. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion proof**]<**Insert motor enclosure type**>.
    b. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
    c. Motor Bearings: <**Insert requirements**>.
    d. Efficiency: Premium efficiency.
    e. NEMA Design: <**Insert designation**>.
    f. Service Factor: [**1.15**]<**Insert number**>.
    g. Suitable for Use with Variable-Frequency Drive: [**Yes**][**No**].
    h. Electrical Characteristics:

        1) Motor Size: <**Insert horsepower**>.
        2) Motor Rpm: <**Insert number**>.
        3) Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
        4) Phase: [**Single**][**Three**].
        5) Hertz: 60 Hz.
        6) Full-Load Amperes: <**Insert number**> A.
        7) Minimum Circuit Ampacity: <**Insert number**> A.
        8) Maximum Overcurrent Protection: <**Insert number**> A.

19. Discharge Sound Power:

    a. 1st Octave: <**Insert dB**>.
    b. 2nd Octave: <**Insert dB**>.
    c. 3rd Octave: <**Insert dB**>.
    d. 4th Octave: <**Insert dB**>.
    e. 5th Octave: <**Insert dB**>.
    f. 6th Octave: <**Insert dB**>.
    g. 7th Octave: <**Insert dB**>.
    h. 8th Octave: <**Insert dB**>.

20. Inlet Sound Power:

    a. 1st Octave: <**Insert dB**>.
    b. 2nd Octave: <**Insert dB**>.
    c. 3rd Octave: <**Insert dB**>.
    d. 4th Octave: <**Insert dB**>.
    e. 5th Octave: <**Insert dB**>.
    f. 6th Octave: <**Insert dB**>.
    g. 7th Octave: <**Insert dB**>.
    h. 8th Octave: <**Insert dB**>.

21. Vibration Isolators: [**Spring**][**Restrained spring**]<**Insert type**> isolators with a static deflection of [**1 inch (25 mm)**]<**Insert deflection**>.
22. Spark-Resistance Class: Classified in accordance with AMCA 99, Section 8, [**Type A**][**Type B**][**Type C**].

H. Service Conditions:

1. Ambient Temperature: <**Insert number**> **deg F (deg C)**.
2. Altitude: <**Insert number**> **feet (m)** above sea level.
3. Humidity: <**Insert number**> **deg F (deg C)** wet bulb.

2.2 FANS, TUBEAXIAL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Carnes Company**]
6. [**Chicago Blower Corporation**]
7. [**Cincinnati Fan**]
8. [**Greenheck Fan Corporation**]
9. [**Hartzell Fan Incorporated**]
10. [**Howden American Fan Company**]
11. [**Loren Cook Company**]
12. [**New York Blower Company (The)**]
13. [**Northern Blower, Inc.**]
14. [**PennBarry; division of Air System Components**]
15. [**S & P Products**]
16. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Carnes Company**]
6. [**Chicago Blower Corporation**]
7. [**Cincinnati Fan**]
8. [**Greenheck Fan Corporation**]
9. [**Hartzell Fan Incorporated**]
10. [**Howden American Fan Company**]
11. [**Loren Cook Company**]
12. [**New York Blower Company (The)**]
13. [**Northern Blower, Inc.**]
14. [**PennBarry; division of Air System Components**]
15. [**S & P Products**]
16. **<Insert manufacturer's name>**

C. Source Limitations: Obtain tubeaxial fans from single manufacturer.

D. Standards: Comply with UL 705.

E. Description: Fan wheel and housing, factory-mounted motor with [**belt**][**or**][**direct**] drive, an inlet cone section, and accessories.

F. Housings: [**Steel**][**Galvanized steel**][**Aluminum**][**Fiberglass-reinforced plastic**][**Stainless steel**] with flanged inlet and outlet connections.

G. Wheel Assemblies: [**Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**][**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**][**Cast aluminum; machined and**

fitted to shaft].

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.2**][**1.3**][**1.4**][**1.5**].
3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
9. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 50,000 hours**]<**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 50,000 hours**]<**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

I. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**][**and**][**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**][**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for bolting to fan discharge or outlet cone, of same material as housing.
11. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to **300 deg F (149 deg C)**.
12. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
13. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation, of same material as housing.
14. Inlet Bell: Curved inlet for when fan is not attached to duct[**, of same material as housing**][**; aluminum**].
15. Inlet Cone: Round-to-round transition, of same material as housing.
16. Outlet Cone: Round-to-round transition, of same material as housing.
17. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
18. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
19. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

J. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**][**Zinc**][**Phenolic**][**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.3 FANS, VANEAXIAL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Chicago Blower Corporation**]
5. [**Greenheck Fan Corporation**]
6. [**Hartzell Fan Incorporated**]
7. [**Howden American Fan Company**]
8. [**Loren Cook Company**]
9. [**New York Blower Company (The)**]
10. [**Northern Blower, Inc.**]
11. [**PennBarry; division of Air System Components**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Chicago Blower Corporation**]
5. [**Greenheck Fan Corporation**]
6. [**Hartzell Fan Incorporated**]
7. [**Howden American Fan Company**]
8. [**Loren Cook Company**]
9. [**New York Blower Company (The)**]
10. [**Northern Blower, Inc.**]
11. [**PennBarry; division of Air System Components**]
12. <**Insert manufacturer's name**>

C. Source Limitations: Obtain vaneaxial fans from single manufacturer.

D. Standards: Comply with UL 705.

E. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt or direct drive, an inlet cone section, and accessories.

1. Variable-Pitch Fans: Internally mounted [**electric**][**electronic**] actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.

F. Housings: [**Steel**][**Aluminum**][**Fiberglass-reinforced plastic**][**Stainless steel**]<**Insert material**>.

1. Inlet and Outlet Connections: Flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

G. Wheel Assemblies: [**Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**][**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**][**Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced**].

H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**][**1.3**][**1.4**][**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
8. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**]<**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**]<**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

I. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**][**and**][**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**][**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
11. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Section 230923.23 "Pressure Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."
12. Flow Measurement Port: Pressure measurement taps installed in fan inlet to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are

specified in Section 230923.14 "Flow Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."

13. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to **300 deg F (148 deg C)**.
14. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
15. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
16. Inlet Cone: Round-to-round transition, of same material as housing.
17. Outlet Cone: Round-to-round transition, of same material as housing.
18. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
19. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
20. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

J. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**][**Zinc**][**Phenolic**][**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.4 FANS, MIXED FLOW

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Greenheck Fan Corporation**]
3. [**Howden American Fan Company**]
4. [**Loren Cook Company**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Greenheck Fan Corporation**]
3. [**Howden American Fan Company**]
4. [**Loren Cook Company**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain mixed-flow fans from single manufacturer.

D. Standards: Comply with UL 705.

E. Description: Fan wheel and housing,[**straightening vane section,**] factory-mounted motor with [**belt drive**][**or**][**direct drive**], and accessories.

F. Housings: [**Steel**][**Galvanized steel**][**Aluminum**].

1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

3. Mixed-Flow Outlet Connection: [**One**][**Two**] flanged discharge(s) perpendicular to fan inlet.

G. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**][**1.3**][**1.4**][**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
7. Shaft Bearings: Radial, self-aligning bearings.

   a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**]<**Insert life**>.
   b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**]<**Insert life**>.
   c. Extend lubrication lines to outside of casing and terminate with grease fittings.

I. Accessories:

1. Mounting Clips: [**Horizontal ceiling**][**Vertical mounting**] clips welded to fan housing, of same material as housing.
2. Inlet and Outlet Screens: On unducted fan inlet and outlet - wire-mesh screen, of same material as housing.
3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
6. Inlet Cones: Round-to-round transition, of same material as housing.
7. Outlet Cones: Round-to-round transition, of same material as housing.
8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
9. Belt Guard: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
10. Direct-Driven Units: Encase motor in housing outside of airstream.
11. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

J. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**][**Zinc**][**Phenolic**][**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.5 FANS, CENTRIFUGAL - BACKWARD-INCLINED BLADES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Canarm Ltd.**]
4. [**Central Blower Company**]
5. [**Chicago Blower Corporation**]
6. [**Cincinnati Fan**]
7. [**COMEFRI**]
8. [**Loren Cook Company**]
9. [**New York Blower Company (The)**]
10. [**Northern Blower, Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Canarm Ltd.**]
4. [**Central Blower Company**]
5. [**Chicago Blower Corporation**]
6. [**Cincinnati Fan**]
7. [**COMEFRI**]
8. [**Loren Cook Company**]
9. [**New York Blower Company (The)**]
10. [**Northern Blower, Inc.**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain backward-inclined centrifugal fans from single manufacturer.

D. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
2. Factory-installed and -wired disconnect switch.

E. Standards: Comply with UL 705.

F. Housings:

1. Housing Material: [**Reinforced steel**][**Shaped fiberglass-reinforced plastic**][**Aluminum**][**Stainless steel**][**See schedule**]<**Insert material**>.
2. Housing Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates[**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.

9. Discharge Arrangement: Fan scroll housing is field rotatable to any of [**seven**][**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

G. Wheels:

1. Wheel Configuration: [**SWSI**][**DWDI**] construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels are to be statically and dynamically balanced, and nonoverloading.
2. Wheel and Blade Material: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**][**See schedule**].
3. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**][**Type B**][**Type C**].
4. Wheel and Blade Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
6. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

7. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

H. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

I. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece,

cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

J. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**][**1.4**][**1.3**][**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than [**5**]<**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

K. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Explosion proof**][**Totally enclosed, air over**]<**Insert motor enclosure type**>.

L. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: **NPS 1 (DN 25)** steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**][**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.6 FANS, CENTRIFUGAL - FORWARD-CURVED BLADES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Canarm Ltd.**]
3. [**Central Blower Company**]
4. [**Lau Fan**]
5. [**New York Blower Company (The)**]
6. [**Plastec Ventilation Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Canarm Ltd.**]
3. [**Central Blower Company**]
4. [**Lau Fan**]
5. [**New York Blower Company (The)**]
6. [**Plastec Ventilation Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain forward-curved blade centrifugal fans from single manufacturer.

D. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

E. Standards: Comply with UL 705.

F. Housings:

1. Housing Material: [**Reinforced steel**][**Shaped fiberglass-reinforced plastic**][**Aluminum**][**Stainless steel**][**See schedule**].
2. Housing Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates [**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**][**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

G. Wheels:

1. Wheel Configuration: [**SWSI**][**DWDI**] construction with a curved inlet flange and a backplate fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**][**See schedule**].

   a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**][**Type B**][**Type C**].

3. Wheel and Blade Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.
5. Forward-Curved Wheels:

   a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow

blades with inlet and tip curved forward in direction of airflow.
b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

H. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

I. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

a. Self-aligning, pillow-block-type [**ball**][**roller**] bearings.
b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

J. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**][**1.4**][**1.3**][**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

K. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion proof**].

L. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: **NPS 1 (DN 25)** steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**][**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.7 FANS, CENTRIFUGAL, INLINE - SQUARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**PennBarry; division of Air System Components**]
11. [**Quietaire Inc.**]
12. [**Rupp Air Management Systems**]
13. [**S & P USA Ventilation Systems, LLC**]
14. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**PennBarry; division of Air System Components**]
11. [**Quietaire Inc.**]
12. [**Rupp Air Management Systems**]
13. [**S & P USA Ventilation Systems, LLC**]
14. **<Insert manufacturer's name>**

C. Source Limitations: Obtain square inline centrifugal fans from single manufacturer.

D. Description: Square-housing in-line centrifugal fans.

E. Standards: Comply with UL 705.

F. Housing:

1. Housing Material: [**Reinforced steel**][**Aluminum**][**Stainless steel**][**See schedule**]<**Insert material**>.
2. Housing Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
3. Housing Construction: Side panels are to be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

G. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

H. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

I. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

J. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion-proof**]<**Insert motor enclosure type**>.

K. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: **1/2- by 1-inch (13- by 25-mm)** mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor: Epoxy-coated steel.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.8 FANS, CENTRIFUGAL, INLINE - TUBULAR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Hartzell Fan Incorporated**]
5. [**JencoFan**]
6. [**Loren Cook Company**]
7. [**New York Blower Company (The)**]
8. [**Peerless Blowers**]
9. [**PennBarry; division of Air System Components**]
10. [**S & P USA Ventilation Systems, LLC**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**American Coolair Corporation**]
4. [**Hartzell Fan Incorporated**]
5. [**JencoFan**]
6. [**Loren Cook Company**]
7. [**New York Blower Company (The)**]
8. [**Peerless Blowers**]
9. [**PennBarry; division of Air System Components**]
10. [**S & P USA Ventilation Systems, LLC**]
11. **<Insert manufacturer's name>**

C. Source Limitations: Obtain tubular in-line centrifugal fans from single manufacturer.

D. Description: Tubular-housing in-line centrifugal fans.

E. Housing:

1. Housing Material: [**Reinforced steel**][**Shaped fiberglass-reinforced plastic**][**Aluminum**][**Stainless steel**][**See schedule**]<**Insert material**>.
2. Housing Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
3. Housing Construction: Split, [**spun aluminum**]with [**aluminum**]straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

F. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

G. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

H. Fan Wheels: [**Steel**][**Aluminum**], airfoil blades welded to aluminum hub.

I. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion proof**]<**Insert motor enclosure type**>.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: **1/2- by 1-inch (13- by 25-mm)** mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor Cover: Epoxy-coated steel.
7. Belt Guard: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.9 FANS, PLENUM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**Chicago Blower Corporation**]
3. [**Cincinnati Fan**]
4. [**COMEFRI**]
5. [**Loren Cook Company**]
6. [**New York Blower Company (The)**]
7. [**Northern Blower, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**Chicago Blower Corporation**]
3. [**Cincinnati Fan**]
4. [**COMEFRI**]
5. [**Loren Cook Company**]
6. [**New York Blower Company (The)**]
7. [**Northern Blower, Inc.**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain plenum fans from single manufacturer.

D. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. [**Factory-installed and -wired disconnect switch.**]

E. Standards: Comply with UL 705.

F. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**][**See schedule**].

   a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**][**Type B**][**Type C**].

3. Wheel and Blade Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

G. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

H. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**][**1.4**][**1.3**][**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**] diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion proof**].

K. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle

frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.10 FANS, PLUG

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**Chicago Blower Corporation**]
3. [**Cincinnati Fan**]
4. [**Loren Cook Company**]
5. [**New York Blower Company (The)**]
6. [**Northern Blower, Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**Chicago Blower Corporation**]
3. [**Cincinnati Fan**]
4. [**Loren Cook Company**]
5. [**New York Blower Company (The)**]
6. [**Northern Blower, Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain plug fans from single manufacturer.

D. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

E. Standards: Comply with UL 705.

F. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**][**See schedule**].

a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8 [**Type A**][**Type B**][**Type C**].

3. Wheel and Blade Coating: [**None**][**Themoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

G. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

H. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**][**120,000**]<**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**][**1.4**][**1.3**][**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Explosion proof**].

K. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.11 FANS, UTILITY SET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**American Coolair Corporation**]
3. [**Canarm Ltd.**]
4. [**Carnes Company**]
5. [**Delhi Industries Inc**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**New York Blower Company (The)**]
9. [**Peerless Blowers**]
10. [**PennBarry; division of Air System Components**]
11. [**Quietaire Inc.**]
12. [**Rupp Air Management Systems**]
13. [**S & P USA Ventilation Systems, LLC**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
2. [**American Coolair Corporation**]
3. [**Canarm Ltd.**]
4. [**Carnes Company**]
5. [**Delhi Industries Inc**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**New York Blower Company (The)**]
9. [**Peerless Blowers**]
10. [**PennBarry; division of Air System Components**]
11. [**Quietaire Inc.**]
12. [**Rupp Air Management Systems**]
13. [**S & P USA Ventilation Systems, LLC**]

14. **<Insert manufacturer's name>**

C. Source Limitations: Obtain fan utility sets from single manufacturers.

D. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

E. Standards: Comply with UL 705.

F. Housings:

1. Housing Material: [**Reinforced steel**][**Shaped fiberglass-reinforced plastic**][**Aluminum**][**Stainless steel**][**See schedule**]<**Insert material**>.
2. Housing Coating: [**None**][**Themoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**][**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

G. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: [**Steel**][**Aluminum**][**One-piece fiberglass-reinforced plastic**][**Stainless steel**][**See schedule**].

   a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8 [**Type A**][**Type B**][**Type C**].

3. Wheel and Blade Coating: [**None**][**Thermoplastic vinyl**][**Epoxy**][**Synthetic resin**][**Phenolic**][**Hot-dip galvanized**][**Powder-baked enamel**][**See schedule**]<**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

5. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

6. Backward-Inclined Flat Blades:

   a. Flat design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

7. Forward-Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

H. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

I. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast-iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, [**L50 of 200,000 hours**][**L10 of 80,000 hours**]<**Insert life**>.
3. Roller-Bearing Rating Life: ABMA 11, [**L50 of 200,000 hours**][**L10 of 80,000 hours**]<**Insert life**>.
4. Extend grease fitting to accessible location outside of unit.

J. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: [**1.5**][**1.4**][**1.3**][**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert value**> hp; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

K. Motor Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Explosion proof**]<**Insert motor enclosure type**>.

L. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, fabricated in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: **NPS 3/4 (DN 20)** threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
12. Discharge Dampers: Assembly with [**parallel**][**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of

airstream to single control lever of same material as housing.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.12 VENTILATORS, AXIAL - ROOF MOUNTED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**Hartzell Fan Incorporated**]
9. [**JencoFan**]
10. [**Loren Cook Company**]
11. [**Moffitt Corporation**]
12. [**New York Blower Company (The)**]
13. [**PennBarry; division of Air System Components**]
14. [**Quietaire Inc.**]
15. [**Rupp Air Management Systems**]
16. [**S & P USA Ventilation Systems, LLC**]
17. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**Hartzell Fan Incorporated**]
9. [**JencoFan**]
10. [**Loren Cook Company**]
11. [**Moffitt Corporation**]
12. [**New York Blower Company (The)**]
13. [**PennBarry; division of Air System Components**]
14. [**Quietaire Inc.**]
15. [**Rupp Air Management Systems**]
16. [**S & P USA Ventilation Systems, LLC**]
17. **<Insert manufacturer's name>**

C. Source Limitations: Obtain roof-mounted axial ventilators from single manufacturer.

D. Standards: Comply with UL 705.

E. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece,

hinged, aluminum base.

F. Fan Wheel: [**Aluminum**][**Steel**] hub and blades. [**Spark-resistant construction classified in accordance with AMCA 99, Section 8,**][**Type A**][**Type B**][**Type C**].

G. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.

H. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**][**outside**] fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, **1/2-inch (13-mm)** mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

I. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid, fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**][**Built-in cant and mounting flange**][**Built-in raised cant and mounting flange**].
2. Overall Height: [**8 inches (203 mm)**][**9-1/2 inches (240 mm)**][**12 inches (305 mm)**][**16 inches (400 mm)**][**18 inches (450 mm)**].
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (20-mm-)**] thick steel bars welded in place to form **6-inch (150-mm)** squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.13 VENTILATORS, CENTRIFUGAL - CEILING MOUNTED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**American Coolair Corporation**]
3. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]

8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**Panasonic Eco Solutions**]
11. [**PennBarry; division of Air System Components**]
12. [**S & P USA Ventilation Systems, LLC**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**American Coolair Corporation**]
3. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**Panasonic Eco Solutions**]
11. [**PennBarry; division of Air System Components**]
12. [**S & P USA Ventilation Systems, LLC**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain ceiling-mounted centrifugal ventilators from single manufacturer.

D. Standards: Comply with UL 705.

E. Housing: Steel, lined with acoustical insulation.

F. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel are removable for service.

G. Back-draft damper: Integral.

H. Grille: [**Plastic**][**Stainless steel**][**Aluminum**][**Painted aluminum**], louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

I. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

J. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.14 VENTILATORS, CENTRIFUGAL - ROOF-MOUNTED DOWNBLAST

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**New York Blower Company (The)**]
11. [**Northern Blower, Inc.**]
12. [**PennBarry; division of Air System Components**]
13. [**Quietaire Inc.**]
14. [**Rupp Air Management Systems**]
15. [**S & P USA Ventilation Systems, LLC**]
16. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Carnes Company**]
6. [**FloAire National**]
7. [**Greenheck Fan Corporation**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**New York Blower Company (The)**]
11. [**Northern Blower, Inc.**]
12. [**PennBarry; division of Air System Components**]
13. [**Quietaire Inc.**]
14. [**Rupp Air Management Systems**]
15. [**S & P USA Ventilation Systems, LLC**]
16. **<Insert manufacturer's name>**

C. Source Limitations: Obtain roof-mounted downblast centrifugal ventilators from single manufacturer.

D. Standards: Comply with UL 705.

E. Housing: Downblast; removable [**spun-aluminum dome top and outlet baffle**][**extruded-aluminum rectangular top**][**galvanized-steel mushroom-domed top**][**spun aluminum**]; square, one-piece aluminum base with venturi inlet cone.

F. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**][**Type A**][**Type B**][**Type C**].

G. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.
6. Fan and motor are isolated from exhaust airstream.

H. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**][**outside**] fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, **1/2-inch (13-mm)** mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.

I. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid, fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**][**Built-in cant and mounting flange**][**Built-in raised cant and mounting flange**][**Manufactured to accommodate roof slope**].
2. Overall Height: [**8 inches (203 mm)**][**9-1/2 inches (240 mm)**][**12 inches (305 mm)**][**16 inches (400 mm)**][**18 inches (450 mm)**].
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (20-mm-)**] thick steel bars welded in place to form **6-inch (150-mm)** squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.

2.15 VENTILATORS, CENTRIFUGAL - ROOF-MOUNTED UPBLAST OR SIDEWALL MOUNTED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Canarm Ltd.**]
6. [**Carnes Company**]
7. [**FloAire National**]
8. [**Greenheck Fan Corporation**]

9. [**JencoFan**]
10. [**Loren Cook Company**]
11. [**New York Blower Company (The)**]
12. [**PennBarry; division of Air System Components**]
13. [**Quietaire Inc.**]
14. [**Rupp Air Management Systems**]
15. [**S & P USA Ventilation Systems, LLC**]
16. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Canarm Ltd.**]
6. [**Carnes Company**]
7. [**FloAire National**]
8. [**Greenheck Fan Corporation**]
9. [**JencoFan**]
10. [**Loren Cook Company**]
11. [**New York Blower Company (The)**]
12. [**PennBarry; division of Air System Components**]
13. [**Quietaire Inc.**]
14. [**Rupp Air Management Systems**]
15. [**S & P USA Ventilation Systems, LLC**]
16. <**Insert manufacturer's name**>

C. Source Limitations: Obtain roof-mounted upblast or sidewall-mounted centrifugal ventilators from single manufacturer.

D. Standards:

1. Comply with UL 705.
2. Power ventilators for use with restaurant kitchen exhaust are to comply with UL 762.

E. Configuration: Centrifugal [**roof upblast**][**roof upblast, kitchen grease hood**][**sidewall**] ventilator.

F. Housing: Removable [**spun-aluminum dome top and outlet baffle**][**extruded-aluminum rectangular top**][**galvanized-steel, mushroom-domed top**][**spun aluminum**]; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. [**Provide grease collector.**]

G. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**][**Type A**][**Type B**][**Type C**].

H. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA 9, [**L10 of 100,000 hours**]<**Insert life**>.

4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.
6. Fan and motor are isolated from exhaust airstream.

I. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**][**outside**] fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, **1/2-inch (13-mm)** mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Wall Mount Adapter: Attach wall-mounted fan to wall.
8. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

J. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid, fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**][**Built-in cant and mounting flange**][**Built-in raised cant and mounting flange**][**Manufactured to accommodate roof slope**].

K. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**][**Built-in cant and mounting flange**][**Built-in raised cant and mounting flange**][**manufactured to accommodate roof slope**].
2. Overall Height: [**8 inches (203 mm)**][**9-1/2 inches (240 mm)**][**12 inches (305 mm)**][**16 inches (400 mm)**][**18 inches (450 mm)**].
3. Sound Curb: Curb with sound-absorbing insulation[**and galvanized metal liner**].
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (20-mm-)**] thick steel bars welded in place to form **6-inch (150-mm)** squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.
9. Vented Curb: For kitchen exhaust; **12-inch- (300-mm-)** high galvanized steel; unlined, with louvered vents in vertical sides.
10. NFPA 96 code requirements for commercial cooking operations.
11. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

2.16 FANS, PROPELLER - SIDEWALL MOUNTED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Canarm Ltd.**]
6. [**Carnes Company**]
7. [**JencoFan**]
8. [**Loren Cook Company**]
9. [**Moffitt Corporation**]
10. [**Peerless Blowers**]
11. [**PennBarry; division of Air System Components**]
12. [**Quietaire Inc.**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aerovent; a division of Twin City Fan Companies, Ltd.**]
3. [**Airmaster Fan; a brand of MAICO**]
4. [**American Coolair Corporation**]
5. [**Canarm Ltd.**]
6. [**Carnes Company**]
7. [**JencoFan**]
8. [**Loren Cook Company**]
9. [**Moffitt Corporation**]
10. [**Peerless Blowers**]
11. [**PennBarry; division of Air System Components**]
12. [**Quietaire Inc.**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain sidewall-mounted propeller fans from single manufacturer.

D. Standards: Comply with UL 705.

E. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

F. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

G. Fan Wheel: Replaceable, [**cast**][**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

H. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

I. Fan Drive, Belt:

1. Belt drive.
2. Resiliently mounted to housing.
3. Statically and dynamically balanced.
4. Selected for continuous operation at maximum-rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.

6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**]<**Insert life**>.

9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
10. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**insert value**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

J. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.
8. Belt Guard: For motor mounted on outside of fan cabinet. Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.17 FANS, PROPELLER - ROOF-MOUNTED UPBLAST

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Airmaster Fan; a brand of MAICO**]
3. [**American Coolair Corporation**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**Greenheck Fan Corporation**]
7. [**Hartzell Fan Incorporated**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**Moffitt Corporation**]
11. [**New York Blower Company (The)**]
12. [**Northern Blower, Inc.**]
13. [**PennBarry; division of Air System Components**]
14. [**Quietaire Inc.**]
15. [**Rupp Air Management Systems**]
16. [**S & P USA Ventilation Systems, LLC**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Airmaster Fan; a brand of MAICO**]
3. [**American Coolair Corporation**]
4. [**Canarm Ltd.**]
5. [**Carnes Company**]
6. [**Greenheck Fan Corporation**]
7. [**Hartzell Fan Incorporated**]
8. [**JencoFan**]
9. [**Loren Cook Company**]
10. [**Moffitt Corporation**]
11. [**New York Blower Company (The)**]
12. [**Northern Blower, Inc.**]
13. [**PennBarry; division of Air System Components**]
14. [**Quietaire Inc.**]
15. [**Rupp Air Management Systems**]
16. [**S & P USA Ventilation Systems, LLC**]
17. <**Insert manufacturer's name**>

C. Source Limitations: Obtain roof-mounted upblast propeller fans from single manufacturer.

D. Standards: Comply with UL 705.

E. Configuration: Upblast propeller ventilator.

F. Wind Band, Fan Housing, and Base: Reinforced and braced [**galvanized steel**][**aluminum**], containing [**galvanized-steel**][**aluminum**] butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with [**bronze**][**nylon**] bearings.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

G. Fan Wheel: Replaceable, [**cast**][**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**][**Type A**][**Type B**][**Type C**].

H. Belt Drives:

1. Resiliently mounted to housing.
2. Weatherproof housing of same material as fan housing.
3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
6. Motor Pulleys: Adjustable pitch for use with motors through [**5**]<**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**]<**Insert number**> hp.
7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

I. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**][**outside**] fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, **1/2-inch (13-mm)** mesh, aluminum or brass wire.
3. Inspection Door: Hinged.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Extended Lubrication Lines.
7. Belt Guard: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

J. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid, fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**][**Built-in cant and mounting flange**][**Built-in raised cant and mounting flange**].
2. Overall Height: [**8 inches (203 mm)**][**9-1/2 inches (240 mm)**][**12 inches (305 mm)**][**16 inches (400 mm)**][**18 inches (450 mm)**].
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper.
5. Burglar Bars: [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (20-mm-)**] thick steel bars welded in place to form **6-inch (150-mm)** squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.

2.18 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.19 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

C. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor-mounted fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install roof-mounted fans on roof curbs or support steel. See Drawings for specific requirements.
3. Unit Support: Install fans level on structural curbs. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**][**Secure units to structural support with anchor bolts.**]
4. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
5. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
6. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

F. Unit Support: Install centrifugal fans level on structural [**curbs**][**pilings**]. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**][**Secure units to structural support with anchor bolts.**]

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation[**and seismic-control**] devices.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."

H. Install units with adequate clearances for service and maintenance.

I. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 PIPING CONNECTIONS

A. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

B. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing in accordance with Section 230533 "Heat Tracing for HVAC Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE:

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.

10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 23 34 00 00

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Task	Specification	Specification Description
23 34 13 00	23 34 00 00	HVAC Fans
23 34 16 00	23 34 00 00	HVAC Fans
23 34 23 00	23 34 00 00	HVAC Fans

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SECTION 23 34 33 00 - COMMERCIAL AIR CURTAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial air-curtain unit.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air curtain units.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For air curtain units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by a qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-curtain unit mounting assemblies.
2. Include design calculations for selecting vibration isolators[**and seismic restraints**].

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtain units to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish one set of filters[**for each unit installed**].

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of air curtain units that fail in materials or workmanship within specified warranty period.

1. Warranty Period (Nonheating Units): [**60**][**24**]<**Insert number**> months.
2. Warranty Period (Electric Heating Units): [**18**][**24**]<**Insert number**> months.
3. Warranty Period (Hot-Water or Steam Heating Units): [**18**][**24**]<**Insert number**> months.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions:

1. Base fan-performance ratings on the following:

a. Ambient Temperature: <**Insert number**> **deg F (deg C)**.
b. Altitude: <**Insert number**> **feet (m)** above sea level.
c. Humidity: <**Insert number**> wet bulb **deg F (deg C)**.
d. <**Insert conditions**>.

B. Capacities and Characteristics:

1. Application: [**Thermal barrier**][**Wind resistance**][**Interior separation**][**Fly and insect control**].
2. Mounting Type: [**Suspension**][**Wall brackets**][**Keyhole wall mount**].
3. Discharge Direction: Vertical.
4. Door Type: [**Exterior**][**Interior**].
5. Door Height: <**Insert dimension**> **inches (mm)**.
6. Door Width: <**Insert dimension**> **inches (mm)**.
7. Unit Length: [**36 (900)**][**42 (1050)**][**48 (1200)**][**60 (1500)**][**72 (1800)**][**84 (2100)**][**96 (2400)**][**108 (2700)**][**120 (3000)**][**144 (3600)**]<**Insert dimension**> **inches (mm)**.
8. Net Weight: <**Insert number**> **lb (kg)**.
9. Nozzle Velocity: <**Insert number**> **fpm (m/s)**.
10. Average Outlet Velocity: <**Insert number**> **fpm (m/s)**.
11. Outlet Velocity Uniformity: <**Insert number**> percent.
12. Velocity Projection: <**Insert dimension**> **inches (mm)**.
13. Airflow: <**Insert number**> **cfm (L/s)**.
14. Intake: Internal.
15. Number of Fan(s): [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
16. Fan Motor:

a. Electrical Characteristics:

1) Horsepower: [**0.2**][**0.5**]<**Insert number**> hp.
2) Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
3) Phase: [**Single**][**Three**].
4) Hertz: 60 Hz.
5) Speed: [**1750**]<**Insert number**> rpm.
6) Full-Load Amperes: <**Insert number**> A.
7) Minimum Circuit Ampacity: <**Insert number**> A.
8) Maximum Overcurrent Protection: <**Insert number**> A.

17. Sound Level Measured 10 Feet (3 m) from Nozzle: <**Insert number**> dBA.
18. Hot-Water Coil:

    a. Entering-Water Temperature: <**Insert number**> **deg F (deg C)**.
    b. Leaving-Water Temperature: <**Insert number**> **deg F (deg C)**.
    c. Water Flow: <**Insert number**> **gpm (L/s)**.
    d. Water Pressure Drop: <**Insert number**> **feet of head (kPa)**.
    e. Air-Temperature Rise: <**Insert number**> **deg F (deg C)**.
    f. Number of Coil Row(s): [**One**][**Two**]<**Insert number**>.

19. Steam Coil:

    a. Capacity: <**Insert number**> **MBh (kW)**.
    b. Air-Temperature Rise: <**Insert number**> **deg F (deg C)**.
    c. Number of Coil Row(s): [**One**][**Two**]<**Insert number**>.
    d. Inlet Pressure: [**5**]<**Insert number**> **psig (kPa)**.
    e. Condensing Capacity: <**Insert number**> **lb/h (g/s)**.

20. Electric Heater:

    a. Capacity: <**Insert kilowatts**>.
    b. Air-Temperature Rise: <**Insert number**> **deg F (deg C)**.
    c. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
    d. Phase: [**Single**][**Three**].
    e. Hertz: 60 Hz.
    f. Minimum Circuit Ampacity: <**Insert number**> A.
    g. Maximum Overcurrent Protection: <**Insert number**> A.
    h. Control Step(s): [**One**][**Two**]<**Insert number**>.

2.2 COMMERCIAL AIR-CURTAIN UNIT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Berner International**]
2. [**Fantech**]
3. [**Loren Cook Company**]
4. [**Marley Engineered Products**]
5. [**Mars Air Systems**]
6. [**Powered Aire Inc.**]
7. [**TMI, LLC; Cutron Products Division**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Berner International**]
2. [**Fantech**]
3. [**Loren Cook Company**]
4. [**Marley Engineered Products**]
5. [**Mars Air Systems**]
6. [**Powered Aire Inc.**]
7. [**TMI, LLC; Cutron Products Division**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain air curtain from single source from single manufacturer.

D. Housing: [**Galvanized steel with electrostatically applied epoxy-enamel powder-coat finish**][**Type 304 stainless steel with No. 3 finish**][**Type 304 stainless steel with No. 4 finish**][**Type 316 stainless steel with No. 3 finish**][**Type 316 stainless steel with No. 4 finish**].

1. Discharge Nozzle: Integral to housing, containing adjustable air-directional vanes with 40-degree sweep front to back.

E. Mounting Brackets: Galvanized steel, for [**wall**][**ceiling**] mounting.

F. Air-Intake Grilles:

1. Grilles: Integral to, and same material as, housing.

G. Fans: [**Galvanized steel**][**Painted steel**][**Aluminum**].

1. Centrifugal, forward curved, double width, double inlet.
2. Statically and dynamically balanced.
3. Direct drive.

H. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Motor Speed: [**Single speed**][**Two speed**][**Multispeed**][**Variable speed**].
3. Resiliently mounted.
4. Continuous duty.
5. Totally enclosed, air over.
6. Integral thermal-overload protection.
7. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
8. Disconnect: [**Internal power cord with plug and receptacle**][**Lockable disconnect**]<**Insert disconnect type**>.

I. Water Coils:

1. Type: [**Continuous circuit**][**Self-draining**][**Cleanable**].
2. Piping Connections: Threaded on [**same end**][**opposite ends**].
3. Tube Material: Copper, complying with ASTM B75/B75M.

   a. Tube Diameter: **0.625 inch (15.9 mm)**.

4. Fins: [**Aluminum**][**Copper**] with fin spacing [**0.167 (4.23)**][**0.125 (3.18)**][**0.091 (2.31)**][**0.071 (1.80)**][**0.067 (1.70)**][**0.056 (1.42)**][**0.0075 (0.19)**]<**Insert dimension**> **inch (mm)**.
5. Fin and Tube Joint: Mechanical bond.
6. Headers: Seamless copper tube with brazed joints, prime coated.
7. Frames: Galvanized-steel channel frame, [**0.052 (1.3)**][**0.064 (1.6)**][**0.079 (2.0)**][**0.0625 (1.59)**]<**Insert dimension**> **inch (mm)**.
8. Ratings: In accordance with ASHRAE 33.
9. Working-Pressure Ratings: **200 psig (1380 kPa)**, **325 deg F (163 deg C)**.

J. Steam Coils: [**Distribution-header**][**Single-tube**] coil, with threaded steam supply and condensate connections.

1. Piping Connections: [**Same end**][**Opposite ends**][**Steam supply on both ends; condensate on one end**].
2. Tube Material: Copper, complying with ASTM B75/B75M.
3. Tube Diameter: **0.625 inch (15.9 mm)**.
4. Fins: Aluminum, with fin spacing [**0.167 (4.23)**][**0.125 (3.18)**][**0.091 (2.31)**][**0.071 (1.80)**][**0.067 (1.70)**][**0.056 (1.42)**][**0.0075 (0.19)**]<**Insert dimension**> **inch (mm)**.
5. Fin and Tube Joint: Mechanical bond.
6. Headers: Seamless copper tube with brazed joints, prime coated.
7. Frames: Galvanized-steel channel frame, [**0.052 (1.3)**][**0.064 (1.6)**][**0.079 (2.0)**][**0.0625 (1.59)**]<**Insert dimension**> **inch (mm)**.
8. Pressure and Temperature Ratings: **100 psig (690 kPa)**, **400 deg F (205 deg C)** in accordance with ASHRAE 33.

K. Electric-Resistance Coils:

1. Coil Assembly: Comply with UL 1995.
2. Frame: Galvanized-steel frame.
3. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
4. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.

    a. [**Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.**]

5. Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection. Include the following controls:

    a. Magnetic contactor.
    b. [**Solid-state stepless pulse**][**Step**] controller.
    c. [**Time-delay relay.**]
    d. [**Pilot lights; one per step.**]
    e. Airflow-proving switch.

L. Filters:

1. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in [**cardboard**][**galvanized-steel**] frame.
2. Washable Panel Filters: Removable, [**aluminum**][**stainless steel**], baffle-type filters with spring-loaded fastening; with minimum **0.0781-inch- (1.984-mm-)** thick, stainless steel filter frame.
3. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

M. Controls:

1. Thermostat: [**Built-in**][**Remote, field-installed**]; [**line voltage**][**24 V**], factory installed and wired to [**junction box on air curtain**][**motor-control panel**].
2. Automatic Door Switch: [**Roller type**][**Combination roller-plunger type**][**Plunger type**][**Magnetic**], installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
3. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.
4. Three-Speed Switch: Manually activates, deactivates, and controls air-curtain fan speed.
5. [**Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.**]

6. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, [**Type 1**][**Type 12**] enclosure [**with door-mounted, HAND-OFF-AUTO switch**][**with built-in, variable fan-speed control**].

N. Accessories:

1. Mounting Brackets: Adjustable mounting brackets for [**wall**][**top**] mounting.
2. Discharge Extension Neck: For ceiling-recessed installation.

2.3 SOURCE QUALITY CONTROL

A. Source Quality Control: Test to **300 and 200 psig (2070 and 1380 kPa)** underwater.

B. Testing: Test and inspect steam coils in accordance with ASHRAE 33.

C. AMCA Certification for Fan Aerodynamic Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 211.

D. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 311.

E. Comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.

F. Comply with NSF 37, "Air Curtains for Entranceways in Food and Food Service Establishments."

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

H. Steam coil will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine work areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**hot-water**][**steam and condensate**] piping systems to verify actual locations of piping connections before air-curtain installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install air curtains with clearance for equipment service and maintenance.

B. Equipment Installation: Install air curtains[**with seismic-restraint devices**]. Comply with requirements

for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 PIPING CONNECTIONS

A. Comply with requirements for heating hot-water piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Adjust motor speed to achieve specified airflow.

B. Adjust discharge louver and dampers to regulate airflow.

C. Adjust air-directional vanes.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
3. Inspect for [**water**][**steam and condensate**] leaks.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Air-curtain unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain commercial air curtains.

END OF SECTION 23 34 33 00

Task	Specification	Specification Description
23 34 33 00	23 34 00 00	HVAC Fans

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SECTION 23 35 00 00 - LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UL-listed, factory-fabricated grease duct - double-wall, 2-hour fire-rated, zero clearance.
2. UL-listed, factory-fabricated grease duct - double wall, reduced clearance.
3. UL-listed, factory-fabricated grease duct - single wall.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UL-listed grease ducts.

B. Shop Drawings: For UL-listed, factory-fabricated grease ducts.

1. Plans, elevations, sections, and attachment details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Details of fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D9.1/D9.1M.

PART 2 - PRODUCTS

2.1 UL-LISTED, FACTORY-FABRICATED GREASE DUCT - DOUBLE-WALL, 2-HOUR FIRE-RATED, ZERO CLEARANCE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. **<Insert manufacturer's name>**

C. Description: Factory-fabricated, UL-listed and -labeled, double-wall, 2-hour, fire-rated duct system tested in accordance with UL 1978 and UL 2221 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.

D. Construction: Inner shell and outer jacket separated by at least a [**1-inch (25-mm)**][**2-inch (50-mm)**][**3-inch (75-mm)**][**4-inch (100-mm)**] annular space filled with high-temperature, ceramic-fiber insulation, and complying with zero inches clearance to combustibles.

1. Inner Shell: ASTM A666, [**Type 304**][**Type 316**] stainless steel.
2. Outer Jacket: [**Aluminized**][**ASTM A666 stainless**] steel where concealed from occupied space. Stainless steel where exposed to occupied space.

E. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at **1500 deg F (816 deg C)** minimum.

F. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

G. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.

H. Grease Duct Access Doors: Provide access doors where indicated and where necessary for cleaning and inspection of duct interior.

1. Description: Factory-fabricated, -listed, and -labeled, double-wall [**personnel**][**and**][**maintenance**] access doors tested in accordance with UL 1978 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure

and complying with NFPA 96.

2. Construction: [**0.0625 inch (1.6 mm)**][**No. 16 MSG**][**Steel having a thickness not less than that required for the duct**][**Type 304**][**Type 316**] stainless steel inner shell and [**aluminized-steel**][**stainless steel**] outer cover with two handles.
3. Fasteners: Stainless steel bolts and wing nuts.

   a. Ensure that bolts do not penetrate interior of duct space.

4. Maintenance Access Door Minimum Dimensions: [**7 by 7 inches (178 by 178 mm)**]<**Insert dimensions**>.
5. Personnel Access Door Minimum Dimensions: [**22 by 20 inches (559 by 508 mm)**][**24 by 18 inches (610 by 458 mm)**][**24 by 24 inches (610 by 610 mm)**]<**Insert dimensions**>.
6. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

2.2 UL-LISTED, FACTORY-FABRICATED GREASE DUCT - DOUBLE-WALL, REDUCED CLEARANCE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, UL-listed and -labeled, double-wall duct system tested in accordance with UL 1978 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.

D. Construction: Inner shell and outer jacket separated by at least a [**1-inch (25-mm)**][**2-inch (50-mm)**][**3-inch (75-mm)**][**4-inch (100-mm)**] annular space filled with high-temperature, ceramic-fiber insulation. This insulation thickness is to comply with [**2-inch (50-mm)**][**4-inch (100-mm)**][**6-inch (150-mm)**]<**Insert clearance dimension to combustibles dimension**> clearance to combustibles.

1. Inner Shell: ASTM A666, [**Type 304**][**Type 316**] stainless steel.
2. Outer Jacket: [**Aluminized**][**ASTM A666 stainless**] steel where concealed from occupied space. Stainless steel where exposed to occupied space.

E. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at **1500 deg F (816 deg C)** minimum.

F. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

G. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.

H. Grease Duct Access Doors: Provide access doors where indicated and where necessary for cleaning and inspection of duct interior.

1. Description: Factory-fabricated, -listed, and -labeled, double-wall [**personnel**][**and**][**maintenance**] access doors tested in accordance with UL 1978 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.
2. Construction: [**0.0625 inch (1.6 mm)**][**No. 16 MSG**][**Steel having a thickness not less than that required for the duct**][**Type 304**][**Type 316**] stainless steel inner shell and [**aluminized-steel**][**stainless steel**] outer cover with two handles.
3. Fasteners: Stainless steel bolts and wing nuts.

   a. Ensure that bolts do not penetrate interior of duct space.

4. Maintenance Access Door Minimum Dimensions: [**7 by 7 inches (178 by 178 mm)**]<**Insert dimensions**>.
5. Personnel Access Door Minimum Dimensions: [**22 by 20 inches (559 by 508 mm)**][**24 by 18 inches (610 by 458 mm)**][**24 by 24 inches (610 by 610 mm)**]<**Insert dimensions**>.
6. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

2.3 UL-LISTED, FACTORY-FABRICATED GREASE DUCT - SINGLE WALL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ampco Stacks; DuraVent**]
2. [**DuraVent**]
3. [**Jeremias Inc.**]
4. [**Metal-Fab, Inc**]
5. [**Schebler Co. (The)**]
6. [**Security Chimneys; DuraVent**]
7. [**Selkirk Corporation; DuraVent**]
8. [**Van-Packer Co.**]
9. [**Ventilation Direct**]
10. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, UL-listed and -labeled, single-wall duct system tested in accordance with UL 1978 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.

D. Construction: Wall constructed of ASTM A666, [**Type 304**][**Type 316**] stainless steel.

E. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at **1500 deg F (816 deg C)** minimum.

F. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

G. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.

H. Grease Duct Access Doors: Provide access doors where indicated and where necessary for cleaning and inspection of duct interior.

1. Description: Factory-fabricated, -listed, and -labeled, [**personnel**][**and**][**maintenance**] access doors tested in accordance with UL 1978 and rated for **500 deg F (260 deg C)** continuously, or **2000 deg F (1093 deg C)** for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.
2. Construction: [**0.0625 inch (1.6 mm)**][**No. 16 MSG**][**Steel having a thickness not less than that required for the duct**][**Type 304**][**Type 316**] stainless steel inner shell and [**aluminized-steel**][**stainless steel**] outer cover with two handles.
3. Fasteners: Stainless steel bolts and wing nuts.

   a. Ensure that bolts do not penetrate interior of duct space.

4. Maintenance Access Door Minimum Dimensions: [**7 by 7 inches (178 by 178 mm)**]<**Insert dimensions**>.
5. Personnel Access Door Minimum Dimensions: [**22 by 20 inches (559 by 508 mm)**][**24 by 18 inches (610 by 458 mm)**][**24 by 24 inches (610 by 610 mm)**]<**Insert dimensions**>.
6. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Comply with requirements in Section 077200 "Roof Accessories."

B. Coordinate connections to kitchen exhaust hoods with requirements in Section 233813 "Commercial-Kitchen Hoods."

C. Coordinate connections to exhaust fans with requirements in Section 233400 "HVAC Fans."

D. Coordinate firestopping where grease ducts penetrate fire separations with requirements in Section 078413 "Penetration Firestopping."

E. Comply with all installation requirements of NFPA 96, all applicable codes, and authorities having jurisdiction.

F. Comply with minimum clearances from combustibles and minimum termination heights in accordance with product listing or NFPA 96 and UL 2221, whichever is most stringent.

G. Install airtight [**personnel**][**and**][**maintenance**] access doors where indicated.

H. Seal between sections of grease exhaust ducts in accordance with manufacturer's written installation instructions; use sealants recommended in writing by manufacturer.

I. Grease Duct Supports: Construct duct bracing and supports from noncombustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of [**the International Building Code**][**and**][**NFPA 96**]<**Insert code reference document**>.
2. Ensure that bolts, screws, rivets, and other mechanical fasteners do not penetrate duct walls.

J. Connections: Make grease duct connections in accordance with requirements of applicable codes and authorities having jurisdiction.

1. Grease Duct to Exhaust Fan Connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.
2. Grease Duct to Hood Connections:

a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.
b. Make watertight grease duct to hood joints connections using flanges, gaskets, and bolts.

K. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

1. Securely attach supports and bracing to structure.
2. Where grease ducts and access doors are large enough for service personnel to enter, provide sufficient structural support to accommodate additional load.

L. Grease Duct Enclosures: Comply with requirements of all applicable codes and authorities having jurisdiction.

M. Coordinate fire-rated enclosure construction with Section 092116.23 "Gypsum Board Shaft Wall Assemblies."

N. Repair damage to adjacent materials caused by installation of listed kitchen ventilation system exhaust ducts.

3.3 FIELD QUALITY CONTROL

A. Perform air leakage test [**in presence of Owner's Representative**]before concealment of any portion of grease duct system.

END OF SECTION 23 35 00 00

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Task	Specification	Specification Description
23 35 13 00	23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts
23 35 13 13	23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts
23 35 16 00	23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts
23 35 16 16	23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts
23 35 19 00	23 35 00 00	Listed Kitchen Ventilation System Exhaust Ducts

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SECTION 23 36 00 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bypass, single-duct air terminal units.
2. Modulating, single-duct air terminal units.
3. Parallel fan-powered air terminal units.
4. Series fan-powered air terminal units.
5. Dual-duct air terminal units.
6. Induction air terminal units.
7. Diffuser-type air terminal units.
8. Balancing terminal units.
9. Pressure-control terminal units.
10. Critical environment control valve.
11. Underfloor air distribution terminal units.
12. Exhaust single-duct terminal units.
13. DOAS, series, fan-powered air terminal units.
14. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.

D. Delegated Design Submittal: For vibration isolation[**and supports,**][**, and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data[**signed and sealed by the qualified professional engineer responsible for their preparation**].

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**][**and seismic restraints**].

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: For air terminal units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish [**one**]<**Insert number**> spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating,

Ventilating, and Air Conditioning."

D. Delegated Design: [**Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to**] design vibration isolation[**, supports,**][**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Seismic Performance: Air terminal units shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 BYPASS, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
5. [**METALAIRE, Inc**]
6. [**Nailor Industries Inc**]
7. [**Titus; brand of Johnson Controls International plc, Global Products**]
8. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
5. [**METALAIRE, Inc**]
6. [**Nailor Industries Inc**]
7. [**Titus; brand of Johnson Controls International plc, Global Products**]
8. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
9. <**Insert manufacturer's name**>

C. Description: Pressure-dependent, diverting-damper assembly inside unit casing with control components inside a protective metal shroud. Configuration enables variable volume airflow to individual zones while bypassing the unneeded air to the ceiling plenum for recirculation.

D. Casing: Minimum [**20-gauge-**][**22-gauge-**]<**Insert dimension**> thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with**

"Antimicrobial Erosion-Resistant Coating" Subparagraph][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].

E. Diverter Assembly:

1. Damper, shaft, and heavy-duty self-lubricating bearings.

F. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, with noise transmission loss performance as required in schedules on Drawings.

G. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
8. Pneumatic-electric switches and relays.
9. Magnetic contactor for each step of control (for three-phase coils).

I. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**][**, with microswitch to enable heating control circuit**].
2. Electric Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

J. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Electronic Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

K. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to

minimum and maximum air volumes.

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

L. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**].

2.3 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

C. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections[**, size matching inlet size**].
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

F. Velocity Sensors: Multipoint array with velocity inlet sensors.

G. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, with noise transmission loss performance as required in schedules on Drawings.

H. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

J. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and

maximum position stops.

K. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

L. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted pneumatic type [**direct acting**][**and**][**reverse acting**] with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

M. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with [**temperature set-point adjustment and**]access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, integrated actuators, and room sensors to be furnished under Section 230923 "Direct Digital Controls (DDC) for HVAC."

N. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.4 PARALLEL FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North**

America]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. **<Insert manufacturer's name>**

C. Description: Volume-damper assembly and centrifugal fan in parallel arrangement inside unit casing with control components inside a protective metal shroud[**; low-profile design**].

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal, located at plenum air inlet.

E. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-Pa)**]**<Insert value>** inlet static pressure.

F. Velocity Sensors: Multipoint array with velocity inlet sensors.

G. Fan Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: [**Open dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**]<**Insert material**>.
6. Motor Bearings: <**Insert requirements**>.
7. Unusual Service Conditions:

    a. Ambient Temperature: <**Insert deg F (deg C)**>.
    b. Altitude: <**Insert feet (m)**> above sea level.
    c. High humidity.
    d. <**Insert conditions**>.

8. Efficiency: Premium efficient as defined in NEMA MG-1.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Variable speed**].

    a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

12. Electrical Characteristics:

    a. Horsepower: <**Insert horsepower**>.
    b. Volts: [**120**][**208**][**230**][**460**]<**Insert value**>.
    c. Phase: [**Single**][**Poly**].
    d. Hertz: 60.
    e. Full-Load Amperes: <**Insert value**>.
    f. Minimum Circuit Ampacity: <**Insert value**>.
    g. Maximum Overcurrent Protection: <**Insert amperage**>.

H. Filters:

1. Polyurethane Foam: [**MERV 3**]<**Insert value**>. Minimum efficiency reporting value and average arrestance is in accordance with ASHRAE 52.2.
2. [**Flat, Nonpleated**][**Pleated**] Glass Fiber: Factory-fabricated, self-supported disposable air filter with holding frames. Provide [**MERV 6**][**MERV 13**]<**Insert value**> filter with minimum efficiency reporting value is to be in accordance with ASHRAE 52.2.

I. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the [**plenum inlet**][**and**][**discharge outlet**] of the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

J. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Locate coil in [**plenum air inlet**][**discharge-air outlet**] airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.

K. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Locate coil in discharge-air outlet airstream. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].

2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

L. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs will match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
3. Disconnect Switch: Factory-mounted fuse type.

M. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

N. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

O. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

P. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted pneumatic-type, [**direct acting**][**reverse acting**][**direct or reverse acting as indicated on Drawings**], with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

Q. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller with integrated actuator and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with[**temperature set-point adjustment and**] access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

R. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.5 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]

10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

C. Description: Volume-damper assembly and centrifugal fan in series arrangement inside unit casing with control components inside a protective metal shroud.

1. Designed for quiet operation.
2. Low-profile design.

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal.

E. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

F. Velocity Sensors: Multipoint array with velocity sensors in air inlet.

G. Fan Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: [**Open dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**]<**Insert material**>.
6. Motor Bearings: <**Insert requirements**>.
7. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert deg F (deg C)**>.
   b. Altitude: <**Insert feet (m)**> above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

8. Efficiency: Premium efficient as defined by NEMA MG-1.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Variable speed**].

    a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

12. Electrical Characteristics:

    a. Horsepower: <**Insert horsepower**>.
    b. Volts: [**120**][**208**][**230**][**460**]<**Insert value**>.
    c. Phase: [**Single**][**Poly**].
    d. Hertz: 60.
    e. Full-Load Amperes: <**Insert value**>.
    f. Minimum Circuit Ampacity: <**Insert value**>.
    g. Maximum Overcurrent Protection: <**Insert amperage**>.

H. Filters:

1. Polyurethane Foam: [**MERV 3**]<**Insert value**>. Minimum efficiency reporting value and average arrestance in accordance with ASHRAE 52.2.
2. [**Flat, Nonpleated**][**Pleated**] Glass Fiber: Factory-fabricated, self-supported disposable air filter with holding frames. Provide [**MERV 6**][**MERV 13**]<**Insert value**> filters with minimum efficiency reporting value is to be in accordance with ASHRAE 522.

I. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the [**plenum inlet**][**and**][**discharge outlet**] of the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

J. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Locate coil in discharge outlet airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.

K. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Locate coil in discharge outlet airstream. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

L. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
3. Disconnect Switch: Factory-mounted fuse type.

M. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

N. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius[**, and space temperature set point**].
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

O. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

P. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted, pneumatic type, [**direct acting**][**and**][**reverse acting**], with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

Q. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Instrumentation and Control for HVAC."

2. Room Sensor: Wall mounted with[**temperature set-point adjustment and**] access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal unit manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) for HVAC".

R. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.6 DUAL-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Carnes Company**]
3. [**Carrier Global Corporation**]
4. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
5. [**Johnson Controls, Inc.**]
6. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
7. [**METALAIRE, Inc**]
8. [**Nailor Industries Inc**]
9. [**Price Industries Limited**]
10. [**Titus; brand of Johnson Controls International plc, Global Products**]
11. [**Trane**]
12. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
13. <**Insert manufacturer's name**>

C. Description: [**Mixing**][**and**][**nonmixing**] with two volume dampers inside unit casing with mixing attenuator section and control components inside a protective metal shroud.

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, <**Insert number**> percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

F. Velocity Sensors: Multipoint array with velocity sensors in each air inlet and air outlet.

G. Attenuator Section: Casing material and thicknesses matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

H. Electric Controls:

1. Electric Damper Actuator, Hot Deck: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Damper Actuator, Cold Deck: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

I. Electronic Controls:

1. Electronic Damper Actuator, Hot Deck: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Damper Actuator, Cold Deck: 24 V, [**spring- return open**][**spring- return closed**][**capacitor- discharge- return open**][**capacitor- discharge- return closed**][**fail in last position**].
3. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
4. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at each air inlet.

J. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at each air inlet.

K. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

1. Occupied and unoccupied operating mode.
2. Remote reset of airflow or temperature set points.
3. Adjusting and monitoring with portable terminal.
4. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

L. Room Sensor: Wall mounted with [**temperature set-point adjustment and**]access for connection of

portable operator terminal.

M. Terminal Unit Controller, Section 230923: Controllers and actuators are to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

N. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.7 INDUCTION AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
3. <**Insert manufacturer's name**>

C. Description: Primary volume-damper and venturi assembly inside unit casing with mechanical induction damper mounted on casing and control components inside a protective metal shroud.

D. Casing: Minimum 22-gauge-thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections[**, size matching inlet size**].
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Fan: Forward-curved centrifugal.

E. Primary Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, <**Insert number**> percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

F. Induction Damper: Galvanized-steel, multiblade assembly with self-lubricating bearings.

G. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary

manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

I. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius[**, and space temperature set point**].
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

J. Electronic Controls:

1. Electronic Damper Actuator: 24 V, powered open, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

K. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted pneumatic type, [**direct acting**][**reverse acting**][**direct or reverse acting as indicated on Drawings**], with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

L. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller with integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

    a. Occupied and unoccupied operating mode.

b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller and actuators are to be factory mounted and wired by air terminal unit manufacturer; unit controller, actuator, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

M. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.8 DIFFUSER-TYPE AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acutherm; by Price**]
2. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
3. [**Carnes Company**]
4. [**Jackson Systems, LLC**]
5. [**Rickard Air Diffusion**]
6. [**Titus; brand of Johnson Controls International plc, Global Products**]
7. [**Warren Technology**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acutherm; by Price**]
2. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
3. [**Carnes Company**]
4. [**Jackson Systems, LLC**]
5. [**Rickard Air Diffusion**]
6. [**Titus; brand of Johnson Controls International plc, Global Products**]
7. [**Warren Technology**]
8. <**Insert manufacturer's name**>

C. Description: Volume-damper, diffuser, controller assembly[**and inlet electric heater**] and wall-mounted temperature-sensing device[**with master-drone capability**].

D. Volume Damper: [**Galvanized steel**]<**Insert material**> with peripheral gasket and self-lubricating bearings.

E. Diffuser: [**Galvanized steel**][**Aluminum**]<**Insert material**> with [**white**][**powder coat**][**or**][**baked-enamel finish**]<**Insert color and finish**>.

F. Wall-Mounted Temperature Sensor/Controller:

1. Digital display LCD wall-mounted controller.
2. Intuitive user operation.
3. Controller settings retained during power loss.

4. Communication Interface: [**BACnet**][**Modbus**]<**Insert protocol**> compatible for integration with building automation system.
5. Operational features:

    a. Set-point indication.
    b. Set-point adjustment.
    c. Changeover temperature indication.
    d. Changeover temperature set-point adjustment.
    e. Minimum damper position adjustment for ventilation air.

G. Accessories:

1. Modular plenum-rated plug-in cables for interconnecting master-drone diffusers.
2. Blank-off panels.
3. Pressure-relief ring.
4. 24 V ac transformer/power supply for master-drone configurations.
5. Plenum-rated, plug-in, diffuser interconnection cables for master-drone configurations.
6. Diffuser back-pan insulation.
7. T-bar mounting frame.
8. Plaster ceiling frame.

H. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.9 BALANCING TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Titus; brand of Johnson Controls International plc, Global Products**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Titus; brand of Johnson Controls International plc, Global Products**]
2. <**Insert manufacturer's name**>

C. Description: Manually operated volume-damper assembly with locking mechanism inside unit casing with multipoint, center-averaging velocity sensors[**for installation above a ceiling**].

D. Casing: Minimum 22-gauge-thick galvanized steel.

1. Leakage: Maximum 2 percent of nominal airflow at **1.5-inch wg (375-Pa)** static pressure.
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**2**]<**Insert number**> percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

2.10 PRESSURE-CONTROL TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carnes Company**]
2. [**Price Industries Limited**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carnes Company**]
2. [**Price Industries Limited**]
3. <**Insert manufacturer's name**>

C. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud, designed to regulate duct pressure via throttling to control discharge pressure in a variable volume system.

D. Casing: Minimum 22-gauge-thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Damper Assembly: Damper, shaft, and heavy-duty self-lubricating bearings.

E. Attenuator Section: Construction materials and thicknesses matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

F. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent controller and integrated [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail-in-last-position**] actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum discharge pressures.

a. Occupied and unoccupied operating mode.
b. Remote reset of discharge pressure set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Discharge Static Pressure Sensor: Discharge static pressure sensor to maintain constant static

pressure within [**5**]<**Insert number**> percent of set point.

3. Terminal Unit Controller and Discharge Static Pressure Sensor, Section 230923: Controller, actuator, and sensor to be factory mounted and wired by air terminal manufacturer; unit controller, actuator, and sensor are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

G. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.11 CRITICAL ENVIRONMENT CONTROL VALVE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Phoenix Controls Corporation**]
3. [**Price Industries Limited**]
4. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Phoenix Controls Corporation**]
3. [**Price Industries Limited**]
4. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
5. <**Insert manufacturer's name**>

C. Description: Volume-damper or venturi assembly inside a unit casing with control components inside a protective metal shroud, for general exhaust applications or for exhaust applications where pressurization control via exhaust and supply airflow control is desired and airstream corrosion and contamination may be a concern.

D. Casing:

1. Material: [**Type 304 stainless steel**][**or**][**Type 316 stainless steel**][**Minimum 22-gauge galvanized steel with phenolic coating**]<**Insert material**>.

E. [**Airflow Metering, Option: Calibrated shaft position with self-adjusting, spring-loaded cone.**]

F. [**Sensors, Option: Multipoint,**][**Type 316 stainless steel**]<**Insert material**>[**, removable**].

G. Direct Digital Controls:

1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

H. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.12 UNDERFLOOR AIR DISTRIBUTION TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Johnson Controls, Inc.**]
3. [**Nailor Industries Inc**]
4. [**Price Industries Limited**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Johnson Controls, Inc.**]
3. [**Nailor Industries Inc**]
4. [**Price Industries Limited**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. <**Insert manufacturer's name**>

C. Description: Volume-damper assembly and fan in series arrangement inside low-profile unit casing with control components inside a protective metal shroud within a raised access floor. Design configuration for [**pressurized floor cavity supply**][**and**][**ducted air supply**].

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Integral floor discharge diffusers.
2. Mixing damper.
3. VAV throttling damper.
4. Leveling feet.
5. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
6. Air Outlet: S-slip and drive connections.
7. Access: Removable panels on top of casing, for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
8. Fan: Forward-curved centrifugal [**in double blower configuration**][**with double blowers as scheduled**].

E. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.
2. Damper Position: Normally [**open**][**closed**].

F. Velocity Sensors: Multipoint array with velocity sensors in air inlets.

G. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements

for motors specified in Section 230500 "Common Work Results for HVAC."

2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: [**Open dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**]<**Insert material**>.
6. Motor Bearings: <**Insert requirements**>.
7. Unusual Service Conditions:

    a. Ambient Temperature: <**Insert deg F (deg C)**>.
    b. Altitude: <**Insert feet (m)**> above sea level.
    c. High humidity.
    d. <**Insert conditions**>.

8. Efficiency: Premium efficient.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Variable speed**].
12. Electrical Characteristics:

    a. Horsepower: <**Insert horsepower**>.
    b. Volts: [**120**][**208**][**230**][**460**]<**Insert value**>.
    c. Phase: [**Single**][**Poly**].
    d. Hertz: 60.
    e. Full-Load Amperes: <**Insert value**>.
    f. Minimum Circuit Ampacity: <**Insert value**>.
    g. Maximum Overcurrent Protection: <**Insert amperage**>.

H. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Locate coil in discharge outlet airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Locate coil in discharge outlet airstream. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.

2. Wiring Terminations: Fan and controls to terminal strip. Verify terminal lugs match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
3. Disconnect Switch: Factory-mounted fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

L. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

M. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller with integrated actuator and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Set-point adjustment and access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

N. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.13 EXHAUST SINGLE-DUCT TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
2. [**Nailor Industries Inc**]
3. [**Price Industries Limited**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]

2. [**Nailor Industries Inc**]
3. [**Price Industries Limited**]
4. <**Insert manufacturer's name**>

C. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud, for exhaust applications where pressurization control via exhaust and supply airflow control is desired.

D. Casing: Minimum [**22-gauge-**][**20-gauge-**]<**Insert value**> thick galvanized steel.

1. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
2. Air Outlet: S-slip and drive connections[**, size matching inlet size**].
3. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-Pa)**]<**Insert value**> inlet static pressure.

F. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

G. Electric Controls:

1. Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.
3. Differential Pressure Sensor: Wall-mounted type with set point.

H. Electronic Controls:

1. Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.
3. Differential Pressure Sensor: Wall-mounted electronic type with set-point display.

I. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, controller and integrated [**spring-return open**][**spring-return closed**][**capacitor-discharge open**][**capacitor-discharge-return closed**][**fail-in-last-position**] actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with differential pressure set-point adjustment[**and access for connection of portable operator terminal**].
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."
4. Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].

J. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.14 DOAS, SERIES, FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Johnson Controls, Inc.**]
2. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
3. [**Nailor Industries Inc**]
4. [**Price Industries Limited**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. [**Trane**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Johnson Controls, Inc.**]
2. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
3. [**Nailor Industries Inc**]
4. [**Price Industries Limited**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. [**Trane**]
7. <**Insert manufacturer's name**>

C. Description: Primary outside-air volume-damper assembly and fan in series arrangement inside unit casing, with control components inside a protective metal shroud, with chilled-water coil for sensible cooling.

D. Casing: Minimum [**20-gauge-**][**22-gauge-**] thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for [**"Casing Liner, Fibrous Glass" Paragraph**][**"Casing Liner, Flexible Elastomeric" Paragraph**][**with "Antimicrobial Erosion-Resistant Coating" Subparagraph**][**with "Foil-Faced Liner" Subparagraph**][**with "Solid Metal Liner" Subparagraph**][**with "Perforated Metal Liner" Subparagraph**][**with "Specialty Liner" Subparagraph**].
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections[**, size matching inlet size**].
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [**1**][**2**] percent of nominal airflow at [**3-inch wg (750-**

Pa)]<**Insert value**> inlet static pressure.

F. Velocity Sensors: Multipoint array with velocity inlet sensors.

G. Fan Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: [**Open dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**]<**Insert material**>.
6. Motor Bearings: <**Insert requirements**>.
7. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert deg F (deg C)**>.
   b. Altitude: <**Insert feet (m)**> above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

8. Efficiency: Premium efficient as defined in NEMA MG-1.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Variable speed**].

    a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

12. Electrical Characteristics:

    a. Horsepower: <**Insert horsepower**>.
    b. Volts: [**120**][**208**][**230**][**460**]<**Insert value**>.
    c. Phase: [**Single**][**Poly**].
    d. Hertz: 60.
    e. Full-Load Amperes: <**Insert value**>.
    f. Minimum Circuit Ampacity: <**Insert value**>.
    g. Maximum Overcurrent Protection: <**Insert amperage**>.

H. Filters:

1. Polyurethane Foam: [**MERV 3**]<**Insert value**>. Minimum efficiency reporting value and average arrestance in accordance with ASHRAE 52.2.
2. [**Flat, Nonpleated**][**Pleated**] Glass Fiber: Factory-fabricated, self-supported disposable air filter with holding frames. Provide [**MERV 6**][**MERV 13**]<**Insert value**> filter with minimum efficiency reporting value in accordance with ASHRAE 52.2.

I. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide [**absorptive**][**packless**] attenuator integral with the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.

J. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

K. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum,

mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): [**One**][**Two**][**Three**].
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

L. Hydronic Cooling Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than [**0.1 inch (2.5 mm)**][**0.08 inch (2.0 mm)**]. Include manual air vent and drain valve. Locate cooling coils at plenum air inlet. Include galvanized-steel factory-installed drip tray [**and moisture sensor**]for safety in cases where cooling coil temporarily experiences nondesign conditions.

M. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
3. Disconnect Switch: Factory-mounted fuse type.

N. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

O. Electric Controls:

1. Electric Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**fail in last position**].
2. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Air Volume Controls: Pressure-dependent volume controls with field-adjustable minimum and maximum position stops.

P. Electronic Controls:

1. Electronic Damper Actuator: 24 V, [**spring-return open**][**spring-return closed**][**capacitor-discharge-return open**][**capacitor-discharge-return closed**][**fail in last position**].
2. Electronic Thermostat: Wall-mounted electronic type with temperature display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

Q. Pneumatic Controls:

1. Pneumatic Damper Actuator: [**0 to 13 psig (0 to 90 kPa)**]<**Insert range**> spring range.
2. Pneumatic Thermostat: Wall-mounted, pneumatic type, [**direct acting**][**and**][**reverse acting**], with appropriate mounting hardware.
3. Pneumatic Air Volume Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to pneumatic thermostat signal while compensating for inlet static-pressure variations of up to **4 inches wg (1000 Pa)**; includes a multipoint velocity sensor at air inlet.

R. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller with integrated actuator and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.

   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."
4. Cooling Coil Drip Pan Sensor: Shuts off fan upon detection of moisture in drip pan.

S. Control Sequence: See [**Section 230993.11 "Sequence of Operation for HVAC"**][**Drawings**] for control sequences.

2.15 CASING LINER

A. Casing Liner, Fibrous Glass: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A or NFPA 90B, and with NAIMA AH124.

1. Minimum Thickness: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].

   a. Maximum Thermal Conductivity:

      1) Type I, Flexible: [**0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)**]<**Insert value**> at **75 deg F (24 deg C)** mean temperature.
      2) Type II, Rigid: [**0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K)**]<**Insert value**> at **75 deg F (24 deg C)** mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to surface of liner that will form interior surface of duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Foil-Faced Liner: Minimum **0.001-inch (0.03-mm)** reinforced, nonporous aluminum foil applied to matted insulation airstream face. [**Encapsulate all insulation edges with sheet metal angles and channels, or tape.**]
4. Solid Metal Liner: Solid [**galvanized sheet metal**]<**Insert material**> encapsulating matted insulation face from airstream.

5. Perforated Metal Liner: Perforated [**galvanized sheet metal**]<**Insert material**> encapsulating matted insulation face from airstream.
6. Specialty Liner: <**Insert specialty liner in coordination with manufacturers**>.
7. [**Solvent**][**Water**]-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

    a. Adhesive shall have a VOC content of 80 g/L or less.
    b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    c. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    d. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    e. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    f. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Casing Liner, Flexible Elastomeric: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Minimum Thickness: [**1/2 inch (13 mm)**]<**Insert dimension**>.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. Adhesive shall have a VOC content of 80 g/L or less.
    b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    c. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    d. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
    e. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    f. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.16 SOURCE QUALITY CONTROL

A. [**AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.**]

B. [**AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.**]

C. Water Coils: Factory pressure test to **300 psig (2070 kPa)** in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

D. Install wall-mounted thermostats.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water [**and**][**Chilled-Water**] Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating [**and**][**cooling**] coils to supply piping with shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in [**Section 233113 "Metal Ducts"**][**Section 233116 "Nonmetal Ducts"**] for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows[**, and coil type**]. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.
7. <**Insert startup steps if any**>.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00 00

Task	Specification	Specification Description
23 36 13 00	23 36 00 00	Air Terminal Units
23 36 13 00	23 37 13 00	Registers and Grilles
23 36 16 00	23 36 00 00	Air Terminal Units
23 36 16 00	23 37 13 00	Registers and Grilles
23 37 00 00	23 31 16 23	Fabric Air-Distribution Devices

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SECTION 23 37 13 00 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Registers - adjustable-blade face.
2. Registers - fixed-blade face.
3. Grilles - adjustable-blade face.
4. Grilles - fixed-blade face.
5. Grilles - linear bar.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.
3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.
4. Section 233716 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   b. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.

C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Actual size of smallest register and grille indicated.

D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Actual size of smallest size register and grille indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Registers - Adjustable-Blade Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A-J Manufacturing Co., Inc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**Dayus Register & Grille Inc.**]
   e. [**Hart & Cooley, LLC**]
   f. [**Kees, Inc**]
   g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   h. [**METALAIRE, Inc**]
   i. [**Nailor Industries Inc**]
   j. [**Price Industries Limited**]
   k. [**Raymon Company**]
   l. [**Shoemaker Mfg. Co.**]
   m. [**Titus; brand of Johnson Controls International plc, Global Products**]
   n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**A-J Manufacturing Co., Inc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**Dayus Register & Grille Inc.**]
   e. [**Hart & Cooley, LLC**]
   f. [**Kees, Inc**]
   g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   h. [**METALAIRE, Inc**]
   i. [**Nailor Industries Inc**]
   j. [**Price Industries Limited**]
   k. [**Raymon Company**]
   l. [**Shoemaker Mfg. Co.**]
   m. [**Titus; brand of Johnson Controls International plc, Global Products**]
   n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
   o. **<Insert manufacturer's name>**

3. Material: [**Steel**][**Aluminum**][**Stainless steel**].
4. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Clear anodized**]<**Insert finish**>.
5. Face-Blade Arrangement: Face blades with adjustable angle to permit manual adjustment of air discharge direction. Blades [**horizontally**][**vertically**] spaced [**3 inches (76 mm)**][**1-1/2 inches (38 mm)**][**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
6. Core Construction: [**Integral**][**Removable**].
7. Rear-Blade Arrangement: Rear blades with adjustable angle to permit manual adjustment of air discharge direction. Blades [**horizontally**][**vertically**] spaced [**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
8. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**]<**Insert dimension**> wide.
9. Filter-Mounting Frame: <**Insert frame size and style**>.
10. Mounting: [**Countersunk screw**][**Concealed**][**Lay in**].
11. Accessories:

    a. Damper Type: [**Multishutter**][**Adjustable opposed blade**][**NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C)**].
    b. [**Front**][**Rear**]-blade gang operator.
    c. Filter.

B. Registers - Fixed-Blade Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A-J Manufacturing Co., Inc**]
    b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    c. [**Carnes Company**]
    d. [**Dayus Register & Grille Inc.**]
    e. [**Hart & Cooley, LLC**]
    f. [**Kees, Inc**]
    g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
    h. [**METALAIRE, Inc**]
    i. [**Nailor Industries Inc**]
    j. [**Price Industries Limited**]
    k. [**Raymon Company**]
    l. [**Shoemaker Mfg. Co.**]
    m. [**Titus; brand of Johnson Controls International plc, Global Products**]
    n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A-J Manufacturing Co., Inc**]
    b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    c. [**Carnes Company**]
    d. [**Dayus Register & Grille Inc.**]
    e. [**Hart & Cooley, LLC**]
    f. [**Kees, Inc**]
    g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
    h. [**METALAIRE, Inc**]
    i. [**Nailor Industries Inc**]

j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

3. Material: [**Steel**][**Aluminum**][**Stainless steel**].
4. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Clear anodized**]<**Insert finish**>.
5. Face-Blade Arrangement: Fixed-position face blades, [**horizontally**][**vertically**] spaced [**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
6. Core Construction: [**Integral**][**Removable**].
7. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**]<**Insert dimension**> wide.
8. Filter-Mounting Frame: <**Insert frame size and style**>.
9. Mounting: [**Countersunk screw**][**Concealed**][**Lay in**].
10. Damper Type: [**Multishutter**][**Adjustable opposed blade**][**NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C)**].
11. Accessory: Filter.

2.2 GRILLES

A. Grilles - Adjustable-Blade Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Dayus Register & Grille Inc.**]
e. [**Hart & Cooley, LLC**]
f. [**Kees, Inc**]
g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
h. [**METALAIRE, Inc**]
i. [**Nailor Industries Inc**]
j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Dayus Register & Grille Inc.**]
e. [**Hart & Cooley, LLC**]

f. [**Kees, Inc**]
g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
h. [**METALAIRE, Inc**]
i. [**Nailor Industries Inc**]
j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

3. Material: [**Steel**][**Aluminum**][**Stainless steel**].
4. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Clear anodized**]<**Insert finish**>.
5. Face-Blade Arrangement: Face blades with adjustable angle to permit manual adjustment of discharge direction. Blades [**horizontally**][**vertically**] spaced [**3 inches (76 mm)**][**1-1/2 inches (38 mm)**][**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
6. Core Construction: [**Integral**][**Removable**].
7. Rear-Blade Arrangement: All rear blades with adjustable angle to permit manual adjustment of air-discharge direction. Blades [**horizontally**][**vertically**] spaced [**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
8. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**]<**Insert dimension**> wide.
9. Filter-Mounting Frame: <**Insert frame size and style**>.
10. Mounting: [**Countersunk screw**][**Concealed**][**Lay in**].
11. Accessories:

    a. Damper: Opposed blade, spring closing, and with NRTL listed fusible link for **160 deg F (71 deg C)**.
    b. [**Front**][**Rear**]-blade gang operator.
    c. Filter.

B. Grilles - Fixed-Blade Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**A-J Manufacturing Co., Inc**]
    b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    c. [**Carnes Company**]
    d. [**Dayus Register & Grille Inc.**]
    e. [**Hart & Cooley, LLC**]
    f. [**Kees, Inc**]
    g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
    h. [**METALAIRE, Inc**]
    i. [**Nailor Industries Inc**]
    j. [**Price Industries Limited**]
    k. [**Raymon Company**]
    l. [**Shoemaker Mfg. Co.**]
    m. [**Titus; brand of Johnson Controls International plc, Global Products**]
    n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
    o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Dayus Register & Grille Inc.**]
e. [**Hart & Cooley, LLC**]
f. [**Kees, Inc**]
g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
h. [**METALAIRE, Inc**]
i. [**Nailor Industries Inc**]
j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

3. Material: [**Steel**][**Aluminum**][**Stainless steel**].
4. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**]<**Insert finish**>.
5. Face-Blade Arrangement: Fixed-face blade position, [**horizontally**][**vertically**] spaced [**3/4 inch (19 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> apart.
6. Core Construction: [**Integral**][**Removable**].
7. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**]<**Insert dimension**> wide.
8. Filter-Mounting Frame: <**Insert frame size and style**>.
9. Mounting: [**Countersunk screw**][**Concealed**][**Lay in**].
10. Accessory: Filter.

C. Grilles - Linear Bar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Dayus Register & Grille Inc.**]
e. [**Hart & Cooley, LLC**]
f. [**Kees, Inc**]
g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
h. [**METALAIRE, Inc**]
i. [**Nailor Industries Inc**]
j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Dayus Register & Grille Inc.**]
e. [**Hart & Cooley, LLC**]
f. [**Kees, Inc**]
g. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
h. [**METALAIRE, Inc**]
i. [**Nailor Industries Inc**]
j. [**Price Industries Limited**]
k. [**Raymon Company**]
l. [**Shoemaker Mfg. Co.**]
m. [**Titus; brand of Johnson Controls International plc, Global Products**]
n. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
o. <**Insert manufacturer's name**>

3. Material: [**Steel**][**Stainless steel**][**Aluminum**].
4. Finish: [**Baked enamel, white**][**Clear anodized**][**Baked enamel, color selected by Architect**]<**Insert finish**>.
5. Face-Blade Arrangement:

   a. Blade width: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]
   b. Blade spacing; [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**7/16 inch (11 mm)**].
   c. Fixed [**0**][**15**][**30**]-degree discharge angle.

6. Core Construction: [**Integral**][**Removable**].
7. Distribution plenum.

   a. Internal insulation.
   b. Inlet damper.

8. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**]<**Insert dimension**> wide.
9. Filter-Mounting Frame: <**Insert frame size and style**>.
10. Some manufacturers can supply a filter-mounting frame on a limited number of grille dimensions. Verify with manufacturer before specifying.
11. Mounting: [**Countersunk screw**][**Concealed**][**Lay in**].
12. Damper Type: Adjustable opposed blade.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF REGISTERS AND GRILLES

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13 00

Task	Specification	Specification Description
23 37 13 00	23 31 16 23	Fabric Air-Distribution Devices

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SECTION 23 37 13 13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling diffusers - round face.
2. Ceiling diffusers - rectangular and square face.
3. Diffusers - perforated face.
4. Diffusers - louver face.
5. Diffusers - linear bar.
6. Diffusers - ceiling-integral plenum slot.
7. Diffusers - ceiling-linear continuous slot.
8. Diffusers - light troffer.
9. Diffusers - induction underfloor air-distribution, round.
10. Diffuser plenums - linear underfloor air-distribution.
11. Diffusers - drum louvers, high capacity.
12. Diffusers - modular-core grille, high capacity.
13. Diffusers - HEPA, laminar flow, filtered.
14. Diffusers - jet nozzle and punkah.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.
4. Section 233716 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source Quality Control Reports: For air diffusers.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS - ROUND FACE

A. Ceiling Diffuser - Round Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
b. [**Carnes Company**]
c. [**Hart & Cooley, LLC**]
d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
e. [**METALAIRE, Inc**]
f. [**Nailor Industries Inc**]
g. [**Price Industries Limited**]
h. [**Shoemaker Mfg. Co.**]
i. [**Titus; brand of Johnson Controls International plc, Global Products**]
j. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Round ceiling diffuser with duct collar and a series of conical curved blades to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**][**Aluminum**][**Stainless steel**] .
5. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Anodized aluminum**].
6. Face Style: [**Four**][**Three**][**Two**] cone.
7. Mounting: [**Ceiling**][**Duct**] .
8. Pattern: [**Fixed**][**Adjustable**] .
9. Dampers: [**Radial opposed blade**][**Butterfly**][**Combination damper and grid**] .
10. Accessories:

a. Equalizing grid.
b. Plaster ring.
c. Safety chain.
d. Wire guard.

e. Sectorizing baffles.
f. Manual remote balancing damper operator.

g. UL 555C fire-rated assembly, including fire damper and insulating blanket.

2.2 CEILING DIFFUSERS - RECTANGULAR AND SQUARE FACE

A. Ceiling Diffuser - Rectangular and Square :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Hart & Cooley, LLC**]
e. [**Kees, Inc**]
f. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
g. [**METALAIRE, Inc**]
h. [**Nailor Industries Inc**]
i. [**Price Industries Limited**]
j. [**Raymon Company**]
k. [**Shoemaker Mfg. Co.**]
l. [**Titus; brand of Johnson Controls International plc, Global Products**]
m. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: [**Square**][**Rectangular**] ceiling diffuser with round or rectangular duct collar and a series of curved louvers to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**][**Aluminum**][**Stainless steel**] .
5. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Anodized aluminum**].
6. Face Size: [**24 by 24 inches (600 by 600 mm)**][**20 by 20 inches (500 by 500 mm)**][**12 by 12 inches (300 by 300 mm)**].
7. Face Style: [**Three cone**][**Four cone**][**Plaque**] .
8. Mounting: [**Surface**][**T-bar**][**Snap in**][**Spline**][**Mounting panel**] .
9. Pattern: [**Fixed**][**Two position**][**Adjustable**] .
10. Dampers: [**Radial opposed blade**][**Butterfly**][**Combination damper and grid**] .
11. Accessories:

a. Equalizing grid.
b. Plaster ring.
c. Safety chain.
d. Wire guard.
e. Sectorizing baffles.
f. Manual remote balancing damper operator.

g. UL 5555C fire-rated assembly, including fire damper and insulating blanket.

2.3 DIFFUSERS - PERFORATED FACE

A. Diffuser - Perforated Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**A-J Manufacturing Co., Inc**]
    b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    c. [**Carnes Company**]
    d. [**Kees, Inc**]
    e. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
    f. [**METALAIRE, Inc**]
    g. [**Nailor Industries Inc**]
    h. [**Price Industries Limited**]
    i. [**Raymon Company**]
    j. [**Shoemaker Mfg. Co.**]
    k. [**Titus; brand of Johnson Controls International plc, Global Products**]
    l. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
    m. [**Warren Technology**]

2. Description: Square ceiling diffuser with duct collar and perforated face plate.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel backpan and pattern controllers, with [**steel**][**aluminum**] face.
5. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Anodized aluminum**].
6. Face Size: [**12 by 12 inches (300 by 300 mm)**][**24 by 12 inches (600 by 300 mm)**][**36 by 12 inches (900 by 300 mm)**][**48 by 12 inches (1200 by 300 mm)**][**16 by 16 inches (400 by 400 mm)**][**20 by 20 inches (500 by 500 mm)**][**24 by 24 inches (600 by 600 mm)**][**36 by 24 inches (900 by 600 mm)**][**48 by 24 inches (1200 by 600 mm)**].
7. Duct Inlet: [**Round**][**Square**] .
8. Face Style: [**Flush**][**Drop extended**] .
9. Mounting: [**Surface**][**T-bar**][**Snap in**][**Spline**][**Mounting panel**] .
10. Pattern Controller: [**Four louvered deflector patches**][**Fixed with curved blades at inlet**][**Adjustable with louvered pattern modules at inlet**][**None**] .
11. Dampers: [**Opposed blade**][**Radial opposed blade**][**Butterfly**][**Combination damper and grid**] .
12. Accessories:

    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Manual remote balancing damper operator.

    g. UL 555C fire-rated assembly, including fire damper and insulating blanket.

2.4 DIFFUSERS - LOUVER FACE

A. Diffuser - Louver Face :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Hart & Cooley, LLC**]
e. [**Kees, Inc**]
f. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
g. [**METALAIRE, Inc**]
h. [**Nailor Industries Inc**]
i. [**Price Industries Limited**]
j. [**Raymon Company**]
k. [**Shoemaker Mfg. Co.**]
l. [**Titus; brand of Johnson Controls International plc, Global Products**]
m. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Square diffuser with outer border, duct collar, and curved face louvers to direct air discharge in one, two, three, or four directions, parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**][**Aluminum**][**Stainless steel**] .
5. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**][**Anodized aluminum**].
6. Mounting: [**Surface**][**Surface with beveled frame**][**T-bar**][**Snap in**][**Spline**][**Mounting panel**] .
7. Pattern: [**One-way**][**Two-way**][**Two-way corner**][**Three-way**][**Four-way**][**Adjustable**] core style [**as indicated on the Drawings**] .
8. Dampers: [**Radial opposed blade**][**Butterfly**][**Combination damper and grid**] .
9. Accessories:

a. Square to round neck adaptor.
b. Adjustable pattern vanes.
c. Throw reducing vanes.
d. Equalizing grid.
e. Plaster ring.
f. Safety chain.
g. Wire guard.
h. Sectorizing baffles.
i. Manual remote balancing damper operator.

j. UL 555C fire-rated assembly including fire damper and insulating blanket.

2.5 DIFFUSERS - LINEAR BAR

A. Diffuser - Linear Bar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
b. [**Carnes Company**]
c. [**Dayus Register & Grille Inc.**]
d. [**Hart & Cooley, LLC**]
e. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
f. [**METALAIRE, Inc**]

g. [**Nailor Industries Inc**]
h. [**Price Industries Limited**]
i. [**Raymon Company**]
j. [**Titus; brand of Johnson Controls International plc, Global Products**]
k. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Frame with multiple fixed or adjustable vanes or blades to deflect supply air direction. Frame width and length are as indicated [**on Drawings**][**in Specifications**] .
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**][**Aluminum**][**Stainless steel**] .
5. Finish: [**Baked enamel, white**][**Baked enamel, color selected by Architect**] .

6. Narrow Core Spacing Arrangement: **1/8-inch- (3-mm-)** thick blades spaced **1/4 inch (6 mm)** apart; [**zero**][**15**] -degree deflection.
7. Wide Core Spacing Arrangement:

   a. **1/8-inch- (3-mm-)** thick blades spaced **1/2 inch (13 mm)** apart; [**zero**][**15**] -degree deflection.
   b. **3/16-inch- (5-mm-)** thick blades spaced **1/2 inch (13 mm)** apart; [**zero**][**15**][**30**] -degree deflection.

8. Pencil-Proof Core Spacing Arrangement: **3/16-inch- (5-mm-)** thick blades spaced **7/16 inch (11 mm)** apart; [**zero**][**15**][**30**] -degree deflection.
9. Deflection Vanes:

   a. One-Way Deflection Vanes: Extruded construction; [**fixed**][**adjustable**] louvers with removable core.
   b. Two-Way Deflection Vanes: Extruded construction; [**fixed**][**adjustable**] louvers with removable core.

10. Frame: [**1-1/4 inches (32 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**][**1/2 inch (13 mm)**][**3/16 inch (5 mm)**] wide.

11. Mounting Frame: [**Filter**].
12. Mounting: [**Countersunk screw**][**Concealed bracket**][**Spring clip**] .
13. Damper Type: [**Adjustable opposed-blade assembly**][**Hinged single blade**] .
14. Accessories: [**Plaster frame**][**Directional vanes**][**Alignment pins**][**Core clips**][**Blank-off strips**] .

2.6 DIFFUSERS - CEILING-INTEGRAL PLENUM SLOT

A. Diffuser - Ceiling-Integral Plenum Slot :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   b. [**Carnes Company**]
   c. [**Hart & Cooley, LLC**]
   d. [**Kees, Inc**]
   e. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   f. [**METALAIRE, Inc**]

g. [**Nailor Industries Inc**]
h. [**Price Industries Limited**]
i. [**Raymon Company**]
j. [**Shoemaker Mfg. Co.**]
k. [**Titus; brand of Johnson Controls International plc, Global Products**]
l. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Diffuser assembly with integral pattern controller, one or more linear discharge slots, and an integral plenum and duct collar. Assembly is to be installed in modular T-bar ceilings.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material:

a. Face: [**Steel**][**Aluminum**] .
b. Pattern Controller and Tees: Aluminum.
c. Plenum: Steel [**internally insulated**][**uninsulated**] .

d. Plenum Insulation: Comply with UL 181.

5. Finish:

a. Face and Plenum: [**Baked enamel**].
b. Pattern Controller: [**Baked enamel, black**].
c. Tees: [**Baked enamel, white**][**Baked enamel, color selected by Architect**].

6. Slot Width: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] .
7. Number of Slots: [**One**][**Two**][**Three**][**Four**].
8. Length: [**24 inches (600 mm)**][**30 inches (750 mm)**][**36 inches (900 mm)**][**48 inches (1200 mm)**][**60 inches (1500 mm)**] .
9. Accessories: [**Plaster frame**][**T-bar slot**][**Center notch**][**T-bar on inlet side**][**T-bar on both sides**][**T-bar clip on one side**][**T-bar clips on both sides**] .

10. Fire-Rated Construction: Integral fire damper and fire-rated assembly listing from UL on its "Product iQ" website tested in accordance with UL 263 and complying with NFPA 90A requirements.

2.7 DIFFUSERS - CEILING-LINEAR CONTINUOUS SLOT

A. Diffuser - Ceiling-Linear Continuous Slot :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
b. [**Carnes Company**]
c. [**Dayus Register & Grille Inc.**]
d. [**Hart & Cooley, LLC**]
e. [**Kees, Inc**]
f. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
g. [**METALAIRE, Inc**]
h. [**Nailor Industries Inc**]
i. [**Price Industries Limited**]
j. [**Raymon Company**]
k. [**Shoemaker Mfg. Co.**]

l. [**Titus; brand of Johnson Controls International plc, Global Products**]
m. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Linear diffuser assembly with continuous slots; adjustable vane in each slot to direct airflow in required direction.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Slot Width: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**] .

5. Section Length: [**12 ft. (3.7 m)**].
6. Straight and curved sections as required to accommodate layout.

7. Mitered tees and corners.
8. Pattern control vanes.
9. Material: Aluminum, extruded, heavy wall.
10. Finishes:

    a. Exterior: Standard white.
    b. Interior: Standard black.

11. Throw: [**Horizontal**][**Vertical**] .
12. Mounting: [**Ceiling**][**Sidewall**] .
13. Plenum: [**Noninsulated**][**Insulated**] .
14. Other Features: Blank-offs.

2.8 DIFFUSERS - LIGHT TROFFER

A. Diffuser - Light Troffer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**METALAIRE, Inc**]
    b. [**Price Industries Limited**]
    c. [**Raymon Company**]

2. Description: Combined plenum, inlet, and attachment device for an air-handling light fixture. Unit is to be custom designed to fit light fixtures provided under Section 265000 "Lighting."
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel [**with external insulation**] .
5. Finish: [**None**][**Black enamel on visible surfaces**].
6. Slot Width: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**] .
7. Slot Location: [**One side**][**Two sides**] .
8. Length: [**24 inches (600 mm)**][**36 inches (900 mm)**][**48 inches (1200 mm)**] .
9. Pattern: [**Fixed**][**Adjustable**] .
10. Inlet: [**Top**][**Side**] .
11. Inlet Size: [**5 inches (125 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**] .

2.9 DIFFUSERS - INDUCTION UNDERFLOOR AIR-DISTRIBUTION, ROUND

A. Diffuser - Induction Underfloor Air Distribution, Round :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Nailor Industries Inc**]
    b. [**Price Industries Limited**]
    c. [**Tate Global**]
    d. [**Titus; brand of Johnson Controls International plc, Global Products**]

2. Description: Round face, with openings arranged in a radial pattern to promote a high degree of room air entrainment. Unit is suitable for floor, wall, or ceiling mounting.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Airflow Principle: Swirl-pattern induction.
5. Material: [**High-impact polycarbonate plastic, resistant to cart and foot traffic; tested in accordance with NFPA 90B and UL 94.**][**Cast aluminum, resistant to cart and foot traffic; tested and approved in accordance with NFPA 90B and UL 2043.**]
6. Air-Flow Adjustment: [**Manual**][**Automatic, for connection to building automatic control system**][**Automatic, for control by local space thermostat**] .
7. Color: [**Gray**][**Black**] .
8. Components:

    a. Diffuser core.
    b. Flow regulator.
    c. Dirt and liquid catch pan.
    d. Spacer flange.
    e. Gasketed, underfloor compression ring.

2.10 DIFFUSER PLENUMS - LINEAR UNDERFLOOR AIR-DISTRIBUTION

A. Diffuser Plenum - Linear Underfloor Air Distribution :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
    b. [**Carnes Company**]
    c. [**Hart & Cooley, LLC**]
    d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
    e. [**METALAIRE, Inc**]
    f. [**Nailor Industries Inc**]
    g. [**Price Industries Limited**]
    h. [**Titus; brand of Johnson Controls International plc, Global Products**]

2. Description: Frame with multiple fixed vanes or blades to deflect supply air direction and provide substantial surface for foot traffic.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**][**Aluminum**] .
5. Finish: White baked acrylic.
6. Deflection: [**Zero**][**15**] degrees.
7. Components:

    a. Aluminum diffuser core.

b. Diffuser frame.
c. Plenum, **0.034-inch (0.85-mm)** steel.

2.11 DIFFUSERS - DRUM LOUVERS, HIGH CAPACITY

A. Diffuser - Drum Louver, High Capacity :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**A-J Manufacturing Co., Inc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**Hart & Cooley, LLC**]
   e. [**Kees, Inc**]
   f. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   g. [**METALAIRE, Inc**]
   h. [**Nailor Industries Inc**]
   i. [**Price Industries Limited**]
   j. [**Raymon Company**]
   k. [**Titus; brand of Johnson Controls International plc, Global Products**]
   l. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: High-capacity supply air outlet with adjustable blades for horizontal jet or diffused air patterns and rotatable cylindrical drum for vertical directional control.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Airflow Principle: Extended distance for high airflow rates.
5. Material: [**Aluminum**][**Stainless steel**] , heavy gauge extruded.
6. Finish: White baked acrylic.
7. Border: **1-1/4-inch (32-mm)** width with countersunk screw holes.
8. Gasket between drum and border.
9. Body: Drum shaped; adjustable vertically.
10. Blades: Individually adjustable horizontally.
11. Mounting: Surface to [**duct**][**wall**] .
12. Inlet Width: [**6 inches (150 mm)**][**10 inches (250 mm)**][**12 inches (300 mm)**][**15 inches (380 mm)**].
13. Inlet Length: [**12 inches (300 mm)**][**24 inches (600 mm)**][**36 inches (900 mm)**][**60 inches (1500 mm)**].
14. Accessories:

    a. Opposed-blade steel damper.
    b. Duct-mounting collars with countersunk screw holes.

2.12 DIFFUSERS - MODULAR-CORE GRILLE, HIGH CAPACITY

A. Diffuser - Modular-Core Grille, High Capacity :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Hart & Cooley, LLC**]
e. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
f. [**METALAIRE, Inc**]
g. [**Nailor Industries Inc**]
h. [**Price Industries Limited**]
i. [**Shoemaker Mfg. Co.**]
j. [**Titus; brand of Johnson Controls International plc, Global Products**]
k. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: [**Square**][**Rectangular**] ceiling diffuser with round or rectangular duct collar and multiple modular cores that can each be adjusted to deflect airflow in required direction. Each core is to have a series of curved louvers to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Throw: As scheduled on the Drawings.
5. Material: Steel.
6. Grille Core Modules per Unit: [**One**][**Two**][**Three**][**Four**] .
7. Finish: White baked acrylic.
8. Border: **1-1/2-inch (38-mm)** width.
9. Modules: Removable; rotatable.
10. Mounting: Surface.
11. Accessory: Opposed-blade steel damper.

2.13 DIFFUSERS - HEPA, LAMINAR FLOW, FILTERED

A. Diffuser - HEPA, Laminar Flow, Filtered :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Kees, Inc**]
e. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
f. [**METALAIRE, Inc**]
g. [**Nailor Industries Inc**]
h. [**Shoemaker Mfg. Co.**]
i. [**Titus; brand of Johnson Controls International plc, Global Products**]
j. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Standards:

a. Comply with IEST-RP-CC001.7.
b. Comply with IEST-RP-CC034.4.
c. Comply with UL 586.

5. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with separators.

a. Media-to-Frame Side Bond: Urethane or polyurethane sealant.
b. Frame-to-Grid Bond: [**gasket**][**knife edge for gel-filled channel**] .
c. Application: [**Class 100,000 (ISO 8)**][**Class 10,000 (ISO 7)**][**Class 1,000 (ISO 6)**][**Class 100 (ISO 5)**][**Class 10 (ISO 4)**] clean room.

6. Casing:

a. Configuration: [**Ducted**][**Plenum**] inlet.
b. Module Material: [**Minimum 16-gauge (0.508-mm) extruded aluminum**] with [**mill**] finish.
c. Suspension: [**Ceiling grid**][**Independent**] .

7. Accessories:

a. Diffusion Damper: [**Fixed**][**Adjustable**] .
b. Diffusion-damper adjustment port.
c. Filter test port.

2.14 DIFFUSERS - JET NOZZLE AND PUNKAH

A. Diffuser - Jet Nozzle and Punkah :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Kees, Inc**]
b. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
c. [**METALAIRE, Inc**]
d. [**Nailor Industries Inc**]
e. [**Price Industries Limited**]
f. [**Shoemaker Mfg. Co.**]
g. [**Titus; brand of Johnson Controls International plc, Global Products**]
h. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]

2. Description: High-velocity, high-capacity round nozzle with provision to adjust air-discharge direction in both horizontal and vertical plane.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Style: [**Jet nozzle**][**Punkah**] .
5. Throw: As scheduled.
6. Material: [**Steel**][**Aluminum**] .
7. Nozzles per Unit: [**One**][**Two**][**Three**][**Four**] .
8. Finish: White baked acrylic.
9. Border: **1-1/2-inch (38-mm)** width with countersunk screw holes.

10. Blades:

a. Concentric rings adjustable both horizontally and vertically.
b. Set in modules.

11. Nozzle:

a. Round inner nozzle and round outer frame.
b. Manually adjustable discharge direction without use of tools.

12. Modules: Removable; rotatable.
13. Mounting: Surface.
14. Accessory: Steel volume control damper.

2.15 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DIFFUSERS

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13 13

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Task	Specification	Specification Description
23 37 13 13	23 33 00 00	Air Duct Accessories
23 37 13 13	23 37 13 00	Registers and Grilles
23 37 13 13	23 31 16 23	Fabric Air-Distribution Devices

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SECTION 23 37 13 43 - SECURITY REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Security registers.
2. Security grilles.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.
3. Section 233713.23 "Registers and Grilles" for registers and grilles.
4. Section 233716 "Fabric Air-Distribution Devices" for continuous tubular diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, mounting details, and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For security registers and grilles with factory-applied color finishes.

C. Samples for Verification: For security registers and grilles, in manufacturer's standard sizes to verify color selected.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Source quality control reports.

PART 2 - PRODUCTS

2.1 SECURITY REGISTERS

A. Security Register :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
e. [**Nailor Industries Inc**]
f. [**Price Industries Limited**]
g. [**Titus; brand of Johnson Controls International plc, Global Products**]
h. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A-J Manufacturing Co., Inc**]
b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
c. [**Carnes Company**]
d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
e. [**Nailor Industries Inc**]
f. [**Price Industries Limited**]
g. [**Titus; brand of Johnson Controls International plc, Global Products**]
h. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
i. <**Insert manufacturer's name**>

3. Security Level: [**Maximum**][**Medium**][**Minimum**][**and suicide deterrent**]. Comply with requirements of National Institute of Corrections.
4. Application: [**Ducted supply**][**Ducted return**][**Air transfer**][**Barrier**].
5. Material: [**Steel**][**Stainless Steel**][**Aluminum**].
6. Material Thickness: [**0.19 inch (4.8 mm)**]<**Insert dimension**>.
7. Finish: [**Unfinished**][**Baked enamel, white**][**Baked enamel, color selected by Architect**]<**Insert finish**>.
8. Face Arrangement:

a. Shape: [**Square**][**Rectangular**][**Round**].
b. Design: [**Fixed bar**][**Perforated**][**Lattice**].
c. Frame: [**Yes**][**No**].
d. Deflection: [**Zero**][**38**]<**Insert angle**>degrees.
e. Core: [**None**][**Louvered**].
f. **3/16-inch- (5-mm-)** thick, front lattice plate with **2-by-2-inch- (50-by-50-mm-)** square holes and **1-inch (25-mm)** frets, **0.135-inch (3.43-mm)** wire mesh, and **1/4-inch- (6-mm-)** thick backer plate.
g. **3/16-inch- (5-mm-)** thick, perforated faceplate with **5/16-inch- (8-mm-)** diameter holes spaced **7/16 inch (11 mm)** o.c., staggered at 60 degrees.
h. **1-1/2-inch (38-mm)** bars and mandrel tubes and rods with [**zero**][**15**]-degree deflection in **1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm)** angle border.
i. **1-3/8-inch (35-mm)** bars and double mandrel tubes with [**zero**][**15**]-degree deflection in **1-3/4-inch (45-mm)** angle border.

9. Damper Operation: [**None**][**Face operated**][**Rear operated**].
10. Damper Type: [**Multi-shutter**][**Adjustable opposed blade**][**NRTL listed, opposed blade, spring closing, and with fusible link for 160 deg F (71 deg C)**].

11. Wall Sleeve: [**3/16 inch (5 mm) welded to face**][**1/8 inch (3 mm) welded to face**]<**Insert length**>sleeve length;[**mechanically fastened to border**].
12. Mounting: [**1-by-1-by-3/16-inch (25-by-25-by-5-mm) retaining angle frame**][**1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) retaining angle frame**][**1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) cast-in-place frame and tamperproof machine screws**].

2.2 SECURITY GRILLES

A. Security Grille :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A-J Manufacturing Co., Inc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   e. [**Nailor Industries Inc**]
   f. [**Price Industries Limited**]
   g. [**Titus; brand of Johnson Controls International plc, Global Products**]
   h. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A-J Manufacturing Co., Inc**]
   b. [**Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.**]
   c. [**Carnes Company**]
   d. [**Krueger-HVAC; brand of Johnson Controls International plc, Global Products**]
   e. [**Nailor Industries Inc**]
   f. [**Price Industries Limited**]
   g. [**Titus; brand of Johnson Controls International plc, Global Products**]
   h. [**Tuttle & Bailey; brand of Johnson Controls International plc, Global Products**]
   i. <**Insert manufacturer's name**>

3. Security Level: [**Maximum**][**Medium**][**Minimum**][**and suicide deterrent**]. Comply with requirements of National Institute of Corrections.
4. Application: [**Ducted supply**][**Ducted return**][**Air transfer**][**Barrier**].
5. Material: [**Steel**][**Stainless Steel**][**Aluminum**].
6. Material Thickness: [**0.19 inch (4.8 mm)**]<**Insert dimension**>.
7. Finish: [**Unfinished**][**Baked enamel, white**][**Baked enamel, color selected by Architect**]<**Insert finish**>.
8. Face Arrangement:

   a. Shape: [**Square**][**Rectangular**][**Round**].
   b. Design: [**Fixed bar**][**Perforated**][**Lattice**].
   c. Frame: [**Yes**][**No**].
   d. Deflection: [**Zero**][**38**]<**Insert angle**>degrees.
   e. Core: [**None**][**Louvered**].
   f. **3/16-inch- (5-mm-)** thick, front lattice plate with **2-by-2-inch- (50-by-50-mm-)** square holes and **1-inch (25-mm)** frets, **0.135-inch (3.43-mm)** wire mesh, and **1/4-inch- (6-mm-)** thick

backer plate.

g. 3/16-inch- (5-mm-) thick perforated faceplate with 5/16-inch- (8-mm-) diameter holes spaced 7/16 inch (11 mm) o.c., staggered at 60 degrees.

h. 1-1/2-inch (38-mm) bars and mandrel tubes and rods with [**zero**][**15**]-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) angle border.

i. 1-3/8-inch (35-mm) bars and double mandrel tubes with [**zero**][**15**]-degree deflection in 1-3/4-inch (45-mm) angle border.

9. Wall Sleeve: [3/16 inch (5 mm) **welded to face**][1/8 inch (3 mm) **welded to face**]<**Insert sleeve length**> sleeve length; [**mechanically fastened to border**].

10. Mounting: [1-by-1-by-3/16-inch (25-by-25-by-5-mm) **retaining angle frame**][1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) **retaining angle frame**][1-1/4-by-1-1/4-by-3/16-inch (32-by-32-by-5-mm) **cast-in-place frame and tamperproof machine screws**].

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where security registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECURITY REGISTERS AND GRILLES

A. Install security registers and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features, lighting fixtures, sprinklers, or other items conflict with installation, coordinate with other trades and notify Architect for a determination of final location.

C. Install security registers and grilles with airtight connections to ducts.

D. Provide access to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust security registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13 43

Task	Specification	Specification Description
23 37 13 43	23 33 00 00	Air Duct Accessories
23 37 13 43	23 37 13 00	Registers and Grilles
23 37 13 43	23 31 16 23	Fabric Air-Distribution Devices

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SECTION 23 37 23 00 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Hooded ventilators.
3. Goosenecks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

G. Delegated Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

B. Seismic Qualification Data: Certificates for ventilators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and

describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ventilators.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads, Indicated on Drawings: Determine loads based on pressures as indicated on Drawings.
2. Wind Loads, Basis: Determine loads based on a uniform pressure of [**20 (960)**][**30 (1440)**]<**Insert design wind pressure**> **lbf/sq. ft. (Pa)**, acting inward or outward.
3. Wind Loads, Indicated Below: Determine loads based on pressures indicated below:

   a. Corner Zone: Within <**Insert distance**> of building corners, uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
   b. Other Than Corner Zone: Uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.

4. See [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**] for wind-load requirements.
5. Snow Load: Unit to withstand a minimum of [**20- (960-)**]<**Insert design snow load pressure**> **lbf/sq. ft. (Pa)**snow load.

C. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range):

a. Ambient: [**120 (67)**]<**Insert temperature**> **deg F (deg C)**.
b. Material Surfaces: [**180 (100)**]<**Insert temperature**> **deg F (deg C)**.

G. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

H. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Type: [**Louvered penthouse**][**Hooded penthouse**][**Gooseneck**].
3. Height: <**Insert number**> **inches (mm)**.
4. Width: <**Insert number**> **inches (mm)**.
5. Depth: <**Insert number**> **inches (mm)**.
6. Air Flow: <**Insert number**> **cfm (L/s)**.
7. Maximum Air Pressure Drop: Not more than [**0.10- (25-)**]<**Insert pressure**> **inch wg (Pa)** static pressure drop.
8. Maximum Free Area Velocity: [**600 (3.0)**][**700 (3.6)**][**800 (4.1)**]<**Insert velocity**> **fpm (m/s)**.
9. Function: [**Intake**][**Relief**].

2.2 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 LOUVERED-PENTHOUSE VENTILATORS

A. Description: Multitier rectangular louvered penthouse for [**intake**][**relief**] air.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aire Technologies, Inc.; DMI Companies**]
3. [**Arrow United Industries; Mestek, Inc.**]
4. [**Carnes Company**]
5. [**Greenheck Fan Corporation**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**PennBarry; division of Air System Components**]
9. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
10. [**Safe Air - Dowco**]
11. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Aire Technologies, Inc.; DMI Companies**]
3. [**Arrow United Industries; Mestek, Inc.**]
4. [**Carnes Company**]
5. [**Greenheck Fan Corporation**]
6. [**JencoFan**]
7. [**Loren Cook Company**]
8. [**PennBarry; division of Air System Components**]
9. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
10. [**Safe Air - Dowco**]
11. <**Insert manufacturer's name**>

D. Source Limitations: Obtain louvered-penthouse ventilators from single manufacturer.

E. Construction:

1. Material: All-welded assembly with [**4-inch (100-mm)**][**6-inch (150-mm)**]-deep louvers, mitered corners, and [**aluminum**][**galvanized-steel**] sheet roof.
2. Frame and Blade Material, Extruded Aluminum: Thickness required to comply with structural performance requirements, but not less than [**0.080 (2.0)**]<**Insert value**> **inch (mm)** for frames and [**0.080 (2.0)**][**0.060 (1.5)**]<**Insert value**> **inch (mm)**for blades[**with condensate deflectors**].
3. Frame and Blade Material, Galvanized-Steel Sheet: Thickness required to comply with structural performance requirements, but not less than [**0.052 (1.3)**]<**Insert value**> **inch (mm)** for frames and [**0.040 (1.0)**][**0.052 (1.3)**][**0.064 (1.6)**]<**Insert value**> **inch (mm)** for blades[**with condensate deflectors**].
4. Insulation: [**None**][**Mineral-fiber insulation and vapor barrier**].
5. Wind-Driven Rain Performance: Not less than [**99**][**95**][**80**]<**Insert number**> percent effectiveness when subjected to a rainfall rate of [**3 inches (75 mm)** **per hour and a wind speed of 29 (13 m/s)**]<**Insert value**> **mph (m/s)** at a free-area intake velocity of [**300 (1.5)**][**400 (2.0)**][**500 (2.5)**]<**Insert velocity**> **fpm (m/s)**.
6. Exterior Corners: Prefabricated corner units with [**mitered and welded blades**][**mitered blades with concealed close-fitting splices**] and with [**fully recessed**][**semirecessed**] mullions at

corners.

7. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh or flattened, expanded aluminum, 3/4-inch- (19-mm-) diamond mesh wire**]<**Insert type**>.
8. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh wire**]<**Insert type**>.
9. Galvanized-Steel Sheet Finish:

   a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
   b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
   c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and an overall minimum dry film thickness of **2 mils (0.05 mm)**.

      1) Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Dampers:

1. Location: [**Penthouse neck**][**Inside louver face**][**Curb damper tray**].
2. Control: [**Manual**][**Motorized**][**Gravity backdraft**].
3. Tray: Provide damper tray or shelf with opening [**3 (76)**]<**Insert dimension**> **inches (mm)** [**less than interior curb dimensions indicated**][**of size indicated**].

G. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.
2. Overall Height: [**12 inches (300 mm)**][**36 inches (915 mm)**].

2.4 HOODED VENTILATORS

A. Description: Hooded [**rectangular**][**round**] penthouse for [**intake**][**relief**] air.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Carnes Company**]
3. [**Greenheck Fan Corporation**]
4. [**JencoFan**]
5. [**Loren Cook Company**]
6. [**PennBarry; division of Air System Components**]
7. [**Safe Air - Dowco**]
8. [**Twin City Fan & Blower**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Acme Engineering & Manufacturing Corp.**]
2. [**Carnes Company**]
3. [**Greenheck Fan Corporation**]
4. [**JencoFan**]
5. [**Loren Cook Company**]
6. [**PennBarry; division of Air System Components**]
7. [**Safe Air - Dowco**]
8. [**Twin City Fan & Blower**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain hooded ventilators from single manufacturer.

E. Construction:

1. Material, Galvanized Steel: Thickness required to comply with structural performance requirements, but not less than **0.064-inch- (1.62 mm-)** thick base and **0.040-inch- (1.0-mm-)** thick hood; suitably reinforced.
2. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than **0.063-inch- (1.6-mm-)** thick base and **0.050-inch- (1.27-mm-)** thick hood; suitably reinforced.
3. Insulation: [**None**][**Mineral-fiber insulation and vapor barrier**].
4. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh or flattened, expanded aluminum, 3/4-inch (19-mm) diamond mesh wire**]<**Insert type**>.
5. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh wire**]<**Insert type**>.

F. Galvanized-Steel Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and an overall minimum dry film thickness of **2 mils (0.05 mm)**.

    a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Dampers:

1. Location: [**Hood neck**][**Curb damper tray**].
2. Control: [**Manual**][**Motorized**][**Gravity backdraft**].
3. Tray: Provide damper tray or shelf with opening [**3 (76)**]<**Insert dimension**> **inches (mm)** [**less than interior curb dimensions indicated**][**of size indicated**].

H. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.

2. Overall Height: [**12 inches (300 mm)**][**36 inches (900 mm)**].

2.5 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of **0.052-inch- (1.3-mm-)** thick, galvanized-steel sheet.

B. Bird Screening: [**Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire**][**Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire**][**Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick**]<**Insert type**>.

C. Insect Screening: [**Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm)**]<**Insert type**>.

D. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat and an overall minimum dry film thickness of **2 mils (0.05 mm)**.

a. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; **1-1/2-inch- (40-mm-)** thick, rigid fiberglass insulation adhered to inside walls; and **1-1/2-inch (40-mm)** wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: [**Self-flashing without a cant strip, with**][**Built-in cant and**][**Built-in raised cant and**] mounting flange.
2. Overall Height: [**12 inches (300 mm)**][**36 inches (900 mm)**].

2.6 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.7 MATERIALS

A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A666, Type 304, with No. [**4**][**6**] finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise

indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use [**Phillips flat**][**hex-head or Phillips pan**]-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware [**, that comply with the wind and seismic fastening requirements**]. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."

C. Install goosenecks on curb base where throat size exceeds [**9 by 9 inches (230 by 230 mm)**]<**Insert measurement**>.

D. Install gravity ventilators with clearances for service and maintenance.

E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

G. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

J. Refer to Section 077200 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 37 23 00

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Task	Specification	Specification Description
23 37 23 00	23 31 16 23	Fabric Air-Distribution Devices
23 37 23 13	23 31 16 23	Fabric Air-Distribution Devices
23 37 23 13	23 37 23 00	HVAC Gravity Ventilators

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SECTION 23 38 13 00 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial-kitchen hoods, Type I.
2. Commercial-kitchen hoods, Type II.

B. Related Requirements:

1. Section 233533 "Listed Kitchen Ventilation System Exhaust Ducts" for fire-rated ducts connecting to kitchen hoods.

1.2 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

D. Type II Hood: A hood designed for heat and steam removal and for other nongrease applications.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Required Attendance:

a. <**Insert personnel by title**>.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Standard hoods.
2. Filters/baffles.
3. Fire-suppression systems.
4. Luminaires.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Shop Drawing Scale: [**1/4 inch = 1 foot (1:50)**]<**Insert scale**>.
2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct

connection sizes, and attachments to other work.
3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
5. Show water-supply and drain piping connections.
6. Show control cabinets.
7. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
8. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
9. Design Calculations: Calculate requirements for selecting seismic restraints.
10. Include diagrams for power, signal, and control wiring.
11. Duct Connections: Detail connections between ducts and hoods, including access doors and panels.
12. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

    a. Piping Diagram Scale: [**1/4 inch = 1 foot (1:50)**]<**Insert scale**>.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Coordination Drawing Scale: [**1/4 inch = 1 foot (1:50)**]<**Insert scale**>.
2. Suspended ceiling assembly components.
3. Structural members to which equipment will be attached.
4. Roof framing and support members for duct penetrations.
5. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Moldings on hoods and accessory equipment.
    g. <**Insert item**>.

B. Welding certificates.

C. Seismic Qualification Data: Submit certification that commercial-kitchen hoods, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Grease Filters/Baffles: [**One**]<**Insert number**> complete set(s).

1.7 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A666, Type 304.

1. Minimum Thickness: [**0.037 inch (0.94 mm)**][**0.050 inch (1.3 mm)**]<**Insert dimension**>.
2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.

   a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.

3. Concealed Stainless-Steel Surfaces: ASTM A480/A480M, No. 2B finish (bright, cold-rolled, unpolished finish).
4. Exposed Surfaces: [**ASTM A480/A480M, No. 2B finish (bright, cold-rolled, unpolished)**][**ASTM A480/A480M, No. 3 finish (intermediate polished surface)**][**ASTM A480/A480M, No. 4 finish (directional satin)**][**ASTM A480/A480M, No. 6 finish (dull satin)**][**ASTM A480/A480M, No. 7 finish (reflective, directional polish)**][**ASTM A480/A480M, No. 8 finish (mirrorlike reflective, nondirectional polish)**].
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Carbon-Steel Sheets: ASTM A1008/A1008M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.

1. Minimum Thickness: [**0.043 inch (1.09 mm)**][**0.0478 inch (1.2 mm)**]<**Insert dimension**>.

C. Galvanized-Steel Sheet: Lock-forming quality; ASTM A653/A653M, **G90 (Z275)** coating designation.

1. Minimum Thickness: [**0.052 inch (1.32 mm)**]<**Insert dimension**>.

D. Zinc-Coated Steel Shapes: ASTM A36/A36M, zinc coated according to ASTM A123/A123M requirements.

E. Sealant: ASTM C920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial-kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

F. Sound Dampening: NSF-certified, non-absorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum **1/8-inch (3-mm)** thickness that does not chip, flake, or blister.

G. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.3 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A780/A780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets unless otherwise indicated.

J. Fabricate seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."

K. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

L. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on [**one**][**two**][**three**][**four**][**all exposed**] side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
2. Wall Offset Spacer: Minimum of **3 inches (75 mm)**.
3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," with minimum **0.0625-inch- (1.58-mm-)** thick, stainless-steel shelf tops.

2.4 EXHAUST HOOD FABRICATION, TYPE I HOOD

A. Exhaust Hood Fabricators, Type I Hood:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CaptiveAire Systems**]
b. [**Carrier Global Corporation**]
c. [**Duke Manufacturing Company**]
d. [**Gaylord Industries, Inc**]
e. [**Giles Enterprises, Inc**]
f. [**Grease Master**]
g. [**Greenheck Fan Corporation**]
h. [**Halton Company**]
i. [**LCSystems, Inc.**]
j. [**Sturdi-Bilt Restaurant Equipment**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CaptiveAire Systems**]
b. [**Carrier Global Corporation**]
c. [**Duke Manufacturing Company**]

d. [**Gaylord Industries, Inc**]
e. [**Giles Enterprises, Inc**]
f. [**Grease Master**]
g. [**Greenheck Fan Corporation**]
h. [**Halton Company**]
i. [**LCSystems, Inc.**]
j. [**Sturdi-Bilt Restaurant Equipment**]
k. **<Insert manufacturer's name>**

B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.

1. Fabricate hoods according to NSF 2, "Food Equipment."
2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
3. Hoods shall be designed, fabricated, and installed according to NFPA 96.
4. Include access panels as required for access to fire dampers and fusible links.
5. Duct Collars: Minimum **0.0598-inch- (1.5-mm-)** thick steel at least **3 inches (75 mm)** long, continuously welded to top of hood and at corners.[**Fabricate a collar with a 0.5-inch- (13-mm-) wide duct flange.**]
6. Duct-Collar Fire Dampers: Collar and damper shall comply with UL 710 testing and listing required for the entire hood.

   a. Collar: Minimum **0.0598-inch- (1.5-mm-)** thick stainless steel, at least **3 inches (75 mm)** long, continuously welded to top of hood and at corners.[**Fabricate a collar with a minimum 0.5-inch- (13-mm-) wide duct flange.**]
   b. Blades: Minimum **0.1046-inch- (2.7-mm-)** thick stainless steel, counterbalanced to remain closed after actuation.
   c. Blade Pivot and Spring: Stainless steel.
   d. Fusible Link: Replaceable, **212 deg F (100 deg C)** rated.

7. Makeup Air Fire Dampers: Labeled, according to UL 555, by a testing agency acceptable to authorities having jurisdiction.

   a. Fire Rating: 1-1/2 hours.
   b. Frame: SMACNA [**Type A**][**Type B**], with blades in airstream; fabricated with roll-formed, [**galvanized**][**stainless**] steel; with mitered and interlocking corners.
   c. Blades: Roll-formed, interlocking or folded, minimum **0.034-inch- (0.86-mm-)** thick, galvanized-steel sheet.
   d. Horizontal Dampers: Include a blade lock and stainless-steel closure spring.
   e. Fusible Link: Replaceable, [**165 deg F (74 deg C)**][**212 deg F (100 deg C)**] rated.

C. Hood Configuration: Exhaust [**only**][**and makeup air**].

1. Makeup air shall be introduced by [**induction**][**combination of induction and diffusion**] inside canopy. If makeup air is not heated, insulate interior of makeup air plenum with high-density insulation having maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Makeup air shall be introduced through [**front**][**and**][**bottom**] of canopy through [**perforated diffusers**][**supply-air registers with adjustable guide vanes**].
3. Makeup air shall be introduced through laminar-flow-type, perforated metal panels on front of hood canopy.
4. Makeup air shall be introduced through laminar-flow-type, perforated metal diffusers mounted in the ceiling in front of hood canopy. Furnish laminar-flow-type diffusers with baked [**white**]**<Insert color>** enamel finish and volume-control dampers.

5. Makeup air shall be introduced through plenum at rear of hood, extending down below appliance cooking surfaces.

D. Hood Style: [**Wall-mounted canopy**][**Single-island canopy**][**Double-island canopy**][**Back shelf**][**Eyebrow**][**Pass over**].

E. Filters/Baffles: Removable, [**stainless-steel**][**aluminum**][**, with spring-loaded fastening**]. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Safety for Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

F. Removable Water-Wash Grease Extractor: Stainless steel, tested with hood according to UL 710.

G. Stationary Water-Wash Grease Extractor: Integral, automatically self-cleaning, spraying hot water and detergent over the entire length of exhaust plenum. Fabricate to supply **140 deg F (60 deg C)** water at **1.25 gpm/ft. (0.26 L/s per m)** of hood length, at **40- to 60-psig (276- to 414-kPa)** inlet pressure.

1. Water Piping: ASTM A270/A270M, Type 304 stainless steel.
2. Fabricate to drain water and detergent to a collection trough having stainless-steel drain fittings.
3. Single, [**hood**][**wall**]-mounting control panel with a solid-state, programmable controller shall control all hoods on Project. Wash cycle shall be factory set to operate for 10 minutes after fans stop.
4. Detergent shall be supplied by an adjustable-flow, 120-V ac injection pump from a reservoir with a minimum capacity of **2.5 gal. (9.5 L)**.

H. Water-mist option shall supply a maximum of **0.1 gpm/ft. (0.02 L/s per m)** of hood length through stainless-steel piping and nozzles.

1. Water Piping: ASTM A270/A270M, Type 304 stainless steel.

I. Luminaires: [**Recessed**][**Surface-mounted**], [**LED**][**fluorescent**][**incandescent**] luminaires and lamps with lenses sealed vapor tight. Wiring shall be in conduit on hood exterior. Number and location of luminaires shall provide a minimum of **70 fc (753 lx)** at **30 inches (762 mm)** above finished floor.

1. Light switches shall be mounted [**on front panel of hood canopy**][**on wall adjacent to hood**][**in hood control panel**].
2. Luminaires: [**LED**][**Fluorescent**][**Incandescent**] complying with UL 1598.

J. Comply with hood control requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

K. Hood Controls: [**Hood**][**Wall**]-mounting control cabinet, [**factory wired to control groups of adjacent hoods, and**]fabricated of stainless steel.

1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. [**Interlock exhaust fan with makeup air supply fan to operate simultaneously.**]Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation.

   a. Exhaust Fan Motor Starter: [**Comply with Section 262913.03 "Manual and Magnetic Motor Controllers."**][**Fan Motor Starter: Comply with Section 262913.06 "Soft-Start Motor Controllers."**]

2. Exhaust Fan Interlock: Factory wire the exhaust fan starters in a single control cabinet for adjacent hoods to operate together.
3. Photocell and Temperature Control, Cycling: Cycle makeup air and exhaust-air fans on and off,

based on temperature at hood discharge and opacity of smoke in hood. Interlock fan control with fire-suppression system to operate during fire-suppression-agent release and to remain in operation until manually stopped. Provide air-purge fan and conduit to photocell and reflector to avoid grease accumulation that will negatively affect performance of system.

4. Photocell and Temperature Control, Two Speed: Change speed (off, low, and high) of makeup air and exhaust-air fans with speed switch, based on temperature at hood discharge and opacity of smoke in hood. Interlock fan control with fire-suppression system to operate at high speed during fire-suppression-agent release and to remain in high-speed operation until manually stopped. Provide air-purge fan and conduit to photocell and reflector to avoid grease accumulation that will negatively affect performance of system. Controller shall limit exhaust-duct velocity between <**Insert minimum velocity**> and <**Insert maximum velocity**>. Controller shall limit supply quantity to <**Insert minimum quantity**> for proper operation of makeup air unit.
5. Photocell and Temperature Control, Variable Speed: Vary speed of makeup air and exhaust-air fans with variable-frequency controllers, based on temperature at hood discharge and opacity of smoke in hood. Interlock fan control with fire-suppression system to operate at high speed during fire-suppression-agent release and to remain in high-speed operation until manually stopped. Provide air-purge fan and conduit to photocell and reflector to avoid grease accumulation that will negatively affect performance of system. Controller shall limit exhaust-duct velocity between <**Insert minimum velocity**> and <**Insert maximum velocity**>. Controller shall limit supply quantity to <**Insert minimum quantity**> for proper operation of makeup air unit.
6. High-Temperature Control: Alarm shall sound and cooking equipment shall shut down before hood discharge temperature rises to actuation temperature of fire-suppression system.
7. Water-Wash Timer: [**24-hour clock**][**365-day, programmable timer**] shall control sequential wash of multiple hood sections.
8. Water Mist: Solenoid valve interlocked with exhaust fan to open with hood operation.

L. Capacities and Characteristics:

1. Nominal Hood Length: <**Insert inches (mm)**>.
2. Nominal Hood Width: <**Insert inches (mm)**>.
3. Canopy Height: <**Insert inches (mm)**>.
4. Exhaust Airflow: <**Insert cfm (L/s)**>.
5. Exhaust-Air Pressure Loss: <**Insert inches wg (kPa)**>.
6. Makeup Air Airflow: <**Insert cfm (L/s)**>.
7. Makeup Air Pressure Loss: <**Insert inches wg (kPa)**>.
8. Water-Supply Connection: <**Insert NPS (DN)**>.
9. Washdown Water Flow: <**Insert gpm (L/s)**>.
10. Minimum Water Pressure: <**Insert psig (kPa)**>.
11. Mist Water Flow: <**Insert gpm (L/s)**>.
12. Sanitary Drain Connection: <**Insert NPS (DN)**>.

2.5 EXHAUST HOOD FABRICATION, TYPE II HOOD

A. Exhaust Hood Fabricators, Type II Hood:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CaptiveAire Systems**]
   b. [**Carrier Global Corporation**]
   c. [**Duke Manufacturing Company**]
   d. [**Gaylord Industries, Inc**]

e. [**Giles Enterprises, Inc**]
f. [**Grease Master**]
g. [**Greenheck Fan Corporation**]
h. [**Halton Company**]
i. [**LCSystems, Inc.**]
j. [**Sturdi-Bilt Restaurant Equipment**]
k. [**Vent Master**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CaptiveAire Systems**]
b. [**Carrier Global Corporation**]
c. [**Duke Manufacturing Company**]
d. [**Gaylord Industries, Inc**]
e. [**Giles Enterprises, Inc**]
f. [**Grease Master**]
g. [**Greenheck Fan Corporation**]
h. [**Halton Company**]
i. [**LCSystems, Inc.**]
j. [**Sturdi-Bilt Restaurant Equipment**]
k. [**Vent Master**]
l. <**Insert manufacturer's name**>

B. Fabricate hoods according to NSF 2, "Food Equipment."

C. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible."

D. Hood Configuration: Exhaust [**only**][**and makeup air**].

1. Makeup air shall be introduced by [**induction**][**combination of induction and diffusion**] inside canopy. If makeup air is not heated, insulate interior of makeup air plenum with high-density insulation having maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Makeup air shall be introduced through [**front**][**and**][**bottom**] of canopy through supply-air registers.
3. Makeup air shall be introduced through laminar-flow-type, perforated metal panels on front of hood canopy.
4. Makeup air shall be introduced through plenum at rear of hood, extending down below appliance cooking surfaces.

E. Hood Type: [**Heat and vapor**][**Condensate**] removal.

F. Hood Style: [**Wall-mounted canopy**][**Single-island canopy**][**Double-island canopy**][**Back shelf**][**Eyebrow**][**Pass over**].

G. Condensate Hood Baffles: Removable, stainless-steel baffles to drain into a hood drain trough, and stainless-steel drain piping.

H. Luminaires: [**Recessed**][**Surface-mounted**], [**LED**][**fluorescent**][**incandescent**] luminaires and lamps with lenses sealed vapor tight. Wiring shall be installed in stainless-steel conduit on hood exterior. Number and location of luminaires shall provide a minimum of **70 fc (753 lx)** at **30 inches (762 mm)** above finished floor.

1. Light switches shall be mounted [**on front panel of hood canopy**][**on wall adjacent to hood**][**in hood control panel**].
2. Luminaires: [**LED**][**Fluorescent**][**Incandescent**] complying with UL 1598.

I. Capacities and Characteristics:

1. Nominal Hood Length: <**Insert inches (mm)**>.
2. Nominal Hood Width: <**Insert inches (mm)**>.
3. Canopy Height: <**Insert inches (mm)**>.
4. Exhaust Airflow: <**Insert cfm (L/s)**>.
5. Exhaust-Air Pressure Loss: <**Insert inches wg (kPa)**>.
6. Makeup Air Airflow: <**Insert cfm (L/s)**>.
7. Makeup Air Pressure Loss: <**Insert inches wg (kPa)**>.

2.6 FIRE-SUPPRESSION SYSTEM, WET CHEMICAL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Badger Fire Protection; a Carrier company**]
3. [**Kidde; Carrier Global Corporation**]
4. [**Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
2. [**Badger Fire Protection; a Carrier company**]
3. [**Kidde; Carrier Global Corporation**]
4. [**Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

C. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, **NPS 2 (DN 50)** and Smaller: ASTM A53/A53M, Type S, Grade A, Schedule 40, plain ends.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on [**hood**][**or**][**wall**]. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
5. Furnish electric-operated gas shutoff valve; see [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**]
6. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.

7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Coordinate equipment layout and installation with adjacent Work, including luminaires, HVAC equipment, plumbing, and fire-suppression system components.

B. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in "General Hood Fabrication Requirements" Article.

C. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

D. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners unless otherwise indicated.

F. Install hoods to operate free from vibration.

G. Install seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."

H. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at **48 inches (1200 mm)** o.c. maximum.

I. Install sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

J. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

K. Set initial temperatures, and calibrate sensors.

L. Set field-adjustable switches.

3.3 CONNECTIONS

A. Where installing piping adjacent to hoods, allow space for service and maintenance.

B. Install reduced-pressure backflow preventer on washer-water supply. Backflow preventer is specified in Section 221119 "Domestic Water Piping Specialties."

C. Install washer-water drain piping full size of hood connection to an adjacent floor drain or a floor sink.

D. Makeup Water Connection: Comply with applicable requirements for valves and accessories on piping connections to water-cooled units in Section 221119 "Domestic Water Piping Specialties."

E. Connect ducts according to requirements in Section 233300 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.

F. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

D. Commercial-kitchen hoods will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain commercial-kitchen hoods.

END OF SECTION 23 38 13 00

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Task	Specification	Specification Description
23 38 13 13	23 38 13 00	Commercial-Kitchen Hoods
23 38 13 16	11 40 00 00	Foodservice Equipment
23 38 13 16	23 31 13 00	Metal Ducts
23 38 13 16	23 37 23 00	HVAC Gravity Ventilators
23 38 13 16	23 38 13 00	Commercial-Kitchen Hoods

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SECTION 23 41 00 00 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal panel filters.
2. Flat panel filters.
3. Pleated panel filters.
4. Ring panel filters.
5. Nonsupported bag filters.
6. Supported bag filters.
7. Rigid cell box filters.
8. V-bank cell filters.
9. Self-supported pocket filters.
10. Bulk media.
11. Front- or back-access filter frames.
12. Side-access filter housings.
13. Filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for particulate air filters.
2. Section 233400 " HVAC Fans" for customized fan and filter units.
3. Section 234133 "High-Efficiency Particulate Air Filtration" for HEPA filters used in combination with particulate air filters.
4. Section 234300 "Electronic Air Cleaners" for electronic units combined with particulate filters as part of a system.

1.2 DEFINITIONS

A. HIPS: High-impact polystyrene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.

2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each filter, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.
2. Provide [**one**]<**Insert number**> container(s) of red oil for inclined manometer filter gauge.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove

just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with NFPA 90A and NFPA 90B.

D. Comply with UL 900.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 METAL PANEL FILTERS

A. Description: Factory-fabricated, self-supported, cleanable, all-metal, impingement-type, panel-type, permanent air filters with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. System Airflow: <**Insert number**> **cfm (L/s)**.
6. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
7. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
8. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
9. Access: [**Front**][**Back**][**Side**].

F. Media: Minimum of [**three**][**four**]<**Insert number**> alternate layers of [**galvanized-steel**][**aluminum**][**stainless steel**] flat and herringbone or serpentine-crimp mesh screen.

1. Non-oiled for grease removal application.
2. Adhesive coating.

G. Filter-Media Frame: [**Galvanized steel**][**Hot-dip galvanized steel**][**Aluminum**][**Stainless steel**], hinged, and with pull and retaining handles fastened to the media.

1. Drain holes.

H. Efficiency: Minimum [**90**]<**Insert number**> percent efficiency on particles [**10**]<**Insert number**> microns and larger.

2.3 FLAT PANEL FILTERS

A. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Columbus Industries, Inc**]
3. [**Flanders Corporation**]
4. [**Glasfloss Industries**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]

7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Columbus Industries, Inc**]
3. [**Flanders Corporation**]
4. [**Glasfloss Industries**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: [**4 inches (100 mm)**]<**Insert dimension**> nominal.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. System Airflow: <**Insert number**> **cfm (L/s)**.
6. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
7. Initial Resistance: [**0.45-inch wg (112 Pa)**]<**Insert value**> at [**500 fpm (2.5 m/s)**]<**Insert value**>.
8. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value and Average Arrestance: MERV [**4**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" and "Average Arrestance" according to ASHRAE 52.2.
10. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: [**Interlaced glass or**][**Cotton and**] synthetic fibers coated with nonflammable adhesive.

1. Media shall be coated with an antimicrobial agent.
2. Metal Retainer: Upstream side and downstream side.

G. Filter-Media Frame: [**Cardboard with perforated metal retainer**][**Galvanized steel with metal grid on outlet side and steel rod grid on inlet side, hinged, with pull and retaining handles**] sealed or bonded to the media.

2.4 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AAF International**]
3. [**Air-Nu**]

4. [**Camfil Farr Inc.**]
5. [**Columbus Industries, Inc**]
6. [**Filtration Group**]
7. [**Flanders Corporation**]
8. [**Glasfloss Industries**]
9. [**Koch Filter Corporation**]
10. [**Parker Hannifin Corporation; HVAC Filtration Division**]
11. [**Tri-Dim Filter Corporation**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AAF International**]
3. [**Air-Nu**]
4. [**Camfil Farr Inc.**]
5. [**Columbus Industries, Inc**]
6. [**Filtration Group**]
7. [**Flanders Corporation**]
8. [**Glasfloss Industries**]
9. [**Koch Filter Corporation**]
10. [**Parker Hannifin Corporation; HVAC Filtration Division**]
11. [**Tri-Dim Filter Corporation**]
12. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**> nominal.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. System Airflow: <**Insert number**> **cfm (L/s)**.
6. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
7. Initial Resistance: [**0.25-inch wg (62 Pa)**][**0.35-inch wg (87.2 Pa)**][**0.45-inch wg (112 Pa)**][**0.60-inch wg (150 Pa)**]<**Insert value**> at [**350 fpm (1.8 m/s)**][**500 fpm (2.5 m/s)**]<**Insert value**>.
8. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value: MERV [**6**][**13**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
10. Access: [**Front**][**Back**][**Side**].

F. Media: [**Interlaced glass or**][**Cotton and**] synthetic fibers coated with nonflammable adhesive.[**Coat media with an antimicrobial agent.**]

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Welded-wire grid shall be on downstream side to maintain pleat.
3. Media shall be bonded to frame to prevent air bypass.
4. Support members on upstream and downstream sides to maintain pleat spacing.

G. Filter-Media Frame: [**Cardboard frame with perforated metal retainer**][**Galvanized steel**][**Aluminized steel**][**with metal grid on outlet side and steel rod grid on inlet side, hinged, with pull and retaining handles**] sealed or bonded to the media.

2.5 RING PANEL FILTERS

A. Description: Internally supported, flat panel filters for installation in a filter track.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Columbus Industries, Inc**]
2. [**Filtration Group**]
3. [**Flanders Corporation**]
4. [**Glasfloss Industries**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Columbus Industries, Inc**]
2. [**Filtration Group**]
3. [**Flanders Corporation**]
4. [**Glasfloss Industries**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: <**Insert number**> **inches (mm)**.
3. Depth: [**1-1/2 inches (38 mm)**][**1-3/4 inches (44 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. System Airflow: <**Insert number**> **cfm (L/s)**.
6. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
7. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
8. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
10. Access: Side.
11. Media: [**Two**][**Three**][**Four**]<**Insert number**>-ply polyester with sealed edges.[**Coat with antimicrobial agent.**]
12. Panel Construction: [**Single**][**with one edge unsealed for support removal**][**Linked**].

F. Internal Support: 9-gauge steel-wire frame.

2.6 NONSUPPORTED BAG FILTERS

A. Description: Factory-fabricated, dry, extended-surface, nonsupported filters with header frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Filtration Group**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Filtration Group**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: [**12 inches (300 mm)**][**22 inches (550 mm)**][**30 inches (750 mm)**]<**Insert dimension**>.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Minimum Efficiency Reporting Value: MERV [**11**][**13**][**15**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: [**Glass-fiber**][**Synthetic**] material constructed so individual pockets are maintained in tapered form under rated-airflow conditions by flexible internal supports.[**Coat media with an antimicrobial agent.**]

G. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

2.7 SUPPORTED BAG FILTERS

A. Description: Factory-fabricated, dry, extended surface, self-supported filters with holding frames in steel, basket-type retainer, internal metal grid retainer, or self-supporting media pockets.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Filtration Group**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Filtration Group**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: [**12 inches (300 mm)**][**22 inches (550 mm)**][**30 inches (750 mm)**]<**Insert dimension**>.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Minimum Efficiency Reporting Value: MERV [**11**][**13**][**15**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.[**Coat media with an antimicrobial agent.**]

G. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

2.8 RIGID CELL BOX FILTERS

A. Description: Factory-fabricated, [**adhesive-coated,**]disposable, packaged air filters with media perpendicular to airflow, and with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air-Nu**]
2. [**Camfil Farr Inc.**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Flanders Corporation**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air-Nu**]
2. [**Camfil Farr Inc.**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Flanders Corporation**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Minimum Efficiency Reporting Value: MERV [**9**][**11**][**13**][**14**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.[**Coat media with antimicrobial agent**].

G. Filter-Media Frames: [**Galvanized steel**]<**Insert material**>.

2.9 V-BANK CELL FILTERS

A. Description: Factory-fabricated, [**adhesive-coated,**]disposable, packaged air filters with media angled to airflow, and with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AAF International**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Flanders Corporation**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AAF International**]
3. [**Camfil Farr Inc.**]
4. [**Columbus Industries, Inc**]
5. [**Flanders Corporation**]
6. [**Glasfloss Industries**]
7. [**Koch Filter Corporation**]
8. [**Parker Hannifin Corporation; HVAC Filtration Division**]
9. [**Tri-Dim Filter Corporation**]
10. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
5. Number of Filters, Wide by High: <**Insert number wide by number high**>.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Minimum Efficiency Reporting Value: MERV [**11**][**13**][**14**][**15**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: Fibrous material constructed so individual mini-pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.[**Coat media with an antimicrobial agent.**]

G. Filter-Media Frames: [**HIPS**]<**Insert material**>.

2.10 SELF-SUPPORTED POCKET FILTERS

A. Description: Factory-fabricated, panel-type, disposable air filters with contoured, self-supported media for extended surface.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Columbus Industries, Inc**]
3. [**Filtration Group**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Columbus Industries, Inc**]
3. [**Filtration Group**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Number of Filters, Wide by High: <**Insert number wide by number high**>.
5. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Minimum Efficiency Reporting Value: MERV [**6**][**8**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
11. Access: [**Front**][**Back**][**Side**].

F. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.[**Coat media with an antimicrobial agent.**]

G. Configuration: [**Single-pocket cube**][**Multipocket**].

H. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

2.11 BULK MEDIA

A. Description: Air-filter media, factory custom cut or rolled.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Glasfloss Industries**]
6. [**Koch Filter Corporation**]
7. [**Parker Hannifin Corporation; HVAC Filtration Division**]
8. [**Tri-Dim Filter Corporation**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Columbus Industries, Inc**]
4. [**Filtration Group**]
5. [**Glasfloss Industries**]
6. [**Koch Filter Corporation**]
7. [**Parker Hannifin Corporation; HVAC Filtration Division**]
8. [**Tri-Dim Filter Corporation**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Capacities and Characteristics:

1. Thickness: <**Insert number**> **inches (mm)**.
2. System Airflow: <**Insert number**> **cfm (L/s)**.
3. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
4. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
5. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.

   a. Minimum Efficiency Reporting Value and Average Arrestance: MERV [**4**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" and "Average Arrestance" according to ASHRAE 52.2.

6. Minimum Efficiency Reporting Value: MERV [**6**][**8**]<**Insert value**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

F. Media: [**Spun glass**][**Synthetic**][**Polyester**], [**in a roll**][**cut into pads**].

1. Pad Dimensions: <**Insert number**> **inches (mm)** by <**Insert number**> **inches (mm)**.

2.12 FRONT- OR BACK-ACCESS FILTER FRAMES

A. Description: [**Galvanized-steel**][**Aluminum**] framing members with access for either upstream (front) or downstream (back) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with filter installation or operation.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Flanders Corporation**]
3. [**Koch Filter Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Flanders Corporation**]
3. [**Koch Filter Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Prefilters: Incorporate a separate track[**with spring clips**], removable from front[**or back**].

F. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.13 SIDE-ACCESS FILTER HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of [**galvanized steel**][**aluminum**], with flanges to connect to duct or casing system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Prefilters: Integral tracks to accommodate [**2-inch- (50-mm-)**]<**Insert dimension**> thick, disposable [**or washable**]filters.

F. Access Doors: [**Hinged, with continuous**][**Continuous**] gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

G. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.14 FILTER GAUGES

A. Diaphragm-type gauge with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

D. Source Limitations: Obtain from single source from single manufacturer.

E. Diameter: [**4-1/2 inches (115 mm)**][**2 inches (50 mm)**].

F. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: **0- to 0.5-inch wg (0 to 125 Pa)**.

G. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: **0- to 1.0-inch wg (0 to 250 Pa)**.

H. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: **0- to 2.0-inch wg (0 to 500 Pa)**.

I. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: **0- to 3.0-inch wg (0 to 750 Pa)**.

J. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: **0- to 4.0-inch wg (0 to 1000 Pa)**.

K. Manometer-Type Filter Gauge: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from **0- to 3.0-inch wg (0 to 750 Pa)**, and accurate within 3 percent of the full-scale range.

L. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gauge for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Coordinate filter installations with duct and air-handling-unit installations.

3.3 INSTALLATION OF FILTER GAUGES

A. Install filter gauge for each filter bank.

B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Test for leakage of unfiltered air while system is operating.

E. Air filter will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00 00

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Task	Specification	Specification Description
23 41 13 00	23 41 00 00	Particulate Air Filtration
23 41 13 00	23 42 00 00	Gas-Phase Air Filtration
23 41 13 00	23 43 00 00	Electronic Air Cleaners
23 41 16 00	23 41 00 00	Particulate Air Filtration
23 41 16 00	23 43 00 00	Electronic Air Cleaners
23 41 19 00	23 41 00 00	Particulate Air Filtration
23 41 19 00	23 43 00 00	Electronic Air Cleaners

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SECTION 23 41 33 00 - HIGH-EFFICIENCY PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HEPA rigid-cell box filters.
2. HEPA V-bank cell filters.
3. HEPA filter diffusers.
4. HEPA filter fan modules.
5. ULPA filters.
6. 95 percent DOP filters.
7. HEPA/ULPA filter holding frames.
8. Side-access HEPA/ULPA filter housings.
9. Side-access HEPA/ULPA filter containment housings.
10. HEPA, ULPA, and 95 percent DOP filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for HEPA filters.
2. Section 234100 "Particulate Air Filtration" for particulate-air filters used in combination with HEPA filters.

1.2 DEFINITIONS

A. DOP: Dioctyl phthalate.

B. HEPA: High-efficiency particulate air.

C. PAO: Poly-alpha-olefin.

D. PSL: Polystyrene latex.

E. ULPA: Ultralow penetration air.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air filters.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
3. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each filter, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE 62.1 Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."

C. Comply with NFPA 90A and NFPA 90B.

D. Comply with UL 900.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.

F. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert designation**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**][**12 by 24 inches (300 by 600 mm)**]<**Insert dimensions**>.
3. Depth: <**Insert number**> **inches (mm)** nominal.
4. Surface Area: <**Insert number**> **sq. ft. (sq. m)**.
5. Number of Filters, Wide by High: <**Insert number wide by number high**>.
6. System Airflow: <**Insert number**> **cfm (L/s)**.
7. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
8. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
9. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
10. Access: [**Front**][**Back**][**Side**].
11. Performance Level: [**99.97 percent HEPA**][**99.9997 percent ULPA**][**95 percent DOP**]<**Insert requirement**>.

2.2 HEPA RIGID-CELL BOX FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Flanders Corporation**]
5. [**Glasfloss Industries**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Air-Nu**]
3. [**Camfil Farr Inc.**]
4. [**Flanders Corporation**]
5. [**Glasfloss Industries**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**Upstream**][**and**][**downstream**].

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**]<**Insert material**>.
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.3 HEPA V-BANK CELL FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, disposable, packaged air filters with media at an angle to airflow and with holding frames.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert sealant**>.

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**]<**Insert material**>.
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.4 HEPA FILTER DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Flanders Corporation**]
5. [**Microzone Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Flanders Corporation**]
5. [**Microzone Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with separators.

1. Media to Frame Side Bond: Urethane or polyurethane sealant.
2. Frame to Grid Bond: <**Insert type of gasket**>[**gasket**][**Knife edge for gel-filled channel**].
3. Application: [**Class 100,000 (ISO 8)**][**Class 10,000 (ISO 7)**][**Class 1,000 (ISO 6)**][**Class 100 (ISO 5)**][**Class 10 (ISO 4)**]<**Insert class**> clean room.

G. Casing:

1. Configuration: [**Ducted**][**Plenum**] inlet.
2. Module Material: [**Minimum 16-gauge (0.508-mm) extruded aluminum**]<**Insert gauge and material**> with [**mill**]<**Insert type**> finish.
3. Suspension: [**Ceiling grid**][**Independent**].

H. Accessories:

1. [**Fixed**][**Adjustable**] diffusion damper.
2. Diffusion-damper adjustment port.
3. Filter test port.

2.5 HEPA FILTER FAN MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Microzone Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Envirco**]
4. [**Microzone Corporation**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated, HEPA filter ceiling module with fan.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

F. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with separators.

1. Frame Material: [**Aluminum**]<**Insert material**>.
2. Media to Frame Side Bond: Urethane or polyurethane sealant.
3. Frame to Grid Bond: <**Insert type of gasket**>[**gasket**][**Knife edge for gel-filled channel**].
4. Application: [**Class 100,000 (ISO 8)**][**Class 10,000 (ISO 7)**][**Class 1,000 (ISO 6)**][**Class 100 (ISO 5)**][**Class 10 (ISO 4)**]<**Insert class**> clean room.
5. Faceguard: [**Stainless steel**]<**Insert material**>.

G. Casing:

1. Configuration: [**Ducted inlet**][**Plenum inlet**][**Plenum inlet with MERV 8 prefilter**].
2. Module Material: [**Minimum 16-gauge (0.508-mm) extruded aluminum**]<**Insert gauge and material**> with [**mill**]<**Insert type**> finish.
3. Suspension: [**Ceiling grid**][**Independent**].

H. Accessories: Filter test port.

I. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**].
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: <**Insert type**>.
5. Enclosure Materials: <**Insert type**>.
6. Motor Bearings: <**Insert special requirements**>.
7. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert number**>**deg F (deg C)**.
   b. Altitude: <**Insert number**> **feet (m)** above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

8. Efficiency: Premium efficient.
9. NEMA Design: <**Insert designation**>.
10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Multispeed**][**with variable-speed control**].
12. Electrical Characteristics:

a. Horsepower: <**Insert number**> hp.
b. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
c. Phase: [**Single**][**Three**].
d. Hertz: 60 Hz.
e. Full-Load Amperes: <**Insert number**> A.
f. Minimum Circuit Ampacity: <**Insert number**> A.
g. Maximum Overcurrent Protection: <**Insert number**> A.

2.6 ULPA FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-fabricated ULPA filters with holding casing.

E. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC007.3.
4. Comply with IEST-RP-CC034.4.

F. Media: Fibrous material, constructed of continuous sheets with closely spaced pleats that are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**upstream**][**and**][**downstream**].

G. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Silicone Gel**][**Urethane Gel**]<**Insert material**>.

3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.7 95 PERCENT DOP FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain filters from single source from single manufacturer.

D. Description: Factory-fabricated, 95 percent DOP filters with holding casing.

E. Media: Fibrous material, constructed of continuous sheets with closely spaced pleats that are maintained under rated-airflow conditions.

1. Internal Separators: [**None**][**Corrugated aluminum**]<**Insert type**>.
2. Media to Filter Frame Seal Material: [**Polyurethane**]<**Insert material**>.
3. Faceguard Material: [**Aluminum**][**Stainless steel**]<**Insert material**>.
4. Faceguard Location: [**None**][**Upstream**][**Downstream**].

F. Filter-Media Frames:

1. Material: [**Fire-retardant plywood**][**Aluminum**][**Fire-retardant particleboard**][**Galvanized steel**][**Non-fire-retardant particleboard**]<**Insert material**>.
2. Filter Frame to Mounting Frame Seal Material: [**Neoprene**][**Knife edge in silicone gel-filled channel**][**Knife edge in urethane gel-filled channel**].
3. Filter Frame to Mounting Frame Seal Location: [**Upstream**][**Downstream**].
4. Style: [**Box**][**Gel track**]<**Insert style**>.

2.8 HEPA/ULPA FILTER HOLDING FRAMES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]

4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. **<Insert manufacturer's name>**

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Framing members with access for upstream (front) or downstream (back) filter servicing, cut to size and prepunched for assembly into modules, specifically designed for HEPA/ULPA/95 percent DOP filter banks.

E. Material: Minimum **14-gauge (1.9-mm)** [**stainless-**][**or**][**galvanized-**]steel framing members. Factory-prepunched holes and dimples for ease of filter alignment and assembly.

F. Prefilters: Incorporate a separate holding frame for prefilter, removable from front or back.

G. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter latching mechanism to seat each filter firmly against holding frame surface.

H. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

2.9 SIDE-ACCESS HEPA/ULPA FILTER HOUSINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. **<Insert manufacturer's name>**

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-assembled, side-access filter housings, specifically designed for HEPA/ULPA/95 percent DOP filter banks, with flanges to connect to duct or casing system.

E. Factory Testing: Factory pressure test housing and sealed joints at [**6.0-inch wg (1500 Pa)**]<**Insert value**>. Document and submit to confirm maximum <**Insert percentage**> leakage.

F. Materials: [**Galvanized steel**]<**Insert material**>[**double-wall casing with 1-inch (25-mm) insulation**][**double-wall casing with 2-inch (50-mm) insulation**].

1. Pressure taps and fittings.
2. DOP test ports.
3. Mounted magnehelic gauges.

G. Prefilters: Integral tracks to accommodate [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**]<**Insert dimension**> thick, disposable [**or washable**]filters.

H. Access Doors: [**Hinged, with continuous**][**Continuous**] gaskets on perimeter and positive-locking devices. Arranged for filter access from [**one-side**][**both-sides**] access door.

I. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter latching mechanism to seat each filter firmly against side-access housing channel surface.

J. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

2.10 SIDE-ACCESS HEPA/ULPA FILTER CONTAINMENT HOUSINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Factory-assembled, side-access housings, with bag in/bag out feature to protect maintenance personnel from coming into direct contact with the interior of the housing and the contaminated filter media during required filter change out, with flanges to connect to duct or casing system.

E. Standards: Test according to ASME AG-1.

F. Casing:

1. Material: Constructed of minimum **16-gauge- (1.5-mm-)** thick, [**galvanized steel**][**stainless steel**][**, double-wall casing with 2-inch (50-mm) fiberglass insulation,**] to hold filters. Side servicing through gasketed access doors on one side. Equip housings to be capable of connection to other housings. Equip housings with metal slide channel tracks and locking mechanisms to hold filters, and the following:

   a. Pressure gauge tap and fitting.
   b. DOP test ports.
   c. Lifting lugs.

2. Casing Pressure: Casing constructed for up to [**positive/negative 6.0-inch wg (1500 Pa)**][**positive/negative 10-inch wg (2500 Pa)**]<**Insert casing pressure requirement**>.

G. Isolation Dampers:

1. Material: Stainless-steel body, blade, and flanges.
2. Round Damper Blade: <**Insert diameter**> damper, replaceable, solid silicone gasket sandwiched between stainless-steel plates, providing silicone gasket blade to knife edge seal.

   a. Bubble-tight seal at minimum **10-inch wg (2490-Pa)** differential pressure to comply with ASME N509.

H. Prefilters: Integral tracks to accommodate [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable filters.

I. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Provide ribbed bagging rim behind access door and PVC bags for bag-in, bag-out arrangement. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:

1. Combination prefilter and HEPA filter.
2. HEPA filter.
3. Upstream and downstream test section.

J. Gasketed Sealing: Factory-installed, positive-sealing device for each filter to ensure seal between gasketed filter elements to prevent bypass of unfiltered air. Filter locking mechanism to seat each filter firmly against side-access housing channel surface.

K. Knife-Edge Sealing: Knife-edge to mate with [**HEPA**][**and**][**ULPA**] filter elements to prevent bypass of unfiltered air. Factory-installed, positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

L. Accessories:

1. Filter change-out trays.
2. Document-storage pocket.
3. Filter removal rod.

2.11 HEPA, ULPA, AND 95 PERCENT DOP FILTER GAUGES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Ashcroft Inc**]
2. [**Dwyer Instruments, Inc**]
3. [**Orange Research**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ashcroft Inc**]
2. [**Dwyer Instruments, Inc**]
3. [**Orange Research**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

D. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: [**4-1/2 inches (115 mm)**][**2-1/2 inches (75 mm)**]<**Insert dimension**>.
2. Material: [**Stainless-steel**]<**Insert material**> case and [**die-cast aluminum**][**stainless-steel**]<**Insert material**> body with [**wetted material matching body material**]<**Insert wetted material**>.
3. Accuracy: [**Plus/minus 2 percent of full scale**]<**Insert accuracy**>.
4. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: **0- to 3.0-inch wg (0 to 750 Pa)**.
5. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: **0- to 4.0-inch wg (0 to 1000 Pa)**.

E. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.

D. Coordinate filter installations with duct and air-handling unit installations.

3.3 INSTALLATION OF HEPA, ULPA, AND 95 PERCENT DOP FILTER GAUGES

A. Install filter gauge for each filter bank.

B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. HEPA and ULPA Filters: Pressurize housing to a minimum of [**6.0-inch wg (1500 Pa)**]<**Insert value**>, and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME AG-1.

E. Air filter will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

3.7 PROTECTION

A. Protect installed products and accessories from damage during construction.

END OF SECTION 23 41 33 00

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Task	Specification	Specification Description
23 41 33 00	23 41 00 00	Particulate Air Filtration

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SECTION 23 42 00 00 - GAS-PHASE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas-phase panel filters.
2. Gas-phase, deep-V filters.
3. Gas-phase, V-cell filters.
4. Gas-phase, cylindrical-canister filters.
5. Gas-phase, rigid-cell box filters.
6. Front- or back-access filter frames.
7. Side-access filter housings.
8. Filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for gas-phase filters.
2. Section 233400 "HVAC Fans" for customized fan and filter units.
3. Section 234133 "High-Efficiency Particulate Filtration" for high-efficiency particulate air (HEPA) filters used in combination with gas-phase filters.
4. Section 234300 "Electronic Air Cleaners" for electronic units combined with gas-phase filters as part of a system.

1.2 DEFINITIONS

A. HIPS: High impact polystyrene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For gas-phase air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for gas-phase filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each gas-phase filter, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of gas-phase filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of filters for each filter or filter bank.
2. Provide [**one**]<**Insert number**> complete 100 percent refill supply for each filter requiring loose-fill media.
3. Provide [**one**]<**Insert number**> container(s) of red oil for inclined manometer filter gage.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

C. Comply with NFPA 90A and NFPA 90B.

2.2 GAS-PHASE PANEL FILTERS

A. Description: Factory-fabricated panel or pleated adsorbent media filter.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. [**Purafil, Inc.**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. [**Purafil, Inc.**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

D. Filter Unit Class: UL 900, [**Class 2**]<**Insert class**>.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**20 by 24 inches (500 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**]<**Insert dimensions**> nominal.
3. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**> nominal.
4. System Airflow: <**Insert cfm (L/s)**>.
5. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
6. No. of Filters, Wide by High: <**Insert number wide by number high**>.
7. Service Access Location (Front, Back, Side): <**Insert access location**>.
8. Initial Resistance: [**0.50-inch wg (125 Pa)**]<**Insert value**>.
9. Final Resistance: [**1.0-inch wg (250 Pa)**]<**Insert value**>.

F. Media:

1. Flat-panel or pleated, multilayer filter with an inlet layer of nonwoven polyester fibers, bonded or supported by a grid, to a layer of [**activated carbon**]<**Insert adsorbent media type**>
2. Housed in a [**beverage board**]<**Insert material**> frame.
3. Minimum CTC activity level of [**60**]<**Insert number**> percent.

G. MERV Rating: Minimum [**MERV 6**][**MERV 8**]<**Insert value**>, according to ASHRAE 52.2.

H. Maximum Continuous Operating Temperature: [**150 deg F (65 deg C)**]<**Insert temperature**>.

I. Pre-installation Protection: Package each gas-phase filter in a sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.3 GAS-PHASE, DEEP-V FILTERS

A. Description: Factory-fabricated modules with adsorbent media trays or self-supporting bonded media panels in deep-V arrangement with disposable [**prefilter**][**and**][**final filter**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. [**Tri-Dim Filter Corporation**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. [**Tri-Dim Filter Corporation**]
6. <**Insert manufacturer's name**>

D. Filter Unit Class: UL 900, [**Class 2**]<**Insert class**>.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**20 by 24 inches (500 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**][**12 by 24 inches (300 mm by 600 mm)**]<**Insert dimensions**> nominal.
3. Depth: <**Insert dimension**> nominal.
4. System Airflow: <**Insert cfm (L/s)**>.
5. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
6. No. of Tray/Cassette/Panel Modules, Wide by High: <**Insert number wide by number high**>.
7. Service Access Location (Front, Back, or Side): <**Insert access location**>.
8. Resistance: [**0.50-inch wg (125 Pa)**]<**Insert value**>.
9. Recommended Change-out Interval Frequency: [**1 year**]<**Insert change-out interval frequency**>.

F. Module Housing:

1. Frame: [**Galvanized or powder-coated steel**][**Stainless steel**][**HIPS**][**Galvanized steel, powder-coated steel, stainless steel, or HIPS**] to hold adsorbent media-filled trays or panels.

2. Access: [**Front access**][**or**][**Side access through gasketed access doors on both sides**] and able to connect to other housings.
3. Equip housings with [**metal slide channel tracks to hold adsorbent media trays or self-supporting panels**][**or**][**interlocking modular cassettes to hold adsorbent media**][**and**][**particulate prefilter**][**final filter**].
4. Finish: [**unfinished HIPS material**][**or**][**Steel with treatment(s) as indicated in "Frame" Subparagraph above**], [**factory**][**primed**][**primed and painted**], [**outside**][**inside and outside**][**inside**].
5. Pressure tap and fitting.

G. Media-Holding Panels:

1. [**Refillable**][**Disposable**][**or**][**Incinerable**] adsorbent media trays or self-supporting panels.

H. Activated Carbon Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of [**loose-fill**][**loose-fill or bonded-panel**][**bonded-panel**] coconut-shell activated carbon.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

I. Potassium-Permanganate-Impregnated Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of [**loose-fill**][**loose-fill or bonded-panel**][**bonded-panel**] activated alumina or zeolite impregnated with potassium permanganate.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

J. Caustic Sodium-Hydroxide-Impregnated Activated Carbon Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of [**loose-fill**][**loose-fill or bonded-panel**][**bonded-briquette**] caustic sodium-hydroxide-impregnated activated carbon.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

K. Blended Activated Carbon and Potassium-Permanganate-Impregnated Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of [**loose-fill**][**loose-fill or bonded-panel**][**bonded-panel**], 50/50 blended activated carbon and alumina or zeolite impregnated with potassium permanganate.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.

3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

L. Phosphoric-Acid-Impregnated Activated Carbon Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of [**loose-fill**][**loose-fill or bonded-panel**][**bonded-panel**] activated carbon impregnated with phosphoric acid.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

M. Prefilter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**flat**][**pleated**][**ring**] panel. Size and airflow capacity shall match those of gas-phase filters.

1. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.
2. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
3. Initial Resistance: [**0.25-inch wg (62.3 Pa)**][**0.35-inch wg (87.2 Pa)**][**0.45-inch wg (112.1 Pa)**][**0.60-inch wg (150 Pa)**]<**Insert value**> at [**350 fpm (1.8 m/s)**][**500 fpm (2.5 m/s)**]<**Insert value**>.
4. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
5. Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**]<**Insert value**>, according to ASHRAE 52.2.

6. Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

N. Final Filter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**supported bag**][**unsupported bag**][**rigid-cell box**][**V-bank cell**][**self-supported pocket**] filter. Size and airflow capacity shall match those of gas-phase filters.

1. Depth: [**12 inches (300 mm)**][**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**>.
2. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
3. Initial Resistance: [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**]<**Insert value**> at **500 fpm (2.5 m/s)**.
4. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
5. Filter Unit Class: UL 900, [**Class 1**][**Class 2**].
6. Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

O. Pre-installation Protection: Package each gas-phase filter in sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.4 GAS-PHASE, V-CELL FILTERS

A. Description: Factory-fabricated, dry, V-shaped cartridges containing loose-fill adsorbent media with

holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Filtration Group**]
4. [**Flanders Corporation**]
5. [**Koch Filter Corporation**]
6. [**Purafil, Inc.**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Filtration Group**]
4. [**Flanders Corporation**]
5. [**Koch Filter Corporation**]
6. [**Purafil, Inc.**]
7. [**Tri-Dim Filter Corporation**]
8. <**Insert manufacturer's name**>

D. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**20 by 24 inches (500 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**]<**Insert dimensions**>nominal.
3. Depth: [**12 inches (300 mm)**]<**Insert dimension**> nominal.
4. System Airflow: <**Insert cfm (L/s)**>.
5. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
6. No. of Filters, Wide by High: <**Insert number wide by number high**>.
7. Service Access Location (Front, Back, or Side): <**Insert access location**>.
8. Resistance: [**0.50-inch wg (125 Pa)**]<**Insert value**>.
9. Recommended Change-out Interval Frequency: [**1 year**]<**Insert change-out interval frequency**>.

E. Cartridges: V-cell configuration; plastic enclosure caps; galvanized-steel, HIPS, or ABS frame with vertical galvanized-steel, HIPS, or ABS channel supports. Integral, [**1-inch (25-mm)**]<**Insert media bed thickness**> thick panels constructed of honeycombed paper and nylon mesh or mini-pleats on each side of adsorbent media.

F. Coconut-Shell Activated Carbon Media: <**Insert lb (kg)**> of activated carbon per **1000 cfm (470 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

G. Activated Alumina or Zeolite Impregnated with Potassium-Permanganate Media: <**Insert lb (kg)**> of adsorbent per **500 cfm (236 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

H. Caustic Sodium-Hydroxide-Impregnated Carbon Media: <**Insert lb (kg)**> of adsorbent per **500 cfm (236 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

I. 50/50 Blended Carbon and Alumina or Zeolite Impregnated with Potassium-Permanganate Media: <**Insert lb (kg)**> of adsorbent per **500 cfm (236 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

J. Activated Carbon Impregnated with Phosphoric Acid Media: <**Insert lb (kg)**> of adsorbent per **500 cfm (236 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

K. Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of <**Insert type of media and adsorbent**>.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: <**Insert number**>, when tested according to ASTM D3802.
6. Prefilter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**flat**][**pleated**][**ring**] panel. Size and airflow capacity shall match those of gas-phase filters.

a. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.
b. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
c. Initial Resistance: [**0.25-inch wg (62.3 Pa)**][**0.35-inch wg (87.2 Pa)**][**0.45-inch wg (112.1 Pa)**][**0.60-inch wg (150 Pa)**]<**Insert value**> at [**350 fpm (1.8 m/s)**][**500 fpm (2.5 m/s)**]<**Insert value**>.
d. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
e. Filter Unit Class: UL 900, [**Class 2**]<**Insert class**>.
f. Minimum Efficiency Reporting Value and Average Arrestance:

1) MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], according to ASHRAE 52.2.

g. Minimum Efficiency Reporting Value:

1) MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

7. Final Filter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**supported bag**][**unsupported bag**][**rigid-cell box**][**V-bank cell**][**self-supported pocket**] filter. Size and airflow capacity shall match those of gas-phase filters.

a. Depth: [**12 inches (300 mm)**][**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**>.
b. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
c. Initial Resistance: [**1-inch wg (250 Pa)**][**2-inch wg (500 Pa)**]<**Insert value**> at **500 fpm (2.5 m/s)**.
d. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
e. Filter Unit Class: UL 900, [**Class 1**][**Class 2**].
f. Minimum Efficiency Reporting Value:

1) MERV Rating: [**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

L. Pre-installation Protection: Package each filter in a sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.5 GAS-PHASE, CYLINDRICAL-CANISTER FILTERS

A. Description: Factory-fabricated, dry, cylindrical canisters containing loose-fill adsorbent with holding frames.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Camfil Farr Inc.**]
2. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Camfil Farr Inc.**]
2. <**Insert manufacturer's name**>

D. Filter Unit Class: UL 900, [**Class 2**]<**Insert class**>.

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Module Face Size: [**24 by 24 inches (600 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**]<**Insert dimensions**> nominal.
3. Cylinder Diameter: [**6 inches (150 mm)**]<**Insert dimension**> nominal.
4. Cylinder Length: [**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**> nominal.
5. System Airflow: [**Insert cfm (L/s)**].
6. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
7. No. of Modules, Wide by High: <**Insert number wide by number high**>.
8. Service Access Location (Front, Back, Side): <**Insert access location**>.
9. Resistance: [**0.50-inch wg (125 Pa)**]<**Insert value**>.
10. Recommended Change-out Interval Frequency: [**1 year**]<**Insert change-out frequency**>.

F. Cylinders: [**Disposable plastic, 105 deg F (41 deg C) maximum continuous operating temperature)**][**Factory-refillable stainless steel, 140 deg F (60 deg C) maximum continuous operating temperature**].

G. Media: **1-inch- (25-mm-)** thick adsorbent bed, **1.5 lb (0.68 kg)** <**Insert lb. (kg)**> of adsorbent per **6-inch- (150-mm-)** diameter cylinder of [**activated carbon**][**activated alumina or zeolite impregnated with potassium permanganate**][**caustic sodium-hydroxide-impregnated carbon**][**50/50 blended carbon and alumina or zeolite impregnated with potassium permanganate**][**activated carbon impregnated with phosphoric acid**]<**Insert media type**> per canister.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: <**Insert number**>, when tested according to ASTM D3802.

H. Cylinder-Canister Filter-Mounting Frames: [**Disposable plastic**][**Factory-refillable stainless steel**]<**Insert material**> with adsorbent cylinder air paths and mounting perforations; designed for connecting together into built-up filter banks. Secure cylinders to mounting frame with bayonet mounts and gasket seals.

I. Cylindrical-Canister Filter Side Access Housing Modules: [**16-gage aluminized steel**]<**Insert material**>, gasketed dual access doors, [**anodized-aluminum**]<**Insert material**> filter tracks for cylindrical-canister filters[**, with separate track for**][**2-inch (50-mm)**]<**Insert prefilter thickness**> prefilters; individual modules designed for connecting together into built-up filter banks.

J. Prefilter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**flat**][**pleated**][**ring**] panel. Size and airflow capacity shall match those of gas-phase filters.

1. Depth: [**2 inches (50 mm)**]<**Insert dimension**>.
2. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
3. Initial Resistance: [**0.25-inch wg (62.3 Pa)**]<**Insert value**> at [**500 fpm (2.5 m/s)**]<**Insert value**>.
4. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
5. Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating: [**MERV 4**]<**Insert value**>, according to ASHRAE 52.2.

6. Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

K. Pre-installation Protection: Package each gas-phase filter in a sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.6 GAS-PHASE, RIGID-CELL BOX FILTERS

A. Description: Factory-fabricated, adsorbent media bonded to nonwoven deep pleats with plastic pleat spacers, contained in a rigid-cell box.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Filtration Group**]
4. [**Flanders Corporation**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Purafil, Inc.**]
8. [**Tri-Dim Filter Corporation**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Filtration Group**]
4. [**Flanders Corporation**]
5. [**Koch Filter Corporation**]
6. [**Parker Hannifin Corporation; HVAC Filtration Division**]
7. [**Purafil, Inc.**]
8. [**Tri-Dim Filter Corporation**]
9. <**Insert manufacturer's name**>

D. Filter Unit Class: UL 900, [**Class 1**][**Class 2**].

E. Capacities and Characteristics:

1. Drawing Tag No.: <**Insert number**>.
2. Face Size: [**24 by 24 inches (600 by 600 mm)**][**24 by 12 inches (600 by 300 mm)**]<**Insert dimensions**> nominal.
3. Depth: [**12 inches (300 mm)**]<**Insert dimension**> nominal.
4. System Airflow: <**Insert cfm (L/s)**>.
5. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert value**>.
6. Initial Resistance: [**0.50-inch wg (140 Pa)**]<**Insert value**>.
7. Recommended Final Resistance: [**1.5 in wg (370 Pa)**]<**Insert inches wg (Pa)**>.
8. Minimum Toluene Removal Efficiency: [**90**]<**Insert value**> percent.

F. Activated Carbon Media: <**Insert lb (kg)**> of activated carbon per **1000 cfm (470 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m) value**>.

4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

G. 50/50 Blended Carbon and Alumina or Zeolite Impregnated with Potassium-Permanganate Media: <**Insert lb (kg)**> of adsorbent per **1000 cfm (470 L/s)** of airflow.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number range**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft. (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

H. Media: <**Insert lb (kg)**> per **1000 cfm (470 L/s)** of <**Insert type of media and adsorbent**>.

1. Ash Content: <**Insert number range**> percent.
2. Percentage of CTC Activity: [**60**]<**Insert number range**> percent minimum, when tested according to ASTM D3467.
3. Bulk Density: <**Insert lb/cu. ft (kg/cu. m)**>.
4. Mesh Size: [**4 x 6 U.S. standard mesh (4.75 x 3.35 mm)**]<**Insert mesh size**>, [**90**]<**Insert number**> percent minimum.
5. Hardness Factor: [**95**]<**Insert number**>, when tested according to ASTM D3802.

I. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

J. Pre-installation Protection: Package each gas-phase filter in a sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.7 FRONT- OR BACK-ACCESS FILTER FRAMES

A. Framing System: [**Galvanized-steel**][**Aluminum**] framing members with access for upstream (front) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Flanders Corporation**]
3. [**Koch Filter Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]
5. [**Purafil, Inc.**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Flanders Corporation**]
3. [**Koch Filter Corporation**]
4. [**Parker Hannifin Corporation; HVAC Filtration Division**]

5. [**Purafil, Inc.**]
6. <**Insert manufacturer's name**>

D. Prefilters: Incorporate a separate track[**with spring clips**], removable from front [**or**][**back**].

E. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

2.8 SIDE-ACCESS FILTER HOUSINGS

A. Description: Factory-assembled, side-access housings constructed of [**galvanized steel**][**aluminum**]<**Insert material**> with flanges to connect to duct or casing system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. [**Purafil, Inc.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAF International**]
2. [**Camfil Farr Inc.**]
3. [**Flanders Corporation**]
4. [**Koch Filter Corporation**]
5. [**Parker Hannifin Corporation; HVAC Filtration Division**]
6. [**Purafil, Inc.**]
7. <**Insert manufacturer's name**>

D. Prefilters: Integral tracks to accommodate [**2-inch- (50-mm-)**]<**Insert thickness**> thick, disposable[**or washable**] filters.

E. Access Doors: [**Hinged with continuous**][**Continuous**] gaskets on perimeter and with positive-locking devices. Arrange so filter cartridges can be loaded from either access door.

F. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.9 FILTER GAUGES

A. Diaphragm type, with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. **<Insert manufacturer's name>**

D. Diameter: [**4-1/2 inches (115 mm)**][**2 inches (50 mm)**].

E. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: **0- to 0.5-inch wg (0 to 125 Pa)**.

F. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: **0- to 1.0-inch wg (0 to 250 Pa)**.

G. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: **0- to 2.0-inch wg (0 to 500 Pa)**.

H. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: **0- to 3.0-inch wg (0 to 750 Pa)**.

I. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: **0- to 4.0-inch wg (0 to 1000 Pa)**.

J. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage; graduated to read from **0- to 3.0-inch wg (0 to 750 Pa)** and accurate within 3 percent of full-scale range.

K. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

A. Position each filter unit with required clearance for service and maintenance. Anchor filter-mounting frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Do not operate fan system until particulate filters (temporary or permanent) are in place. Replace

temporary filters used during construction and testing with new, clean filters.

D. Do not install gas-phase filters until fan system is clean and there is no risk of construction debris loading the filter.

E. Install filter-gauge, static-pressure taps upstream and downstream from each filter bank. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

F. Coordinate filter installations with duct and air-handling-unit installations.

G. Install all manufacturer-provided accessories in accordance with manufacturer's written installation instructions.

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC control system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test for leakage of unfiltered air while system is operating.

D. Air filters will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new particulate filter media.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain filters.

END OF SECTION 23 42 00 00

Task	Specification	Specification Description
23 42 13 00	23 41 00 00	Particulate Air Filtration
23 42 13 00	23 42 00 00	Gas-Phase Air Filtration

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SECTION 23 43 00 00 - ELECTRONIC AIR CLEANERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electronic air cleaners.
2. Fan section.
3. Cabinet.
4. Filter gauges.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for particulate air filters.
2. Section 233416 "Centrifugal HVAC Fans" for customized fan and filter units.
3. Section 234133 "High-Efficiency Particulate Air Filtration" for high-efficiency particulate air filters used in combination with particulate air filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For each electronic air cleaner.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show filter assembly, dimensions, materials, and methods of assembly of components.
3. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for filters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each filter, for tests performed by [**manufacturer and witnessed by a**

qualified testing agency][**a qualified testing agency**].

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and housing to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide [**one**]<**Insert number**> complete set(s) of prefilters for each filter bank.
2. Provide detergent for [**one**][**two**]<**Insert number**> refill(s).
3. Provide [**one**]<**Insert number**> container(s) of red oil for inclined manometer filter gauge.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with AHRI 850.

D. Comply with [**NFPA 90A**][**NFPA 90B**].

E. Comply with UL 867.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

2.2 CAPACITIES AND CHARACTERISTICS

A. Drawing Tag. No.: <**Insert number**>.

B. Face Size: [**48 by 24 inches (1152 by 600 mm)**]<**Insert dimensions**> nominal.

C. Number of Cleaner Units: <**Insert number**>.

D. Unit Depth: <**Insert dimensions**> nominal.

E. Frame Access Location: [**Front**][**back**][**or**][**side**].

F. System Airflow: <**Insert number**> **cfm (L/s)**.

G. Maximum or Rated Face Velocity: [**500 fpm (2.5 m/s)**]<**Insert number**>.

H. Power Pack:

1. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60 Hz.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.

I. Maximum Overcurrent Protection Device: <**Insert number**> A.

J. Efficiency: <**Insert number**> percent on particles <**Insert number**> microns and larger at **500 fpm (2.5 m/s)**.

K. Initial Resistance: [**0.25-inch wg (63 Pa)**]<**Insert number**>.

L. Prefilter Type: Integral tracks to accommodate [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable[**or washable**] filters.

1. Prefilter Face Size: <**Insert width by height**>.
2. Number of Prefilters, Wide by High: <**Insert number wide by number high**>.
3. Minimum Efficiency Reporting Value (MERV) and Average Arrestance: MERV [**4**]<**Insert number**>, with "Composite Average Particle Size Efficiency and Arrestance, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
4. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

M. Final Filter Type: Integral tracks to accommodate [**12-inch (300-mm)**][**18-inch (450-mm)**][**24-inch (600-mm)**]<**Insert dimension**> disposable filters.

1. Final-Filter Face Size: <**Insert width by height**>.
2. Number of Final Filters, Wide by High: <**Insert number wide by number high**>.
3. Minimum Efficiency Reporting Value: MERV [**6**]<**Insert number**>, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

N. Fan Motor Electrical Characteristics:

1. Horsepower: <**Insert number**> hp.
2. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
3. Phase: [**Single**][**3**].
4. Hertz: 60 Hz.
5. Full-Load Amperes: <**Insert number**> A.
6. Minimum Circuit Ampacity: <**Insert number**> A.
7. Maximum Overcurrent Protection Device: <**Insert number**> A.

O. Cleaning System: [**Manual**][**or**][**automatic**].

P. Reservoir Tank: [**30 gal. (114 L)**][**50 gal. (190 L)**].

Q. Connections:

1. Water Supply: <**Insert number**> **NPS (DN)**.
2. Drain: <**Insert number**> **NPS (DN)**.

2.3 ELECTRONIC AIR CLEANERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Quality Engineering, Inc.**]
2. [**CosaTron, a division of CRS Industries, Inc.**]
3. [**Trion, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Quality Engineering, Inc.**]
2. [**CosaTron, a division of CRS Industries, Inc.**]
3. [**Trion, Inc.**]
4. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, electronic air cleaner operating by electrostatic precipitation principles.

D. Prefilter Media: [**Four**][**Six**] alternate layers of [**galvanized-steel**][**aluminum**][**stainless-steel**], flat and herringbone-crimp screen.

E. Prefilter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**flat**][**pleated**][**ring**] panel. Size and airflow capacity shall match those of electronic air cleaners.

1. Depth: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.
2. Comply with UL 900.

F. Final Filter: Comply with requirements in Section 234100 "Particulate Air Filtration" for [**supported bag**][**unsupported bag**][**rigid-cell box**][**V-bank cell**][**self-supported pocket**]. Size and airflow capacity shall match those of electronic air cleaners.

1. Depth: [**12 inches (300 mm)**][**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**>.
2. Comply with UL 900.

G. Collection Cells: Aluminum, independently supported and nested.

1. Ionizing Section: Alternately spaced grounded struts and charged ionizing wires.
2. Collecting Section: Alternately grounded and charged plates, with insulators located out of airstream.

H. Power Pack: Self-contained, prewired rectifying unit to convert power, as [**scheduled on Drawings**][**identified in "Capacities and Characteristics" Article**], to approximately 12,000 V dc for ionizer and 6000 V dc for collector; include overload protection, on-off switch, pilot light showing operating status, and access door interlock. Alternatively provide high-voltage and high-frequency-grid excitation technology power pack and system.

I. Safety Accessories: Manual-reset safety switches and warning lights for filter plenum access doors, signal lights and safety switching upstream and downstream from unit within duct, and enameled high-voltage warning signs.

J. Collection Section Cleaning System:

1. Detergent Reservoir Tank: [**30 gal. (110 L)**][**55 gal. (200 L)**]<**Insert capacity**> with pump, motor, solenoid valve, level sensor, backflow preventer, wye-strainer, and ball valve.
2. Detergent.
3. Dispensing System: Motor-driven oscillating copper manifolds with brass spray nozzles on each side of the collector.

K. Controls: Programmable logic controller in remotely mounted, NEMA 250, Type 12 enclosure; with integral time clock and manual override.

1. Contacts for enable-disable control by building automation system.

L. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.

2.4 FAN SECTION

A. Fan: [**Forward curved, belt driven**]<**Insert fan and drive type**>.

B. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Type: [**Permanent-split capacitor with SCR for speed adjustment**][**Electronically commutated motor**]<**Insert type**>.
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: Totally enclosed, fan cooled, and [**explosion proof**][**dust-ignition proof**]<**Insert type**>.
5. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**]<**Insert type**>.
6. Motor Bearings: Sealed ball, <**Insert special requirements**>.
7. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert number**> **deg F (deg C)**.
   b. Altitude: <**Insert number**> **feet (m)** above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

8. Efficiency: Premium efficient.
9. NEMA Design: <**Insert designation**>.

10. Service Factor: <**Insert value**>.
11. Motor Speed: [**Single speed**][**Multispeed**][**Infinitely adjustable with electronic controls**].

2.5 CABINET

A. Description: Minimum <**Insert number**> **gauge (mm)** galvanized steel with <**Insert type**> finish for suspended, wall, frame, or duct mounting.

2.6 FILTER GAUGES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dwyer Instruments, Inc**]
2. [**Parker Hannifin Corporation; HVAC Filtration Division**]
3. <**Insert manufacturer's name**>

C. Description: Diaphragm type, with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: [**4-1/2 inches (115 mm)**][**2 inches (50 mm)**].
2. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: **0- to 0.5-inch wg (0 to 125 Pa)**.
3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: **0- to 1.0-inch wg (0 to 250 Pa)**.
4. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: **0- to 2.0-inch wg (0 to 500 Pa)**.

D. Manometer-Type Filter Gauge: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gauge, with integral leveling indicator, graduated to read from **0- to 3.0-inch wg (0 to 750 Pa)**, and accurate within 3 percent of full-scale range.

E. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine electronic air cleaners and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Position each electronic air cleaner unit with clearance for normal service and maintenance. Anchor electronic air cleaners to substrate.

B. Do not operate fan system until electronic air cleaners and associated prefilters and final filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

C. Operate electronic air cleaners for 24 hours as part of startup before units are put into operation.

D. Install filter-gauge, static-pressure taps upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

E. Install and connect water-supply and drainage piping.

F. Coordinate electronic air cleaner and associated prefilter and final filter installations with duct and air-handling-unit installations.

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and [**DDC system**]<**Insert system description**>.

C. Connect control wiring between controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Test for leakage of unfiltered air while system is operating.

E. Electronic air cleaner and associated filters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean electronic air filter housings and install new prefilter and final-filter media.

3.6 PROTECTION

A. Protect installed products and accessories from damage during construction.

END OF SECTION 23 43 00 00

Task	Specification	Specification Description
23 43 23 00	23 43 00 00	Electronic Air Cleaners

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SECTION 23 51 13 00 - DRAFT CONTROL FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Draft inducer fans.
2. Venturi-draft inducer fans.
3. Mechanical-draft vent fans.
4. Vent exhaust fans.
5. Combustion-air fans.

B. Related Requirements:

1. Section 235113.16 "Vent Dampers" for barometric dampers and vent dampers.
2. Section 235116 "Fabricated Breechings and Accessories" for listed, refractory-lined metal breechings and field-fabricated metal breechings.
3. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.
4. Section 235133 "Insulated Sectional Chimneys" for listed chimney liners; listed building-heating-appliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of product.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For draft control fans to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of [**draft inducer fans**][**venturi-draft inducer fans**][**mechanical-draft vent fans**][**vent exhaust fans**][**combustion-air fans**] that fail in materials or workmanship within specified warranty period.

1. Failure includes failure of the fan due to corrosion.
2. Warranty Period: [**Two**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DRAFT INDUCER FANS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Effikal International Inc**]
2. [**ENERVEX Inc.**]
3. [**Field Controls L.L.C**]
4. [**Quickdraft**]
5. [**Tec-Air Inc.**]
6. [**Tjernlund Products, Inc.**]
7. [**Wing Draft Inducers**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Effikal International Inc**]
2. [**ENERVEX Inc.**]
3. [**Field Controls L.L.C**]
4. [**Quickdraft**]
5. [**Tec-Air Inc.**]
6. [**Tjernlund Products, Inc.**]
7. [**Wing Draft Inducers**]
8. <**Insert manufacturer's name**>

C. Fan Construction: [**Galvanized**][**Aluminized**]-steel housing and radial-blade centrifugal fan.

1. Fan Motor: Permanent-split-capacitor type.

D. Controls:

1. Draft-proving switch.
2. Control kit to cycle fan with gas flow to a single burner.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 VENTURI-DRAFT INDUCER FANS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Quickdraft**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Quickdraft**]
2. <**Insert manufacturer's name**>

C. Fan Construction: Enameled-steel venturi tube for vents **20 inches (508 mm)** in diameter and smaller and ASTM A666, Type 304, stainless-steel venturi tube for vents **22 to 48 inches (559 to 1219 mm)** in diameter. [**Galvanized**][**Enameled**]-steel fan housing with radial-blade centrifugal wheel.

1. Fan Motor: Permanent-split-capacitor type.

D. Controls:

1. Draft-proving switch.
2. Control kit to cycle fan with gas flow to a single burner.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 MECHANICAL-DRAFT VENT FANS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bradford White Corporation**]
2. [**Effikal International Inc**]
3. [**ENERVEX Inc.**]
4. [**Field Controls L.L.C**]
5. [**Quickdraft**]
6. [**Tec-Air Inc.**]
7. [**Tjernlund Products, Inc.**]
8. [**Wing Draft Inducers**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bradford White Corporation**]
2. [**Effikal International Inc**]
3. [**ENERVEX Inc.**]
4. [**Field Controls L.L.C**]
5. [**Quickdraft**]
6. [**Tec-Air Inc.**]
7. [**Tjernlund Products, Inc.**]

8. [**Wing Draft Inducers**]
9. <**Insert manufacturer's name**>

C. Fan Construction: Forward-curved centrifugal fan and scroll fabricated of [**aluminized**][**galvanized**] steel; direct-drive, ball-bearing motor lubricated with synthetic oil; internal cooling fan; stainless-steel shaft; and integral pressure-sensing switch.

1. Fan Motor: Permanent-split-capacitor type.

D. Controls:

1. Draft-proving switch.
2. Control kit to cycle fan with gas flow to [**single**][**multiple**] burner(s).

E. Accessories:

1. [**Aluminized**][**Stainless**]-steel, wall-vent hood.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 VENT EXHAUST FANS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ENERVEX Inc.**]
2. [**Field Controls L.L.C**]
3. [**Tjernlund Products, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ENERVEX Inc.**]
2. [**Field Controls L.L.C**]
3. [**Tjernlund Products, Inc.**]
4. <**Insert manufacturer's name**>

C. General: Centrifugal fan with [**variable**][**constant**]-speed control mounted at end of [**sidewall**][**vertical**] vent.

D. Test Standard: UL 378.

E. Fan Construction:

1. [**Cast-aluminum**][**Galvanized-steel**][**Stainless-steel**] housing [**painted manufacturer's standard color of baked enamel**].
2. [**Galvanized**][**Stainless**]-steel vent.
3. [**Cast-aluminum**][**Stainless-steel**] wheel.
4. Backward-inclined centrifugal or axial fan wheel statically and dynamically balanced.
5. Access panel at the discharge area.

6. Concentric makeup air-inlet duct surrounding the vent to allow zero clearance to combustibles.

F. Motor: Fully enclosed,[**variable-speed duty,**] permanent-split capacitor, out of the airstream, with prelubricated and sealed ball bearings.

G. Constant-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure switch permits burner operation via interlock with boiler. Fan-proving switch is adjustable between **minus 0.07- and minus 0.15-inch wg (minus 17 and minus 37 Pa)**.

H. Variable-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure controller, control transformer, and miscellaneous controls for automatic modulation of fan speed to maintain preset negative pressure between **zero- and minus 1.0-inch wg (zero and minus 249 Pa)**. Include controller with indicator lights, pressure-differential transmitter, chimney pressure-sensor probe, and fan-proving switch adjustable between **minus 0.07- and minus 0.15-inch wg (minus 17 and minus 37 Pa)**. Include tubing.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 COMBUSTION-AIR FANS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ENERVEX Inc.**]
2. [**Field Controls L.L.C**]
3. [**Tjernlund Products, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ENERVEX Inc.**]
2. [**Field Controls L.L.C**]
3. [**Tjernlund Products, Inc.**]
4. <**Insert manufacturer's name**>

C. Fan Construction: [**Galvanized**][**Aluminized**]-steel housing; steel forward-curved fan and scroll; direct-drive, totally enclosed, fan-cooled motor with ball bearings; stainless-steel shaft; and integral pressure-sensing switch.

1. Internal bypass to temper supply-air temperature to room.

D. Controls:

1. Fan-proving switch to permit burner operation when combustion-air fan is operating.
2. Multiple-appliance control starts fan with operation of any one of [**three**][**four**] appliances.
3. Modulating combustion-air fan speed to control pressure differential in room with respect to outdoors.
4. Manual-reset, high-limit switch stops operation with **160 deg F (71 deg C)** room temperature.
5. Optional Controls:

a. Alarm circuit.
b. Excessive negative pressure limit.

c. Interface relay for vent exhaust fan, draft inducer fan, or mechanical-draft vent fan.
d. [**Galvanized-steel**][**Aluminum**] intake hood.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.7 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Manufacturer: <**Insert manufacturer**>.
2. Model No.: <**Insert number**>.
3. Rated Appliance Input: <**Insert Btu/h (kW)**>.
4. Airflow: <**Insert cfm (L/s)**>.
5. Speed: <**Insert value**> rpm.
6. Static Pressure: <**Insert inches wg (Pa)**>.
7. Electrical Characteristics:

a. Motor Horsepower: <**Insert value**>.
b. Volts: [**115**][**208**][**230**][**460**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install listed components in a manner complying with the listing.

B. Install draft inducer fans in single-wall vent section that is designed to couple with other vent materials.

C. Secure draft inducer fans to appliances, breechings, or stacks with hardware compatible with connected materials.

D. Install draft inducer fans with clearances for service and maintenance.

E. Install[**PVC**] intake duct that is sized according to manufacturer's written instructions.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 51 13 00

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SECTION 23 51 13 00a - GAS VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UL-listed Type B double-wall vents.
2. UL-listed Type B single-wall vents.
3. UL-listed Type BW double-wall vents.
4. UL-listed Type BW single-wall vents.
5. UL-listed Type L vents.
6. UL-listed special double-wall gas vents.
7. UL-listed special single-wall gas vents.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
3. Section 235116 "Fabricated Breechings and Accessories" for listed, refractory-lined metal breechings and field-fabricated metal breechings.
4. Section 235133 "Insulated Sectional Chimneys" for listed chimney liners; listed building-heating-appliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

B. Shop Drawings: For vents.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M for hangers and supports.
2. AWS D9.1/D9.1M for shop and field welding of joints and seams in vents.

B. Certified Sizing Calculations: Manufacturer is to certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 UL-LISTED TYPE B DOUBLE-WALL VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated UL-listed and labeled, double-wall metal vents listed and labeled in accordance with UL 441, rated for 400 deg F (204 deg C) continuously with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.

D. Inner Shell: [**ASTM B209 (ASTM B209M), Type 1100 aluminum**] [**ASTM B209 (ASTM B209M), Type 3003 aluminum**] [**ASTM B209 (ASTM B209M), Type 3105 aluminum**] [**or**] [**ASTM A666/A666M, Type 430 stainless steel**].

E. Outer Jacket: [**Galvanized**] [**Aluminized**] steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.2 UL-LISTED TYPE B SINGLE-WALL VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, UL-listed and labeled, single-wall metal vents listed and labeled in accordance with UL 441, rated for 400 deg F (204 deg C) continuously with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: [**ASTM B209 (ASTM B209M), Type 1100 aluminum**] [**ASTM B209 (ASTM B209M), Type 3003 aluminum**] [**ASTM B209 (ASTM B209M), Type 3105 aluminum**] [**or**] [**ASTM A666/A666M, Type 430 stainless steel**].

D. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.3 UL-LISTED TYPE BW DOUBLE-WALL VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated UL-listed and labeled, double-wall metal vents listed and labeled in accordance with UL 441, rated for 480 deg F (240 deg C) continuously with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.

D. Inner Shell: [**ASTM B209 (ASTM B209M), Type 1100 aluminum**] [**ASTM B209 (ASTM B209M), Type 3003 aluminum**] [**ASTM B209 (ASTM B209M), Type 3105 aluminum**] [**or**] [**ASTM A666/A666M, Type 430 stainless steel**].

E. Outer Jacket: [**Galvanized**] [**Aluminized**] steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.4 UL-LISTED TYPE BW SINGLE-WALL VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, UL-listed and labeled, single-wall metal vents listed and labeled in accordance with UL 441, rated for 480 deg F (249 deg C) continuously with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: [**ASTM B209 (ASTM B209M), Type 1100 aluminum**] [**ASTM B209 (ASTM B209M), Type 3003 aluminum**] [**ASTM B209 (ASTM B209M), Type 3105 aluminum**] [**or**] [**ASTM A666/A666M, Type 430 stainless steel**].

D. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.5 UL-LISTED TYPE L VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, UL-listed and labeled, double-wall metal vents listed and labeled in accordance with UL 641 and rated for 570 deg F (300 deg C) continuously or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a [**1/4-inch (6-mm)**] [**1-inch (25-mm)**] [**2-inch (50-mm)**] [**4-inch (100-mm)**] airspace filled with high-temperature, [**ceramic-fiber**] [**mineral-wool**] insulation.

D. Inner Shell: ASTM A666/A666M, [**Type 304**] [**Type 316**] stainless steel.

E. Outer Jacket: [**Galvanized**] [**Aluminized**] [**Stainless**] steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.6 UL-LISTED SPECIAL DOUBLE-WALL GAS VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, double-wall metal vents listed and labeled in accordance with UL 1738 and rated for [**210 deg F (99 deg C)**] [**300 deg F (149 deg C)**] [**330 deg F (177 deg C)**] [**400 deg F (204 deg C)**] [**480 deg F (249 deg C)**] [**550 deg F (287 deg C)**] continuously, with positive or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) airspace.

D. Inner Shell: ASTM A959, Type AL 29-4C or other UL 1738-approved stainless steel suitable for the application.

E. Outer Jacket: [**Aluminized**] [**Stainless**] steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

2.7 UL-LISTED SPECIAL SINGLE-WALL GAS VENTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated, UL-listed and labeled, single-wall metal vents listed and labeled in accordance with UL 1738 and rated for [**210 deg F (99 deg C)**] [**300 deg F (149 deg C)**] [**330 deg F (177 deg C)**] [**400 deg F (204 deg C)**] [**480 deg F (249 deg C)**] [**550 deg F (287 deg C)**] continuously, with positive or negative flue pressure complying with NFPA 54 and NFPA 211.

C. Construction: ASTM A959, Type AL 29-4C or other UL 1738-approved stainless steel.

D. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination:

a. Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
b. <**Insert termination**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B and Type BW Vents: Vents for certified gas appliances.

B. Listed Type L Vent: Vents for low-heat appliances.

C. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF UL-LISTED VENTS

A. Install all vent systems in accordance with vent system component manufacturer's written instructions and associated appliance manufacturer's written instructions.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Comply with minimum clearances from combustibles and minimum termination heights in accordance with product listing or NFPA 54[**, and NFPA 31,**] whichever is most stringent.

D. Seal between sections of positive-pressure vents in accordance with manufacturer's written installation instructions, using sealants recommended by manufacturer.

E. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

F. Lap joints in direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 23 51 13 00a

SECTION 23 51 13 00b - INSULATED SECTIONAL CHIMNEYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UL-listed chimney liners.
2. UL-listed building-heating-appliance chimney - 1000 deg F (538 deg C).
3. UL-listed building-heating-appliance chimney - 1400 deg F (760 deg C).
4. UL-listed building-heating-appliance chimney - Type HT.
5. Field-fabricated metal chimneys.
6. Guying and bracing materials.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
3. Section 235116 "Fabricated Breechings and Accessories" for UL-listed, refractory-lined metal breechings and field-fabricated metal breechings.
4. Section 235123 "Gas Vents" for Type B and Type BW vents, Type L vents, and UL-listed special gas vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes for product.

B. Shop Drawings: For chimneys and stacks.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Seismic Qualification Certificates: For factory-fabricated chimneys and stacks, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M for hangers and supports.
2. AWS D9.1/D9.1M for shop and field welding of joints and seams in stacks.

B. Certified Sizing Calculations: Manufacturer to certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 UL-LISTED CHIMNEY LINERS

A. UL-Listed Chimney Liners:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description, Gas-Fuel-Fired: [**Rigid**] [**Flexible**], single-wall chimney liner UL-listed and labeled in accordance with UL 1777 and rated for 470 deg F (243 deg C) for gas-fired appliances with negative or positive flue pressure complying with NFPA 54 and NFPA 211.
3. Description, Oil-Fuel-Fired: [**Rigid**] [**Flexible**], single-wall chimney liner UL-listed and labeled in accordance with UL 1777 and rated for 570 deg F (300 deg C) for oil-fired appliances with negative or positive flue pressure complying with NFPA 54 and NFPA 211.
4. Description, Gas/Oil-Fuel-Fired Combination: [**Rigid**] [**Flexible**], single-wall chimney liner UL-listed and labeled in accordance with UL 1777 and rated for 570 deg F (300 deg C) for combination gas/oil-fired appliances with negative or positive flue pressure complying with NFPA 54 and NFPA 211.
5. Description, Solid-Fuel-Fired: [**Rigid**] [**Flexible**], single-wall chimney liner tested, listed, and labeled in accordance with UL 1777 and rated for 1000 deg F (538 deg C) continuously and for 2100 deg F (1150 deg C) for 10 minutes for solid-fuel-fired appliances with negative or positive flue pressure complying with NFPA 54 and NFPA 211.
6. Rigid Liner Materials: ASTM A666/A666M, [**Type 304**] [**Type 316**] [**Type 430**] [**or**] [**Type 446**] stainless steel.
7. Flexible Liner Materials: [**ASTM A240/A240M, Type 321**] [**ASTM A240/A240M, Type 430**] [**or**] [**ASTM A959, Type 29-4C**] stainless steel.
8. Accessories:

   a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   b. Sealant: Manufacturer's standard high-temperature sealant.
   c. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner, including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.
   d. Termination:

1) Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
2) <**Insert termination**>.

B. UL-Listed Building-Heating-Appliance Chimney - 1000 deg F (538 deg C):

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Double-wall metal vents UL-listed and labeled in accordance with UL 103 and rated for 1000 deg F (538 deg C) continuously; with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.
3. Construction: Inner shell and outer jacket separated by at least a [**1/2-inch (25-mm)**] [**1-inch (50-mm)**] [**2-inch (50-mm)**] [**3-inch (75-mm)**] [**4-inch (100-mm)**] annular space[**filled with high-temperature, ceramic-fiber insulation**].
4. Inner Shell: ASTM A666/A666M, [**Type 304**] [**Type 316**] stainless steel.
5. Outer Jacket: [**Galvanized**] [**Aluminized**] [**ASTM A666/A666M stainless**] steel.
6. Accessories:

   a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   b. Termination:

      1) Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
      2) <**Insert termination**>.

C. UL-Listed Building-Heating-Appliance Chimney - 1400 deg F (760 deg C):

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Double-wall metal vents tested, listed, and labeled in accordance with UL 103 and UL 2561 and rated for 1400 deg F (760 deg C) continuously; with positive or negative flue pressure complying with NFPA 54 and NFPA 211.
3. Construction: Inner shell and outer jacket separated by at least a [**1-inch (25-mm)**] [**2-inch (50-mm)**] [**3-inch (75-mm)**] [**4-inch (100-mm)**] annular space filled with high-temperature, ceramic-fiber insulation.
4. Inner Shell: ASTM A666/A666M, [**Type 304**] [**Type 316**] stainless steel.
5. Outer Jacket: [**Galvanized**] [**Aluminized**] [**ASTM A666/A666M stainless**] steel.
6. Accessories:

   a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   b. Termination:

      1) Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
      2) <**Insert termination**>.

D. UL-Listed Building-Heating-Appliance Chimney - Type HT:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Double-wall metal vents tested, listed, and labeled in accordance with UL 103 and rated for 1000 deg F (538 deg C) continuously and for 2100 deg F (1150 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 54 and NFPA 211.

3. Construction: Inner shell and outer jacket separated by at least a [**1-inch (25-mm)**] [**1-1/2-inch (38-mm)**] [**2-inch (50-mm)**] [**4-inch (100-mm)**] annular space filled with high-temperature, ceramic-fiber insulation.
4. Inner Shell: [**ASTM A666/A666M, Type 304**] [**ASTM A666/A666M, Type 316**] [**ASTM A240/A240M, Type 430**] stainless steel.
5. Outer Jacket: [**Galvanized**] [**Aluminized**] [**ASTM A666/A666M stainless**] steel.
6. Accessories:

   a. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   b. Sealant: Manufacturer's standard high-temperature sealant.
   c. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner, including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.
   d. Termination:

      1) Vent cap designed to avoid downdrafts and entry of rain, snow, and animals in accordance with NFPA 54 and NFPA 211.
      2) <**Insert termination**>.

2.2 FIELD-FABRICATED METAL CHIMNEYS

A. Fabricate freestanding chimneys in accordance with SMACNA's "Guide for Free Standing Steel Stack Construction." Design for minimum <**Insert ft. (m)**> high and <**Insert inches (mm)**> in diameter.

B. Fabricate chimneys from ASTM A1011/A1011M hot-rolled steel with continuously welded joints, complying with NFPA 54 and NFPA 211 for minimum metal thickness.

   1. Equal to or Less Than 1.069 Sq. Ft. (0.099 Sq. m.) or 14 Inches (356 mm) in Diameter: 0.053 inch (1.35 mm).
   2. Up to 1.396 Sq. Ft. (0.129 Sq. m) or 16 Inches (406 mm) in Diameter: 0.067 inch (1.7 mm).
   3. Up to 1.764 Sq. Ft. (0.164 Sq. m.) or 18 Inches (457 mm) in Diameter: 0.093 inch (2.36 mm).
   4. Larger than 18 Inches (457 mm) in Diameter: 0.123 inch (3.124 mm).

C. Fabricate chimneys and vent connectors from galvanized steel, complying with NFPA 54 and NFPA 211 for minimum metal thickness.

   1. Equal to or Less Than 6 Inches (152 mm) in Diameter: 0.019 inch (0.48 mm).
   2. Up to 10 Inches (254 mm) in Diameter: 0.024 inch (0.61 mm).
   3. Up to 16 Inches (406 mm) in Diameter: 0.029 inch (0.74 mm).
   4. Larger than 16 Inches (406 mm) in Diameter: 0.056 inch (1.42 mm).

D. Fabricate chimneys and vent connectors from ASTM B209 (ASTM B209M), Type 1100 or Type 3003, aluminum or stainless steel, complying with NFPA 54 and NFPA 211 for the following minimum metal thicknesses:

   1. Aluminum: 0.027 inch (0.69 mm).
   2. Stainless Steel: 0.012 inch (0.31 mm).

E. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

   1. Gasket: Fiberglass rope.

F. Fabricate engine exhaust from ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, [**Schedule 40**] [**Schedule 80**] pipe; with welded joints and carbon-steel fittings and flanges.

1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, including bolts, nuts, and fiberglass gaskets.

2.3 GUYING AND BRACING MATERIALS

A. See Drawings for guying and bracing design and details.

B. Guying and Bracing Materials:

1. Cable: Galvanized, stranded wires of the following thickness:

a. Minimum Size: 1/4 inch (6 mm) in diameter.
b. Minimum Size for Chimney ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
c. Minimum Size for Chimney ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).
d. Minimum Size for Chimney ID Sizes 27 to 30 Inches (685 to 762 mm): 7/16 inch (11 mm).
e. Minimum Size for Chimney ID Sizes 33 to 36 Inches (838 to 915 mm): 1/2 inch (13 mm).
f. Minimum Size for Chimney ID Sizes 39 to 48 Inches (990 to 1220 mm): 9/16 inch (14.3 mm).
g. Minimum Size for Chimney ID Sizes 51 to 60 Inches (1295 to 1524 mm): 5/8 inch (16 mm).

2. Pipe: Galvanized steel, minimum [**NPS 1-1/4 (DN 32)**] <**Insert size**>.
3. Angle Iron: Galvanized steel, minimum [**2 by 2 by 0.25 inch (50 by 50 by 6 mm)**] <**Insert size**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. UL-Listed Chimney Liners: High-efficiency [**boiler**] [**or**] [**furnace**] stacks in masonry chimney.

B. UL-Listed Building-Heating-Appliance Chimney - 1000 deg F (538 deg C): [**Dual-fuel boilers,**] [**oven vents,**] [**water heaters,**] [**and**] [**engine exhausts**].

C. UL-Listed Building-Heating-Appliance Chimney - 1400 deg F (760 deg C): [**Dual-fuel boilers,**] [**oven vents,**] [**water heaters,**] [**and**] [**engine exhausts**].

D. UL-listed Building-Heating-Appliance Chimney - Type HT: [**Fireplaces**] <**Insert other solid-fuel-burning appliance**>.

E. Field-Fabricated Metal Chimneys: [**Dual-fuel boilers,**] [**oven vents,**] [**water heaters,**] [**engine exhausts,**] [**and**] [**fireplaces,**] <**Insert other solid-fuel-burning appliance**>.

F. <**Insert chimney type and application.**>

3.3 INSTALLATION OF UL-LISTED CHIMNEYS

A. Install chimneys in accordance with chimney and components manufacturer's written instructions, associated appliance manufacturer's written instructions, NFPA 31, NFPA 54, NFPA 211, and AHJ requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete, reinforcement, and formwork.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

D. Comply with minimum clearances from combustibles and minimum termination heights in accordance with product listing, NFPA 54, or NFPA 211, whichever is most stringent.

E. Seal between sections of positive-pressure vents in accordance with manufacturer's written installation instructions, using sealants recommended by manufacturer.

F. Lap joints in direction of flow.

3.4 INSTALLATION OF FIELD-FABRICATED METAL CHIMNEYS

A. Suspend chimneys independent of their appliance connections.

B. Install seismic restraints in accordance with manufacturer's written instructions. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Lap joints in direction of flow.

D. Support chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C clamps, or beam clamps in accordance with manufacturer's written instructions.

3.5 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Provide temporary closures at ends of chimneys and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 13 00b

Task	Specification	Specification Description
23 51 13 13	23 51 13 00	Draft Control Fans
23 51 13 13	23 51 16 00	Fabricated Breechings and Accessories
23 51 13 13	23 51 13 00a	Gas Vents
23 51 13 13	23 51 13 00b	Insulated Sectional Chimneys

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SECTION 23 51 13 16 - VENT DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Barometric dampers.
2. Vent dampers.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235116 "Fabricated Breechings and Accessories" for listed, refractory-lined metal breechings and field-fabricated metal breechings.
3. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.
4. Section 235133 "Insulated Sectional Chimneys" for listed chimney liners; listed building-heating-appliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of product.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For draft control devices to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of [**barometric dampers**][**vent dampers**] that fail in materials or workmanship within specified warranty period.

1. Failure includes failure due to corrosion.
2. Warranty Period: [**Two**][**10**]**<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BAROMETRIC DAMPERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Effikal International Inc**]
2. [**ENERVEX Inc.**]
3. [**FAMCO**]
4. [**Field Controls L.L.C**]
5. [**Quickdraft**]
6. [**Snappy Air Distribution Products**]
7. [**Tec-Air Inc.**]
8. [**Tjernlund Products, Inc.**]
9. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Effikal International Inc**]
2. [**ENERVEX Inc.**]
3. [**FAMCO**]
4. [**Field Controls L.L.C**]
5. [**Quickdraft**]
6. [**Snappy Air Distribution Products**]
7. [**Tec-Air Inc.**]
8. [**Tjernlund Products, Inc.**]
9. **<Insert manufacturer's name>**

C. Damper Construction: High-temperature-enamel-painted steel damper and housing with galvanized-steel breeching connection. Adjustable counterweight with lock. Include knife-edge bearings that do not require lubrication.

2.2 VENT DAMPERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Effikal International Inc**]
2. [**Field Controls L.L.C**]
3. [**Johnson Controls, Inc.**]
4. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Effikal International Inc**]
2. [**Field Controls L.L.C**]
3. [**Johnson Controls, Inc.**]
4. <**Insert manufacturer's name**>

C. Damper Construction: Stainless steel damper blade, shaft, and vent pipe with metal, prelubricated bearings.

1. Electric motor sized to power damper open and closed in approximately 15 seconds in each direction. Power is off when damper is at rest.
2. Comply with ANSI Z21.66.

D. Controls:

1. Control transformer.
2. Keyed wiring harness.
3. Damper end switch to prove damper is open.
4. Interlock with boiler to permit burner operation when damper is open.
5. Hold-open switch for troubleshooting boiler controls.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.4 CAPACITIES AND CHARACTERISTICS

A. Damper:

1. Manufacturer: <**Insert manufacturer**>.
2. Model No.: <**Insert number**>.
3. Rated Appliance Input: <**Insert Btu/h (kW)**>.
4. Vent Size: <**Insert inches (mm)**>.
5. Electrical Characteristics:

a. Motor Horsepower: <**Insert value**>.
b. Volts: [**115**]<**Insert value**>.
c. Phase: Single.
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install listed components in a manner complying with the listing.

B. Secure barometric dampers to breechings with hardware compatible with connected materials.

C. Locate barometric and motorized vent dampers as close to draft hood collar as possible.

D. Secure barometric and motorized vent dampers to appliances, breechings, or chimneys with hardware compatible with connected materials.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 51 13 16

Task	Specification	Specification Description
23 51 13 16	23 51 13 00	Draft Control Fans
23 51 13 16	23 51 16 00	Fabricated Breechings and Accessories
23 51 13 16	23 51 13 00a	Gas Vents
23 51 13 16	23 51 13 00b	Insulated Sectional Chimneys
23 51 13 19	23 33 00 00	Air Duct Accessories
23 51 13 19	23 51 13 00	Draft Control Fans
23 51 13 19	23 51 13 00a	Gas Vents
23 51 13 19	23 51 13 00b	Insulated Sectional Chimneys

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SECTION 23 51 16 00 - FABRICATED BREECHINGS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Listed, refractory-lined breechings.
2. Field-fabricated metal breechings.
3. Guying and bracing materials.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
3. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.
4. Section 235133 "Insulated Sectional Chimneys" for listed chimney liners; listed building-heating-appliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

B. Shop Drawings: For breechings.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Seismic Qualification Certificates: For factory-fabricated breeching, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in breechings.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, structural failures caused by expansion and contraction.
2. Warranty Period: [**10**][**15**][**25**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED, REFRACTORY-LINED METAL BREECHINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Van-Packer Co.**]
2. [**Warren Environment, Inc**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Van-Packer Co.**]
2. [**Warren Environment, Inc**]
3. <**Insert manufacturer's name**>

C. Comply with ASME STS-1.

D. Design Wind Loads: [**150 mph (241 km/h)**]<**Insert wind speed**>.

E. Design for seismic conditions at Project site.

F. Refractory Lining: Tested according to UL 959 for temperature and acid resistance and bearing the testing laboratory label.

1. Temperature Rating: **1800 deg F (982 deg C)** continuously and **2000 deg F (1093 deg C)** intermittently.

2. Acid Extraction: Maximum of 0.2 percent.
3. Cold Crushing Strength: Minimum of **3200 psig (22 MPa)**.
4. Thickness: Minimum of **2 inches (50 mm)**.

G. Finish: Factory-applied, high-heat-resistant paint; color as selected by Architect.

2.2 FIELD-FABRICATED METAL BREECHINGS

A. Fabricate breechings from ASTM A1011/A1011M hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.

1. Equal to or Less Than **1.069 Sq. Ft. (0.099 Sq. m.)** or **14 Inches (356 mm)** in Diameter: **0.053 inch (1.35 mm)**.
2. Up to **1.396 Sq. Ft. (0.129 Sq. m)** or **16 Inches (406 mm)** in Diameter: **0.067 inch (1.7 mm)**.
3. Up to **1.764 Sq. Ft. (0.164 Sq. m.)** or **18 Inches (457 mm)** in Diameter: **0.093 inch (2.36 mm)**.
4. Larger Than **1.764 Sq. Ft. (0.164 Sq. m.)** or **18 Inches (457 mm)** in Diameter: **0.123 inch (3.12 mm)**.

B. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

C. Fabricate engine exhaust from ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, [**Schedule 40**][**Schedule 80**] pipe; with welded joints and carbon-steel fittings and flanges.

1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, including bolts, nuts, and gaskets.

2.3 GUYING AND BRACING MATERIALS

A. Cable: [**Three**][**Four**]<**Insert number**> galvanized, stranded wires of the following thickness:

1. Minimum Size: **1/4 inch (6 mm)** in diameter.
2. For ID Sizes **4 to 15 Inches (100 to 381 mm)**: **5/16 inch (8 mm)**.
3. For ID Sizes **18 to 24 Inches (457 to 610 mm)**: **3/8 inch (9.5 mm)**.
4. For ID Sizes **27 to 30 Inches (685 to 762 mm)**: **7/16 inch (11 mm)**.
5. For ID Sizes **33 to 36 Inches (838 to 915 mm)**: **1/2 inch (13 mm)**.
6. For ID Sizes **39 to 48 Inches (990 to 1220 mm)**: **9/16 inch (14.3 mm)**.
7. For ID Sizes **51 to 60 Inches (1295 to 1524 mm)**: **5/8 inch (16 mm)**.

B. Pipe: [**Two**][**Three**]<**Insert number**> galvanized steel, **NPS 1-1/4 (DN 32)**.

C. Angle Iron: [**Two**][**Three**]<**Insert number**> galvanized steel, **2 by 2 by 0.25 inch (50 by 50 by 6 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed, Refractory-Lined Metal Breechings: Freestanding dual-fuel boiler vents, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.

B. Field-Fabricated Metal Breechings: Dual-fuel boilers, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.

3.3 INSTALLATION OF UNLISTED, FIELD-FABRICATED BREECHINGS

A. Suspend breechings independent of their appliance connections.

B. Install seismic restrains according to manufacturer's written instructions. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Align breechings at connections, with smooth internal surface and a maximum **1/8-inch (3-mm)** misalignment tolerance.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Support breechings from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C clamps, or beam clamps according to manufacturer's written instructions.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings that are not completed or connected to equipment.

END OF SECTION 23 51 16 00

Task	Specification	Specification Description
23 51 16 00	23 51 13 00a	Gas Vents
23 51 16 00	23 51 13 00b	Insulated Sectional Chimneys

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SECTION 23 52 13 00 - ELECTRIC BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electric boilers, trim, and accessories for generating [**hot water**][**and**][**steam**].

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.

C. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for boilers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

E. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. CSA B51 pressure vessel Canadian Registration Number (CRN).
3. Startup service reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace pressure vessels of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Acme Engineering Products Inc**]
2. [**Argo Technology, Inc.**]
3. [**Benjamin Heating Products**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Fulton Boiler Works, Inc**]
7. [**Lattner Boiler Manufacturing**]
8. [**Lion Boilers; a division of Concept Manufacturing Inc.**]
9. [**Lochinvar, LLC**]
10. [**Patterson-Kelley**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**Reimers Electra Steam, Inc**]
14. [**Sussman Electric Boilers**]
15. [**Thermon, Inc.**]
16. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Acme Engineering Products Inc**]
2. [**Argo Technology, Inc.**]
3. [**Benjamin Heating Products**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Fulton Boiler Works, Inc**]
7. [**Lattner Boiler Manufacturing**]
8. [**Lion Boilers; a division of Concept Manufacturing Inc.**]
9. [**Lochinvar, LLC**]
10. [**Patterson-Kelley**]
11. [**Precision Boilers**]
12. [**PVI; A WATTS Brand**]
13. [**Reimers Electra Steam, Inc**]
14. [**Sussman Electric Boilers**]
15. [**Thermon, Inc.**]
16. <**Insert manufacturer's name**>

2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate [**hot water**][**steam**].

B. Pressure Vessel: [**Carbon-steel**][**Cast-iron**] pressure vessel mounted on structural-steel base.

C. Nozzles: Flanges for [**water inlet and**][**steam**] outlet and heating element inserts; threaded connections for trim and controls.

D. Insulation: [**One layer**][**Two layers**] of minimum [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**]<**Insert thickness**> thick, glass-fiber insulation.

E. Jacket: [**Galvanized**]sheet metal casing with [**baked-enamel**][**powder-coated**] protective finish and removable panels with snap-in or interlocking closures for access to pressure vessel.

F. Lifting Lugs: Welded to pressure vessel, extending above jacket.

G. Heating Elements: [**Copper**][**Incoloy**]-sheathed, replaceable electric-resistance element, rated 20-kW maximum, with maximum [**50 W/sq. in. (7.7 W/sq. cm)**][**75 W/sq. in. (11.5 W/sq. cm)**]<**Insert value**> over heat-transfer length.

H. Mounting Base: For securing boiler to concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. ASME Compliance: Fabricate and label boilers to comply with 2013 ASME Boiler and Pressure Vessel Code.

K. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, Article 424, Paragraphs G and H.

L. UL Compliance: Test boilers for compliance with UL 834. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

M. CSA Compliance: Test boilers for compliance with CSA B51.

2.3 TRIM FOR HOT-WATER BOILERS

A. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**][**CSA B51**].

B. Aquastat Controllers: Operating auto-reset high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: [**Automatic**][**Manual**].

F. Dip-tube in water outlet.

G. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end ball valve sized according to requirements of authorities having jurisdiction.

H. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.

1. Tappings **NPS 2 (DN 50)** and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Tappings **NPS 2-1/2 (DN 65)** and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.4 TRIM FOR STEAM BOILERS

A. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**][**CSA B51**].

B. Pressure Controllers: Operating auto-reset high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment according to 2013 ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet, with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum **3-1/2-inch (89-mm)** diameter. Gage shall have normal operating pressure

about 50 percent of full range.

E. Water Column: Minimum **12-inch (300-mm)** glass gage with shutoff cocks.

F. Drain Valves: Minimum **NPS 3/4 (DN 20)** or nozzle size with hose-end connection.

G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.[**Blowdown valves shall be combination of slow and quick acting, as required by ASME B31.1.**]

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than **NPS 2 (DN 50)** shall have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet, with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.

1. Tappings **NPS 2 (DN 50)** and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Tappings **NPS 2-1/2 (DN 65)** and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.5 CONTROLS

A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Step controller.
3. Recycling relay returns controller to off position after power failure.
4. Multistage thermostat.
5. Control-circuit switch.
6. Visual indication for each step.
7. Supply-voltage indicator.
8. Set-Point Adjust: Set points shall be adjustable.
9. Operating Level Control: Factory wired and mounted to cycle feedwater pump(s) for makeup water control.
10. Sequence of Operation:

a. Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain space temperature in response to thermostat with heat anticipator located in heated space.

1) Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.

b. Electric, factory-fabricated and field-installed panel to control element sequence controller to reset supply-water temperature inversely with outside-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outside-air temperature, set supply-water temperature at [**200 deg F (93 deg C)**]<**Insert temperature**>; at [**60 deg F (15**

deg C)]<**Insert temperature**> outside-air temperature, set supply-water temperature at [140 deg F (60 deg C)]<**Insert temperature**>.

1) Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.

c. Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

1) Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.

C. Safety Controls: To maintain safe operating conditions, safety controls limit boiler operation.

1. High Cutoff: [**Manual**][**Automatic**] reset stops boiler if operating conditions rise above set point or maximum boiler design [**temperature**][**pressure**].
2. Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe shall prevent boiler operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

a. Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring**>.
b. Control: On/off operation, [**hot water supply temperature set-point adjustment**][**steam pressure adjustment**]<**Insert control**>.

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available and monitoring points displayed locally at boiler control panel shall be available through building management system.

2.6 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.

1. Field power interface shall be to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**].
2. Interlock with door to de-energize power with door open.

B. Electrical Enclosures: NEMA 250, Type [**1**]<**Insert type**> enclosure with hinged door and key-locking handle.

C. Install factory wiring outside of an enclosure in a [**metal**]raceway.

D. Comply with NFPA 70.

1. Electrical Circuits: 48 A, maximum.

E. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.

F. Fuses: NEMA FU 1, Class J or K5; 60 A, maximum.

G. Contactors: Three-pole magnetic contactors, listed for 500,000 cycles at full load.

H. Factory-wired internal control devices and heating elements.

1. Wiring shall be numbered and color coded to match wiring diagram.

2.7 CAPACITIES AND CHARACTERISTICS

A. Hot-Water Heating:

1. Design Water-Pressure Rating: [**160 psig (1100 kPa)**]<**Insert pressure rating**>.
2. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
5. Design Water Flow Rate: <**Insert gpm (L/s)**>.
6. Design Pressure Drop: <**Insert psig (kPa)**>.

B. Steam Heating:

1. Design Steam-Pressure Rating: [**15 psig (104 kPa)**][**60 psig (420 kPa)**][**125 psig (860 kPa)**]<**Insert pressure rating**>.
2. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
3. Steam Operating Pressure: <**Insert psig (kPa)**>.
4. Steam Flow Rate: <**Insert lb/h (kg/s)**>.

C. Output Capacity: <**Insert MBh (kW)**>.

D. Equivalent Direct Radiation: <**Insert EDR (W)**>.

E. Tankless Water Heater:

1. Design Water Flow: <**Insert gpm (L/s)**>.
2. Design Pressure Drop: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

F. Electrical Characteristics:

1. Kilowatts: <**Insert number**> kW.
2. Volts: [**208**][**480**]<**Insert number**> V.
3. Phase: Three.
4. Hertz: [**50**][**60**]<**Insert number**> Hz.
5. Full-Load Amperes: <**Insert number**> A.
6. Minimum Circuit Ampacity: <**Insert number**> A.
7. Maximum Overcurrent Protection: <**Insert number**> A.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to [**2013 ASME Boiler and Pressure Vessel Code**][**CSA B51**].

B. Hydrostatic Test: Factory test assembled boiler, including hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces, including required space for element removal, for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in [**Section 232113 "Hydronic Piping"**][**and**][**Section 232213 "Steam and Condensate Heating Piping."**] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect hot-water piping to supply- and return-boiler tappings, with shutoff valve and union or flange at each connection.

D. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings, with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Install piping from safety relief valves to drip-pan elbow and to nearest floor drain.

G. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

   a. Check and adjust initial operating set points and high- and low-limit safety set points of water level and [**water temperature**][**steam pressure**].
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Remove and replace malfunctioning units and retest as specified above.

E. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
3. Perform field performance tests to determine the capacity of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

F. Boiler will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12 months**]<**Insert time period**> of date of

Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 52 13 00

SECTION 23 52 16 00 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pulse-combustion, fire-tube condensing boilers.
2. Floor-mounted, forced-draft, fire-tube condensing boilers.
3. Wall-hung, forced-draft, fire-tube condensing boilers.
4. Water-jacketed condensing boilers.
5. Condensate-neutralization units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 90.1.

C. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and sections, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for boiler, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

F. Product Certificates:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. CSA B51 pressure vessel Canadian Registration Number (CRN).

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.

1. Warranty Period for Pulse-Combustion Boilers:

a. Heat Exchanger Damaged by Thermal Shock: [**10**]<**Insert number**> years from date of Substantial Completion.
b. Flue-Gas Condensate Corrosion of Heat Exchanger: [**Prorated Year 0 to 7 - 100 percent; Year 8 - 50 percent; Year 9 - 30 percent; Year 10 - 20 percent**][**Nonprorated**] for [**10**]<**Insert number**> years from date of Substantial Completion.

2. Warranty Period for Floor-Mounted Fire-Tube Condensing Boilers:

a. Heat Exchanger and Tank: Free from defects in material and workmanship.
b. Warranty Coverage: [**Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10 - 10 percent**] for <**Insert number**> years from date of Substantial Completion.

3. Warranty Period for Wall-Hung Fire-Tube Condensing Boilers:

a. Heat Exchanger and Tank: Free from defects in material and workmanship.

b. Warranty Coverage: [**Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10 - 10 percent**]<**Insert number**> years from date of Substantial Completion.

4. Warranty Period for Floor-Mounted Water-Tube Condensing Boilers:

a. Heat Exchanger and Tank: Free from defects in material and workmanship.
b. Warranty Coverage: [**Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10- 10 percent**]<**Insert number**> years from date of Substantial Completion.

5. Warranty Period for Wall Hung Water-Tube Condensing Boilers:

a. Heat Exchanger and Tank: Free from defects in material and workmanship.
b. Warranty Coverage: [**Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10- 10 percent**]<**Insert number**> years from date of Substantial Completion.

6. Warranty Period for Water-Jacketed Condensing Boilers:

a. Heat Exchanger and Tank: Free from defects in material and workmanship.
b. Warranty Coverage: [**Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10 - 10 percent**] for <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency in accordance with Table 6.8.1-6 and other requirements in Ch. 6 of ASHRAE/IES 90.1.

D. ASHRAE 90.2 Compliance: Boilers shall have minimum efficiency in accordance with Ch. 6 of ASHRAE 90.2.

E. DOE Compliance: Minimum efficiency shall comply with [**10 CFR 431, Subpart E, Appendix N**][**10 CFR 430, Subpart B, Appendix N**].

F. Mounting Base: [**For securing boiler to concrete base**][**For securing boiler to structural wall**].

1. Seismic Fabrication Requirements: Fabricate [**mounting base**][**and**][**wall support**] and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

2.2 PULSE-COMBUSTION, FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Fulton Boiler Works, Inc**]
2. [**IBC Technologies; a Rheem brand**]
3. [**RIELLO**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Fulton Boiler Works, Inc**]
2. [**IBC Technologies; a Rheem brand**]
3. [**RIELLO**]
4. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, pulse-combustion condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

D. Combustion Chamber: [**Type 316L stainless steel**][**Carbon steel**].

E. Heat Exchangers: [**Type 316L stainless steel**][**Carbon steel**].

F. Pressure Vessel: Carbon steel with welded heads and tube connections.

G. Exhaust Decoupler: Fiberglass composite material in a corrosion-resistant steel box.

H. Burner: [**Natural**][**Propane**] gas, self-aspirating and self-venting after initial start.

I. Blower: Centrifugal fan to operate only during start of each burner sequence.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

J. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

K. Ignition: Direct-spark ignition with transformer and 100 percent main-valve shutoff with electronic flame supervision.

L. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: [**Baked-enamel**][**Powder-coated**][**Stainless steel**] protective finish.
4. Insulation: Minimum **2-inch- (50-mm-)** thick, mineral-fiber insulation surrounding heat exchanger.
5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.

M. Mufflers: Carbon-steel intake muffler and stainless steel exhaust.

N. Condensate Trap: Cast-iron body with stainless steel internal parts.

O. Capacities and Characteristics:

1. Design Water-Pressure Rating: [**15 psig (104 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure rating**>.
2. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
5. Design Water Flow Rate: <**Insert gpm (L/s)**>.
6. Design Pressure Drop: <**Insert psig (kPa)**>.
7. Minimum Efficiency AFUE: <**Insert number**> percent.
8. Minimum Thermal Efficiency: <**Insert number**> percent.
9. Minimum Combustion Efficiency: <**Insert number**> percent.
10. AGA Input: <**Insert MBh (kW)**>.
11. Gas Input: <**Insert cfh (mL/s)**>.
12. AGA Output Capacity: <**Insert MBh (kW)**>.
13. DOE Output Capacity: <**Insert MBh (kW)**>.
14. Equivalent Direct Radiation: <**Insert EDR (kW)**>.
15. Electrical Characteristics:

    a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: [**50**][**60**]<**Insert number**> Hz.
    d. Full-Load Amperes: <**Insert number**> A.
    e. Minimum Circuit Ampacity: <**Insert number**> A.
    f. Maximum Overcurrent Protection: <**Insert number**> A.

2.3 FLOOR-MOUNTED, FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AERCO; A WATTS Brand**]
2. [**Bosch Thermotechnology Corp.**]
3. [**Cleaver-Brooks**]
4. [**Fulton Boiler Works, Inc**]
5. [**Heat Transfer Products, Inc**]
6. [**IBC Technologies; a Rheem brand**]
7. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
8. [**Lochinvar, LLC**]
9. [**Patterson-Kelley**]
10. [**Raypak; a Rheem brand**]
11. [**Weil-McLain**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AERCO; A WATTS Brand**]
2. [**Bosch Thermotechnology Corp.**]
3. [**Cleaver-Brooks**]

4. [**Fulton Boiler Works, Inc**]
5. [**Heat Transfer Products, Inc**]
6. [**IBC Technologies; a Rheem brand**]
7. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
8. [**Lochinvar, LLC**]
9. [**Patterson-Kelley**]
10. [**Raypak; a Rheem brand**]
11. [**Weil-McLain**]
12. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, fire-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

D. Primary Heat Exchanger: Corrosion-resistant [**Type 316 stainless steel**][**cast iron**][**or**][**aluminum**].

E. Secondary Heat Exchanger: Corrosion-resistant [**Type 316 stainless steel**][**cast iron**][**or**][**aluminum**].

F. Combustion Chamber and Flue Pipes: Corrosion-resistant [**stainless steel**][**or**][**aluminum**].

G. Pressure Vessel: Carbon steel with welded heads and tube connections.

H. Burner: [**Natural gas**][**Propane**][**Dual fuel (gas and propane)**][**Dual fuel (gas and No. 2 fuel oil)**], forced draft.

I. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

J. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

K. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

L. Casing:

1. Jacket: [**Sheet metal**][**Plastic**], with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: [**Baked-enamel**][**Powder-coated**][**Stainless steel**] protective finish.
4. Insulation: Minimum **2-inch- (50-mm-)** thick, [**mineral-fiber**][**polyurethane-foam**] insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

M. Capacities and Characteristics:

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: [**160 psig (1100 kPa)**]<**Insert value**>.
3. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.

5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
6. Design Water Flow Rate: <**Insert gpm (L/s)**>.
7. Minimum Water Flow Rate: <**Insert gpm (L/s)**>.
8. Design Pressure Drop: <**Insert psig (kPa)**>.
9. Minimum Efficiency AFUE: <**Insert number**> percent.
10. Minimum Thermal Efficiency: <**Insert number**> percent.
11. Minimum Combustion Efficiency: <**Insert number**> percent.
12. AGA Input: <**Insert MBh (kW)**>.
13. Gas Input: <**Insert cfh (mL/s)**>.
14. AGA Output Capacity: <**Insert MBh (kW)**>.
15. DOE Output Capacity: <**Insert MBh (kW)**>.
16. Equivalent Direct Radiation: <**Insert EDR (kW)**>.
17. Electrical Characteristics:

    a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: [**50**][**60**]<**Insert number**> Hz.
    d. Full-Load Amperes: <**Insert number**> A.
    e. Minimum Circuit Ampacity: <**Insert number**> A.
    f. Maximum Overcurrent Protection: <**Insert number**> A.

2.4 WALL-HUNG, FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Heat Transfer Products, Inc**]
2. [**IBC Technologies; a Rheem brand**]
3. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
4. [**Lochinvar, LLC**]
5. [**Navien Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Heat Transfer Products, Inc**]
2. [**IBC Technologies; a Rheem brand**]
3. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
4. [**Lochinvar, LLC**]
5. [**Navien Inc.**]
6. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, fire-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

D. Heat Exchanger: Corrosion-resistant [**Type 316 stainless steel**].

E. Fire Tubes: Corrosion-resistant [**Type 316 stainless steel**][**or**][**aluminum core**].

F. Combustion Chamber and Flue Pipes: Corrosion-resistant [**stainless steel**][**or**][**aluminum**].

G. Burner: [**Natural gas**][**Propane**], forced draft.

H. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

I. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

J. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

K. Integral Circulator: Cast-iron body and stainless steel impeller sized for minimum flow required in heat exchanger.

L. Casing:

1. Jacket: [**Sheet metal**][**Plastic**], with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: [**Baked-enamel**][**Powder-coated**][**Stainless steel**] protective finish.
4. Insulation: Minimum **2-inch- (50-mm-)** thick, [**mineral-fiber**][**polyurethane-foam**] insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

M. Capacities and Characteristics:

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: [**160 psig (1100 kPa)**]<**Insert value**>.
3. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
6. Design Water Flow Rate: <**Insert gpm (L/s)**>.
7. Minimum Water Flow Rate: <**Insert gpm (L/s)**>.
8. Design Pressure Drop: <**Insert psig (kPa)**>.
9. Minimum Efficiency AFUE: <**Insert number**> percent.
10. Minimum Thermal Efficiency: <**Insert number**> percent.
11. Minimum Combustion Efficiency: <**Insert number**> percent.
12. AGA Input: <**Insert MBh (kW)**>.
13. Gas Input: <**Insert cfh (mL/s)**>.
14. AGA Output Capacity: <**Insert MBh (kW)**>.
15. DOE Output Capacity: <**Insert MBh (kW)**>.
16. Equivalent Direct Radiation: <**Insert EDR (kW)**>.
17. Electrical Characteristics:

a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: [**50**][**60**]<**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A.
f. Maximum Overcurrent Protection: <**Insert number**> A.

2.5 FLOOR-MOUNTED, WATER-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Advanced Thermal Hydronics; a Mestek company**]
2. [**AERCO; A WATTS Brand**]
3. [**Bosch Thermotechnology Corp.**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Embassy Industries, Inc.**]
7. [**Gasmaster Industries Incorporated**]
8. [**Heat Transfer Products, Inc**]
9. [**Hydrotherm, Inc./Mestek, Inc.**]
10. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
11. [**Lochinvar, LLC**]
12. [**Patterson-Kelley**]
13. [**Raypak; a Rheem brand**]
14. [**Smith Cast Iron Boilers**]
15. [**Triangle Tube**]
16. [**Viessmann Manufacturing Co. (US) Inc.**]
17. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Advanced Thermal Hydronics; a Mestek company**]
2. [**AERCO; A WATTS Brand**]
3. [**Bosch Thermotechnology Corp.**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Embassy Industries, Inc.**]
7. [**Gasmaster Industries Incorporated**]
8. [**Heat Transfer Products, Inc**]
9. [**Hydrotherm, Inc./Mestek, Inc.**]
10. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
11. [**Lochinvar, LLC**]
12. [**Patterson-Kelley**]
13. [**Raypak; a Rheem brand**]
14. [**Smith Cast Iron Boilers**]
15. [**Triangle Tube**]
16. [**Viessmann Manufacturing Co. (US) Inc.**]
17. **<Insert manufacturer's name>**

C. Description: Factory-fabricated, -assembled, and -tested, water-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

D. Heat Exchanger: Stainless steel primary and secondary heat exchangers.

E. Combustion Chamber: Stainless steel, sealed.

F. Burner: [**Natural**][**Propane**] gas, forced draft drawing from gas-premixing valve.

G. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

H. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

I. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

J. Integral Circulator: Cast-iron body and stainless steel impeller sized for minimum flow required in heat exchanger.

K. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: [**Baked-enamel**][**Powder-coated**][**Stainless steel**] protective finish.
4. Insulation: Minimum [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**] thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

L. Capacities and Characteristics:

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: [**160 psig (1100 kPa)**]<**Insert value**>.
3. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
6. Design Water Flow Rate: <**Insert gpm (L/s)**>.
7. Minimum Water Flow Rate: <**Insert gpm (L/s)**>.
8. Design Pressure Drop: <**Insert psig (kPa)**>.
9. Fuel: [**Natural gas**][**Propane**][**Dual fuel (gas and propane)**].
10. Minimum Efficiency AFUE: <**Insert number**> percent.
11. Minimum Thermal Efficiency: <**Insert number**> percent.
12. Minimum Combustion Efficiency: <**Insert number**> percent.
13. AGA Input: <**Insert MBh (kW)**>.
14. Gas Input: <**Insert cfh (mL/s)**>.
15. AGA Output Capacity: <**Insert MBh (kW)**>.
16. DOE Output Capacity: <**Insert MBh (kW)**>.
17. Electrical Characteristics:

a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: [**50**][**60**]<**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A.
f. Maximum Overcurrent Protection: <**Insert number**> A.

2.6 WALL HUNG, WATER-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Embassy Industries, Inc.**]
2. [**Heat Transfer Products, Inc**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Smith Cast Iron Boilers**]
7. [**Triangle Tube**]
8. [**Viessmann Manufacturing Co. (US) Inc.**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Embassy Industries, Inc.**]
2. [**Heat Transfer Products, Inc**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
5. [**Lochinvar, LLC**]
6. [**Smith Cast Iron Boilers**]
7. [**Triangle Tube**]
8. [**Viessmann Manufacturing Co. (US) Inc.**]
9. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, water-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

D. Heat Exchanger: Stainless steel primary and secondary heat exchangers.

E. Combustion Chamber: Stainless steel, sealed.

F. Burner: [**Natural**][**Propane**] gas, forced draft drawing from gas-premixing valve.

G. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

H. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

I. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

J. Integral Circulator: Cast-iron body and stainless steel impeller sized for minimum flow required in heat exchanger.

K. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: [**Baked-enamel**][**Powder-coated**][**Stainless steel**] protective finish.
4. Insulation: Minimum [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**] thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

L. Capacities and Characteristics:

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: [**160 psig (1100 kPa)**]<**Insert value**>.
3. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
6. Design Water Flow Rate: <**Insert gpm (L/s)**>.
7. Minimum Water Flow Rate: <**Insert gpm (L/s)**>.
8. Design Pressure Drop: <**Insert psig (kPa)**>.
9. Fuel: [**Natural gas**][**Propane**][**Dual fuel (gas and propane)**].
10. Minimum Efficiency AFUE: <**Insert number**> percent.
11. Minimum Thermal Efficiency: <**Insert number**> percent.
12. Minimum Combustion Efficiency: <**Insert number**> percent.
13. AGA Input: <**Insert MBh (kW)**>.
14. Gas Input: <**Insert cfh (mL/s)**>.
15. AGA Output Capacity: <**Insert MBh (kW)**>.
16. DOE Output Capacity: <**Insert MBh (kW)**>.
17. Electrical Characteristics:

    a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: [**50**][**60**]<**Insert number**> Hz.
    d. Full-Load Amperes: <**Insert number**> A.
    e. Minimum Circuit Ampacity: <**Insert number**> A.
    f. Maximum Overcurrent Protection: <**Insert number**> A.

2.7 WATER-JACKETED CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Thermotechnology Corp.**]
2. [**Heat Transfer Products, Inc**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Lochinvar, LLC**]
5. [**RIELLO**]
6. [**Viessmann Manufacturing Co. (US) Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Thermotechnology Corp.**]

2. [**Heat Transfer Products, Inc**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Lochinvar, LLC**]
5. [**RIELLO**]
6. [**Viessmann Manufacturing Co. (US) Inc.**]
7. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

D. Heat Exchanger: Stainless steel primary and secondary heat exchangers.

E. Burner: [**Natural**][**Propane**] modulating gas, forced draft; stainless steel cylinder burner.

F. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.

H. Ignition: Electric-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Powder-coated protective finish.
4. Insulation: Minimum **2-inch- (50-mm-)** thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

J. Capacities and Characteristics:

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: [**160 psig (207 kPa)**]<**Insert value**>.
3. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
4. Maximum Design Temperature: **210 deg F (99 deg C)**.
5. Entering-Water Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
7. Design Water Flow Rate: <**Insert gpm (L/s)**>.
8. Design Pressure Drop: <**Insert psig (kPa)**>.
9. Minimum Efficiency AFUE: <**Insert number**> percent.
10. Minimum Thermal Efficiency: <**Insert number**> percent.
11. Minimum Combustion Efficiency: <**Insert number**> percent.
12. AGA Input: <**Insert MBh (kW)**>.
13. Gas Input: <**Insert cfh (mL/s)**>.
14. AGA Output Capacity: <**Insert MBh (kW)**>.
15. DOE Output Capacity: <**Insert MBh (kW)**>.

16. Equivalent Direct Radiation: <**Insert EDR (kW)**>.
17. Electrical Characteristics:

    a. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
    b. Phase: [**Single**][**Three**].
    c. Hertz: [**50**][**60**]<**Insert number**> Hz.
    d. Full-Load Amperes: <**Insert number**> A.
    e. Minimum Circuit Ampacity: <**Insert number**> A.
    f. Maximum Overcurrent Protection: <**Insert number**> A.

2.8 TRIM - FOR HOT-WATER BOILERS

A. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**].

B. Aquastat Controllers: Operating[**, firing rate,**] and high limit with [**manual**][**automatic**] reset.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gauge: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. High and low gas-pressure switches.

F. Alarm bell with silence switch.

G. Boiler Air Vent: [**Automatic**][**Manual**].

H. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end gate valve.

I. Circulation Pump: Nonoverloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.9 CONTROLS

A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: All set points shall be adjustable.
3. Electric, factory-fabricated and [**factory-installed**][**field-installed**] panel to [**modulate burner**][**and**][**control burner-firing rate**] to maintain space temperature in response to thermostat with heat anticipator located in heated space.

    a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

4. Electric, factory-fabricated and [**factory-installed**][**field-installed**] panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outside-air temperature, set supply-water temperature

at [140 deg F (60 deg C)]<**Insert temperature**>; at [60 deg F (15 deg C)]<**Insert temperature**> outside-air temperature, set supply-water temperature at [90 deg F (32 deg C)]<**Insert temperature**>.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: [**Manual**][**Automatic**] reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch [**factory**][**field**] mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

a. Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring**>.
b. Control: On/off operation, [**hot-water-supply temperature set-point adjustment**]<**Insert control**>.

2. A [**BACnet**][**Metasys**][**Lonworks**]<**Insert type**> communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. All monitoring and control features, which are available at the local boiler control panel, shall also be available at the remote operator workstation through the building automation system.

2.10 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, [**Type 1**]<**Insert type**> enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a [**metal**]raceway.
4. Field power interface shall be to [**wire lugs**][**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**].
5. Provide branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
6. Provide each motor with overcurrent protection.

2.11 VENTING KITS

A. Kit: Complete system, ASTM A959, Type 29-4C stainless steel pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel pipe, vent terminal with screen, inlet air coupling, and sealant.

2.12 CONDENSATE-NEUTRALIZATION UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Neutra-Safe Corporation**]
2. [**SFA Saniflo USA**]
3. [**Skidmore Pump**]
4. [**Wessels Company**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Neutra-Safe Corporation**]
2. [**SFA Saniflo USA**]
3. [**Skidmore Pump**]
4. [**Wessels Company**]
5. <**Insert manufacturer's name**>

C. Description: Factory-fabricated and -assembled condensate-neutralizing [**capsule**][**tank**] assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

D. [**Capsule**][**Tank**] features:

1. All corrosion-resistant material.
2. Suitable for use on all natural gas and propane boilers.
3. Includes initial charge of neutralizing agent.
4. Neutralizing agent to be easily replaceable when exhausted.
5. Inlet and outlet pipe connections.

E. Capsule Configuration:

1. Low-profile design for applications where boiler condensate drain is close to the floor.
2. Easily removed and opened for neutralizing agent replacement.
3. Multiple units may be used for larger capacity.

F. Tank Configuration:

1. Utilized where boiler is elevated or where tank is installed in a pit with tank top flush with floor.
2. Top easily removed for neutralizing agent replacement.
3. Internal baffles to channel flow for complete neutralization.

4. Integral bypass to prevent condensate backflow into appliance.
5. Multiple units may be used for larger capacity.

2.13 SOURCE QUALITY CONTROL

A. UL Compliance: Test gas-fired boilers having input of more than **400,000 Btu/h (117 kW)** for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

B. UL Compliance, Oil-Fired: Test oil-fired boilers for compliance with UL 726. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

C. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

D. CSA Compliance: Test boilers for compliance with ANSI Z21.13-2017/CSA 4.9.

E. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.

F. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

G. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

H. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install floor-mounted boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place

Concrete."
2. Install wall-hung boilers where indicated on Drawings using suitable hangers. Comply with manufacturer's mounting instructions.
3. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 PIPING CONNECTIONS

A. Comply with requirements for hydronic piping specified in Section 232113 "Hydronic Piping."

B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.

E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

F. Install condensate piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

G. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

H. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve, and union or flange at each connection.

I. Install piping from safety relief valves to nearest floor drain.

3.4 DUCT CONNECTIONS

A. Boiler Venting:

1. Install flue-venting kit and combustion-air intake.
2. Field fabricate and install boiler vent and combustion-air intake.
3. Utilize vent and intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.

4. Connect boiler vent full size to boiler connections.
5. Comply with requirements in Section 235123 "Gas Vents."
6. Comply with all boiler manufacturer's installation instructions.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert size**> high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert size**> high.

3.7 FIELD QUALITY CONTROL

A. Testing Agency, Owner: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[**with the assistance of a factory-authorized service representative**]:

E. Tests and Inspections:

1. Perform installation and startup checks in accordance with manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel

ratio and combustion.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

F. Boiler will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Occupancy Adjustments: When requested within [**12 months of date of Substantial Completion**]<**Insert time period**>, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training." [**Video record the training sessions and provide electronic copy to Owner.**]

1. Instructor shall be factory trained and certified.
2. Provide not less than [**two**]<**Insert number**> hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 23 52 16 00

Task	Specification	Specification Description
23 52 16 13	23 52 16 00	Condensing Boilers
23 52 16 16	23 52 16 00	Condensing Boilers
23 52 16 19	23 52 16 00	Condensing Boilers
23 52 16 23	23 52 16 00	Condensing Boilers

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SECTION 23 52 23 00 - CAST-IRON BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cast-iron boilers, trim, and accessories for generating hot water and steam.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.

C. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for boiler, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

E. Product Test Reports:

1. CSA B51 pressure vessel Canadian Registration Number (CRN).
2. Startup service reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace controls and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Controls: [**Two**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: [**Five**][**10**][**20**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers are to have minimum efficiency in accordance with "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency is to comply with 10 CFR 430, Subpart B, Appendix N.

E. I=B=R Compliance: Boilers are to be tested and rated in accordance with AHRI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. UL Compliance: Test boilers for compliance with [**UL 726**][**UL 726 and UL 795**][**UL 795**]. Boilers are to be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. CSA Compliance: Test boilers for compliance with CSA B51.

H. Mounting Frame: Steel rails used to mount assembled boiler package on concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

2.2 CAST-IRON BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Burnham Hydronics**]
2. [**Crown Boiler Co**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Lennox**]
5. [**Peerless Boilers; PB Heat LLC**]
6. [**Slant/Fin Corp**]
7. [**Smith Cast Iron Boilers**]
8. [**Viessmann Manufacturing Co. (US) Inc.**]
9. [**Weil-McLain**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Burnham Hydronics**]
2. [**Crown Boiler Co**]
3. [**Hydrotherm, Inc./Mestek, Inc.**]
4. [**Lennox**]
5. [**Peerless Boilers; PB Heat LLC**]
6. [**Slant/Fin Corp**]
7. [**Smith Cast Iron Boilers**]
8. [**Viessmann Manufacturing Co. (US) Inc.**]
9. [**Weil-McLain**]
10. <**Insert manufacturer's name**>

C. Description: Factory fabricated and [**field**]assembled.

1. Cast-iron sections are to be sealed pressure tight and held together with tie rods[**set on an insulated steel base**], including insulated jacket and flue-gas vent connection.
2. Ship cast-iron sections disassembled with all materials and equipment, including seals, tie rods, and insulated jacket and flue-gas vent connection for field assembly.

D. Cast-Iron Section Design:

1. Configuration: Wet [**base**][**back**][**leg**].
2. Number of Passes: [**Single**][**Multiple**].
3. Sectional Joints: High-temperature sealant to seal flue-gas passages not in contact with heating medium, [**tapered cast-iron push nipples,**][**O-ring gaskets,**][**fiber roping,**] and held together with tie rods.
4. Drain and blowdown tappings.
5. Return injection tube to equalize water flow to all sections.
6. Crown inspection tappings with brass plugs.
7. Built-in air separator.

E. Combustion Chamber: Equipped with [**ceramic-fiber target wall**][**refractory**][**insulation**][**and**] flame observation ports, front and back.

F. Casing:

1. Jacket: [**Galvanized sheet**][**Sheet**] metal, with snap-in or interlocking closures and [**baked-enamel**][**powder-coated**] protective finish.
2. Insulation: Minimum [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**] thick, mineral-fiber insulation surrounding the heat exchanger.
3. Combustion Chamber Access: Refractory lined, hinged, front.
4. Access: For cleaning between cast-iron sections.
5. Draft Hood: Flue canopy and [**top**][**rear**] flue connection are to be constructed of [**aluminized**][**stainless**] steel containing adjustable outlet damper assembly.
6. Insulated base constructed of aluminized steel to permit boiler to be installed on combustible floor.
7. Control Cabinet: Sheet metal casing covers all controls, gas train, and burner.

G. Draft Diverter: [**Steel assembly integral with boiler casing**][**Separate galvanized-steel assembly**].

2.3 ATMOSPHERIC-GAS BURNER

A. Burner Tubes and Orifices: [**Stainless steel**][**Cast iron**], for [**natural**][**propane**] gas.

B. Gas Train for Commercial Boilers: Control devices and [**full-modulation**][**on-off**][**low-high-low**] control sequence are to comply with requirements in [**ASME CSD-1**][**FM Global**][**IRI**][**UL**].

C. Gas Train for Residential Boilers: Combination-gas valve with manual shutoff, pressure regulator, and pilot adjustment.

D. Pilot: [**Standing**][**Intermittent-electric-spark**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

2.4 SEALED-COMBUSTION BURNER

A. Burner Tubes and Orifices: [**Stainless steel**][**Cast iron**], for [**natural**][**propane**] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor, with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

D. Pilot: [**Standing**][**Intermittent-electric-spark**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

2.5 FORCED-DRAFT BURNER

A. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for [**natural**][**propane**] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor, with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Gas Train: Control devices and [**modulating**][**on-off**][**low-high-low**] control sequence are to comply with requirements in [**ASME CSD-1**][**FM Global**][**IRI**][**UL**].

D. Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

E. Flue-Gas Recirculation: Burner connections are to be equipped for recirculating flue gas.

1. Maximum Oxides of Nitrogen Emissions: [**20**][**30**]<**Insert number**> ppm.

2.6 OIL BURNER

A. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for fuel oil.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor, with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Oil Supply: Control devices and [**modulating**][**on-off**][**low-high-low**] control sequence are to comply with requirements in [**ASME CSD-1**][**FM Global**][**IRI**][**UL**].

1. Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] capable of producing **300-psig (2070-kPa)** discharge pressure and **15-inch Hg (50.7-kPa)** vacuum.
2. Oil Piping Specialties:

a. Suction-line, manual gate valve.
b. Removable-mesh oil strainer.
c. **0- to 30-inch Hg (0- to 101.3-kPa)** vacuum; **0- to 30-psig (0- to 207-kPa)** vacuum-pressure gage.
d. **0- to 300-psig (0- to 2070-kPa)** oil-nozzle pressure gage.
e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using [**cadmium sulfide**][**UV scanner**] flame-safety control.

E. Flue-Gas Recirculation: Burner connections are to be equipped for recirculating flue gas.

1. Maximum Oxides of Nitrogen Emissions: [**20**][**30**]<**Insert number**> ppm.

2.7 COMBINATION GAS AND OIL BURNER

A. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for fuel oil and [**natural**][**propane**] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor, with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Oil Supply: Control devices and [**modulating**][**on-off**][**low-high-low**] control sequence are to comply with requirements in [**ASME CSD-1**][**FM Global**][**IRI**][**UL**].

1. Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] capable of producing **300-psig (2070-kPa)** discharge pressure and **15-inch Hg (50.7-kPa)** vacuum.
2. Oil Piping Specialties:

a. Suction-line, manual, gate valve.
b. Removable-mesh oil strainer.
c. **0- to 30-inch Hg (0- to 101.3-kPa)** vacuum; **0- to 30-psig (0- to 207-kPa)** vacuum-pressure gage.
d. **0- to 300-psig (0- to 2070-kPa)** oil-nozzle pressure gage.
e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. Gas Train: Control devices and [**modulating**][**on-off**][**low-high-low**] control sequence are to comply with requirements in [**ASME CSD-1**][**FM Global**][**IRI**][**UL**].

E. Gas Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

F. Oil Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with [**cadmium sulfide**][**UV scanner**] flame-safety control.

G. Flue-Gas Recirculation: Burner connections are to be equipped for recirculating flue gas.

1. Maximum Oxides of Nitrogen Emissions: [**20**][**30**]<**Insert number**> ppm.

2.8 TRIM FOR HOT-WATER BOILERS

A. Include devices sized to comply with ASME B31.9.

B. Aquastat Controllers: Operating[**, firing rate,**] and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gage. Gages are to have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: [**Automatic**][**Manual**].

F. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end gate valve.

G. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.

1. Tappings NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1 for pipe threads.
2. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.

2.9 TRIM FOR STEAM BOILERS

A. Include devices sized to comply with ASME B31.9.

B. Pressure Controllers: Operating[**, firing rate,**] and high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment in accordance with 2010 ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum **3-1/2-inch (89-mm)** diameter. Gage is to have normal operating pressure about 50 percent of full range.

E. Water Column: Minimum **12-inch (300-mm)** glass gage with shutoff cocks.

F. Drain Valves: Minimum **NPS 3/4 (DN 20)** or nozzle size with hose-end connection.

G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, are to be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size as or larger than nozzle. Valves larger than **NPS 2 (DN 50)** have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.

1. Tappings NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1 for pipe

threads.

2. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.

2.10 CONTROLS

A. See Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Boiler operating controls include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points are to be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.

a. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.

1) Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.

b. Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outside-air temperature, set supply-water temperature at [**200 deg F (93 deg C)**]<**Insert temperature**>; at [**60 deg F (15 deg C)**]<**Insert temperature**> outside-air temperature, set supply-water temperature at [**140 deg F (60 deg C)**]<**Insert temperature**>.

1) Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.

c. Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

1) Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.

C. Safety Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: [**Manual**][**Automatic**] reset stops burner if operating conditions rise above maximum boiler design [**temperature**][**pressure**].
2. Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe prevents burner operation on low water. Cutoff switch is to be [**manual**][**automatic**]-reset type.
3. Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.
4. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
5. Audible Alarm: Factory mounted on control panel with silence switch; alarm sounds for above conditions.

D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

   a. Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring**>.
   b. Control: On/off operation, [**hot-water-supply temperature set-point adjustment**][**steam pressure adjustment**]<**Insert control**>.

2. A communication interface with building management system is to enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available and monitoring points displayed, locally at boiler control panel is to be available through building management system.

2.11 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary provide a single-point field power connection to boiler.

1. House in NEMA 250, Type [**1**]<**Insert type**> enclosure.
2. Wiring is to be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a [**metal**]raceway.
4. Field power interface is to be to [**wire lugs**][**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**].
5. Provide branch power circuit to each motor and to controls[**with disconnect switch or circuit breaker**].
6. Provide each motor with overcurrent protection.

2.12 CAPACITIES AND CHARACTERISTICS

A. Hot-Water Heating:

1. Design Water-Pressure Rating: [**30 psig (207 kPa)**][**50 psig (345 kPa)**][**80 psig (550 kPa)**]<**Insert pressure rating**>.
2. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
5. Design Water Flow Rate: <**Insert gpm (L/s)**>.
6. Design Pressure Drop: <**Insert psig (kPa)**>.

B. Steam Heating:

1. Design Steam-Pressure Rating: [**Steam, 15 psig (104 kPa)**]<**Insert pressure rating**>.
2. Safety Relief Valve Setting: <**Insert psig (kPa)**>.
3. Steam Operating Pressure: <**Insert psig (kPa)**>.
4. Steam Flow Rate: <**Insert lb/h (kg/s)**>.

C. Minimum Efficiency AFUE: <**Insert number**> percent.

D. Minimum Thermal Efficiency: <**Insert number**> percent.

E. Minimum Combustion Efficiency: <**Insert number**> percent.

F. Number of Passes: [**One**][**Two**]<**Insert number**>.

G. Input Rating Method:

1. AGA Input: <**Insert MBh (kW)**>.
2. I=B=R Input: <**Insert MBh (kW)**>.
3. Gas Input: <**Insert cfh (mL/s)**>.
4. Oil Input: <**Insert gph (mL/s)**>.

H. Output Capacity

1. AGA Output Capacity: <**Insert MBh (kW)**>.
2. DOE Output Capacity: <**Insert MBh (kW)**>.
3. Net I=B=R Output Capacity: <**Insert MBh (kW)**>.
4. Gross I=B=R Output Capacity: <**Insert MBh (kW)**>.
5. Equivalent Direct Radiation: <**Insert EDR (W)**>.

I. Tankless Water Heater:

1. Design Water Flow: <**Insert gpm (L/s)**>.
2. Design Pressure Drop: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

J. Blower:

1. Motor Horsepower: <**Insert number**> hp.
2. RPM: <**Insert number**>.

K. Electrical Characteristics:

1. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: [**50**][**60**]<**Insert number**> Hz.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.
6. Maximum Overcurrent Protection: <**Insert number**> A.

2.13 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, in accordance with [**2010 ASME Boiler and Pressure Vessel Code**][**CSA B51**].

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CAST-IRON BOILERS

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install gas-fired boilers in accordance with NFPA 54.

C. Install oil-fired boilers in accordance with NFPA 31.

D. Assemble boiler sections in sequence and seal between each section.

E. Assemble and install boiler trim.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

G. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in [**Section 232113 "Hydronic Piping"**][**and**][**Section 232213 "Steam and Condensate Heating Piping."**] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect gas piping to boiler gas-train inlet with union. Piping is to be at least full size of gas-train connection. Provide a reducer if required.

D. Connect oil piping full size to burner inlet with shutoff valve and union.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at

each connection.

F. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. Install piping from equipment drain connection to nearest floor drain. Piping is to be at least full size of connection. Provide an isolation valve if required.

J. Connect breeching full size to boiler outlet. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for venting materials.

K. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Section 235123 "Gas Vents" for recirculation duct materials.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform installation and startup checks in accordance with manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
    b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and [**water temperature**][**steam pressure**].
    c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Remove and replace malfunctioning units and retest as specified above.

E. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers are to comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.

    a. For dual-fuel boilers, perform tests for each fuel.

b. Test for full capacity.
c. Test for boiler efficiency at [**low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20**]<**Insert range**> percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

F. Boiler will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12 months**]<**Insert time period**> of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boilers. See Section 017900 "Demonstration and Training."

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SECTION 23 52 33 00 - WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Finned water-tube boilers.
2. Steel or flexible water-tube boilers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, include the following:

1. Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.
4. Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.
5. Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.
6. Calculations showing predicted surface temperature of boiler jacket with basis indicated.
7. Force and moment capacity of each piping and flue connection.
8. Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.
9. Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
10. Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.
11. Pressure rating, size, and materials of construction for boiler fuel train components, including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.
12. Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.
13. Product data for each motor, including performance, operating characteristics, and materials of construction.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.

C. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Design calculations and base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting [**vibration isolators and**] seismic restraints and for designing bases.
b. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
5. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to <**Insert scale**> scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:

1. Column grids, beams, columns, and concrete housekeeping pads.
2. Room layout with walls, floors, and roofs, including each room name and number.
3. Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems, and plumbing systems.

B. Seismic Qualification Certificates: For boilers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Installation instructions.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

G. Other Informational Submittals:

1. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. Startup service reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:

1. A tool kit specially designed by boiler manufacturer for use in servicing boiler(s) furnished.
2. Special tools required to service boiler components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Boiler Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **0.5 inch (13 mm)** high.

B. Touch-up Paint: [**32-oz. (1-L)**]<**Insert volume**> container of paint used for finish coat. Label on outside of container shall have a detailed description of paint to allow for procurement of a matching paint in the future.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.

B. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.

C. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

D. Package boiler for export shipping in totally enclosed [**bagging**][**crate**][**crate with bagging**].

1.7 WARRANTY

A. Special Warranty:

1. Manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.

   a. Warranty Period for Heat Exchangers: [**20**]<**Insert number**> years from date of Substantial Completion.
   b. Warranty Period for Vent Dampers: [**Five**]<**Insert number**> years from date of Substantial Completion.

2. Manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.

   a. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner:

[**Five**]<**Insert number**> years from date of Substantial Completion, pro rata.
b. Warranty Period for Pressure Vessel: [**20**]<**Insert number**> years from date of Substantial Completion, for thermal shock.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fuel-to-steam and fuel-to-water efficiency indicated is to be based on the following:

1. Efficiency Testing Method:

a. BTS-2000.
b. ASME Performance Test Code (PTC) 4, [**Input-Output**][**Heat Loss**] method.
c. <**Insert test requirement**>.

2. Test Operating Conditions:

a. Ambient Temperature: <**Insert temperature**>.
b. Ambient Relative Humidity: <**Insert relative humidity**>.
c. Percent Excess Air in Exhaust Flue Gas: [**15**]<**Insert number**>.
d. Fuel Heating Value: <**Insert value**>.

B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.

1. Carbon Monoxide:

a. [**50**]<**Insert number**> parts per million at any point from 100 percent to [**50**]<**Insert number**> percent fire.
b. [**150**]<**Insert number**> parts per million at any point below [**50**]<**Insert number**>percent fire.

2. Nitrogen Compounds: [**30**][**20**][**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
3. Sulfur Compounds: [**One**]<**Insert number**> part per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
4. Hydrocarbon and Volatile Organic Compounds: [**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
5. Particulate Matter: [**0.01 lb/MMBtu**]<**Insert value**>.
6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

C. Oil-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.

1. Carbon Monoxide:

a. [**50**]<**Insert number**> parts per million at any point from 100 percent to [**50**]<**Insert number**> percent fire.
b. [**150**]<**Insert number**> parts per million at any point below [**50**]<**Insert number**> percent fire.

2. Nitrogen Compounds: [**30**][**20**][**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
3. Sulfur Compounds: [**One**]<**Insert number**> part per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
4. Hydrocarbon and Volatile Organic Compounds: [**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
5. Particulate Matter: [**0.01 lb/MMBtu**]<**Insert value**>.
6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

D. Multiple Boiler Operation: Equip individual boilers in multiple boiler applications with integral controls to provide multiple boiler operation for optimum system performance, energy efficiency, and the following:

1. Equalize runtime of boilers in service.
2. Operate multiple boilers hot to minimize disruption of service in the event of single boiler failure.
3. Configure controls so any boiler can be taken out of service with power disconnected and not impact multiple boiler operation.
4. <**Insert requirement**>.

E. Seismic Performance: Boiler shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the boiler will remain in place without separation of any parts when subjected to the seismic forces specified[**and the boiler will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

F. Sound: Boiler sound level, measured according to parameters defined in ABMA publication "Boiler 304 Measurement of Sound from Steam Generators" shall not exceed <**Insert number**> dBA.

G. Steam Quality: [**99**][**99.5**]<**Insert number**> percent dry[**and saturated**].

H. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a back-up power source or through normal power if restored before back-up power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

I. Outdoor Installations:

1. Boiler shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**]<**Insert number**> -year period, with minimal degradation due to exposure to outdoor ambient conditions.
2. Boilers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**]<**Insert number**> -year period. Provide as part of boiler package, products, such as combustion-air pre-heaters and other means and methods required.

J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

L. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

M. DOE Compliance: Minimum efficiency for boilers with capacity of **300,000 Btu/h (87.9 kW)** shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

N. UL Compliance: Test boilers for compliance with [**UL 726**][**UL 726 and UL 795**][**UL 795**]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.2 FINNED WATER-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A. O. Smith Corporation**]
2. [**Ajax Boiler Inc**]
3. [**Allied Engineering Co.**]
4. [**Green Boiler Technologies**]
5. [**Harsco Industrial, Patterson-Kelley**]
6. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
7. [**Lochinvar, LLC**]
8. [**Precision Boilers**]
9. [**Raypak; a Rheem brand**]
10. [**RBI**]
11. [**RECO USA**]
12. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A. O. Smith Corporation**]
2. [**Ajax Boiler Inc**]
3. [**Allied Engineering Co.**]
4. [**Green Boiler Technologies**]
5. [**Harsco Industrial, Patterson-Kelley**]
6. [**Laars Heating Systems Company; a subsidiary of Bradford White Corporation**]
7. [**Lochinvar, LLC**]
8. [**Precision Boilers**]
9. [**Raypak; a Rheem brand**]
10. [**RBI**]
11. [**RECO USA**]
12. **<Insert manufacturer's name>**

C. Description: Factory-fabricated, -assembled, and -tested boiler, with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air-intake connections, water supply and return connections, and controls.

D. Heat Exchanger:

1. Finned [**copper**][**steel**][**or**][**copper-nickel**] tubing with stainless steel baffles.
2. [**Bronze**][**Cast-iron**][**or**][**Steel**] headers.
3. [**Single**][**Two**]-pass, [**horizontal**][**vertical**][**or**][**coil**] configuration.
4. Tubes shall be sealed in header [**with silicone O-ring gaskets**][**by welding**][**or**][**by mechanically rolling tubes in header**].

E. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures of up to **2000 deg F (1100 deg C)**.

F. Casing:

1. Jacket: [**Sheet metal**][**or**][**Stainless steel**], with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: [**Baked enamel over primer**][**Baked enamel over galvanizing**][**Powder coated**].
4. Insulation: Minimum [**1-inch- (25-mm-)**][**2-inch- (50-mm-)**]<**Insert value**> thick, mineral-fiber insulation surrounding the heat exchanger.
5. Draft Hood: [**Integral**][**External**].
6. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
7. Mounting base to secure boiler[**with accessory for mounting on combustible surface**].

G. Burner:

1. Burner Tubes and Orifices: Stainless steel, for [**natural**][**propane**] gas.[**Mount burner tubes in a slide-out burner drawer for ease of inspection.**]

   a. Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
   b. Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.

2. Vertical Burner:

   a. [**High-temperature stainless steel**][**Ceramic**] to fire in a 360-degree pattern.
   b. Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply [**room**][**outdoor**] air[**through a replaceable 99 percent efficient (1-micrometer particles) filter**] to boiler burner.
   c. Fan shall be controlled to prepurge and postpurge the combustion chamber before firing.

3. Gas Train for Commercial Boilers: Control devices and [**full-modulation**][**on/off**][**low/high/low**][**proportional**] control sequence shall comply with [**AGA**][**ASME CSD-1**][**FM Global**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.
4. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
5. Pilot: [**Standing**][**Intermittent-electric-spark**][**Hot-surface**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
6. Flue-Gas Recirculation System: Centrifugal fans on burner assembly to recirculate flue gas to decrease emissions to requirements indicated. Complete package integrating burner, fan, damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.
7. Motors: Comply with requirements for motors specified in Section 230500 "Common Work Results for HVAC."

H. Hot-Water Boiler Trim:

1. Hot-Water Temperature Controllers: Operating[**, firing rate,**] and high limit.
2. Safety Relief Valve: ASME rated.
3. Pressure and Temperature Gage: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
4. Boiler Air Vent: [**Automatic**][**Manual**].
5. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end valve.
6. Circulation Pump: Non-overloading, in-line pump with [**split-capacitor**]motor having thermal-overload protection and lubricated bearings; designed to operate at boiler flow rate, pressures, and temperatures.

I. Controls:

1. Boiler operating controls shall include the following devices and features:

   a. Control transformer.
   b. Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.
   c. Set-Point Adjust: Set points shall be adjustable.
   d. Sequence of Operation:

      1) Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
      2) Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outdoor-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**200 deg F (93 deg C)**]<**Insert temperature**>; at [**60 deg F (15 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**140 deg F (60 deg C)**]<**Insert temperature**>.

   e. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

   a. High Cutoff: [**Manual**][**Automatic**] reset stops burner if operating conditions rise above maximum boiler design temperature.
   b. Water Flow Switch: Automatic-reset paddle-switch shall prevent burner operation on low water flow.
   c. Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.
   d. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
   e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

3. DDC System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

   a. Hardwired I/O Points:

      1) Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring point**>.

2) Control: On/off operation, [**hot-water-supply temperature set-point adjustment**]<**Insert control point**>.

b. Communication Interface: [**ASHRAE 135 (BACnet)**][**(LonTalk)**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface shall enable control system operator to remotely control on/off operation and capacity of boiler and monitor the boiler operation from an operator workstation. The control features and monitoring points at the boiler-control panel shall be available to the control system through an interface.

2.3 STEEL OR FLEXIBLE WATER-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ajax Boiler Inc**]
2. [**Bryan Boilers; Bryan Steam LLC**]
3. [**Cleaver-Brooks**]
4. [**Miura North America, inc.**]
5. [**Parker Boiler**]
6. [**Raypak; a Rheem brand**]
7. [**Rite Engineering & Mfg. Corp.**]
8. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ajax Boiler Inc**]
2. [**Bryan Boilers; Bryan Steam LLC**]
3. [**Cleaver-Brooks**]
4. [**Miura North America, inc.**]
5. [**Parker Boiler**]
6. [**Raypak; a Rheem brand**]
7. [**Rite Engineering & Mfg. Corp.**]
8. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
9. <**Insert manufacturer's name**>

C. Description: Factory-fabricated and [**field**]-assembled water-tube boiler, with heat exchanger sealed pressure tight, and built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.

D. Heat-Exchanger Design, Straight Steel Tubes Rolled into Steel Headers:

1. Accessible head plates at both ends.
2. Handholes[**or couplings**] in headers for waterside inspections.
3. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
4. Lifting lugs on top of boiler.
5. Built-in air separator.

E. Heat-Exchanger Design, Bent Steel Tubes and Steel Headers:

1. Tube/Header Connection: [**Swaged**][**Welded**].
2. Water Wall Design: [**Waterfall**]<**Insert design type**>.

3. Limit tube configurations to [**two**][**four**]<**Insert number**>.
4. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
5. Accessible inspection ports in drum, mud legs, and tube manifolds.
6. Lifting lugs on top of boiler.
7. Built-in air separator.

F. Combustion Chamber: Equipped with minimum [**2-1/2-inch (64-mm)**][**3-inch (75-mm)**][**4-inch (100-mm)**], **2700 deg F (1482 deg C)** poured refractory on floor and minimum [**2-inch (50-mm)**][**3-1/2-inch (89-mm)**]<**Insert value**> lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front [**and**][**or**] back.

G. Casing:

1. Insulation: Minimum[**2-inch (50-mm) thick, lightweight refractory; 1-inch (25-mm) thick insulating board; galvanized-steel membrane; and**] **2-inch (50-mm)** thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
2. Top Flue Connection: Constructed of [**aluminized**][**or**][**stainless**] steel.
3. Jacket:

   a. Mirror-finish stainless steel, with screw-fastened closures.
   b. [**Galvanized**]sheet metal, with screw-fastened closures and [**baked-enamel**][**powder-coated**] protective finish.

4. Mounting Base: Secures boiler to concrete base.

H. Draft Control: [**Draft diverter**][**Barometric damper**]; galvanized-steel assembly with flue-gas thermometer.

I. Atmospheric Gas Burner:

1. Burner and Orifices: [**Stainless steel**][**Cast iron**], for [**natural**][**propane**] gas.
2. Gas Train for Commercial Boilers: Control devices and [**full-modulation**][**on/off**][**low/high/low**] control sequence shall comply with [**ASME CSD-1**][**FM Global**][**NFPA 85**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.
3. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
4. Pilot: [**Standing**][**Intermittent-electric-spark**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

J. Forced-Draft Gas Burner:

1. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for [**natural**][**propane**] gas.[**Mount burner on hinged access door to permit access to combustion chamber.**]
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
3. Gas Train: Control devices and [**modulating**][**on/off**][**low/high/low**] control sequence shall comply with [**ASME CSD-1**][**FM Global**][**NFPA 85**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.
4. Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

K. Forced-Draft Oil Burner:

1. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for fuel oil.[

Mount burner on hinged access door to permit access to combustion chamber.]

2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
3. Oil Supply: Control devices and [**modulating**][**on/off**][**low/high/low**] control sequence shall comply with [**ASME CSD-1**][**FM Global**][**NFPA 85**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.

    a. Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] shall be capable of producing **300-psig (2070-kPa)** discharge pressure and **15-inch Hg (50.7-kPa)** vacuum.
    b. Oil Piping Specialties:

        1) Suction-line, manual, gate valve.
        2) Removable-mesh oil strainer.
        3) **0- to 30-inch Hg (0- to 101.3-kPa)** vacuum; **0- to 30-psig (0- to 207-kPa)** vacuum-pressure gage.
        4) **0- to 300-psig (0- to 2070-kPa)** oil-nozzle pressure gage.
        5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety-shutoff solenoid using [**cadmium sulfide**][**UV scanner**] flame-safety control.

L. Forced-Draft Combination Gas and Oil Burner:

1. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser for fuel oil and [**natural**][**propane**] gas.[**Mount burner on hinged access door to permit access to combustion chamber.**]
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
3. Oil Supply: Control devices and [**modulating**][**on/off**][**low/high/low**] control sequence shall comply with [**ASME CSD-1**][**FM Global**][**NFPA 85**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.

    a. Oil Pump: Two-stage, gear-type oil pump[**integral to and directly driven by blower**] shall be capable of producing **300-psig (2070-kPa)** discharge pressure and **15-inch Hg (50.7-kPa)** vacuum.
    b. Oil Piping Specialties:

        1) Suction-line, manual, gate valve.
        2) Removable-mesh oil strainer.
        3) **0- to 30-inch Hg (0- to 101.3-kPa)** vacuum; **0- to 30-psig (0- to 207-kPa)** vacuum-pressure gage.
        4) **0- to 300-psig (0- to 2070-kPa)** oil-nozzle pressure gage.
        5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Gas Train: Control devices and [**modulating**][**on/off**][**low/high/low**] control sequence shall comply with [**ASME CSD-1**][**FM Global**][**NFPA 85**][**Industrial Risk Insurers (IRI)**][**and**][**UL**] requirements.
5. Gas Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
6. Oil Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety-shutoff solenoid with [**cadmium sulfide**][**UV scanner**] flame-safety control.

M. Motors: Comply with requirements for motors specified in Section 230500 "Common Work Results for HVAC" unless more stringent requirements are indicated below:

1. Efficiency: [**Premium efficient**]<**Insert requirement**>.
2. Enclosure: [**Open dripproof**][**Totally enclosed**][**or**][**Totally enclosed, fan cooled**].
3. Insulation Class: [**F**][**H**]<**Insert requirement**>.
4. Service Factor: [**1.15**]<**Insert value**>.
5. Motors operated through variable-frequency controllers shall be inverter duty rated according to NEMA MG-1.
6. Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

N. Flue-Gas Recirculation System:

1. Equip boiler with packaged flue-gas recirculation system if required to satisfy emission requirements.
2. Complete package integrating burner, combustion-air blower and damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.

O. Hot-Water Boiler Trim:

1. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**].
2. Hot-Water Temperature Controllers: Operating[**, firing rate,**] and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: [**Automatic**][**Manual**].
6. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end valve.
7. Tankless Heater: [**Carbon-steel**][**Bronze**] header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.

    a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
    b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

P. Steam Boiler Trim:

1. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**].
2. Pressure Controllers: Operating[**, firing rate,**] and high limit.
3. Safety Relief Valve:

    a. Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.
    b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

        1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
        2) Exhaust Head: Install exhaust head on vent pipe connected to safety relief valve.

4. Pressure Gage: Minimum **3-1/2-inch (89-mm)** diameter. Gage shall have normal operating pressure of about 50 percent of full range.
5. Water Column: Minimum **12-inch (300-mm)** glass gage with gage rods to protect glass, ball check and shutoff cocks, water column blowdown valves, and vacuum breaker. Midpoint of gauge shall be at normal operating water level.

6. Bottom Blowdown Valves: Factory-installed, duty-rated, slow-acting blowdown valves and interconnecting piping same size as boiler nozzle.[**Blowdown valves shall be combination of slow and quick acting as required by ASME B31.1.**]
7. Surface Blowdown Valves: Factory-installed, duty-rated isolation valves and interconnecting piping.[**In addition, provide electrically operated control valve, duty rated, to control total dissolved solids (TDS) through boiler controls.**]
8. Stop Valves: Boiler outlets, except safety relief valves, shall be equipped with stop valve in an accessible location as near as is practical to boiler nozzle and same size or larger than nozzle. Valves larger than **NPS 2 (DN 50)** shall have rising stem.
9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

    a. Feedwater Valves: Factory-installed, duty-rated stop and check valves and interconnecting piping. Stop valves larger than **NPS 2 (DN 50)** shall have rising stem.
    b. Factory-installed, three-valve bypass arrangement with modulating control valve positioned between duty-rated stop valves, bypass piping with throttling valve, check valve, and interconnecting piping. Stop and throttling valves larger than **NPS 2 (DN 50)** shall have rising stem. Modulating control valve shall have the following features and characteristics:

        1) Duty rated with electric operator to control water level through boiler controls.
        2) Equal percentage flow characteristic.
        3) Valve Flow: [**Indicated on Drawings**][**1.25 times boiler output**]<**Insert requirement**>.
        4) Valve Pressure and Temperature Rating: Equal to boiler.
        5) Shut-off Leakage: [**0.0001**]<**Insert number**> percent of valve coefficient.

10. Chemical Injection Assembly: Factory-installed, duty-rated injection quill with ball check valve and isolation valve compatible with dispensed chemical.
11. Sample Cooler: Factory [**installed**][**or**][**furnished for field installation**], with [**needle**] valve for each connection.[**Constructed of 316 stainless steel.**]
12. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.

    a. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
    b. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

Q. Controls:

1. Boiler operating controls shall include the following devices and features:

    a. Control transformer(s) with fuse protection, as required by manufacturer, to implement requirements indicated. Provide transformer with 25 percent spare capacity.
    b. Set-Point Adjust: Operating and alarm set points shall be field adjustable.

2. Pressure Control for Steam Boilers:

    a. Operating-Pressure Control: Factory wired and mounted to control boiler to maintain boiler at constant pressure within [**2**]<**Insert number**> percent of set point.
    b. High-Pressure Cutoff with Automatic Reset: Control stops burner if operating conditions rise above normal operating-pressure set point. Set point shall be adjustable.
    c. High-Pressure Cutoff with Manual Reset: Control stops burner operation upon reaching adjustable high limit set point that is below safety valve setting.

3. Water-Level Control for Steam Boilers:

    a. Operating Water-Level Control: [**Cycle feedwater pump(s)**][**Operate feedwater pump(s) continuously and modulate boiler feedwater valve**] for water-level control.
    b. Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
    c. Auxiliary Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.
    d. Microprocessor-based control.
    e. Accuracy within [**0.01 inch (0.25 mm)**]<**Insert value**>.
    f. Visual indication of level, alarms, and errors through alphanumeric display.
    g. Features:

        1) Continuous water-level indication.
        2) Low-water cutoff and alarm.
        3) High-water alarm.
        4) Low- and high-water warning.
        5) Control of feedwater pump.
        6) Control of modulating feedwater control valve.
        7) Continuous monitoring of float operation.
        8) Column blowdown detection and reminder.
        9) Auxiliary low-water cutoff check.
        10) Auto and manual reset.
        11) Alarm annunciation.
        12) <**Insert feature**>.

4. Operating Controls for Hot-Water Boilers:

    a. Sequence of Operation:

        1) Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outdoor-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**200 deg F (93 deg C)**]<**Insert temperature**>; at [**60 deg F (15 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**140 deg F (60 deg C)**]<**Insert temperature**>.
        2) Indicated on Drawings.
        3) <**Insert requirements**>.

5. Multiple Boiler Operation: Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
6. Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Manufacturer to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.
7. Chemical Feed System Interface: Dry contacts to interface control and operation of chemical feed pump.
8. Burner Safety Controls for Steam Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

    a. High Cutoff: [**Automatic**][**and**][**Manual**] reset stops burner if operating conditions rise above maximum boiler operating pressure.
    b. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
    c. Auxiliary Low-Water Cutoff Switch: Float and electronic probe shall prevent burner

operation on low-water alarm limit. Cutoff switch shall be manual-reset type.

d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

9. Burner Safety Controls for Hot-Water Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

   a. High Cutoff: [**Automatic**][**and**][**Manual**] reset stops burner if operating conditions rise above boiler design temperature.
   b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
   c. Auxiliary Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.
   d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

10. Burner Flame Safeguard Controls:

   a. Factory equipped with flame safeguard control and infrared flame scanner.
   b. Microprocessor-based, solid-state control having sequence and flame-on visual indication and fault code indications of flame safeguard trip functions.
   c. Control shall include dynamic self-check logic.
   d. Control shall have a fixed operating sequence incapable of being manually altered that includes start, prepurge, pilot and main fuel ignition run, and postpurge cycles.
   e. Control shall be nonrecycle type for maximum safety that shall shut down the burner and indicate, as a minimum, the following trip functions:

      1) Pilot and main flame failure.
      2) High- and low-fire proving switch faults.
      3) Running interlocks open.
      4) False flame signal and fuel valve open.

   f. Control shall include a run/test switch to allow interruptions to sequence just after prepurge and during pilot ignition trial, and run cycles for adjustments to firing rate motor, damper linkages, and pilot flame for minimum turndown tests.

11. Combustion-Air Controls: Factory equipped with motor-operated combustion-air damper and blower control to regulate burner fire according to load demand.
12. Oxygen Trim Control:

   a. Provide oxygen trim system to continuously monitor and display oxygen concentrations in boiler flue gas and adjust fuel and airflow to maintain an adjustable oxygen-level set point.
   b. System shall compensate for changes in ambient temperature, barometric pressure, humidity, and variations in fuel characteristics.

13. Surface Blowdown Control: Provide a conductivity sensor and control circuitry to operate an automatic control valve in surface blowdown piping to maintain total dissolved solids (TDS) within boiler manufacturer's prescribed level.
14. DDC System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

   a. Hardwired I/O Points:

      1) Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring points**>.
      2) Control: On/off operation, [**hot-water-supply temperature set-point**

adjustment][**steam pressure adjustment**]<**Insert control points**>.

b. Communication Interface: [**ASHRAE 135 (BACnet)**][**(LonTalk)**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface shall enable control system operator to remotely control on/off and capacity of boiler and monitor the boiler operation from an operator workstation. Control features are available, and monitoring points are displayed locally at boiler control panel through the interface.

15. Integrated Boiler Control System:

a. Integral control of burner management for flame safety, boiler modulation, and operator interface functions with features and functions indicated.
b. Factory preconfigured.
c. Utilizing solid-state controls and sensors to provide various control functions, including the following:

1) Automatic sequencing of the boiler through standby, prepurge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout, and postpurge.
2) Full modulating control of air and fuel through Proportional-Integral-Derivative (PID) algorithm.
3) Thermal shock protection.
4) High and low limit alarms and shutdowns.

d. Local operator interface through nominal [**10-inch (250-mm)**]<**Insert size**> color touch screen graphical display for setup, monitoring, and data acquisition.

1) Manual control of the boiler firing rate using control screens to increment or decrement firing rate.
2) Indication of burner management controller status and diagnostics.
3) Display of system alarms and faults.
4) Display of history of alarms and faults.
5) Display of recommendations for troubleshooting of fault conditions.
6) Display of water-level indication and alarm(s).
7) Stack flue-gas, combustion-air, and shell water-temperature indication.
8) Boiler efficiency calculation and display.
9) Low-fire hold with minimum temperature control.
10) Assured low-fire cutoff (ALFCO).
11) High stack temperature annunciation with auto cutoff.
12) Audible alarm and silencing through touch screen intervention.

e. Fully integrated control of the following:

1) Blower operation and combustion-air damper for varying operating conditions.
2) Oxygen trim and monitoring to compensate for combustion-air variations.
3) Parallel positioning for independent fuel and air control for enhanced fuel efficiency.
4) Multiple boiler lead/lag control with hot standby.
5) Draft control for maintaining proper and consistent draft for enhanced fuel efficiency.
6) <**Insert additional features**>.

f. E-mail and paging feature to multiple contacts via Internet and phone line independent of control system interface.
g. LAN/WAN interface with remote monitoring software to allow remote monitoring independent of control system interface.

16. Control Enclosures:

    a. NEMA 250, Type [**1**]<**Insert type**>.

        1) Provide enclosure with integral vents, fans, heater, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.

    b. Wiring shall be numbered and color-coded to match wiring diagram.[**Provide a laminated wiring diagram located inside enclosure.**]
    c. Mounted on boiler assembly at a location convenient to operator.
    d. Provide hinged full-size door with key lock. Provide common key for all locks.
    e. Enclosure shall consist of multiple sections divided by a partition with a separate hinged door for each section. One section shall house low-voltage controls and other section shall house line voltage controls.
    f. Enclosure shall house the following:

        1) Control transformers with fuses.
        2) Labeled terminal strips.
        3) Controller(s) to provide control and alarm functions indicated.
        4) Audible indication of safety alarms.

    g. Face of enclosure shall provide the following:

        1) Visual indication of operating components and alarms.
        2) Auto/local capability to allow operator to manually operate boiler locally.
        3) Audible alarm-silence capability.
        4) Labels for switches, lights, and displays to provide clear indication of service.

17. Control Instrument Enclosures: Control instruments and devices that are mounted on the boiler assembly and cannot be installed inside the control enclosure shall have same or higher level of protection indicated for control enclosures.
18. Control Cable and Wire:

    a. Control cable and wiring shall be numbered and color-coded to match wiring diagram.
    b. Install cable and wiring located outside of enclosure(s) in a[**metal**] raceway. Use flexible conduit to make final terminations. Provide watertight installation for applications exposed to moisture.

2.4 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

    1. Enclosure: NEMA 250, Type [**1**]<**Insert type**>.

        a. Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
        b. Mounted on boiler assembly at a location convenient to operator.
        c. Enclosure shall have hinged full-size door with key lock with common key for all locks.

    2. Wiring shall be numbered and color-coded to match wiring diagram.[**Provide a laminated wiring diagram located inside enclosure.**]

3. Install factory wiring outside of an enclosure in a [**metal**]raceway. Make final connections to motors using flexible conduit. Provide watertight installation for applications exposed to moisture.
4. Field power interface shall be to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.
5. Provide branch power circuit to each motor and to controls[**with disconnect switch or circuit breaker**].
6. Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
7. Provide transformer with fuses and power wiring to power a 20-A 120-V duplex receptacle mounted in each boiler control panel for use in connecting analytical and testing equipment.

2.5 VENTING KITS

A. Vent Damper: Motorized; UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.

B. Kit: Complete system, [**ASTM A959, Type 29-4C**]stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.

C. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.6 CAPACITIES AND CHARACTERISTICS

A. Heating Medium: [**Hot water**][**Steam**].

B. Design Pressure and Temperature Rating: [**160 psig (1100 kPa), 250 deg F (120 deg C)**]<**Insert values**>.

C. Design Pressure Rating:

1. [**60 psig (420 kPa)**][**100 psig (690 kPa)**][**140 psig (966 kPa)**][**160 psig (1100 kPa)**]<**Insert value**>.
2. [**15 psig (104 kPa)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert value**>.

D. Safety Relief Valve Setting: <**Insert psig (kPa)**>.

E. Entering-Water Temperature: <**Insert deg F (deg C)**>.

F. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

G. Design Water-Flow Rate: <**Insert gpm (L/s)**>.

H. Design Pressure Drop: <**Insert psig (kPa)**>.

I. Steam Operating Pressure: <**Insert psig (kPa)**>.

J. Steam-Flow Rate: <**Insert lb/h (kg/s)**>.

K. Minimum Efficiency AFUE: <**Insert number**> percent.

L. Minimum Thermal Efficiency: <**Insert number**> percent.

M. Minimum Combustion Efficiency: <**Insert number**> percent.

N. Fuel-to-[**Steam**][**Water**] Efficiency: <**Insert number**> percent.

O. Number of Passes: [**One**][**Two**]<**Insert number**>.

P. Gas Input: <**Insert MBh (kW)**>.

Q. Gas Input Flow: <**Insert cfh (mL/s)**>.

R. Gas Pressure: <**Insert psig (kPa)**>.

S. Oil Input: <**Insert MBh (kW)**>.

T. Oil Input Flow: <**Insert gph (mL/s)**>.

U. Output Capacity: <**Insert MBh (kW)**>.

V. Tankless Water Heater:

1. Design Water Flow: <**Insert gpm (L/s)**>.
2. Design Pressure Drop: <**Insert psig (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

W. Burner Blower:

1. Motor Horsepower: <**Insert number**> hp.

X. Electrical Characteristics:

1. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: [**50**][**60**]<**Insert number**> Hz.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.
6. Maximum Overcurrent Protection: <**Insert number**> A.

Y. Sound (decibels, A weighted): <**Insert number**> dB.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test:

1. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.
2. Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.

C. Witness Testing:

1. Allow Owner access to witness source quality-control testing of boilers.
2. Notify [**Architect**][**Owner**][**15**]<**Insert number**> days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.

B. Examine areas where boilers will be installed for suitable conditions.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BOILERS

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install gas-fired boilers according to NFPA 54.

D. Install oil-fired boilers according to NFPA 31.

E. Assemble boiler tubes in sequence and seal each tube joint.

F. Assemble and install boiler trim, components, and accessories that are not factory installed.

G. Install control and electrical devices furnished with boiler that are not factory mounted.

H. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.

I. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests.[**Boiler manufacturer's factory-authorized representative shall witness boil-out and cleaning procedures.**] Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.

J. Protect boiler fireside and waterside from corrosion.

1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
2. After boiler is filled with water, and left not fired for more than [**10**]<**Insert number**> days, protect by wet storage method recommended by boiler manufacturer.
3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions. Refer to <**Insert applicable Section number and title**> for additional requirements.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to boiler(s), allow space for service and maintenance.

C. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

D. Connect oil piping to oil-train connection with dirt leg, shutoff valve, and union. Piping shall be at least full size of oil-train connection. Provide a reducer if required. Provide drain valve with threaded plug at piping low point.

E. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and union or flange at each connection.

F. Connect steam and condensate piping to supply-, return-, and blowdown-boiler connections with union or flange at each connection. Provide each connection with shutoff valve if shutoff valves are not factory furnished with boiler trim.[**Provide check valves in blowdown piping of each boiler that connects multiple boilers.**]

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.

I. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

J. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled nonpotable domestic cold water source to cool hot equipment drains to deliver a discharge temperature of <**Insert temperature**>.

K. Connect chemical-treatment piping to each boiler chemical-treatment connection with check valve and isolation valve.

3.4 FLUE CONNECTIONS

A. Boiler Flue Venting:

1. Install venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."

B. Connect breeching to full size of boiler outlet. Comply with requirements in [**Section 235116 "Fabricated Breechings and Accessories"**][**and**][**Section 235133 "Insulated Sectional Chimneys"**] for venting materials.

C. Install flue-gas recirculation duct from vent to burner if not factory furnished and installed. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for recirculation duct materials.

D. Install easily accessible test ports for field testing of flue gas from each boiler.

3.5 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.

C. Connect control wiring between boiler control interface and [**DDC control system**]<**Insert system description**> for remote monitoring and control of boilers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC"**]<**Insert Section number and title**>.

3.7 NETWORK AND PHONE CONNECTIONS

A. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.

B. Connect phone system cable to boiler controls to provide connectivity for remote monitoring and alarm notification through integrated boiler control system.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform installation and startup checks according to manufacturer's written instructions.

2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
    b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and [**water temperature**][**steam pressure**].
    c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within [**12 months of date of Substantial Completion**]<**Insert time period**>, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

G. Performance Tests:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field-performance tests. Adjust, modify, or replace equipment in order to comply.
3. Perform field-performance tests to determine the capacity and efficiency of the boilers.

    a. For dual-fuel boilers, perform tests for each fuel.
    b. Test for full capacity.
    c. Test for boiler efficiency at [**low fire, 10, 20, 30, 40, 50, 60, 70, 80, 90, and high fire (100)**]<**Insert range**> percent of full capacity. Determine and document efficiency at each test point.

4. Test each safety valve. Record pressure at valve blowdown and reset. Test valve(s) with boiler operating at full capacity to ensure valve has capacity to prevent further rise in pressure.
5. For boilers equipped with automatic oxygen trim control, conduct tests with automatic oxygen trim control on manual at zero trim and record performance. Repeat tests with automatic oxygen trim control under automatic control and record performance.
6. Repeat tests until results comply with requirements indicated.
7. Provide measurement and analysis equipment required to determine performance.
8. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
9. Notify [**Architect**][**Owner**][**20**]<**Insert number**> days in advance of test dates.
10. Document test results in a report and submit with informational submittals.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boilers.[**Video training sessions and provide electronic copy of video to Owner.**] Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 52 33 00

Task	Specification	Specification Description
23 52 33 13	23 52 33 00	Water-Tube Boilers
23 52 33 16	23 52 33 00	Water-Tube Boilers
23 52 36 00	23 52 39 00	Fire-Tube Boilers

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SECTION 23 52 39 00 - FIRE-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal fire-tube boilers.
2. Vertical fire-tube boilers.
3. Fire box boilers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, include the following:

1. Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.
4. Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.
5. Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.
6. Calculations showing predicted surface temperature of boiler jacket with basis indicated.
7. Force and moment capacity of each piping and flue connection.
8. Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.
9. Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
10. Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.
11. Pressure rating, size, and materials of construction for boiler fuel train components including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.
12. Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.
13. Product data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Design calculations and base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting [**vibration isolators and**] seismic restraints and for designing bases.

b. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
5. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to <**Insert scale**> scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:

1. Column grids, beams, columns, and concrete housekeeping pads.
2. Room layout with walls, floors, and roofs, including each room name and number.
3. Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems, and plumbing systems.

B. Seismic Qualification Certificates: For boilers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Installation instructions.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

G. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. Startup service reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:

1. A tool kit specially designed by boiler manufacturer for use in servicing boiler(s) furnished.
2. Special tools required to service boiler components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Boiler Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **0.5 inch (13 mm)** high.

B. Touch-up Paint: [**32 oz. (1 L)**]<**Insert volume**> container of paint used for finish coat. Label on outside of container shall have a detailed description of paint to allow for procurement of a matching paint in the future.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.

B. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.

C. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

D. Package boiler for export shipping in totally enclosed [**bagging**][**crate**][**crate with bagging**].

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace front- and rear-door refractories and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.

1. Horizontal Fire-Tube and Firebox Boilers: Refractory in front and rear doors, [**10**]<**Insert number**> years from date of startup by factory-authorized personnel.
2. Vertical Fire-Tube Boilers and Heat Exchanger: [**Five**]<**Insert number**> years from date of Substantial Completion, if following water-treatment program recommended by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fuel-to-[**steam**][**water**] efficiency indicated shall be based on the following:

1. ASME Performance Test Code (PTC) 4, [**Input-Output**][**Heat Loss**] method.
2. <**Insert test requirement**>.

3. Test Operating Conditions:

   a. Ambient Temperature: <**Insert temperature**>.
   b. Ambient Relative Humidity: <**Insert relative humidity**>.
   c. Percent Excess Air in Exhaust Flue Gas: [**15**]<**Insert number**>.
   d. Fuel Heating Value: <**Insert value**>.

B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient air quality standards in governing jurisdiction and indicated values.

1. Carbon monoxide:

   a. [**50**]<**Insert number**> parts per million at any point from 100 percent to [**50**]<**Insert number**> percent fire.
   b. [**150**]<**Insert number**> parts per million at any point below [**50**]<**Insert number**>percent fire.

2. Nitrogen compounds: [**30**][**20**][**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
3. Sulfur compounds: [**One**]<**Insert number**> part per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
4. Hydrocarbon and Volatile Organic Compounds: [**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
5. Particulate Matter: [**0.01 lb/MMBtu**]<**Insert value**>.
6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

C. Oil-Fired Boiler Emissions: Not to exceed allowable ambient air quality standards in governing jurisdiction and indicated values.

1. Carbon Monoxide:

   a. [**50**]<**Insert number**> parts per million at any point from 100 percent to [**50**]<**Insert number**> percent fire.
   b. [**150**]<**Insert number**> parts per million at any point below [**50**]<**Insert number**>percent fire.

2. Nitrogen Compounds: [**30**][**20**][**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
3. Sulfur Compounds: [**One**]<**Insert number**> part per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
4. Hydrocarbon and Volatile Organic Compounds: [**10**]<**Insert number**> parts per million (dry volume basis and corrected to [**3**]<**Insert number**> percent oxygen) at any point from 100 percent to low fire.
5. Particulate Matter: [**0.01 lb/MMBtu**]<**Insert number**>.
6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

D. Multiple Boiler Operation: Equip individual boilers in multiple boiler applications with integral controls to provide multiple boiler operation for optimum system performance, energy efficiency, and the following:

1. Equalize runtime of boilers in service.
2. Operate multiple boilers hot to minimize disruption of service in the event of single boiler failure.
3. Configure controls so any boiler can be taken out of service with power disconnected and not impact multiple boiler operation.
4. <**Insert requirement**>.

E. Seismic Performance: Boiler shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the boiler will remain in place without separation of any parts when subjected to the seismic forces specified[**and the boiler will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

F. Sound: Boiler sound level, measured according to parameters defined in ABMA publication "Boiler 304 Measurement of Sound from Steam Generators" shall not exceed <**Insert number**> dBA.

G. Steam Quality: [**99**][**99.5**]<**Insert number**> percent dry[**and saturated**].

H. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a back-up power source or through normal power if restored before back-up power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

I. Outdoor Installations:

1. Boiler shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**]<**Insert number**> -year period, with minimal degradation due to exposure to outdoor ambient conditions.
2. Boilers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**]<**Insert number**> -year period. Provide as part of boiler package, products such as combustion-air pre-heaters, and other means and methods required.

J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

L. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

M. ISO 14000 Certification: Boiler manufacturer to provide certification stating that it has self-certified its company to ISO 14000.

N. UL Compliance: Test Boilers for compliance with [**UL 726**][**UL 726 and UL 795**][**UL 795**]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.2 HORIZONTAL FIRE-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Burnham Hydronics**]
2. [**Cleaver-Brooks**]
3. [**Green Boiler Technologies**]
4. [**Hurst Boiler & Welding Company, Inc.**]
5. [**IBC Technologies; a Rheem brand**]
6. [**Johnston Boiler Company**]
7. [**L.E.S., Inc.**]
8. [**Lattner Boiler Manufacturing**]
9. [**Superior Boiler Works, Inc**]
10. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Burnham Hydronics**]
2. [**Cleaver-Brooks**]
3. [**Green Boiler Technologies**]
4. [**Hurst Boiler & Welding Company, Inc.**]
5. [**IBC Technologies; a Rheem brand**]
6. [**Johnston Boiler Company**]
7. [**L.E.S., Inc.**]
8. [**Lattner Boiler Manufacturing**]
9. [**Superior Boiler Works, Inc**]
10. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
11. <**Insert manufacturer's name**>

C. Pressure Vessel Design: [**Dry-**][**or**][**water**]back design with the following:

1. [**One**][**Two**][**Three**][**or**][**Four**] pass(es).
2. Minimum Heat-Exchanger Surface: [**5 sq. ft./bhp (2.1 sq. m/10 kW)**][**As required to achieve performance indicated**]<**Insert value**>.
3. Provisions for lifting boiler in-place.

D. Base:

1. Factory-mounted pressure vessel and other boiler components on steel saddles or supports that are fastened securely to a structural steel base that is constructed to make a complete self-supported unit requiring only a flat level surface for support.
2. Base included with attachments if required to secure boiler to structure.
3. Manufacturer's standard provisions for lifting include the following.

   a. Designed for handling and installation conditions encountered.
   b. Sufficient to carry total weight of fully assembled boiler with a safety factor of [**1.2**]<**Insert value**>.

E. Shell:

1. Horizontal, cylindrical, steel pressure vessel of size to satisfy performance requirements indicated.
2. Manholes and Handholes:

a. Manhole for waterside inspection and access.
b. Handholes at front and rear of boiler for waterside inspections.
c. According to 2010 ASME Boiler and Pressure Vessel Code.

3. Hot-Water Boilers:

a. Supply- and return-water piping connections.
b. Connections with safety relief valve(s).
c. Drain connection(s), each with drain valve, at shell low point.
d. Connections for other trim indicated.
e. Built-in air separator.

4. Steam Boilers:

a. Connections for steam supply, feedwater, level controls, and chemical treatment.
b. Baffle in shell below steam outlet to provide dry steam with no water carry over.
c. Bottom and surface blowdown connections.
d. Connections with safety relief valve(s).
e. Connections for other trim indicated.

F. Furnace:

1. Welded cylindrical steel chamber that is welded to steel tube sheets.
2. Arranged to provide uniform heat distribution under all firing conditions with no flame impingement on any refractory-covered or waterbacked surface.
3. Surrounded by water without interfering with natural circulation of water within shell.
4. Positioned from shell to inhibit unequal thermal stresses during operation.

G. Fire Tubes:

1. Steel, seamless or resistance welded.
2. Fitted in accurately sized holes in tube sheets and [**rolled**][**or**][**welded**] in place.
3. Aligned to prevent noticeable deformation with undue stress when boiler is put in service.
4. Tube and tube sheet assembly shall be water- and gastight.
5. Arranged not to interfere with natural circulation of water in shell or to inhibit cleaning and flushing of water sides.
6. Readily removable from one end of boiler.
7. Provided without spinners, turbulators, and other inserted devices.

H. Flue:

1. Flanged connection located along top centerline of boiler and capable of supporting a field-installed flue stack with a weight of at least [**2000 lb (8.9 kN)**]<**Insert weight**>.
2. Equip boiler flue with bimetal thermometer in a stainless steel case, with angle position adjustment and nominal [**5-inch (120-mm)**]<**Insert size**> diameter face having a graduated scale and range of approximately [**1.5**]<**Insert number**> times the outlet temperature. Mount thermometer in a Type 316 stainless steel thermowell that is located in a visible location to indicate flue-gas temperature.

I. Front and Rear Doors:

1. [**Bolted**][**hinged**][**or**][**davited**], sealed with heat-resistant gaskets and fastened with lugs and cap screws.
2. Designed so tube sheets and flues are fully accessible for inspection or cleaning when doors are open[**without the need to disconnect burner, blower, and fuel piping**].
3. Include observation ports in doors at both ends of boiler for inspection of flame conditions.

4. Door [**refractory**][**or**][**and**][**insulation**] shall be accessible for inspection and maintenance.
5. Reinforce doors of dryback boilers to limit deflection due to thermal stresses and burner combustion pulsations to prevent progressive cracking and loosening of refractory.

J. Refractories:

1. Refractories retained shall withstand temperature occurring under maximum load conditions.
2. Formed or cast-in sections shall be easily replaceable through factory openings.
3. Secure refractory sections in position to withstand vibration and shock occurring during shipment, and to withstand burner combustion pulsations.
4. Where used for the burner combustion ring and rear or target baffle, refractories shall have a parametric cone equivalent of not less than 33.
5. Provide refractory for doors and end covers exposed to temperatures of [**600 deg F (316 deg C)**]<**Insert value**> and higher.

K. Insulation:

1. Minimum **2-inch- (50-mm-)** thick, mineral-fiber insulation surrounding the boiler shell and secured in place to prevent sagging or displacement.
2. Insulation of sufficient density or attached with reinforcement to prevent permanent deformation of protective jacket when subjected to an impact force of <**Insert value**> and forces associated with service personnel walking, kneeling, and laying on boiler while performing service.
3. Insulating value sufficient to limit exterior surface temperature of pressure vessel jacket, doors, and end covers from exceeding <**Insert temperature**> while operating in an ambient environment with a temperature of <**Insert temperature**>, surface wind velocity of <**Insert velocity**>, and boiler operating at full capacity.

L. Jacket: [**Galvanized sheet**][**Sheet**] metal, with factory-applied protective finish.

1. Nominal Thickness: Not less than [**0.030 inch (0.8 mm)**][**0.048 inch (1.2 mm)**]<**Insert thickness**>.
2. Preformed shape to follow a smooth and uniform contour of pressure vessel and encapsulating insulation.
3. Consisting of multiple removable sections attached with corrosion-resistant screw-fasteners to facilitate removal and replacement multiple times.
4. Painted after assembly.

2.3 VERTICAL FIRE-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Columbia Boiler Company**]
2. [**Fulton Boiler Works, Inc**]
3. [**Harsco Industrial, Patterson-Kelley**]
4. [**Hurst Boiler & Welding Company, Inc.**]
5. [**IBC Technologies; a Rheem brand**]
6. [**L.E.S., Inc.**]
7. [**Lattner Boiler Manufacturing**]
8. [**Lochinvar, LLC**]
9. [**Precision Boilers**]
10. [**PVI; A WATTS Brand**]
11. [**Raypak; a Rheem brand**]

12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Columbia Boiler Company**]
2. [**Fulton Boiler Works, Inc**]
3. [**Harsco Industrial, Patterson-Kelley**]
4. [**Hurst Boiler & Welding Company, Inc.**]
5. [**IBC Technologies; a Rheem brand**]
6. [**L.E.S., Inc.**]
7. [**Lattner Boiler Manufacturing**]
8. [**Lochinvar, LLC**]
9. [**Precision Boilers**]
10. [**PVI; A WATTS Brand**]
11. [**Raypak; a Rheem brand**]
12. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, vertical fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water-supply and -return connections, and controls.

D. Pressure Vessel Design: Straight, steel pipe welded in a concentric pattern to separate flue-gas and heating media to form [**two**][**four**] passes with welded fins to improve heat transfer in secondary flue-gas passages. Include the following accessories:

1. Handholes for waterside inspections.
2. Lifting lugs on top of boiler.
3. Minimum **NPS 1 (DN 25)** hose-end drain valves at water passage low point.
4. Tappings or flanges for water-supply and -return piping.
5. Built-in air separator.
6. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
7. Tappings for steam supply, makeup, level controls, and chemical treatment.

E. Combustion Chamber: Equipped with flame retainer to lengthen flame-residence time.

F. Insulation: Minimum **4-inch- (100-mm-)** thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.

G. Flue: Top connection, constructed of [**aluminized**][**stainless**] steel.

H. Jacket:

1. Mirror-finish stainless steel with screw-fastened closures.
2. [**Galvanized sheet**][**Sheet**] metal, with screw-fastened closures and [**baked-enamel**][**powder-coated**] protective finish.
3. Mounting base to secure boiler to concrete base.

I. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum **3-1/2-inch- (89-mm-)** diameter dial.

2.4 FIREBOX BOILERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Hurst Boiler & Welding Company, Inc.**]
2. [**L.E.S., Inc.**]
3. [**Superior Boiler Works, Inc**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hurst Boiler & Welding Company, Inc.**]
2. [**L.E.S., Inc.**]
3. [**Superior Boiler Works, Inc**]
4. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, -assembled, and -tested, firebox boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water-supply and -return connections, and controls.

D. Pressure Vessel Design: Straight, steel tubes [**rolled**][**or**][**welded**] into steel headers. Three passes with wetback design. Minimum heat-exchanger surface of **5 sq. ft./bhp (2.1 sq. m/10 kW)**. Include the following features and accessories:

1. Tube Size and Thickness: [**Minimum NPS 2 (DN 50), minimum 0.105 inch (2.667 mm) thick**]<**Insert size and thickness**>.
2. Brass washout plugs.
3. Steel turbulators.
4. Lifting lugs on top of boiler.
5. Minimum **NPS 1 (DN 25)** hose-end drain valves at shell low point.
6. Tappings or flanges for water-supply and -return piping.
7. Built-in air separator.
8. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
9. Tappings for steam supply, makeup, level controls, and chemical treatment.

E. Combustion Chamber: Welded steel, [**waterwall and -floor design**][**water-leg design with refractory insulation poured in the floor**]. Flame observation port.

F. Insulation:

1. Minimum **2-inch- (50-mm-)** thick, [**foil-backed,**]mineral-fiber insulation surrounding the boiler shell.
2. Insulated removable smoke boxes and reversing chamber cover.

G. Flue: Steel, [**top**][**or**][**rear**].

H. Jacket: Sheet metal, with screw-fastened closures and [**baked-enamel**][**powder-coated**] protective finish.

I. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum **3-1/2-inch- (89-mm-)** diameter dial.

2.5 BURNER

A. Burner designed to fire [**gas**][**oil**][**combination gas and oil**]. [**Single burner shall be used for duel**

fuels.]

B. Welded construction with multivane, stainless steel, flame-retention diffuser.

C. Single-tip retractable nozzle for low-pressure air-atomizing burner.

D. Mount burner [**on hinged front access door**] to permit unrestricted access to combustion chamber.

E. Burner Operation: [**On/off**][**Low-high fire**][**or**][**full modulating**] control to return to low-fire position for ignition.

1. Gas-Fired Burner: [**4 to 1**][**8 to 1**][**10 to 1**]<**Insert value**> turndown.
2. Oil-Fired Burner: [**4 to 1**][**8 to 1**]<**Insert value**> turndown.
3. Combination Gas- and Oil-Fired Burner: [**4 to 1**][**8 to 1**]<**Insert value**> turndown.
4. A lesser turndown shall be considered if published factory performance testing shows no loss in operating performance and no negative impact on service life and maintenance while operating throughout full range of system operating conditions encountered.

F. Burner Fuel Combustion Efficiency: Minimum [**99.9**]<**Insert number**> percent.

G. Gas Pilot: Premix type with automatic electric ignition, complete with electronic flame scanner to monitor the pilot, so primary fuel valve cannot open until pilot flame has been established.

H. Oil Pilot: [**Intermittent**][**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with [**cadmium sulfide**][**UV scanner**] flame-safety control.

I. Manual adjustments not required to operate at varying loads.

J. Performance shall be repeatable after changes in firing rate.

K. Control devices and sequence shall comply with [**ASME CSD-1**][**NFPA 85**][**FM Global**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.

L. Damper: Designed to provide accurate control of combustion air with minimum hysteresis. Damper shall close when boiler is off.

2.6 BLOWER

A. Combustion air supplied by a forced-draft blower assembly that is isolated to reduce vibration and noise.

B. Mount blower [**integral to burner**][**or**][**on hinged front access door**] to permit unrestricted access to combustion chamber.

C. Centrifugal type, with a forward-curve, backward-inclined airfoil or radial blade wheel.

D. Blower and drive assembly shall be controlled through boiler's integral controls in response boiler manufacturer's prescribed sequence of operation that is coordinated with burner and fuel train to achieve performance indicated.

1. Where indicated or required to achieve performance, provide blower with unit-mounted variable-frequency controller to vary blower speed in response to prescribed control set point and changes in operating conditions.
2. Variable-speed fan operation shall be checked for resonant frequencies and adjusted to provide

no resonant frequencies throughout entire operating range.

E. Blower Drive Assembly: [**Belt**][**or**][**direct**] drive.

1. Belts: Multiple matching belts that are oil resistant, non-static conducting and sized for a [**2.0**]<**Insert value**> service factor.
2. Belt Guards: Easily removable guard that encloses drive.

F. Blower Motor:

1. General Requirements: Comply with requirements for motors specified in Section 230500 "Common Work Results for HVAC" unless more stringent requirements are indicated below:

   a. Efficiency: [**Premium efficient**]<**Insert requirement**>.
   b. Enclosure: [**Open dripproof**][**Totally enclosed**][**or**][**totally enclosed, fan cooled**].
   c. Insulation Class: [**F**][**H**]<**Insert requirement**>.
   d. Service Factor: [**1.15**]<**Insert value**>.
   e. Motors operated through variable-frequency controllers shall be inverter duty rated according to NEMA MG-1.

2. Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

2.7 GAS TRAIN

A. Comply with Owner insurance underwriter requirements. In absence of specific requirements, comply with more stringent requirements indicated.

B. Pilot gas piping train shall include:

1. One manually operated, lubricated plug cock or ball valve upstream of all valves and accessories.
2. One pressure regulator with vent.
3. Pressure gage located downstream of pressure regulator. Nominal [**2-inch (50-mm)**][**4-inch (100-mm)**]<**Insert size**> diameter face with graduated scale to indicate gas pressure. Gage shall have normal operating pressure of about [**50**]<**Insert number**> percent of full range.
4. Primary and secondary automatic valves to operate simultaneously.
5. Normally open, full port electrically operated valve in a vent pipe connected between automatic valves.
6. Manually operated valve with threaded plug located downstream of both automatic gas valves to permit leakage testing.
7. <**Insert feature**>.

C. Main gas piping train shall include:

1. Threaded pressure tapping with threaded plug upstream and downstream of valve and regulator.
2. One manually operated, lubricated plug cock, ball valve, or butterfly valve upstream and downstream of all valves and accessories.
3. One main pressure regulator with vent.
4. Primary and secondary automatic valves to operate simultaneously.
5. Manually operated gas valve with threaded plug located downstream of both automatic gas valves to permit leakage testing.
6. Normally open, full port electrically operated valve in a vent pipe connected between automatic valves.
7. Pressure gage with isolation valve located upstream and downstream of pressure regulator and

at inlet to burner. Nominal [**2-inch (50-mm)**]<**Insert size**> diameter face with graduated scale to indicate gas pressure. Gage shall have normal operating pressure of about [**50**]<**Insert value**> percent of full range.

8. Proof of closure switch for each motor-operated valve and pressure regulator.
9. Low-gas-pressure and high-gas-pressure switch.
10. <**Insert feature**>.

D. Control devices and sequence shall comply with [**ASME CSD-1**][**NFPA 85**][**FM Global**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.

E. Main gas valves shall be wired to close automatically in the event of power failure[**, low water level,**]or any safety shutdown condition.

F. Mount pilot and main gas trains on side of boiler and support from boiler base.

2.8 OIL TRAIN

A. Comply with Owner insurance underwriter requirements. In absence of specific requirements, comply with more stringent requirements indicated.

B. Control devices and sequence shall comply with [**ASME CSD-1**][**NFPA 85**][**FM Global**][**Industrial Risk Insurers (IRI)**][**and**][**or**][**UL**] requirements.

C. Oil Pump:

1. Gear-type oil pump, factory [**mounted**][**furnished and shipped loose for field installation**].
2. [**Single-**][**or**][**Two-**] stage pump capable of producing <**Insert value**> discharge pressure and [**15-inch Hg (51-kPa)**]<**Insert value**> vacuum.
3. Capacity equal to approximately [**2**]<**Insert number**> times maximum burner fuel consumption.
4. Motor shall comply with requirements for motors specified in Section 230500 "Common Work Results for HVAC."

D. Low-Pressure Air-Atomizing System:

1. Separate air compressor module, factory [**mounted**][**furnished and shipped loose for field installation**], with burner-mounted, low-atomizing-air-pressure switch.
2. Complete system for each burner, furnished by burner manufacturer, including compressor, drive, air filter, after cooler, low-pressure switch, and piping.
3. Low-air-pressure switch interlocked to prevent burner operation if air pressure failure occurs.
4. Motor shall comply with requirements for motors specified in Section 230500 "Common Work Results for HVAC."

E. Oil Burner Piping:

1. Factory-installed fuel oil piping shall include the following:

   a. Oil-pressure-regulating devices.
   b. Oil metering controls.
   c. Low-oil-pressure switch.
   d. Two motorized oil valves.
   e. Pressure gauges.

F. Piping Specialties:

1. Suction-line, manual shutoff valve.

2. Removable-mesh strainer.
3. Oil Filter: Oil filter with permanent edge-type elements that are cleanable by rotation of a handle without interruption to flow.

    a. Element Spacing: **0.0035 inch (0.1 mm)**.
    b. Maximum Pressure Loss: [**3 psig (20 kPa)**]<**Insert value**>.
    c. Provide with plugged drain.

4. **0- to 30-inch Hg (0- to 101.3-kPa)** vacuum; **0- to 30-psig (0- to 207-kPa)** vacuum-pressure gage.
5. [**0- to 300-psig (0- to 2070-kPa)**]<**Insert pressure**> oil-nozzle pressure gage.
6. Nozzle-line, solenoid-safety-shutoff oil valve.
7. Relief valve located in discharge piping of oil pump with valve discharge connected to oil pump suction piping.

G. Main piping shall include the following (in order, starting at field connection and moving to burner):

1. Manual shutoff valve, first instance.
2. Removable-mesh strainer.
3. Oil filter.
4. Pressure gage with isolation valve, first instance.
5. Pressure regulator.
6. Low-pressure switch.
7. High-pressure switch.
8. Flow meter.
9. Flow control valve.
10. Thermometer.
11. Valved drain.
12. Automatic safety shutoff valve, first instance.
13. Valved leak test, first instance.
14. Automatic safety shutoff valve, second instance.
15. Valved leak test, second instance.
16. Manual shutoff valve, second instance.
17. Pressure gage with isolation valve, second instance.
18. <**Insert component**>.

H. Mount train on side of boiler and support from boiler base.

2.9 FLUE-GAS RECIRCULATION

A. Equip boiler with packaged flue-gas recirculation system if required to satisfy emission requirements.

B. Complete package integrating burner, combustion-air blower and damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.

2.10 HOT-WATER BOILER TRIM

A. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**].

B. Water Temperature Controllers: Operating[**, firing rate,**] and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum [**3-1/2-inch- (89-mm-)**]<**Insert size**> diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about [**50**]<**Insert number**> percent of full range.

E. Boiler Air Vent: [**Automatic**][**Manual**].

F. Drain Valve: Minimum [**NPS 3/4 (DN 20)**]<**Insert size**> hose-end valve with threaded cap and chain.

2.11 STEAM BOILER TRIM

A. Include devices sized to comply with [**ASME B31.1**][**ASME B31.9**].

B. Pressure Controllers: Operating[**, firing rate,**] and high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

   a. Drip-Pan Elbow: Cast iron and having flanged or threaded inlet and outlet with threads complying with ASME B1.20.1.
   b. Exhaust Head: Install exhaust head on vent pipe connected to safety relief valve.

D. Pressure Gage: Nominal [**4-inch (100-mm)**][**6-inch (150-mm)**][**8-inch (200-mm)**]<**Insert size**> diameter face with graduated scale and siphon, with isolation valve to indicate pressure vessel steam pressure. Gage shall have boiler normal operating pressure of about [**50**]<**Insert number**> percent of full range and an accuracy of [**0.5**][**1**]<**Insert number**> percent.

E. Bimetal Thermometer: Stainless steel case with angle position adjustment and nominal [**5-inch (125-mm)**]<**Insert size**> diameter face having a graduated scale with a range of approximately [**1.5**]<**Insert number**> times the outlet temperature. Mount thermometer in a Type 316 stainless steel thermowell to indicate steam temperature inside pressure vessel.

F. Water Column: Minimum [**12-inch (300-mm)**]<**Insert size**>[**reflex**] glass gage with gage rods to protect glass, ball check and shutoff cocks, water column blowdown valves, and vacuum breaker. Midpoint of gage shall be at normal operating water level.

G. Bottom Blowdown Valves: Factory-installed, duty-rated, slow-acting blowdown valves and interconnecting piping same size as boiler nozzle.[**Blowdown valves shall be combination of slow and quick acting as required by ASME B31.1.**]

H. Surface Blowdown Valves: Factory-installed, duty-rated isolation valves and interconnecting piping.[**In addition, provide electrically operated control valve, duty rated, to control total dissolved solids (TDS) through boiler controls.**]

I. Stop Valves: Boiler outlets, except safety relief valves, shall be equipped with duty-rated stop valve in an accessible location as near as is practical to boiler nozzle and same size or larger than nozzle. Valves larger than **NPS 2 (DN 50)** shall have rising stem.

J. Stop-Check Valves: Factory-installed, duty-rated stop-check valve and stop valve at boiler outlet with free-blow drain valve field installed between the two valves and visible when operating stop-check valve.

K. Feedwater Valves:

1. Factory-installed, duty-rated stop and check valves and interconnecting piping. Stop valves larger than **NPS 2 (DN 50)** shall have rising stem.
2. Factory-installed, three-valve bypass arrangement with modulating control valve positioned between duty-rated stop valves, bypass piping with throttling valve, check valve, and interconnecting piping. Stop and throttling valves larger than **NPS 2 (DN 50)** shall have rising stem. Modulating control valve shall have the following features and characteristics:
3. Duty rated with electric operator to control water level through boiler controls.
4. Equal percentage flow characteristic.
5. Valve Flow: [**Indicated on Drawings**][**1.25 times boiler output**]<**Insert requirements**>.
6. Valve Pressure and Temperature Rating: Equal to boiler.
7. Shut-off Leakage: [**0.0001**]<**Insert number**> percent of valve coefficient.

L. Chemical Injection Assembly: Factory-installed, duty-rated injection quill with ball check valve and isolation valve compatible with dispensed chemical.

M. Sample Cooler: Factory [**installed**][**or**][**furnished for field installation**], with [**needle**] valve for each connection.[**Constructed of Type 316 stainless steel.**]

2.12 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer(s) with fuse protection, as required by manufacturer, to implement requirements indicated. Provide transformer with 25 percent spare capacity.
2. Set-Point Adjust: Operating and alarm set points shall be field adjustable.

B. Pressure Control for Steam Boilers:

1. Operating-Pressure Control: Factory wired and mounted to control boiler to maintain boiler at constant pressure within [**2**]<**Insert number**> percent of set point.
2. High-Pressure Cutoff with Automatic Reset: Control stops burner if operating conditions rise above normal operating-pressure set point. Set point shall be adjustable.
3. High-Pressure Cutoff with Manual Reset: Control stops burner operation upon reaching adjustable high limit set point that is below safety valve setting.

C. Water-Level Control for Steam Boilers:

1. Operating Water-Level Control:

   a. Cycle feedwater pump(s) for water-level control.
   b. Operate feedwater pump(s) continuously and modulate boiler feedwater valve in response to [**water level**][**steam flow rate and rate of pressure change**][**water level, steam flow rate, and rate of pressure change**] for water-level control.

2. Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
3. Auxiliary Low-Water Cutoff Switch: [**Electronic**][**Float and electronic**] probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.
4. Microprocessor-based control.
5. Accuracy within [**0.01 inch (0.25 mm)**]<**Insert value**>.
6. Visual indication of level, alarms, and errors through alphanumeric display.
7. Features:

a. Continuous water-level indication.
b. Low-water cutoff and alarm.
c. High-water alarm.
d. Low- and high-water warning.
e. Control of feedwater pump.
f. Control of modulating feedwater control valve.
g. Continuous monitoring of float operation.
h. Column blowdown detection and reminder.
i. Auxiliary low-water cutoff check.
j. Auto and manual reset.
k. Alarm annunciation.
l. <**Insert feature**>.

D. Operating Controls for Hot-Water Boilers:

1. Sequence of Operation:

a. Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outdoor-air temperature. At [**0 deg F (minus 17 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**200 deg F (93 deg C)**]<**Insert temperature**>; at [**60 deg F (15 deg C)**]<**Insert temperature**> outdoor-air temperature, set supply-water temperature at [**140 deg F (60 deg C)**]<**Insert temperature**>.
b. Indicated on Drawings.
c. <**Insert requirements**>.

E. Multiple Boiler Operation: Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

F. Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Manufacturer to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.

G. Chemical Feed System Interface: Dry contacts to interface control and operation of chemical feed pump.

H. Burner Safety Controls for Steam Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: [**Automatic**][**and**][**Manual**] reset stops burner if operating conditions rise above maximum boiler operating pressure.
2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
3. Auxiliary Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

I. Burner Safety Controls for Hot-Water Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: [**Automatic**][**and**][**Manual**] reset stops burner if operating conditions rise above boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**][**automatic**]-reset type.
3. Auxiliary Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low-water

alarm limit. Cutoff switch shall be manual-reset type.

4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

J. Burner Flame Safeguard Controls:

1. Factory equipped with flame safeguard control and infrared flame scanner.
2. Microprocessor-based, solid-state control having sequence and flame-on visual indication and fault code indications of flame safeguard trip functions.
3. Control shall include dynamic self-check logic.
4. Control shall have a fixed operating sequence incapable of being manually altered that includes start, prepurge, pilot and main fuel ignition run, and postpurge cycles.
5. Control shall be nonrecycle type for maximum safety that shall shut down the burner and indicate, as a minimum, the following trip functions:

    a. Pilot and main flame failure.
    b. High- and low-fire proving switch faults.
    c. Running interlocks open.
    d. False flame signal and fuel valve open.

6. Control shall include a run/test switch to allow interruptions to sequence just after prepurge and during pilot ignition trial, and run cycles for adjustments to firing rate motor, damper linkages, and pilot flame for minimum turndown tests.

K. Combustion-Air Controls: Factory equipped with motor-operated combustion-air damper and blower control to regulate burner fire according to load demand.

L. Oxygen Trim Control:

1. Provide oxygen trim system to continuously monitor and display oxygen concentrations in boiler flue gas and adjust fuel and airflow to maintain an adjustable oxygen-level set point.
2. System shall compensate for changes in ambient temperature, barometric pressure, humidity, and variations in fuel characteristics.

M. Surface Blowdown Control: Provide a conductivity sensor and control circuitry to operate an automatic control valve in surface blowdown piping to maintain total dissolved solids (TDS) within boiler manufacturer's prescribed level.

N. DDC System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

1. Hardwired I/O Points:

    a. Monitoring: On/off status, [**common trouble alarm**][**low-water-level alarm**]<**Insert monitoring points**>.
    b. Control: On/off operation, [**hot-water-supply temperature set-point adjustment**][**steam pressure adjustment**]<**Insert control points**>.

2. Communication Interface: [**ASHRAE 135 (BACnet)**][**(LonTalk)**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface shall enable control system operator to remotely control on/off and capacity of boiler and monitor the boiler operation from an operator workstation. Control features are available, and monitoring points are displayed locally at boiler-control panel through the interface.

O. Integrated Boiler-Control System:

1. Integral control of burner management for flame safety, boiler modulation, and operator interface functions with features and functions indicated.
2. Factory preconfigured.
3. Utilizing solid-state controls and sensors to provide various control functions, including the following:

    a. Automatic sequencing of the boiler through standby, prepurge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout, and postpurge.
    b. Full modulating control of air and fuel through Proportional-Integral-Derivative (PID) algorithm.
    c. Thermal shock protection.
    d. High and low limit alarms and shutdowns.

4. Local operator interface through nominal [**10-inch (250-mm)**]<**Insert size**> color touch screen graphical display for setup, monitoring, and data acquisition.

    a. Manual control of the boiler firing rate using control screens to increment or decrement firing rate.
    b. Indication of burner management controller status and diagnostics.
    c. Display of system alarms and faults.
    d. Display of history of alarms and faults.
    e. Display of recommendations for troubleshooting of fault conditions.
    f. Display of water-level indication and alarm(s).
    g. Stack flue-gas, combustion-air, and shell water-temperature indication.
    h. Boiler efficiency calculation and display.
    i. Low-fire hold with minimum temperature control.
    j. Assured low-fire cutoff (ALFCO).
    k. High stack temperature annunciation with auto cutoff.
    l. Audible alarm and silencing through touch screen intervention.

5. Fully integrated control of the following:

    a. Blower operation and combustion-air damper for varying operating conditions.
    b. Oxygen trim and monitoring to compensate for combustion-air variations.
    c. Parallel positioning for independent fuel and air control for enhanced fuel efficiency.
    d. Multiple boiler lead/lag control with hot standby.
    e. Draft control for maintaining proper and consistent draft for enhanced fuel efficiency.
    f. <**Insert additional features**>.

6. E-mail and paging feature to multiple contacts via Internet and phone line independent of control system interface.
7. LAN/WAN interface with remote monitoring software to allow remote monitoring independent of control system interface.

P. Control Enclosures:

1. NEMA 250, Type [**1**][**4**][**4X**][**12**]<**Insert type**>.

    a. Provide enclosure with integral vents, fans, heater, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.

2. Wiring shall be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
3. Mounted on boiler assembly at a location convenient to operator.
4. Provide hinged full-size door with key lock. Provide common key for all locks.

5. Enclosure shall consist of multiple sections divided by a partition with a separate hinged door for each section. One section shall house low-voltage controls and other section shall house line voltage controls.
6. Enclosure shall house the following:

    a. Control transformers with fuses.
    b. Labeled terminal strips.
    c. Controller(s) to provide control and alarm functions indicated.
    d. Audible indication of safety alarms.

7. Face of enclosure shall provide the following:

    a. Visual indication of operating components and alarms.
    b. Auto/local capability to allow operator to manually operate boiler locally.
    c. Audible alarm-silence capability.
    d. Labels for switches, lights, and displays to provide clear indication of service.

Q. Control Instrument Enclosures: Control instruments and devices that are mounted on the boiler assembly and cannot be installed inside the control enclosure shall have same or higher level of protection indicated for control enclosures.

R. Control Cable and Wire:

1. Control cable and wiring shall be numbered and color-coded to match wiring diagram.
2. Install cable and wiring located outside of enclosure(s) in a[**metal**] raceway. Use flexible conduit to make final terminations. Provide watertight installation for applications exposed to moisture.

2.13 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. Enclosure: NEMA 250, Type [**1**][**4**][**4X**][**12**]<**Insert type**>.

    a. Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
    b. Mounted on boiler assembly at a location convenient to operator.
    c. Enclosure shall have hinged full-size door with key lock with common key for all locks.

2. Wiring shall be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
3. Install wiring outside of an enclosure in a [**metal**]raceway. Make final connections to motors using flexible conduit. Provide watertight installation for applications exposed to moisture.
4. Field power interface shall be to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.
5. Provide branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
6. Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
7. Provide transformer with fuses and power wiring to power a 20-A 120-V duplex receptacle

mounted in each boiler control panel for use in connecting analytical and testing equipment.

2.14 FINISH

A. General:

1. Paint boiler, using manufacturer's standard procedures, except comply with requirements indicated.
2. Miscellaneous surfaces shall be finished to match continuous surfaces.
3. Manufacturer shall field touch up or entirely repaint surface finishes, which were damaged during shipment, to original condition, using original materials and methods.
4. Paint shall be suitable for temperatures encountered on painted surfaces.
5. Requirements indicate minimum quality level. Provide more robust paint system if required to comply with other requirements indicated.

B. Preparation:

1. Follow paint manufacturer's published preparation and application instructions.
2. When paint manufacturer's recommended preparation requirements differ from those specified, use more stringent requirements.
3. Structural steel with visible corrosion shall be sandblasted according to SSPC SP-6 or SSPC SP-10 before applying primer and paint.
4. Before application of a primer and a top coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner according to SSPC SP-1.
5. Treat galvanized-steel surfaces that cannot be procured with a phosphatized finish with a phosphate rinse to ensure proper paint adhesion.

C. Primer:

1. Rust-inhibiting type with a minimum dry film thickness of [**2 mils (0.05 mm)**]<**Insert thickness**>.
2. Provide multiple passes if required to prevent runs.
3. Select a primer that is compatible with substrate and finish coat.

D. Finish Coat:

1. Finish coat shall be [**alkyd enamel**][**epoxy**][**polyurethane**]<**Insert type**>.
2. Use dry film thickness recommended by paint manufacturer, but not less than [**2 mils (0.05 mm)**]<**Insert thickness**>. Provide multiple passes if required to prevent runs.

E. Paint the following surfaces with both a primer and finish coat:

1. Base and miscellaneous supports that are not hot dip galvanized.
2. Carbon steel that is not galvanized.
3. Exterior surfaces of unit exposed to view.
4. Piping and trim.

F. Do not paint aluminum or stainless steel.

2.15 FLUE-GAS ECONOMIZER

A. Where indicated, provide heat exchanger to transfer heat from boiler flue gas to boiler feedwater.

B. Type: Rectangular configuration with replaceable finned tubes, arranged for up-flow flue gas and

parallel flow water.

C. Internal Bypass: Economizer furnished with an internal bypass diverter to provide emergency bypass operation, with no external ducting, for controlling the following:

1. Stack corrosion.
2. Turndown performance.
3. Excessive flue-gas backpressure due to fouling.

D. Construction:

1. Comply with 2010 ASME Boiler and Pressure Vessel Code.
2. Design for abnormal operation with no water in tubes at temperature indicated.
3. Design Pressure:

   a. Water Tubes: [**300 psig (2050 kPa)**]<**Insert value**>.
   b. Inner Casing: [**10 inches wc (2500 Pa)**]<**Insert value**>.
   c. Design Temperature: [**700 deg F (370 deg C)**]<**Insert value**>.

4. Tubes and Headers:

   a. ASTM A254, Type 316 stainless steel.
   b. Helically wound, nonserrated stainless steel fins continuously welded to tubes.
   c. Arrange tubes to permit cleaning by soot blowing.
   d. Fin Density: [**48 fins per foot (157 fins per meter)**]<**Insert value**>.
   e. Fin Height: [**0.5 inch (13 mm)**]<**Insert value**>.
   f. Return bend areas shall be exposed to the bulk temperature of the flue gas.
   g. Headers shall be external to the casing.
   h. Flanged piping connections.
   i. Drainable by gravity.

5. Casing:

   a. Double wall, with [**hinged**][**or**][**removable**] panels and insulation between inner and outer casing. Access panels shall allow access to tubes and internal bypass diverter for cleaning and replacement.
   b. Casing shall be gas tight.
   c. Inner Casing: Stainless steel, all welded.
   d. Insulation: Mineral fiber, [**2 inch (50 mm)**]<**Insert value**> thick.
   e. Outer Casing: Galvanized, stainless or painted carbon steel.
   f. Angle flanges on flue-gas inlet and outlet for attachment of breeching and stack.

E. Accessories:

1. Inlet and Outlet Transitions: Designed by economizer manufacturer and furnished with economizer.
2. Safety Relief Valve: Selected by economizer manufacturer according to 2010 ASME Boiler and Pressure Vessel Code requirements.
3. Soot Blowers: Steam-operated, rotating valve-in-head. Provide sufficient number to clean all tube areas. Location, arrangement, and quantity based on recommendations of soot blower manufacturer for type and size of economizer furnished.
4. Thermometers:

   a. Water Inlet and Discharge Thermometers: Bimetal thermometer in a stainless steel case with angle position adjustment, nominal [**5-inch (120-mm)**]<**Insert size**> diameter face

having graduated scale and range of approximately [**1.5**]<**Insert number**> times the discharge temperature. Mount thermometer in a Type 316 stainless steel thermowell that is located in a visible location to indicate water inlet and discharge temperature.

b. Flue-Gas Inlet and Discharge Thermometers: Bimetal thermometer in a stainless steel case with angle position adjustment, nominal [**5-inch (120-mm)**]<**Insert size**> diameter face having graduated scale and range of approximately [**1.5**]<**Insert number**> times the inlet temperature. Mount thermometer in a Type 316 stainless steel thermowell that is located in a visible location to indicate flue-gas inlet and discharge temperature.

F. Factory Test and Inspections:

1. Inspect completed economizer assembly according to 2010 ASME Boiler and Pressure Vessel Code.
2. Certify inspection and submit completed ASME form for each economizer.

2.16 CAPACITIES AND CHARACTERISTICS

A. Heating Medium: [**Hot water**][**Steam**].

B. Design Pressure Rating, Hot-Water Boilers: [**30 psig (207 kPa)**][**60 psig (420 kPa)**][**100 psig (690 kPa)**][**125 psig (860 kPa)**][**140 psig (966 kPa)**][**160 psig (1100 kPa)**]<**Insert value**>.

C. Design Pressure Rating, Steam Boilers: [**15 psig (104 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**]<**Insert value**>.

D. Safety Relief Valve Setting: <**Insert psig (kPa)**>.

E. Entering-Water Temperature: <**Insert deg F (deg C)**>.

F. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

G. Design Water-Flow Rate: <**Insert gpm (L/s)**>.

H. Design Pressure Drop: <**Insert psig (kPa)**>.

I. Steam Operating Pressure: <**Insert psig (kPa)**>.

J. Steam-Flow Rate: <**Insert lb/h (kg/s)**>.

K. Fuel-to-Steam Efficiency: <**Insert number**> percent.

L. Fuel-to-Water Efficiency: <**Insert number**> percent.

M. Number of Passes: [**One**][**Two**][**Three**][**or**][**Four**]<**Insert number**>.

N. Gas Input: <**Insert MBh (kW)**>.

O. Gas Input Flow: <**Insert cfh (mL/s)**>.

P. Gas Pressure: <**Insert psig (kPa)**>.

Q. Oil Input: <**Insert MBh (kW)**>.

R. Oil Input Flow: <**Insert gph (mL/s)**>.

S. Output Capacity: <**Insert MBh (kW)**>.

T. Flue-Gas Economizer:

1. Design Feedwater Flow: <**Insert gpm (L/s)**>.
2. Design Feedwater Pressure Drop: <**Insert psig (kPa)**>.
3. Entering-Feedwater Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Feedwater Temperature: <**Insert deg F (deg C)**>.
5. Design Flue-Gas Flow: <**Insert cfm (L/s)**>.
6. Design Flue-Gas Pressure Drop: <**Insert inches wc (Pa)**>.
7. Entering-Flue-Gas Temperature: <**Insert deg F (deg C)**>.
8. Leaving-Flue-Gas Temperature: <**Insert deg F (deg C)**>.

U. Burner Blower:

1. Motor Horsepower: <**Insert number**> hp.

V. Electrical Characteristics:

1. Volts: [**115**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: [**50**][**60**]<**Insert number**> Hz.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.
6. Maximum Overcurrent Protection: <**Insert number**> A.

W. Sound (decibels, A weighted): <**Insert number**> dB.

2.17 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test:

1. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.
2. Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.

C. Witness Testing:

1. Allow Owner access to witness source quality-control testing of boilers.
2. Notify [**Architect**][**Owner**][**15**]<**Insert number**> days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.

B. Examine areas where boilers will be installed for suitable conditions.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install gas-fired boilers according to NFPA 54.

D. Install oil-fired boilers according to NFPA 31.

E. Assemble and install boiler trim, components, and accessories that are not factory installed.

F. Install control and electrical devices furnished with boiler that are not factory mounted.

G. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.

H. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests.[**Boiler manufacturer's factory-authorized representative shall witness boil-out and cleaning procedures.**] Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.

I. Protect boiler fireside and waterside from corrosion.

1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
2. After boiler is filled with water, and left not fired for more than [**10**]<**Insert number**> days, protect by wet storage method recommended by boiler manufacturer.
3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions. Refer to <**Insert applicable Section number and title**> for additional requirements.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to boiler(s), allow space for service and maintenance.

C. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

D. Connect oil piping to oil-train connection with dirt leg, shutoff valve, and union. Piping shall be at least full size of oil-train connection. Provide a reducer if required. Provide drain valve with threaded plug at piping low point.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

F. Connect steam and condensate piping to supply-, return-, and blowdown-boiler connections with union or flange at each connection. Provide each connection with shutoff valve if shutoff valves are not factory furnished with boiler trim.[**Provide check valves in blowdown piping of each boiler that connects multiple boilers.**]

G. Connect feedwater piping to inlet- and discharge-flue-gas economizer connections with union or flange at each connection. Provide each connection with shutoff valve and other accessories indicated and recommended by manufacturer.

H. Install piping from safety relief valves to nearest floor drain.

I. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.

J. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

K. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled nonpotable domestic cold water source to cool hot equipment drains to deliver a discharge temperature of <**Insert temperature**>.

L. Connect chemical-treatment piping to each boiler chemical-treatment connection with check valve and isolation valve.

3.4 FLUE CONNECTIONS

A. Connect breeching to full size of boiler outlet. Comply with requirements in [**Section 235116 "Fabricated Breechings and Accessories"**][**and**][**Section 235133 "Insulated Sectional Chimneys"**] for venting materials.

B. Install flue-gas recirculation duct from vent to burner if not factory furnished and installed. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for recirculation duct materials.

C. Install easily accessible test ports for field testing of flue gas from each boiler.

D. Install flue-gas economizer with factory-furnished transitions to connect to boiler and to field-installed breeching.

3.5 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.

C. Connect control wiring between boiler control interface and [**DDC control system**]<**Insert system description**> for remote monitoring and control of boilers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

3.7 NETWORK AND PHONE CONNECTIONS

A. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.

B. Connect phone system cable to boiler controls to provide connectivity for remote monitoring and alarm notification through integrated boiler control system.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

   a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
   b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and [**water temperature**][**steam pressure**].
   c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within [**12 months of date of Substantial Completion**]<**Insert time period**>, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

G. Performance Tests:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field-performance tests. Adjust, modify, or replace equipment in order to comply.
3. Perform field-performance tests to determine the capacity and efficiency of boilers.

    a. For dual-fuel boilers, perform tests for each fuel.
    b. Test for full capacity.
    c. Test for boiler efficiency at [**low fire, 10, 20, 30, 40, 50, 60, 70, 80, 90, and high fire (100)**]<**Insert range**> percent of full capacity. Determine and document efficiency at each test point.
    d. For boilers equipped with flue-gas economizers, perform tests with and without flue-gas economizer operating.

4. Test each safety valve. Record pressure at valve blowdown and reset. Test valve(s) with boiler operating at full capacity to ensure valve has capacity to prevent further rise in pressure.
5. For boilers equipped with automatic oxygen trim control, conduct tests with automatic oxygen trim control on manual at zero trim and record performance. Repeat tests with automatic oxygen trim control under automatic control and record performance.
6. Repeat tests until results comply with requirements indicated.
7. Provide measurement and analysis equipment required to determine performance.
8. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
9. Notify [**Architect**][**Owner**][**20**]<**Insert number**> days in advance of test dates.
10. Document test results in a report and submit with informational submittals.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boilers.[**Video training sessions and provide electronic copy of video to Owner.**] Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 52 39 00

Task	Specification	Specification Description
23 52 39 13	23 52 39 00	Fire-Tube Boilers

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SECTION 23 53 13 00 - BOILER FEEDWATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Feedwater units.
2. Feedwater unit with vacuum producer.

1.2 DEFINITIONS

A. NPSHR: Net-positive suction head required.

1.3 ACTION SUBMITTALS

A. Product Data: For each unit to include the following:

1. Equipment performance and operating characteristics, such as rated makeup water, feedwater, steam condensate, and steam flow rates; working pressure; tank capacities; temperature and NPSHR; and pump performance curves with selection points clearly indicated.
2. Furnished specialties and accessories.
3. Construction details, material descriptions, dimensions and weight of individual components, and profiles and finishes.
4. Force and moment capacity of each field piping connection.
5. Dimensioned location of low, high, and normal water level showing operating set point and each alarm set point.
6. Temperature and pressure rating, size, and materials of construction for trim components including piping, fittings, flanges, unions, and valves. Provide valve manufacturer Product Data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
7. Manufacturer Product Data showing size, scale range, and accuracy of thermometers and pressure gages.
8. Detailed information of controls including Product Data with technical performance, operating characteristics, and sequence of operation.
9. Product Data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

C. Delegated Design Submittals: For boiler feedwater pumps.

1. Include design calculations for selecting [**vibration isolators and**]seismic restraints and for designing vibration isolation bases.
2. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to <**Insert scale**> scale, indicating equipment manufacturer's service clearances, structure and base attachment, piping, power, and controls. Each view to show screened background with the following:

1. Column grids, beams, columns, and concrete equipment bases.
2. Room layout with walls, floors, and roofs, including each room name and number.
3. Equipment and products located in vicinity of boiler feedwater pumps and part of final installation including products of other trades, such as lighting, fire suppression systems, and plumbing systems.

B. Seismic Qualification Data: Certificates, for feedwater equipment, accessories, and components, from manufacturer.

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For feedwater equipment to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gaskets: Furnish [**one**]<**Insert number**> replacement gasket(s) for each gasketed opening.
2. Gage Glass: Furnish [**one**]<**Insert number**> replacement glass(es) for each gage glass.
3. Pump Mechanical Seal Set: Furnish [**one**]<**Insert number**> replacement mechanical seal set(s) for each unique pump mechanical seal.
4. <**Insert extra materials**>.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipping:

1. Clean flanges and exposed-metal surfaces and treat with anticorrosion compound after assembly and testing.
2. Protect flanges, pipe openings, and nozzles with flange covers or with screwed-in plugs.
3. Ship boiler feedwater pumps from the factory free of water. Drain water and blow pumps dry with compressed air if required to remove all water before shipping.
4. Cover and protect electrical and control devices and open connections.

B. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

C. Comply with manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design equipment bases, vibration isolation, and seismic restraints for boiler feedwater pumps.

B. Seismic Performance: Boiler feedwater pumps shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the boiler feedwater pumps will remain in place without separation of any parts when subjected to the seismic forces specified[**and the boiler feedwater pumps will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. ASME Compliance:

1. Fabricate and label unit receivers of boiler feedwater pumps according to ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
2. Factory-installed piping that connects pumps to receivers shall comply with [**ASME B31.1, "Power Piping."**][**ASME B31.9, "Building Services Piping."**]
3. Safety valves and pressure vessels shall bear the appropriate ASME label.

D. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the state in which equipment was operating immediately before loss of normal power. This shall be accomplished without need for manual intervention by an operator when power is restored either through a backup power source or through normal power if restored before backup power is brought on-line.
2. See Drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FEEDWATER UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alyan Pump Company**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**BFS Industries, LLC**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Deaerating Designs**]
7. [**Domestic Pump**]
8. [**Eastern Industrial Products, Inc.**]
9. [**Flotronics, Inc**]
10. [**Gerow Equipment Co.**]
11. [**Industrial Steam**]
12. [**Lattner Boiler Manufacturing**]
13. [**Lockwood Products**]
14. [**MEPCO, LLC.**]
15. [**Parker Boiler**]
16. [**Precision Boilers**]
17. [**PVI; A WATTS Brand**]
18. [**Roth Pump Company**]
19. [**Sellers Engineering Co**]
20. [**Shippensburg Pump Co., Inc**]
21. [**Skidmore Pump**]
22. [**Smith-Koch, Inc**]
23. [**Stickle Steam Specialties Co., Inc.**]
24. [**Superior Boiler Works, Inc**]
25. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
26. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Alyan Pump Company**]
2. [**Aurora Pump; Pentair Ltd.**]
3. [**BFS Industries, LLC**]
4. [**Bryan Boilers; Bryan Steam LLC**]
5. [**Cleaver-Brooks**]
6. [**Deaerating Designs**]
7. [**Domestic Pump**]
8. [**Eastern Industrial Products, Inc.**]
9. [**Flotronics, Inc**]
10. [**Gerow Equipment Co.**]
11. [**Industrial Steam**]
12. [**Lattner Boiler Manufacturing**]
13. [**Lockwood Products**]
14. [**MEPCO, LLC.**]
15. [**Parker Boiler**]
16. [**Precision Boilers**]
17. [**PVI; A WATTS Brand**]
18. [**Roth Pump Company**]
19. [**Sellers Engineering Co**]

20. [**Shippensburg Pump Co., Inc**]
21. [**Skidmore Pump**]
22. [**Smith-Koch, Inc**]
23. [**Stickle Steam Specialties Co., Inc.**]
24. [**Superior Boiler Works, Inc**]
25. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
26. <**Insert manufacturer's name**>

C. Description: Factory-assembled and -tested unit consisting of a receiver, feedwater pumps, controls, and the following features and accessories:

1. [**Liquid-filled industrial**][**Bimetal dial-type**] thermometer graduated in [**Fahrenheit**][**and**][**Celsius**].
2. Level gage glass[**, reflex flat type,**] with stops at top and bottom.
3. Lifting eyes.
4. Companion flanges.
5. Pump, suction and discharge isolation valve, inlet strainer, discharge check valve, and liquid-filled pressure gage.
6. Makeup Water Assembly: [**Float operated with integral valve**][**Electric level controller and valve**]; with inlet strainer and three-valve bypass.
7. Feedwater Heater: Sparge tube, thermostat, and control valve.
8. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A53/A53M, Type S (seamless), Grade B; or ASTM A106/A106M, Type S, Grade B, [**Schedule 40**][**Schedule 80**]; with threaded joints and fittings.

    a. Cast-Iron Threaded Fittings: ASME B16.4; Class [**125**][**250**].
    b. Malleable-Iron Threaded Fittings: ASME B16.3, Class [**150**][**300**].
    c. Forged-Steel Fittings: ASME B16.11, Class 3000.
    d. Malleable-Iron Unions: ASME B16.39; Class [**150**][**300**].
    e. Forged-Steel Unions: MSS SP-83, Class 3000.

9. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with welded joints and carbon-steel fittings and flanges.

    a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
    b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class [**150**][**300**], including bolts, nuts, and gaskets.

10. Pump-discharge bypass with relief valve or orifice plate sized to provide continuous pump operation with boiler feedwater valve closed.
11. Threaded connection and provision for chemical injection quill.
12. Sample cooler.
13. <**Insert accessory**>.

D. Receiver:

1. Material: [**Close-grain cast iron**][**Welded carbon steel**][**Welded carbon steel galvanized after fabrication**][**Stainless steel**].
2. Additional corrosion protection:

    a. [**0.07-inch (1.8-mm)**][**0.13-inch (3.3-mm)**][**0.19-inch (4.8-mm)**]<**Insert dimension**> thickness allowance.
    b. Electrolytic corrosion-inhibitor anode.

3. Finish: [**Primer**][**Primer under enamel topcoat**][**Primer under epoxy topcoat**].

4. Factory-Applied Insulation and Jacket: Minimum thickness of [**2 inches (50 mm)**]<**Insert dimension**> for mineral-fiber pipe and tank insulation. Cover insulation with [**painted steel**][**stucco-embossed aluminum**][**stainless steel**] jacket.
5. Mounting Arrangement: [**Recessed below floor**][**Floor mounted**].
6. Mounting Frame: Structural-steel stand to support receiver and pumps.[**Fabricate stand with bracing adequate for seismic forces, according to authorities having jurisdiction, and to allow anchoring mounting frame to floor.**]
7. Drain connection with valve.

E. Vertical Feedwater Pump: Flange-mounted, close-coupled, [**single-stage,**][**multistage,**] radially split-case-design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: [**Bronze**][**Stainless steel**].
2. Seals: Mechanical.
3. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

F. Horizontal Feedwater Pump: Base-mounted, [**single-stage,**][**multistage,**] radially split-case-design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: [**Bronze**][**Stainless steel**].
2. Coupling: [**Close**][**Flexible**].
3. Seals: Mechanical.
4. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

G. Control panel shall be unit mounted and factory wired and shall include the following:

1. NEMA 250, [**Type 1**][**Type 4**][**Type 4X**][**Type 12**]<**Insert type**> enclosure.
2. Single-point field power interface to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.

    a. Branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].

3. NEMA-rated motor controller for each motor, and include a hand-off-auto switch and overcurrent protection.

    a. Alternating controls for multiple-pump units with intermittent operation as indicated by control sequence.
    b. Provide variable-frequency controller [**with manual bypass**]and line reactors for each variable-speed motor.

4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
5. Wiring outside of an enclosure in a [**metal**]raceway. Make connections to motor with liquidtight conduit.
6. Removable control mounting plate.
7. Visual indication of status and alarm[**with momentary test push button**].
8. Audible alarm and silence switch.
9. Visual indication of elapsed run time, graduated in hours.

10. Fused control-circuit transformer.
11. Microprocessor-based controller.

H. Feedwater Single-Pump Control Sequence:

1. Boiler water-level controller starts and stops pump to maintain boiler water-level set point.
2. Visual indication of pump on[**and off**] status.
3. Visual[**and audible**] alarm indication of pump failure.

I. Feedwater Multiple-Pump with Intermittent Operation Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
3. Lead pump failure [**automatically starts lag pump if lead pump cannot maintain set point**][**manually starts lag pump**].
4. Visual indication of pump on[**and off**] status.
5. Visual indication of pump lead/lag status.
6. Visual[**and audible**] alarm indication of pump failure.

J. Feedwater Multiple-Pump with Continuous Operation Control Sequence:

1. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
2. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
3. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
4. Lead pump failure automatically starts lag pump.
5. Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
6. Feedwater pressure controller controls operating feedwater pump(s) speed and starts and stops lag pump(s) to maintain feedwater pressure set point.
7. Visual indication of pump on[**and off**] status.
8. Visual indication of pump lead/lag status.
9. Visual[**and audible**] alarm indication of pump failure.

K. Receiver Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain receiver water-level set point.
2. Mechanical float operates integral valve to maintain water-level set point.
3. Visual[**and audible**] alarm indication of low[**and high**] receiver-water level.

L. Control System Interface: Factory install hardware to enable remote monitoring.

1. Hardwired Monitoring Points: On/off status for each pump[**, failure alarm for each pump**][**, receiver low-water-level alarm**][**, receiver high-water-level alarm**][**, feedwater temperature**]<**Insert monitoring**>.

M. Capacities and Characteristics:

1. Condensate Receiver:

a. Volume: <**Insert gal. (L)**>.
b. Diameter: <**Insert inches (mm)**>.
c. Length: <**Insert inches (mm)**>.
d. Height to Condensate Inlet: <**Insert inches (mm)**>.
e. Condensate Return Minimum Inlet Size: <**Insert NPS (DN)**>.

f. Makeup Water Minimum Inlet Size: <**Insert NPS (DN)**>.
g. Sparge-Tube Steam Supply: <**Insert lb/h (kW)**>.

2. Feedwater Pumps:

a. No. of Pumps: [**Simplex**][**Duplex**]<**Insert number**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. NPSHR: <**Insert psig (kPa)**>.
d. Rated Operating Temperature: <**Insert deg F (deg C)**>.
e. Head Pressure: <**Insert psig (kPa)**>.
f. Horsepower: <**Insert horsepower**>.
g. Speed: <**Insert value**> rpm.

3. Unit Single-Point Power Electrical Characteristics:

a. Volts: [**208**][**460**]<**Insert value**> V.
b. Phase: Three.
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 FEEDWATER UNIT WITH VACUUM PRODUCER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alyan Pump Company**]
2. [**Domestic Pump**]
3. [**Flotronics, Inc**]
4. [**Lockwood Products**]
5. [**MEPCO, LLC.**]
6. [**Shippensburg Pump Co., Inc**]
7. [**Skidmore Pump**]
8. [**U.S. Deaerator Co**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alyan Pump Company**]
2. [**Domestic Pump**]
3. [**Flotronics, Inc**]
4. [**Lockwood Products**]
5. [**MEPCO, LLC.**]
6. [**Shippensburg Pump Co., Inc**]
7. [**Skidmore Pump**]
8. [**U.S. Deaerator Co**]
9. <**Insert manufacturer's name**>

C. Description: Receiver mounted, consisting of multijet vacuum producer, centrifugal pump and motor assembly mounted on separation chamber, and automatic pressure and water temperature controls. Include the following accessories:

1. [**Liquid-filled industrial**][**Bimetal dial-type**] thermometer graduated in [**Fahrenheit**][**and**][**Celsius**].
2. Vacuum Gage: Dial-type register in **inches of mercury (kPa)**.
3. Level Gage Glass: Stops top and bottom.
4. Air-suction check valve.
5. Lifting eyes.
6. Companion flanges.
7. Low-water cutoff switch.
8. Cooling-Water Control: Aquastat, inlet strainer, and electric valve.
9. Air vent.
10. Overflow drain from vacuum-producer receiver.
11. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A53/A53M, Type S (seamless), Grade B; or ASTM A106/A106M, Type S, Grade B, [**Schedule 40**][**Schedule 80**]; with threaded joints and fittings.

    a. Cast-Iron Threaded Fittings: ASME B16.4; Class [**125**][**250**].
    b. Malleable-Iron Threaded Fittings: ASME B16.3, Class [**150**][**300**].
    c. Forged-Steel Fittings: ASME B16.11, Class 3000.
    d. Malleable-Iron Unions: ASME B16.39; Class [**150**][**300**].
    e. Forged-Steel Unions: MSS SP-83, Class 3000.

12. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with welded joints and carbon-steel fittings and flanges.

    a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
    b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class [**150**][**300**], including bolts, nuts, and gaskets.

13. Pump-discharge bypass with relief valve or orifice plate sized to provide continuous pump operation with boiler feedwater valve closed.
14. Threaded connection and provision for chemical injection quill.
15. Sample cooler.
16. <**Insert accessory**>.

D. Vacuum-Producer Reservoir and Vacuum Receiver:

1. Material: [**Close-grain cast iron**][**Welded carbon steel**][**Welded carbon steel galvanized after fabrication**][**Stainless steel**].
2. Additional corrosion protection:

    a. [**0.07-inch (1.8-mm)**][**0.13-inch (3.3-mm)**][**0.19-inch (4.8-mm)**]<**Insert dimension**> thickness allowance.
    b. Electrolytic corrosion-inhibitor anode.

3. Finish: [**Primer**][**Primer under enamel topcoat**][**Primer under epoxy topcoat**].
4. Factory-Applied Insulation and Jacket: Minimum thickness of [**2 inches (50 mm)**]<**Insert dimension**> for mineral-fiber pipe and tank insulation. Cover insulation with [**painted steel**][**stucco-embossed aluminum**][**stainless steel**] jacket.
5. Mounting Arrangement: [**Recessed below floor**][**Floor mounted**].
6. Mounting Frame: Structural-steel stand to support receiver and pumps.[**Fabricate stand with bracing adequate for seismic forces, according to authorities having jurisdiction, and to allow anchoring mounting frame to floor.**]
7. Drain connection with valve.

E. Vertical Vacuum-Producer Pump: Flange-mounted, close-coupled, single-stage, radially split-case-

design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: Bronze.
2. Shaft: Stainless steel.
3. Seals: Mechanical.
4. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

F. Horizontal Vacuum-Producer Pump: Base-mounted, single-stage, radially split-case-design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: Bronze.
2. Shaft: Stainless steel.
3. Coupling: [**Close**][**Flexible**].
4. Seals: Mechanical.
5. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

G. Vertical Feedwater Pump: Flange-mounted, close-coupled, [**single-stage,**][**multistage,**] radially split-case-design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: [**Bronze**][**Stainless steel**].
2. Seals: Mechanical.
3. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

H. Horizontal Feedwater Pump: Base-mounted, [**single-stage,**][**multistage,**] radially split-case-design centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of at least [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

1. Impeller: [**Bronze**][**Stainless steel**].
2. Coupling: [**Close**][**Flexible**].
3. Seals: Mechanical.
4. Motor: [**Open dripproof**][**Totally enclosed**][**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230500 "Common Work Results for HVAC."

I. Control panel shall be unit mounted and factory wired and include the following:

1. Vacuum Switches for Simplex Vacuum-Producer Pumps: Include pressure adjustment, and test push button. Factory set to operate pump between **3 and 6 inches of mercury (10.1 and 20.2 kPa)**.
2. Vacuum Switches for Duplex Vacuum-Producer Pumps: Include pressure adjustment, and test push button. Factory set so one pump operates for **3 to 5 inches of mercury (10.1 to 16.9 kPa)** and both pumps operate for **4 to 6 inches of mercury (13.5 to 20.2 kPa)**.
3. NEMA 250, [**Type 1**][**Type 4**][**Type 4X**][**Type 12**]<**Insert type**> enclosure.
4. Single-point field power interface to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.

a. Branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].

5. NEMA-rated motor controller for each motor and include a hand-off-auto switch and overcurrent protection.

   a. Alternating control for multiple pump units with intermittent operation as indicated by control sequence.
   b. Provide variable-frequency controller [**with manual bypass**]and line reactors for each variable-speed motor.

6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Wiring outside of an enclosure in a [**metal**]raceway. Make connections to motor with liquidtight conduit.
8. Removable control mounting plate.
9. Visual indication of status and alarm[**with momentary test push button**].
10. Audible alarm and silence switch.
11. Visual indication of elapsed run time, graduated in hours.
12. Fused control-circuit transformer.

J. Vacuum-Producer Control Sequence:

1. Cycle pumps to maintain vacuum-pressure set point.
2. Visual indication of pump on[**and off**] status.
3. Visual[**and audible**] alarm indication of pump failure.

K. Feedwater Single-Pump Control Sequence:

1. Boiler water-level controller starts and stops pump to maintain boiler water-level set point.
2. Visual indication of pump on[**and off**] status.
3. Visual[**and audible**] alarm indication of pump failure.

L. Feedwater Multi-Pump with Intermittent Operation Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
3. Lead pump failure [**automatically starts lag pump if lead pump cannot maintain set point**][**manually starts lag pump**].
4. Visual indication of pump on[**and off**] status.
5. Visual indication of pump lead/lag status.
6. Visual[**and audible**] alarm indication of pump failure.

M. Feedwater Multi-Pump with Continuous Operation Control Sequence:

1. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
2. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
3. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
4. Lead pump failure automatically starts lag pump.
5. Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
6. Feedwater pressure controller controls operating feedwater pump(s) speed and starts and stops lag pump(s) to maintain feedwater pressure set point.
7. Visual indication of pump on[**and off**] status.
8. Visual indication of pump lead/lag status.

9. Visual[**and audible**] alarm indication of pump failure.

N. Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain water temperature set point.
2. Visual[**and audible**] alarm indication of low[**and high**] water level.

O. Control System Interface: Factory install hardware to enable remote monitoring.

1. Hardwired Monitoring Points: On/off status for each pump[**, failure alarm for each pump**][**, receiver low-water-level alarm**][**, receiver high-water-level alarm**][**, feedwater temperature**]<**Insert monitoring**>.

P. Capacities and Characteristics:

1. Vacuum-Producer Reservoir:

a. Volume: <**Insert gal. (L)**>.
b. Diameter: <**Insert inches (mm)**>.
c. Length: <**Insert inches (mm)**>.
d. Cooling Makeup Water Supply: <**Insert NPS (DN)**>.
e. Overflow Drain: <**Insert NPS (DN)**>.

2. Vacuum-Producer Pumps:

a. No. of Pumps: [**Simplex**][**Duplex**]<**Insert number**>.
b. Air Capacity: <**Insert cfm (L/s)**>.
c. Head Pressure: <**Insert inches of mercury (kPa)**>.
d. Horsepower: <**Insert horsepower**>.
e. Speed: <**Insert value**> rpm.

3. Vacuum Receiver:

a. Volume: <**Insert gal. (L)**>.
b. Diameter: <**Insert inches (mm)**>.
c. Length: <**Insert inches (mm)**>.
d. Height to Condensate Inlet: <**Insert inches (mm)**>.
e. Condensate Return Minimum Inlet Size: <**Insert NPS (DN)**>.

4. Feedwater Pumps:

a. No. of Pumps: [**Simplex**][**Duplex**]<**Insert number**>.
b. Flow Rate: <**Insert gpm (L/s)**>.
c. NPSHR: <**Insert psig (kPa)**>.
d. Rated Operating Temperature: <**Insert deg F (deg C)**>.
e. Head Pressure: <**Insert psig (kPa)**>.
f. Horsepower: <**Insert horsepower**>.
g. Speed: <**Insert value**> rpm.

5. Unit Single-Point Power Electrical Characteristics:

a. Volts: [**208**][**460**]<**Insert value**> V.
b. Phase: Three.
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**>.

e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test performance and submit test results on packaged boiler feedwater pump units, according to ASME PTC 12.1, before shipping to Project.

B. Witness Testing:

1. Allow Owner access to witness source quality-control testing.
2. Notify [**Architect**][**Owner**][**15**]<**Insert time**> days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting feedwater unit performance, maintenance, and operations.

1. Boiler feedwater pump unit locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, control, and electrical connections.

B. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping to verify actual locations of piping connections before installation of boiler feedwater pumps.

C. Examine areas for suitable conditions where boiler feedwater pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:

1. Install feedwater units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install unit to permit access for maintenance.

D. Support piping independent of equipment.

E. Install parts and accessories shipped loose.

F. Install control and electrical devices furnished with units that are not factory mounted.

G. Install control and power wiring to field-mounted control and electrical devices furnished with units that are not factory installed.

H. Protect units from corrosion.

1. Before filling with water, protect by dry storage method recommended by manufacturer.
2. After filled with water, protect by wet storage method recommended by manufacturer.

I. Chemical Treatment: Quality of water in units shall be maintained by a professional water treatment organization that shall provide on-site supervision to maintain the required water quality during periods of storage, operating, standby, and test conditions. Comply with requirements in [**Section 232500 "HVAC Water Treatment,"**][**Section 232519 "Water Treatment for Steam System Feedwater,"**] for additional requirements.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to boiler feedwater pumps, allow space for service and maintenance.

C. Connect makeup water piping and cooling-water piping with reduced-pressure backflow preventers.

D. Install overflow drain piping to nearest floor drain.

E. Install piping from unit drain connections and extend to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation if required.

F. Install vents and extend to outdoors; terminate with elbow turned down and an insect screen.

G. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled, non-potable, domestic cold water source to cool hot equipment drains to deliver a discharge temperature of <**Insert temperature**>.

H. Connect chemical treatment piping to each boiler feedwater pump unit chemical treatment connection with check valve and isolation valve.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between boiler feedwater pump units and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between boiler feedwater pump unit control interface and control system to provide remote monitoring.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Check bearing lubrication.
4. Verify proper motor rotation.
5. Startup service.
6. Report results in writing.

D. Boiler feedwater pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust boiler water-level controls to properly stage unit.

B. Set field-adjustable controls.

3.8 CLEANING

A. Clean equipment internally; remove coatings applied for protection during shipping and storage, foreign material, and oily residue according to manufacturer's written instructions. Following cleaning procedures, unit shall be washed and flushed until water leaving unit is clear.

B. Clean strainers.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain boiler feedwater units.

B. Video training sessions, and provide electronic copy of video to Owner.

END OF SECTION 23 53 13 00

SECTION 23 53 16 00 - DEAERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged, factory-assembled deaerators.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. Feedwater Pump: Pump that moves feedwater from the deaerator to the boiler.

C. NPSHR: Net-positive suction head required.

D. Transfer Pump: Pump that moves feedwater from the surge tank to the deaerator.

1.3 ACTION SUBMITTALS

A. Product Data: For each unit to include the following:

1. Equipment performance and operating characteristics, such as rated makeup water, feedwater, steam condensate and steam flow rates; working pressure; tank capacities, storage capacity in minutes; temperature and NPSHR; and pump performance curves with selection points clearly indicated.
2. Furnished specialties and accessories.
3. Construction details, material descriptions, dimensions and weight of individual components, and profiles and finishes.
4. Force and moment capacity of each field piping connection.
5. Dimensioned location of low, high, and normal water level showing operating set point and each alarm set point.
6. Temperature and pressure rating, size, and materials of construction for trim components including, piping, fittings, flanges, unions, and valves. Provide valve manufacturer Product Data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
7. Manufacturer Product Data showing size, scale range, and accuracy of thermometers and pressure gages.
8. Detailed information of controls including Product Data with technical performance, operating characteristics, and sequence of operation.
9. Product Data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.

4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

C. Delegated Design Submittals: For deaerators, signed and sealed by a qualified professional engineer.

1. Include design calculations for selecting [**vibration isolators and**]seismic restraints and for designing vibration isolation bases.
2. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to <**Insert scale**> scale, indicating equipment manufacturer's service clearances, structure and base attachment, piping, power, and controls. Each view to show screened background with the following:

1. Column grids, beams, columns, and concrete equipment bases.
2. Room layout with walls, floors, and roofs, including each room name and number.
3. Equipment and products located in vicinity of deaerators and part of final installation including products of other trades, such as lighting, fire suppression systems, and plumbing systems.

B. Seismic Qualification Certificates: For deaerators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Startup service reports.

F. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to deaerator.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For deaerators, components, and accessories to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gaskets: Furnish [**one**]<**Insert number**> replacement gasket(s) for each gasketed opening.
2. Gage Glass: Furnish [**one**]<**Insert number**> replacement glass(es) for each gage glass.
3. Pump Mechanical Seal Set: Furnish [**one**]<**Insert number**> replacement mechanical seal set(s) for each unique pump mechanical seal.
4. <**Insert extra materials**>.

B. Tool Kit:

1. A tool kit specially designed by deaerator manufacturer for use in servicing deaerator(s) furnished.
2. Special tools required to service deaerator components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Deaerator Tool Kit." Text size is to be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size is to be at least **0.5 inch (13 mm)** high.

C. Touchup Paint: [**32 oz. (1 L)**]<**Insert volume**> container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship deaerators from the factory free of water. Drain water and blow deaerators dry with compressed air if required to remove all water before shipping.

B. Cover and protect flanges, pipe openings, nozzles, bearings, and couplings from damage during shipping, storage, and handling.

C. Cover and protect electrical and control devices and open connections.

D. Comply with manufacturer's written rigging instructions.

E. Deliver deaerators as factory-assembled units with protective crating and covering.

1. Package deaerator for export shipping in totally enclosed [**bagging**][**crate**][**crate with bagging**].

F. Protect deaerator components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Deaerator is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the deaerator will remain in place without separation of any parts

when subjected to the seismic forces specified[**and the deaerator will be fully operational after the seismic event**]."

2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system will automatically return equipment and associated controls to the operating state. This will occur immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source or through normal power if restored before backup power is brought on-line.
2. See Drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

C. Outdoor Installations:

1. Deaerators are to be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**]<**Insert value**>-year period with minimal degradation due to exposure to outdoor ambient conditions.
2. Deaerators equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**]<**Insert value**>-year period.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. ASME Compliance: Fabricate and label deaerators and components to comply with ASME Boiler and Pressure Vessel Code.

2.2 PACKAGED, FACTORY-ASSEMBLED DEAERATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ambassador Heat Transfer Company**]
2. [**Bethlehem Corporation (The)**]
3. [**Bryan Boilers; Bryan Steam LLC**]
4. [**Cleaver-Brooks**]
5. [**Cochrane, Inc.**]
6. [**Deaerating Designs**]
7. [**Eastern Industrial Products, Inc.**]
8. [**Ecodyne Limited**]
9. [**Enpro, Incorporated**]
10. [**Industrial Steam**]
11. [**International Boiler Works Co. (The)**]
12. [**Kansas City Deaerator Company**]
13. [**Lockwood Products**]
14. [**Nationwide Boiler Incorporated**]
15. [**Precision Boilers**]

16. [**PVI; A WATTS Brand**]
17. [**Sellers Engineering Co**]
18. [**Skidmore Pump**]
19. [**Smith-Koch, Inc**]
20. [**Sterling Deaerator Co**]
21. [**U.S. Deaerator Co**]
22. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
23. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ambassador Heat Transfer Company**]
2. [**Bethlehem Corporation (The)**]
3. [**Bryan Boilers; Bryan Steam LLC**]
4. [**Cleaver-Brooks**]
5. [**Cochrane, Inc.**]
6. [**Deaerating Designs**]
7. [**Eastern Industrial Products, Inc.**]
8. [**Ecodyne Limited**]
9. [**Enpro, Incorporated**]
10. [**Industrial Steam**]
11. [**International Boiler Works Co. (The)**]
12. [**Kansas City Deaerator Company**]
13. [**Lockwood Products**]
14. [**Nationwide Boiler Incorporated**]
15. [**Precision Boilers**]
16. [**PVI; A WATTS Brand**]
17. [**Sellers Engineering Co**]
18. [**Skidmore Pump**]
19. [**Smith-Koch, Inc**]
20. [**Sterling Deaerator Co**]
21. [**U.S. Deaerator Co**]
22. [**York-Shipley Global; Division of Power Mechanical, Inc.**]
23. <**Insert manufacturer's name**>

C. [**Horizontal**][**Vertical**], [**packed-column**][**spray**][**tray**], single-compartment deaerator[**, and a separate packaged surge tank with transfer and feedwater pumps and controls to supply feedwater to deaerator**].

D. [**Horizontal**][**Vertical**], [**packed-column**][**spray**][**tray**], two-compartment deaerator. One compartment for deaeration and one for surge volume, each with its own transfer and feedwater pumps and controls.

E. [**Horizontal**][**Vertical**], [**packed-column**][**spray**][**tray**], single-compartment deaerator and separate surge tank, both mounted on same factory-fabricated stand with necessary transfer and feedwater pumps and controls.

F. Material for Wetted Components: Components in contact with water that has not been deaerated are to be made of Type [**304**][**316**] stainless steel.

G. Adjustable Spray Valves: Type 316 stainless steel. Arrange spray valves for counterflow of steam and condensate and so corrosive gases being vented do not contact deaerator's head or shell.

H. Vent Condenser: Stainless steel, with automatic and manual vent valves.

I. Deaerator and Storage Tank:

1. Material: [**Welded carbon steel**][**Welded carbon steel galvanized after fabrication**][**Stainless steel**].
2. Additional Corrosion Protection:

    a. [**0.07-inch (1.8-mm)**][**0.13-inch (3.3-mm)**][**0.19-inch (4.8-mm)**]<**Insert dimension**> thickness allowance.
    b. Electrolytic corrosion-inhibitor anode.

3. Access: Manhole in deaerator and storage tank for access to internal components for inspection and service.

    a. Manhole cover is to be [**davited**][**or**][**hinged**].

4. Factory-Applied Insulation and Jacket:

    a. Minimum thickness of [**2 inches (50 mm)**]<**Insert dimension**> for mineral-fiber pipe and tank insulation.
    b. Cover insulation with preformed and removable sections of [**painted steel**][**stucco-embossed aluminum**][**or**][**stainless steel**] jacket to uniformly follow the contour of the tank. Jacket nominal thickness is not less than [**0.030 inch (0.8 mm)**][**0.048 inch (1.2 mm)**]<**Insert dimension**>.

5. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A53/A53M, Type S (seamless), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with threaded joints and fittings.

    a. Cast-Iron Threaded Fittings: ASME B16.4, Class [**125**][**250**].
    b. Malleable-Iron Threaded Fittings: ASME B16.3, Class [**150**][**300**].
    c. Forged-Steel Fittings: ASME B16.11, Class 3000.
    d. Malleable-Iron Unions: ASME B16.39, Class [**150**][**300**].
    e. Forged-Steel Unions: MSS SP-83, Class 3000.

6. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with welded joints and carbon-steel fittings and flanges.

    a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
    b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class [**150**][**300**], including bolts, nuts, and gaskets.

J. Accessories:

1. Lifting eyes.
2. Companion flanges.
3. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
4. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in [**pounds force per square inch**][**kilopascals**][**both pounds force per square inch and kilopascals**].
5. Pump-discharge bypass [**relief valve**][**orifice plate**][**relief valve with orifice plate**] sized to provide continuous pump operation with boiler feedwater valve closed.
6. Makeup Water Assembly:

    a. Factory-mounted modulating valve with mechanical level control, external float cage, and stainless steel float.
    b. [**Factory**][**Field**]-mounted, electric, [**pilot-operated, solenoid**][**modulating**] valve with

factory-mounted, [**probe-type**]water-level controller.

c. [**Factory**][**Field**]-mounted, pneumatic modulating valve with factory-mounted water-level controller.

d. [**Factory**][**Field**]-mounted, three-valve bypass and inlet strainer.

7. Steam Pressure-Reducing Valve(s): [**Steam**][**Electric**][**Pneumatic**] operated[**with three-valve bypass**], and sized to reduce boiler outlet pressure to the deaerator design pressure.
8. Tank Overflow Drain: Sized to relieve full capacity at operating pressure.
9. Tank Overflow Drainer: Float-type trap, sized to relieve full capacity at operating pressure, with steel housing and stainless steel float ball.
10. Safety Valve(s): ASME labeled and sized to relieve full capacity of pressure-reducing valve. Provide each safety valve with a drip-pan elbow.[**For units installed outdoors, provide each safety valve vent with an exhaust head.**]
11. Vents: Manual and automatic vent valves.

    a. Automatic air vents are to be thermostatically controlled to provide a fast means of venting when a sudden buildup of gas occurs.

    b. Manual air vents are to have an orifice to provide continuous venting at a rate of up to 0.1 percent of rated deaerator capacity at operating pressure indicated.

    c. For units installed outdoors, provide each vent with a drip-pan elbow and exhaust head.

12. High-temperature condensate diffuser tube.
13. Vacuum breaker.
14. Meters and Gages:

    a. Full-height, water-level gage glass[**, reflex flat type,**] with gage rods to protect glass and stop valve set, ball check and shutoff cocks, water-column blowdown valves, and vacuum breaker.

    b. Thermometer:

        1) [**Liquid-filled industrial**][**Bimetal dial-type**] thermometer graduated in [**Fahrenheit**][**Celsius**][**both Fahrenheit and Celsius**] mounted to measure temperature in storage [**and steam**]section of tank.

        2) Graduated scale with a range of approximately [**1.5**]<**Insert value**> times the normal operating temperature.

        3) Any angle position adjustment.

        4) Stainless steel case with nominal [**5-inch- (125-mm-)**]<**Insert dimension**> diameter face.

        5) Mount thermometer in a Type 316 stainless steel thermowell.

    c. Pressure Gage:

        1) Pressure gage graduated in [**pounds force per square inch**][**kilopascals**][**both pounds force per square inch and kilopascals**] mounted to measure pressure in steam section of tank and pressure at feedwater discharge manifold pipe.

        2) Nominal [**4-inch- (100-mm-)**]<**Insert dimension**> diameter face with graduated scale and siphon with isolation valve. Gage is to have normal operating pressure about [**50**]<**Insert number**> percent of full range and an accuracy of [**0.5**][**1**] percent.

    d. Flow meter mounted in feedwater discharge manifold pipe and positioned to measure and display flow supplied by deaerator to boilers. Accuracy within [**2**]<**Insert value**> of actual reading when measured across design to minimum flow range.

    e. Meters and gages are to be easily readable by operator standing at grade adjacent to unit. Provide remote reading gages if required to comply with requirement.

15. Provision for chemical injection quill.

16. Chemical injection quill with check valve and isolation valve.
17. Sample Cooler: Factory [**installed**][**or**][**furnished for field installation**], with [**needle**] valve for each connection.[**Constructed of Type 316 stainless steel.**]
18. Tank drain connection with valve.
19. Oxygen test kit.
20. <**Insert accessory**>.

K. Support Frame: Structural-steel frame for supporting tank and pumps. Weld or bolt to tank.

1. Fabricate support frame with bracing adequate for seismic forces in accordance with authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.
2. Minimum height of frame is to be as required by application, but not less than <**Insert height**>.

L. Feedwater Pump: Cast-iron, [**flange**][**base**]-mounted volute; with [**bronze**][**stainless steel**], [**multistage centrifugal**][**turbine**] impeller, renewable bronze case ring, and stainless steel shaft.

1. Seals: Mechanical, suitable for [**250 deg F (121 deg C)**]<**Insert temperature**>.
2. Pump Motor: [**Vertical**][**Horizontal**], [**close**][**or**][**flexible**] coupled to pump. Comply with requirements in Section 230500 "Common Work Results for HVAC" unless more stringent requirements are indicated below:

   a. Efficiency: [**Premium efficient**]<**Insert requirement**>.
   b. Enclosure: [**Open dripproof**][**totally enclosed**][**or**][**totally enclosed fan cooled**].
   c. Insulation Class: [**F**][**H**]<**Insert requirement**>.
   d. Service Factor: [**1.15**]<**Insert value**>.
   e. Motors operated through variable-frequency controllers are to be inverter duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."

3. Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

2.3 SURGE TANK ASSEMBLY

A. Description: Factory-assembled and -tested unit consisting of a condensate receiver, transfer pumps, and controls.

B. Accessories:

1. Thermometer:

   a. [**Liquid-filled industrial**][**Bimetal dial-type**] thermometer graduated in [**Fahrenheit**][**Celsius**][**both Fahrenheit and Celsius**].
   b. Graduated scale with a range of approximately [**1.5**]<**Insert value**> times the normal operating temperature.
   c. Any angle position adjustment.
   d. Stainless steel case with nominal [**5-inch- (125-mm-)**]<**Insert dimension**> diameter face.
   e. Mount thermometer in a Type 316 stainless steel thermowell.

2. Full-height, water-level gage glass[**, reflex flat type,**] with gage rods to protect glass and stop valve set, ball check and shutoff cocks, water-column blowdown valves, and vacuum breaker.
3. Lifting eyes.
4. Companion flanges.
5. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.

6. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in [**pounds force per square inch**][**kilopascals**][**both pounds force per square inch and kilopascals**]. Gage with nominal [**4-inch- (100-mm-)**]<**Insert dimension**> diameter face, isolation valve, normal operating pressure about [**50**]<**Insert number**> percent of full range, and an accuracy of [**0.5**][**1**] percent.
7. Gages are to be easily readable by operator standing at grade adjacent to unit. Provide remote reading gages if required to comply with requirement.
8. Pump-discharge bypass [**relief valve**][**orifice plate**][**relief valve with orifice plate**] sized to provide continuous pump operation.
9. <**Insert accessories**>.

C. Factory-Installed Pipe, NPS 2-1/2 (DN 65) and Smaller: ASTM A53/A53M, Type S (seamless), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with threaded joints and fittings.

1. Cast-Iron Threaded Fittings: ASME B16.4, Class [**125**][**250**].
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class [**150**][**300**].
3. Forged-Steel Fittings: ASME B16.11, Class 3000.
4. Malleable-Iron Unions: ASME B16.39, Class [**150**][**300**].
5. Forged-Steel Unions: MSS SP-83, Class 3000.

D. Factory-Installed Pipe, NPS 3 (DN 80) and Larger: ASTM A53/A53M, Type E (electric-resistance welded), Grade B; or ASTM A106/A106M, Type S, Grade B, Schedule [**40**][**80**]; with welded joints and carbon-steel fittings and flanges.

1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class [**150**][**300**], including bolts, nuts, and gaskets.

E. Tank:

1. Material: [**Welded carbon steel**][**Welded carbon steel galvanized after fabrication**][**Stainless steel**].
2. Additional Corrosion Protection:

   a. [**0.07-inch (1.8-mm)**][**0.13-inch (3.3-mm)**][**0.19-inch (4.8-mm)**]<**Insert dimension**> thickness allowance.
   b. Electrolytic corrosion-inhibitor anode.

3. Access: Manhole in tank for access to internal components for inspection and service.

   a. Manhole cover is to be [**davited**][**or**][**hinged**].

4. Factory-Applied Insulation and Jacket:

   a. Minimum thickness of [**2 inches (50 mm)**]<**Insert dimension**> for mineral-fiber pipe and tank insulation.
   b. Cover insulation with preformed and removable sections of [**painted steel**][**stucco-embossed aluminum**][**stainless steel**] jacket to uniformly follow the contour of the tank. Jacket nominal thickness is not less than [**0.030 inch (0.8 mm)**][**0.048 inch (1.2 mm)**]<**Insert dimension**>.

F. Support Frame: Structural-steel frame for supporting tank. Weld or bolt to tank.

1. Fabricate support frame with bracing adequate for seismic forces in accordance with authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.
2. Minimum height of frame is to be as required by application, but not less than <**Insert height**>.

G. Transfer Pump:

1. Vertical, flange-mounted, close-coupled, [**single-stage**][**multistage**], radially split-case centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

   a. Impeller: [**Bronze**][**Stainless steel**].
   b. Seals: Mechanical.

2. Horizontal, base-mounted, [**single-stage**][**multistage**], radially split-case centrifugal pump; rated for [**175-psig (1205-kPa)**]<**Insert value**> minimum working pressure and a continuous water temperature of [**225 deg F (107 deg C)**]<**Insert temperature**>; with the following features:

   a. Impeller: [**Bronze**][**Stainless steel**].
   b. Coupling: [**Close**][**Flexible**].
   c. Seals: Mechanical.

H. Transfer Pump Motor: Comply with requirements in Section 230500 "Common Work Results for HVAC" unless more stringent requirements are indicated below:

1. Efficiency: [**Premium efficient**]<**Insert requirement**>.
2. Enclosure: [**Open dripproof**][**totally enclosed**][**or**][**totally enclosed fan cooled**].
3. Insulation Class: [**F**][**H**]<**Insert requirement**>.
4. Service Factor: [**1.15**]<**Insert value**>.
5. Motors operated through variable-frequency controllers is to be inverter duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
6. Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

2.4 CONTROLS

A. Factory-installed and -wired controllers, meters, sensors, switches, transformers, transmitters, valves, and other control devices necessary to provide a complete and functioning unit to operate as indicated and connect to field control interfaces indicated.

B. Operating controls include the following devices and features:

1. Control transformer(s) with fuse protection, as required by manufacturer, to implement requirements indicated. Provide transformer with 25 percent spare capacity.
2. Set-Point Adjust: Operating and alarm set points are to be field adjustable.

C. Control Enclosures:

1. NEMA 250, Type [**1**][**4**][**4X**][**12**]<**Insert type**>.

   a. Provide enclosure with integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.

2. Wiring is to be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
3. Mounted on deaerator assembly at a location convenient to operator.

4. Provide hinged full-size door with key lock. Provide common key for all locks.
5. Enclosure is to consist of multiple sections divided by a partition with a separate hinged door for each section. One section houses low-voltage controls; other section houses line voltage controls.
6. Enclosure houses the following:

    a. Control transformers with fuses.
    b. Labeled terminal strips.
    c. [**Controller(s)**][**Microprocessor-based controller(s)**] to provide control and alarm functions indicated.
    d. Audible indication of safety alarms.
    e. Dry Contacts:

        1) For interface with chemical feed pump controls.
        2) <**Insert additional requirements**>.

7. Face of enclosure provides the following:

    a. Visual indication of operating components and alarms[**with momentary test push button**].
    b. Visual indication of elapsed run time, graduated in hours.
    c. Auto/local capability to allow operator to manual operate unit locally.
    d. Audible alarm silence capability.
    e. Labels for switches, lights, and displays to provide clear indication of service.

8. For units with surge tank assembly mounted on a separate support frame from deaerator assembly, [**provide a separate**][**provide a common**][**manufacturer has option to provide a separate or common**] control panel for deaerator and surge tank assemblies.

D. Control Instrument Enclosures: Control instruments and devices that are mounted on the deaerator assembly and cannot be installed inside the control enclosure is to have same or higher level of protection indicated for control enclosures.

E. Control Cable and Wire:

1. Control cable and wiring is to be numbered and color-coded to match wiring diagram.
2. Install cable and wiring located outside of enclosure(s) in a[**metal**] raceway.
3. Use flexible conduit to make final terminations.
4. Provide watertight installation for applications exposed to moisture.

F. Touch-Screen Local Operator Interface: Provide local operator interface through a nominal [**10-inch (250-mm)**]<**Insert dimension**> touch-screen graphical color display for setup, monitoring, and data acquisition.

1. Monitoring:

    a. Pump operating status (on/off).
    b. Pump lead/lag status (lead/lag position).
    c. Pump speed for variable-speed pumps (analog value, zero to 100 percent).
    d. Pump operation failure alarm.
    e. Pump starts.
    f. Pump run time.
    g. Feedwater pump manifold pipe discharge flow rate (analog valve).
    h. Feedwater pump manifold pipe discharge pressure (analog valve, gage pressure).
    i. Steam pressure (analog value, gage pressure).
    j. Steam valve open position (analog value, zero to 100 percent).

k. Tank water level (analog value).
l. Tank high-water-level alarm (analog value).
m. Tank low-water-level alarm (analog value).
n. Tank low-water-level cutoff alarm (digital value).
o. Makeup water valve open position (analog value, zero to 100 percent).
p. Tank temperature (analog value).
q. <**Insert monitoring**>.

2. Control Setup:

a. Pump operation (on/off).
b. Pump lead/lag operation (lead/lag position).
c. Pump speed for variable-speed pumps (analog value, zero to 100 percent).
d. Pump manifold pipe discharge pressure set point (analog valve, gage pressure).
e. Steam pressure set point (analog value, gage pressure).
f. Steam valve open position override (analog value, zero to 100 percent).
g. Tank water level set point (analog value).
h. Tank high-water-level alarm set point (analog value).
i. Tank low-water-level alarm set point (analog value).
j. Tank low-water-level cutoff alarm set point (digital value).
k. Makeup water valve open position override (analog value, zero to 100 percent).
l. <**Insert control**>.

G. System Interface: Factory install hardware and software to enable [**building automation**][**DDC**] system to monitor, control, and display deaerator status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On/off status for each pump[**, failure alarm for each pump**][**, low-water-level alarm**][**, high-water-level alarm**][**, feedwater temperature**][**, feedwater flow rate**]<**Insert monitoring point**>.
b. Control: On/off operation, [**on/off operation of each pump,**][**lead/lag position of each pump,**][**feedwater supply pressure set-point adjustment,**][**tank water level set-point adjustment**]<**Insert control point**>.

2. Communication Interface: [**ASHRAE 135 (BACnet)**][**(LonTalk)**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface enables control system operator to remotely control and monitor deaerator operation from an operator workstation. Control features available, and monitoring points displayed, locally at deaerator control panel are to be available to control system through the interface.

H. Feedwater Pump Start-Stop Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
3. Lead pump failure [**automatically starts lag pump if lead pump cannot maintain set point**][**manually starts lag pump**].
4. Visual indication of pump on[**and off**] status.
5. Visual indication of pump starts.
6. Visual indication of pump run time.
7. Visual indication of pump lead/lag status.
8. Visual[**and audible**] alarm indication of pump failure.

I. Feedwater Pump Continuous Control Sequence:

1. Pump runs continuously while boiler operates. Electric interlock with boiler control to start lead pump when boiler starts.
2. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
3. Lead and lag pumps alternate [**after each start**][**to equalize run time**].
4. Lead pump failure automatically starts lag pump.
5. Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
6. Feedwater pressure controller controls operating feedwater pump(s) speed and starts and stops lag pump(s) to maintain feedwater pressure set point.
7. Visual indication of pump on[**and off**] status.
8. Visual indication of pump starts.
9. Visual indication of pump run time.
10. Visual indication of pump lead/lag status.
11. Visual[**and audible**] alarm indication of pump failure.
12. Visual indication of feedwater flow rate.

J. Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain tank water-level set point.
2. Pneumatic level controller operates pneumatic control valve to maintain tank water-level set point.
3. Mechanical float operates valve to maintain water-level set point.
4. Visual[**and audible**] alarm indication of low[**and high**] tank water level.
5. Low-water level stops pumps.
6. Visual indication of makeup water flow rate.

K. Transfer Pump Start-Stop Control Sequence: Deaerator water-level controller controls lead pump; alternator switches lead and lag pump(s) [**after each start**][**to equalize run time**]; failure of lead pump switches to lag pump[**and sounds audible alarm**].

L. Transfer Pump Continuous-Run Control Sequence: Lead pump runs continuously while deaerator is operating; deaerator water-level controller modulates water-level-control valve; lead and lag pump(s) switch to equalize run time; lag pump operates if lead pump fails[**; pump failure sounds audible alarm**].

2.5 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary to provide a single-point field power connection to unit.

1. For units with surge tank assembly mounted on a separate support frame from deaerator assembly, [**provide a separate**][**provide a common**][**manufacturer has option to provide a separate or common**] field electrical connection for deaerator and surge tank assemblies.
2. Enclosure: NEMA 250, Type [**1**][**4**][**4X**][**12**]<**Insert type**>.

   a. Enclosure is to have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
   b. Mounted on deaerator assembly at a location convenient to operator.
   c. Enclosure is to have hinged full-size door with key lock with common key for all locks.

3. Wiring is to be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
4. Install wiring outside of an enclosure in a [**metal**]raceway. Make final connections to motors using

flexible conduit. Provide watertight installation for applications exposed to moisture.

5. Field power interface is to be to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Withstanding rating of disconnecting means is to protect equipment. Coordinate requirements with field electrical power source.
6. Provide branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
7. Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller [**with manual bypass**]and line reactors for each variable-speed motor indicated.

    a. Alternating control as indicated by control sequence for each pump.

8. Provide transformer with fuses and power wiring to power a 20-A, 120-V duplex receptacle mounted in each control panel for use in connecting analytical and testing equipment.

2.6 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Manufacturer's standard paint in standard colors, applied to factory-assembled and -tested unit before shipping.

C. General:

1. Paint deaerator, using manufacturer's standard procedures, except comply with requirements indicated.
2. Miscellaneous surfaces are to be finished to match continuous surfaces.
3. Manufacturer is to field touch-up or entirely repaint surface finishes, damaged during shipment, to original condition, using original materials and methods.
4. Paint is to be suitable for temperatures encountered on painted surfaces.
5. Requirements indicate minimum quality level. Provide more robust paint system if required to comply with other requirements indicated.

D. Preparation:

1. Follow paint manufacturer's published preparation and application instructions.
2. When paint manufacturer's recommended preparation requirements differ from those specified, use more stringent requirements.
3. Structural steel with visible corrosion is to be sandblasted in accordance with SSPC SP-6 or SSPC SP-10 before applying primer and paint.
4. Before applying a primer and a topcoat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner in accordance with SSPC SP-1.
5. Treat galvanized-steel surfaces that cannot be procured with a phosphatized finish with a phosphate rinse to ensure proper paint adhesion.

E. Primer:

1. Rust-inhibiting type with a minimum dry film thickness of [**2 mils (0.05 mm)**]<**Insert thickness**>.
2. Provide multiple passes if required to prevent runs.
3. Select a primer that is compatible with substrate and with finish coat.

F. Finish Coat:

1. Finish coat is to be [**alkyd enamel**][**epoxy**][**polyurethane**]<**Insert type**>.

2. Use dry film thickness recommended by paint manufacturer, but not less than [**2 mils (0.05 mm)**]<**Insert thickness**>. Provide multiple passes if required to prevent runs.

G. Paint the following surfaces with primer and finish coat:

1. Base and miscellaneous supports that are not hot-dip galvanized.
2. Carbon steel that is not galvanized.
3. Exterior surfaces of unit exposed to view.
4. Piping and trim.

H. Do not paint aluminum, galvanized-steel, and stainless steel surfaces.

2.7 CAPACITIES AND CHARACTERISTICS

A. Nominal Capacity: <**Insert lb/h (kg/h)**>.

B. Design Feedwater Flow Rate: <**Insert gpm (L/s)**>.

C. Steam Flow Rate: <**Insert lb/h (kg/h)**>.

D. Steam Condensate Flow Rate: <**Insert gpm (L/s)**>.

E. Steam Condensate Temperature: <**Insert deg F (deg C)**>.

F. Makeup Water Flow Rate: <**Insert gpm (L/s)**>.

G. Makeup Water Temperature: <**Insert deg F (deg C)**>.

H. Capacity: Capable of raising temperature of condensate and makeup water to within [**3 deg F (2 deg C)**]<**Insert temperature**> of saturated steam temperature.

I. Minimum Working Pressure: [**50 psig (345 kPa)**]<**Insert value**>.

J. Operating Pressure Range: [**Atmospheric**][**From 2 to 15 psig (14 to 104 kPa)**]<**Insert pressure range**>.

K. Resultant Oxygen Content: Not more than [**0.03**][**0.005**] cc/L through an operating range between [**zero**][**3**][**5**]<**Insert number**> and 100 percent of full load.

L. Storage Tank:

1. Tank Capacity to Overflow: <**Insert gal. (L)**>.
2. Storage Time: [**10**]<**Insert number**> minutes.

M. Feedwater Pumps:

1. No. of Pumps: [**Duplex**]<**Insert quantity**>.
2. Design Flow Rate: <**Insert gpm (L/s)**>.
3. Minimum Flow Rate: <**Insert gpm (L/s)**>.
4. NPSHR: <**Insert psig (kPa)**>.
5. Rated Operating Temperature: <**Insert deg F (deg C)**>.
6. Head Pressure: <**Insert psig (kPa)**>.
7. Close-off Pressure: <**Insert psig (kPa)**>.
8. Horsepower: <**Insert value**>.

9. Speed: <**Insert rpm**>.

N. Surge Tank:

1. Tank Capacity to Overflow: <**Insert gal. (L)**>.
2. Storage Time: <**Insert number**> minutes.

O. Transfer Pumps:

1. No. of Pumps: [**Duplex**]<**Insert quantity**>.
2. Design Flow Rate: <**Insert gpm (L/s)**>.
3. Minimum Flow Rate: <**Insert gpm (L/s)**>.
4. NPSHR: <**Insert psig (kPa)**>.
5. Rated Operating Temperature: <**Insert deg F (deg C)**>.
6. Head Pressure: <**Insert psig (kPa)**>.
7. Close-off Pressure: <**Insert psig (kPa)**>.
8. Horsepower: <**Insert value**>.
9. Speed: <**Insert rpm**>.

P. Deaerator Assembly Single-Point Power Electrical Characteristics:

1. Volts: [**208**][**230**][**460**]<**Insert value**> V.
2. Phase: Three.
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

Q. Surge Tank Assembly Single-Point Power Electrical Characteristics:

1. Volts: [**208**][**230**][**460**]<**Insert value**> V.
2. Phase: Three.
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

2.8 SOURCE QUALITY CONTROL

A. Fabricate and label deaerator tanks in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

B. Factory install and test piping that connects pumps to tanks in accordance with [**ASME B31.1, "Power Piping."**][**ASME B31.9, "Building Services Piping."**].

C. Factory Tests: Test performance and submit test results on packaged deaerator units, in accordance with ASME PTC 12.3, before shipping to Project.

D. Witness Testing:

1. Allow Owner access to witness source quality-control testing.
2. Notify [**Architect**][**Owner**][**15**]<**Insert time**> days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting deaerator performance, maintenance, and operations.

1. Deaerator locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping to verify actual locations of piping connections before installation of deaerators.

C. Examine areas for suitable conditions where deaerators will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, FACTORY-ASSEMBLED DEAERATORS

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:

1. Install deaerators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install deaerators to permit access for service and maintenance.

D. Where installing piping adjacent to machine, allow space for service and maintenance.

E. Support piping independent of equipment.

F. Install base-mounted pumps on concrete base with grouted base frame.

G. Install all parts and materials not factory installed.

H. Assemble and install deaerators trim, components, and accessories that are not factory installed.

I. Install control and electrical devices furnished with deaerators that are not factory mounted.

J. Install control and power wiring to field-mounted control and electrical devices furnished with deaerators that are not factory installed.

K. Perform cleaning procedures in accordance with manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests. Following cleaning procedures, deaerator is to be washed and flushed until water leaving deaerator is clear.

L. Protect deaerators from corrosion.

1. Before filling with water, protect by dry storage method recommended by manufacturer.
2. After filled with water, protect by wet storage method recommended by manufacturer.

M. Chemical Treatment: Quality of water in deaerators is to be maintained by a professional water treatment organization that will provide on-site supervision to maintain the required water quality during periods of storage, operating, standby, and test conditions. See applicable water treatment Section, <**Insert Section number and title**>, for additional requirements.

3.3 PIPING CONNECTIONS

A. Steam and condensate piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect steam and condensate piping to tank tappings with shutoff valves and unions or flanges at each connection.

C. Connect condensate drains, pump-discharge piping, vents, overflow drains, makeup water, steam supply, and cooling water piping.

1. Extend overflow drains to [**floor**][**or**][**sanitary**] drains.
2. Extend vent piping to outside and terminate with manufacturer-approved cap furnished with deaerator.
3. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest [**floor**][**or**][**sanitary**] drain.
4. Install piping from equipment drain connection to nearest [**floor**][**or**][**sanitary**] drain. Piping is to be at least full size of connection. Provide an isolation valve if required.

D. Hot equipment drains connected to sanitary drainage system is to be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled, non-potable, domestic cold water source to cool hot equipment drains to deliver a discharge temperature of <**Insert temperature**>.

E. Connect chemical treatment piping to each deaerator chemical treatment connection with check valve and isolation valve.

F. Where installing piping adjacent to deaerators, allow space for service and maintenance.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between deaerators and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between deaerator control interface and [**DDC system**]<**Insert system description**> for remote monitoring and control of deaerators. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections, for compliance with requirements.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Verify bearing lubrication.
4. Verify proper motor rotation.
5. Test Reports: Prepare a written report to record the following:

   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Deaerator will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Set makeup water-level controls.
3. Set operating controls.
4. Verify safety controls.
5. Verify lubrication.
6. Verify proper motor rotation.
7. Start pumps in accordance with manufacturer's written instructions.
8. <**Insert startup steps if any**>.

B. Report: Prepare a written report to record the following:

1. Procedures used.
2. Initial findings.
3. Final results.
4. Corrective action taken to achieve compliance with requirements indicated.

5. Date of testing.
6. Name and contact information for person performing testing.

3.8 ADJUSTING AND CLEANING

A. Adjust initial temperature and pressure set points.

B. Set field-adjustable switches and circuit-breaker trip ranges.

C. Clean strainers.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain deaerators.

B. Video training sessions, and provide electronic copy of video to Owner.

END OF SECTION 23 53 16 00

Task	Specification	Specification Description
23 53 16 00	23 53 13 00	Boiler Feedwater Pumps

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SECTION 23 54 13 00 - ELECTRIC-RESISTANCE FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric-resistance furnaces.
2. Thermostats and humidistats.
3. Air filters.
4. Air cleaners.
5. UV germicidal lights.
6. Humidifiers.
7. Ventilation air heat exchangers.
8. Refrigeration components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals:

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Furnace and accessories complete with controls.
b. Air filter.
c. Air cleaner.
d. UV germicidal light.
e. Humidifier.
f. Ventilation heat exchanger.
g. Refrigeration components.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Disposable Air Filters: Furnish [**two**]<**Insert number**> complete sets.
2. Disposable Air-Cleaner Media: Furnish [**one**]<**Insert number**> complete set(s).
3. Fan Belts: Furnish [**one**]<**Insert number**> set(s) for each furnace fan.
4. Disposable Humidifier Media: Furnish [**one**]<**Insert number**> set(s).

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: [**10 years**][**20 years**][**Lifetime**]<**Insert value**>.
b. Integrated Ignition and Blower Control Circuit Board: [**Five years**]<**Insert value**>.
c. Draft-Inducer Motor: [**Five years**]<**Insert value**>.
d. Refrigeration Compressors: [**10 years**][**Lifetime**]<**Insert value**>.
e. Evaporator and Condenser Coils: [**Five years**]<**Insert value**>.
f. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 ELECTRIC-RESISTANCE FURNACES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
2. [**Fedders North America Inc.**]
3. [**Intertherm Heating and Cooling**]
4. [**Wellman Furnaces, Inc.**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Broan.; a Broan-NuTone LLC brand; a Nortek company**]
2. [**Fedders North America Inc.**]
3. [**Intertherm Heating and Cooling**]
4. [**Wellman Furnaces, Inc.**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

C. Furnace: Factory assembled, piped, wired, and tested.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

E. Cabinet: Steel, with duct liner[**downstream from cooling coil**].

1. Duct Liner: Fiberglass, minimum [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**] thick, complying with ASTM C1071 and having a coated surface exposed to airstream complying with NFPA 90A or NFPA 90B and with NAIMA's "Fibrous Glass Duct Liner Standard."

   a. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Factory paint external cabinets in manufacturer's standard color.

F. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
2. Special Motor Features:

   a. Single speed, premium efficiency, as defined in Section 230500 "Common Work Results for HVAC," and with internal thermal protection and permanent lubrication.
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

G. Electric-Resistant Heating Elements: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports.

H. Heating-Element Control: Sequencer relay with relay for each element; switches elements on and off, with delay between each increment; initiates, stops, or changes fan speed.

I. Summer Fan Switch: Connected to permit independent on-off switch of unit fan.

J. Capacities and Characteristics:

1. Airflow Configuration: [**Upflow**][**Counterflow**][**Horizontal**].
2. Electric Heating Element:

a. Capacity: <**Insert MBh (kW)**>.
b. Number of Steps: <**Insert number**>.
c. Volts: <**Insert value**>.
d. Phase: <**Insert value**>.
e. Hertz: <**Insert value**>.
f. Full-Load Amperes: <**Insert value**>.
g. Minimum Circuit Ampacity: <**Insert value**>.
h. Maximum Overcurrent Protection: <**Insert amperage**>.

3. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (Pa)**>.
c. Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

d. Volts: <**Insert value**>.
e. Phase: <**Insert value**>.
f. Hertz: <**Insert value**>.
g. Full-Load Amperes: <**Insert value**>.
h. Minimum Circuit Ampacity: <**Insert value**>.
i. Maximum Overcurrent Protection: <**Insert amperage**>.

4. Furnace Electrical Connection:

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 THERMOSTATS AND HUMIDISTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

B. Solid-State Thermostat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with [**automatic**][**manual**] switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

D. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

E. Heating-Only Thermostat: [**Single**][**Two**]-stage, wall-mounted unit with fan on-automatic selector.

F. Solid-State, Combination Thermostat and Humidistat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with automatic switching from heating to cooling and humidifying to dehumidifying, preferential rate control, seven-day programmability with minimum of four

temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

G. Humidistat: Adjustable, [**wall**][**duct**]-mounted unit.

H. Control Wiring:

1. Balanced twisted-pair cabling [**complying with requirements for Category 5e in Section 260523 "Control Voltage Cables for Electrical Equipment."**][**complying with requirements for Category 5e in Section 271513 "Communications Copper Horizontal Cabling."**]
2. Balanced Twisted-Pair Cabling:

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
      2) [**Belden Inc.**]
      3) [**Berk-Tek, a Leviton Company**]
      4) [**CommScope, Inc**]
      5) [**General Cable; Prysmian Group North America**]
      6) [**Hitachi Cable America Inc.**]
      7) [**Mohawk; a division of Belden Networking, Inc.**]
      8) [**West Penn Wire; brand of Belden, Inc.**]
      9) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
      2) [**Belden Inc.**]
      3) [**Berk-Tek, a Leviton Company**]
      4) [**CommScope, Inc**]
      5) [**General Cable; Prysmian Group North America**]
      6) [**Hitachi Cable America Inc.**]
      7) [**Mohawk; a division of Belden Networking, Inc.**]
      8) [**West Penn Wire; brand of Belden, Inc.**]
      9) <**Insert manufacturer's name**>

   c. Description: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**], No. 24 AWG, 100 ohm, four pair.
   d. Cable Jacket Color: [**Blue**]<**Insert color**>.

2.3 AIR FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]

4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]
4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

C. Washable Filters: **1-inch- (25-mm-)** thick urethane pad.

D. Disposable Filters: [**1-inch- (25-mm-)**]<**Insert dimension**> thick fiberglass media[**with ASHRAE 52.2 MERV rating of 6 or higher,**] in sheet metal frame.

E. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

F. HEPA Air-Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter[**, carbon VOC,**] and high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

2.4 AIR CLEANERS

A. Electronic Air Cleaners: Packaged system, including sheet metal housing, prefilter, power supply, and automatic control device, arranged for mounting in return-air duct at furnace; equip with on-off and test switches and pilot light.

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, particle size to 0.01 micrometer.
3. Static Pressure Drop: Maximum **0.14-inch wg (35 Pa)** at **300-fpm (1.52-m/s)** air velocity.

B. Capacities and Characteristics:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Minimum Circuit Ampacity: <**Insert value**>.
5. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 UV GERMICIDAL LIGHTS

A. Description: Lighting unit in metal housing arranged for installation in supply-air duct and controlled to cycle on and off with furnace fan, with [**one**][**two**] 75-W UV-light bulb(s).

2.6 HUMIDIFIERS

A. Minimum capacity rating indicated according to AHRI 610.

B. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.

C. Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.

D. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.

E. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.

F. Steam type with electric heating element in stainless-steel reservoir with float-valve level control; arranged for attachment to duct or plenum and for control by humidistat.

G. Comply with applicable requirements in ASHRAE 62.1.

H. Capacities and Characteristics:

1. Type: [**Steam**][**Media wheel**][**Wetted pad with reservoir**][**Wetted pad with continuous drain**][**Wetted-pad bypass**].
2. Steam Capacity: <**Insert lb/h (kg/h)**>.
3. Water Connection Size: <**Insert NPS (DN)**>.
4. Drain Connection Size: <**Insert NPS (DN)**>.
5. Volts: <**Insert value**>.
6. Phase: <**Insert value**>.
7. Hertz: <**Insert value**>.
8. Minimum Circuit Ampacity: <**Insert value**>.
9. Maximum Overcurrent Protection: <**Insert amperage**>.

2.7 VENTILATION AIR HEAT EXCHANGERS

A. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.

B. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.

C. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Section 230500 "Common Work Results for HVAC."

D. Filters: **1-inch- (25-mm-)** thick disposable type[**with ASHRAE 52.2 MERV rating of 6 or higher**], in galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.

E. Wiring: Wire motors and controls so only external connections are required during installation.

2.8 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet[**complying with ASHRAE 62.1**].

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I, [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."

E. Air-Cooled Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed [**reciprocating**][**or**][**scroll**] type.

   a. Crankcase heater.
   b. [**Restrained vibration**][**Vibration**] isolation mounts for compressor.
   c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
   e. Refrigerant Charge: [**R-407C**][**R-410A**]<**Insert type**>.
   f. Refrigerant: R-407C or R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Heat-Pump Components: Reversing valve and low-temperature air cutoff thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C)**.
8. Mounting Base: Polyethylene.

F. Capacities and Characteristics:

1. Refrigerant Coil:

   a. Total Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.

c. Heating Capacity: <**Insert Btu/h (kW)**>.
d. Maximum Air Pressure Drop: <**Insert inches wg (Pa)**>.
e. Condensate Drain Size: <**Insert NPS (DN)**>.

2. Compressor-Condenser Unit:

a. Cooling Energy Efficiency[**(EER)**][**(SEER)**]: <**Insert value**>.
b. Heating Coefficient of Performance: <**Insert value**>.
c. Volts: <**Insert value**>.
d. Phase: <**Insert value**>.
e. Hertz: <**Insert value**>.
f. Full-Load Amperes: <**Insert value**>.
g. Minimum Circuit Ampacity: <**Insert value**>.
h. Maximum Overcurrent Protection: <**Insert amperage**>.
i. Fan Motor Full-Load Amperes: <**Insert value**>.
j. Compressor Running-Load Amperes: <**Insert value**>.
k. Compressor Motor Full-Load Amperes: <**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

B. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

1. Anchor furnace to substrate to resist code-required seismic acceleration.

C. Controls: Install thermostats and humidistats at mounting height of **60 inches (1500 mm)** above floor.

D. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

E. Install ground-mounted, compressor-condenser components on **4-inch- (100-mm-)** thick, reinforced

concrete base; **4 inches (100 mm)** larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

F. Install ground-mounted compressor-condenser components on polyethylene mounting base.

G. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

3.3 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Water piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.

C. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
2. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings[**and adjust belt tension**].

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 54 13 00

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Task	Specification	Specification Description
23 54 16 00	23 54 13 00	Electric-Resistance Furnaces

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SECTION 23 54 16 13 - GAS-FIRED FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas-fired furnaces, noncondensing.
2. Gas-fired furnaces, condensing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Furnace and accessories complete with controls.
b. Air filter.
c. Air cleaner.

d. UV germicidal light.
e. Humidifier.
f. Ventilation heat exchanger.
g. Refrigeration components.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Disposable Air Filters: Furnish [**two**]<**Insert number**> complete sets.
2. Disposable Air-Cleaner Media: Furnish [**one**]<**Insert number**> complete set(s).
3. Fan Belts: Furnish [**one**]<**Insert number**> set(s) for each furnace fan.
4. Disposable Humidifier Media: Furnish [**one**]<**Insert number**> set(s).

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: [**10 years**][**20 years**][**Lifetime**]<**Insert value**>.
b. Integrated Ignition and Blower Control Circuit Board: [**Five years**]<**Insert value**>.
c. Draft-Inducer Motor: [**Five years**]<**Insert value**>.
d. Refrigeration Compressors: [**10 years**][**Lifetime**]<**Insert value**>.
e. Evaporator and Condenser Coils: [**Five years**]<**Insert value**>.
f. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

B. General Requirements for Noncondensing Gas-Fired Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

2.2 GAS-FIRED FURNACES, NONCONDENSING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adams Manufacturing Company**]
2. [**Amana Heating & Air Conditioning; under license to Goodman Company, L.P.**]
3. [**Arcoaire; Carrier Global Corporation**]
4. [**Bard Manufacturing Company**]
5. [**Bryant; Carrier Global Corporation**]
6. [**Carrier Global Corporation**]
7. [**Comfort-Aire; a division of Heat Controller, Inc.**]
8. [**Comfortmaker; Carrier Global Corporation**]
9. [**Dornback Furnace**]
10. [**Goodman Manufacturing Company, L.P.**]
11. [**Heil; Carrier Global Corporation**]
12. [**Lennox**]
13. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Ruud Air Conditioning Division**]
15. [**Tempstar; Carrier Global Corporation**]
16. [**Thermo Products, Inc.**]
17. [**Trane**]
18. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
19. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adams Manufacturing Company**]
2. [**Amana Heating & Air Conditioning; under license to Goodman Company, L.P.**]
3. [**Arcoaire; Carrier Global Corporation**]
4. [**Bard Manufacturing Company**]
5. [**Bryant; Carrier Global Corporation**]
6. [**Carrier Global Corporation**]
7. [**Comfort-Aire; a division of Heat Controller, Inc.**]
8. [**Comfortmaker; Carrier Global Corporation**]
9. [**Dornback Furnace**]
10. [**Goodman Manufacturing Company, L.P.**]
11. [**Heil; Carrier Global Corporation**]
12. [**Lennox**]
13. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Ruud Air Conditioning Division**]
15. [**Tempstar; Carrier Global Corporation**]
16. [**Thermo Products, Inc.**]
17. [**Trane**]
18. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
19. <**Insert manufacturer's name**>

C. Cabinet: [**Steel**][**Galvanized steel**].

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Fan: Centrifugal, factory balanced, resilient mounted, [**direct drive**][**belt drive**][**direct or belt drive**][**drive type indicated on Drawings**].

1. Fan Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
2. Special Motor Features, Single Speed: Single speed, premium efficiency, as defined in Section 230500 "Common Work Results for HVAC," and with internal thermal protection and permanent lubrication.
3. Special Motor Features, Multispeed: Multitapped, multispeed with internal thermal protection and permanent lubrication.
4. Special Motor Features, ECM: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

E. Type of Gas: [**Natural**][**Propane**].

F. Heat Exchanger: [**Aluminized**][**Stainless**] steel.

G. Burner:

1. Gas Valve: 100 percent safety [**two-stage**][**modulating**] main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

H. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

I. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

J. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.

K. Vent Materials: Comply with requirements in Section 235123 "Gas Vents" for Type B metal vents.

L. Capacities and Characteristics:

1. Airflow Configuration: [**Upflow**][**Counterflow**][**Horizontal**].
2. Gas:

a. Type: [**Natural**][**Propane**].
b. Venting Type: [**Power venter**][**with combustion-air intake**].
c. Minimum Efficiency AFUE: <**Insert number**> percent.
d. Minimum Thermal Efficiency: <**Insert number**> percent.
e. Minimum Combustion Efficiency: <**Insert number**> percent.
f. Input: <**Insert MBh (kW)**>.
g. Heat Output: <**Insert MBh (kW)**>.
h. Gas Connection Size: <**Insert NPS (DN)**>.
i. Draft-Inducer Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

j. Combustion-Air Inlet Size: <**Insert inches (mm)**>.
k. Combustion-Air Inlet Material: [**Galvanized steel**][**Stainless steel**][**PVC**].
l. Heat-Exchanger Condensate Drain Size: <**Insert NPS (DN)**>.
m. Vent Size: <**Insert inches (mm)**>.

3. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (Pa)**>.
c. Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

d. Volts: <**Insert value**>.
e. Phase: <**Insert value**>.
f. Hertz: <**Insert value**>.
g. Full-Load Amperes: <**Insert value**>.
h. Minimum Circuit Ampacity: <**Insert value**>.
i. Maximum Overcurrent Protection: <**Insert amperage**>.

4. Furnace Electrical Connection:

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 GAS-FIRED FURNACES, CONDENSING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adams Manufacturing Company**]
2. [**Amana Heating & Air Conditioning; under license to Goodman Company, L.P.**]
3. [**Arcoaire; Carrier Global Corporation**]
4. [**Bryant; Carrier Global Corporation**]
5. [**Carrier Global Corporation**]
6. [**Comfort-Aire; a division of Heat Controller, Inc.**]
7. [**Comfortmaker; Carrier Global Corporation**]
8. [**Dornback Furnace**]
9. [**Goodman Manufacturing Company, L.P.**]
10. [**Heil; Carrier Global Corporation**]
11. [**Lennox**]
12. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
13. [**Ruud Air Conditioning Division**]
14. [**Tempstar; Carrier Global Corporation**]
15. [**Thermo Products, Inc.**]
16. [**Trane**]

17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Adams Manufacturing Company**]
2. [**Amana Heating & Air Conditioning; under license to Goodman Company, L.P.**]
3. [**Arcoaire; Carrier Global Corporation**]
4. [**Bryant; Carrier Global Corporation**]
5. [**Carrier Global Corporation**]
6. [**Comfort-Aire; a division of Heat Controller, Inc.**]
7. [**Comfortmaker; Carrier Global Corporation**]
8. [**Dornback Furnace**]
9. [**Goodman Manufacturing Company, L.P.**]
10. [**Heil; Carrier Global Corporation**]
11. [**Lennox**]
12. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
13. [**Ruud Air Conditioning Division**]
14. [**Tempstar; Carrier Global Corporation**]
15. [**Thermo Products, Inc.**]
16. [**Trane**]
17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. **<Insert manufacturer's name>**

C. Cabinet: [**Steel**][**Galvanized steel**].

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
2. Special Motor Features, Single Speed: Single speed, premium efficiency, as defined in Section 230500 "Common Work Results for HVAC," and with internal thermal protection and permanent lubrication.
3. Special Motor Features, Multispeed: Multitapped, multispeed with internal thermal protection and permanent lubrication.
4. Special Motor Features, ECM: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

E. Type of Gas: [**Natural**][**Propane**].

F. Heat Exchanger:

1. Primary: [**Aluminized**][**Stainless**] steel.
2. Secondary: [**Polyethylene-coated**][**Stainless**] steel.

G. Burner:

1. Gas Valve: 100 percent safety [**two-stage**][**modulating**] main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and

combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

H. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

I. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

J. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories[**; diagnostic light with viewport**].

K. Accessories:

1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through [**outside wall**][**roof**].
2. CPVC Plastic Vent Materials:

a. CPVC Plastic Pipe: Schedule 40, complying with ASTM F441/F441M.
b. CPVC Plastic Fittings: Schedule 40, complying with ASTM F438, socket type.
c. CPVC Solvent Cement: ASTM F493.

1) Solvent cement shall have a VOC content of 490 g/L or less.
2) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

3. PVC Plastic Vent Materials:

a. PVC Plastic Pipe: Schedule 40, complying with ASTM D1785.

b. PVC Plastic Fittings: Schedule 40, complying with ASTM D2466, socket type.
c. PVC Solvent Cement: ASTM D2564.

1) Adhesive primer shall have a VOC content of 550 g/L or less.
2) Solvent cement shall have a VOC content of 510 g/L or less.
3) Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4) Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5) Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6) Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
7) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
10) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
11) Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

L. Capacities and Characteristics:

1. Airflow Configuration: [**Upflow**][**Counterflow**][**Horizontal**].
2. Gas:

a. Type: [**Natural**][**Propane**].
b. Venting Type: [**Power venter**][**Power venter with combustion-air intake**].

c. Minimum Efficiency AFUE: <**Insert number**> percent.
d. Minimum Thermal Efficiency: <**Insert number**> percent.
e. Minimum Combustion Efficiency: <**Insert number**> percent.
f. Input: <**Insert MBh (kW)**>.
g. Heat Output: <**Insert MBh (kW)**>.
h. Gas Connection Size: <**Insert NPS (DN)**>.
i. Draft-Inducer Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

j. Combustion-Air Inlet Size: <**Insert inches (mm)**>.
k. Combustion-Air Inlet Material: [**CPVC**][**PVC**].
l. Heat-Exchanger Condensate Drain Size: <**Insert NPS (DN)**>.
m. Vent Size: <**Insert inches (mm)**>.
n. Vent Material: [**CPVC**][**PVC**].

3. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (Pa)**>.
c. Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

d. Volts: <**Insert value**>.
e. Phase: <**Insert value**>.
f. Hertz: <**Insert value**>.
g. Full-Load Amperes: <**Insert value**>.
h. Minimum Circuit Ampacity: <**Insert value**>.
i. Maximum Overcurrent Protection: <**Insert amperage**>.

4. Furnace Electrical Connection:

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 THERMOSTATS AND HUMIDISTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

B. Solid-State Thermostat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with [**automatic**][**manual**] switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

D. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

E. Heating-Only Thermostat: [**Single**][**Two**]-stage, wall-mounted unit with fan on-automatic selector.

F. Solid-State, Combination Thermostat and Humidistat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with automatic switching from heating to cooling and humidifying to dehumidifying, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

G. Humidistat: Adjustable, [**wall**][**duct**]-mounted unit.

H. Control Wiring: Balanced twisted-pair cabling complying with requirements for Category 5e in [**Section 260523 "Control-Voltage Electrical Power Cables."**][**Section 271513 "Communications Copper Horizontal Cabling."**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**Berk-Tek, a Leviton Company**]
   d. [**CommScope, Inc**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**West Penn Wire; brand of Belden, Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**Berk-Tek, a Leviton Company**]
   d. [**CommScope, Inc**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**West Penn Wire; brand of Belden, Inc.**]
   i. <**Insert manufacturer's name**>

3. Description: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**], No. 24 AWG, 100 ohms, four pair.
4. Cable Jacket Color: [**Blue**]<**Insert color**>.

2.5 AIR FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]
4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]
4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

C. Washable Filters: **1-inch- (25-mm-)** thick urethane pad.

D. Disposable Filters: [**1-inch- (25-mm-)**]<**Insert dimension**> thick fiberglass media[**with ASHRAE 52.2 MERV rating of 6 or higher,**] in sheet metal frame.

E. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

F. HEPA Air Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter[**, carbon VOC,**] and high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

2.6 AIR CLEANERS

A. Electronic Air Cleaners: Packaged system, including sheet metal housing, prefilter, power supply, and automatic control device, arranged for mounting in return-air duct at furnace; equip with on-off and test switches and pilot light.

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, particle size to 0.01 micrometer.
3. Static Pressure Drop: Maximum **0.14-inch wg (35 Pa)** at **300-fpm (1.52-m/s)** air velocity.

B. Capacities and Characteristics:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Minimum Circuit Ampacity: <**Insert value**>.
5. Maximum Overcurrent Protection: <**Insert amperage**>.

2.7 UV GERMICIDAL LIGHTS

A. Description: Lighting unit in metal housing arranged for installation in supply-air duct and controlled to cycle on and off with furnace fan, with [**one**][**two**] 75-W UV-light bulb(s).

2.8 HUMIDIFIERS

A. Minimum capacity rating indicated according to AHRI 610.

B. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.

C. Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.

D. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.

E. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.

F. Steam type with electric heating element in stainless-steel reservoir with float-valve level control; arranged for attachment to duct or plenum and for control by humidistat.

G. Comply with applicable requirements in ASHRAE 62.1.

H. Capacities and Characteristics:

1. Type: [**Steam**][**Media wheel**][**Wetted pad with reservoir**][**Wetted pad with continuous drain**][**Wetted-pad bypass**].
2. Steam Capacity: <**Insert lb/h (kg/h)**>.
3. Water Connection Size: <**Insert NPS (DN)**>.
4. Drain Connection Size: <**Insert NPS (DN)**>.
5. Volts: <**Insert value**>.
6. Phase: <**Insert value**>.
7. Hertz: <**Insert value**>.
8. Minimum Circuit Ampacity: <**Insert value**>.
9. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 VENTILATION AIR HEAT EXCHANGERS

A. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.

B. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.

C. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Section 230500 "Common Work Results for HVAC."

D. Filters: **1-inch- (25-mm-)** thick disposable type[**with ASHRAE 52.2 MERV rating of 6 or higher**], in

galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.

E. Wiring: Wire motors and controls so only external connections are required during installation.

2.10 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet[**complying with ASHRAE 62.1**].

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I, [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."

E. Air-Cooled Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed [**reciprocating**][**or**][**scroll**] type.

a. Crankcase heater.
b. [**Restrained vibration**][**Vibration**] isolation mounts for compressor.
c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
e. Refrigerant Charge: [**R-407C**][**R-410A**]<**Insert type**>.
f. Refrigerant: R-407C or R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C)**.
8. Mounting Base: Polyethylene.

F. Capacities and Characteristics:

1. Refrigerant Coil:

    a. Total Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.
    c. Heating Capacity: <**Insert Btu/h (kW)**>.
    d. Maximum Air Pressure Drop: <**Insert inches wg (Pa)**>.
    e. Condensate Drain Size: <**Insert NPS (DN)**>.

2. Compressor-Condenser Unit:

    a. Cooling Energy Efficiency[**(EER)**][**(SEER)**]: <**Insert value**>.
    b. Heating Coefficient of Performance: <**Insert value**>.
    c. Volts: <**Insert value**>.
    d. Phase: <**Insert value**>.
    e. Hertz: <**Insert value**>.
    f. Full-Load Amperes: <**Insert value**>.
    g. Minimum Circuit Ampacity: <**Insert value**>.
    h. Maximum Overcurrent Protection: <**Insert amperage**>.
    i. Fan Motor Full-Load Amperes: <**Insert value**>.
    j. Compressor Running-Load Amperes: <**Insert value**>.
    k. Compressor Motor Full-Load Amperes: <**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for gas[**and refrigerant**] piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

    1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

    1. Anchor furnace to substrate to resist code-required seismic acceleration.

D. Controls: Install thermostats and humidistats at mounting height of **60 inches (1500 mm)** above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install ground-mounted, compressor-condenser components on **4-inch- (100-mm-)** thick, reinforced concrete base; **4 inches (100 mm)** larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

G. Install ground-mounted compressor-condenser components on polyethylene mounting base.

H. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

3.3 PIPING CONNECTIONS

A. Gas piping installation requirements are specified in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Water piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.

D. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Section 235123 "Gas Vents."

E. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

   a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D2846/D2846M, Appendix.
   c. PVC Pressure Piping: Join schedule number ASTM D1785 PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.

4. Slope pipe vent back to furnace or to outside terminal.

F. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."

2. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

G. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 DUCTWORK CONNECTIONS

A. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings[**and adjust belt tension**].

3.8 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.9 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and test for leaks. Repair leaks, replace lost refrigerant, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 54 16 13

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Task	Specification	Specification Description
23 54 16 13	23 54 13 00	Electric-Resistance Furnaces

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SECTION 23 54 16 16 - OIL-FIRED FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Oil-fired furnaces.
2. Thermostats and humidistats.
3. Air filters.
4. Air cleaners.
5. UV germicidal lights.
6. Humidifiers.
7. Ventilation air heat exchangers.
8. Refrigeration components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Product Data: For energy performance.
4. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
5. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Furnace and accessories complete with controls.
    b. Air filter.
    c. Air cleaner.
    d. UV germicidal light.
    e. Humidifier.
    f. Ventilation heat exchanger.
    g. Refrigeration components.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Disposable Air Filters: Furnish [**two**]<**Insert number**> complete sets.
2. Disposable Air-Cleaner Media: Furnish [**one**]<**Insert number**> complete set(s).
3. Fan Belts: Furnish [**one**]<**Insert number**> set(s) for each furnace fan.
4. Disposable Humidifier Media: Furnish [**one**]<**Insert number**> set(s).

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

    a. Furnace Heat Exchanger: [**10 years**][**20 years**][**Lifetime**]<**Insert value**>.
    b. Integrated Ignition and Blower Control Circuit Board: [**Five years**]<**Insert value**>.
    c. Draft-Inducer Motor: [**Five years**]<**Insert value**>.
    d. High-Efficiency Oil Furnace Burner: [**Three years**]<**Insert value**>.
    e. Refrigeration Compressors: [**10 years**][**Lifetime**]<**Insert value**>.
    f. Evaporator and Condenser Coils: [**Five years**]<**Insert value**>.
    g. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 OIL-FIRED FURNACES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Adams Manufacturing Company**]
2. [**Arcoaire; Carrier Global Corporation**]
3. [**Bard Manufacturing Company**]
4. [**Carrier Global Corporation**]
5. [**Comfort-Aire; a division of Heat Controller, Inc.**]
6. [**Comfortmaker; Carrier Global Corporation**]
7. [**Dornback Furnace**]
8. [**Heil; Carrier Global Corporation**]
9. [**Lennox**]
10. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Ruud Air Conditioning Division**]
12. [**Thermo Products, Inc.**]
13. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Adams Manufacturing Company**]
2. [**Arcoaire; Carrier Global Corporation**]
3. [**Bard Manufacturing Company**]
4. [**Carrier Global Corporation**]
5. [**Comfort-Aire; a division of Heat Controller, Inc.**]
6. [**Comfortmaker; Carrier Global Corporation**]
7. [**Dornback Furnace**]
8. [**Heil; Carrier Global Corporation**]
9. [**Lennox**]
10. [**Luxaire; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Ruud Air Conditioning Division**]
12. [**Thermo Products, Inc.**]
13. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
14. <**Insert manufacturer's name**>

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

D. Manufactured Units: Factory assembled, piped, wired, and tested; complying with UL 727 and with NFPA 31.

2.2 FURNACES

A. Cabinet: [**Steel**][**Galvanized steel**].

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.

4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Fan: Centrifugal, factory balanced, resilient mounted, [**direct drive**][**belt drive**][**direct or belt drive**][**drive type indicated on Drawings**].

1. Fan Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
2. Special Motor Features:

a. Single speed, premium efficiency, as defined in Section 230500 "Common Work Results for HVAC," and with internal thermal protection and permanent lubrication.
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

C. Heat Exchanger: Welded steel with [**ceramic-fiber liner**][**refractory insert**] at the burner in the combustion chamber. Minimum **2-inch- (50-mm-)** diameter access ports in heat exchanger to permit access for cleaning.

D. Burner: High-pressure atomizing type, with rubber-mounted, adjustable, combustion-air blower; integrated fuel pump; hinged, flame-inspection port; cadmium-sulfide flame sensor; electrodes; ignition transformer; and oil nozzle.

1. Time-Delay Relay: Limits time for establishing main flame.
2. Flame Sensor: Monitors flame and stops burner on flame failure.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

E. Barometric Draft Regulator: Match furnace; for mounting in flue.

F. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.

G. Vent Materials: Comply with requirements in Section 235123 "Gas Vents" for Type B metal vents.

H. Capacities and Characteristics:

1. Airflow Configuration: [**Upflow**][**Counterflow**][**Horizontal**].
2. Minimum Efficiency AFUE: <**Insert number**> percent.
3. Minimum Thermal Efficiency: <**Insert number**> percent.
4. Oil:

a. Input: <**Insert gph (L/s)**>.
b. Heat Output: <**Insert MBh (kW)**>.
c. Burner Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

d. Vent Size: <**Insert inches (mm)**>.

5. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (Pa)**>.
c. Motor:

1) Size: <**Insert horsepower**>.
2) Speed: <**Insert rpm**>.

d. Volts: <**Insert value**>.
e. Phase: <**Insert value**>.
f. Hertz: <**Insert value**>.
g. Full-Load Amperes: <**Insert value**>.
h. Minimum Circuit Ampacity: <**Insert value**>.
i. Maximum Overcurrent Protection: <**Insert amperage**>.

6. Furnace Electrical Connection:

a. Volts: <**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 THERMOSTATS AND HUMIDISTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

B. Solid-State Thermostat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with [**automatic**][**manual**] switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

D. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

E. Heating-Only Thermostat: [**Single**][**Two**]-stage, wall-mounted unit with fan on-automatic selector.

F. Solid-State, Combination Thermostat and Humidistat: [**Wall-mounted**][**Freestanding**][**Wireless**], programmable, microprocessor-based unit with automatic switching from heating to cooling and humidifying to dehumidifying, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

G. Humidistat: Adjustable, [**wall**][**duct**]-mounted unit.

H. Control Wiring: Unshielded twisted-pair cabling.

1. No. 24 AWG, 100 ohm, four pair.
2. Cable Jacket Color: [**Blue**]<**Insert color**>.

2.4 AIR FILTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]
4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aprilaire; Research Products Corp**]
2. [**Filtrete Home Filtration Products; a 3M brand**]
3. [**General Filters, Inc.**]
4. [**Permatron Corporation**]
5. <**Insert manufacturer's name**>

C. Washable Filters: **1-inch- (25-mm-)** thick urethane pad.

D. Disposable Filters: [**1-inch- (25-mm-)**]<**Insert dimension**> thick fiberglass media[**with ASHRAE 52.2 MERV rating of 6 or higher,**] in sheet metal frame.

E. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

F. HEPA Air Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter[**, carbon VOC,**] and high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

2.5 AIR CLEANERS

A. Electronic Air Cleaners: Packaged system, including sheet metal housing, prefilter, power supply, and automatic control device, arranged for mounting in return-air duct at furnace; equip with on-off and test switches and pilot light.

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, particle size to 0.01 micrometer.
3. Static Pressure Drop: Maximum **0.14-inch wg (35 Pa)** at **300-fpm (1.52-m/s)** air velocity.

B. Capacities and Characteristics:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Minimum Circuit Ampacity: <**Insert value**>.
5. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 UV GERMICIDAL LIGHTS

A. Description: Lighting unit in metal housing arranged for installation in supply-air duct and controlled to cycle on and off with furnace fan, with [**one**][**two**] 75-W UV light bulb(s).

2.7 HUMIDIFIERS

A. Minimum capacity rating indicated according to AHRI 610.

B. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.

C. Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.

D. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.

E. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.

F. Steam type with electric heating element in stainless-steel reservoir with float-valve level control; arranged for attachment to duct or plenum and for control by humidistat.

G. Comply with applicable requirements in ASHRAE 62.1.

H. Capacities and Characteristics:

1. Type: [**Steam**][**Media wheel**][**Wetted pad with reservoir**][**Wetted pad with continuous drain**][**Wetted-pad bypass**].
2. Steam Capacity: <**Insert lb/h (kg/h)**>.
3. Water Connection Size: <**Insert NPS (DN)**>.
4. Drain Connection Size: <**Insert NPS (DN)**>.
5. Volts: <**Insert value**>.
6. Phase: <**Insert value**>.
7. Hertz: <**Insert value**>.
8. Minimum Circuit Ampacity: <**Insert value**>.
9. Maximum Overcurrent Protection: <**Insert amperage**>.

2.8 VENTILATION AIR HEAT EXCHANGERS

A. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.

B. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.

C. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Section 230500 "Common Work Results for HVAC."

D. Filters: **1-inch- (25-mm-)** thick disposable type[**with ASHRAE 52.2 MERV rating of 6 or higher**], in galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.

E. Wiring: Wire motors and controls so only external connections are required during installation.

2.9 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet[**complying with ASHRAE 62.1**].

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I, [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."

E. Air-Cooled Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed [**reciprocating**][**or**][**scroll**] type.

   a. Crankcase heater.
   b. [**Restrained vibration**][**Vibration**] isolation mounts for compressor.
   c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
   e. Refrigerant Charge: [**R-407C**][**R-410A**]<**Insert type**>.
   f. Refrigerant: R-407C or R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C)**.
8. Mounting Base: Polyethylene.

F. Capacities and Characteristics:

1. Refrigerant Coil:

a. Total Cooling Capacity: <**Insert Btu/h (kW)**>.
b. Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.
c. Heating Capacity: <**Insert Btu/h (kW)**>.
d. Maximum Air Pressure Drop: <**Insert inches wg (Pa)**>.
e. Condensate Drain Size: <**Insert NPS (DN)**>.

2. Compressor-Condenser Unit:

a. Cooling Energy Efficiency[**(EER)**][**(SEER)**]: <**Insert value**>.
b. Heating Coefficient of Performance: <**Insert value**>.
c. Volts: <**Insert value**>.
d. Phase: <**Insert value**>.
e. Hertz: <**Insert value**>.
f. Full-Load Amperes: <**Insert value**>.
g. Minimum Circuit Ampacity: <**Insert value**>.
h. Maximum Overcurrent Protection: <**Insert amperage**>.
i. Fan Motor Full-Load Amperes: <**Insert value**>.
j. Compressor Running-Load Amperes: <**Insert value**>.
k. Compressor Motor Full-Load Amperes: <**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for oil[**and refrigerant**] piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install oil-fired furnaces and associated fuel and vent piping according to NFPA 31.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

1. Anchor furnace to substrate to resist code-required seismic acceleration.

D. Controls: Install thermostats and humidistats at mounting height of **60 inches (1500 mm)** above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install ground-mounted, compressor-condenser components on **4-inch- (100-mm-)** thick, reinforced concrete base; **4 inches (100 mm)** larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

G. Install ground-mounted compressor-condenser components on polyethylene mounting base.

H. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

3.3 CONNECTIONS

A. Oil piping installation requirements are specified in Section 231113 "Facility Fuel-Oil Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect oil piping with union or flange and [**ball**][**gate**] valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Water piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.

D. Vent Connections: Connect Type L vents to furnace vent connection and extend outdoors. Type L vents and their installation requirements are specified in Section 235123 "Gas Vents."

E. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

F. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
2. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

G. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings[**and adjust belt tension**].

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 54 16 16

Task	Specification	Specification Description
23 54 16 16	23 54 13 00	Electric-Resistance Furnaces
23 54 19 00	23 54 13 00	Electric-Resistance Furnaces

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SECTION 23 55 23 13 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Forced-draft heaters.
2. Draft-induced heaters.
3. Multiple-burner heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.
2. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail fabrication and assembly of high-intensity, gas-fired, radiant heaters, as well as procedures and diagrams.
5. Include diagrams for power[**, signal, and control**] wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Gas piping to heater installations
3. Thermostats and wiring to heaters.
4. Heater locations and clearance requirements.
5. Other suspended ceiling components including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Sprinklers.
d. <**Insert item**>.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Igniter: [**One**]<**Insert number**> hot-surface burner igniter(s) for each style of high-intensity, gas-fired, radiant heater furnished.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.

a. Burner Assembly: [**Three**][**Five**][**10**]<**Insert number**> years.
b. Combustion and Emitter Tubes: [**Two**][**Three**][**Five**]<**Insert number**> years.
c. Heater Controls: One <**Insert number**> year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FORCED-DRAFT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Calcana Industries Ltd.**]
3. [**Combustion Research Corporation**]
4. [**Detroit Radiant Products Company**]
5. [**Roberts-Gordon, Inc**]
6. [**Schwank Inc.**]

7. [**Solaronics, Inc.**]
8. [**Space-Ray; a division of Gas-Fired Products Inc.**]
9. [**Sterling HVAC Products; a Mestek company**]
10. [**Superior Radiant Products Ltd.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Calcana Industries Ltd.**]
3. [**Combustion Research Corporation**]
4. [**Detroit Radiant Products Company**]
5. [**Roberts-Gordon, Inc**]
6. [**Schwank Inc.**]
7. [**Solaronics, Inc.**]
8. [**Space-Ray; a division of Gas-Fired Products Inc.**]
9. [**Sterling HVAC Products; a Mestek company**]
10. [**Superior Radiant Products Ltd.**]
11. <**Insert manufacturer's name**>

C. Description: Factory-assembled, [**indoor**][**outdoor**], overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

D. Fuel Type: Design burner for [**natural**][**propane**] gas having characteristics same as those of gas available at Project site.

E. Burner Assembly:

1. Combustion-Air Inlet:

   a. Non-ducted, unvented.
   b. Ducted horizontal to outdoors through sidewall with vent caps.
   c. Ducted vertical to outdoors through roof with vent caps.

2. Burner Control Housing: [**Stainless steel**][**Corrosion-resistant, aluminized steel**][**Steel**].

   a. Totally enclosed with [**stainless steel**][**steel**] access cover.
   b. Sight glass for visual inspection of burner.
   c. Finish: [**Enameled finish**][**or**][**powder-coated finish**].

3. Burner: [**Stainless steel**][**One-piece cast iron**].
4. Ignition System: [**Silicon carbide hot-surface igniter**][**Direct spark**][**24/25-V ac**][**115/120-V ac**] with flame rod sensing capabilities[**and self-diagnostic control module**].
5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with [**cast-aluminum-alloy**][**stainless steel**]<**Insert material**> impeller and [**aluminized-**]steel housing, with a minimum temperature rating of **450 deg F (232 deg C)**.
6. Motors: General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Combustion Chamber: **4-inch- (100-mm-)** diameter, [**12**][**16**]-gauge, [**aluminized-**][**titanium-coated aluminized-**][**stainless**][**hot-rolled-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

G. Emitter Tube: [**4-inch- (100-mm-)**][**3-inch- (76-mm-)**] diameter, [**12**][**16**]-gauge, [**aluminized-**][**hot-rolled-**][**stainless**][**titanium-coated aluminized-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.[**Emitter tubing shall be equipped with baffles to maximize heating efficiency.**]

1. Tubing Connections: [**Stainless steel threaded couplings**][**Interlocking flare joints with stainless steel draw bolts**][**Compression couplings made from aluminized or stainless steel**].
2. [**90**][**180**]-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
3. Exhaust Vent Termination: [**Vertical through roof**][**Horizontal though side wall**] with vent caps.

H. Reflector: [**Polished aluminum**][**Polished stainless steel**][**High-grade steel with a heat- and corrosion-resistant, hot-bonded, aluminum-silicon alloy coating**], with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

I. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Protective grilles mounted to reflectors to protect emitter tubing.
3. Stainless steel flexible connector with manual valve for gas supply.
4. Hanger chain with "S" hooks.
5. **3/16-inch- (5-mm-)** diameter, [**galvanized**][**aluminized**]-steel wire tubing hangers and reflector supports.
6. Rigid mounting kits.
7. Outdoor use conversion kit.
8. Clearance warning plaque.

J. Capacities and Characteristics:

1. Gas Input: <**Insert Btu/h (kW)**>.
2. Gas Output: <**Insert Btu/h (kW)**>.
3. Fuel-Supply Connection: <**Insert inches (mm)**>.
4. Combustion-Air Fan Motor Size: <**Insert value**> hp.

a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 DRAFT-INDUCED HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Combustion Research Corporation**]
2. [**Detroit Radiant Products Company**]
3. [**Roberts-Gordon, Inc**]
4. [**Schwank Inc.**]
5. [**Solaronics, Inc.**]
6. [**Space-Ray; a division of Gas-Fired Products Inc.**]
7. [**Superior Radiant Products Ltd.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Combustion Research Corporation**]
2. [**Detroit Radiant Products Company**]
3. [**Roberts-Gordon, Inc**]
4. [**Schwank Inc.**]
5. [**Solaronics, Inc.**]
6. [**Space-Ray; a division of Gas-Fired Products Inc.**]
7. [**Superior Radiant Products Ltd.**]
8. <**Insert manufacturer's name**>

C. Description: Factory-assembled, [**indoor**][**outdoor**], overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

D. Fuel Type: Design burner for [**natural**][**propane**] gas having characteristics same as those of gas available at Project site.

E. Burner Assembly:

1. Combustion-Air Inlet:

   a. Non-ducted, unvented.
   b. Ducted horizontal to outdoors through sidewall with vent caps.
   c. Ducted vertical to outdoors through roof with vent caps.

2. Burner Control Housing: [**Stainless steel**][**Corrosion-resistant, aluminized steel**][**Steel**].

   a. Totally enclosed with [**stainless steel**][**steel**] access cover.
   b. Sight glass for visual inspection of burner.
   c. Finish: [**Enameled finish**][**or**][**powder-coated finish**].

3. Burner: [**Stainless steel**][**One-piece cast iron**].
4. Ignition System: [**Silicon carbide hot-surface igniter**][**Direct spark**][**24/25-V ac**][**115/120-V ac**] with flame rod sensing capabilities[**and self-diagnostic control module**].
5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with [**cast-aluminum-alloy**][**stainless steel**]<**Insert material**> impeller and [**aluminized-**]steel housing, with a minimum temperature rating of **450 deg F (232 deg C)**.
6. Motors: General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Combustion Chamber: **4-inch- (100-mm-)** diameter, [**12**][**16**]-gauge, [**aluminized-**][**titanium-coated aluminized-**][**stainless**][**hot-rolled-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

G. Emitter Tube: [**4-inch- (100-mm-)**][**3-inch- (76-mm-)**] diameter, [**12**][**16**]-gauge, [**aluminized-**][**hot-rolled-**][**stainless**][**titanium-coated aluminized-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.[**Emitter tubing shall be equipped with baffles to maximize heating efficiency.**]

1. Tubing Connections: [**Stainless steel threaded couplings**][**Interlocking flare joints with stainless steel draw bolts**][**Compression couplings made from aluminized or stainless steel**].
2. [**90**][**180**]-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.

H. Vacuum Exhaust Fan: Dynamically balanced, direct-driven, [**cast-aluminum-alloy**][**stainless steel**] impeller in aluminized-steel housing, isolated from emitter tubing exhaust system by high-temperature flexible vibration isolation connector. Fan and connector to have a minimum temperature rating of **450 deg F (232 deg C)**.

1. Motors: General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Balancing Dampers: Plate type, mounted in cast, double-flange fitting with vacuum test plug.
3. Filter: Cartridge type for mounting on burner housing.
4. Exhaust Vent Termination: [**Vertical through roof**][**Horizontal though side-wall**] with vent caps.

I. Reflector: [**Polished aluminum**][**Polished stainless steel**][**High-grade steel with a heat- and corrosion-resistant, hot-bonded, aluminum-silicon alloy coating**], with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

J. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Protective grilles mounted to reflectors to protect emitter tubing.
3. Stainless steel flexible connector with manual valve for gas supply.
4. Hanger chain with "S" hooks.
5. **3/16-inch- (5-mm-)** diameter, [**galvanized**][**aluminized**]-steel wire tubing hangers and reflector supports.
6. Rigid mounting kits.
7. Outdoor use conversion kit.
8. Clearance warning plaque.

K. Capacities and Characteristics:

1. Gas Input: <**Insert Btu/h (kW)**>.
2. Gas Output: <**Insert Btu/h (kW)**>.
3. Fuel-Supply Connection: <**Insert inches (mm)**>.
4. Combustion-Air Fan Motor Size: <**Insert value**> hp.

   a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

5. Vacuum Exhaust Fan Motor Size: <**Insert value**> hp.

   a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 MULTIPLE-BURNER HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Combustion Research Corporation**]
2. [**Detroit Radiant Products Company**]
3. [**Roberts-Gordon, Inc**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Combustion Research Corporation**]
2. [**Detroit Radiant Products Company**]
3. [**Roberts-Gordon, Inc**]
4. <**Insert manufacturer's name**>

C. Description: Factory-assembled, [**indoor**][**outdoor**], overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

D. Fuel Type: Design burner for [**natural**][**propane**] gas having characteristics same as those of gas available at Project site.

E. Burner Assembly: .

1. Combustion-Air Inlet:

   a. Non-ducted, unvented.
   b. Ducted horizontal to outdoors through sidewall with vent caps.

c. Ducted vertical to outdoors through roof with vent caps.

2. Burner Control Housing: [**Stainless steel**][**Corrosion-resistant, aluminized steel**][**Steel**].

   a. Totally enclosed with [**stainless steel**][**steel**] access cover.
   b. Sight glass for visual inspection of burner.
   c. Finish: [**Enameled finish**][**or**][**powder-coated finish**].

3. Burner: [**Stainless steel**][**One-piece cast iron**].
4. Ignition System: [**Silicon carbide hot-surface igniter**][**Direct spark**][**24/25-V ac**][**115/120-V ac**] with flame rod sensing capabilities[**and self-diagnostic control module**].
5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with [**cast-aluminum-alloy**][**stainless steel**]<**Insert material**> impeller and [**aluminized-**]steel housing, with a minimum temperature rating of **450 deg F (232 deg C)**.
6. Motors: General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Combustion Chamber: **4-inch- (100-mm-)** diameter, [**12**][**16**]-gauge, [**aluminized-**][**titanium-coated aluminized-**][**stainless**][**hot-rolled-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

G. Emitter Tube: [**4-inch- (100-mm-)**][**3-inch- (76-mm-)**] diameter, [**12**][**16**]-gauge, [**aluminized-**][**hot-rolled-**][**stainless**][**porcelain-lined-**][**titanium-coated aluminized-**] steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.[**Emitter tubing shall be equipped with baffles to maximize heating efficiency.**]

1. Tubing Connections: [**Stainless steel threaded couplings**][**Interlocking flare joints with stainless steel draw bolts**][**Compression couplings made from aluminized or stainless steel**].
2. [**90-degree bends**][**180-degree bends**][**Tee fittings**][**Cross fittings**] made from [**stainless steel**] with corrosion-resistant, high-temperature black coating.
3. Condensing Tubing: **4-inch- (100-mm-)** diameter, stainless steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.

H. Vacuum Exhaust Fan: Dynamically balanced, direct-driven, [**cast-aluminum-alloy**][**stainless steel**] impeller in aluminized-steel housing, isolated from emitter tubing exhaust system by high-temperature flexible vibration isolation connector. Fan and connector to have a minimum temperature rating of **450 deg F (232 deg C)**.

1. See [**Section 230548 "Vibration and Seismic Controls for HVAC"**][**Section 230548.13 "Vibration Controls for HVAC"**] for mounting vacuum exhaust fan.
2. Motors: General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

   a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Balancing Dampers: Plate type, mounted in cast, double-flange fitting with vacuum test plug.
4. Filter: Cartridge type for mounting on burner housing.
5. Exhaust Vent Termination: [**Vertical through roof**][**Horizontal though side wall**] with vent caps.

I. Reflector: [**Polished aluminum**][**Polished stainless steel**][**High-grade steel with a heat- and corrosion-resistant, hot-bonded, aluminum-silicon alloy coating**], with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

J. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degreesfrom vertical.
2. Protective grilles mounted to reflectors to protect emitter tubing.
3. Stainless steel flexible connector with manual valve for gas supply.
4. Hanger chain with "S" hooks.
5. **3/16-inch- (5-mm-)** diameter, [**galvanized**][**aluminized**]-steel wire tubing hangers and reflector supports.
6. Rigid mounting kits.
7. Outdoor use conversion kit.
8. Clearance warning plaque.

K. Capacities and Characteristics:

1. Gas Input: <**Insert Btu/h (kW)**>.
2. Gas Output: <**Insert Btu/h (kW)**>.
3. Fuel-Supply Connection: <**Insert inches (mm)**>.
4. Combustion-Air Fan Motor Size: <**Insert value**> hp.

   a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

5. Vacuum Exhaust Fan Motor Size: <**Insert value**> hp.

   a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 CONTROLS AND SAFETIES

A. Gas Control Valve: [**Single**][**Two**]-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

C. Prepurge of [**15**][**30**][**45**] seconds of air control system prior to burner ignition.

D. Safety lockout of burner after [**three consecutive ignition failures**][**flame is not reestablished within trial ignition period**].

E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.

F. Control Panel Interlock: Stops burner if panel is open.

G. Indicator Lights: [**"Airflow-on"**][**and**][**"burner-on"**] indicator lights.

H. Thermostat:

1. Devices and wiring are specified in Section 230923.27 "Temperature Instruments."
2. Single-stage, wall-mounted type with **50 to 90 deg F (10 to 32 deg C)** operating range and fan on switch.

   a. Control transformer, integrally mounted.

3. Two-stage, wall-mounted type with **50 to 90 deg F (10 to 32 deg C)** operating range and fan on switch.

   a. Control transformer, integrally mounted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structures, substrates, areas and conditions, with Installer present, for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to [**NFPA 54**][**CSA B149.1**].

B. Suspended Units: [**Suspend from substrate using chain hanger kits and building attachments**][**Mount to substrate using manufacturer's rigid mounting kits or custom fabricated brackets**].

1. Restrain the unit to resist seismic acceleration. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

3.3 CONNECTIONS

A. Gas Piping: Comply with [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

1. Gas Connections: Connect gas piping to radiant heaters according to [**NFPA 54**][**CSA B149.1**].

B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

C. Vent Connections: Comply with Section 233113 "Metal Ducts" and with Section 235123"Gas Vents."

D. Electrical Connections: Comply with applicable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain gas-fired, radiant heaters.

END OF SECTION 23 55 23 13

SECTION 23 55 33 13 - OIL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Oil-fired unit heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of oil-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For oil-fired unit heaters[**; signed and sealed by a qualified professional engineer**]. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of oil-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power[**, signal, and control**] wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:

a. Vent and oil piping rough-ins and connections.
b. <**Insert item**>.

B. Seismic Qualification Certificates: For oil-fired unit heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For oil-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> for each belt-driven fan size.

1.6 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of oil-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Oil-fired unit heaters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. Seismic Fabrication Requirements: Fabricate and reinforce suspension attachments of oil-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when oil-fired unit heater is anchored to building structure.
2. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Capacities and Characteristics:

1. Oil Input: <**Insert gph (L/s)**>.
2. Heat Output: <**Insert Btu/h (kW)**>.
3. Annual Fuel Utilization Efficiency: [**80**]<**Insert number**> percent.
4. Minimum Airflow: <**Insert cfm (L/s)**>.
5. External Static Pressure: <**Insert inches wg (kPa)**>.
6. Motor Enclosure: Totally enclosed, fan cooled.
7. Electrical Characteristics:

    a. Motor Size: <**Insert horsepower**>.
    b. Motor Speed: <**Insert number**> rpm.
    c. Volts: [**120**][**208**][**230**]<**Insert value**>.
    d. Phase: [**Single**][**Poly**].
    e. Hertz: 60.
    f. Full-Load Amperes: <**Insert value**>.
    g. Minimum Circuit Ampacity: <**Insert value**>.
    h. Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 OIL-FIRED UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Modine Manufacturing Company**]
2. [**REZNOR, a brand of Nortek Global HVAC**]
3. [**Sterling HVAC Products; a Mestek company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Modine Manufacturing Company**]
2. [**REZNOR, a brand of Nortek Global HVAC**]
3. [**Sterling HVAC Products; a Mestek company**]
4. <**Insert manufacturer's name**>

C. Description: Factory assembled, piped, and wired, and complying with UL 731.

D. Housing: Steel, with inserts for suspension mounting rods.

1. External Casings and Cabinets: [**Baked enamel**][**Powder coating**] over corrosion-resistant-treated surface.
2. Discharge Louvers: Independently adjustable, [**horizontal**][**vertical**] blades.
3. Discharge Nozzle: Discharge at [**25 to 65 degrees (0.44 to 1.13 radians)**][**50 to 90 degrees (0.87 to 1.57 radians)**] from horizontal.

E. Accessories:

1. Oil Booster Pump: [**30-gph (108-L/h)**][**70-gph (252-L/h)**] capacity; motor and two-stage fuel unit with pressure-regulating valve and strainer.
2. Oil safety valve.
3. Outdoor Combustion-Air Adapter: Sealed to housing and fitted with quick access cover or door and fitting for terminating outdoor-air duct.

F. Heat Exchanger: Minimum **0.09-inch (2.2-mm)** steel.

G. Burners: Flame-retention, pressure-atomizing, forced-draft, gun type; with integral fuel pump and electronic spark ignition and flame safety.

1. Safety Device: Oil-pressure switch.

H. Propeller Unit Fan:

1. Aluminum blades dynamically balanced and resiliently mounted.
2. Steel fan-blade guard.

I. Centrifugal Unit Fan:

1. Steel, centrifugal fan dynamically balanced and resiliently mounted.
2. Belt driven with adjustable-pitch motor sheave.

J. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Enclosure Materials: Rolled steel.
3. Motor Bearings: <**Insert requirements**>.
4. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (m)**> above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

5. Efficiency: Premium efficient.
6. NEMA Design: <**Insert designation**>.
7. Service Factor: <**Insert value**>.

K. Controls: Factory piped and prewired to electrical junction box mounted on unit, including the following:

1. Control Transformer: Integrally mounted, 120- to 24-V ac.
2. Cad-cell safety system.
3. Manual reset safety.
4. Automatic Fan Thermal Switch: Fan operates with heat-exchanger temperature more than **135 deg F (58 deg C)**.
5. Thermostat:[**Devices and wiring are specified in Section 230923.27 "Temperature Instruments."**]

   a. Mounting: [**Wall**][**Unit**].
   b. [**Single**][**Two**] stage.
   c. Fan on-off-automatic switch.
   d. 24-V ac.
   e. **50 to 90 deg F (10 to 32 deg C)** operating range.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect oil-fired unit heaters and associated fuel and vent piping according to [**NFPA 31**][**CSA B139**], applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Threaded Rods, Spring Hangers, and Building Attachments: Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 230548 "Vibration and Seismic Controls for HVAC."
2. Threaded Rods, Spring Hangers, Building Attachments, and Seismic Restraints: Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." and Section 230548 "Vibration and Seismic Controls for HVAC"
3. Anchor the unit to resist code-required horizontal acceleration.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to oil-fired unit heater, allow space for service and maintenance.

C. Fuel Oil Piping: Comply with Section 231113 "Facility Fuel-Oil Piping." Connect to fuel oil supply and return piping with shutoff valve and union at each connection.

D. Vent Connections: Comply with Section 235123 "Gas Vents."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.

b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Oil-fired unit heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain oil-fired unit heaters.

END OF SECTION 23 55 33 13

SECTION 23 55 33 16 - GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas-fired unit heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired unit heaters[**; signed and sealed by a qualified professional engineer**]. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power[**, signal, and control**] wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:

a. Vent and gas piping rough-ins and connections.
b. <**Insert item**>.

B. Seismic Qualification Certificates: For gas-fired unit heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> for each belt-driven fan size.

1.6 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas-fired unit heaters shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. Seismic Fabrication Requirements: Fabricate and reinforce suspension attachments of gas-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when gas-fired unit heater is anchored to building structure.
2. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Capacities and Characteristics:

1. Gas Input: <**Insert Btu/h (kW)**>.
2. Gas Output: <**Insert Btu/h (kW)**>.
3. Annual Gas Utilization Efficiency: [**80**]<**Insert number**> percent.
4. Minimum Airflow: <**Insert cfm (L/s)**>.
5. External Static Pressure: <**Insert inches wg (kPa)**>.
6. Motor Enclosure: Totally enclosed, fan cooled.
7. Electrical Characteristics:

    a. Motor Size: <**Insert horsepower**>.
    b. Motor Speed: <**Insert number**> rpm.
    c. Volts: [**120**][**208**][**230**]<**Insert value**>.
    d. Phase: [**Single**][**Poly**].
    e. Hertz: 60.
    f. Full-Load Amperes: <**Insert value**>.
    g. Minimum Circuit Ampacity: <**Insert value**>.
    h. Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 GAS-FIRED UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Lennox**]
2. [**Modine Manufacturing Company**]
3. [**REZNOR, a brand of Nortek Global HVAC**]
4. [**Sterling HVAC Products; a Mestek company**]
5. [**Trane**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Lennox**]
2. [**Modine Manufacturing Company**]
3. [**REZNOR, a brand of Nortek Global HVAC**]
4. [**Sterling HVAC Products; a Mestek company**]
5. [**Trane**]
6. <**Insert manufacturer's name**>

C. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

D. Gas Type: Design burner for [**natural**][**propane**] gas having characteristics same as those of gas available at Project site.

E. Type of Venting: [**Gravity**][**Powered**][**Indoor, separated combustion, power**] vented.

F. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: [**Baked enamel**][**Powder coating**] over corrosion-resistant-treated surface.
2. Discharge Louvers: Independently adjustable, [**horizontal**][**vertical**] blades.
3. Discharge Nozzle: Discharge at [**25 to 65 degrees (0.44 to 1.13 radians)**][**50 to 90 degrees (0.87 to 1.57 radians)**] from horizontal.

G. Accessories:

1. Four-point suspension kit.
2. Power Venter: Centrifugal aluminized-steel fan, with stainless steel shaft; 120-V ac motor.
3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

H. Heat Exchanger: [**Aluminized**][**Stainless**] steel.

I. Burner Material: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].

J. Propeller Unit Fan:

1. [**Formed-steel**][**Aluminum**] propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

K. Centrifugal Unit Fan:

1. Steel, centrifugal fan dynamically balanced and resiliently mounted.
2. Belt-Driven Drive Assembly:

   a. Resiliently mounted to housing, with the following features:

      1) Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
      2) Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
      3) Pulleys: Cast-iron, adjustable-pitch motor pulley.

L. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Enclosure Materials: Rolled steel.
3. Motor Bearings: <**Insert requirements**>.
4. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (m)**> above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

5. Efficiency: Premium efficient.
6. NEMA Design: <**Insert designation**>.
7. Service Factor: <**Insert value**>.

M. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
2. Ignition: [**Standing pilot**][**Electronically controlled electric spark with flame sensor**].
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: [**Flame rollout switch**][**Differential pressure switch to verify open**

vent].

5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostat:[**Devices and wiring are specified in Section 230923.27 "Temperature Instruments."**]

    a. Mounting: [**Wall**][**Unit**].
    b. [**Single**][**Two**] stage.
    c. Fan on-off-automatic switch.
    d. 24-V ac.
    e. **50 to 90 deg F (10 to 32 deg C)** operating range.

N. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to [**NFPA 54**][**CSA B149.1**], applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

B. Substrate-Mounted Units: Provide supports connected to substrate. Secure units to supports.

1. Spring hangers[**and seismic restraints**] are specified in [**Section 230529 "Hangers and Supports for HVAC Piping and Equipment."**][**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 230548 "Vibration and Seismic Controls for HVAC."**]
2. Threaded Rods, Spring Hangers, and Building Attachments: Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 230548 "Vibration and Seismic Controls for HVAC."
3. Threaded Rods, Spring Hangers, Building Attachments, and Seismic Restraints: Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." and Section 230548 "Vibration and Seismic Controls for HVAC."
4. Anchor the unit to resist code-required horizontal acceleration.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Gas Piping: Comply with [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Section 235123 "Gas Vents."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 23 55 33 16

SECTION 23 57 00 00 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shell-and-tube heat exchangers.
2. Gasketed-plate heat exchangers.
3. Brazed-plate heat exchangers.

1.2 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
2. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

C. Delegated Design Submittal: Details and design calculations for seismic restraints for heat exchangers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room plan or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for heat exchanger, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Heat Exchanger: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of heat exchanger anchorage devices on which certification is based and their installation requirements.

C. Product Certificates: For each type of shell-and-tube heat exchanger. Documentation that shell-and-

tube heat exchangers comply with "TEMA Standards."

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including heat exchanger, storage tank, and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Shell-and-Tube Heat Exchangers:

1) Tube Coil: [**One**]<**Insert number**> year(s).
2) Other Components: [**One**]<**Insert number**> year(s).

b. Plate Heat Exchangers:

1) Brazed-Plate Type: [**One**]<**Insert number**> year(s).
2) Gasketed-Plate Type; [**One**]<**Insert number**> year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for heat exchangers.

B. Seismic Performance: Heat exchangers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor is [**1.5**][**1.0**].

3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Maxi-Therm**]
9. [**Spirax Sarco Limited**]
10. [**Taco Comfort Solutions**]
11. [**Thermo Dynamics Ltd.**]
12. [**Thrush Co. Inc.**]
13. [**Wessels Company**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Maxi-Therm**]
9. [**Spirax Sarco Limited**]
10. [**Taco Comfort Solutions**]
11. [**Thermo Dynamics Ltd.**]
12. [**Thrush Co. Inc.**]
13. [**Wessels Company**]
14. <**Insert manufacturer's name**>

C. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.

D. Construction:

1. Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
2. Fabricate and label shell-and-tube heat exchangers to comply with "TEMA Standards."

E. Configuration: [**U-tube with removable**][**Straight tube with removable**][**Straight tube with fixed**] bundle.

F. Shell Materials: [**Steel**][**Stainless steel**].

G. Head:

1. Materials: [**Cast iron**][**Cast stainless steel**][**Fabricated steel**][**Fabricated steel with removable cover**][**Fabricated stainless steel**][**Fabricated stainless steel with removable cover**].
2. Flanged and bolted to shell.

H. Tube: [**Seamless copper**][**Steel**][**Cupronickel**][**Stainless steel**] tubes.

1. Tube diameter is determined by manufacturer based on service.

I. Tubesheet Materials: [**Steel**][**Stainless steel**].

J. Baffles: [**Steel**][**Stainless steel**].

K. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. **NPS 2 (DN 50)** and Smaller: Threaded ends in accordance with ASME B1.20.1.
2. **NPS 2-1/2 (DN 65)** and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

L. Support Saddles:

1. Fabricated of material similar to shell.
2. Fabricate foot mount with provision for anchoring to support.

M. Capacities and Characteristics:

1. General:

a. Shell Diameter: <**Insert inches (mm)**>.
b. Heat-Exchanger Length: <**Insert inches (mm)**>.
c. Heat-Exchanger Surface Area: <**Insert sq. ft. (sq. m)**>.
d. Number of Passes: <**Insert number**>.
e. Heat Exchanged: <**Insert Btu/h (kW)**>.
f. Operating Weight: <**Insert lb (kg)**>.

2. Shell Side:

a. Fluid: [**Water**][**Steam**]<**Insert type**>.
b. Working Pressure: <**Insert psig (kPa)**>.
c. Supply Pressure: <**Insert psig (kPa)**>.
d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
e. Water-Flow Rate: <**Insert gpm (L/s)**>.
f. Pressure Drop: <**Insert psig (kPa)**>.
g. Inlet Temperature: <**Insert deg F (deg C)**>.
h. Outlet Temperature: <**Insert deg F (deg C)**>.
i. Fouling Factor: <**Insert value**>.
j. Inlet Size: <**Insert NPS (DN)**>.
k. Outlet Size: <**Insert NPS (DN)**>.

3. Tube Side:

a. Fluid: [**Water**][**Steam**]<**Insert type**>.

b. Working Pressure: <**Insert psig (kPa)**>.
c. Supply Pressure: <**Insert psig (kPa)**>.
d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
e. Water-Flow Rate: <**Insert gpm (L/s)**>.
f. Pressure Drop: <**Insert psig (kPa)**>.
g. Inlet Temperature: <**Insert deg F (deg C)**>.
h. Outlet Temperature: <**Insert deg F (deg C)**>.
i. Fouling Factor: <**Insert value**>.
j. Inlet Size: <**Insert NPS (DN)**>.
k. Outlet Size: <**Insert NPS (DN)**>.

2.3 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Polaris Heat Exchangers**]
9. [**SEC Heat Exchangers**]
10. [**Taco Comfort Solutions**]
11. [**Tranter, Inc**]
12. [**Weil-McLain**]
13. [**Wessels Company**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Polaris Heat Exchangers**]
9. [**SEC Heat Exchangers**]
10. [**Taco Comfort Solutions**]
11. [**Tranter, Inc**]
12. [**Weil-McLain**]
13. [**Wessels Company**]
14. <**Insert manufacturer's name**>

C. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.

D. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel

Code, Section VIII, "Pressure Vessels," Division 1.

E. Frame:

1. Capacity to accommodate [**20**]<**Insert number**> percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

F. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger support bars and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger support bars and guide bars are anchored to building structure.

G. End-Plate Material: Painted carbon steel.

H. Tie Rods and Nuts: Steel or stainless steel.

I. Plate Material: [**0.024 inch (0.6 mm)**][**0.031 inch (0.8 mm)**][**0.039 inch (1 mm)**]<**Insert thickness**> thick before stamping; [**Type 304**][**Type 304L**][**Type 316**][**Type 316L**] stainless steel.

J. Gasket Materials: [**Glued**][**Glue free**][**Nitrile rubber**][**EPDM rubber**]<**Insert material**>.

1. Glue: Chlorine free.

K. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. **NPS 2 (DN 50)** and Smaller: Threaded ends in accordance with ASME B1.20.1.
2. **NPS 2-1/2 (DN 65)** and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

L. Enclose plates in solid [**aluminum**][**stainless steel**] removable shroud.

M. Capacities and Characteristics:

1. General:

a. Heat-Exchanger Surface Area: <**Insert sq. ft. (sq. m)**>.
b. Number of Plates: <**Insert number**>.
c. Number of Passes: [**One**]<**Insert number**>.
d. Heat Exchanged: <**Insert Btu/h (kW)**>.
e. Operating Weight: <**Insert lb (kg)**>.

2. Hot Side:

a. Fluid: [**Water**][**Steam**]<**Insert type**>.
b. Working Pressure: <**Insert psig (kPa)**>.
c. Supply Pressure: <**Insert psig (kPa)**>.
d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
e. Water-Flow Rate: <**Insert gpm (L/s)**>.
f. Pressure Drop: <**Insert psig (kPa)**>.
g. Inlet Temperature: <**Insert deg F (deg C)**>.
h. Outlet Temperature: <**Insert deg F (deg C)**>.
i. Fouling Factor: <**Insert value**>.

j. Inlet Size: <**Insert NPS (DN)**>.
k. Outlet Size: <**Insert NPS (DN)**>.

3. Cold Side:

a. Fluid: [**Water**][**Steam**]<**Insert type**>.
b. Working Pressure: <**Insert psig (kPa)**>.
c. Supply Pressure: <**Insert psig (kPa)**>.
d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
e. Water-Flow Rate: <**Insert gpm (L/s)**>.
f. Pressure Drop: <**Insert psig (kPa)**>.
g. Inlet Temperature: <**Insert deg F (deg C)**>.
h. Outlet Temperature: <**Insert deg F (deg C)**>.
i. Fouling Factor: <**Insert value**>.
j. Inlet Size: <**Insert NPS (DN)**>.
k. Outlet Size: <**Insert NPS (DN)**>.

2.4 BRAZED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Polaris Heat Exchangers**]
9. [**Tranter, Inc**]
10. [**Weil-McLain**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alfa Laval Inc.**]
2. [**API Heat Transfer Inc.**]
3. [**Armstrong Fluid Technology**]
4. [**Bell & Gossett; a Xylem brand**]
5. [**Delta T Heat Exchangers**]
6. [**Flo Fab Inc**]
7. [**Kelvion, Inc.**]
8. [**Polaris Heat Exchangers**]
9. [**Tranter, Inc**]
10. [**Weil-McLain**]
11. [**Wessels Company**]
12. <**Insert manufacturer's name**>

C. Configuration: Brazed assembly, consisting of embossed or pressed stainless steel plates brazed together and two end plates, one with threaded nozzles and one with pattern-embossed plates. Floor-mounted heat exchangers must have factory-furnished integral legs with mounting feet.

D. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

E. End-Plate Material: Type 316 stainless steel.

F. Threaded Nozzles: Type 316 stainless steel.

G. Plate Material: Type 316 stainless steel.

H. Brazing Material: [**Copper**][**or**][**nickel**].

I. Capacities and Characteristics:

1. General:

   a. Heat-Exchanger Surface Area: <**Insert sq. ft. (sq. m)**>.
   b. Heat Exchanged: <**Insert Btu/h (kW)**>.
   c. Operating Weight: <**Insert lb (kg)**>.

2. Hot Side:

   a. Fluid: [**Water**][**Steam**]<**Insert type**>.
   b. Working Pressure: <**Insert psig (kPa)**>.
   c. Supply Pressure: <**Insert psig (kPa)**>.
   d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
   e. Water-Flow Rate: <**Insert gpm (L/s)**>.
   f. Pressure Drop: <**Insert psig (kPa)**>.
   g. Inlet Temperature: <**Insert deg F (deg C)**>.
   h. Outlet Temperature: <**Insert deg F (deg C)**>.
   i. Fouling Factor: <**Insert value**>.
   j. Inlet Size: <**Insert NPS (DN)**>.
   k. Outlet Size: <**Insert NPS (DN)**>.

3. Cold Side:

   a. Fluid: [**Water**][**Steam**]<**Insert type**>.
   b. Working Pressure: <**Insert psig (kPa)**>.
   c. Supply Pressure: <**Insert psig (kPa)**>.
   d. Steam-Flow Rate: <**Insert lb/h (kg/h)**>.
   e. Water-Flow Rate: <**Insert gpm (L/s)**>.
   f. Pressure Drop: <**Insert psig (kPa)**>.
   g. Inlet Temperature: <**Insert deg F (deg C)**>.
   h. Outlet Temperature: <**Insert deg F (deg C)**>.
   i. Fouling Factor: <**Insert value**>.
   j. Inlet Size: <**Insert NPS (DN)**>.
   k. Outlet Size: <**Insert NPS (DN)**>.

2.5 ACCESSORIES

A. Hangers and Supports:

1. Custom-built steel supports and saddles for mounting on [**floor**][**wall**][**structural steel**].

a. Minimum Number of Saddles: <**Insert number**>.

2. Supports and saddles to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Shroud: [**Steel**][**Stainless steel**][**Aluminum**] sheet.

C. Miscellaneous Components for High-Temperature, Hot-Water Unit: Control valve, valves, thermometers, and piping. [**Include components fitted for**][**pneumatic control**][**electric control**][**electronic control**].

D. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometers, and piping. [**Include components fitted for**][**pneumatic control**][**electric control**][**electronic control**].

E. Pressure-Relief Valves: [**Cast iron**][**Steel**][**Bronze**][**Brass**], <**Insert NPS (DN)**>, ASME rated and stamped.

1. Pressure-relief valve setting: <**Insert psig (kPa)**>.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.

B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HEAT EXCHANGER, GENERAL

A. Equipment Mounting:

1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for

equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF SHELL-AND-TUBE HEAT EXCHANGER

A. Install heat exchangers on saddle supports.

B. Heat-Exchanger Supports: Mount heat exchanger on steel saddles and supports specifically designed for each heat exchanger.

C. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.

3.4 INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER

A. Install wall-mounted gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

B. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base, and fasten legs to base.

C. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF BRAZED-PLATE HEAT EXCHANGER

A. Install wall-mounted brazed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

B. Install floor-mounted brazed-plate heat exchangers on cast-in-place concrete equipment base and fasten legs to base.

3.6 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell.

When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.

G. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.

H. Pipe pressure-relief valves, full size of valve connection, to floor drain.

I. Install vacuum breaker at heat-exchanger steam inlet connection.

J. Install hose end valve to drain shell.

K. Install thermometer on each heat-exchanger fluid[**inlet and**] outlet piping. Comply with requirements for thermometers specified in Section 230500 "Common Work Results for HVAC."

L. Install pressure gauges on each heat-exchanger fluid [**inlet and**] outlet piping[**and steam inlet piping**]. Comply with requirements for pressure gauges specified in Section 230500 "Common Work Results for HVAC."

3.7 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.

C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

3.8 FIELD QUALITY CONTROL

A. Testing Agency, Owner: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[**with the assistance of a factory-authorized service representative**]:

E. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Heat exchanger will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 23 57 00 00

Task	Specification	Specification Description
23 57 13 00	23 57 00 00	Heat Exchangers for HVAC
23 57 16 00	23 57 00 00	Heat Exchangers for HVAC
23 57 19 00	23 57 00 00	Heat Exchangers for HVAC
23 57 19 13	23 57 00 00	Heat Exchangers for HVAC
23 57 19 19	23 57 00 00	Heat Exchangers for HVAC
23 57 19 23	23 57 00 00	Heat Exchangers for HVAC
23 61 16 00	23 64 16 00	Centrifugal Water Chillers

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SECTION 23 62 00 00 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Compressor and condenser units, air cooled, 1 to 5 tons (3.5 to 17.6 kW).
2. Compressor and condenser units, air cooled, 6 to 120 tons (21 to 422 kW).

1.2 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings: For compressor and condenser units.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For compressor and condenser units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
3. Calculate requirements for selecting vibration isolators [**and seismic restraints**][**and wind restraints**] and for designing vibration isolation bases.
4. Indicate compliance with "Performance Requirements" Article.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for compressor and condenser units, accessories, and

components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Startup service reports.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate installation of steel dunnage and metal work platforms. These items are specified in Section 051200 "Structural Steel Framing," and Section 055000 "Metal Fabrications."

D. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Compressor failure.
   b. Condenser coil leak.

2. Warranty Period: [**Five**][**10**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period (Compressor Only): [**Five**][**Seven**][**10**]<**Insert number**> years from date of Substantial Completion.
4. Warranty Period (Components Other Than Compressor): [**Five**][**10**]<**Insert number**> years from date of Substantial Completion.
5. Warranty Period (Condenser Coil Only): [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**vibration isolation**][**seismic restraints**][**and**][**wind restraints**].

B. Seismic Performance: Compressor and condenser units are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. Wind-Restraint Performance:

1. See [**Section 230548 "Vibration and Seismic Controls for HVAC**][**Section 230548.13 "Vibration Controls for HVAC"**] for requirements.

D. Fabricate and label refrigeration system in accordance with ASHRAE 15 and ASHRAE 34.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS (3.5 TO 17.6 kW)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Continental Products**]
3. [**Heatcraft Refrigeration Products LLC**]
4. [**Lennox**]
5. [**Ruud Air Conditioning Division**]
6. [**Trane**]
7. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Continental Products**]
3. [**Heatcraft Refrigeration Products LLC**]
4. [**Lennox**]
5. [**Ruud Air Conditioning Division**]

6. [**Trane**]
7. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
8. <**Insert manufacturer's name**>

C. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

D. Compressor Type: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: [**Single**][**Two**][**Variable**] speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
3. Variable-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
4. Accumulator: Suction tube.

E. Refrigerant: [**R-410A**][**or**]<**Insert type**>.

F. Condenser Coil: Seamless copper-tube, [**aluminum**][**copper**]-fin coil; [**circuited for integral liquid subcooler,**]with removable drain pan and brass service valves with service ports.

G. Condenser Fan: Direct-drive, metal propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection[**and ball bearings**].

1. Fin Spacing: [**Eight**][**20**][**22**]<**Insert value**> per inch.

H. Accessories:

1. Crankcase heater.
2. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
3. [**Electronic programmable thermostat**][**Low-voltage thermostat and subbase**] to control compressor and condenser unit and evaporator fan.
4. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
5. Filter-dryer.
6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
7. Liquid-line solenoid.
8. Low-Ambient Controller:

   a. Cycles condenser fan to permit operation down to [**30 deg F (minus 1 deg C)**][**0 deg F (minus 18 deg C)**][**with time-delay relay to bypass low-pressure switch**].
   b. Controls condenser fan speed to permit operation down to **minus 20 deg F (minus 29 deg C)**[**with time-delay relay to bypass low-pressure switch**].

9. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
10. Plastic mounting base.
11. Precharged and preinsulated suction and liquid tubing.
12. Sound Hood: Wraps around sound attenuation cover for compressor.
13. Thermostatic expansion valve for installation at evaporator coil.
14. Fixed orifice for installation at evaporator coil.
15. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
16. Reversing valve.
17. <**Insert accessories**>.

I. Unit Casing: Galvanized steel, finished with [**baked enamel**][**baked powder-coat**]; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gauge ports on exterior of casing.

J. Capacities and Characteristics:

1. Compressor and Condenser Unit:

   a. Full-Load Cooling Capacity: <**Insert MBh (kW)**>.
   b. Energy-Efficiency Ratio (EER): <**Insert value**>.
   c. Seasonal Energy-Efficiency Ratio (SEER): <**Insert value**>.
   d. Coefficient of Performance (COP): <**Insert value**>.
   e. Compressor Suction Temperature: <**Insert deg F (deg C)**>.

2. Refrigerant Connections:

   a. Liquid Pipe Size: <**Insert NPS (DN)**>.
   b. Suction Pipe Size: <**Insert NPS (DN)**>.
   c. Connection Type: [**Brazed**][**or**][**flared**].

3. Compressor:

   a. Number of Compressors: <**Insert value**>.
   b. Motor Speed: <**Insert value**>.
   c. Rated-Load Amperes: <**Insert value**> A.
   d. Locked-Rotor Amperes: <**Insert value**> A.
   e. Power Input: <**Insert kilowatts**>.

4. Air-Cooled Condenser:

   a. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
   b. Airflow: <**Insert cfm (L/s)**>.
   c. Number of Condenser Fans: <**Insert number**>.
   d. Condenser Fan Motor Size: <**Insert horsepower**>.

5. Electrical Characteristics:

   a. Kilowatt Input: <**Insert value**>.
   b. Volts: [**208**]<**Insert value**> V.
   c. Phase: [**1**]<**Insert value**>.
   d. Hertz: [**60**]<**Insert value**> Hz.
   e. Maximum Circuit Ampacity: <**Insert value**> A.
   f. Maximum Instantaneous Current Flow during Startup: <**Insert value**>.
   g. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS (21 TO 422 kW)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Engineered Air**]

5. [**Lennox**]
6. [**Trane**]
7. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Engineered Air**]
5. [**Lennox**]
6. [**Trane**]
7. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
8. <**Insert manufacturer's name**>

C. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

D. Compressor:

1. Scroll: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

   a. Capacity Control: [**On-off compressor cycling**][**Hot-gas bypass**].

2. Rotary Screw: Hermetic or semihermetic rotary-screw compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

   a. Capacity Control: [**On-off compressor cycling**][**Modulating slide-valve assembly or port unloaders**][**Variable-frequency controller**][**Hot-gas bypass**].

E. Refrigerant: [**R-407C**][**or**][**R-410A**]<**Insert type**>.

F. Condenser Coil: [**Seamless copper-tube**][**or**][**aluminum microchannel-tube**], aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve.

1. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
2. Provide factory-applied [**baked epoxy**][**phenolic**] anti-corrosion coating to assembled coil.

G. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

1. Permanently lubricated, ball-bearing[**totally enclosed, air-over**] motors.
2. Separate motor for each fan.
3. Dynamically and statically balanced fan assemblies.

H. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.

5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

I. Accessories:

1. [**Electronic programmable thermostat**][**Low-voltage thermostat and subbase**] to control compressor and condenser unit and its associated evaporator fan.
2. Low-Ambient Controller:

   a. Cycles condenser fan to permit operation down to **0 deg F (minus 18 deg C)**[**with time-delay relay to bypass low-pressure switch**].
   b. Controls condenser fan speed to permit operation down to **minus 20 deg F (minus 29 deg C)**[**with time-delay relay to bypass low-pressure switch**].

3. Gauge Panel: Package with refrigerant circuit suction and discharge gauges.
4. Hot-gas bypass kit.
5. Part-winding-start timing relay, circuit breakers, and contactors.
6. Reversing valve.
7. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection. See Section 262816 "Enclosed Switches and Circuit Breakers."
8. Low-noise fans.
9. 115 V ac convenience, ground-fault circuit interrupter receptacle in weatherproof enclosure.
10. Vibration isolation [**resilient**][**spring**] mounts.
11. Security grilles.
12. <**Insert accessories**>.

J. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.

   a. Corrosion Resistance: [**500**][**1000**]<**Insert value**>-hour salt spray test, in accordance with ASTM B117.

2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Condenser coil [**hail guard**][**grille**].

K. Capacities and Characteristics:

1. Compressor and Condenser Unit:

   a. Full-Load Cooling Capacity: <**Insert MBh (kW)**>.
   b. Energy-Efficiency Ratio (EER): <**Insert value**>.
   c. Seasonal Energy-Efficiency Ratio (SEER): <**Insert value**>.
   d. Coefficient of Performance (COP): <**Insert value**>.
   e. Compressor Suction Temperature: <**Insert deg F (deg C)**>.
   f. Capacity Steps: <**Insert number**>.

2. Refrigerant Connections:

   a. Liquid Pipe Size: <**Insert NPS (DN)**>.

b. Suction Pipe Size: <**Insert NPS (DN)**>.

3. Compressors:

a. Number of Compressors: <**Insert number**>.
b. Rated-Load Amperes: <**Insert value**> A.
c. Locked-Rotor Amperes: <**Insert value**> A.
d. Power Input: <**Insert kilowatts**>.

4. Air-Cooled Condenser:

a. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
b. Airflow: <**Insert cfm (L/s)**>.
c. Number of Condenser Fans: <**Insert number**>.
d. Condenser Fan Motor Size: <**Insert horsepower**>.

5. Electrical Characteristics:

a. Kilowatt Input: <**Insert value**>.
b. Volts: <**Insert value**> V.
c. Phase: <**Insert value**>.
d. Hertz: <**Insert value**> Hz.
e. Maximum Circuit Ampacity: <**Insert value**> A.
f. Maximum Instantaneous Current Flow during Startup: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert value**> A.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.5 SOURCE QUALITY CONTROL

A. Performance Ratings: Certify capacity performance ratings of compressor and condenser units in accordance with [**AHRI 210/240**][**AHRI 340/360**].

B. Sound-Power Level Ratings: Factory test sound-power-level ratings in accordance with [**AHRI 270**][**AHRI 370**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections

before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

C. Install roof-mounting units on [**steel dunnage**][**access platform**] specified in Section 051200 "Structural Steel Framing" or Section 055000 Metal Fabrications, or on equipment supports specified in Section 077200 "Roof Accessories."

D. Equipment Mounting:

1. Install compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-In-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Loose Components: Install piping specialties, electrical components, devices, and accessories that are not factory mounted.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

a. Inspect for physical damage to unit casing.
b. Verify that access doors move freely and are weathertight.
c. Clean units and inspect for construction debris.
d. Verify that all bolts and screws are tight.
e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Start unit in accordance with manufacturer's written instructions and complete manufacturer's startup checklist.

C. Measure and record airflow and air temperature rise over coils.

D. Verify operation of condenser capacity control device.

E. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify manufacturer's required airflow over coils.

D. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.

E. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 23 62 00 00

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Task	Specification	Specification Description
23 62 13 00	23 62 00 00	Packaged Compressor and Condenser Units
23 62 13 00	23 64 13 16	Indirect-Fired Absorption Water Chillers
23 62 23 00	23 62 00 00	Packaged Compressor and Condenser Units

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SECTION 23 63 13 00 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged air-cooled refrigerant condensers.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-cooled refrigerant condenser.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Sustainable Design Submittals:

1. Product Data for EA Credit 4, "Enhanced Refrigerant Management": Indicating that products meet requirements for refrigerant management.
2. Product Data for EA Credit "Enhanced Refrigerant Management": Indicating that products meet requirements for refrigerant management.
3. Product data showing compliance with ASHRAE 90.1.

C. Shop Drawings: For air-cooled refrigerant condensers.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For air-cooled refrigerant condensers indicated, to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: For air-cooled refrigerant condensers, accessories, and components, from

manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. Fabricate and label refrigeration system in accordance with ASHRAE 15 and ASHRAE 34.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis, using performance requirements and design criteria indicated.

E. Seismic Performance: Air-cooled refrigerant condensers are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response**

Modification Factor>.

F. Capacities and Characteristics:

1. Heat-Rejection Capacity: <**Insert MBh (kW)**>.
2. Condensing Temperature:

   a. Saturated Discharge Temperature: <**Insert deg F (deg C)**>.
   b. Saturated Suction Temperature: <**Insert deg F (deg C)**>.
   c. Subcooling Temperature: <**Insert deg F (deg C)**>.

3. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
4. Refrigerant Pipe Connections:

   a. Number of Connections: <**Insert number**>.
   b. Liquid Pipe Size: <**Insert NPS (DN)**>.
   c. Suction Pipe Size: <**Insert NPS (DN)**>.

5. Coils:

   a. Arrangement: <**Insert description**>.
   b. Number of Rows: <**Insert number**>.
   c. Fin Spacing: [**8 fins/inch (3.0 mm)**][**10 fins/inch (2.5 mm)**][**12 fins/inch (2.0 mm)**][**14 fins/inch (1.8 mm)**][**16 fins/inch (1.6 mm)**]<**Insert value**>.
   d. Total Face Area: <**Insert sq. ft. (sq. m)**>.

6. Fans:

   a. Number of Condenser Fans: <**Insert number**>.
   b. Diameter: <**Insert inches (mm)**>.
   c. [**Constant**][**Variable**]-speed.
   d. RPM: <**Insert number**>.
   e. Total Airflow: <**Insert cfm (L/s)**>.
   f. Condenser Fan Motor Size: <**Insert number**> hp.

7. Electrical Characteristics:

   a. Kilowatts: <**Insert number**>.
   b. Volts: <**Insert number**>.
   c. Phase: <**Insert number**>.
   d. Hertz: <**Insert number**>.
   e. Maximum Circuit Ampacity: <**Insert number**> A.
   f. Maximum Instantaneous Current Flow during Startup: <**Insert number**>.
   g. Maximum Overcurrent Protection: <**Insert number**> A.

2.2 PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Heatcraft Refrigeration Products LLC**]
3. [**Trane**]
4. [**USA Coil & Air**]

5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Heatcraft Refrigeration Products LLC**]
3. [**Trane**]
4. [**USA Coil & Air**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain air-cooled refrigerant condensers from single source from single manufacturer.

D. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.

E. Refrigerant: [**R-134A**][**R-404A**][**R-407C**][**or**][**R-410A**]<**Insert type**>.

F. Condenser Coil: Factory tested at **425 psig (2930 kPa)**.

1. Tube: [**1/2-inch- (13-mm-) diameter seamless copper.**][**3/8-inch- (10-mm-) diameter seamless copper.**][**5/8-inch- (16-mm-) diameter seamless copper.**]
2. Coil Fin: [**Aluminum**][**Copper**].
3. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

    a. Enclosure Type: [**Totally enclosed, air-over (TEAO)**][**Open, drip-proof (ODP)**].
    b. Motor Sizes: Minimum size as indicated. If not indicated, large enough, so driven load will not require motor to operate in service factor range above 1.0.
    c. Mount unit-mounted disconnect switches on [**exterior**][**interior**] of unit.
    d. <**Insert unique motor characteristics**>.

4. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for condensers requiring a corrosion-resistant coating.
5. Coating, Coils: [**None**][**Corrosion resistant**].
6. Coating, Fans: [**None**][**Corrosion resistant**].
7. Coating, Casing: [**None**][**Corrosion resistant**].
8. Circuit: To match compressors[**with liquid subcooling coil**].

G. Condenser Fans and Drives:

1. Directly driven propeller fans with [**aluminum or galvanized-steel**][**galvanized-steel**] fan blades, for [**vertical**][**horizontal**] air discharge; manufactured with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
2. Forward-curved centrifugal fans for [**vertical**][**horizontal**] air discharge.

    a. Fan on steel shaft with self-aligning ball bearings.
    b. V-belt drive with minimum of two belts; variable-pitch drive pulley.
    c. Motor mounted on adjustable slide base.

3. Fan Motors:

a. Weather-proof motors with rain shield and shaft slinger.
b. [**Totally enclosed air-over (TEAO)**][**Open-drip proof (ODP)**].
c. [**Constant**][**Variable**] speed.

H. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; [**115-V**][**24-V**] control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.

1. Fan Cycling Control: [**Head pressure switches**][**Head pressure sensors**][**Ambient thermostats**].

I. Casings: [**Galvanized-steel or zinc-coated-steel treated and finished with manufacturer's standard paint coating**][**Aluminum**]<**Insert material**>, designed for outdoor installation with weather protection for components and controls, and with the following:

1. Removable panels for access to controls, condenser fans, motors, and drives.
2. Coating: [**None**][**Corrosion resistant**].
3. [**Vinyl-coated**][**Plated**] steel fan guards.
4. Lifting holes.
5. Removable legs, [**20 inches (500 mm)**][**30 inches (760 mm)**][**36 inches (910 mm)**][**42 inches (1060 mm)**] high.

2.3 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: **ASTM B209 (ASTM B209M)**.

E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**500**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
c. ASTM B3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
4. Gloss: Minimum gloss of 60 on a 60 degree meter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Equipment Mounting:

1. Install air-cooled condenser refrigerant condensers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Refrigerant Piping: Where indicated on Drawings, connect piping to unit with pressure-relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line.

D. Apply labels to refrigerant lines in accordance with Section 230553, "Identification for HVAC Piping and Equipment."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each condenser unit electrical power connection.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.

2. Lubricate bearings on fan motors.
3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
4. Adjust fan belts to proper alignment and tension.
5. Start unit in accordance with manufacturer's written instructions and complete manufacturer's startup checklist.
6. Measure and record airflow and air-temperature rise over coils.
7. Verify proper operation of capacity control device.
8. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
9. After startup and performance test, lubricate bearings.

3.7 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

E. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

F. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION 23 63 13 00

Task	Specification	Specification Description
23 63 13 00	23 62 00 00	Packaged Compressor and Condenser Units
23 63 13 00	23 81 26 00	Split-System Air-Conditioners

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SECTION 23 64 13 16 - INDIRECT-FIRED ABSORPTION WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indirect-fired absorption water chillers.
2. Heat-exchanger, brush-cleaning system.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 560 and referenced to AHRI standard rating conditions.

D. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 560 and intended for operating conditions other than the AHRI standard rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Indirect-fired absorption water chillers.
2. Heat-exchanger, brush-cleaning system.

B. Product Data Submittals: For each type of product. Include rated capacities, operating characteristics, furnished specialties and accessories, and the following:

1. Performance at AHRI standard conditions and at conditions indicated.
2. Performance at AHRI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Absorbent capacity of chiller.
5. Refrigerant capacity of chiller.
6. Liquid capacity of evaporator and condenser.
7. Liquid capacity of generator.
8. Characteristics of safety relief devices.
9. Minimum entering condenser-liquid temperature.
10. Performance at varying capacities with constant design condenser-liquid temperature. Repeat performance at varying capacities for different condenser-liquid temperatures from design to minimum in [**5 deg F (3 deg C)**]<**Insert temperature**> increments.

C. Sustainable Design Submittals:

1. Product Data: For energy performance.

D. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Insulated Surface Diagrams: Indicating cold and hot surfaces requiring field-applied insulation with area tabulated for each.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Startup service reports.

E. Test and inspection startup reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers factory charged with nitrogen.

B. Ship absorbent and refrigerant in chillers or in containers separate from chillers.

C. Ship [**absorbent**][**and**][**refrigerant**] in containers separate from chillers.

D. Package chiller for export shipping in totally enclosed [**bagging**][**crate**][**crate with bagging**].

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller.
b. [**Pumps and motors**][**Purge unit**]<**Insert components**>.
c. [**Absorbent**][**Absorbent and refrigerant**] only.
d. Parts [**only**][**and labor**].
e. Loss of absorbent and refrigerant for any reason.

2. Warranty Period: [**One**][**Two**][**Three**][**Four**][**Five**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain chillers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. AHRI Rating: Rate chiller performance in accordance with requirements in AHRI 560.

B. ASHRAE Compliance:

1. ASHRAE 15 and ASHRAE 34 for safety code for mechanical refrigeration.
2. ASHRAE/IES 90.1.

C. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.

D. Comply with NFPA 70.

E. UL Compliance:

1. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

F. Seismic Performance: Indirect-fired absorption water chillers are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

G. Condenser-Liquid Temperature Performance:

1. Startup Condenser-Liquid Temperature: Provide chiller capable of starting with entering condenser-liquid temperature of [**64 deg F (17.7 deg C)**][**45 deg F (7.2 deg C)**]<**Insert temperature**> and providing stable operation until system temperature is elevated to minimum operating entering condenser-liquid temperature.
2. Minimum Operating Condenser-Liquid Temperature: Provide chiller capable of continuous operation over entire capacity range indicated with an entering condenser-liquid temperature of [**65 deg F (18 deg C)**][**60 deg F (16 deg C)**][**55 deg F (13 deg C)**].
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

H. Site Altitude: Provide chiller suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

I. Performance Tolerance: Comply with following in lieu of AHRI 560:

1. Allowable Capacity Tolerance: [**Zero**]<**Insert number**> percent.
2. Allowable IPLV/NPLV Performance Tolerance: [**Zero**]<**Insert number**> percent.

2.3 CAPACITIES AND CHARACTERISTICS

A. Capacity: <**Insert tons (kW)**>.

B. Full-Load Efficiency (COP): <**Insert number**>.

C. Part-Load Efficiency:

1. IPLV: <**Insert number**>.
2. NPLV: <**Insert number**>.

D. Evaporator:

1. Pressure Rating: [**150 psig (1035 kPa)**][**300 psig (2070 kPa)**]<**Insert number**>.
2. Number of Passes: [**One**][**Two**][**Three**]<**Insert number**>.
3. Liquid Type: [**Water**]<**Insert liquid type**>.
4. Design Liquid Flow Rate: <**Insert gpm (L/s)**>.
5. Minimum Liquid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Liquid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Liquid Temperature: <**Insert deg F (deg C)**>.
8. Liquid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Liquid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000045 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**>.

E. Absorber/Condenser:

1. Pressure Rating: [**150 psig (1035)**][**300 psig (2070)**]<**Insert number**>.
2. Number of Passes: [**One**][**Two**][**Three**].

3. Liquid Type: [**Water**]<**Insert liquid type**>.
4. Design Liquid Flow Rate: <**Insert gpm (L/s)**>.
5. Entering-Liquid Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Liquid Temperature: <**Insert deg F (deg C)**>.
7. Liquid Pressure Drop: <**Insert feet of head (kPa)**>.
8. Liquid Velocity: <**Insert fps (m/s)**>.
9. Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu (0.000045 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**][**0.001 sq. ft. x h x deg F/Btu (0.00022 sq. m x deg C/W)**]<**Insert value**>.

F. Pump Horsepower:

1. Purge: <**Insert number**>.
2. Refrigerant: <**Insert number**>.
3. Solution: <**Insert number**>.

G. Chiller Control Electrical Requirements:

1. Power Input: <**Insert kilowatts**>.
2. Minimum Circuit Ampacity: <**Insert value**> A.
3. Maximum Overcurrent Protection Device: <**Insert value**> A.
4. Characteristics: [**120**]<**Insert number**> V ac, single phase, 60 Hz.

H. Chiller Electrical Requirements:

1. Power Input: <**Insert kilowatts**>.
2. Minimum Circuit Ampacity: <**Insert value**> A.
3. Maximum Overcurrent Protection Device: <**Insert value**> A.
4. Characteristics: [**208**][**240**][**480**]<**Insert number**> V ac, three phase, 60 Hz.

I. Noise Rating: [**38**][**51**][**80**]<**Insert dBA**> sound power level when measured in accordance with AHRI 575. Provide factory-installed sound treatment if necessary to achieve performance indicated.

2.4 INDIRECT-FIRED ABSORPTION WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Trane / Thermax**]
3. [**Yazaki Energy Systems**]
4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Trane / Thermax**]
3. [**Yazaki Energy Systems**]
4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

C. Description: Factory-assembled and -tested, hermetic-design chiller complete with absorber,

evaporator, condenser, generator, solution heat exchanger, controls, absorbent solution pump with motor, refrigerant pump with motor, purge unit with motor, motor controllers, rupture disk, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

1. Disassemble chiller into major assemblies as required for installation, after factory testing and before packaging for shipment.

D. Absorbent and Refrigerant:

1. Absorbent: Lithium bromide solution with corrosion inhibitor.
2. Refrigerant: Deionized [**or**][**distilled**] water.
3. Performance Enhancer: Heat and mass transfer enhancer to improve performance.

E. Seismic Fabrication Requirements: Fabricate mounting base and attachment to chiller, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

F. Pumps:

1. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating tapered carbon bearings.
2. Provide pump motor assembly designed to operate for not less than [**25,000**][**50,000**] hours between inspections.
3. Pump motors cooled, and bearings lubricated, either by liquid being pumped.
4. Provide isolation valves at pump suction and discharge.
5. Provide separate and dedicated pumps for absorbent solution and refrigerant.

    a. Provide chiller manufacturer's recommended absorbent solution and refrigerant flow-control method, to comply with operating requirements indicated.

6. Purge System: Unit mounted and factory wired, equipped with controls and pump to automatically remove noncondensable vapors.

    a. Purge Pump Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

        1) Enclosure: [**Open dripproof**][**or**][**totally enclosed**].

G. Heat-Exchanger Shells:

1. Configuration for Single-Effect Chillers: Two shells; one shell consists of absorber/evaporator and other shell consists of condenser/generator.
2. Configuration for Double-Effect Chillers: Two shells; one shell consists of absorber/evaporator, low-stage generator/condenser and other shell consists of high-stage generator.
3. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.
4. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.
5. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between liquid in tubes and refrigerant in shell.
6. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
7. Generator/Condenser Shell Pressure Relief Device: Manufacturers standard rupture disk

complying with requirements in ASHRAE 15 and ASHRAE 34 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

H. Absorber:

1. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes. Constructed of brass, stainless steel, or another material that will not corrode.
2. Tubes:

   a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
   b. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
   c. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**>.
   d. External Finish: Manufacturer's standard.
   e. Internal Finish: [**Enhanced**][**or**][**smooth**].

3. Water Boxes:

   a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Water Box with Piping Connections: [**Standard**][**Marine**] type.

      1) Water boxes [**and marine water-box covers**]with lifting lugs or eyebolts.
      2) Hinged water boxes.
      3) Hinged marine water-box covers.

   c. Water Box without Piping Connections: Standard type.

      1) Water boxes with lifting lugs or eyebolts.
      2) Hinged water boxes.

   d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
   e. Thermistor or RTD temperature sensor factory installed in each nozzle.
   f. Fit each water box with [**3/4-inch (19-mm)**][**or**][**1-inch (25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

4. Additional Corrosion Protection:

   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
   c. Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with corrosion-resistant finish.

5. Absorber/Condenser Crossover Piping: Factory furnished and installed piping connecting liquid connection of absorber discharge to condenser inlet.

I. Evaporator:

1. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes; constructed of brass, stainless steel, or another material that will not corrode when exposed to absorbent.
2. Refrigerant Holding Pan: Steel or stainless steel.
3. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes, and integrity of tube-tube sheet connections.
b. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
c. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**>.
d. External Finish: Manufacturer's standard.
e. Internal Finish: [**Enhanced**][**or**][**smooth**].

4. Water Boxes:

a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Water Box with Piping Connections: [**Standard**][**Marine**] type.

1) Water boxes [**and marine water-box covers**]with lifting lugs or eyebolts.
2) Hinged water boxes.
3) Hinged marine water-box covers.

c. Water Box without Piping Connections: Standard type.

1) Water boxes with lifting lugs or eyebolts.
2) Hinged water boxes.
3) Hinged marine water-box covers.

d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with [**3/4-inch (19-mm)**][**or**][**1-inch (25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

J. Condenser:

1. Refrigerant Holding Pan: Steel or stainless steel.
2. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
c. Minimum Wall Thickness: [**Manufacturer's choice**]<**Insert inches (mm)**>.
d. External Finish: Manufacturer's standard.
e. Internal Finish: [**Enhanced**][**or**][**smooth**].

3. Water Boxes:

a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Water Box with Piping Connections. [**Standard**][**Marine**] type.

1) Water boxes [**and marine water-box covers**]with lifting lugs or eyebolts.
2) Hinged water boxes.
3) Hinged marine water-box covers.

c. Water Box without Piping Connections: Standard type.

1) Water boxes with lifting lugs or eyebolts.
2) Hinged water boxes.
3) Hinged marine water-box covers.

d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with [**3/4-inch (19-mm)**][**or**][**1-inch (25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

4. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
c. Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with corrosion-resistant finish.

K. Generator for Single-Effect Chillers:

1. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: [**06/11 copper-nickel alloy**][**Stainless steel**][**Titanium**][**06/11 copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
c. Minimum Wall Thickness: [**Manufacturer's choice**][**0.035 inch (0.9 mm)**]<**Insert dimension**>.
d. External Finish: Manufacturer's standard.
e. Internal Finish: [**Enhanced**][**or**][**smooth**].

2. Water Boxes:

a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard type.
c. Provide water boxes with lifting lugs or eyebolts.
d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with [**3/4-inch (19-mm)**][**or**][**1-inch (25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

3. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
c. Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

L. First-Stage Generator for Double-Effect Chillers:

1. Tubes:

a. Replaceable, straight, or U tubes expanded into tube sheets.
b. Material: [**Manufacturer's standard**][**06/11 copper-nickel alloy**][**Type 409 stainless steel**][**Titanium**][**06/11 copper-nickel alloy, Type 409 stainless steel**]<**Insert material**>.
c. Minimum Wall Thickness: [**Manufacturer's choice**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**>.
d. External Finish: Manufacturer's standard.
e. Internal Finish: [**Enhanced**][**or**][**smooth**].

2. Water Boxes:

a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard type.
c. Provide water boxes with lifting lugs or eyebolts.
d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

3. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode.
b. Coat wetted surfaces with a corrosion-resistant finish.
c. Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

M. Second-Stage Generator for Double-Effect Chillers:

1. Tubes:

a. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
b. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**][**Stainless steel**][**Titanium**]<**Insert material**>.
c. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**>.
d. External Finish: Manufacturer's standard.
e. Internal Finish: [**Enhanced**][**or**][**smooth**].

2. Water Boxes:

a. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Standard type.
c. Provide water boxes with lifting lugs or eyebolts.
d. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
e. Thermistor or RTD temperature sensor factory installed in each nozzle.
f. Fit each water box with [**3/4-inch (19-mm)**][**or**][**1-inch (25-mm)**]<**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

3. Additional Corrosion Protection:

   a. Electrolytic corrosion-inhibitor anode.
   b. Coat wetted surfaces with a corrosion-resistant finish.
   c. Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

N. Solution Heat Exchanger:

1. Description: Shell-and-tube or brazed-plate heat exchanger; integral part of chiller to increase cycle efficiency by preheating weak solution on its way to generator while precooling strong solution returning from generator.

O. Steam Condensate Drain Cooler:

1. Description: Shell-and-tube heat exchanger constructed of carbon-steel shell and copper-nickel-alloy or stainless steel tubes.

P. Factory-Applied Insulation:

1. Factory-Applied Insulation on Cold Surfaces:

   a. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tube and Type II for sheet materials.

      1) Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38mm)**]<**Insert dimension**>.

   b. Adhesive: As recommended by insulation manufacturer.
   c. Factory apply insulation over all cold surfaces of chiller capable of forming condensation. Insulated components include, but are not limited to, evaporator shell and end tube sheets; evaporator water boxes including nozzles; refrigerant pump; cold surfaces of motor; and cold piping.

      1) Apply adhesive to 100 percent of insulation contact surface.
      2) Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
      3) Seal seams and joints to provide a vapor barrier.
      4) After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2. Factory-Applied Insulation on Hot Surfaces:

   a. Mineral-fiber board, pipe, or tank insulation complying with one of the following:

      1) ASTM C547, Type I or Type II, Grade A.
      2) ASTM C612, Type IB.
      3) ASTM C1393, Type II or Type IIIA, Category 2.
      4) Thickness: [**1-1/2 inches (38 mm)**][**2 inches (50mm)**]<**Insert dimension**>.

   b. Adhesive: As recommended by insulation manufacturer.
   c. Factory apply materials over all hot surfaces to provide smooth, straight, and even surfaces; free of voids.

      1) Apply adhesive to insulation contact surface as recommended by insulation manufacturer.
      2) Install insulation anchor pins and washers if required by insulation manufacturer to

secure insulation to surfaces to be insulated.

3) Completely encapsulate insulation with metal jacket, leaving no exposed insulation. Provide removable jacket on components requiring access for service and inspection.

4) Paint exposed surfaces of metal jacket to match other painted parts unless jacket material is aluminum or stainless steel.

Q. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Provide devices with minimum withstand rating as required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert number**> A.

   a. Branch power circuit to each motor, dedicated electrical load, and controls[**with disconnect switch or circuit breaker**].

      1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.

      2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

   b. NEMA ICS 2, Class A, full-voltage, nonreversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.

   c. Control-circuit transformer with primary and secondary side fuses.

3. Terminal blocks with numbered [**and color-coded**]wiring to match wiring diagram. Include spare wiring terminal block for connection to external controls or equipment.
4. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than a **24-inch (610-mm)** length of [**liquidtight**][**or**][**flexible metallic**] conduit. Coordinate conduit requirements with requirements in Section 260533.13 "Conduits for Electrical Systems."

R. Controls:

1. Control: Standalone and microprocessor based, with programs and configuration settings stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Type 4x**]<**Insert type**>, hinged or lockable.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. Display following information in either imperial or metric units selectable through interface.

   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outdoor-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled and condenser water.
   g. Refrigerant temperature.
   h. Solution concentration and temperature.
   i. Indication of solution and purge-pump operation.
   j. Generator shell pressure.
   k. Number of starts.

l. Number of purge cycles.
m. Hot-water valve actuator potentiometer position (percentage).
n. Entering and leaving hot-water temperatures.
o. Steam demand limit.
p. Inlet steam pressure and temperature.
q. Steam valve actuator potentiometer position (percentage).
r. First-stage generator pressure and temperature.
s. <**Insert status display items**>.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Automatic cycle to prevent crystallization.
c. Entering and leaving chilled-water temperatures and control set points. Reset chilled-water temperature based on [**return-water**][**outdoor-air**][**space**] temperature.
d. Condenser-liquid temperature.
e. Measure and record cooling provided and heating energy used within programmable time periods, minimum monthly.
f. <**Insert control functions**>.

5. Capacity Control: Automatically controls input flow rate of heat source to maintain chilled-water temperature set point for cooling loads ranging from 10 to 100 percent.
6. Control Valve Package: [**Factory-furnished, for field installation,**][**Factory-installed**] control valve package suitable for energy source indicated.

a. Body: Cast-iron, carbon-steel, or stainless steel body with flanged connections.
b. Type: [**Manufacturer's choice**][**V-notch ball**][**Butterfly**][**Globe style with cage-guide plug**]<**Insert type**> constructed of stainless steel.
c. Rating: Pressure and temperature rating to match heat exchanger.
d. Shutoff: Capable of bubble-tight shutoff against maximum system pressure.
e. Size: Determined by chiller manufacturer.
f. Modulation: [**Two**][**Three**] way.
g. Turndown: As required to achieve stable control through indicated operating range.
h. Actuator: Electric powered from chiller control panel and installed on valve.

7. Safety Shutdowns: To automatically shut down chiller and require manual reset before restart. Display message following each safety shutdown.

a. Crystallization.
b. Low refrigerant temperature.
c. Loss of chilled- or condenser-water flow.
d. Low leaving chilled-water temperature[**, 2 deg F (1 deg C) below set point**].
e. First-stage generator low-solution level.
f. First-stage generator high temperature or pressure.
g. Power failure.
h. Solution pump overloads.
i. External auxiliary safety shutdown.
j. High solution concentration.
k. Incomplete dilution cycle.
l. High entering-water temperature.
m. High inlet steam pressure and temperature.
n. <**Insert conditions**>.

8. Warning Conditions: Provide control panel that closes warning contacts and generates message when one of the following operating conditions is detected:

a. Low refrigerant temperature.
b. High generator temperature or pressure.
c. High entering generator-water temperature (single-stage generator only).
d. High or low entering condenser-water temperature.
e. Solution temperature sensor failure.
f. Low chilled-water flow.
g. <**Insert warning conditions**>.

9. Trending: Capability to trend analog data up to five parameters simultaneously over adjustable period and frequency of polling.
10. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
11. Control Authority: At least four conditions: off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
12. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting printer [**or**][**electronic monitoring device**].
13. BAS Interface: Factory-installed hardware and software to enable BAS to monitor, control, and display chiller status and alarms.

    a. Hardwired Points:

        1) Monitoring: On-off status, [**common trouble alarm**]<**Insert monitoring point**>.
        2) Control: On-off operation, [**chilled-water, discharge temperature set-point adjustment**][**generator heat source capacity limiting**]<**Insert control point**>.

    b. Provide [**ASHRAE 135 (BACnet)**][**LonTalk**][**Modbus**]<**Insert type of interface**> communication interface with BAS to enable BAS operator to control and monitor chiller from remote operator workstation. Provide for control features and monitoring points displayed locally at chiller control panel to be available through BAS.

S. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

    a. Provide at least one coat of primer with a total dry film thickness of at least **2 mils (0.05 mm)**.
    b. Provide at least two coats of [**alkyd-modified, vinyl enamel**][**epoxy**][**polyurethane**] finish with a total dry film thickness of at least **4 mils (0.10 mm)**.
    c. Paint surfaces that are to be insulated before applying insulation.
    d. Paint installed insulation to match adjacent uninsulated surfaces.
    e. Color of finish coat to be [**manufacturer's standard**][**custom color selected by Architect**]<**Insert color description**>.

2. Furnish Owner with quart container of paint used in application of topcoat to use in touchup applications after Project closeout.

T. Accessories:

1. Sight Glasses: Equip unit with sight glasses for visual inspection of absorbent solution and refrigerant levels. Provide at least one sight glass in absorber and evaporator sections.
2. Flow Switches:

    a. Furnish chiller-manufacturer-supplied hall flow switch for each [**condenser**][**evaporator**

and condenser] and verify field-mounting location before installation.

b. Paddle Flow Switches:

1) Vane operated to actuate double-pole, double-throw switch with one pole field wired to chiller control panel and other pole field wired to BAS.
2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120 V ac.
3) Pressure rating equal to pressure rating of heat exchanger.
4) Construct body and wetted parts of Type 316 stainless steel.
5) House switch in a NEMA 250, [**Type 4**]<**Insert type**> enclosure constructed of die-cast aluminum.
6) Vane length to suit installation.

c. Pressure Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch suitable to withstand, without damage, full-pressure rating of heat exchanger applied to either port and exhibit no set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, [**Type 4**]<**Insert type**>.
6) Switch Action: Double-pole, double-throw switch with one pole field wired to chiller control panel and other pole field wired to BAS.

3. Vibration Isolation:

a. Chiller-manufacturer-furnished, neoprene-pad vibration isolation for each chiller.

1) Two layers of **0.375-inch- (10-mm-)** thick, ribbed- or waffle-pattern neoprene pads separated by 16-gauge, stainless steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless steel square bearing plate to load pad uniformly between **20 and 40 psi (138 and 276 kPa)** with **0.12- to 0.16-inch (3- to 4-mm)** deflection.

2.5 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Provide brush-cleaning system on each chiller [**condenser**]<**Insert heat exchanger**> for tube cleaning and improved heat transfer.

B. Cleaning system to maintain tube fouling at or below design conditions without interrupting normal equipment operation.

C. System consisting of brush inserted in each tube and catch basket attached to each end of tube. Four-way valve to reverse direction of water flow to push brush through tube while removing tube deposits. Control four-way reversing valve's actuator by preset time cycle that provides regular tube brushing during equipment operation. Program frequency of brushing cycle to match Project requirements.

D. Components:

1. Brush: Each brush with nylon bristles, titanium wires, and polypropylene tips. Select brush interference fit with ID of tube not exceeding **0.025 inch (0.6 mm)**.
2. Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design to allow for insertion of eddy current probe or removal of brushes without removing baskets from valve.
3. Four-Way Valve:

a. Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
b. Configure valve with parallel flow connections to minimize field installation piping.
c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
d. Provide flanged pipe connections.
e. Valve manufacturer to test and certify maximum leakage rate of less than 0.05 percent of design flow rate at operation conditions of maximum differential pressure.
f. Hydrostatically test to 1.5 times design working pressure.
g. Design valve to cause no more than **0.5-psig (3-kPa)** pressure drop at design flow conditions.
h. Provide valve with valve-mounted indicating/warning light, that energizes before valve begins rotation.
i. Valve Actuator, Electric: Provide actuator to operate valve. Coordinate actuator power and signal requirements with control system and valve operating requirements.
j. Valve Actuator, Pneumatic: Mount pneumatic piston-type actuator to operate valve. Actuator is suitable for operation using field-supplied air pressure.
k. Position Switches: Factory mount microswitches on valve to indicate complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount control panel including the following features on chiller:

a. NEMA 250, [**Type 1**][**Type 4**][**Type 4x**][**Type 12**] enclosure.
b. Timer to automatically initiate cleaning cycle over a 24-hour period.
c. Manual override of preset cleaning cycle.
d. Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating slow turn or incomplete valve turn.
e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in control panel.
f. Flow-switch bypass.
g. Unloading signal to chiller.

2.6 SOURCE QUALITY CONTROL

A. Perform functional [**run**]tests of chillers before shipping.

B. Factory test and inspect absorber, generator, evaporator, and condenser in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times rated pressure. Vacuum and pressure test shells for leaks.

C. Factory Performance Testing: Test chillers, before shipping, in accordance with AHRI 560.

1. Test the following conditions:

a. Design conditions indicated.
b. Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with condenser liquid at design conditions.
c. Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with varying entering condenser-liquid temperature from design to minimum conditions in [**5 deg F (3 deg C)**]<**Insert temperature**> increments.
d. At [**one**][**two**][**three**][**four**][**five**][**10**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

D. Factory Sound Testing: Test chillers, before shipping, in accordance with AHRI 575.

1. Test the following conditions:

    a. Design conditions indicated.
    b. Chiller operating at calculated worst-case sound condition.
    c. At [**one**][**two**][**three**][**four**][**five**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

E. Allow [**Owner**]<**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**]<**Insert number**> days in advance of testing.

F. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDIRECT-FIRED ABSORPTION WATER CHILLERS

A. Install chillers on support structure indicated.

B. Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with absorbent and refrigerant if not factory charged.

E. Install separate devices furnished by manufacturer and not factory installed.

F. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated, and are not factory insulated. Comply with requirements in Section 230716 "HVAC Equipment Insulation."

3.3 INSTALLATION OF HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Install brush-cleaning system control panel adjacent to chiller control panel.

B. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.

C. Provide field electric power, as required, to each system control panel and electric actuated valve.

D. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.

E. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.

F. Functionally test entire brush-cleaning system, including valve, actuator, position indicator, and control panel, with chiller in operation.

3.4 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for hydronic piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties" for steam and condensate piping. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chiller, allow space for service and maintenance.

D. Generator Steam Piping Connections:

1. Connect steam piping with trapped drip leg, gate valve, strainer, control valve, and pressure gauge. Install pressure reducing valve and safety relief valve upstream from steam-control valve to protect control valve from excessive steam pressure. Make connections to chiller with [**flange**][**or**][**union**].
2. Connect steam condensate piping with vacuum breaker, trapped drip leg, gate valve, strainer, float and thermostatic trap(s), [**condensate cooler,**][**condensate receiver,**][**condensate receiver and pump,**] and check valve. Make connections to chiller with [**flange**][**or**][**union**].

E. Generator Hot-Water Connections: Connect to generator inlet with shutoff valve, [**strainer,**][**flexible connector,**] control valve, thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to generator outlet with shutoff valve, check valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**][**or**][**mechanical coupling**].

F. Evaporator-Liquid Connections: Connect to evaporator inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**][**or**][**mechanical coupling**].

G. Absorber/Condenser-Liquid Connections: Connect to inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**][**or**][**mechanical coupling**].

1. If not factory furnished or installed, provide pipe connecting liquid connection of absorber discharge and condenser inlet.

H. Refrigerant Pressure Relief Device Connections: Extend [**vent piping**][**separate vent piping for each chiller**] to outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

I. Extend [**purge vent piping**][**separate purge vent piping for each chiller**] to outdoors. Comply with ASHRAE 15.

J. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.5 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished with chiller but not factory mounted.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

2. Operate chiller for run-in period.
3. Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.
4. Verify that pumps are installed and functional.
5. Verify that thermometers and gauges are installed.
6. Verify that refrigerant pressure relief device is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.
9. Verify and record performance of liquid flow and low-temperature interlocks for evaporator and condenser.
10. Verify and record performance of chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
12. <**Insert startup steps if any**>.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Absorption water chillers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain chillers.[**Video record training sessions.**]

END OF SECTION 23 64 13 16

SECTION 23 64 16 00 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal water chillers.
2. Packaged refrigerant-recovery units.
3. Heat-exchanger, brush-cleaning system.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 284400 "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

1.2 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input, using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated in accordance with the method defined by **AHRI 550/590** **(AHRI 551/591)** and referenced to AHRI standard rating conditions.

E. kVAR: Kilovolt-ampere reactive.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated in accordance with the method defined by **AHRI 550/590** **(AHRI 551/591)** and intended for operating conditions other than the AHRI standard rating conditions.

G. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.

5. Minimum condenser[**and heat-reclaim condenser**] flow rate.
6. Refrigerant capacity of chiller.
7. Oil capacity of chiller.
8. Fluid capacity of evaporator, condenser[**, and heat-reclaim condenser**].
9. Characteristics of safety relief valves.
10. Minimum entering condenser-fluid temperature.
11. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in [**5 deg F (3 deg C)**]<**Insert temperature**> increments.
12. Force and moment capacity of each piping connection.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Product data indicating compliance with ASHRAE/IES 90.1.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Certifications: For chillers.

D. Field quality-control reports.

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are pre-recorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tool Kit:

1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size must be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size must be at least **1/2 inch (13 mm)** high.

B. Touchup Paint: [**32-oz. (1-L)**]<**Insert volume**> container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.

1. Ship oil [**factory installed in chiller**][**in containers separate from chiller**].

D. Package chiller for export shipping in totally enclosed [**bagging**][**crate**][**crate with bagging**].

1.8 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace chillers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Complete chiller, including refrigerant and oil charge.
b. Complete compressor and drive assembly, including refrigerant and oil charge.
c. Refrigerant[**and oil**] charge.

1) Loss of refrigerant charge for any reason due to manufacturer product defect and product installation.

d. Parts [**only**][**and labor**].

2. Warranty Period: [**Two**][**Three**][**Four**][**Five**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain centrifugal chillers from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Centrifugal chillers are to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria,

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller is to be capable of starting with an entering condenser-fluid temperature of [**60 deg F (16 deg C)**][**55 deg F (13 deg C)**][**40 deg F (4 deg C)**]<**Insert temperature**> and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller is to be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of [**65 deg F (18 deg C)**][**60 deg F (16 deg C)**][**55 deg F (13 deg C)**].
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

C. Site Altitude: Chiller is to be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

D. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
3. ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-513A, R-515B, or R-1234ze(E) refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Comply with requirements of UL Standards & Engagement Inc., and include label by a qualified testing agency showing compliance.

H. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system are to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

I. Outdoor Installations:

1. Chiller must be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**]<**Insert number**>-year period, with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers are equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**]<**Insert number**>-year period.

2.3 CAPACITIES AND CHARACTERISTICS

A. Capacity: <**Insert tons (kW)**>.

B. Full-Load Efficiency:

1. COP: <**Insert value**>.
2. EER: <**Insert value**>.
3. Power Input/Cooling Output: <**Insert kW/ton (kW/kW)**>.
4. Comply with FEMP.

C. Part-Load Efficiency:

1. IPLV: <**Insert value**>.
2. NPLV: <**Insert value**>.
3. Comply with FEMP.

D. Evaporator:

1. Pressure Rating: <**Insert psig (kPa)**>.
2. Number of Passes: [**One**][**Two**][**Three**].
3. Fluid Type: [**Water**]<**Insert fluid type**>.
4. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.
5. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid-Pressure Drop: <**Insert feet of head (kPa)**>.
9. Fluid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**>.

E. Condenser:

1. Pressure Rating: <**Insert psig (kPa)**>.
2. Number of Passes: [**One**][**Two**][**Three**].
3. Fluid Type: [**Water**]<**Insert fluid type**>.

4. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.
5. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid-Pressure Drop: <**Insert feet of head (kPa)**>.
9. Fluid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**][**0.001 sq. ft. x h x deg F/Btu (0.00022 sq. m x deg C/W)**]<**Insert value**>.

F. Heat-Reclaim Condenser:

1. Pressure Rating: <**Insert psig (kPa)**>.
2. Number of Passes: [**One**][**Two**][**Three**].
3. Fluid Type: [**Water**]<**Insert fluid type**>.
4. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.
5. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid-Pressure Drop: <**Insert feet of head (kPa)**>.
9. Fluid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**>.

G. Compressor:

1. Number of Compressors: [**One**][**Two**]<**Insert number**>.
2. [**First**]Compressor Rated-Load Amperes: <**Insert number**> A.
3. [**First**]Compressor Locked-Rotor Amperes: <**Insert number**> A.
4. Second Compressor Rated-Load Amperes: <**Insert number**> A.
5. Second Compressor Locked-Rotor Amperes: <**Insert number**> A.

H. Chiller Control Electrical Requirements:

1. Power Connections: [**Integral**][**Field**].
2. Power Input: <**Insert number**> kW.
3. Minimum Circuit Ampacity: <**Insert number**> A.
4. Maximum Overcurrent Protection Device: <**Insert number**> A.
5. Volts: [**120**]<**Insert number**> V ac.
6. Phase: [**Single**][**Three**].
7. Hertz: 60.

I. Chiller Electrical Requirements:

1. Power Input: <**Insert number**> kW.
2. Power Factor: [**0.90**][**0.95**]<**Insert value**>.
3. Minimum Circuit Ampacity: <**Insert number**> A.
4. Maximum Overcurrent Protection Device: <**Insert number**> A.
5. Volts: [**208**][**240**][**480**][**600**][**2300**][**4160**]<**Insert number**> V ac.
6. Phase: Three.
7. Hertz: 60.

J. Noise Rating: [**85**]<**Insert number**> dBA sound power level when measured in accordance with AHRI 575. Provide factory-installed sound treatment if necessary to achieve performance indicated.

2.4 CENTRIFUGAL WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Trane**]
4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Trane**]
4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. <**Insert manufacturer's name**>

C. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller,[**lubrication system**] evaporator, condenser,[**heat-reclaim condenser as indicated,**] controls, interconnecting unit piping and wiring, and indicated accessories.

1. Multi-Piece Assembly: Disassemble chiller into major assemblies as required by the installation after factory testing[**and before packaging for shipment**].
2. Dual-Compressor Chillers: For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails.

D. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

E. Compressor-Drive Assembly: Single-stage or multistage, variable- or dynamic-displacement, centrifugal-type compressor driven by an electric motor.

1. Oil-Free Technology:

a. [**Where indicated, compressors**][**Compressors**] must have oil-free technology.
b. [**Where indicated, compressors**][**Compressors**] must have oil-free technology using a permanent magnet synchronous motor, magnetic bearings, integral variable-frequency controller, and digital electronic controls.

1) Magnetic Bearings or Roller Element Bearings:

a) Levitated shaft position is to be actively controlled and monitored by an X-, Y-, and Z-axis digital position sensor.
b) Compressor assembly is to be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.

2) Integrate monitoring and controls associated with magnetic bearings into chiller controls, including following:

a) Operating Information: Positions, currents, temperatures, rotor elongation,

and speed.
b) Warning Messages: Vibration.
c) Safety Shutdown: Internal fault, high bearing temperature or current, startup failure, speed signal fault, overspeed fault, communication error, rotor elongation, oscillator fault, rotor contraction, unauthorized rotation, and high and low voltage.
d) Cycling Shutdown: Position, low-frequency displacement, vibration, speed signal fault, startup failure, serial communications fault.

2. Compressor:

a. Casing: Cast iron, precision ground.
b. Impeller: High-strength cast-aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

3. Drive: [**Direct-drive, hermetic**][**Gear-drive, hermetic**][**Gear-drive, open**][**Direct- or gear-drive, hermetic**][**Direct- or gear-drive, open or hermetic**] design, using an electric motor as the driver.

a. Gear Drives:

1) For chillers with oil-lubricated gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating.
2) For chillers with oil-free technology, gear drives are to be of single- or double-helical gear design without the need for oil while chiller is operating, starting, and stopping.
3) Gears must comply with American Gear Manufacturer Association standards.

b. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
c. Seals: Seal drive assembly to prevent refrigerant leakage.

4. Compressor Motor:

a. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
b. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
c. Motor is to be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
d. For chillers with open drives, provide motor with [**open-dripproof**][**weather-protected, Type I**][**weather-protected, Type II**][**totally enclosed**] enclosure.
e. Provide motor with thermistor or RTD in [**single motor winding**][**each of three-phase motor windings**] to monitor temperature and report information to chiller control panel.
f. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
g. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

5. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

a. Overspeed Test: At least [**20**][**25**] percent above design operating speed.
b. Vibration Limits: Velocities not to exceed **0.15 inch/s (3.8 mm/s)** and **0.8 mil (0.02 mm)** peak to peak on all axes.

6. Service: Easily accessible for inspection and service.

a. Compressor's internal components are to be accessible without having to remove compressor-drive assembly from chiller.
b. Provide lifting lugs or eyebolts attached to casing.

7. Economizers: For multistage chillers, provide interstage economizers.
8. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

a. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
b. Operating Range: From 100 to [**15**][**10**][**5**][**zero**]<**Insert number**> percent of design capacity.
c. Condenser-Fluid Unloading Requirements over Operating Range: [**Constant-design of entering condenser-fluid temperature**][**Drop-in entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) for each 10 percent in capacity reduction**]<**Insert conditions**>.
d. Chillers with variable-frequency controllers must modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
e. Avoid use of hot-gas bypass if other options are available to achieve performance indicated. Apply hot-gas bypass in accordance with ASHRAE/IES 90.1 and governing codes.

9. Oil Lubrication System: Consisting of pump, filtration,[**heater,**] cooler, factory-wired power connection, and controls.

a. Bearings, gears, and other rotating surfaces are to be lubricated at all operating, startup, coast down, and standby conditions, including power failure.
b. [**Manufacturer's standard method**][**Thermostatically controlled oil heater properly sized**] to remove refrigerant from oil.
c. [**Oil filter**][**Dual oil filters, one redundant,**] to be the easily replaceable cartridge type, minimum [**0.3**][**0.5**]-micron efficiency, with means of positive isolation while servicing.
d. [**Refrigerant**][**Water**][**Refrigerant- or water**]-cooled oil cooler.
e. Factory-installed and pressure-tested piping with isolation valves and accessories.
f. Oil compatible with refrigerant and chiller components.
g. Positive visual indication of oil level.

F. Refrigeration:

1. Refrigerant:

a. Type: [**R-513A; ASHRAE 34, Class A1**][**R-514A; ASHRAE 34, Class B1**][**R-515B; ASHRAE 34, Class A1**][**R-1233zd(E); ASHRAE 34, Class A1**][**R-1234ze(E); ASHRAE 34, Class A2L**].
b. Compatibility: Chiller parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.

2. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
3. Pressure Relief Device:

a. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
b. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
c. Where dual pressure relief devices are installed in series, provide a sensor with indicator between devices to indicate refrigerant release past first device.

d. For Chillers Using R-514A or R-1233zd(E): [**Manufacturer's standard offering complying with ASHRAE 15 and ASHRAE 147**][**Rupture disc constructed of frangible carbon**][**or**][**spring-loaded, pressure relief valve; single- or multiple-reseating type**].
e. For Chillers Using R-513A, R-515B, or R-1234ze(E): ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Provide pressure relief valve(s) for each chiller heat exchanger. Provide condenser with dual valves, one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

4. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
5. Refrigerant Isolation for Chillers Using R-513A, R-515B, or R-1234ze(E):

a. Factory install[**positive shutoff, manual**] isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.
b. Suction side of compressor from evaporator is to have an isolation valve to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

6. Purge System:

a. For chillers operating at subatmospheric pressures[**using R-514A or R-1233zd(E) refrigerant**], factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables, including, but not limited to, water, water vapor, and noncondensable gases.
b. System is to be of thermal purge design, refrigerant or air cooled, and equipped with a carbon filter that includes an automatic regeneration cycle.
c. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
d. Construct components of noncorrodible materials.
e. Controls are to interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
f. Efficiency of not more than **0.02 lb of refrigerant per pound of air (9 g of refrigerant per gram of air)** when rated in accordance with AHRI 580.
g. Operation independent of chiller in accordance with ASHRAE 147.

7. Positive-Pressure System:

a. For chillers operating at subatmospheric pressures using [**R-514A**][**or**][**R-1233zd(E)**] refrigerant, factory install an automatic positive-pressure system.
b. During nonoperational periods, positive-pressure system is to automatically maintain a positive pressure for atmosphere in the refrigerant-pressure vessel of not less than **0.5 psig (3 kPa)** adjustable up to a pressure that remains within the vessel design pressure limits.
c. Provide factory-wired system including controller, electric heat, pressure transmitter, or switch.

G. Evaporator:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent liquid refrigerant carryover from entering compressor.
4. Evaporator must have sight glass or other form of positive visual verification of liquid-refrigerant level.

5. Tubes:

    a. Individually replaceable from either end and without damage to tube sheets and other tubes.
    b. Mechanically expanded into end sheets and[**physically attached to**] intermediate tube sheets.
    c. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
    d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**].
    e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert value**>.
    f. External Finish: Manufacturer's standard.
    g. Internal Finish: [**Enhanced**][**Smooth**][**Enhanced or smooth**].

6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear[**, but not more than 4 ft. (1.2 m) apart**].
8. Water Box:

    a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
    b. [**Standard**][**Marine**] type for water box with piping connections; standard type for water box without piping connections.
    c. Provide water boxes[**and marine water-box covers**] with lifting lugs or eyebolts.
    d. [**Hinged**][**Davited**][**Hinged or davited**] water boxes.
    e. [**Hinged**][**Davited**][**Hinged or davited**] marine water-box covers.
    f. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
    g. Thermistor or RTD temperature sensor factory installed in each nozzle.
    h. Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert size**> drain connection at low point and vent connection at high point, each with threaded plug.

9. Additional Corrosion Protection:

    a. Electrolytic corrosion-inhibitor anode, [**zinc**][**or**][**magnesium**].
    b. Coat wetted surfaces with a corrosion-resistant finish.
    c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

10. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

H. Condenser:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is to be separate from evaporator.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Condenser is to have sight glass or other form of positive visual verification of refrigerant charge and condition.
5. Tubes:

a. Individually replaceable from either end and without damage to tube sheets and other tubes.
b. Mechanically expanded into end sheets and[**physically attached to**] intermediate tube sheets.
c. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**].
e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert value**>.
f. External Finish: Manufacturer's standard.
g. Internal Finish: [**Enhanced**][**Smooth**][**Enhanced or smooth**].

6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear[**, but not more than 4 ft. (1.2 m) apart**].
8. Water Box:

a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. [**Standard**][**Marine**] type for water box with piping connections. Standard type for water box without piping connections.
c. Water boxes[**and marine water-box covers**] are to have lifting lugs or eyebolts.
d. [**Hinged**][**Davited**][**Hinged or davited**] water boxes.
e. [**Hinged**][**Davited**][**Hinged or davited**] marine water-box covers.
f. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
g. Thermistor or RTD temperature sensor factory installed in each nozzle.
h. Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert size**> drain connection at low point and vent connection at high point, each with threaded plug.

9. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode, [**zinc**][**or**][**magnesium**].
b. Coat wetted surfaces with a corrosion-resistant finish.
c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

10. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

I. Heat-Reclaim Condenser:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Tubes:

a. Individually replaceable from either end and without damage to tube sheets and other tubes.

b. Mechanically expanded into end sheets and[**physically attached to**] intermediate tube sheets.
c. Material: [**Copper**][**Copper-nickel alloy**][**Stainless steel**][**Titanium**][**Copper, copper-nickel alloy, stainless steel, or titanium**]<**Insert material**>.
d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**].
e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert value**>.
f. External Finish: Manufacturer's standard.
g. Internal Finish: [**Enhanced**][**Smooth**][**Enhanced or smooth**].

5. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
6. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear[**, but not more than 4 ft. (1.2 m) apart**].
7. Water Box:

a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. [**Standard**][**Marine**] type for water box with piping connections; standard type for water box without piping connections.
c. Water boxes[**and marine water-box covers**] are to have lifting lugs or eyebolts.
d. [**Hinged**][**Davited**][**Hinged or davited**] water boxes.
e. [**Hinged**][**Davited**][**Hinged or davited**] marine water-box covers.
f. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**].
g. Thermistor or RTD temperature sensor factory installed in each nozzle.
h. Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert size**> drain connection at low point and vent connection at high point, each with threaded plug.

8. Additional Corrosion Protection:

a. Electrolytic corrosion-inhibitor anode, [**zinc**][**or**][**magnesium**].
b. Coat wetted surfaces with a corrosion-resistant finish.
c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

9. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

J. Insulation:

1. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C534, Type I for tubular materials and Type II for sheet materials.

a. Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**]<**Insert value**>.

2. Adhesive: As recommended by insulation manufacturer.
3. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components include, but are not limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

a. Apply adhesive to 100 percent of insulation contact surface.

b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
c. Seal seams and joints to provide a vapor barrier.
d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
e. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
f. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

4. Field-Applied Insulation:

a. Components that are not factory insulated are to be field insulated to comply with requirements indicated.
b. Manufacturer must be responsible for chiller insulation whether factory or field installed, to ensure manufacturer is the single point of responsibility for chillers.
c. Manufacturer factory-authorized service representative is to instruct and supervise installation of field-applied insulation.
d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

K. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**]. Minimum SCCR in accordance with UL 508 is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.

a. Branch power circuit to each motor, electric heater, dedicated electrical load, and control, with [**circuit breaker**][**or**][**disconnect switch**] having SCCR to match main disconnecting means.

1) NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

b. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller for each variable-speed motor furnished.
c. Control-circuit transformer with primary and secondary side fuses.

3. Terminal blocks with numbered[**and color-coded**] wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Factory-installed wiring located outside of enclosures is to be installed in metal raceway. Provide terminal connections with not more than a **24-inch (610-mm)** length of [**liquidtight**][**flexible metallic**][**liquidtight or flexible metallic**] conduit.
5. Factory install and wire capacitor bank for the purpose of power factor correction to [**0.95**]<**Insert value**> at [**full load**][**all operating conditions**].

a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as that for motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
b. Capacitors are to be of non-PCB dielectric fluid, metallized electrode design, with low loss with low-temperature rise. Indicate kVAR ratings and do not exceed the maximum

limitations set by NFPA 70. Provide individual cells as required.

c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.

d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

L. Motor Controller:

1. Enclosure: [**Factory installed, unit mounted**][**Factory furnished, field mounted**], [**NEMA 250**][**NEMA ICS 6**], [**Type 1**][**Type 4**][**Type 4X**][**Type 12**]<**Insert type**>, with hinged full-front access door[**with lock and key or padlock and key**].
2. Control Circuit: Obtained from [**integral control power transformer**]<**Insert source of control power**> with a control power [**transformer**][**source**] of enough capacity to operate connected control devices.
3. Size overload relay in accordance with UL 1995 or provide as integral component of chiller control microprocessor.
4. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
5. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.
6. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.
7. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

   a. Include surge suppressor in solid-state power circuits to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

   b. Visual indication of motor and control status, including the following conditions:

      1) Controller on.
      2) Overload trip.
      3) Loss of phase.
      4) Starter fault.

8. Accessories: Factory install devices in controller enclosure unless otherwise indicated.

   a. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**]. SCCR in accordance with UL 508 is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.

   b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

   c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

   d. Control Relays: Time-delay relays.

   e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.

   f. Number-of-Starts Counter: Numerical readout on face of enclosure.

   g. Meters: Panel type, [**2-1/2 inches (64 mm)**][**4-1/4 inches (108 mm)**] with [**90**][**120**][**270**]-degree scale and [**1**][**2**] percent accuracy. Where indicated, provide transfer device with an off position. Meters indicate the following:

      1) Ammeter: Output current for each phase, with current sensors rated to suit application.
      2) Voltmeter: Output voltage for each phase.
      3) Frequency Meter: Output frequency.
      4) Real-time clock with current time and date.
      5) Total run time.

6) <**Insert features**>.

h. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1) Selectable, digital display of the following:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

2) Mounting: Display and control unit flush or semirecessed in instrument compartment door.

i. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
j. Power Protection: Chiller must shut down within six cycles of power interruption.

M. Variable-Frequency Controller:

1. Motor controller is to be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
2. Description: NEMA ICS 2; listed and labeled in accordance with UL 508 as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 4**][**Type 4x**][**Type 12**], with hinged full-front access door with lock and key.
4. Integral Disconnecting Means:[**Door-interlocked,**] NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum SCCR in accordance with UL 508 is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
5. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors; suitable for variable torque loads.
6. Controller is to consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

a. Rectifier Section: Full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier is to be insensitive to phase rotation of the ac line.
b. Regulator: Full digital control of frequency and voltage.
c. Inverter Section: Change fixed dc voltage to variable-frequency, variable ac voltage for application to a squirrel-cage motor. Inverter is to produce a sine-coded, PWM output waveform and conduct no RFI back to the input power supply.

7. Output Rating: Three phase, with voltage proportional to frequency throughout voltage range.
8. Operating Requirements:

a. Input AC Voltage Tolerance: [**460-V ac, plus 10 percent or 506 V maximum**]<**Insert**

voltage and tolerance>.

b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.

c. Capable of driving full load, without derating, under the following conditions:

1) Ambient Temperature: [**Zero**]<**Insert number**> to [**40**][**50**]<**Insert number**> deg C.
2) Relative Humidity: Up to [**90**][**95**]<**Insert number**> percent (noncondensing).
3) Altitude: Up to [**3300 ft. (1005 m)**][**6600 ft. (2010 m)**]<**Insert value**>.

d. Minimum Efficiency: 96 percent at 60 Hz, full load.

e. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter; 98 percent with harmonic filter.

f. Overload Capability: 1.05 times the full-load current for seven seconds.

g. Starting Torque: As required by compressor-drive assembly.

h. Speed Regulation: Plus or minus 1 percent.

i. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.

j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller is to not operate continuously.

k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

9. Internal Adjustability Capabilities: Integral to controller or through chiller control panel.

a. Minimum Output Frequency: 6 Hz.

b. Maximum Output Frequency: 60 Hz.

c. Acceleration: Two seconds to a minimum of 60 seconds.

d. Deceleration: Two seconds to a minimum of 60 seconds.

e. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

10. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions must not result in component failure or the need for replacement:

a. Overtemperature.

b. Short circuit at controller output.

c. Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.

d. Open circuit at controller output.

e. Input undervoltage.

f. Input overvoltage.

g. Loss of input phase.

h. Reverse phase.

i. AC line switching transients.

j. Instantaneous overload, line to line or line to ground.

k. Sustained overload exceeding 100 percent of controller-rated current.

l. Starting a rotating motor.

11. Motor Protection: Controller is to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

12. Automatic Reset and Restart:

a. Capable of [**three**][**five**]<**Insert number**> restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

b. Controller is to be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

13. Visual Indication: On face of controller enclosure or chiller control enclosure. indicating the

following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.
g. Motor speed (percent).
h. Fault or alarm status (code).
i. DC-link voltage.
j. Motor output voltage.
k. Input kilovolt amperes.
l. Total power factor.
m. Input kilowatts.
n. Input kilowatt-hours.
o. Three-phase input voltage.
p. Three-phase output voltage.
q. Three-phase input current.
r. Three-phase output current.
s. Three-phase input voltage THD.
t. Three-phase input current THD.
u. Output frequency (Hertz).
v. Elapsed operating time (hours).
w. Diagnostic and service parameters.

14. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
15. Control Signal Interface:

    a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
    b. Manufacturer has option to incorporate control signal interface into chiller control panel.

16. Active Harmonic Distortion Filter:

    a. Factory mounted and wired to limit total voltage and current distortion to [**5**]<**Insert number**> percent.
    b. Factory mounted and wired to limit total demand distortion (TDD) to [**5**]<**Insert number**> percent of unit input.

17. Input Line Conditioning: <**Insert requirements**>.
18. Cooling: [**Air**][**Refrigerant**][**Water**][**Air, refrigerant, or water**] cooled.

N. Accessory Control Relays:

1. Control Relays: Auxiliary and adjustable time-delay relays.
2. Devices are to be factory installed in controller enclosure unless otherwise indicated.

O. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

P. Controls:

1. Description: Standalone and microprocessor based, with all memory stored in nonvolatile memory, so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 4**][**Type 4x**][**Type 12**]<**Insert type**>, hinged or lockable, factory wired with a single-point, with field-power connection and a separate control circuit.
3. House factory-installed wiring outside of enclosures in a NFPA 70-approved raceway.[**Make terminal connections with liquidtight or flexible metallic conduit.**]
4. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Fault history with not less than last 10 faults displayed.
    d. Set points of controllable parameters.
    e. Trend data.
    f. Operating hours.
    g. Number of chiller starts.
    h. Outdoor-air temperature or space temperature if required for chilled-water reset.
    i. Entering- and leaving-fluid temperatures of evaporator and condenser.
    j. Difference in fluid temperatures of evaporator and condenser.
    k. Fluid flow of evaporator and condenser.
    l. Fluid-pressure drop of evaporator and condenser.
    m. Refrigerant pressures in evaporator and condenser.
    n. Refrigerant saturation temperature in evaporator and condenser shell.
    o. Compressor refrigerant suction and discharge temperature.
    p. Compressor bearing temperature.
    q. Motor bearing temperature.
    r. Motor winding temperature.
    s. Oil temperature.
    t. Oil discharge pressure.
    u. Phase current.
    v. Percentage of motor-rated load amperage.
    w. Phase voltage.
    x. Demand power (kilowatts).
    y. Energy use (kilowatt-hours).
    z. Power factor.
    aa. For chillers equipped with variable-frequency controllers and harmonic filters, include the following:
    bb. Output voltage and frequency.
    cc. Voltage THD for each phase.
    dd. Supply current TDD for each phase.
    ee. Inlet vane position.
    ff. Controller internal ambient temperature.
    gg. Heatsink temperature.
    hh. Purge suction temperature if purge system is provided.
    ii. Purge elapsed time if purge system is provided.
    jj. <**Insert status display items**>.

5. Control Functions:

    a. Manual or automatic startup and shutdown time schedule.
    b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator-fluid temperature is to be reset based on [**return-water**][**outdoor-air**][**space**] temperature.
    c. Current limit and demand limit.

d. Condenser-fluid temperature.
e. External chiller emergency stop.
f. Variable evaporator flow.
g. Thermal storage.
h. Heat reclaim.
i. <**Insert control functions**>.

6. Manually Reset Safety Controls: The following conditions are to shut down chiller and require manual reset:

   a. Low evaporator [**pressure**][**temperature**][**pressure or temperature**]; high condenser pressure.
   b. Low evaporator-fluid temperature.
   c. Low oil differential pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. High compressor-discharge temperature.
   g. Loss of condenser-fluid flow.
   h. Loss of evaporator-fluid flow.
   i. Motor overcurrent.
   j. Motor overvoltage.
   k. Motor undervoltage.
   l. Motor phase reversal.
   m. Motor phase failure.
   n. Sensor- or detection-circuit fault.
   o. Processor communication loss.
   p. Motor controller fault.
   q. Extended compressor surge.
   r. Excessive air-leakage detection for chillers using R-514A or R-1233zd(E) refrigerant.
   s. <**Insert manually reset safety controls**>.

7. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
8. Security Access: Provide electronic security access to controls through identification and password, with at least three levels of access: view only; view and operate; and view, operate, and service.
9. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
10. Communication Port: RS-232 port, USB 2.0 port or higher, or equivalent connection capable of connecting a printer[**and a notebook computer**].
11. [**BAS**][**DDC System**] Interface: Factory install hardware and software to enable system to monitor, control, and display chiller status and alarms.

    a. Hardwired I/O Points:

       1) Monitoring: On-off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt-hours)**][**power factor**]<**Insert monitoring point**>.
       2) Control: On-off operation, [**chilled-water, discharge temperature set-point adjustment**][**electrical power demand limit**]<**Insert control point**>.

    b. Communication Interface: [**ASHRAE 135 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface is to enable control system operator to remotely control and monitor the chiller from an operator workstation.

1) Control features and monitoring points displayed locally at chiller control panel are to be available through the control system, including, at a minimum, the following:

a) Start-stop command from remote source.
b) Unit control source, local, analog, digital or modem.
c) Chiller control panel start-stop.
d) Accumulated operating hours.
e) Accumulated starts.
f) Compressor motor status.
g) Unit operation code.
h) Unit safety fault code.
i) Unit cycling fault code.
j) Chilled-water pump status.
k) Chilled-water flow proof.
l) Chilled-water entering temperature.
m) Chilled-water leaving temperature.
n) Chilled-water leaving temperature set-point adjustment from remote source.
o) Condenser(s) water entering temperature.
p) Condenser(s) water leaving temperature.
q) Evaporator refrigerant pressure.
r) Condenser(s) refrigerant pressure.
s) Evaporator refrigerant saturation temperature.
t) Condenser(s) refrigerant saturation temperature.
u) Refrigerant discharge temperature.
v) Refrigerant level.
w) Refrigerant liquid level set point.
x) Oil pressure differential.
y) Oil sump pressure.
z) Oil pump pressure.
aa) Oil sump temperature.
bb) High-speed thrust bearing proximity position.
cc) High-speed thrust bearing proximity reference.
dd) Motor current percent of full-load amps.
ee) Motor current Phase A.
ff) Motor current Phase B.
gg) Motor current Phase C.
hh) Motor current set-point adjustment from remote source.
ii) Motor bearing shaft end vibration.
jj) Motor bearing opposite shaft end vibration.
kk) Motor bearing shaft end temperature.
ll) Motor bearing opposite shaft end temperature.
mm) Motor average winding temperature.
nn) Variable-frequency controller selection, auto or fixed.
oo) Variable-frequency controller output voltage.
pp) Variable-frequency controller input power, rate.
qq) Variable-frequency controller input power, consumption.
rr) Variable-frequency controller DC bus voltage.
ss) Variable-frequency controller inverter link current.
tt) Variable-frequency controller output frequency.
uu) Variable-frequency controller internal ambient temperature.
vv) Variable-frequency controller converter heatsink temperature.
ww) Variable-frequency controller harmonic filter installed, true or false.
xx) Harmonic Filter THD at maximum voltage, percent.
yy) Harmonic filter total demand distortion at maximum current, percent.
zz) Harmonic filter total supply kVA.
aaa) Anti-recycle time remaining.

bbb) Liquid line solenoid.
ccc) Pre-rotation vanes position.
ddd) Adaptive capacity control valve surge map installed, true or false.
eee) Adaptive capacity control new surge point, true or false.
fff) Adaptive capacity control surge type, pressure differential or current.
ggg) Adaptive capacity control surge count.
hhh) Adaptive capacity control PRV position.
iii) Adaptive capacity control output frequency.
jjj) <**Insert point**>.

12. Quick-Start Feature:

a. Automatically restore chiller operation up to [**100**]<**Insert number**> percent capacity within [**three**][**five**]<**Insert number**> minutes after a [**15**]<**Insert number**> -second power interruption.
b. Quick-start feature is to ensure guide vanes remain open following a power interruption event and quick ramp-up speed logic is employed to facilitate shortest time to deliver chilled water at set-point temperature.
c. Chiller manufacturer is to provide integral UPS unit(s) with chiller controls if required to keep chiller integral controls operational to comply with requirement.
d. Chiller manufacturer is to demonstrate chiller start time with the quick-start feature enabled while simulating power fault, power service return, restart time, and capacity control, to produce desired chilled-water temperature at load indicated.

Q. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

a. Provide at least one coat of primer with a total dry film thickness of at least [**1.5 mils (0.03 mm)**][**2 mils (0.05 mm)**]<**Insert thickness**>.
b. Provide at least [**one coat**][**two coats**] of [**alkyd-modified, vinyl enamel**][**epoxy**][**polyurethane**] finish with a total dry film thickness of at least [**2 mils (0.05 mm)**][**3 mils (0.08 mm)**][**4 mils (0.1 mm)**]<**Insert thickness**>.
c. Paint surfaces that are to be insulated before applying the insulation.
d. Paint installed insulation to match adjacent uninsulated surfaces.
e. Color of finish coat is to be [**manufacturer's standard**][**custom color selected by Architect**]<**Insert color description**>.

R. Accessories:

1. Flow Switches:

a. Chiller manufacturer is to furnish a switch for each evaporator and [**condenser**][**heat-reclaim condenser**] and verify field-mounting location before installation.
b. Paddle Flow Switches:

1) Vane operated to actuate a double-pole, double-throw switch, with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
3) Pressure rating equal to pressure rating of heat exchanger.
4) Construct body and wetted parts of Type 316 stainless steel.
5) House switch in a NEMA 250, [**Type 4**]<**Insert type**> enclosure constructed of die-

cast aluminum.
6) Vane length to suit installation.

c. Pressure-Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch is to withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, [**Type 4**]<**Insert type**>.
6) Switch Action: Double-pole, double-throw switch, with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

2. Vibration Isolation:

a. Chiller manufacturer is to furnish vibration isolation for each chiller.
b. Neoprene Pad:

1) Two layers of **0.375-inch- (10-mm-)** thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gauge, stainless steel plate.
2) Fabricate pads from 40- to [**50**][**60**]<**Insert number**>-durometer neoprene.
3) Provide stainless steel square bearing plate to load the pad uniformly between **20 and 40 psig (138 and 276 kPa)** with a **0.12- to 0.16-inch (3- to 4-mm)** deflection.

c. Spring Isolator:

1) Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions.
2) Design isolators so that the Kx/Ky ratio will be 1.0 or more for stability.
3) Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Provide aluminum components that are etched and painted. Provide nuts, bolts, and washers that are zinc electroplated.
4) Isolators are to be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate.
5) An elastomeric pad with a minimum thickness of **0.25 inch (6 mm)** is to be bonded to the baseplate.
6) Spring assembly is to be removable and fit within a welded-steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation.
7) Isolated restraining bolts are to not be engaged during normal operation and are to connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
8) Select isolators for a nominal [**1-inch (25-mm)**][**2-inch (50-mm)**]<**Insert dimension**> deflection.
9) Integrate seismic restraints in applications that require seismic requirements.

3. Sound Barrier:

a. Provide sound barrier only if required to comply with sound requirements indicated.
b. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
c. Provide for repeated installation and removal without use of tape or caulk.
d. Inner and outer cover is to consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic

barrier.

e. Covers are to be double sewn and lock stitched, with edges folded and sewn so no raw cut edges are exposed.

f. Form covers around control devices, gauges, conduit, piping, and supports without degrading sound-barrier performance.

g. Continuously lap all exposed seams at least **2 inches (50 mm)** for better sound containment.

h. Permanently label each section of cover to indicate its location, description, size, and number sequence.

i. Randomly place stainless steel quilting pins to prevent covers from shifting and sagging.

2.5 PACKAGED REFRIGERANT-RECOVERY UNITS

A. Description: Packaged portable unit, furnished by chiller manufacturer, consisting of compressor, air- or water-cooled condenser, recovery system, tank pressure gauges, filter dryer, and valving that allows for switching between liquid- and vapor-recovery mode.

B. Refrigerant-recovery unit is to be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.

C. Provide units with lockable casters that permit rolling unit into position before locking position in place.

D. Review chiller layout and provide refrigerant hoses of sufficient length to permit positioning of unit near chiller without compromising service access and safety.

E. On water-cooled units, provide water hoses of sufficient length and pressure rating to permit positioning unit near chiller while connecting to closest field water source.

F. Terminate hoses with quick-connect fittings and mating adapters.

G. Provide unit power cord terminated with NEMA-rated plug suitable for unit power requirements.

1. Quantity of mating receptacle(s) as required by application. [**Refer to Drawings for requirements**]<**Insert requirements**>.
2. Power cord to be of sufficient length and rating to permit positioning unit near chiller while connecting to closest field power source. Power cord is not to be less than <**Insert length**> long.

2.6 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Description: Factory provided by chiller manufacturer, field-installed, brush-cleaning system on each chiller [**condenser**]<**Insert heat exchanger**> for tube cleaning and improved heat transfer.

B. System is to prevent tube fouling at or below design conditions without interrupting normal equipment operation.

C. System is to consist of a brush inserted into each tube and a catch basket attached to each end of the tube. A four-way valve is to operate to reverse the direction of water flow, to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator is to be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle is to be set up to match Project requirements.

D. Components:

1. Brush: Each brush is to have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube is not to exceed **0.025 inch (0.6 mm)**.
2. Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design is to provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
3. Four-Way Valve:

    a. Construct valve body of carbon steel, with internal sealing parts of hard rubber and Type 304 stainless steel.
    b. Configure valve with parallel flow connections to minimize field installation of piping.
    c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to that of condenser.
    d. Provide flanged pipe connections.
    e. Valve manufacturer is to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operating conditions of maximum differential pressure.
    f. Hydrostatically test to 1.5 times the design working pressure.
    g. Design the valve to cause no more than **0.5-psig (3-kPa)** pressure drop at design flow conditions.
    h. Provide valve with valve-mounted indicating/warning light that will light before the valve begins rotation.
    i. Valve Actuator, Electric: Mount electric actuator to operate valve.
    j. Valve Actuator, Pneumatic: Mount pneumatic piston-type actuator to operate valve. Actuator is to be suitable for operation using field-supplied air pressure.
    k. Position Switches: Factory mount microswitches on the valve to indicate the complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount a control panel on chiller. Control panel is to include the following features:

    a. NEMA 250, [**Type 1**][**Type 4**][**Type 4x**][**Type 12**] enclosure.
    b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
    c. Manual override of preset cleaning cycle.
    d. Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction," indicating a slow turn or incomplete valve turn.
    e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
    f. Flow switch bypass.
    g. Unloading signal to chiller.

2.7 SOURCE QUALITY CONTROL

A. AHRI Certification: Certify chiller in accordance with "Water-Cooled Chiller Certification Program."

B. Performance Tolerance: Comply with the following in lieu of **AHRI 550/590 (AHRI 551/591)**:

1. Allowable Capacity Tolerance: [**Zero**]<**Insert number**> percent.
2. Allowable Full-Load Energy Efficiency Tolerance: [**Zero**]<**Insert number**> percent.
3. Allowable Part-Load Energy Efficiency Tolerance: [**Zero**]<**Insert number**> percent.

C. Perform functional[**run**] tests of chillers before shipping.

D. Factory Performance Testing:

1. Factory performance test chillers, before shipping, in accordance with **AHRI 550/590 (AHRI 551/591)**.

2. Test the following conditions:

    a. Design conditions indicated.
    b. Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with condenser fluid at design conditions.
    c. Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with varying entering condenser-fluid temperature from design to minimum conditions in [**5 deg F (3 deg C)**]<**Insert temperature**> increments.
    d. At [**one**][**two**][**three**][**four**][**five**][**10**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

3. Allow [**Owner**]<**Insert entity**> access to place where chillers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

E. Factory Sound Testing:

1. For chillers located indoors, rate sound power level in accordance with AHRI 575.
2. Factory sound test chillers, before shipping, in accordance with AHRI 575.
3. Test the following conditions:

    a. Design conditions indicated.
    b. Chiller operating at calculated worst-case sound condition.
    c. At [**one**][**two**][**three**][**four**][**five**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

4. Allow [**Owner**]<**Insert entity**> access to place where chillers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
5. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

F. Factory test and inspect evaporator [**and condenser**][**, condenser, and heat-reclaim condenser**] in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

G. Factory test and inspect evaporator [**and condenser**][**, condenser and heat-reclaim condenser**] in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of **45 psig (310 kPa)**. Vacuum and pressure test for leaks.

H. Eddy Current Testing:

1. Perform factory testing of evaporator and condenser tubes of each chiller to ensure tube quality and longevity.
2. Submit test report, including, at a minimum:

    a. List of equipment used and equipment settings.
    b. Test data reports and accompanying strip charts of calibrations.
    c. Identify tubes with significant defects and typical indications.
    d. Statistical summary of defect indications.
    e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
    f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

I. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness factory testing. Total value attributed to travel expenses is to be clearly indicated.
2. Expenses are to include roundtrip coach airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [**one**][**two**]<**Insert number**> Owner representative(s) with origin of <**Insert city, state, country**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, control and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and control and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CENTRIFUGAL WATER CHILLERS

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Install chillers on support structure indicated.

D. Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel are to charge chiller with refrigerant and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies are to be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 INSTALLATION OF PACKAGED REFRIGERANT-RECOVERY UNIT

A. Install field electric power as required for unit furnished. Install power connections at multiple locations as recommended by chiller manufacturer for unit to service chillers indicated. Install receptacle(s) furnished with unit.

B. Install field water source as required for unit furnished. Install connections at multiple locations as recommended by chiller manufacturer for unit to service chillers indicated. Terminate connections with valves.

C. Install quick-connect adapters furnished with unit.

D. Functionally test unit for proper operations with field connections to power and water, as applicable.

3.4 INSTALLATION OF HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Install brush-cleaning system control panel adjacent to chiller control panel.

B. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.

C. Install field electric power, as required, to each system control panel and electric actuated valve.

D. Install pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.

E. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.

F. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

3.5 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," and Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator-Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve.

3. Make connections to chiller with a [**flange**][**mechanical coupling**][**flange or mechanical coupling**].

D. Condenser-Fluid Connections:

1. Connect to condenser inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to condenser outlet with shutoff valve, balancing valve,[**flexible connector,**] thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve.
3. Make connections to chiller with a [**flange**][**mechanical coupling**][**flange or mechanical coupling**].

E. Heat-Reclaim Condenser-Fluid Connections:

1. Connect to condenser inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to condenser outlet with shutoff valve, balancing valve,[**flexible connector,**] thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve.
3. Make connections to chiller with a [**flange**][**mechanical coupling**][**flange or mechanical coupling**].

F. Refrigerant-Pressure Relief Device Connections:

1. For chillers installed indoors, extend [**vent piping**][**separate vent piping for each chiller**] to the outdoors without valves or restrictions.
2. Comply with ASHRAE 15.
3. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

G. For chillers equipped with a purge system, extend [**purge vent piping**][**separate purge vent piping for each chiller**] to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

H. Connect each chiller drain connection with a drain valve, which is full size of drain connection. [**Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.**]

I. Connect each chiller water box vent connection with an [**automatic**][**or**][**manual**] vent, which is full size of vent connection.

3.6 ELECTRICAL POWER CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.7 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and [**DDC control system**]<**Insert system description**> for remote monitoring and control of chillers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

D. Install nameplate on face of chiller control panel indicating the control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **0.5 inch (12.7 mm)** high.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gauges are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator[**and condenser**][**, condenser, and heat-reclaim condenser**].
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, piping, controls and electrical connections for proper assembly, installation, and connection.

C. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

D. Prepare test and inspection startup reports.

3.9 WARRANTY PERIOD TESTING

A. Within [**one**]<**Insert number**> month(s) of warranty period expiration, perform testing, analysis, and reporting indicated for each chiller.

B. Eddy Current Testing:

1. Solicit services of a third-party testing agency, specializing in such analysis, to perform testing of evaporator and condenser tubes, to ensure tube quality and longevity.
2. Submit test report to Owner, including, at a minimum:

   a. List of equipment used and equipment settings.
   b. Test data reports and accompanying strip charts of calibrations.
   c. Identify tubes with significant defects and typical indications.

d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

C. Oil Analysis:

1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.
2. Submit analysis results and recommendations to Owner.

D. Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to Owner.

E. Site Access and Scheduling:

1. Contact Owner to schedule testing at least 30 days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate Owner's request for testing.
3. Review, with Owner, requirements for visitors in advance of testing.
4. Comply with Owner requirements for visitors while on-site.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.[**Video record the training sessions and provide electronic copy to Owner.**]

1. Instructor must be factory trained and certified.
2. Provide not less than [**eight**]<**Insert number**> hours of training.
3. Provide not less than [**16**]<**Insert number**> hours of training spread across consecutive days, not to exceed [**eight**]<**Insert number**>hours per day.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training is to be held at Project site.

END OF SECTION 23 64 16 00

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Task	Specification	Specification Description
23 64 16 16	23 64 16 00	Centrifugal Water Chillers
23 64 23 00	23 64 23 13	Air-Cooled, Scroll Water Chillers
23 64 23 00	23 64 23 16	Water-Cooled, Scroll Water Chillers

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SECTION 23 64 23 13 - AIR-COOLED, SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-cooled, scroll water chillers.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. DDC: Direct digital control.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by **AHRI 550/590** **(AHRI 551/591)** and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by **AHRI 550/590** **(AHRI 551/591)** and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.

3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Oil capacity of water chiller.
7. Fluid capacity of evaporator.
8. Characteristics of safety relief valves.
9. Force and moment capacity of each piping connection.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For water chiller supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: [**Wind-**][**and**][**seismic-**] detail fabrication and attachment of [**wind and**] seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Sustainable Design Submittals:

1. Product Data: For energy performance.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturers. Submit certification that specifies equipment will withstand wind forces identified in Section 018123 "Facility Seismic and Wind Criteria" and coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Installation instructions.

E. Source quality control reports.

F. Startup service reports.

G. Sample Warranty: For specified special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:

1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit" with text size at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size is to be at least **1/2 inch (13 mm)** high.

B. Touchup Paint: [**32 oz. (1 L)**]<**Insert volume**> container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.7 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller in accordance with AHRI 590 certification program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.

b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant [**and oil**] charge.

1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

d. Parts [**only**][**and labor**] .

2. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for chillers, including comprehensive engineering analysis.

B. Wind-Restraint Performance:

1. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building classification criteria.

C. Seismic Performance: Scroll water chillers to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Component Amplification Factor: <**Insert value**> .
4. Component Response Modification Factor: <**Insert value**> .

D. Site Altitude: Chiller is to be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

G. Comply with NFPA 70.

H. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

2.2 AIR-COOLED, SCROLL WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Trane**]
4. [**WaterFurnace International, Inc.**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Trane**]
4. [**WaterFurnace International, Inc.**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
6. <**Insert manufacturer's name**>

C. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, air-cooled condenser with fans, electrical power, controls, and indicated accessories.

D. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

E. Sound-reduction package is to have the following:

1. Acoustic enclosure around compressors.
2. Reduced-speed fans with acoustic treatment.
3. Designed to reduce sound level without affecting performance.

F. Security Package: Security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles are to be coated for corrosion resistance and are to be removable for service access.

G. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a [**500**]<**Insert time**> -hour salt-spray test in accordance with ASTM B117.

H. Compressor-Drive Assemblies:

1. Compressors:

a. Description: Positive-displacement direct drive with hermetically sealed casing.
b. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.

1) For multiple compressor assemblies, it is acceptable to isolate each compressor

assembly in lieu of each compressor.

c. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
d. Capacity Control: On-off compressor cycling [**, plus hot-gas bypass**] .

1) Digital compressor unloading is an acceptable alternative to achieve capacity control.

e. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.

1) Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

f. Vibration Isolation: Mount individual compressors on vibration isolators.

1) For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

2. Compressor Motors:

a. Hermetically sealed and [**cooled by refrigerant suction gas**][**or**][**air-cooled**] .
b. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

3. Compressor Motor Controllers:

a. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

I. Refrigeration System:

1. Refrigerant: [**R-32, ASHRAE 34 Safety Group A2L**][**R-454B, ASHRAE 34 Safety Group A2L**]<**Insert refrigerant type**> .
2. Refrigerant Compatibility: Parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit is to include [**an electronic**][**or**][**a thermal**] -expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in compressor discharge line and refrigerant liquid-line to allow the isolation and storage of refrigerant charge in the chiller condenser.

a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.

5. Pressure Relief Device:

a. Comply with requirements in ASHRAE 15 [**, ASHRAE 147,**] and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
c. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) is to be provided for each heat exchanger.

J. Evaporator:

1. Brazed-plate or shell-and-tube design, as indicated on Drawings.
2. Shell and Tube:

   a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
   b. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code.
   c. Shell Material: Carbon steel.
   d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
   e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping. [**Furnish flange adapters to mate to flanged piping.**]
   f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

3. Brazed Plate:

   a. Direct-expansion, single-pass, brazed-plate design.
   b. Type [**304**][**or**][**316**] stainless steel construction.
   c. Code Compliance: Tested in accordance with ASME Boiler and Pressure Vessel Code.
   d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. [**Furnish flange adapters to mate to flanged piping.**]
   e. Inlet Strainer: Factory-furnished, [**20**][**or**][**40**]<**Insert value**> -mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

4. Flow Switch: Factory-furnished [**and -installed,**][**thermal-type**] flow switch wired to chiller operating controls.
5. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to [**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**> .
6. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

K. Air-Cooled Condenser:

1. Coil(s) with integral subcooling on each circuit.
2. Copper Tube with Plate Fin Coils:

   a. Construct coils of copper tubes mechanically bonded to [**aluminum**][**copper**] fins.
   b. Coating: [**None**][**Corrosion resistant**] .

3. Aluminum Microchannel Coils:

   a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
   b. Single- or multiple-pass arrangement.
   c. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
5. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

6. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

    a. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

7. Fan Guards: Removable steel safety guards with corrosion-resistant [**PVC**] coating.

L. Heat Recovery Condenser:

1. Brazed plate, or shell and tube; as indicated, capable of [**full**][**partial**] heat recovery.
2. Shell and Tube:

    a. Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
    b. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code.
    c. Shell Material: Carbon steel.
    d. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
    e. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
    f. Provide each condenser circuit with a pressure relief device, purge cock, and liquid-line shutoff valve.
    g. Provide each condenser with water circuit vent and drain.

3. Brazed Plate:

    a. Type 316 stainless steel construction.
    b. Code Compliance: Tested in accordance with ASME Boiler and Pressure Vessel Code.
    c. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
    d. Inlet Strainer: Factory-furnished, [**20**][**or**][**40**]<**Insert value**> -mesh strainer for field installation in supply piping to condenser. Manufacturer has option to factory install strainer.

4. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the heat recovery condenser to [**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**> .
5. Insulation: Insulation on heat recovery condenser is to match evaporator insulation.
6. Controls: Integral to chiller control package.

M. Chilled-Water Hydronic Package:

1. Factory-furnished [**and -installed**] hydronic package consisting of the following:

    a. Pumps: Single or dual pumps with capacity, as indicated.

        1) [**Vertical in-line**]<**Insert type**> type, single-stage design, serviceable without disturbing piping connections.
        2) Cast-iron, ductile-iron, bronze, or stainless steel body.
        3) Bronze or stainless steel impeller keyed to shaft and secured with screw.
        4) Premium efficiency motor with TEFC motor enclosure.
        5) Dual pump packages to provide for servicing and replacement of failed pump with other pump operating.

6) Variable-speed pumps with variable-frequency controllers integral to pump motor or provided with chiller electrical package.

b. Expansion Tank: [**Replaceable**] bladder type. [**Pre-charge tank to x psi (y kPa).**]
c. Storage Tank: Insulated carbon-steel tank with [**internal baffles,**] drain and vent connections; with capacity indicated.
d. Piping: [**Copper tube**][**or**][**carbon-steel pipe**] .
e. Strainers: Y-type at suction side of each pump.
f. Valves:

1) Ball- or butterfly-style valves for isolation and balancing.
2) Check valve on each pump discharge for dual pump packages.
3) Drain valves to be positioned to drain isolated sections of pipe and equipment.
4) Option to use combination valves.

g. Hydronic Specialties:

1) Air Vents: [**Automatic**][**or**][**manual**] air vents located and arranged to vent air from high points and locations capable of trapping air.
2) Test Plugs: Located to measure pressure difference across each pump and strainer.

2. Hydronic package rated for same pressure as evaporator.
3. Pressure and leak tested before apply insulation.
4. Insulation on hydronic package is to match evaporator insulation.
5. Controls:

a. Lead/lag operation for dual pump packages.
b. Controlled to automatically equalize run time.
c. Control of variable-speed pumps.
d. Integral to chiller control package.
e. Remotely controlled through field interface with building controls.

6. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the chilled-water hydronic package to [**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**> .

N. Insulation:

1. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.

a. Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**]<**Insert dimension**> .

2. Adhesive: As recommended by insulation manufacturer.
3. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components are to include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

a. Apply adhesive to 100 percent of insulation contact surface.
b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
c. Seal seams and joints to provide a vapor barrier.
d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
e. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.

f. Field-Applied Insulation:

1) Components that are not factory insulated are to be field insulated to comply with requirements indicated.
2) Manufacturer is to be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
3) Manufacturer's factory-authorized service representative is to instruct and supervise installation of field-applied insulation.
4) After field-applied insulation is complete, paint insulation to match factory-applied finish.

O. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary are to provide a single-point field power connection to water chiller.
3. House in a unit-mounted, ANSI/NEMA EN 10250, [**Type 3R**]<**Insert type**> enclosure with hinged access door with lock and key or padlock and key.
4. Wiring is to be numbered and color-coded to match wiring diagram.
5. Factory wiring is to be located outside of an enclosure in a [**metal**] raceway. Make terminal connections with not more than a **24-inch (610-mm)** length of [**liquidtight**][**or**][**flexible metallic**] conduit.
6. Field power interface is to be to [**wire lugs**][**NEMA BS 31047 heavy duty disconnect switch**][**circuit breaker**] . Minimum SCCR in accordance with UL 508 to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
7. Each motor is to have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

   a. NEMA BS 31047, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
   b. NEMA BS 31047, heavy-duty, nonfusible switch.
   c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

8. Each motor is to have overcurrent protection.
9. Overload relay sized in accordance with UL 1995, or an integral component of water chiller control microprocessor.
10. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
11. Power Factor Correction: Capacitors to correct power factor to [**0.90**][**0.95**]<**Insert value**> at full load.
12. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
13. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
14. Service Receptacle:

    a. Unit-mounted, 120-V GFI duplex receptacle.
    b. Power receptacle from chiller internal electrical power wiring.

15. Indicate the following for water chiller electrical power supply:

    a. Current, phase to phase, for all three phases.
    b. Voltage, phase to phase and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).

e. Power factor.
f. Running log of total power versus time (kilowatt hours).
g. Fault log, with time and date of each.

16. Controls:

a. Factory installed and wired, and functionally tested at factory before shipment.
b. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
c. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
d. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:

1) Date and time.
2) Operating or alarm status.
3) Operating hours.
4) Outside-air temperature if required for chilled-water reset.
5) Temperature and pressure of operating set points.
6) Chilled-water entering and leaving temperatures.
7) Refrigerant pressures in evaporator and condenser.
8) Saturation temperature in evaporator and condenser.
9) No cooling load condition.
10) Elapsed time meter (compressor run status).
11) Pump status.
12) Antirecycling timer status.
13) Percent of maximum motor amperage.
14) Current-limit set point.
15) Number of compressor starts.
16) Alarm history with retention of operational data before unit shutdown.
17) Superheat.

e. Control Functions:

1) Manual or automatic startup and shutdown time schedule.
2) Capacity control based on evaporator leaving-fluid temperature.
3) Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4) Chilled-water entering and leaving temperatures, control set points, and motor load limit. Reset chilled-water leaving temperature based on [**return-water**][**outside-air**][**space**]<**Insert variable**> temperature.
5) Current limit and demand limit.
6) Condenser-water temperature.
7) External water chiller emergency stop.
8) Antirecycling timer.
9) Automatic lead-lag switching.

17. Manual-Reset Safety Controls: The following conditions are to shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.

g. Loss of condenser-water flow.
h. Control device failure.

18. BAS or DDC System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

a. Hardwired I/O Points:

1) Monitoring: On/off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt hours)**]<**Insert monitoring point**> .
2) Control: On/off operation, [**chilled-water discharge temperature set-point adjustment**][**electrical power demand limit**]<**Insert control point**> .

b. Communication Interface: [**ASHRAE 135 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted open-protocol**]<**Insert type of interface**> communication interface is to enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel are to be available through DDC system for HVAC.

19. Factory-installed wiring outside of enclosures is to be in NFPA 70-complaint raceway. [**Make terminal connections with liquidtight or flexible metallic conduit.**]

P. Accessories:

1. Factory-furnished [**neoprene**][**or**][**spring**] isolators [**with seismic restraints**] for field installation.

a. Spring Deflection: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert inches (mm)**> .

Q. Capacities and Characteristics:

1. Capacity: <**Insert tons (kW)**> .
2. Full-Load Efficiency:

a. COP: <**Insert number**> .
b. EER: <**Insert number**> .
c. Power Input/Cooling Output: <**Insert kW/ton (kW/kW)**> .

3. Part-Load Efficiency:

a. IPLV: <**Insert number**> .
b. NPLV: <**Insert number**> .

4. Low Ambient Operation: Chiller designed for operation to [**0 deg F (minus 18 deg C)**][**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**> .
5. High Ambient Operation: Chiller designed for operation to [**115 deg F (46 deg C)**][**120 deg F (50 deg C)**]<**Insert temperature**> .
6. Evaporator:

a. Type: [**Brazed plate**][**or**][**shell and tube**] .
b. Pressure Rating: <**Insert psig (kPa)**> .
c. Fluid Type: [**Water**]<**Insert fluid type**> .
d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .

g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
i. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

7. Condenser Entering-Air Temperature: <**Insert deg F (deg C)**> .
8. Site Altitude: <**Insert feet (m)**> .
9. Heat Recovery Condenser:

a. Type: [**Brazed plate**][**or**][**shell and tube**] .
b. Capacity: <**Insert MBH (kW)**> .
c. Pressure Rating: <**Insert psig (kPa)**> .
d. Fluid Type: [**Water**]<**Insert fluid type**> .
e. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
g. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
i. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
j. Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**][**0.001 sq. ft. x h x deg F/Btu (0.00022 sq. m x deg C/W)**]<**Insert factor**> .

10. Number of Refrigeration Circuits: [**One**][**Two**] .
11. Hydronic Package:

a. Number of Pumps: [**One**][**Two**] .
b. Pump Control: [**Constant**][**Variable**] speed.
c. Pump Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
d. Pump Dynamic Head: <**Insert feet of head (kPa)**> .
e. Pump Speed: <**Insert rpm**> .
f. Pump Motor Horsepower: <**Insert horsepower**> .
g. Storage Tank: <**Insert storage capacity**> .

12. Compressor Rated Load Amperes: <**Insert value**> .
13. Compressor Locked-Rotor Amperes: <**Insert value**> .
14. Controls Power Connection: Fed through integral transformer.
15. Chiller Power Input: <**Insert kilowatts**> .
16. Chiller Minimum Circuit Ampacity: <**Insert value**> .
17. Chiller Maximum Overcurrent Protection Device: <**Insert amperage**> .
18. Chiller Electrical Characteristics: [**208**][**240**][**480**][**600**]<**Insert value**> -V ac, three phase, 60 Hz.
19. Noise Rating: <**Insert dBA**> at <**Insert distance in feet (m)**> when measured in accordance with AHRI 370.

R. Materials:

1. Steel:

a. ASTM A36/A36M for carbon structural steel.
b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.
b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.
4. Aluminum: ASTM B209/B209M.
5. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
6. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**> -hour salt-spray test in accordance with ASTM B117.

    a. Standards:

        1) ASTM B117 for salt spray.
        2) ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
        3) ASTM D3359 for cross hatch adhesion of 5B.

    b. Application: [**Immersion**][**Spray**] .
    c. Thickness: [**1 mil (0.025 mm)**]<**Insert value**> .
    d. Gloss: Minimum gloss of 60 on a 60-degree meter.

S. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system is to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. See Drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

T. Outdoor Installations:

1. Chiller is to be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**]<**Insert time**> -year period with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**]<**Insert time**> -year period.

U. Source Quality Control:

1. Perform functional test of water chillers before shipping.
2. Factory performance test water chillers, before shipping, in accordance with **AHRI 550/590 (AHRI 551/591)**.

    a. Test the following conditions:

        1) Design conditions indicated.
        2) **AHRI 550/590 (AHRI 551/591)** part-load points.

3. Factory performance test water chillers before shipping. Comply with the following in lieu of **AHRI 550/590 (AHRI 551/591)**.

    a. Allowable Capacity Tolerance: [**Zero**]<**Insert number**> percent.
    b. Allowable Full-Load Energy Efficiency Tolerance: [**Zero**]<**Insert number**> percent.
    c. Allowable Part-Load Energy Efficiency Tolerance: [**Zero**]<**Insert number**> percent.
    d. Allow [**Owner**]<**Insert entity**> access to witness water chiller testing. Notify

[**Owner**]<**Insert entity**>[**14**][**30**]<**Insert number**> days in advance of testing.

4. Factory test and inspect evaporator [**and water-cooled condenser**] in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
5. For water chillers located outdoors, rate sound power level in accordance with AHRI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF AIR-COOLED, SCROLL WATER CHILLERS

A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel are to charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies are to be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to evaporator outlet with shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer, plugged tee with pressure gauge, [**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**][**flange**][**or**][**mechanical coupling**] .

E. Heat Recovery Condenser Fluid Connections:

1. Connect to condenser inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to condenser outlet with shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer, plugged tee with pressure gauge, [**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**][**flange**][**or**][**mechanical coupling**] .

F. Connect each drain connection with a drain valve full size of drain connection. [**Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.**]

G. Connect each chiller vent connection with [**an automatic**][**or**][**a manual**] vent, full size of vent connection.

H. Vent and purge air from hydronic systems, and ensure that expansion tank is properly charged with air to suit system Project requirements.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and [**DDC system**]<**Insert system description**> for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections [**with the assistance of a factory-authorized service representative**] .

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Air-cooled scroll water chillers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gauges are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

9. Verify and record performance of chilled- [**and heat recovery condenser-**] water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. [**Video record the training sessions and provide electronic copy to Owner.**]

1. Instructor is to be factory trained and certified.
2. Provide not less than [**eight**]<**Insert time**> hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Hold Owner training at Project site.

END OF SECTION 23 64 23 13

Task	Specification	Specification Description
23 64 23 13	23 64 23 16	Water-Cooled, Scroll Water Chillers

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SECTION 23 64 23 16 - WATER-COOLED, SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water-cooled, scroll water chillers.

B. Related Requirements:

1. Section 284400 "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

1.2 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and referenced to AHRI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in **tons (kW)** at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and intended for operating conditions other than AHRI standard rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

a. Performance at AHRI standard conditions and at conditions indicated.
b. Performance at AHRI standard unloading conditions.
c. Minimum evaporator and condenser flow rate.
d. Refrigerant capacity of water chiller.
e. Oil capacity of water chiller.
f. Fluid capacity of evaporator.
g. Fluid capacity of condenser.

h. Characteristics of safety relief valves.
i. Minimum entering condenser-water temperature.
j. Performance at varying capacity with constant design condenser-water temperature. Repeat performance at varying capacity for different condenser-water temperatures from design to minimum in [**5 deg F (3 deg C)**] increments.
k. Force and moment capacity of each piping connection.

B. Shop Drawings: Complete set of manufacturer's prints of water-chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For water-chiller supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: [**Seismic-**][**Detail**] fabrication and attachment of [**wind and**] seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Sustainable Design Submittals:

1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

2. Product Data: For refrigerants, indicating refrigerant type, GWP, amount in system and total GWP.

3. Product Data: For energy performance.

4. Inventory List: For all refrigerant-containing equipment present in Project, confirming that specified low- or no-refrigerant options have been installed.

5. Product Data: For heat or energy recovery system, demonstrating 70 percent enthalpy recovery ratio or 75 percent sensible heat recovery ratio.

6. Product Data for Automated Demand Response Controls: For automated demand response controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturer. Submit certification that specified equipment will withstand wind forces identified in Section 018123 "Facility Seismic and Wind Criteria" and coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source Quality Control Reports: For test reports.

E. Startup Service Reports: For test reports.

F. Qualification Statements: For factory-authorized service representative.

G. Delegated Design Engineer Qualifications: For water-cooled, scroll water-chillers design services.

H. Sample Warranty: For specified special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit specially designed by chiller manufacturer for use in servicing chiller(s) to include the following:

1. Special tools required to service chiller components that are not readily available to the Owner's service personnel in performing routine maintenance.
2. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size is to be at least **1 inch (25 mm)** high.
3. List of each tool furnished. Permanently attach the list to underside of case cover. Text size is to be at least **0.5 inch (13 mm)** high.

B. Touch-up Paint: [**32 oz. (1 L)**] container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer [**to perform startup services**][**and**][**to train the Owner personnel**] .

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. AHRI Certification: Certify chiller in accordance with **AHRI 550/590** **(AHRI 551/591)** certification program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of oil.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant [**and oil**] charge.

1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

d. For Parts: [**One**][**Five**] year(s) from date of Substantial Completion.
e. For Labor: [**One**][**Five**] year(s) from date of Substantial Completion.

2. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain water-cooled, scroll water chillers from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration mounts [**and seismic restraints**] for chillers, including comprehensive engineering analysis.

B. Seismic Performance: Scroll water chillers to withstand the effects of earthquake motions. See Section 018123 "Facility Seismic and Wind Criteria" and Section 230548 "Vibration and Seismic Controls for HVAC" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

C. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller is to be capable of starting with an entering condenser-fluid temperature of [**60 deg F (16 deg C)**][**55 deg F (13 deg C)**][**40 deg F (4 deg C)**] and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller is to be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of [**65 deg F (18 deg C)**][**60 deg F (16 deg C)**][**55 deg F (13 deg C)**].
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

D. Site Altitude: Chiller is to be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

E. Performance Tolerance: Comply with the following in lieu of **AHRI 550/590 (AHRI 551/591)**:

1. Allowable Capacity Tolerance: [**Zero**] percent.
2. Allowable Full-Load Energy-Efficiency Tolerance: [**Zero**] percent.
3. Allowable Part-Load Energy-Efficiency Tolerance: [**Zero**] percent.

F. AHRI Rating: Rate water-chiller performance in accordance with requirements in **AHRI 550/590 (AHRI 551/591)**.

G. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

H. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Comply with requirements of UL 1995 and include label by a qualified testing agency showing compliance.

K. ASME Compliance: Fabricate and label water-chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

L. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system is to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored, either through a backup power source or through normal power if restored before backup power is brought online.
2. See Drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

2.3 WATER-COOLED, SCROLL WATER CHILLERS

A. Water-Cooled, Scroll Water Chiller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Carrier Global Corporation**]
b. [**Daikin Applied**]
c. [**WaterFurnace International, Inc.**]
d. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]

2. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.

3. Fabricate water-chiller mounting base with reinforcement strong enough to resist water-chiller movement during a seismic event when water chiller is anchored to field support structure.
4. Compressor-Drive Assemblies:

a. Compressors:

1) Description: Positive-displacement direct drive with hermetically sealed casing.

2) Each compressor is to have suction and discharge service valves, crankcase oil heater, and suction strainer.

a) For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

3) Operating Speed: Nominal 3600 rpm for 60 Hz applications.

4) Capacity Control: On-off compressor cycling [**plus hot-gas bypass**] .

a) Digital compressor unloading is an acceptable alternative to achieve capacity control.
b) Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
c) Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

5) Vibration Isolation: Mount individual compressors on vibration isolators.

a) For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

b) Sound-reduction package is to consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.

6) Compressor Motors:

a) Hermetically sealed and cooled by refrigerant suction gas.
b) High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
c) Compressor Motor Controllers:

7) Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

5. Refrigeration System:

a. Refrigerant Type: [**R-32**][**R-454B**].
b. Refrigerant Compatibility: Parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
c. Refrigerant Circuit: Each circuit is to include [**an electronic-**][**a thermal-**] expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

d. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

1) For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.

e. Pressure Relief Device:

1) Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2) Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3) Device is to be ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Each heat exchanger is to be equipped with pressure relief valve(s).

6. Evaporator:

a. Brazed-plate or shell-and-tube design, as indicated on Drawings.

b. Shell and Tube:

1) Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
2) Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code.
3) Shell Material: Carbon steel.
4) Shell Heads: Removable carbon steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
5) Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping. [**Furnish flange adapters to mate to flanged piping.**]
6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

c. Brazed Plate:

1) Direct-expansion, single-pass, brazed-plate design.
2) Construction: [**Type 304**][**Type 316**] stainless steel.
3) Code Compliance: Tested in accordance with ASME Boiler and Pressure Vessel Code.
4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
5) Inlet Strainer: Factory-furnished [**20**][**40**] mesh strainer for field installation in supply

piping to evaporator. Manufacturer has option to factory install a strainer.

7. Condenser:

   a. Brazed plate, shell and tube, or without integral condenser; as indicated on Drawings.

   b. Shell and Tube:

      1) Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
      2) Positive subcooling of liquid refrigerant.
      3) Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code.
      4) Shell Material: Carbon steel.
      5) Water Boxes: Removable, of carbon steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping. [**Furnish flange adapters to mate to flanged piping.**]
      6) Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
      7) Each condenser is to have a pressure relief device, purge cock, and liquid-line shutoff valve.

   c. Brazed Plate:

      1) Direct-expansion, single-pass, brazed-plate design for positive subcooling of liquid refrigerant.
      2) Construction: Type 316 stainless steel.
      3) Code Compliance: Tested in accordance with ASME Boiler and Pressure Vessel Code.
      4) Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
      5) Inlet Strainer: Factory-furnished, [**20**][**40**] mesh strainer for field installation in supply piping to condenser. Manufacturer has option to factory install a strainer.

   d. Condenserless Chiller: Designed for field connection to remote condenser. Coordinate requirements with Section 236313 "Air-Cooled Refrigerant Condensers."

8. Insulation:

   a. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C534/C534M, Type 1 for tubular materials and Type 2 for sheet materials.

      1) Thickness: As required to comply with building codes applicable to Project.

   b. Adhesive: As recommended in writing by insulation manufacturer.
   c. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components are to include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

      1) Apply adhesive to 100 percent of insulation contact surface.
      2) Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
      3) Seal seams and joints for a vapor barrier.

4) After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5) Manufacturer has option to factory- or field-insulate chiller components of chillers to reduce potential for damage during installation.
6) Field-Applied Insulation:

   a) Components that are not factory insulated are to be field insulated to comply with requirements indicated.
   b) Manufacturer is to be responsible for chiller insulation whether factory or field installed to ensure manufacturer is the single point of responsibility for chillers.
   c) Manufacturer factory-authorized service representative is to instruct and supervise installation of field-applied insulation.
   d) After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.4 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary are to provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, [**Type 1**] enclosure with hinged access door with lock and key or padlock and key.

D. Wiring is to be numbered and color-coded to match wiring diagram.

E. Install factory wiring located outside of an enclosure in a [**metal**] raceway. Make terminal connections with not more than **24-inch (610-mm)** length of [**liquidtight**][**flexible metallic**] conduit.

F. Field power interface is to be [**wire lugs**][**NEMA KS 1, heavy-duty, nonfused disconnect switch**][**circuit breaker**] . Minimum short-circuit current rating (SCCR) in accordance with UL 508 is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**] A.

G. Each motor is to have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

   1. UL 489, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses for Type 2 protection in accordance with IEC 60947-4-1.
   2. NEMA KS 1, heavy-duty, nonfusible switch.
   3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

H. Each motor is to have overcurrent protection.

I. Overload relay sized in accordance with UL 1995, or an integral component of water-chiller control microprocessor.

J. Phase Failure and Undervoltage: Solid-state sensing with adjustable settings.

K. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

L. Control Relays: Auxiliary and adjustable time-delay relays, or an integral component to water-chiller

microprocessor.

M. Indicate the following for water-chiller electrical power supply:

1. Current, phase to phase, for all three phases.
2. Voltage, phase to phase and phase to neutral for all three phases.
3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt hours).
7. Fault log, with time and date of each.

N. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system is to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored, either through a backup power source or through normal power if restored before backup power is brought online.
2. See Drawings for equipment served by backup power systems.

2.5 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or include a separate enclosure of matching construction.

D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, LCD or LEDs. Display the following:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Entering and leaving temperatures of chilled water.
7. Entering and leaving temperatures of condenser water.
8. Refrigerant pressures in evaporator and condenser.
9. Saturation temperature in evaporator and condenser.
10. No cooling load condition.
11. Elapsed time meter (compressor run status).
12. Pump status.
13. Antirecycling timer status.
14. Percentage of maximum motor amperage.
15. Current-limit set point.
16. Number of compressor starts.
17. Alarm history with retention of operational data before unit shutdown.
18. Superheat.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature is to be reset based on [**return-water**][**outside-air**][**space**] temperature.
5. Current limit and demand limit.
6. Condenser-water temperature.
7. External water-chiller emergency stop.
8. Antirecycling timer.
9. Automatic lead-lag switching.
10. Ice-building mode.

F. Manual-Reset Safety Controls: The following conditions are to shut down water chiller and require manual reset:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. High or low oil pressure.
5. High oil temperature.
6. Loss of chilled-water flow.
7. Loss of condenser-water flow.
8. Control device failure.

G. System Interface: [**BAS**][**DDC**] . Factory install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On/off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt hours)**].
b. Control: On/off operation, [**chilled-water discharge temperature set-point adjustment**][**electrical power demand limit**].

2. Communication Interface: [**ASHRAE 135 (BACnet)**][**Modbus**][**Industry-recognized open-protocol**] communication interface is to enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water-chiller control panel are to be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures is to be in NFPA 70-complaint raceway. [**Make terminal connections with liquidtight or flexible metallic conduit.**]

2.6 ACCESSORIES

A. Flow Switches: Factory-furnished, chilled- [**and condenser-**] water, [**paddle**][**pressure-differential**] flow switches for field installation.

1. Manufacturer has option to factory install switches.

B. Individual Compressor Suction and Discharge Pressure Gauges: With shutoff valves for each refrigeration circuit.

1. Pressure measurement and display through chiller integral controls is an acceptable alternative.

C. Isolators: Factory-furnished [**neoprene**][**spring**] isolators [**with seismic restraints**] for field installation.

2.7 CAPACITIES AND CHARACTERISTICS

A. Evaporator:

1. Type: [**Brazed plate**][**Shell and tube**][**Brazed plate, or shell and tube**] .
2. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**].

B. Condenser:

1. Type: [**Brazed plate**][**Shell and tube**][**Chiller without integral condenser**] .
2. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**].

C. Number of Refrigeration Circuits: [**One**][**Two**] .

D. Controls Power Connection: Fed through integral transformer.

E. Chiller Electrical Characteristics: [**208**][**240**][**480**][**600**] V ac, three phase, 60 Hz.

F. Noise Rating: In accordance with AHRI 575.

2.8 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, in accordance with **AHRI 550/590 (AHRI 551/591)**.

1. Test the following conditions:

a. Design conditions indicated.

b. **AHRI 550/590 (AHRI 551/591)** part-load points.

2. Allow [**the Owner**] access to place where water chillers are being tested. Notify [**the Owner**] **14**][**30**] days in advance of testing.

C. Factory Testing and Inspection: Factory test and inspect evaporator [**and water-cooled condenser**] in accordance with ASME Boiler and Pressure Vessel Code Section VIII, Division 1. Stamp with ASME label.

D. For water chillers located indoors, rate sound power level in accordance with AHRI 575 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water-chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water-chiller performance, maintenance, and operations.

1. Water-chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WATER-COOLED, SCROLL WATER CHILLERS

A. Coordinate sizes and locations of bases with actual equipment to be installed. Cast anchor-bolt inserts into concrete bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment to be installed.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel are to charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies are to be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to evaporator outlet with shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer, plugged tee with pressure gauge, [**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**][**flange**][**mechanical coupling**][**union, flange, or mechanical coupling**] .

E. Condenser Fluid Connections:

1. Connect to condenser inlet with shutoff valve, [**strainer,**][**flexible connector,**] thermometer, and plugged tee with pressure gauge.
2. Connect to condenser outlet with shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer, plugged tee with pressure gauge, [**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**][**flange**][**mechanical coupling**][**union, flange, or mechanical coupling**] .

F. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15.

G. Connect each drain connection with a drain valve, full size of drain connection. [**Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.**]

H. Connect each chiller vent connection with [**an automatic**][**a manual**] vent, full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **0.5 inch (12 mm)** high. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required for a complete and functioning system.

C. Connect control wiring between chiller control interface and [**DDC system**] for remote monitoring and control of chillers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**].

D. Install nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least **0.5 inch (12 mm)** high.

3.6 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Installation and Startup Checks: Complete in accordance with manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gauges are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water-chiller startup and shutdown.
9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
10. Verify and record performance of water-chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Inspect field-assembled components; equipment installation; and piping, controls, and electrical connections for proper assembly, installation, and connection.

E. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

F. Prepare a written startup report that records results of tests and inspections.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain water chillers. [**Video record the training sessions, and provide electronic copy to the Owner.**]

1. Instructor is to be factory trained and certified.
2. Provide not less than [**eight**] hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain the Owner sign-off that training is complete.
6. the Owner training is to be held at Project site as directed by the Owner.

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Task	Specification	Specification Description
23 64 23 16	23 64 23 13	Air-Cooled, Scroll Water Chillers

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SECTION 23 64 26 13 - AIR-COOLED, ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, air-cooled, rotary-screw water chillers.

1.2 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and referenced to AHRI standard rating conditions.

E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in **tons (kW)** at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and intended for operating conditions other than AHRI standard rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

a. Full-load performance at **AHRI 550/590 (AHRI 551/591)** standard conditions and at conditions indicated.
b. Part-load performance at **AHRI 550/590 (AHRI 551/591)** standard unloading conditions and at conditions indicated.
c. Design evaporator fluid flow rate.
d. Minimum evaporator fluid flow rate.
e. Maximum entering evaporator-fluid temperature.
f. Minimum entering evaporator-fluid temperature.
g. Maximum leaving evaporator-fluid temperature.
h. Minimum leaving evaporator-fluid temperature.
i. Fluid pressure drop across evaporator at design flow rate.
j. Fluid pressure drop across evaporator at minimum flow rate.

k. Refrigerant capacity of chiller.
l. Oil capacity of chiller.
m. Fluid capacity of evaporator.
n. Characteristics of safety relief valves.
o. Minimum entering condenser-air temperature at chiller start.
p. Minimum operating entering condenser-air temperature.
q. Maximum entering condenser-air temperature.
r. Performance at varying capacities with constant-design, entering condenser-air temperature. Repeat performance at varying capacities for different entering condenser-air temperatures from design to minimum entering condenser-air temperature in [**10 deg F (6 deg C)**] increments and varying capacities for different leaving evaporator-fluid temperatures from design to maximum in [**1 deg F (0.5 deg C)**] increments.
s. Weights of individual chiller components needed for design of lifting and rigging apparatus associated with ongoing chiller service. List weight for each serviceable and removable chiller component (such as compressor, compressor motor, evaporator, and condenser coil) that weighs more than [**100 lb (45 kg)**].
t. Submit complete product information showing a detailed comparison of proposed products against all the requirements indicated.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For water chiller supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: [**Wind-**][**and**][**seismic-**] detail fabrication and attachment of [**wind and**][**seismic**] restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Sustainable Design Submittals:

1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

2. Product Data: For refrigerants, indicating refrigerant type, GWP, amount in system and total GWP.

3. Product Data: For energy performance.

4. Inventory List: For all refrigerant-containing equipment present in Project, confirming that specified low- or no-refrigerant options have been installed.

5. Product Data: For heat or energy recovery system, demonstrating 70 percent enthalpy recovery ratio or 75 percent sensible heat recovery ratio.

6. Product Data for Automated Demand Response Controls: For automated demand response

controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificate, for chillers, accessories, and components, from manufacturer. Submit certification that specified equipment will withstand wind forces identified in Section 018123 "Facility Seismic and Wind Criteria" and coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source Quality Control Reports: For test reports.

E. Startup Service Reports: For test reports.

F. Delegated Design Engineer Qualifications: For water-cooled, scroll water-chillers design services.

G. Warranty Period Testing Reports: Include warranty testing and inspection reports.

H. Sample Warranty: For specified special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized service representative who is trained and approved by manufacturer [**to perform startup service**][**and**][**to train the Owner personnel**] .

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. AHRI Certification: Certify chiller in accordance with **AHRI 550/590** **(AHRI 551/591)** certification program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each chiller with a full charge of oil.

1. Ship oil [**factory installed in chiller**][**in containers separate from chiller**] .

D. Package chiller for export shipping in totally enclosed [**crate**][**and**][**bagging**] .

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assemblies including refrigerant and oil charge.

2. Warranty Coverage: Parts [**only**][**and labor**] .

3. Warranty Period: [**Two**][**Three**][**Four**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain air-cooled, rotary-screw water chillers from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for chillers, including comprehensive engineering analysis.

B. Wind-Restraint Performance:

1. See Section 018123 "Facility Seismic and Wind Criteria" and Section 230548 "Vibration and Seismic Controls for HVAC" for building classification criteria.

C. Seismic Performance: Air-cooled, rotary-screw water chillers to withstand the effects of earthquake motions. See Section 018123 "Facility Seismic and Wind Criteria" and Section 230548 "Vibration and Seismic Controls for HVAC" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when

subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**] .

D. Site Altitude: Chiller is to be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

E. Performance Tolerance: Comply with the following in lieu of **AHRI 550/590 (AHRI 551/591)**:

1. Allowable Capacity Tolerance: [**Zero**] percent.
2. Allowable IPLV/NPLV Performance Tolerance: [**Zero**] percent.

F. Rapid Restart and Loading Feature: Where indicated by individual chiller characteristics, chiller is to restart and reach the defined percent of design capacity within the defined time of a start or restart signal immediately after an electrical power interruption. Include uninterrupted power supply integral to chiller controls to comply with this requirement.

1. Submit documentation of proposed chiller model's past performance showing a history of achieving rapid restarts and loading. [**Further demonstrate compliance through a documented factory test of at least one chiller being installed on this Project.**]

G. AHRI Rating: Rate chiller performance in accordance with requirements in **AHRI 550/590 (AHRI 551/591)**.

H. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

I. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

J. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code.

K. Comply with NFPA 70.

L. Comply with requirements of UL and include label by a qualified testing agency showing compliance.

M. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system are to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source or through normal power if restored before backup power is brought online.
2. See Drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

2.3 PACKAGED, AIR-COOLED ROTARY-SCREW CHILLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]

4. [**Trane**]
5. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]

B. Description: Factory-assembled, functionally and run-tested, chiller complete with base and frame, casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans, motors and motor controllers, electrical power, controls, [**additional packages indicated**] and accessories.

C. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.

4. Sound-Reduction Package: Designed to reduce sound level without affecting performance and consisting of the following:

   a. Acoustic enclosure around compressors.
   b. Reduced-speed fans with acoustic treatment.

5. Security Package: Provide removable [**wire-mesh grilles**][**louvered panels**] with [**tamperproof**] fasteners for additional security protection without inhibiting service access. Finish to match cabinet.

   a. Partial Protection:

      1) Protect only bottom portion (vertical sides) of chiller to include evaporators and compressors.
      2) Protect only top portion (vertical sides) of chiller to include condenser coils.

   b. Full Protection: Protect bottom and top vertical sides of chiller to include compressors, evaporator, and condenser coils.

E. Compressors: Positive displacement, semi-hermetically sealed and oil lubricated.

1. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
2. Rotors: Manufacturer's standard rotor design.
3. Seals: Seal compressor and drive assembly to prevent refrigerant leakage.
4. Accessories: Provide each compressor with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

F. Compressor Motors:

1. Cooling: Semi-hermetically sealed and cooled by refrigerant suction gas.
2. Type: Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required for performance indicated.
3. Assembly: Factory mounted, aligned, and balanced as part of compressor-drive assembly.
4. Capacity: Motors with sufficient capacity to drive compressors throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.

5. Motor Winding Temperature Monitoring: Thermistor or RTD mounted in [**single motor winding**][**each of three-phase motor windings**] to monitor temperature and report information to chiller control panel.

6. Motor Bearing Temperature Monitoring: Thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

G. Capacity Control: Use on-off compressor cycling, modulating slide-valve assemblies, port unloaders, variable-speed compressor operation, hot-gas bypass, or a combination of these capacity control methods to achieve the performance indicated.

1. Maintain stable operation throughout the range of operation. Configure the chiller to achieve the most energy-efficient operation possible for the operating condition.

2. Operating Range: From 100 to [**20**][**15**][**10**][**5**][**zero**] percent of design capacity.
3. Condenser-Air Unloading Requirements over Operating Range: [**Constant-design, entering condenser-air temperature**][**Drop-in, entering condenser-air temperature of 5 deg F (3 deg C) drop for each 10 percent in capacity reduction**].

H. Compressor and Motor Assembly Vibration Balance: Precision balance chiller compressor and motor assembly to minimize vibration over entire operating range.

I. Compressor and Motor Assembly Field-Service: Design chiller to make compressor and motor assembly easily accessible for field-inspection and -service.

1. Compressor's internal components are to be accessible without having to remove compressor and motor assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing for rigging.

J. Oil Lubrication System: Complete system consisting of pump if required, filtration, heater, cooler, factory-wired power connection(s), and integral controls.

1. Operation: Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions [**including chiller shutdown during a power failure**] .
2. Oil Heater: Thermostatically control and properly size oil heater to separate refrigerant and oil.
3. Oil Cooler: [**Refrigerant**][**Fluid**][**Refrigerant- or fluid**] -cooled oil cooler. Oil cooler may be omitted if not required by chiller field application.
4. Oil Filtration: Easily serviceable and replaceable, with means of positive isolation while servicing.

   a. Type: Chiller manufacturer standard type.
   b. Filtration Efficiency: Efficiency selected by chiller manufacturer for optimum chiller performance and long life.

5. Oil Level Indication: Provide positive visual indication of oil level.
6. Oil: Use an oil that is compatible with the refrigerant and chiller components in contact with the oil.
7. Oil Lubrication System Piping: Factory-installed piping with isolation valves and accessories required for a complete system.
8. Oil Pressure Monitoring and Control: Monitoring and controls to regulate oil pressure within safe operating limits.
9. Oil Sump: Sufficient capacity with reserve needed for safe and reliable operation.
10. Pressure Testing: Factory pressure-test system to verify system has no leaks.

K. Refrigeration System:

1. Refrigerant Type: [**R-513A, ASHRAE 34 Safety Group A1**][**R-515B, ASHRAE 34 Safety Group A1**][**R-1234ze(E), ASHRAE Safety Group A2L**].
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit to include the following:

    a. Electronic-expansion valve.
    b. Refrigerant charging connections and valves.
    c. Hot-gas muffler.
    d. Compressor suction and discharge shutoff valves.
    e. Liquid-line shutoff valves.
    f. Oil filter.
    g. Replaceable-core filter-dryer.
    h. Sight glass with moisture indicator.
    i. Liquid-line solenoid valve.
    j. Refrigerant system economizer.

4. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
5. Pressure Relief Device:

    a. Comply with requirements in ASHRAE 15 and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.
    c. Provide pressure relief valves for each heat exchanger with refrigerant.

L. Evaporator:

1. Shell-and-Tube Heat Exchanger:

    a. Design:

        1) Direct-Expansion (DX): Fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
        2) Flooded: Fluid flowing through tubes and refrigerant flowing around tubes within the shell.

    b. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    c. Fluid Nozzles for DX Evaporators: Terminated with [**mechanical-coupling**][**flanged**][**flanged adapter**] end connections for connection to field piping.
    d. Shell Material: Carbon steel rolled plates with continuously welded seams or seamless pipe.
    e. Shell Heads for DX Evaporators: Removable carbon steel heads located at each end of the tube bundle.
    f. Refrigerant Carryover: Design flooded evaporator with mist eliminator or other means to prevent liquid refrigerant carryover from entering compressor.
    g. Refrigerant Level Indication: Provide flooded evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
    h. Tubes:

        1) Individually field-replaceable without damage to tube sheets and other tubes.
        2) Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
        3) Material: Copper.

4) Nominal OD: Manufacturer's choice.
5) Minimum Wall Thickness: Manufacturer's choice.
6) External Finish: Manufacturer's standard.
7) Internal Finish: Enhanced or smooth.

i. Tube Sheets:

1) End Tube Sheets: Carbon steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
2) Intermediate Tube Sheets: Carbon steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

j. Water Boxes for Flooded Evaporators: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

1) Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
2) Material: Carbon steel construction.
3) Type: Standard.
4) Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
5) Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid-temperature and report information to chiller control panel.
6) Drain Connections: Fit each water box with **3/4- or 1-inch (19- or 25-mm)** NPT connection and threaded plug at low point of water box.
7) Vent Connections: Fit each water box with **3/4- or 1-inch (19- or 25-mm)** NPT connection and threaded plug at high point of water box.

2. Brazed-Plate Heat Exchanger:

a. Design: DX, single-pass, brazed-plate design.
b. Material: [**Type 304**][**Type 316**] stainless steel construction.
c. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. [**Furnish flange adapters to mate to flanged piping.**]
e. Inlet Strainer: Factory-furnished strainer for field installation in supply piping to evaporator. Chiller manufacturer option to factory install the strainer.

1) Strainer Mesh Size: Selected by chiller manufacturer to protect passages of brazed-plate heat exchanger from premature clogging and damage.

3. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator in outdoor temperatures down to [**0 deg F (minus 18 deg C)**][**minus 20 deg F (minus 29 deg C)**].

4. Remote Mounting: Design for remote field mounting where indicated. Provide kit for field installation.

M. Air-Cooled Condenser:

1. Coils:

    a. Aluminum Microchannel Coils:

        1) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
        2) Single- or multiple-pass arrangement.
        3) Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

    b. Plate-Fin Coils:

        1) Construct coil casing of [**aluminum**][**galvanized**][**stainless**] steel.
        2) Construct coils of copper tubes mechanically bonded to [**aluminum**][**aluminum with precoated epoxy-phenolic**][**copper**] fins.

    c. Corrosion-Resistant Coating: Coat condenser coils with an [**epoxy polymer**] coating after fabrication. Coating attributes are as follows:

        1) Salt-Spray (ASTM B117): Pass [**3000**][**8000**][**10000**] hours.

    d. Hail Protection: Provide condenser coils with louvers or other means to protect against hail damage.

2. Fans: Direct-drive propeller or axial type with balanced fan blades, arranged for vertical air discharge.
3. Fan Motors:

    a. Enclosure: Totally enclosed.
    b. Bearings: Sealed and permanently lubricated bearings.
    c. Protection: Built-in overcurrent- and thermal-overload protection integral to motor.

        1) Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

    d. Speed Control: [**Constant**][**variable**] speed [**as indicated**] .
    e. Type: [**Continuous-duty, squirrel-cage, induction-type ac motor**][**Electronically commutated motor**][**permanent magnet dc motor**].

4. Fan Guards: Steel safety guards with corrosion-resistant [**PVC**] coating.
5. Condenser Fan and Motor Assembly Vibration Balance: Precision balance chiller condenser fan and motor assemblies to minimize vibration over entire operating range.

N. Electrical Power: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary to provide a [**multipoint,**][**single-point,**] field-power connection to chiller, as indicated.

1. Enclosure: Unit-mounted, NEMA 250, [**Type 3R**] enclosure with hinged access door [**with lock and key or padlock and key**] .
2. Wiring Identification: Number [**and color-code**] wiring to match wiring diagram.
3. Electrical Power Raceways: Factor install electrical power wiring outside of an enclosure in a weatherproof raceway.
4. Field-Power Interface: Equip chiller with [**wire lugs**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch with lockable handle**][**UL 489, instantaneous-trip circuit breaker with lockable handle**] for interface to field electrical power.

a. Door-Disconnect Interlock: Interlock disconnect means with door operation.

5. Minimum Withstand Rating: As required by field electrical power distribution system, but not less than [**25,000**][**30,000**][**65,000**] A.
6. Branch Circuits: Provide branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.

   a. Factory install a motor controller, hand-off-auto switch, and overcurrent protection for each motor.

7. Constant-Speed Motor Controllers: Factory furnish and install for use with constant-speed motors.

   a. Type:

      1) Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
      2) Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, [**closed**][**open**] transition.
      3) Wye-Delta, Reduced-Voltage Controller: NEMA ICS 2, [**closed**][**open**] transition.

   b. Overload Relays: Size overload relays in accordance with UL 1995 or to be an integral component of chiller control microprocessor.

8. Variable-Speed Motor Controllers: Factory furnish and install for use with variable-speed ac motors.

   a. Design: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   b. Technology: Pulse-width-modulated output suitable for constant or variable torque loads.
   c. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
   d. Operating Requirements:

      1) Input AC Voltage Tolerance: [**Chiller voltage indicated, plus 10 percent**].
      2) Input frequency tolerance of 60 Hz, plus or minus [**2**] Hz.
      3) Capable of driving full load, without derating, under the following conditions:

         a) Outdoor Ambient Temperature: [**0 to 40**] deg C.
         b) Relative Humidity: Up to [**90**][**95**] percent (noncondensing).
         c) Altitude: [**3300 ft. (1005 m)**][**6600 ft. (2010 m)**] .

      4) Minimum Efficiency: [**96**] percent at 60 Hz, full load.
      5) Minimum Displacement Primary-Side Power Factor: [**98**] percent.
      6) Overload Capability: [**1.05**] times the full-load current for seven seconds.
      7) Starting Torque: As required by compressor-drive assembly.
      8) Speed Regulation: Within [**1**] percent.
      9) Isolated control interface to allow controller to follow control signal over a [**5:1**][**10:1**] speed range.
      10) To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller is not to operate continuously.
      11) Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

   e. Internal Adjustability Capabilities:

      1) Minimum Output Frequency: [**6**] Hz.
      2) Maximum Output Frequency: [**60**] Hz.

3) Acceleration: [**2**] to [**60**] seconds.
4) Deceleration: Zero to [**60**] seconds.
5) Current Limit: [**30**] to 100 percent of maximum rating.

f. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions is not to result in component failure or the need for replacement:

1) Overtemperature.
2) Short circuit at controller output.
3) Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.
4) Open circuit at controller output.
5) Input undervoltage.
6) Input overvoltage.
7) Loss of input-phase.
8) Reverse phase.
9) AC line switching transients.
10) Instantaneous overload, line to line or line to ground.
11) Sustained overload exceeding 100 percent of controller rated current.
12) Starting a rotating motor.

g. Motor Protection: Controller to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

h. Automatic Reset and Restart: Capable of [**three**] restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller is to be capable of automatic restart on phase-loss, and overvoltage and undervoltage trips.

i. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1) Power on.
2) Run.
3) Overvoltage.
4) Line fault.
5) Overcurrent.
6) External fault.
7) Motor speed (percent).
8) Fault or alarm status (code).
9) Motor output voltage.
10) Input kilovolt amperes.
11) Total power factor.
12) Input kilowatts.
13) Input kilowatt-hours.
14) Three-phase input voltage.
15) Three-phase output voltage.
16) Three-phase input current.
17) Three-phase output current.
18) Three-phase input voltage, Total Harmonic Distortion (THD).
19) Three-phase input current THD.
20) Output frequency (Hertz).
21) Elapsed operating time (hours).
22) Diagnostic and service parameters.

j. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

k. Control Signal Interface:

1) Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and [**six**] programmable digital inputs.
2) Manufacturer has option to incorporate control signal interface into chiller control panel.

l. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to [**5**] percent.

1) Limit variable-frequency controller voltage THD and current Total Demand Distortion to comply with IEEE 519.

9. Terminal Blocks: With numbered [**and color-coded**] wiring to match wiring diagram. Include spare wiring terminal block for connection to external controls or equipment.
10. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.
11. Control Relays: Auxiliary and adjustable time-delay relays.

12. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus additional [**10**] percent spare capacity.

a. Where indicated, power chiller controls from a dedicated field-installed electrical power circuit.

13. Convenience Power Receptacle: Unit-mounted, [**120**] V, ground-fault interrupt duplex receptacle; rated for not less than [**4**][**10**][**15**][**20**] A.
14. Visual Indication of Chiller Electrical Power: Display the following:

a. Current and phase to phase for all three phases.
b. Voltage, phase to phase, and phase to neutral for all three phases.
c. Three-phase real power (kilowatts).
d. Three-phase reactive power (kilovolt amperes reactive).
e. Power factor.
f. Running log of total power versus time (kilowatt-hours).
g. Fault log, with time and date of each.

O. Controls:

1. Standalone and microprocessor-based controls with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Share an isolated section of electrical power enclosure or provide a separate enclosure [**for remote mounting in the field**] .
3. Control Wiring Raceways: Factory install the control wiring outside of enclosures in a weatherproof raceway.
4. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information as a minimum:

a. Date and time.
b. Operating or alarm status.
c. Operating hours.
d. Outdoor-air temperature.
e. Temperature and pressure of operating set points.
f. Entering and leaving chilled-water temperatures.
g. Refrigerant pressures in evaporator and condenser.

h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.
j. Elapsed time meter (compressor run status).
k. Pump status.
l. Antirecycling timer status.
m. Number of chiller starts.
n. Number of compressor starts.
o. Compressor bearing temperature.
p. Motor bearing temperature.
q. Motor winding temperature.
r. Oil temperature.
s. Oil discharge pressure.
t. Phase current.
u. Percent of maximum motor amperage.
v. Current-limit set point.
w. Phase voltage.
x. Demand power (kilowatts).
y. Energy use (kilowatt-hours).
z. Power factor.

5. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
c. Evaporator Leaving Fluid Temperature Reset: Reset evaporator leaving fluid temperature based on [**return-fluid temperature**][**outdoor-air temperature**][**space temperature**][**remote terminal unit control valve position**].
d. Current limit and demand limit.
e. External chiller emergency stop.
f. Antirecycling timer.
g. Automatic lead-lag switching.
h. Variable evaporator flow.
i. Dual-mode operation with thermal storage.

j. Economizer mode.

k. Heat recovery mode.

6. Manually Reset Safety Controls: The following conditions are to shut down chiller and require manual reset:

a. Low evaporator refrigerant pressure and temperature.
b. High condenser refrigerant pressure.
c. Low evaporator fluid temperature.
d. Low oil differential pressure.
e. High or low oil pressure.
f. High oil temperature.
g. Loss of evaporator fluid flow.
h. Motor overcurrent.
i. Motor overvoltage.
j. Motor undervoltage.
k. Motor phase reversal.
l. Motor phase failure.
m. Motor controller fault.
n. Control device failure.

o. Sensor- or detection-circuit fault.
p. Processor communication loss.
q. Extended compressor surge.

7. Trending: Capability to trend analog data of up to [**three**][**five**] parameters simultaneously over an adjustable period and frequency of polling.
8. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
9. Control Authority: At least four conditions: off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
10. Communication Port: USB 2.0 port or higher, capable of connecting to a notebook computer [**tablet**][**smart phone**][**printer**] .

11. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display chiller status and alarms.

    a. Hardwired Points:

        1) Monitoring: On-off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt-hours)**][**power factor**].
        2) Control: On-off operation, [**evaporator fluid discharge temperature set-point adjustment**][**electrical power demand limit**].

    b. Serial Communication Interface: [**ASHRAE 135 (BACnet) IP**][**ASHRAE 135 (BACnet) MS/TP**][**LonTalk**][**Modbus RTU**][**Modbus TCP/IP**][**Industry-accepted, open-protocol**] communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel are to be available through the DDC system for HVAC.

P. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.

2. Minimum Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**].
3. Adhesive: Apply adhesive as recommended by insulation manufacturer to 100 percent of insulation contact surface.
4. Protective Coating: Apply protective coating to exposed surfaces of insulation to protect insulation from weather.
5. General Requirements for Factory-Applied Insulation:

    a. Before insulating steel surfaces, prepare surfaces for paint.
    b. Prime and paint steel surfaces to be insulated as indicated for other painted components.
    c. Do not insulate unpainted steel surfaces.
    d. Seal seams and joints to provide a vapor barrier.
    e. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
    f. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
    g. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

6. Field-Applied Insulation:

a. Chiller components that require factory-applied insulation and are not factory insulated are to be field insulated to comply with requirements indicated.
b. Chiller manufacturer is responsible for all chiller factory-applied insulation whether factory or field installed, to ensure chiller manufacturer is the single point of responsibility for chillers.
c. Chiller manufacturer factory-authorized service representative to instruct, supervise and approve installation of field-applied insulation and paint.
d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

7. Insulation on Cold Surfaces: Factory apply the insulation over cold surfaces of chiller capable of forming condensation. Components are to include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipes from evaporator(s) to compressors, cold surfaces of compressors, compressor motors, and auxiliary piping.

8. Insulation on Hot Surfaces: For applications that use chillers to supply heating, factory apply the insulation over hot surfaces of chiller for thermal performance and personnel safety. Components are to include, but not be limited to, condenser heat recovery heat-exchanger shell-and-end tube sheets, water boxes including nozzles, refrigerant discharge pipes from compressors to heat recovery heat exchanger, hot surfaces of compressors, compressor motors, and auxiliary piping.

Q. Economizer Package: Factory-furnished and -installed chiller with hydronic economizer package consisting of hydronic coils, interconnecting piping, valves, hydronic specialties, and controls to cool chilled water using outdoor air when outdoor conditions are favorable.

1. Arrangement: [**Arrange economizer package so same fluid circulates through economizer package and evaporator and condenser fans circulate same air through economizer coils before condenser coils.**][**Arrange economizer package so fluid circulating through economizer package is completely isolated from fluid circulating through evaporator and condenser fans circulate same air through economizer coils before condenser coils.**][**Arrange economizer package as a dedicated chiller section so fluid circulating through economizer package is completely isolated from fluid circulating through evaporator and dedicated fans circulate air only through economizer coils.**]

a. Dedicated Heat Exchanger and Pump: Factory-furnished and -installed economizer package with a brazed-plate [**or shell-and-tube**] heat exchanger and hydronic pump to provide a dedicated hydronic loop that is isolated from fluid circulated through evaporator.

b. Dedicated Economizer Section: Factory-furnished and -installed economizer package consisting of a dedicated economizer section that includes hydronic coils, interconnecting piping, valves, hydronic specialties, fans, fan motors, and controls.

2. Performance:

a. Comply with performance indicated [**on Drawings**][**in "Capacities and Characteristics" Paragraph**] .
b. Rate economizer package for same hydronic pressure as evaporator.
c. Pressure test economizer package at [**1.1**][**1.25**] times design pressure to ensure leak free.

3. Hydronic Coils:

a. Aluminum Microchannel Coils:

1) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between hydronic header manifolds.

2) Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

b. Plate-Fin Coils:

1) Construct coil casing of [**aluminum**][**galvanized**][**stainless**] steel.
2) Construct coils of copper tubes mechanically bonded to [**aluminum**][**aluminum with precoated epoxy-phenolic**][**copper**] fins.

c. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant [**epoxy polymer**] coating after fabrication. Coating attributes are to be as follows:

1) Salt-Spray (ASTM B117): Pass [**3000**][**8000**][**10000**] hours.

d. Hail Protection: Provide economizer coils with louvers or other protective means to protect against hail damage.

4. Piping:

a. Material: [**Copper tube**][**carbon steel pipe**][**polypropylene**][**PVC**].
b. Fittings and Joints: Pipe fittings and joining materials selected by chiller manufacturer to comply with ASME or ASTM standards and specifically intended to mate with and join the pipe materials installed.
c. Flanges or Unions: Install flanges or unions to accommodate removal and replacement of individual components without having to cut piping.

5. Valves:

a. Ball- or butterfly-style valves for isolation and balancing.
b. Position drain valves at low points to drain isolated sections of pipe and equipment.

6. Hydronic Specialties:

a. Air Vents: Locate and arrange [**automatic**][**manual**] air vents to vent air from high points and locations capable of trapping air.
b. Test Plugs: Locate test plugs to measure pressure and temperature difference across each coil, each hydronic circuit, and combined pressure drop across entire economizer package.

7. Controls:

a. Factory-installed economizer package controls integral to chiller controls.
b. Provide multiple operating modes including, but not limited to, the following:

1) Mechanical Cooling: 100 percent of chiller cooling provided without any cooling benefit from economizer.
2) Hybrid: Both mechanical and economizer cooling operate together to provide chiller cooling. Economizer first uses ambient outdoor air to provide a portion of the chiller cooling. Mechanical cooling provides the remaining chiller cooling required. Hybrid mode provides some cooling benefit when economizer alone cannot achieve 100 percent of chiller cooling.
3) Economizer: 100 percent of chiller cooling provided by economizer.

c. Install electrically operated control valves in economizer piping to isolate evaporator fluid flow through economizer coils when outdoor conditions are unfavorable for economizer cooling. Power control valves through same chiller power supply to chiller controls.

R. Heat Recovery Package: Factory-furnished and -installed chiller with heat recovery package consisting of hot-gas desuperheater heat exchanger, interconnecting refrigerant piping, isolation valves, refrigeration specialties, and controls to heat water using chiller heat of rejection when conditions are favorable.

1. Performance: Comply with performance indicated [**on Drawings**][**in "Capacities and Characteristics" Paragraph**] .
2. Heat Exchanger:

a. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Heat-reclaim condenser shell is separate from evaporator.
b. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
c. Shell Material: Carbon steel rolled plates with continuously welded seams or seamless pipe.
d. Hot-Gas Dispersion: Design and factory install the baffle plates or other means to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
e. Tubes:

1) Individually field-replaceable without damage to tube sheets and other tubes.
2) Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3) Material: Copper.
4) Nominal OD: Manufacturer's choice.
5) Minimum Wall Thickness: Manufacturer's choice.
6) External Finish: Manufacturer's standard.
7) Internal Finish: Enhanced or smooth.

f. Tube Sheets:

1) End Tube Sheets: Carbon steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
2) Intermediate Tube Sheets: Carbon steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

g. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

1) Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
2) Material: Carbon steel construction.
3) Type: Standard.
4) Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
5) Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid-temperature and report information to chiller control panel.
6) Drain Connections: Fit each water box with **3/4- or 1-inch (19- or 25-mm)** NPT connection and threaded plug at low point of water box.
7) Vent Connections: Fit each water box with **3/4- or 1-inch (19- or 25-mm)** NPT connection and threaded plug at high point of water box.

3. Controls: Factory-installed heat recovery package controls integral to chiller controls.

S. Hydronic Package: Factory-furnished [**and -installed**][**and field-installed**] hydronic package consisting of pumps, piping, valves, strainers, hydronic specialties, expansion tank, storage tank, insulation, and controls.

1. Performance: Comply with performance indicated [**on Drawings**][**in "Capacities and Characteristics" Paragraph**] .

   a. Hydronic package rated for same pressure as evaporator.

2. Pumps: Single or dual pumps with performance, as indicated.

   a. [**Vertical in-line**][**Close-coupled end suction**] type, single-stage design, serviceable without disturbing piping connections.
   b. Cast-iron, ductile-iron, bronze, or stainless steel body.
   c. Bronze or stainless steel impeller keyed to shaft and secured with screw.
   d. Premium efficient motor with totally enclosed motor enclosure.
   e. Dual pump packages to provide for servicing and replacement of failed pump with other pump operating.
   f. Furnish variable-speed pumps with variable-frequency controllers integral to pump motor or provide controllers as part of the chiller electrical power.

3. Expansion Tank: [**Replaceable**] bladder type.

4. Storage Tank: Insulated carbon steel tank with [**internal baffles,**] drain and vent connections; with capacity indicated.
5. Piping: [**Copper tube**][**carbon steel pipe**] .
6. Strainers: Y-type at suction side of each pump.
7. Valves:

   a. Ball- or butterfly-style valves for isolation and balancing.
   b. Check valve on each pump discharge for dual pump packages.
   c. Drain valves positioned at low points to drain isolated sections of pipe and equipment.
   d. Option to use combination valves.

8. Hydronic Specialties:

   a. Air Vents: Locate and arrange [**automatic**][**manual**] air vents to vent air from high points and locations capable of trapping air.
   b. Test Plugs: Locate to measure pressure difference across each pump and strainer.

9. Insulation: For hydronic package to match evaporator insulation.

   a. Pressure and leak test the hydronic package components before applying insulation.

10. Controls:

   a. Lead/lag operation for dual pump packages.
   b. Controlled to automatically equalize run time.
   c. Control of variable-speed pumps.

   d. Integral to chiller control package.
   e. Remotely controlled through field interface with building HVAC controls.

T. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

    a. Primer: As determined by paint manufacturer to provide the performance indicated.
    b. Paint Type: Baked-on powder paint applied using multistep coating process.
    c. Paint Thickness: As determined by paint manufacturer to provide the performance indicated.
    d. Insulated Surfaces:

        1) Paint surfaces that are to be insulated before applying the insulation.
        2) Paint installed insulation to match adjacent uninsulated surfaces.

    e. Finish Coat Color: Color to be chiller manufacturer's standard.
    f. Chiller Cabinet Finish: Paint chiller cabinet (base, frame, and casing) with a corrosion-resistant coating having the following performance attributes:

        1) Salt-Spray Test (ASTM B117): Pass [**500**][**1000**][**3000**] hours.
        2) Minimum Impact Resistance (ASTM D2794): [**100 in lb (11.3 N m)**].
        3) Cross-Hatch Adhesion (ASTM B3359): [**5B**].
        4) UV inhibitor to protect against UV light.

    g. Miscellaneous Chiller Components Finish: Miscellaneous chiller components exposed to outdoor ambient conditions to match chiller cabinet.
    h. Condenser Coils Coating: Coat condenser coils as indicated in "Air-Cooled Condenser" Paragraph.

2. Provide the Owner with the following:

    a. Closeout Submittal Data: Submit paint manufacturer and paint product details for the Owner to procure matching paint in the future.
    b. Spare Paint: Turn over to the Owner a [**one quart**] container of paint to use in touchup applications at Project closeout. Properly label container for ease of future reference.

U. Vibration Control:

1. Vibration Balance: Precision balance chiller compressor and motor assemblies and condenser fan and motor assemblies to minimize vibration over entire operating range.
2. Isolation: Factory-mount individual compressor and motor assemblies on vibration isolators to dampen vibration transmitted to supporting structure.

V. Accessories:

1. Flow Switches: If required for chiller operation and not factory installed, chiller manufacturer to furnish flow switches for field-mounting with installation instructions.

    a. Paddle Flow Switches:

        1) Type: Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
        2) Pressure Rating: Equal to not less than pressure rating of heat exchanger.
        3) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of [**10 A at 120 V ac**].
        4) Enclosure: House switch in NEMA 250, [**Type 4**] enclosure constructed of die-cast aluminum.

5) Construction: Body and wetted parts constructed of Type 316 stainless steel.
6) Vane: Length to suit installation.

b. Pressure Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch is to withstand, without damage, the full-pressure rating of heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type; field adjustable.
4) Electrical Connections: Internally mounted, screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, [**Type 4**].
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

c. Thermal-Dispersion-Type Flow Sensors/Switches: Chiller manufacturer's standard offering.

1) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
2) Factory calibrated for Project-specific application.

2. Vibration Isolation: Chiller manufacturer to furnish isolators for field installation.

a. Neoprene Pads:

1) Two layers of **0.375-inch- (10-mm-)** thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gauge, stainless steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless steel square bearing plate to load the pad uniformly between **20 and 40 psig (138 and 276 kPa)** with a **0.12- to 0.16-inch (3- to 4-mm)** deflection.

W. Capacities and Characteristics:

1. Full-Load Efficiency:

a. Comply with FEMP.

2. Part-Load Efficiency:

a. Comply with FEMP.

3. Low Ambient Operation: Chiller designed for operation to [**0 deg F (minus 18 deg C)**][**Minus 20 deg F (minus 29 deg C)**].

4. High Ambient Operation: Chiller designed for operation to [**115 deg F (46 deg C)**][**125 deg F (52 deg C)**].
5. Evaporator:

a. Configuration: [**Integral to chiller**][**Shipped loose for remote field installation**] .
b. Pressure Rating: [**150 psig (1034 kPa)**][**300 psig (2068 kPa)**].
c. Fluid Type: [**Water**].
d. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**].

6. Number of Refrigerant Circuits: [**Two**][**Independent circuit/compressor**].
7. Packaged Chiller Electrical Requirements:

    a. Power Connections: [**Single-point field power**][**Multipoint field power configured for operation of one chiller refrigeration circuit with other chiller refrigeration circuit deenergized and isolated for service**] .
    b. Power Factor: [**0.95**].
    c. Volts: [**208**][**240**][**480**][**600**] V ac.
    d. Phase: Three.
    e. Hertz: 60.

8. Chiller Control Electrical Requirements:

    a. Power Connections: [**Fed through integral transformer**][**Separate field-power connection**] .

    b. Volts: [**120**] V ac.
    c. Phase: Single.
    d. Hertz: 60.

9. Noise Rating: In accordance with AHRI 370. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

10. Rapid Restart and Loading Feature: Chiller to start and reach [**100**] percent of design capacity within [**160**][**240**][**300**] seconds of a start signal or restart signal after electrical power interruption.

11. Economizer:

    a. Fluid Pressure Rating: [**150 psig (1034 kPa)**][**300 psig (2068 kPa)**].
    b. Fluid Type: [**Water**].

12. Heat Recovery Package Heat Exchanger:

    a. Fluid Pressure Rating: [**150 psig (1034 kPa)**][**300 psig (2068 kPa)**] .
    b. Fluid Type: [**Water**].
    c. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**].

13. Hydronic Package:

    a. Fluid Pressure Rating: [**150 psig (1034 kPa)**][**300 psig (2068 kPa)**].
    b. Fluid Type: [**Water**].

2.4 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. Factory run test each air-cooled chiller with water flowing through evaporator.

C. ASME Testing: Factory test and inspect evaporator in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Eddy Current Testing:

1. Perform factory testing of evaporator tubes of each chiller to ensure tube quality and longevity.
2. Submit test report, including, at a minimum, the following:

   a. List of equipment used and equipment settings.
   b. Test data reports and accompanying strip charts of calibrations.
   c. Identify tubes with significant defects and typical indications.
   d. Statistical summary of defect indications.
   e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
   f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

E. Factory Performance Testing: Factory performance test of air-cooled, rotary-screw water chillers, before shipping, in accordance with **AHRI 550/590 (AHRI 551/591)**.

1. Test the following conditions:

   a. Design conditions indicated.
   b. Part-Load Testing:

      1) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**] with entering condenser-air temperature at design conditions and with leaving evaporator fluid-temperature at design conditions.
      2) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**] with varying entering condenser-air temperature from design to minimum conditions in [**5 deg F (3 deg C)**][**10 deg F (6 deg C)**] increments and with leaving evaporator fluid-temperature constant at design conditions.
      3) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**] with varying entering condenser-air temperature from design to minimum conditions in [**5 deg F (3 deg C)**][**10 deg F (6 deg C)**] increments and with varying leaving evaporator fluid-temperature from design conditions to maximum conditions in [**2 deg F (1 deg C)**] increments.
      4) At [**one**][**two**][**three**][**four**][**five**][**10**] point(s) of varying part-load performance to be selected by the Owner at time of test.

2. Witness Testing: Allow [**the Owner**] access to place where chillers are being tested to witness testing. Notify [**the Owner**][**Architect**] [**14**] days in advance of testing.
3. Test Reports: Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit PDF copy of test report within [**5**] business days of test date.

F. Factory Sound Testing: Factory sound test of water-cooled chillers, before shipping, in accordance with AHRI 370.

1. Test the following conditions:

   a. Design conditions indicated.
   b. Chiller operating at calculated worst-case sound condition.
   c. Additional Conditions Tested: At [**one**][**two**][**three**][**four**][**five**] point(s) of varying part-load performance to be selected by the Owner at time of test.

2. Witness Testing: Allow [**the Owner**] access to place where chillers are being tested to witness testing. Notify [**the Owner**][**Architect**][**14**] days in advance of testing.
3. Test Reports: Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit PDF copy of test report within [**5**] business days of test date as directed by the

Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF AIR-COOLED, ROTARY-SCREW WATER CHILLERS

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

D. Install chillers on support structure indicated on Drawings.

E. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Maintain manufacturer's recommended clearances for proper operation, service, and maintenance.

G. Charge chiller with refrigerant and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

I. Repair damage to chiller factory-installed insulation. Replace insulation if damage is extensive.

J. Repair damage to chiller painted surfaces.

3.3 PIPING CONNECTIONS

A. Hydronic Piping Requirements: Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

B. Refrigerant Piping Requirements: Comply with requirements for piping specified in Section 232300 "Refrigerant Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Install piping adjacent to chiller to allow service and maintenance.

E. Evaporator Fluid Connections:

1. Inlet Connections: Connect to evaporator inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to evaporator outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller with a [**flange**][**mechanical coupling**] .

4. Evaporator Fluid Drain Connections: [**Connect each drain connection with a full-size drain valve.**][**Connect each drain connection with a union and drain pipe, and extend pipe, full size of connection, to sanitary drain. Provide a shutoff valve at each connection.**]
5. Evaporator Fluid Vent Connections: Connect each chiller heat-exchanger fluid vent connection with a full-size [**manual air vent**][**automatic air vent**] . Provide a full-size shutoff valve at each connection.

F. Economizer Package Fluid Connections:

1. Inlet Connections: Connect to economizer package inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to economizer package outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller piping with a [**flange**][**mechanical coupling**] .

4. Fluid Drain Connections: [**Connect each drain connection with a full-size drain valve.**][**Connect each drain connection with a union and drain pipe, and extend pipe, full size of connection, to sanitary drain. Provide a shutoff valve at each connection.**]
5. Fluid Vent Connections: Connect each chiller economizer package fluid vent connection with a full-size [**manual air vent**][**automatic air vent**] . Provide a full-size shutoff valve at each connection.

G. Heat Recovery Package Fluid Connections:

1. Inlet Connections: Connect to heat recovery inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to heat recovery outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller nozzle connections with a

[**flange**][**mechanical coupling**] .

4. Fluid Drain Connections: [**Connect each drain connection with a full-size drain valve.**][**Connect each drain connection with a union and drain pipe, and extend pipe, full size of connection, to sanitary drain. Provide a shutoff valve at each connection.**]
5. Fluid Vent Connections: Connect each chiller heat recovery package fluid vent connection with a full-size [**manual air vent**][**automatic air vent**] . Provide a full-size shutoff valve at each connection.

H. Hydronic Package Fluid Connections:

1. Inlet Connections: Connect to hydronic package inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to hydronic package outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller piping with a [**flange**][**mechanical coupling**] .

4. Fluid Drain Connections: [**Connect each drain connection with a full size drain valve.**][**Connect each drain connection with a union and drain pipe, and extend pipe, full size of connection, to sanitary drain. Provide a shutoff valve at each connection.**]
5. Fluid Vent Connections: Connect each chiller hydronic package fluid vent connection with a full-size [**manual air vent**][**automatic air vent**] . Provide a full-size shutoff valve at each connection.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical power connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Connect control wiring between chillers and other equipment to interlock operation as required to

provide a complete and functioning system.

B. Install control signal wiring to field-mounted control devices and between chiller control interface and [**DDC control system**] for remote monitoring and control of chillers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**].

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Install control devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

F. Install nameplate for each control connection, indicating brief description, controller designation, and controller I/O point number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and pressure gauges are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators during chiller startup, normal operation, and shutdown.
9. Verify and record performance of fluid flow and low-temperature interlocks.
10. Verify and record performance of chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping, controls, and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.7 WARRANTY PERIOD TESTING

A. Perform testing, analysis, and reporting indicated for each chiller.

B. Perform testing, analysis, and reporting within [**one**] month(s) of warranty period expiration, and not less than annually during warranty period.

C. Eddy Current Testing:

1. Solicit services of a third-party testing agency, specializing in such analysis, to perform testing of evaporator and condenser tubes, to ensure tube quality and longevity.
2. Submit test report to the Owner, including, at a minimum, the following:

   a. List of equipment used and equipment settings.
   b. Test data reports and accompanying strip charts of calibrations.
   c. Identify tubes with significant defects and typical indications.
   d. Statistical summary of defect indications.
   e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
   f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

D. Oil Analysis:

1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.
2. Submit analysis results and recommendations to the Owner.

E. Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to the Owner.

F. Site Access and Scheduling:

1. Contact the Owner to schedule testing at least [**30**] days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate the Owner's request for testing.
3. Review, with the Owner, requirements for visitors in advance of testing.
4. Comply with the Owner requirements for visitors while on-site.

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain chillers. [**Video record the training sessions and provide electronic copy to the Owner.**]

1. Instructor must be factory trained and certified.
2. Minimum Training Duration:

   a. Provide not less than [**eight**] hours of training.
   b. Provide not less than [**16**] hours of training spread across consecutive days, not to exceed [**eight**] hours per day.

3. Train the Owner's personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain the Owner sign-off that training is complete.
6. the Owner training is to be held at Project site.

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SECTION 23 64 26 16 - WATER-COOLED, ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, rotary-screw chiller - single compressor.
2. Packaged, water-cooled, rotary-screw chiller - multiple compressor.
3. Modular, housed, water-cooled rotary-screw water chiller.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for non-structural components.
2. Section 284400 "Refrigerant Detection and Alarm" for refrigerant monitors and alarms.

1.2 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

C. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and referenced to AHRI standard rating conditions.

D. kVAr: Kilovolt amperes reactive.

E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in **tons (kW)** at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated in accordance with the method defined by **AHRI 550/590 (AHRI 551/591)** and intended for operating conditions other than AHRI standard rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

a. Full load performance at **AHRI 550/590 (AHRI 551/591)** standard conditions and at conditions indicated.
b. Part load performance at **AHRI 550/590 (AHRI 551/591)** standard unloading conditions and at conditions indicated.

c. Minimum evaporator fluid-flow rate.
d. Minimum leaving evaporator-fluid temperature.
e. Refrigerant capacity of chiller.
f. Oil capacity of chiller.
g. Fluid capacity of evaporator.
h. Characteristics of safety relief valves.
i. Fluid capacity of condenser [**and heat-reclaim condenser**] .
j. Minimum condenser [**and heat-reclaim condenser**] fluid-flow rate.
k. Minimum entering condenser-fluid temperature.
l. Maximum entering condenser [**and heat-reclaim condenser**] -fluid temperature.
m. Performance at varying capacities with constant-design, entering condenser-fluid temperature and constant-design, leaving evaporator-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in [**5 deg F (3 deg C)**]<**Insert temperature**> increments and varying capacities for different leaving evaporator-fluid temperatures from design to maximum in [**1 deg F (0.5 deg C)**]<**Insert temperature**> increments and.

1) Capacity Increments: Performance at different capacity increments of [**10**]<**Insert value**> percent from design to minimum capacity.

n. Weights of individual chiller components needed for design of lifting and rigging apparatus associated with ongoing chiller service. List weight for each serviceable and removeable chiller component (such as compressor, compressor motor, water box) that weighs more than [**100 pounds (45 kg)**]<**Insert weight**> .
o. Chiller total heat rejection to room at worst-case operating condition.
p. Submit complete product information showing a detailed comparison of proposed products against all the requirements indicated.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For energy performance.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificates, for chillers, accessories, and components, from manufacturer. Submit certification that specifies equipment will withstand wind forces identified in Section 018123 "Facility Seismic and Wind Criteria" and coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality control reports.

E. Field Quality Control Reports: Startup service reports.

F. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller in accordance with **AHRI 550/590 (AHRI 551/591)** certification program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each chiller with a full charge of oil.

1. Ship oil [**factory installed in chiller**][**in containers separate from chiller**] .

D. Package chiller for export shipping in totally enclosed [**crate**][**and**][**bagging**] .

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Components include, but are not limited to, the following:

a. Complete chiller, including refrigerant and oil charge.
b. Complete compressor and motor assembly, including refrigerant and oil charge.

2. Warranty Coverage: Parts [**only**][**and labor**] .
3. Warranty Period: [**Two**][**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Water-cooled, rotary-screw chillers are to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**] .
3. Requirements for Component Amplification Factor and Component Response Modification Factor: <**Insert requirements**> .

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller is to be capable of starting with an entering condenser-fluid temperature of [**60 deg F (16 deg C)**][**55 deg F (13 deg C)**][**40 deg F (4 deg C)**]<**Insert temperature**> and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller is to be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of [**65 deg F (18 deg C)**][**60 deg F (16 deg C)**][**55 deg F (13 deg C)**] .
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

C. Site Altitude: Chiller is to be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

D. Performance Tolerance: Comply with the following in lieu of **AHRI 550/590 (AHRI 551/591)**:

1. Allowable Capacity Tolerance: [**Zero**]<**Insert number**> percent.
2. Allowable IPLV/NPLV Performance Tolerance: [**Zero**]<**Insert number**> percent.

E. Rapid Restart and Loading Feature: Where indicated by individual chiller characteristics, chiller to restart and reach the defined percent of design capacity within the defined time period of a start or restart signal immediately after an electrical power interruption. Include uninterrupted power supply (UPS) integral to chiller controls to comply with this requirement.

1. Submit documentation of proposed chiller model's past performance showing a history of achieving rapid restarts and loading. [**Further demonstrate compliance through a documented factory test of at least one chiller being installed on this Project.**]

F. AHRI Rating: Rate chiller performance in accordance with requirements in **AHRI 550/590 (AHRI 551/591)**.

G. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration [**and ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements**] .

H. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

I. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

J. Comply with NFPA 70.

K. Comply with requirements of UL Standards & Engagement Inc., and include label by a qualified testing agency showing compliance.

L. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system are to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement.

2.2 PACKAGED, WATER-COOLED, ROTARY-SCREW CHILLER - SINGLE COMPRESSOR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Trane**]
5. [**WaterFurnace International, Inc.**]
6. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Trane**]
5. [**WaterFurnace International, Inc.**]
6. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged, water-cooled, rotary-screw single compressor chillers from single manufacturer.

D. Description: Factory-assembled, functionally [**and run**] -tested chiller with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, [**heat-reclaim condenser where indicated,**] controls, interconnecting unit piping and wiring, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

E. Base: Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement [**without damage**] during a seismic event when chiller base is anchored to a field support structure.

F. Compressor:

1. Type: Semi-hermetic, positive displacement, and oil lubricated.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard rotor design.
4. Seals: Seal compressor and drive assembly to prevent refrigerant leakage.

G. Compressor Motor:

1. Cooling: Semi-hermetically sealed and cooled by refrigerant suction gas.
2. Type: Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required for performance indicated.
3. Assembly: Factory mounted, aligned, and balanced as part of compressor-drive assembly.
4. Capacity: Motor with sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
5. Motor Winding Temperature Monitoring: Thermistor or RTD mounted in [**single motor winding**][**each of three-phase motor windings**] to monitor temperature and report information to chiller control panel.
6. Motor Bearing Temperature Monitoring: Thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

H. Vibration Balance: Precision balance chiller compressor and motor assembly to minimize vibration over entire operating range.

I. Compressor and Motor Assembly Field-Service: Design chiller to make compressor and motor assembly easily accessible for field-inspection and -service.

1. Compressor's internal components are to be accessible without having to remove compressor and motor assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing for rigging.

J. Capacity Control: Use modulating slide-valve assemblies, port unloaders, variable-speed compressor operation, hot-gas bypass or a combination of these capacity control methods to achieve the performance indicated.

1. Maintain stable operation throughout the range of operation. Configure the chiller to achieve the most energy-efficient operation possible for the operating condition.
2. Avoid use of hot-gas bypass if other options are available to achieve performance indicated. Apply hot-gas bypass in accordance with ASHRAE/IES 90.1 and governing codes.
3. Operating Range: From 100 down to [**20**][**15**][**10**][**5**][**zero**]<**Insert number**> percent of design capacity.
4. Condenser-Fluid Requirements over Operating Range: [**Constant-design, entering condenser-fluid temperature**][**Drop-in, entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) drop for each 10 percent in capacity reduction**]<**Insert conditions**> .

K. Oil Lubrication System: Complete system consisting of pump if required, filtration, heater, cooler, factory-wired power connection(s), and integral controls.

1. Operation: Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions [**including chiller shutdown during a power failure**] .
2. Oil Heater: Thermostatically control and properly size oil heater to separate refrigerant and oil.
3. Oil Cooler: [**Refrigerant**][**Fluid**][**Refrigerant- or fluid**] -cooled oil cooler. Oil cooler may be omitted if not required by chiller field application.
4. Oil Filtration: Easily serviceable and replaceable, with means of positive isolation while servicing.
5. Type: Chiller manufacturer standard type. [**Provide dual oil filters, one redundant.**]
6. Filtration Efficiency: Efficiency selected by chiller manufacturer for optimum chiller performance

and long life [**, minimum efficiency 0.5 microns**] .

7. Oil Level Indication: Provide positive visual indication of oil level.
8. Oil: Use an oil that is compatible with the refrigerant and chiller components in contact with the oil.
9. Oil Lubrication System Piping: Factory-install piping with isolation valves and accessories required for a complete system.
10. Oil Pressure Monitoring and Control: Monitoring and controls to regulate oil pressure within safe operating limits.
11. Oil Sump: Sufficient capacity with reserve needed for safe and reliable operation.
12. Pressure Testing: Factory pressure-test system to verify system has no leaks.

L. Refrigeration System:

1. Refrigerant Type: [**R-513A, ASHRAE 34, Class A1**][**R-513A, ASHRAE 34, Class A1; or R-515B, ASHRAE 34, Class A1; or R-1234ze, ASHRAE 34, Class A2L**]<**Insert type**> .
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
3. Refrigerant Circuit: Circuit to include:

    a. Electronic-expansion valve.
    b. Refrigerant charging connections and valves.
    c. Hot-gas muffler.
    d. Compressor suction and discharge shutoff valves.
    e. Liquid-line shutoff valves.
    f. Replaceable-core filter-dryer.
    g. Sight glass with moisture indicator.
    h. Economizer.

4. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
5. Pressure Relief Device:

    a. Comply with requirements in ASHRAE 15 and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

        1) Provide pressure relief valves for each heat exchanger.
        2) Dual Valves: Include dual valves for each heat exchanger with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

6. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 [**and ASHRAE 147**] .
7. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. [**In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.**]

M. Evaporator:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Evaporator shell is separate from condenser.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless carbon-

steel pipe.

4. Refrigerant Carryover: Design evaporator with mist eliminator or other means to prevent liquid refrigerant carryover from entering compressor.
5. Refrigerant Level Indication: Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
6. Tubes:

    a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.
    b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
    c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .
    d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .
    e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .
    f. External Finish: Manufacturer's standard.
    g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

7. Tube Sheets:

    a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
    b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

    a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
    b. Material: Carbon-steel construction.
    c. Type: [**Standard**][**or**][**Marine**] type for water box with piping connections. Standard type for water boxes without piping connections.
    d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or eyebolts.
    e. Hinged Water Boxes: Factory install hinges on one side of water box for ease of opening and to support the weight of water box when opened.
    f. Hinged Marine Water-Box Covers: Factory install hinges on one side of cover for ease of opening and to support the weight of cover when opened.
    g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
    h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid temperature and report information to chiller control panel.
    i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.
    j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

9. Additional Corrosion Protection:

a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.
b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

N. Condenser:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Condenser shell is separate from the evaporator.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
4. Hot-Gas Dispersion: Design and factory install baffle plates or other means to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
5. Refrigerant Visual Indicator: Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
6. Tubes:

   a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.
   b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .
   d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .
   e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .
   f. External Finish: Manufacturer's standard.
   g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

7. Tube Sheets:

   a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
   b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

   a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
   b. Material: Carbon-steel construction.
   c. Type: [**Standard**][**or**][**marine**] -type water boxes for water boxes with piping connections. Standard type water boxes for water boxes without piping connections.
   d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or eyebolts.
   e. Hinged Water Boxes: Install hinges on one side of water box for ease of opening and to support the weight of water box when opened.
   f. Hinged Marine Water-Box Covers: Install hinges on one side of cover for ease of opening and to support the weight of cover when opened.
   g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
   h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in

each nozzle to monitor fluid temperature and report information to chiller control panel.

i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.

j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

9. Additional Corrosion Protection:

a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.

b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

O. Heat-Reclaim Condenser:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Heat-reclaim condenser shell is separate from evaporator.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
4. Hot-Gas Dispersion: Design and factory-install baffle plates or other means to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
5. Tubes:

a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.

b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.

c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .

d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .

e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .

f. External Finish: Manufacturer's standard.

g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

6. Tube Sheets:

a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

7. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.

b. Material: Carbon-steel construction.

c. Type: [**Standard**][**or**][**Marine**] type water boxes for water boxes with piping connections. Standard type water boxes for water boxes without piping connections.

d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or

eyebolts.

e. Hinged Water Boxes: Install hinges on one side of water box for ease of opening and to support the weight of water box when opened.

f. Hinged Marine Water-Box Covers: Install hinges on one side of cover for ease of opening and to support the weight of cover when opened.

g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .

h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid temperature and report information to chiller control panel.

i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.

j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

8. Additional Corrosion Protection:

a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.

b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

P. Electrical Power:

1. Factory installed and wired, and functionally tested at factory before shipment.

2. Single-Point Field-Power Connections: Provide chiller with single-point, field-power connection to [**wiring lugs**][**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip circuit breaker**] .

a. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> .

b. Withstand Rating: Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.

c. Electrical Power for Controls: Factory-install a control-circuit transformer with primary and secondary side fuses for chillers with single-point, field-power connection.

3. Field-Power Connections: Provide chiller with manufacturer's standard multiple field-power connections to [**wiring lugs**][**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip circuit breaker**] .

a. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> .

b. Withstand Rating: Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.

c. Electrical Power for Controls: Dedicated single-point, field-power connection to chiller controls.

4. Branch Circuits: Provide branch power circuit to each motor, electric heater, dedicated electrical load, and controls [**with disconnect switch or circuit breaker**] with same withstand rating to match main disconnecting means.

a. Factory-install a NEMA ICS 2-rated motor controller, hand-off-auto switch, and overcurrent protection for each auxiliary motor.

5. Terminal Blocks: Terminal blocks with numbered [**and color-coded**] wiring to match wiring diagram. Include spare wiring terminal block for connection to external controls or equipment.

6. Electrical Power Wiring Raceways: Factory-install electrical power wiring outside of enclosures in metal raceways. Terminate connections to each motor and heater with not more than [**24-inch (610-mm)**]<**Insert dimension**> length of [**liquidtight**][**or**][**flexible**] conduit.
7. Power Factor Correction: Factory install and wire a capacitor bank for the purpose of power factor correction to [**0.95**]<**Insert value**> at all operating conditions.

    a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
    b. Capacitors are to be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings are to be indicated and not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
    c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
    d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

Q. Constant-Speed Motor Controllers: Factory-furnished and [**field**] installed for use with constant-speed motors.

1. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> , with hinged full-front access door [**with lock and key or padlock and key**] .
2. Control Circuit: Power obtained from [**integral control power transformer**]<**Insert source of control power**> with enough capacity to operate connected control devices.
3. Overload Relays: Size overload relays in accordance with UL 1995 or be an integral component of chiller control microprocessor.
4. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
5. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, [**closed-**][**or**][**open-**] transition.
6. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

    a. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
    b. Visual indication of motor and control status, including the following conditions:

        1) Controller on.
        2) Overload trip.
        3) Loss of phase.
        4) Starter fault.

7. Accessories: Devices are to be factory installed in controller enclosure unless otherwise indicated.

    a. Disconnect Type: Externally operated [**, door-interlocked**] disconnect; [**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip circuit breaker**] . Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
    b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
    c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
    d. Control Relays: Time-delay relays.
    e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
    f. Number-of-Starts Counter: Numerical readout on face of enclosure.

g. Meters: Panel type, [**2-1/2 inches (64 mm)**][**4-1/4 inches (108 mm)**] with [**90**][**120**][**270**] - degree scale and [**1**][**2**] percent accuracy. Where indicated, provide transfer device with an off position. Meters are to indicate the following:

1) Ammeter: Output current for each phase, with current sensors rated to suit application.
2) Voltmeter: Output voltage for each phase.
3) Frequency Meter: Output frequency.
4) Real-time clock with current time and date.
5) Total run time.

h. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1) Selectable, digital display of the following:

a) Phase Currents, Each Phase: Within [**1**]<**Insert value**> percent.
b) Phase-to-Phase Voltages, Three Phase: Within [**1**]<**Insert value**> percent.
c) Phase-to-Neutral Voltages, Three Phase: Within [**1**]<**Insert value**> percent.
d) Three-Phase Real Power: Within [**2**]<**Insert value**> percent.
e) Three-Phase Reactive Power: Within [**2**]<**Insert value**> percent.
f) Power Factor: Within [**2**]<**Insert value**> percent.
g) Frequency: Within [**0.5**]<**Insert value**> percent.
h) Integrated Demand with Demand Interval: Selectable from [**5 to 60**]<**Insert range**> Minutes: Within [**2**]<**Insert value**> percent.
i) Accumulated Energy, in Megawatt Hours (Joules): Within [**2**]<**Insert value**> percent; stored values unaffected by power outages for up to [**72**]<**Insert value**> hours.

2) Mounting: Display and control unit flush or semirecessed in instrument compartment door.

i. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
j. Power Protection: Chiller is to shut down within [**six**]<**Insert value**> cycles of power interruption.

R. Variable-Frequency Controllers: Factory-furnished and installed for use with variable-speed motors.

1. Factory mount motor controller and wire chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

a. Where indicated on the Drawings or in the "Capacities and Characteristics" paragraphs, install a variable-frequency controller for each variable-speed motor to allow operation of one motor with the other motor disconnected and isolated for service.

2. Design: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, [**Type 1**]<**Insert type**> , with hinged full-front access door with lock and key.
4. Integral Disconnecting Means: [**Door-interlocked,**] UL 489, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated output suitable for constant or variable torque loads.
6. Output Rating: Three-phase; with voltage proportional to frequency throughout voltage range.
7. Operating Requirements:

a. Input AC Voltage Tolerance: [**Chiller voltage indicated, plus 10 percent**]<**Insert voltage and tolerance**> .
b. Input Frequency: Tolerance of 60 Hz, plus or minus [**2**]<**Insert value**> Hz.
c. Capable of driving full load, without derating, under the following conditions:

1) Ambient Temperature: [**0 to 40**]<**Insert temperature range**> deg C.
2) Relative Humidity: Up to [**90**][**95**] percent (noncondensing).
3) Altitude: [**3300 ft. (1005 m)**][**6600 ft. (2010 m)**] .

d. Minimum Efficiency: [**96**]<**Insert value**> percent at 60 Hz, full load.
e. Minimum Displacement Primary-Side Power Factor: [**98**]<**Insert value**> percent.
f. Overload Capability: [**1.05**]<**Insert value**> times the full-load current for seven seconds.
g. Starting Torque: As required by compressor-drive assembly.
h. Speed Regulation: Within [**1**]<**Insert value**> percent.
i. Isolated Control Interface: To allow controller to follow control signal over a [**5:1**][**10:1**]<**Insert value**> speed range.
j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller is not to operate continuously.
k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

8. Internal Adjustability Capabilities:

a. Minimum Output Frequency: [**6**]<**Insert value**> Hz.
b. Maximum Output Frequency: [**60**]<**Insert value**> Hz.
c. Acceleration: [**2**]<**Insert value**> to [**60**]<**Insert value**> seconds.
d. Deceleration: Zero to [**60**]<**Insert value**> seconds.
e. Current Limit: [**30**]<**Insert value**> to 100 percent of maximum rating.

9. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions is to not result in component failure or the need for replacement:

a. Overtemperature.
b. Short circuit at controller output.
c. Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.
d. Open circuit at controller output.
e. Input undervoltage.
f. Input overvoltage.
g. Loss of input-phase.
h. Reverse phase.
i. AC line switching transients.
j. Instantaneous overload, line to line or line to ground.
k. Sustained overload exceeding 100 percent of controller rated current.
l. Starting a rotating motor.

10. Motor Protection: Controller to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
11. Automatic Reset and Restart: Capable of [**three**]<**Insert number**> restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller is to be capable of automatic restart on phase-loss, and overvoltage and undervoltage trips.
12. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.
g. Motor speed (percent).
h. Fault or alarm status (code).
i. Motor output voltage.
j. Input kilovolt amperes.
k. Total power factor.
l. Input kilowatts.
m. Input kilowatt-hours.
n. Three-phase input voltage.
o. Three-phase output voltage.
p. Three-phase input current.
q. Three-phase output current.
r. Three-phase input voltage THD.
s. Three-phase input current THD.
t. Output frequency (Hertz).
u. Elapsed operating time (hours).
v. Diagnostic and service parameters.

13. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
14. Control Signal Interface:

    a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and [**six**]<**Insert value**> programmable digital inputs.
    b. Manufacturer has option to incorporate control signal interface into chiller control panel.

15. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to [**5**]<**Insert number**> percent.

    a. Limit variable-frequency controller voltage Total Harmonic Distortion (THD) and current Total Demand Distortion (TDD) to comply with IEEE 519 requirements.

S. Controls:

1. Standalone and microprocessor based with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 3R**]<**Insert type**> , hinged or lockable.
3. Control Wiring Raceways: Factory-install control wiring outside of enclosures in metal raceway. Terminate connections to each control device with not more than a [**24-inch (610-mm)**]<**Insert dimension**> length of [**liquidtight**][**or**][**flexible**] conduit.
4. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Fault history with not less than last [**10**][**5**]<**Insert value**> faults displayed.
    d. Set points of controllable parameters.
    e. Trend data.
    f. Operating hours.
    g. Number of chiller starts.

h. Outdoor-air temperature or space temperature if required for chilled-water reset.
i. Temperature and pressure of operating set points.
j. Entering- and leaving-fluid temperatures of evaporator and condenser.
k. Difference in fluid temperatures of evaporator and condenser.
l. Refrigerant pressures in evaporator and condenser.
m. Refrigerant saturation temperature in evaporator and condenser.
n. Pump status.
o. Antirecycling timer status.
p. Percent of maximum motor amperage.
q. Current-limit set point.
r. Compressor bearing temperature.
s. Motor bearing temperature.
t. Motor winding temperature.
u. Oil temperature.
v. Oil discharge pressure.
w. Phase current.
x. Percent of motor rated load amperes.
y. Phase voltage.
z. Demand power (kilowatts).
aa. Energy use (kilowatt-hours).
bb. Power factor.

5. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
c. Evaporator Leaving Fluid Temperature Reset: Reset leaving evaporator-fluid temperature based on [**return-fluid temperature**][**outdoor-air temperature**][**space temperature**][**remote terminal unit control valve position**]<**Insert reset variable**> temperature.
d. Current limit and demand limit.
e. Condenser-fluid temperature.
f. External chiller emergency stop.
g. Antirecycling timer.
h. Variable evaporator flow.
i. Thermal storage.
j. Dual mode operation with thermal storage.
k. Heat pump.
l. Heat reclaim.

6. Manually Reset Safety Controls: The following conditions are to shut down chiller and require manual reset:

a. Low evaporator refrigerant pressure or temperature.
b. High condenser pressure.
c. Low evaporator fluid temperature.
d. Low oil differential pressure.
e. High or low oil pressure.
f. High oil temperature.
g. High compressor-discharge temperature.
h. Loss of condenser-fluid flow.
i. Loss of evaporator-fluid flow.
j. Motor overcurrent.
k. Motor overvoltage.
l. Motor undervoltage.

m. Motor phase reversal.
n. Motor phase failure.
o. Sensor- or detection-circuit fault.
p. Processor communication loss.
q. Motor controller fault.
r. Extended compressor surge.

7. Trending: Capability to trend analog data of up to [**three**][**five**]<**Insert value**> parameters simultaneously over an adjustable period and frequency of polling.
8. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
9. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
10. Communication Port: USB 2.0 port or higher, capable of connecting to a notebook computer [**tablet**][**smart phone**][**or**][**printer**] .
11. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display chiller operation and alarms.

    a. Hardwired Points:

        1) Monitoring: On-off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt-hours)**][**power factor**]<**Insert monitoring point**> .
        2) Control: On-off operation, [**leaving evaporator-fluid temperature set-point adjustment**][**electrical power demand limit**]<**Insert control point**> .

    b. Serial Communication Interface: [**ASHRAE 135 (BACnet) IP**][**ASHRAE 135 (BACnet) MS/TP**][**LonTalk**][**Modbus TCP/IP**][**Modbus RTU**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel are to be available through the DDC system for HVAC.

T. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.
2. Minimum Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**]<**Insert dimension**> .
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. General Requirements for Factory-Applied Insulation:

    a. Before insulating steel surfaces, prepare surfaces for paint.
    b. Prime and paint steel surfaces to be insulated as indicated for other painted components.
    c. Do not insulate unpainted steel surfaces.
    d. Seal seams and joints to provide a vapor barrier.
    e. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
    f. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
    g. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

5. Field-Applied Insulation:

a. Chiller components that require factory-applied insulation and are not factory insulated are to be field insulated to comply with requirements indicated.
b. Chiller manufacturer is responsible for all chiller factory-applied insulation whether factory or field installed, to ensure chiller manufacturer is the single point of responsibility for chillers.
c. Chiller manufacturer factory-authorized service representative to instruct, supervise, and approve installation of field-applied insulation and paint.
d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

6. Insulation on Cold Surfaces: Factory-apply insulation over cold surfaces of chiller capable of forming condensation. Components are to include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, compressor motor, and auxiliary piping.
7. Insulation on Hot Surfaces: For applications that use chillers to supply heating, factory-apply insulation over hot surfaces of chiller for thermal performance and personnel safety. Components are to include, but not be limited to, [**evaporator,**] condenser [**, heat-reclaim condenser,**] shell and end tube sheets, water boxes including nozzles, [**refrigerant suction pipe from evaporator to compressor,**] refrigerant discharge pipe from compressor to condenser, hot surfaces of compressor, compressor motor and auxiliary piping.

U. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

a. Primer: Provide at least one coat of primer with a total dry film thickness of at least [**2 mils (0.05 mm)**]<**Insert thickness**> .
b. Paint Type: Provide at least two finish coats of [**alkyd-modified, vinyl enamel**][**epoxy**][**polyurethane**][**manufacturer's standard coating**] .
c. Paint Thickness: Total dry film thickness of at least [**4 mils (0.10 mm)**]<**Insert thickness**> .
d. Insulated Surfaces:

1) Paint surfaces that are to be insulated before applying the insulation.
2) Paint installed insulation to match adjacent uninsulated surfaces.

e. Finish Coat Color: Color of finish coat to be [**manufacturer's standard**][**custom color selected by Architect**]<**Insert color description**> .

2. Provide Owner with the following:

a. Closeout Submittal Data: Submit paint manufacturer and paint product details for Owner to procure matching paint in the future.
b. Spare Paint: Turn over to Owner a [**one quart**]<**Insert size**> container of paint that was used in application of finish coat to use in touchup applications at Project closeout. Properly label container for ease of future reference.

V. Accessories:

1. Flow Switches: If required for chiller operation and not factory installed, chiller manufacturer to furnish flow switches for field-mounting with installation instructions.

a. Paddle Flow Switches:

1) Type: Vane operated to actuate a double-pole, double-throw switch with one pole

field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

2) Pressure Rating: Pressure rating equal to not less than pressure rating of heat exchanger.
3) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of [**10 A at 120 V ac**]<**Insert rating**> .
4) Enclosure: House switch in a NEMA 250, [**Type 4**]<**Insert type**> enclosure constructed of die-cast aluminum.
5) Construction: Construct body and wetted parts of Type 316 stainless steel.
6) Vane: Vane length to suit installation.

b. Pressure Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch is to withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, [**Type 4**]<**Insert type**> .
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

c. Thermal Dispersion Type Flow Sensors/Switches: Chiller manufacturer standard offering.

1) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
2) Factory calibrated for Project-specific application.

2. Vibration Isolation: Chiller manufacturer to furnish chillers with vibration isolation and installation instructions for field-mounting.

a. Neoprene Pads:

1) Two layers of **0.375-inch- (10-mm-)** thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gauge, stainless steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless steel square bearing plate to load the pad uniformly between **20 and 40 psig (138 and 276 kPa)** with a **0.12- to 0.16-inch (3- to 4-mm)** deflection.

3. Sound Barriers:

a. Furnish removable and reusable sound-barrier covers over the compressor housing, motor, compressor suction and discharge piping, and other components as required to achieve sound performance indicated.
b. Design sound-barrier covers for repeated installation and removal without use of tape, caulk, and special tools.
c. Inner and outer surfaces of cover to consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
d. Double sew and lock stitch covers with edges folded and sewn so no raw cut edges are exposed.
e. Form covers around control devices, gauges, conduit, piping, and supports without degrading sound-barrier performance.
f. Continuously lap all exposed joints and seams at least **2 inches (50 mm)** for better sound

containment.

g. Permanently label each section of sound-barrier cover to indicate its location, description, size, and number sequence. Affix a sound-barrier installation diagram on chiller in an easily visible location.

h. Randomly place stainless steel quilting pins to prevent covers from shifting and sagging.

W. Capacities and Characteristics:

1. Capacity: <**Insert tons (kW)**> .
2. Full-Load Efficiency:

   a. COP: <**Insert value**> .
   b. EER: <**Insert value**> .
   c. Power Input/Cooling Output: <**Insert kW/ton (kW/kW)**> .
   d. Comply with FEMP.

3. Part-Load Efficiency:

   a. IPLV: <**Insert value**> .
   b. NPLV: <**Insert value**> .
   c. Comply with FEMP.

4. Evaporator:

   a. Pressure Rating: <**Insert psig (kPa)**> .
   b. Number of Passes: [**One**][**Two**][**Three**][**Four**] .
   c. Fluid Type: [**Water**]<**Insert fluid type**> .
   d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
   e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
   f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
   g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
   h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
   i. Fluid Velocity: <**Insert fps (m/s)**> .
   j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

5. Condenser:

   a. Pressure Rating: <**Insert psig (kPa)**> .
   b. Number of Passes: [**One**][**Two**][**Three**][**Four**] .
   c. Fluid Type: [**Water**]<**Insert fluid type**> .
   d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
   e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
   f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
   g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
   h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
   i. Fluid Velocity: <**Insert fps (m/s)**> .
   j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

6. Heat-Reclaim Condenser:

a. Pressure Rating: <**Insert psig (kPa)**> .
b. Number of Passes: [**One**][**Two**][**Three**] .
c. Fluid Type: [**Water**]<**Insert fluid type**> .
d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
i. Fluid Velocity: <**Insert fps (m/s)**> .
j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

7. Compressor:

a. Rated Load Amperes: <**Insert value**> .
b. Locked-Rotor Amperes: <**Insert value**> .

8. Packaged Chiller Electrical Requirements:

a. Power Input: <**Insert kilowatts**> .
b. Power Factor: [**0.95**]<**Insert value**> .
c. Minimum Circuit Ampacity: <**Insert value**> .
d. Maximum Overcurrent Protection Device: <**Insert amperage**> .
e. Volts: [**208**][**240**][**480**][**600**]<**Insert value**> V ac.
f. Phase: Three.
g. Hertz: 60.

9. Chiller Control Electrical Requirements:

a. Power Connections: [**Fed through integral transformer**][**Separate field-power connection**] .
b. Power Input: <**Insert number**> kW.
c. Minimum Circuit Ampacity: <**Insert number**> A.
d. Maximum Overcurrent Protection Device: <**Insert number**> A.
e. Volts: [**120**]<**Insert number**> V ac.
f. Phase: Single.
g. Hertz: 60.

10. Noise Rating: [**85**]<**Insert dBA**> sound power level when measured in accordance with AHRI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.
11. Rapid Restart and Loading Feature: Chiller to start and reach [**100**]<**Insert value**> percent of design capacity within [**160 seconds**]<**Insert seconds**> of a start signal or restart signal after electrical power interruption.

2.3 PACKAGED, WATER-COOLED, ROTARY-SCREW CHILLER - MULTIPLE COMPRESSOR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]
2. [**Dunham-Bush, Inc**]
3. [**Trane**]

4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Dunham-Bush, Inc**]
3. [**Trane**]
4. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
5. **<Insert manufacturer's name>**

C. Source Limitations: Obtain packaged, water-cooled, rotary-screw multiple-compressor chillers from single manufacturer.

D. Description: Factory-assembled, functionally [**and run-**] tested chiller with compressors, compressor motors and motor controllers, evaporator, condenser where indicated, [**heat-reclaim condenser where indicated,**] electrical power, controls, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

E. Base: Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement [**without damage**] during a seismic event when chiller base is anchored to a field support structure.

F. Compressors: Positive displacement, semi-hermetically sealed and oil lubricated.

1. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
2. Rotors: Manufacturer's standard rotor design.
3. Seals: Seal compressor and drive assembly to prevent refrigerant leakage.

G. Compressor Motors:

1. Cooling: Semi-hermetically sealed and cooled by refrigerant suction gas.
2. Type: Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required for performance indicated.
3. Assembly: Factory mounted, aligned, and balanced as part of compressor-drive assembly.
4. Capacity: Motors with sufficient capacity to drive compressors throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
5. Motor Winding Temperature Monitoring: Thermistor or RTD mounted in [**single motor winding**][**each of three-phase motor windings**] to monitor temperature and report information to chiller control panel.
6. Motor Bearing Temperature Monitoring: Thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

H. Vibration Balance: Precision balance chiller compressor and motor assembly to minimize vibration over entire operating range.

I. Compressor and Motor Assembly Field-Service: Design chiller to make compressor and motor assembly easily accessible for field inspection and service.

1. Compressor's internal components are to be accessible without having to remove compressor and motor assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing for rigging.

J. Capacity Control: Use on-off compressor cycling, modulating slide-valve assemblies, port unloaders, variable-speed compressor operation, hot-gas bypass, or a combination of these capacity control methods to achieve the performance indicated.

1. Maintain stable operation throughout the range of operation. Configure the chiller to achieve the most energy-efficient operation possible for the operating condition.
2. Operating Range: From 100 down to [**20**][**15**][**10**][**5**][**zero**]<**Insert number**> percent of design capacity.
3. Condenser-Fluid Requirements over Operating Range: [**Constant-design, entering condenser-fluid temperature**][**Drop-in, entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) drop for each 10 percent in capacity reduction**]<**Insert conditions**> .

K. Oil Lubrication System: Complete system consisting of pump if required, filtration, heater, cooler, factory-wired power connection(s), and integral controls.

1. Operation: Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions [**including chiller shutdown during a power failure**] .
2. Oil Heater: Thermostatically control and properly size oil heater to separate refrigerant and oil.
3. Oil Cooler: [**Refrigerant**][**Fluid**][**Refrigerant- or fluid**] -cooled oil cooler. Oil cooler may be omitted if not required by chiller field application.
4. Oil Filtration: Easily serviceable and replaceable, with means of positive isolation while servicing.

   a. Type: Chiller manufacturer standard type. [**Provide dual oil filters, one redundant, per refrigerant circuit**] .
   b. Filtration Efficiency: Efficiency selected by chiller manufacturer for optimum chiller performance and long life [**, minimum efficiency 0.5 microns**] .

5. Oil Level Indication: Provide positive visual indication of oil level.
6. Oil: Use an oil that is compatible with the refrigerant and chiller components in contact with the oil.
7. Oil Lubrication System Piping: Factory-install piping with isolation valves and accessories required for a complete system.
8. Oil Pressure Monitoring and Control: Monitoring and controls to regulate oil pressure within safe operating limits.
9. Oil Sump: Sufficient capacity with reserve needed for safe and reliable operation.
10. Pressure Testing: Factory pressure-test system to verify system has no leaks.

L. Refrigeration Systems:

1. Refrigerant Type: [**R-513A, ASHRAE 34 Safety Group A1**]<**Insert type**> .
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit to include:

   a. Electronic-expansion valve.
   b. Refrigerant charging connections and valves.
   c. Hot-gas muffler.
   d. Compressor suction and discharge shutoff valves.
   e. Liquid-line shutoff valves.
   f. Oil filter.
   g. Replaceable-core filter-dryer.
   h. Sight glass with moisture indicator.
   i. Economizer.

4. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying

performance requirements indicated.

5. Pressure Relief Device:

   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

      1) Provide pressure relief valves for each heat exchanger.
      2) Dual Valves: Include dual valves for each heat exchanger with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

6. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. [**In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.**]
7. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 [**and ASHRAE 147**] .

M. Evaporators:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Evaporator shell is separate from condenser.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless carbon-steel pipe.
4. Refrigerant Carryover: Design evaporator with mist eliminator or other means to prevent liquid refrigerant carryover from entering compressor.
5. Refrigerant Level Indication: Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
6. Tubes:

   a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.
   b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .
   d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .
   e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .
   f. External Finish: Manufacturer's standard.
   g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

7. Tube Sheets:

   a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
   b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

    a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
    b. Material: Carbon-steel construction.
    c. Type: [**Standard**][**or**][**Marine**] type for water box with piping connections. Standard type for water boxes without piping connections.
    d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or eyebolts.
    e. Hinged Water Boxes: Factory install hinges on one side of water box for ease of opening and to support the weight of water box when opened.
    f. Hinged Marine Water-Box Covers: Factory install hinges on one side of cover for ease of opening and to support the weight of cover when opened.
    g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
    h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid temperature and report information to chiller control panel.
    i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.
    j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

9. Additional Corrosion Protection:

    a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.
    b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

N. Condensers:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Condenser shell is separate from the evaporator.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
4. Hot-Gas Dispersion: Design and factory install baffle plates or other means to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
5. Refrigerant Visual Indicator: Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
6. Tubes:

    a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.
    b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
    c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .
    d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .
    e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .
    f. External Finish: Manufacturer's standard.
    g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

7. Tube Sheets:

   a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
   b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

   a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
   b. Material: Carbon-steel construction.
   c. Type: [**Standard**][**or**][**Marine**] type water boxes for water boxes with piping connections. Standard type water boxes for water boxes without piping connections.
   d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or eyebolts.
   e. Hinged Water Boxes: Install hinges on one side of water box for ease of opening and to support the weight of water box when opened.
   f. Hinged Marine Water-Box Covers: Install hinges on one side of cover for ease of opening and to support the weight of cover when opened.
   g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
   h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid temperature and report information to chiller control panel.
   i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.
   j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

9. Additional Corrosion Protection:

   a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.
   b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

O. Chillers Without Integral Condensers: Provide chillers without an integral condenser and design chillers for field connection to remote condenser. Coordinate requirements with Section 236313 "Air-Cooled Refrigerant Condensers."

P. Heat-Reclaim Condensers:

1. Design: Shell-and-tube design with fluid in tubes and refrigerant surrounding tubes within shell. Heat-reclaim condenser shell is separate from evaporator.
2. Code Compliance: Tested and stamped in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
4. Hot-Gas Dispersion: Design and factory-install baffle plates or other means to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
5. Tubes:

a. Individually field-replaceable from either end and without damage to tube sheets and other tubes.
b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
c. Material: [**Copper**][**Copper-nickel alloy**][**Copper or copper-nickel alloy**]<**Insert material**> .
d. Nominal OD: [**Manufacturer's choice**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**3/4 or 1 inch (19 or 25 mm)**] .
e. Minimum Wall Thickness: [**Manufacturer's choice**][**0.025 inch (0.6 mm)**][**0.028 inch (0.7 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> .
f. External Finish: Manufacturer's standard.
g. Internal Finish: [**Enhanced**][**or**][**smooth**] .

6. Tube Sheets:

a. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
b. Intermediate Tube Sheets: Carbon-steel plates drilled and reamed to accommodate tubes; welded to shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

7. Water Boxes: Install removable water boxes arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

a. Attachment: Bolt and gasket water boxes to end tube sheets to provide a watertight seal.
b. Material: Carbon-steel construction.
c. Type: [**Standard**][**or**][**Marine**] type water boxes for water boxes with piping connections. Standard type water boxes for water boxes without piping connections.
d. Lifting Provisions: Provide water boxes [**and marine water-box covers**] with lifting lugs or eyebolts.
e. Hinged Water Boxes: Install hinges on one side of water box for ease of opening and to support the weight of water box when opened.
f. Hinged Marine Water-Box Covers: Install hinges on one side of cover for ease of opening and to support the weight of cover when opened.
g. Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**][**Welded, ASME B16.5, raised-face flange**][**Grooved for mechanical-joint coupling**][**Grooved with mechanical-joint coupling and flange adapter**] .
h. Fluid-Temperature Monitoring: Thermistor or RTD temperature sensor factory installed in each nozzle to monitor fluid temperature and report information to chiller control panel.
i. Drain Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at low point of water box.
j. Vent Connections: Fit each water box with [**3/4-inch (19-mm)**][**1-inch (25-mm)**][**3/4- or 1-inch (19- or 25-mm)**]<**Insert dimension**> NPT connection and threaded plug at high point of water box.

8. Additional Corrosion Protection:

a. Anodes: Factory install easily replaceable electrolytic corrosion-inhibitor [**zinc**][**or**][**magnesium**] anodes inside of water boxes.
b. Corrosion-Resistant Finish: Coat wetted surfaces with a corrosion-resistant finish.

Q. Electrical Power:

1. Factory installed and wired, and functionally tested at factory before shipment.

2. Single-Point Field-Power Connections: Provide chiller with single-point, field-power connection to [**wiring lugs**][**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip circuit breaker**] .

    a. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> .
    b. Withstand Rating: Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
    c. Electrical Power for Controls: Factory-install a control-circuit transformer with primary and secondary side fuses for chillers with single-point, field-power connection.

3. Field-Power Connections: Provide chiller with manufacturer's standard multiple field-power connections to [**wiring lugs**][**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip circuit breaker**] .

    a. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> .
    b. Withstand Rating: Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
    c. Electrical Power for Controls: Dedicated single-point, field-power connection to chiller controls.
    d. Where indicated, configure chiller power to allow chiller operation with only one compressor and power to other chiller compressor(s) disconnected and isolated for service.

4. Branch Circuits: Provide branch power circuit to each motor, electric heater, dedicated electrical load, and controls [**with disconnect switch or circuit breaker**] with same withstand rating to match main disconnecting means.

    a. Factory-install a NEMA ICS 2-rated motor controller, hand-off-auto switch, and overcurrent protection for each auxiliary motor.

5. Terminal Blocks: Terminal blocks with numbered [**and color-coded**] wiring to match wiring diagram. Include spare wiring terminal block for connection to external controls or equipment.
6. Electrical Power Wiring Raceways: Factory-install electrical power wiring outside of enclosures in metal raceways. Terminate connections to each motor and heater with not more than [**24-inch (610-mm)**]<**Insert dimension**> length of [**liquidtight**][**or**][**flexible**] conduit.
7. Power Factor Correction: Factory install and wire a capacitor bank for the purpose of power factor correction to [**0.95**]<**Insert value**> at all operating conditions.

    a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
    b. Capacitors are to be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings are to be indicated and not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
    c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
    d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

R. Constant-Speed Motor Controllers: Factory-furnished and [**field**] installed for use with constant-speed motors.

1. Enclosure: NEMA 250, [**Type 1**]<**Insert type**> , with hinged full-front access door [**with lock and key or padlock and key**] .

2. Control Circuit: Power obtained from [**integral control power transformer**]<**Insert source of control power**> with enough capacity to operate connected control devices.
3. Overload Relays: Size overload relays in accordance with UL 1995 or to be an integral component of chiller control microprocessor.
4. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
5. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed or open transition.
6. Accessories: Devices are to be factory installed in controller enclosure unless otherwise indicated.

    a. Disconnect Type: Externally Operated [**, door-interlocked**] disconnect; [**NEMA BS 31047, heavy-duty, fused disconnect switch**][**NEMA BS 31047, heavy-duty, nonfused disconnect switch**][**UL 489, instantaneous-trip Circuit breaker**] . Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
    b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
    c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
    d. Control Relays: Time-delay relays.
    e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
    f. Number-of-Starts Counter: Numerical readout on face of enclosure.
    g. Meters: Panel type, [**2-1/2 inches (64 mm)**][**4-1/4 inches (108 mm)**] with [**90**][**120**][**270**] - degree scale and [**1**][**2**] percent accuracy. Where indicated, provide transfer device with an off position. Meters are to indicate the following:

        1) Ammeter: Output current for each phase, with current sensors rated to suit application.
        2) Voltmeter: Output voltage for each phase.
        3) Frequency Meter: Output frequency.
        4) Real-time clock with current time and date.
        5) Total run time.

    h. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

        1) Selectable, digital display of the following:

            a) Phase Currents, Each Phase: Within [**1**]<**Insert value**> percent.
            b) Phase-to-Phase Voltages, Three Phase: Within [**1**]<**Insert value**> percent.
            c) Phase-to-Neutral Voltages, Three Phase: Within [**1**]<**Insert value**> percent.
            d) Three-Phase Real Power: Within [**2**]<**Insert value**> percent.
            e) Three-Phase Reactive Power: Within [**2**]<**Insert value**> percent.
            f) Power Factor: Within [**2**]<**Insert value**> percent.
            g) Frequency: Within [**0.5**]<**Insert value**> percent.
            h) Integrated Demand with Demand Interval: Selectable from [**5 to 60**]<**Insert range**> Minutes: Within [**2**]<**Insert value**> percent.
            i) Accumulated Energy, in Megawatt Hours (Joules): Within [**2**]<**Insert value**> percent; stored values unaffected by power outages for up to [**72**]<**Insert value**> hours.

        2) Mounting: Display and control unit flush or semirecessed in instrument compartment door.

    i. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
    j. Power Protection: Chiller is to shut down within [**six**]<**Insert value**> cycles of power

interruption.

S. Variable-Frequency Controllers: Factory-furnished and installed for use with variable-speed motors.

1. Factory mount motor controllers and wire chiller to provide a [**multipoint**][**single-point**] , field-power termination to the chiller and its auxiliaries.

   a. Where indicated, install a variable-frequency controller for each variable-speed motor to allow operation of one motor with the other motor(s) disconnected and isolated for service.

2. Design: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, [**Type 1**]<**Insert type**> , with hinged full-front access door with lock and key.
4. Integral Disconnecting Means: [**Door-interlocked,**] UL 489, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**42,000**][**65,000**][**100,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated output suitable for constant or variable torque loads.
6. Output Rating: Three-phase; with voltage proportional to frequency throughout voltage range.
7. Operating Requirements:

   a. Input AC Voltage Tolerance: [**Chiller voltage indicated, plus 10 percent**]<**Insert voltage and tolerance**> .
   b. Input Frequency: Tolerance of 60 Hz, plus or minus [**2**]<**Insert value**> Hz.
   c. Capable of driving full load, without derating, under the following conditions:

      1) Ambient Temperature: [**0 to 40**]<**Insert temperature range**> deg C.
      2) Relative Humidity: Up to [**90**][**95**] percent (noncondensing).
      3) Altitude: [**3300 ft. (1005 m)**][**6600 ft. (2010 m)**] .

   d. Minimum Efficiency: [**96**]<**Insert value**> percent at 60 Hz, full load.
   e. Minimum Displacement Primary-Side Power Factor: [**98**]<**Insert value**> percent.
   f. Overload Capability: [**1.05**]<**Insert value**> times the full-load current for seven seconds.
   g. Starting Torque: As required by compressor-drive assembly.
   h. Speed Regulation: Within [**1**]<**Insert value**> percent.
   i. Isolated Control Interface: To allow controller to follow control signal over a [**5:1**][**10:1**]<**Insert value**> speed range.
   j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller is not to operate continuously.
   k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

8. Internal Adjustability Capabilities:

   a. Minimum Output Frequency: [**6**]<**Insert value**> Hz.
   b. Maximum Output Frequency: [**60**]<**Insert value**> Hz.
   c. Acceleration: [**2**]<**Insert value**> to [**60**]<**Insert value**> seconds.
   d. Deceleration: Zero to [**60**]<**Insert value**> seconds.
   e. Current Limit: [**30**]<**Insert value**> to 100 percent of maximum rating.

9. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions is to not result in component failure or the need for replacement:

   a. Overtemperature.
   b. Short circuit at controller output.

c. Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.
d. Open circuit at controller output.
e. Input undervoltage.
f. Input overvoltage.
g. Loss of input-phase.
h. Reverse phase.
i. AC line switching transients.
j. Instantaneous overload, line to line or line to ground.
k. Sustained overload exceeding 100 percent of controller rated current.
l. Starting a rotating motor.

10. Motor Protection: Controller to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
11. Automatic Reset and Restart: Capable of [**three**]<**Insert number**> restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller is to be capable of automatic restart on phase-loss, and overvoltage and undervoltage trips.
12. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.
g. Motor speed (percent).
h. Fault or alarm status (code).
i. Motor output voltage.
j. Input kilovolt amperes.
k. Total power factor.
l. Input kilowatts.
m. Input kilowatt-hours.
n. Three-phase input voltage.
o. Three-phase output voltage.
p. Three-phase input current.
q. Three-phase output current.
r. Three-phase input voltage THD.
s. Three-phase input current THD.
t. Output frequency (Hertz).
u. Elapsed operating time (hours).
v. Diagnostic and service parameters.

13. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
14. Control Signal Interface:

a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and [**six**]<**Insert value**> programmable digital inputs.
b. Manufacturer has option to incorporate control signal interface into chiller control panel.

15. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to [**5**]<**Insert number**> percent.

a. Limit variable-frequency controller voltage Total Harmonic Distortion (THD) and current

Total Demand Distortion (TDD) to comply with IEEE 519 requirements.

T. Controls:

1. Standalone and microprocessor based with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
2. Enclosure: Unit mounted, NEMA 250, [**Type 1**][**Type 3R**]<**Insert type**> , hinged or lockable.
3. Control Wiring Raceways: Factory-install control wiring outside of enclosures in metal raceway. Terminate connections to each control device with not more than a [**24-inch (610-mm)**]<**Insert dimension**> length of [**liquidtight**][**or**][**flexible**] conduit.
4. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Fault history with not less than last [**10**][**5**]<**Insert value**> faults displayed.
    d. Set points of controllable parameters.
    e. Trend data.
    f. Operating hours.
    g. Number of chiller starts.
    h. Outdoor-air temperature or space temperature if required for chilled-water reset.
    i. Temperature and pressure of operating set points.
    j. Entering- and leaving-fluid temperatures of evaporator and condenser.
    k. Difference in fluid temperatures of evaporator and condenser.
    l. Refrigerant pressures in evaporator and condenser.
    m. Refrigerant saturation temperature in evaporator and condenser.
    n. Elapsed time meter (compressor run status).
    o. Pump status.
    p. Antirecycling timer status.
    q. Percent of maximum motor amperage.
    r. Current-limit set point.
    s. Number of compressor starts.
    t. Compressor bearing temperature.
    u. Motor bearing temperature.
    v. Motor winding temperature.
    w. Oil temperature.
    x. Oil discharge pressure.
    y. Phase current.
    z. Percent of motor rated load amperes.
    aa. Phase voltage.
    bb. Demand power (kilowatts).
    cc. Energy use (kilowatt-hours).
    dd. Power factor.

5. Control Functions:

    a. Manual or automatic startup and shutdown time schedule.
    b. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
    c. Evaporator Leaving Fluid Temperature Reset: Reset leaving evaporator-fluid temperature based on [**return-fluid temperature**][**outdoor-air temperature**][**space temperature**][**remote terminal unit control valve position**]<**Insert reset variable**> temperature.
    d. Current limit and demand limit.
    e. Condenser-fluid temperature.

f. External chiller emergency stop.
g. Antirecycling timer.
h. Automatic lead-lag switching.
i. Variable evaporator flow.
j. Thermal storage.
k. Dual mode operation with thermal storage.
l. Heat pump.
m. Heat reclaim.

6. Manually Reset Safety Controls: The following conditions are to shut down chiller and require manual reset:

   a. Low evaporator refrigerant pressure or temperature.
   b. High condenser refrigerant pressure.
   c. Low evaporator fluid temperature.
   d. Low oil differential pressure.
   e. High or low oil pressure.
   f. High oil temperature.
   g. High compressor-discharge temperature.
   h. Loss of condenser-fluid flow.
   i. Loss of evaporator-fluid flow.
   j. Motor overcurrent.
   k. Motor overvoltage.
   l. Motor undervoltage.
   m. Motor phase reversal.
   n. Motor phase failure.
   o. Sensor- or detection-circuit fault.
   p. Processor communication loss.
   q. Motor controller fault.
   r. Extended compressor surge.

7. Trending: Capability to trend analog data of up to [**three**][**five**]<**Insert value**> parameters simultaneously over an adjustable period and frequency of polling.
8. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
9. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
10. Communication Port: USB 2.0 port or higher, capable of connecting to a notebook computer [**tablet**][**smart phone**][**or**][**printer**] .
11. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display chiller status and alarms.

    a. Hardwired Points:

       1) Monitoring: On-off status, [**common trouble alarm**][**electrical power demand (kilowatts)**][**electrical power consumption (kilowatt-hours)**][**power factor**]<**Insert monitoring point**> .
       2) Control: On-off operation, [**leaving evaporator-fluid temperature set-point adjustment**][**electrical power demand limit**]<**Insert control point**> .

    b. Serial Communication Interface: [**ASHRAE 135 (BACnet) IP**][**ASHRAE 135 (BACnet) MS/TP**][**LonTalk**][**Modbus TCP/IP**][**Modbus RTU**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed

locally at chiller control panel are to be available through the DDC system for HVAC.

U. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.
2. Minimum Thickness: [**3/4 inch (19 mm)**][**1-1/2 inches (38 mm)**]<**Insert dimension**> .
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. General Requirements for Factory-Applied Insulation:

    a. Before insulating steel surfaces, prepare surfaces for paint.
    b. Prime and paint steel surfaces to be insulated as indicated for other painted components.
    c. Do not insulate unpainted steel surfaces.
    d. Seal seams and joints to provide a vapor barrier.
    e. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
    f. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
    g. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

5. Field-Applied Insulation:

    a. Chiller components that require factory-applied insulation and are not factory insulated are to be field insulated to comply with requirements indicated.
    b. Chiller manufacturer is responsible for all chiller factory-applied insulation whether factory or field installed, to ensure chiller manufacturer is the single point of responsibility for chillers.
    c. Chiller manufacturer factory-authorized service representative to instruct, supervise, and approve installation of field-applied insulation and paint.
    d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

6. Insulation on Cold Surfaces: Factory-apply insulation over cold surfaces of chiller capable of forming condensation. Components are to include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, compressor motor, and auxiliary piping.
7. Insulation on Hot Surfaces: For applications that use chillers to supply heating, factory-apply insulation over hot surfaces of chiller for thermal performance and personnel safety. Components are to include, but not be limited to, [**evaporator,**] condenser [**, heat-reclaim condenser**] shell and end tube sheets, water boxes including nozzles, [**refrigerant suction pipe from evaporator to compressor,**] refrigerant discharge pipe from compressor to condenser, hot surfaces of compressor, compressor motor and auxiliary piping.

V. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

    a. Primer: Provide at least one coat of primer with a total dry film thickness of at least [**2 mils (0.05 mm)**]<**Insert thickness**> .
    b. Paint Type: Provide at least two finish coats of [**alkyd-modified, vinyl enamel**][**epoxy**][**polyurethane**][**manufacturer's standard coating**] .
    c. Paint Thickness: Total dry film thickness of at least [**4 mils (0.10 mm)**]<**Insert thickness**> .

d. Insulated Surfaces:

1) Paint surfaces that are to be insulated before applying the insulation.
2) Paint installed insulation to match adjacent uninsulated surfaces.

e. Finish Coat Color: Color of finish coat to be [**manufacturer's standard**][**custom color selected by Architect**]<**Insert color description**> .

2. Provide Owner with the following:

a. Closeout Submittal Data: Submit paint manufacturer and paint product details for Owner to procure matching paint in the future.
b. Spare Paint: Turn over to Owner a [**one-quart**]<**Insert size**> container of paint that was used in application of finish coat to use in touchup applications at Project closeout. Properly label container for ease of future reference.

W. Accessories:

1. Flow Switches: If required for chiller operation and not factory installed, chiller manufacturer to furnish flow switches for field-mounting with installation instructions.

a. Paddle Flow Switches:

1) Type: Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
2) Pressure Rating: Pressure rating equal to not less than pressure rating of heat exchanger.
3) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of [**10 A at 120 V ac**]<**Insert rating**> .
4) Enclosure: House switch in a NEMA 250, [**Type 4**]<**Insert type**> enclosure constructed of die-cast aluminum.
5) Construction: Construct body and wetted parts of Type 316 stainless steel.
6) Vane: Vane length to suit installation.

b. Pressure Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch is to withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, [**Type 4**]<**Insert type**> .
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

c. Thermal Dispersion Type Flow Sensors/Switches: Chiller manufacturer standard offering.

1) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
2) Factory calibrated for Project-specific application.

2. Vibration Isolation: Chiller manufacturer to furnish chillers with vibration isolation and installation instructions for field-mounting.

a. Neoprene Pads:

1) Two layers of **0.375-inch- (10-mm-)** thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gauge, stainless steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless steel square bearing plate to load the pad uniformly between **20 and 40 psig (138 and 276 kPa)** with a **0.12- to 0.16-inch (3- to 4-mm)** deflection.

3. Sound-Barrier Covers:

a. Furnish removable and reusable sound-barrier covers over the compressor housing, motor, compressor suction and discharge piping, and other components as required to achieve sound performance indicated.
b. Design sound-barrier covers for repeated installation and removal without use of tape, caulk, and special tools.
c. Inner and outer surfaces of cover to consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
d. Double sew and lock stitch covers with edges folded and sewn so no raw cut edges are exposed.
e. Form covers around control devices, gauges, conduit, piping, and supports without degrading sound-barrier performance.
f. Continuously lap all exposed joints and seams at least **2 inches (50 mm)** for better sound containment.
g. Permanently label each section of sound-barrier cover to indicate its location, description, size, and number sequence. Affix a sound-barrier installation diagram on chiller in an easily visible location.
h. Randomly place stainless steel quilting pins to prevent covers from shifting and sagging.

4. Sound-Reduction Enclosures: Chiller manufacturer standard factory-furnished [**, field-installed**] acoustic enclosure(s) around the compressors, drive assemblies, and other noise-generating components that are designed to reduce chiller sound levels without affecting performance.

2.4 MODULAR, HOUSED, WATER-COOLED ROTARY-SCREW WATER CHILLER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**WaterFurnace International, Inc.**]
2. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**WaterFurnace International, Inc.**]
2. **<Insert manufacturer's name>**

C. Source Limitations: Obtain modular, housed, water-cooled rotary-screw water chillers from single manufacturer.

D. Description: Modular, housed, water-cooled rotary-screw water chiller/heater producing chilled water and simultaneously producing hot water.

E. Housing/Modular Enclosure:

1. Designed to fit through a [**36 inch (0.9 m)**]<**Insert dimension**> doorway.
2. Each module individually isolatable for service without affecting operation of the rest of the modules in the bank/group.
3. Can be banked/grouped in a row together and controlled as a bank/group of up to and including [**10**]<**Insert number**> modules of [**140 ton (490 kW)**]<**Insert capacity**> maximum capacity each.

F. Compressor: Variable speed control.

G. Compressor Motor: Permanent magnet motor with integrated drive.

H. Capacity: Capable of producing [**40 deg F (4.4 deg C)**]<**Insert temperature**> chilled water and simultaneously producing [**145 deg F (62.8 deg C)**]<**Insert temperature**> hot water.

I. Capacity Control:

1. DC inverter variable speed control.
2. Capable of capacity turndown to 25 percent of rated capacity.
3. Electronic Expansion Valve: To provide superheat control as well as a wider range of operation; superheat values are to be reported back to system controller to allow diagnostic information to be available to the maintenance service technician without requiring use of refrigerant manifold gauges.

J. Refrigerant: [**R-513A, ASHRAE 34 Group A1**]<**Insert refrigerant**> .

K. Evaporator: Brazed plate.

L. Condenser: Stainless steel.

M. Electrical Power:

1. Electrical Connection: Single point.
2. Disconnect Switch: Factory mounted, internally wired, through the door.
3. Withstand Rating: Minimum withstand rating is to be as required by electrical power distribution system, but not less than [**65,000**]<**Insert value**> A.
4. Control-Circuit Transformer: Factory-installed control-circuit transformer with primary-side and secondary-side fuses.

N. Controls:

1. Control Hardware:

a. User Interface: Supervisory controller mounted in NEMA 250 hinged and keyed control box, including 15-amp electrical convenience outlet, color touch screen tablet with customizable 3-D graphical control interface for multiple chillers/pumps.
b. WiFi router.
c. Setpoint, aquastat or network control methods with adjustable PID parameters.
d. Eight, normally open, field-defined user relay outputs.
e. Two, 0-10V, field-defined analog outputs.
f. Six, 0-24VAC, field-defined digital inputs.
g. Two, 0-5V, field-defined pressure sensors.
h. Two, 0-100A, field-defined current transducer inputs.
i. Hardwired Points:

1) Monitoring: On-off status, [**common trouble alarm**][**electrical power demand**

(kilowatts)][**electrical power consumption (kilowatt-hours)**][**power factor**]<**Insert additional monitoring points as desired**> .

2) Control: On-off operation, [**leaving evaporator-fluid temperature set-point adjustment**][**electrical power demand limit**]<**Insert additional control points as desired**> .

j. Communication Interface: Supervisory controller is to provide for single point BAS integration via [**BACnet Advanced Workstation (B-AWS) and BACnet Building Controller (B-BC) compliant**]<**Insert type of interface**> . Communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel are to be available through the DDC system for HVAC.

2. Control Functions:

a. Compressor lead/lag control.
b. Anti-short-cycle compressor protection.
c. Minimum run time compressor protection.
d. High refrigerant pressure and low refrigerant pressure cutouts.
e. Loss of refrigerant charge protection.
f. Slow-opening water valve timing.
g. Selectable water coil freeze detection via refrigerant temperature and suction saturation temperature sensing.
h. Selectable water coil freeze detection via internal heat exchanger fluid temperature sensing.
i. Selectable water coil freeze alarm.
j. Over/under voltage protection.
k. Remote DIP switch override.
l. Load shed.
m. Emergency shutdown.
n. Diagnostic LEDs.
o. Test mode push-button switch.
p. Fault retry with fault history.
q. Source and load entering- and leaving-fluid temperatures.
r. Alarm output with optional E-code pulsing.
s. Four accessory output relays with normally open and normally closed contacts.
t. Modbus communication protocol between sensors and control panel.
u. Energy Monitoring: Monitoring of energy consumption data.
v. Performance Monitoring: Monitoring of water flow and change in temperature.
w. Refrigerant Monitoring: For performance feedback and for maintenance diagnostics.

O. Capacities and Characteristics:

1. Capacity: <**Insert tons (kW)**> .
2. Full-Load Efficiency:

a. COP: <**Insert value**> .
b. EER: <**Insert value**> .
c. Power Input/Cooling Output: <**Insert kW/ton (kW/kW)**> .
d. Comply with FEMP.

3. Part-Load Efficiency:

a. IPLV: <**Insert value**> .

b. NPLV: <**Insert value**> .
c. Comply with FEMP.

4. Evaporator:

a. Pressure Rating: <**Insert psig (kPa)**> .
b. Number of Passes: [**One**][**Two**][**Three**][**Four**] .
c. Fluid Type: [**Water**]<**Insert fluid type**> .
d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
i. Fluid Velocity: <**Insert fps (m/s)**> .
j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

5. Condenser:

a. Pressure Rating: <**Insert psig (kPa)**> .
b. Number of Passes: [**One**][**Two**][**Three**] .
c. Fluid Type: [**Water**]<**Insert fluid type**> .
d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
i. Fluid Velocity: <**Insert fps (m/s)**> .
j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

6. Heat Reclaim Condenser:

a. Pressure Rating: <**Insert psig (kPa)**> .
b. Number of Passes: [**One**][**Two**][**Three**] .
c. Fluid Type: [**Water**]<**Insert fluid type**> .
d. Design Fluid Flow Rate: <**Insert gpm (L/s)**> .
e. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**> .
f. Entering-Fluid Temperature: <**Insert deg F (deg C)**> .
g. Leaving-Fluid Temperature: <**Insert deg F (deg C)**> .
h. Fluid Pressure Drop: <**Insert feet of head (kPa)**> .
i. Fluid Velocity: <**Insert fps (m/s)**> .
j. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**][**0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)**][**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**]<**Insert value**> .

7. Number of Refrigerant Circuits: [**One**][**Two**][**One per compressor**]<**Insert number**> .
8. Compressors:

a. Number of Compressors: [**Two**]<**Insert number**> .
b. Rated Load Amperes/Compressor: <**Insert value**> .

c. Locked-Rotor Amperes/Compressor: <**Insert value**> .

9. Packaged Chiller Electrical Requirements:

a. Power Connections: [**Single-point field power**][**Multi-point field power**][**Multi-point field power configured for operation of one chiller compressor with other chiller compressors deenergized and isolated for service**] .
b. Power Input: <**Insert kilowatts**> .
c. Power Factor: [**0.95**]<**Insert value**> .
d. Minimum Circuit Ampacity: <**Insert value**> .
e. Maximum Overcurrent Protection Device: <**Insert amperage**> .
f. Volts: [**208**][**240**][**480**][**600**]<**Insert value**> V ac.
g. Phase: Three.
h. Hertz: 60.

10. Chiller Control Electrical Requirements:

a. Power Connections: [**Fed through integral transformer**][**Separate field-power connection**] .
b. Power Input: <**Insert number**> kW.
c. Minimum Circuit Ampacity: <**Insert number**> A.
d. Maximum Overcurrent Protection Device: <**Insert number**> A.
e. Volts: [**120**]<**Insert number**> V ac.
f. Phase: Single.
g. Hertz: 60.

11. Noise Rating: [**85**]<**Insert dBA**> sound power level when measured in accordance with AHRI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.
12. Rapid Restart and Loading Feature: Chiller to start and reach [**100**]<**Insert value**> percent of design capacity within [**160 seconds**]<**Insert seconds**> of a start signal or restart signal after electrical power interruption.

2.5 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. ASME Testing: Factory test and inspect evaporator [**and condenser**][**, condenser, and heat-reclaim condenser**] in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Eddy Current Testing:

1. Perform factory testing of evaporator [**and condenser**][**, condenser, and heat-reclaim condenser**] tubes of each chiller to ensure tube quality and longevity.
2. Submit test report, including, at a minimum:

a. List of equipment used and equipment settings.
b. Test data reports and accompanying strip charts of calibrations.
c. Identify tubes with significant defects and typical indications.
d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

D. Factory Performance Testing: Factory performance test water-cooled chillers, before shipping, in accordance with **AHRI 550/590 (AHRI 551/591)**:

1. Test the following conditions:

   a. Design conditions indicated.
   b. Part-Load Testing:

      1) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with condenser fluid at design conditions and with leaving evaporator-fluid temperature at design conditions.
      2) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with varying entering condenser-fluid temperature from design to minimum conditions in [**5 deg F (3 deg C)**]<**Insert temperature**> increments and with leaving evaporator-fluid temperature constant at design conditions.
      3) Reduction in capacity from design to minimum load in steps of [**10**][**25**][**33**]<**Insert number**> with varying entering condenser-fluid temperature from design to minimum conditions in [**5 deg F (3 deg C)**]<**Insert temperature**> increments and with varying leaving evaporator-fluid temperature from design conditions to maximum conditions in [**2 deg F (1 deg C)**]<**Insert temperature**> increments.
      4) At [**one**][**two**][**three**][**four**][**five**][**10**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

2. Witness Testing: Allow [**Owner**]<**Insert entity**> access to place where chillers are being tested to witness testing. Notify [**Owner**][**Architect**]<**Insert entity**>[**14**]<**Insert number**> days in advance of testing.
3. Test Reports: Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit a PDF copy of test report within [**5**]<**Insert number**> business days of test date.

E. Factory Sound Testing: Factory sound test water-cooled chillers, before shipping, in accordance with AHRI 575:

1. Test the following conditions:

   a. Design conditions indicated.
   b. Chiller operating at calculated worst-case sound condition.
   c. Additional Conditions Tested: At [**one**][**two**][**three**][**four**][**five**]<**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

2. Witness Testing: Allow [**Owner**]<**Insert entity**> access to place where chillers are being tested to witness testing. Notify [**Owner**][**Architect**]<**Insert entity**>[**14**]<**Insert number**> days in advance of testing.
3. Test Reports: Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit a PDF copy of test report within [**5**]<**Insert number**> business days of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls connections, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WATER-COOLED, ROTARY-SCREW WATER CHILLERS

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Install chillers on support structure indicated on Drawings.

D. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for proper operation, service, and maintenance.

F. Charge chiller with refrigerant and fill with oil if not factory installed.

G. Install separate devices furnished by manufacturer and not factory installed.

H. Repair damage to chiller factory-installed insulation. Replace insulation if damage is extensive.

I. Repair damage to chiller painted surfaces.

3.3 PIPING CONNECTIONS

A. Hydronic Piping Requirements: Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

B. Refrigerant Piping Requirements: Comply with requirements for piping specified in Section 232300 "Refrigerant Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Install piping adjacent to chiller to allow service and maintenance.

E. Evaporator Fluid Connections:

1. Inlet Connections: Connect to evaporator inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to evaporator outlet with piping that includes shutoff valve,

balancing valve, [**flexible connector,**] flow switch, thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller with a [**flange**][**or**][**mechanical coupling**] .

F. Condenser Fluid Connections:

1. Inlet Connections: Connect to condenser inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to condenser outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller with a [**flange**][**or**][**mechanical coupling**] .

G. Heat-Reclaim Condenser Fluid Connections:

1. Inlet Connections: Connect to condenser inlet with piping that includes shutoff valve, [**strainer,**][**flexible connector,**] thermometer with thermowell, and plugged branch tee with shutoff valve and pressure gauge and drain connection with valve.
2. Outlet Connections: Connect to condenser outlet with piping that includes shutoff valve, balancing valve, [**flexible connector,**] flow switch, thermometer with thermowell, plugged branch tee with shutoff valve and pressure gauge, [**flow meter,**] and drain connection with valve.
3. Final Connections: Make mating connections to chiller with a [**flange**][**or**][**mechanical coupling**] .

H. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend [**vent piping**][**separate vent piping for each chiller**] to the outdoors without valves or restrictions.

1. Comply with ASHRAE 15 and governing code.
2. Connect vent pipe to chiller pressure relief device with flexible connector and dirt leg with drain valve at low point.
3. Terminate each vent pipe with a vent cap.

I. Water Box Drain Connections: Connect each chiller water box drain connection with a [**full size drain valve.**][**union and drain pipe, and extend pipe, full-size of connection, to floor drain. Provide a shutoff valve at each connection.**]

J. Water Box Vent Connections: Connect each chiller heat exchanger vent connection with a full-size [**manual air vent**][**or**][**automatic air vent**] . Provide a full-size shutoff valve at each connection.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical power connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit

number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

B. Install control signal wiring to field-mounted control devices and between chiller control interface and [**DDC control system**]<**Insert system description**> for remote monitoring and control of chillers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Install control devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

F. Install nameplate for each control connection, indicating brief description, controller designation and controller I/O point number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and pressure gauges are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outdoors.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators during chiller startup, normal operation, and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator [**and condenser**][**, condenser, and heat-reclaim condenser**] .
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.7 WARRANTY PERIOD TESTING

A. Within [**one**]<**Insert number**> month(s) of warranty period expiration, perform testing, analysis, and reporting indicated for each chiller.

B. Eddy Current Testing:

1. Solicit services of a third-party testing agency, specializing in such analysis, to perform testing of evaporator and condenser tubes, to ensure tube quality and longevity.
2. Submit test report to Owner, including, at a minimum:

a. List of equipment used and equipment settings.
b. Test data reports and accompanying strip charts of calibrations.
c. Identification of tubes with significant defects and typical indications.
d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

C. Oil Analysis:

1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.
2. Submit analysis results and recommendations to Owner.

D. Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to Owner.

E. Site Access and Scheduling:

1. Contact Owner to schedule testing at least 30 days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate Owner's request for testing.
3. Review, with Owner, requirements for visitors in advance of testing.
4. Comply with Owner requirements for visitors while on-site.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. [**Video record the training sessions and provide electronic copy to Owner.**]

1. Instructor must be factory trained and certified.
2. Minimum Training:

a. Provide not less than [**eight**]<**Insert number**> hours of training.
b. Provide not less than [**16**]<**Insert number**> hours of training spread across consecutive days, not to exceed [**eight**]<**Insert number**> hours per day.

3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training is to be held at Project site.

END OF SECTION 23 64 26 16

SECTION 23 65 13 16 - CLOSED-CIRCUIT, FORCED-DRAFT COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes factory-assembled, closed-circuit, forced-draft cooling towers.

1.2 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at basin heater supply piping connections.
6. Pressure required at collection basin sweeper supply piping connections.
7. Drift loss as percent of design flow rate.
8. Volume of water in suspension for purposes of sizing remote storage.
9. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

10. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    b. Varying ambient wet-bulb temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    c. Varying water flow rates from design to minimum in increments of [**10**]<**Insert number**> percent of flow rate difference between design and minimum flow rates.
    d. Varying fan operation from design to minimum speed in [**5**][**10**]<**Insert number**> percent speed increments, and with fan off.

11. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percentage of brake horsepower).
12. Fan motor electrical characteristics, including but not limited to, speed, voltage, phase hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
13. Pump flow rate, head, brake horsepower, and efficiency.
14. Pump motor electrical characteristics, including but not limited to, speed, voltage, phase hertz,

amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
15. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation[**and seismic controls**].
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.
3. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**][**and wind restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

a. Structural supports.
b. Piping roughing-in requirements.
c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances.

2. Drawings showing plans, sections, and elevation views, drawn to scale of at least <**Insert scale**>.
3. Each view to show screened background with the following:

a. Structural grids.
b. Adjacent walls, floors, and roofs.
c. Equipment and products of other trades that are located in vicinity of cooling towers and are part of final installation, such as controls, power, lighting, fire suppression systems, and plumbing systems.

B. Product Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificates, for cooling towers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Field quality-control reports.

F. Field Test Reports: Include startup service reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are pre-recorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts:

1. Furnish [**one**]<**Insert number**> set(s) of matching belts for each unique belt configuration and size furnished.

B. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **1/2 inch (13 mm)** high.

C. Touch-up Coating: [**32-oz. (1-L)**]<**Insert volume**> container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: [**Certified by CTI**][**An NRTL**].

B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

D. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each package with a unique designation and include assembly instructions for each complete cooling tower.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Fan assembly, including fan, drive, and motor.
3. <**Insert components requiring extended warranty**>.
4. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CLOSED-CIRCUIT, FORCED-DRAFT COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Baltimore Aircoil Company**]
2. [**EVAPCO, Inc**]
3. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
4. [**Recold**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Baltimore Aircoil Company**]
2. [**EVAPCO, Inc**]
3. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
4. [**Recold**]
5. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**][**and wind restraints**], including comprehensive engineering analysis.

B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [**ASCE/SEI 7**][**IBC**][**governing code**]<**Insert requirement**>.

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: <**Insert value**>.
4. Component Response Modification Factor: <**Insert value**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

F. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.3 DESIGN ARRANGEMENT

A. Counterflow pattern with inlet airflow from one side and forced-draft, bottom-mounted, axial fans; and with pressurized pipe distribution near top.

B. Counterflow pattern with inlet airflow from one side and forced-draft, bottom-mounted, centrifugal fans; and with pressurized pipe distribution near top.

C. Low-profile design with counterflow pattern, with inlet airflow from one side and forced-draft, side-mounted, centrifugal fans to reduce overall height; and with pressurized pipe distribution near top.

2.4 CASING AND FRAME

A. Casing Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**or**][**stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.

B. Frame Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**stainless steel, Grade 304**][**Stainless steel, Grade 316**][**materials to match casing**]<**Insert material**>.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight[**by continuous welds**].

2.5 COLLECTION BASIN

A. Factory-Assembled Collection Basin:

1. Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
2. Hardware: [**Galvanized**][**or**][**stainless**] steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight[**by continuous welds**].
5. Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
9. Basin Sweeper Distribution Piping and Nozzles:

   a. Pipe Material: [**PVC**]<**Insert material**>, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
   b. Nozzle Material: [**Plastic**]<**Insert material**>.
   c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
   d. Basin penetrations sealed watertight.
   e. Field Connections: Threaded or flanged, depending on pipe size. Threaded for sizes through <**Insert pipe size**> and flanged for larger sizes.

2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosures: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to [**control makeup-water valve**][**control makeup-water valve and low-level alarm**][**control water makeup valve and low- and high-level alarms**][**control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level**].
3. Electrode Probes: Stainless steel.
4. Water-Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**galvanized steel**][**PVC pipe**][**stainless steel, Grade 304**][**stainless steel, Grade 316**]<**Insert material**>.

5. Makeup Water Valve:

   a. Slow-closing[**with stainless-steel body**].
   b. Valve actuator controlled and powered through level controller in response to water-level set point.
   c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
   d. Fail Position: [**Closed**][**Open**][**Last**].
   e. Action: [**Two position**][**or**][**modulating**].

6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.7 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**]<**Insert Type**>.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**] and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures; except, connections to each electric basin heater shall be liquidtight conduit.

   a. Raceway shall be corrosion-resistant [**stainless steel**][**or**][**PVC-coated steel**].

B. Hot-Water-Coil Heater: Manufacturer's standard heater with indicated capacity.

C. Steam-Coil Heater: Manufacturer's standard heater with indicated capacity.

D. Steam-Injector Heater: Manufacturer's standard offering heater with indicated capacity.

2.8 PRESSURIZED DISTRIBUTION NETWORK

A. Main header and lateral branch piping designed for even distribution over fill and heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, nonclogging spray nozzles.

B. Pipe Material: [**Schedule 40 PVC**]<**Insert material**>.

C. Spray Nozzle Material: [**Plastic**][**Polypropylene**][**or**][**PVC**]<**Insert material**>.

D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.9 HEAT-EXCHANGER COILS

A. Tube and Tube Sheet Materials: [**Copper tube with stainless-steel tube sheet**][**stainless-steel tube and tube sheet**][**or**][**carbon-steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication**].

B. Heat-Exchanger Arrangement:

1. [**Serpentine tubes**][**serpentine tubes with removable cover plate on inlet and outlet headers**][**or**][**straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube**]; and sloped for complete drainage of fluid by gravity.
2. Tubes with extended surface fins if required to achieve performance indicated.
3. Multiple Separate Circuits: Separate circuits to achieve multiple isolated loops as required by application.

C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

D. Field Piping Connections: Vent, supply, and return[**suitable for mating to ASME B16.5, Class 150 flange**].

2.10 DRIFT ELIMINATORS

A. Material: [**PVC**]<**Insert material**>, with maximum flame-spread index of [**5**][**25**]<**Insert number**> according to ASTM E84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Arrangement: Multiple, easily removable sections.

D. Configuration: Multipass, designed and tested to reduce water carryover to [**0.001**]<**Insert number**> percent of design flow rate indicated.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.11 AIR INLET

A. [**Removable**]Air-Intake Screens:

1. [**Galvanized**][**Polymer-coated, galvanized**][**Stainless**]-steel wire mesh, with openings of size sufficient to not restrict airflow or impact performance.
2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.

B. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.12 FAN AND DRIVE ASSEMBLY

A. Axial Fans: Factory balanced[**after assembly**].

1. Blade Material: [**Aluminum**][**or**][**galvanized steel**]<**Insert material**>.
2. Hub Material: [**Aluminum**][**or**][**galvanized steel**]<**Insert material**>.
3. Fan Shaft: Steel, coated to resist corrosion.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**. Bearings designed for an L-10 life of [**40,000**][**50,000**][**100,000**]<**Insert value**> hours.
5. Bearing Grease Fittings: Extended lubrication lines to an easily accessible location.

B. Centrifugal Fans: Double-width, double-inlet, forward-curved blades; statically and dynamically balanced at the factory[**after assembly**].

1. Cooling Tower Cell Fan Assembly: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
2. Fan Wheel and Housing Materials: Hot-dip galvanized steel.
3. Fan Shaft: Steel, coated to resist corrosion.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**. Bearings designed for an L-10 life of [**40,000**][**50,000**][**100,000**]<**Insert value**> hours.
5. Bearing Grease Fittings: Extended lubrication lines to an easily accessible location.
6. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.

C. Belt Drives:

1. Service Factor: [**1.5**]<**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt:

   a. Multiple V-belt design with a matched set of[**cogged**] belts.
   b. One-piece, multigrooved, solid-back belt.

4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
5. Belt-Drive Guard: Comply with OSHA regulations.
6. Two-Motor, Single-Fan Drive:

   a. Two single-speed motors per cooling tower cell fan assembly; one sized for full speed and load and the other sized for [**67**][**100**]<**Insert number**> percent of full-load speed.
   b. Each motor shall have belt drive and be configured for operation when other motor fails.
   c. Controls and wiring same as two-speed, two-winding motor.

D. Fan Motors:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Totally enclosed**][**totally enclosed air-over (TEAO)**][**or**][**totally enclosed fan cooled (TEFC)**][**and with epoxy or polyurethane finish**].
5. Rotor: Random wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.

8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Variable-Speed Motors: Inverter-duty rated according to NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
11. Motor Location: Mounted outside of cooling tower airstream.
12. Severe-Duty Rating:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C.).)**
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

13. Motor Base: Adjustable, or other suitable belt-tensioning provisions.
14. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than [**0.5**]<**Insert value**> percent of motor nameplate horsepower.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.13 AIR DISCHARGE

A. Discharge Hood:

1. Hood Configuration: [**Tapered**][**Straight**]; totally surrounding heat exchanger; pressurized distribution system and drift eliminators; constructed of same material as casing; and having factory-installed [**insulation and**]access doors.
2. Discharge Dampers: Positive-closure, automatic, isolation dampers constructed of [**aluminum**][**galvanized steel**][**stainless steel**]<**Insert material**>, with corrosion-resistant linkages and electric actuators with NEMA 250, Type 4X enclosure.

    a. If not provided with factory controls, field-connect provisions for electrical power and controls to open dampers when pump is energized, and close dampers when pump is de-energized.

3. Capacity-Control Dampers: [**Aluminum**][**Galvanized-steel**][**Stainless-steel**]<**Insert material**> dampers, with corrosion-resistant linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

    a. If not provided with factory controls, provide field power and controls to operate dampers when pump is energized, and close dampers when pump and fan is de-energized.

B. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.14 RECIRCULATING-WATER DISTRIBUTION SYSTEM

A. Pump: Close-coupled, single-stage, [**bronze-fitted**]centrifugal pump with mechanical seal; suitable for outdoor service. Factory install pump with following:

1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.

2. Flanges at pump connections to piping.
3. Strainer[**, with blowdown isolation valve,**] installed in piping on suction side of pump.
4. Flow-balancing valve in piping on discharge side of pump.

B. Pump Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Open dripproof**][**or**][**totally enclosed**][**and with epoxy or polyurethane finish**].
5. Rotor: Random wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.
8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Severe-Duty Rating:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).)**
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

C. Piping:

1. Interconnecting collection basin to pump and pressurization distribution system.

    a. Design delegated to manufacturer.
    b. External to and supported from cooling tower casing and frame.
    c. Material: [**Corrosion-resistant**][**PVC**]<**Insert material**>.
    d. Install flanges at connections to collection basin and pressurized distribution system.
    e. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.

2. Field installed for connection to remotely installed pump and water storage that are not furnished with cooling tower.

2.15 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor and a [**disconnect switch**][**motor controller**] for each pump motor.

B. Factory Install: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor and a [**disconnect switch**][**motor controller**] for each pump motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

    a. Minimum Conduit Size: [**0.75 inch (20 mm)**]<**Insert size**>.

b. Materials: Corrosion resistant[**and constructed of stainless steel or PVC coated steel**].
c. Motor Termination: Liquidtight conduit, not to exceed **36 inches (900 mm)** long.
d. Supports: Support, conduits boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].
e. Wire:

1) Copper, rated for 600-V, solid wire for size [**No. 10 AWG**]<**Insert wire size**> and smaller and stranded wire for larger sizes.
2) Minimum Wire Size: [**No. 12 AWG**]<**Insert wire size**>.
3) Each circuit shall have a ground wire.
4) Install wire in conduit.

f. Boxes, Condulets, and Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

C. Disconnect Switches:

1. Specification Grade; "Heavy-Duty Type," "quick make," "quick break" construction.
2. Three pole [**fused**][**or**][**nonfused**].
3. 600-V rated.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Include a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing motor-rated controller.
2. Configured for control of single- or multi-speed motors.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
4. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
5. SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage

and frequency.

2. Enclosure: Unit mounted, NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
3. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
4. SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBTs); suitable for variable-torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
9. Operating Requirements:

    a. Input AC Voltage Tolerance: [**10**]<**Insert number**> percent.
    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
    c. Capable of driving full motor load, without derating.
    d. Minimum Efficiency: 96 percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 95 percent.
    f. Overload Capability: 1.05 times the full-load current for seven seconds.
    g. Starting Torque: As required by fan and motor drive assembly.
    h. Speed Regulation: 1 percent.
    i. Speed Range: 10:1 speed range.
    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
    k. Capable of being restarted into a motor, coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line-switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.
    m. <**Insert features**>.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

    a. Power on.
    b. Run.
    c. Overcurrent and overvoltage.
    d. Motor speed (percent).
    e. Various faults with alarm status.
    f. Input kilovolt amperes.
    g. Power factor.
    h. Input kilowatts and kilowatt-hours.
    i. Three-phase input and output voltage.
    j. Three-phase input and output current.
    k. Output frequency.
    l. Elapsed operating time (hours).
    m. Diagnostic and service parameters.
    n. <**Insert conditions**>.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of [**two**]<**Insert number**> analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**]<**Insert number**> programmable digital inputs.
17. Bypass Controller:

    a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
    b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller, for safe servicing of variable-frequency controller.
    c. Include "Bypass/VFC" manual selector switch on face of enclosure to provide for local operator control of preferred controller.
    d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
    e. Install bypass controller in same enclosure as variable-frequency controller.

2.16 CONTROLS

A. Vibration Switch: For each fan drive.

    1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
    3. Switch shall have manual-reset button with hardwired connection to fan motor electrical circuit.
    4. Switch shall have field connection for hardwired connection to control system.
    5. Switch shall, on sensing excessive vibration,[**signal an alarm for connection to control system and**] shut down the fan.

B. Control Package:

    1. Factory installed and wired, and functionally tested at factory before shipment.
    2. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**] enclosure with removable, internally mount backplate.
    3. Control-circuit transformer with primary and secondary side fuses.

4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature, with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Collection basin water-level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve" Paragraph.
8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph in "Controls" Article.
10. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**][**for each cooling tower cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

11. Factory-installed wiring outside of enclosures shall be in metal raceway; except, make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm[**with momentary test push button**] for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Cooling tower leaving-fluid temperature.
    c. Fan vibration alarm.
    d. Collection basin [**high**][**low**][**high- and low**]-water-level alarms.
    e. <**Insert conditions to be monitored**>.

2.17 WATER TREATMENT

A. Chemical-Free Water Treatment System: Complete factory-installed system consisting of the following:

1. Pulsed-power technology emitting high-frequency bursts of low-energy electromagnetic fields to the recirculated water to control corrosion, bacteria, and scale.
2. Conductivity control of electrically operated valve designed to control totally dissolved solids levels and bleed rates.
3. Piping associated with system.
4. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.

2.18 SERVICE ACCESS

A. Doors:

1. Large enough for personnel to access cooling tower internal components.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.

4. Hinges and handles shall be [**corrosion-resistant**][**stainless steel**]<**Insert material**>.

B. External Ladders with Safety Cages: [**Aluminum**][**galvanized steel**][**or**][**stainless-steel**]<**Insert material**> fixed ladders, with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

C. External Platforms with Handrails: [**Aluminum**][**galvanized steel**][**or**][**stainless-steel**]<**Insert material**> bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

D. Handrail: [**Aluminum**][**galvanized steel**][**or**][**stainless steel**]<**Insert material**> complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

E. Hardware: Galvanized steel when connecting galvanized-steel components and stainless steel when connecting other materials.

2.19 CAPACITIES AND CHARACTERISTICS

A. Number of Cells: <**Insert quantity**>.

B. Air-Inlet Arrangement: One side.

C. Maximum Drift Loss: [**0.001**]<**Insert number**> percent of design water flow.

D. Heat Exchanger:

1. Fluid Type: [**Water**][**Insert Type**].
2. Design Fluid Flow per Cell: <**Insert gpm (L/s)**>.
3. Minimum Fluid Flow per Cell: <**Insert gpm (L/s)**>.
4. Fluid Pressure Drop: <**Insert psig (kPa)**>.
5. Fluid Pressure Rating: <**Insert psig (kPa)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
9. Air Flow per Cell: <**Insert cfm (L/s)**>.

E. Economizer Mode Performance:

1. Fluid Flow per Cell: <**Insert gpm (L/s)**>.
2. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
4. Entering-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

F. Fan Drive Assembly:

1. Type: Belt.
2. Fan Motor:

a. Type: [**Single speed**][**Two speed, single winding**][**Two-speed, two winding**][**Variable speed**].
b. Motor Size per Cell: <**Insert number**> hp.
c. Full-Load Ampacity: <**Insert number**> A.
d. Minimum Circuit Ampacity: <**Insert number**> A.

e. Maximum Overcurrent Protection Device: <**Insert number**> A.
f. Electrical Characteristics: [**208**][**240**][**480**]<**Insert number**> V ac, 3 phase, 60 Hz.

G. Pump and Motor:

1. Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Motor Size per Cell: <**Insert number**> hp.
3. Full-Load Ampacity: <**Insert number**> A.
4. Minimum Circuit Ampacity: <**Insert number**> A.
5. Maximum Overcurrent Protection Device: <**Insert number**> A.
6. Electrical Characteristics: [**120**][**208**][**240**][**277**][**480**]<**Insert number**> V ac, [**single**][**3**] phase, 60 Hz.

H. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**>[**when measured according to CTI ATC 128**].

I. Collection Basin Heater:

1. Basin Water Temperature: [**40 deg F (5 deg C)**]<**Insert temperature**>.
2. Outdoor Ambient Temperature: [**0 deg F (minus 18 deg C)**][**Minus 20 deg F (Minus 29 deg C)**]<**Insert temperature**>.
3. Capacity per Cell: <**Insert number**> kW.
4. Full-Load Ampacity: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.
6. Maximum Overcurrent Protection Device: <**Insert number**> A.
7. Electrical Characteristics: [**208**][**240**][**480**]<**Insert number**> V ac, 3 phase, 60 Hz.

2.20 SOURCE QUALITY CONTROL

A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS.

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

B. Seismic Performance Testing: Shake table tested by an independent [**or a factory-certified**] laboratory to certify performance complies with seismic requirements indicated.

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Functional Tests:

1. Test collection and distribution basins after assembly, and prove free of leaks.
2. Test factory-installed electric/electronic water-level controls for proper operation.
3. Test factory-installed electric basin heaters for proper operation.
4. Test factory-installed fan and drive assemblies for proper operation.
5. Test factory-installed control package for proper operation.
6. Test access doors to ensure smooth operation and proper fit.
7. <**Insert additional functional test requirements**>.
8. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.

9. Submit report documenting tests performed and results within one week of test date.

D. Heat-Exchanger Factory Pressure and Leak Tests:

1. Pneumatically test heat-exchanger assembly while submerged under water and prove to be free of leaks.
2. Test pressure equal to [**1.5**]<**Insert value**> times rated pressured, but not less than <**Insert psig (kPa)**>.
3. Submit report documenting test and results.

E. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include round-trip coach airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [**one**][**two**]<**Insert number**> Owner representatives with origin of <**Insert city, state, and country**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration

Controls for HVAC."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices, and accessories furnished by manufacturer with cooling tower that are not factory mounted.

1. Loose components shall be installed by [**manufacturer's factory-trained service personnel**][**Contractor under supervision of manufacturer's factory-trained service personnel**].

3.3 DUCT CONNECTIONS

A. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ductwork and accessories.

B. Where installing duct adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible connectors at duct connections to cooling towers.

3.4 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, flow meter, and drain connection with valve and union.

G. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering-cooling-tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to leaving-cooling-tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

H. Basin Heater Hot-Water Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve, strainer, control valve thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
4. Make connections with a flange, union, or mechanical coupling.

I. Basin Heater Steam and Condensate Piping:

1. Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
2. Connect steam supply connection with shutoff valve, strainer, control valve, pressure gage and flow meter.
3. Connect to condensate connection with shutoff valve, strainer, and an appropriate steam trap assembly.
4. Make connections with a flange or union.

J. Basin Sweeper Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve, flow meter, and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve, flow meter, and drain connection with valve.
4. Make connections with a flange or union.

3.5 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.6 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and control system for HVAC for remote

monitoring and control of cooling towers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC"**]<**Insert Section**>.

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identifying products and installations.

3.7 FIELD TESTING PROVISIONS

A. Include provisions for cooling tower future field performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

B. Include provisions in field piping for future field performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

3.8 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Comply with [**ASME PTC 23**][**CTI ATC 105**].

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit, including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Verify pump rotation for correct direction, vibration, cavitation, and flow, and correct

problems.
h. Adjust belts to proper alignment and tension.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.10 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating setpoint.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than [**eight**]<**Insert number**> hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 23 65 13 16

SECTION 23 65 14 13 - OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes factory-assembled, open-circuit, induced-draft, counterflow cooling towers.

1.2 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at basin heater supply piping connections.
6. Pressure required at collection basin sweeper supply piping connections.
7. Drift loss as percent of design flow rate.
8. Volume of water in suspension for purposes of sizing remote storage.
9. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

10. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    b. Varying ambient wet-bulb temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    c. Varying water flow rates from design to minimum in increments of [**10**]<**Insert number**> percent of flow rate difference between design and minimum flow rates.
    d. Varying fan operation from design to minimum speed in [**5**][**10**]<**Insert number**> percent speed increments, and with fan off.

11. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
12. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
13. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation[**and seismic controls**].
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**][**and wind restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   a. Structural supports.
   b. Piping roughing-in requirements.
   c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
   d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances.

2. Drawings showing plans, sections, and elevation views, drawn to scale of at least <**Insert scale**>.
3. Each view to show screened background with the following:

   a. Structural grids.
   b. Adjacent walls, floors, and roofs.
   c. Equipment and products of other trades that are located in vicinity of cooling towers and are part of final installation, such as, controls, power, lighting, fire-suppression systems, and plumbing systems.

B. Seismic Qualification Data: Certificates, for cooling towers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their

installation requirements.

C. Product Certificates: For certification required in "Quality Assurance" Article.

D. Field Test Reports: Include startup service reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts:

1. Furnish [**one**]<**Insert number**> set(s) of matching belts for each unique belt configuration and size furnished.

B. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **1/2 inch (13 mm)** high.

C. Touchup Coating: [**32-oz. (1-L)**]<**Insert volume**> container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: [**Certified by CTI**][**An NRTL**].

B. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

C. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.
2. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Fan assembly including fan, drive, and motor.
3. <**Insert components requiring extended warranty**>.
4. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amcot Cooling Tower Corp.**]
2. [**Baltimore Aircoil Company**]
3. [**Delta Cooling Towers, Inc.**]
4. [**EVAPCO, Inc**]
5. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
6. [**Protec Cooling Towers, Inc**]
7. [**Thermal Care, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Amcot Cooling Tower Corp.**]
2. [**Baltimore Aircoil Company**]
3. [**Delta Cooling Towers, Inc.**]
4. [**EVAPCO, Inc**]
5. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
6. [**Protec Cooling Towers, Inc**]
7. [**Thermal Care, Inc.**]
8. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**][**and wind restraints**], including comprehensive engineering analysis.

B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [**ASCE/SEI 7**][**the IBC**][**governing code**]<**Insert requirement**>.

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: <**Insert value**>.
4. Component Response Modification Factor: <**Insert value**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.3 DESIGN ARRANGEMENT

A. Counterflow design with airflow from all sides and induced-draft, top-mounted axial fan and pressurized pipe distribution.

2.4 CASING AND FRAME

A. Casing Material: [**FRP with UV inhibitors**][**HDPE with UV inhibitors**][**Galvanized steel, ASTM A653/A653M, G210 (Z600) coating**][**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.

B. Frame Material: [**FRP with UV inhibitors**][**HDPE with UV inhibitors**][**galvanized steel, ASTM A653/A653M, G210 (Z600) coating**][**galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**stainless steel, Grade 304**][**stainless steel, Grade 316**][**or**][**materials to match casing**]<**Insert material**>.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight[**by continuous welds**].

2.5 COLLECTION BASIN

A. Field-Constructed Collection Basin: Configure tower without a factory-assembled collection basin for installation and operation with a field-constructed collection basin.

B. Factory-Assembled Collection Basin:

1. Material: [**FRP with UV inhibitors**][**HDPE with UV inhibitors**][**Galvanized steel, ASTM A653/A653M, G210 (Z600) coating**][**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
2. Hardware: [**Galvanized**][**or**][**stainless**] steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight[**by continuous welds**].
5. Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
9. Removable equalization flume plate between adjacent cells of multiple-cell towers.
10. Equalizer connection for field-installed equalizer piping configured to mate to ASME B16.5, Class 150 flange.
11. Basin Sweeper Distribution Piping and Nozzles:

    a. Pipe Material: [**PVC**][**or**][**CPVC**]<**Insert material**>, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
    b. Nozzle Material: [**Plastic**]<**Insert material**>.
    c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
    d. Basin penetrations sealed watertight.
    e. Field Connections: Threaded or flanged depending on pipe size. Thread for sizes through <**Insert pipe size**> and flanged for larger sizes.

2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosures: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to [**control makeup-water valve**][**control makeup-water valve and low-level alarm**][**control makeup-water valve and low- and high-level alarms**][**control makeup-water**

valve, low- and high-level alarms, and output for shutoff of pump on low level].

3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**Galvanized steel**][**PVC pipe**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
5. Makeup-Water Valve:

    a. Slow closing[**with stainless-steel body**].
    b. Valve actuator controlled and powered through level controller in response to water-level set point.
    c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    d. Fail Position: [**Closed**][**Open**][**Last**].
    e. Action: [**Two position**][**or**][**modulating**].

6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

C. Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Controller:

    a. Ultrasonic level sensor/transmitter with local display of measured value.
    b. Factory wired to terminal strip.
    c. Control makeup-water valve in response to water-level set point.
    d. Adjustable level, alarm signal through relay closure[**for connection to control system**].
    e. Continuous level indication through a 4- to 20-mA signal[**for connection to control system**].

3. Water Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**Galvanized steel**][**PVC pipe**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
4. Makeup-Water Valve:

    a. Slow closing[**with stainless-steel body**]
    b. Valve actuator controlled and powered through level controller in response to water-level set point.
    c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    d. Fail Position: [**Closed**][**Open**][**Last**].
    e. Action: [**Two position**][**or**][**modulating**].

5. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.7 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**]<**Insert Type**>.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**] and heater branch circuiting complying with NFPA 70.

8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except connections to each electric basin heater shall be liquidtight conduit.

   a. Raceway shall be corrosion-resistant [**stainless steel**][**or**][**PVC coated steel**].

B. Hot-Water-Coil Heater: Manufacturer's standard heater with indicated capacity.

C. Steam-Coil Heater: Manufacturer's standard heater with indicated capacity.

D. Steam-Injector Heater: Manufacturer's standard heater with indicated capacity.

2.8 PRESSURIZED DISTRIBUTION NETWORK

A. Main header and lateral branch piping designed for even distribution over fill throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, non-clogging spray nozzles.

B. Pipe Material: [**Fiberglass**][**Schedule 40 PVC**][**or**][**galvanized steel**]<**Insert material**>.

C. Spray Nozzle Material: [**Plastic**][**polypropylene**][**or**][**PVC**]<**Insert material**>.

D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.9 FILL

A. Materials: PVC, with maximum flame-spread index of [**5**][**25**]<**Insert value**> according to ASTM E84.

B. Minimum Thickness: [**15 mils (0.4 mm)**][**20 mils (0.5 mm)**]<**Insert value**>, before forming.

C. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.

D. Fill Material Operating Temperature: Suitable for entering-water temperatures up through [**120 deg F (49 deg C)**]<**Insert temperature**>.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.10 DRIFT ELIMINATORS

A. Material: [**FRP**][**PVC**][**FRP or PVC**]<**Insert material**>; with maximum flame-spread index of [**5**][**25**]<**Insert number**> according to ASTM E84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Configuration: Multipass, designed and tested to reduce water carryover to [**0.001**][**0.005**]<**Insert number**> percent of design flow rate indicated.

D. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.11 AIR INLET

A. Air-Intake Louvers:

1. Material: [**FRP**][**PVC**][**Matching casing**]<**Insert material**>.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

B. [**Removable**]Air-Intake Screens:

1. [**Galvanized**][**Polymer-coated, galvanized**][**Stainless**]-steel wire mesh with openings of size sufficient to not restrict airflow or impact performance.
2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.12 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory[**after assembly**].

1. Blade Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
2. Hub Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
3. Blade Pitch: Field adjustable.
4. Fan Shaft: [**Corrosion resistant**][**Stainless steel**]<**Insert material**>.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**. Bearings designed for an L-10 life of [**40,000**][**50,000**][**100,000**]<**Insert value**> hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

B. Belt Drive:

1. Service Factor: [**1.5**]<**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt:

   a. Multiple V-belt design with a matched set of[**cogged**] belts.
   b. One-piece, multigrooved, solid-back belt.

4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
5. Belt-Drive Guard: Comply with OSHA regulations.
6. Two-Motor, Single-Fan Drive:

   a. Two single-speed motors per fan, one sized for full speed and load and the other sized for [**67**]<**Insert number**> percent of full-load speed.
   b. Each motor shall have belt drive and be configured for operation when other motor fails.
   c. Controls and wiring same as two-speed, two-winding motor.

C. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

D. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI

STD 111. Motor and gear drive shall be aligned before shipment.

1. Gear Drive and Coupling Service Factor: [**2.0**]<**Insert value**> based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse. Able to operate throughout entire speed range from design speed indicated down to [**10**][**20**]<**Insert value**> of design speed.
5. Drive-to-Motor Connection: [**Close coupled to motor using a flexible coupling.**][**Connected to motor located outside of cooling tower casing by a full-floating drive shaft.**]
6. Drive Shaft Material: [**Corrosion resistant**][**Stainless steel**], and fitted with flexible couplings on both ends.
7. Drive Guards: Exposed shaft and couplings shall have guards according to OSHA regulations.
8. Extend oil fill, drain, and vent to outside of cooling tower casing using [**galvanized-steel**][**or**][**stainless-steel**] piping. Include oil-level sight glass.

E. Fan Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Totally enclosed**][**Totally enclosed air-over (TEAO)**][**Totally enclosed fan-cooled (TEFC)**][**and with epoxy or polyurethane finish**].
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.
8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
12. Severe-Duty Rating:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**.
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

13. Motor Base: Adjustable, or other suitable belt-tensioning provisions.
14. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than [**0.5**]<**Insert number**> percent of motor nameplate horsepower.

F. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.13 AIR DISCHARGE

A. Low-Profile Fan Discharge Stack:

1. Manufacturer's standard low-profile design.
2. Material: [**Material to match casing**][**FRP**][**Galvanized steel**][**Polymer-coated, galvanized steel**][**Stainless steel**]<**Insert material**>.
3. Stack Extension: Fabricated to extend above fan deck <**Insert distance**> unless otherwise indicated.
4. Stack Termination: Wire-mesh, [**galvanized-steel**][**polymer-coated, galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> screens; segmented into multiple removable pie sections and complying with OSHA regulations.

B. Velocity Recovery Fan Discharge Stack:

1. Design: Tapered and expanded for velocity recovery and improved energy efficiency.
2. Material: FRP or material matching casing.
3. Stack Height: Fabricated to extend above fan deck at least [**5 feet (1.5 m)**]<**Insert dimension**> unless otherwise indicated.
4. Service Access: Fabricated of multiple segments to facilitate removal of fan and drive components from overhead.
5. Stack Termination: Wire-mesh, [**galvanized-steel**][**polymer-coated, galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> screens; segmented into multiple removable pie sections and complying with OSHA regulations.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.14 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor.

B. Factory Install: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

a. Minimum Conduit Size: [**0.75 inch (20 mm)**]<**Insert size**>.
b. Materials: Corrosion resistant[**and constructed of 300L series stainless steel or PVC coated steel**].
c. Motor Termination: Liquidtight conduit, not to exceed **36 inches (900 mm)** long.
d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].
e. Wire:

1) Copper, rated for 600-V, solid wire for size [**No. 10 AWG**]<**Insert wire size**> and smaller and stranded wire for larger sizes.
2) Minimum Wire Size: [**No. 12 AWG**]<**Insert wire size**>.
3) Each circuit shall have a ground wire.
4) Install wire in conduit.

f. Boxes, Condulets, and Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

C. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, [**fused**][**or**][**nonfused**].
3. 600-V rated.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Disconnect switch shall have a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
4. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
5. SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
2. Enclosure: Unit mounted, NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
3. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.

9. Operating Requirements:

    a. Input AC Voltage Tolerance: [**10**]<**Insert number**> percent.
    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
    c. Capable of driving full motor load, without derating.
    d. Minimum Efficiency: 96 percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 95 percent.
    f. Overload Capability: 1.05 times the full-load current for 7 seconds.
    g. Starting Torque: As required by fan and motor drive assembly.
    h. Speed Regulation: 1 percent.
    i. Speed Range: 10:1 speed range.
    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
    k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.
    m. <**Insert features**>.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
    b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

    a. Power on.
    b. Run.
    c. Overcurrent and overvoltage.
    d. Motor speed (percent).
    e. Various faults with alarm status.
    f. Input kilovolt amperes.
    g. Power factor.
    h. Input kilowatts and kilowatt-hours.
    i. Three-phase input and output voltage.
    j. Three-phase input and output current.

k. Output frequency.
l. Elapsed operating time (hours).
m. Diagnostic and service parameters.
n. <**Insert conditions**>.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of [**two**]<**Insert value**> analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**]<**Insert value**> programmable digital inputs.
17. Bypass Controller:

    a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
    b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
    c. Include "Bypass/VFC" manual selector switch on face of enclosure for local operator control of preferred controller.
    d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
    e. Install bypass controller in same enclosure as variable-frequency controller.

2.15 CONTROLS

A. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Switch shall have manual-reset button hardwired connection to fan motor electrical circuit.
4. Switch shall have field connection to a control system hardwired connection to fan motor electrical circuit.
5. Switch shall, on sensing excessive vibration,[**signal an alarm for connection to control system and**] shut down the fan.

B. Vibration Transmitter with Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Display: Local display of measured value, power, and alarm.
3. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point.

    a. Cooling tower manufacturer shall select range that is suitable for cooling tower and recommend switch set point for proper operation and protection.

4. Transmitter: Continuous vibration level indication through a 4- to 20-mA signal for connection to control system.
5. Switch:

    a. Relay and switch with manual-reset button for field connection to control system and hardwired connection to fan motor electrical circuit.
    b. Switch shall, on sensing excessive vibration, signal an alarm to control system and shut down the fan.

6. Mounting: Locate out of cooling tower discharge airstream and mount in a location that is accessible[**and where display is easily viewable**].
7. Field Electrical Connection Requirements: 120 V, single phase, 60 Hz.

C. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch[**for connection to control system**].

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm[**through control system**].

D. Control Package:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**] enclosure with removable internally mount backplate.
3. Control-circuit transformer with primary and secondary side fuses.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Collection basin level controller complying with requirements in [**"Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve"**][**"Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve"**] Paragraph in "Collection Basin Makeup-Water Assembly" Article.
8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
10. Oil-level switch for each fan with a gear drive, complying with requirements in "Gear-Drive, Oil-Level Switch" Paragraph.
11. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**][**for each cooling tower cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Include variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

12. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
13. Visual indication of status and alarm[**with momentary test push button**] for each motor.
14. Audible alarm and silence switch.
15. Visual indication of elapsed run time, graduated in hours for each motor.
16. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Cooling tower leaving-fluid temperature.
    c. Fan vibration alarm.
    d. Oil-level alarm.
    e. Collection basin [**high**][**low**][**high- and low**]-water-level alarms.
    f. <**Insert conditions to be monitored**>.

2.16 SERVICE ACCESS

A. Doors:

1. Large enough for personnel to access cooling tower internal components.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.
4. Hinges and handles shall be [**corrosion resistant**][**stainless steel**]<**Insert material**>.

B. External Ladders with Safety Cages: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

C. External Platforms with Handrails: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

D. External Motor Platforms with Handrails: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

E. Fan Deck Floor between Cooling Tower Cells:

1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
2. Floor materials shall match adjacent cooling tower cell fan deck.
3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
4. Frame shall be constructed of same materials as cooling tower frame.

F. Handrail: [**Aluminum**][**FRP**][**galvanized steel**][**or**][**stainless steel**]<**Insert material**> complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

G. Internal Platforms: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

1. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach.
3. <**Insert platform locations**>.

H. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.17 HOISTING ASSEMBLY

A. Hoisting assembly consisting of pedestal base, davit arm, and winch to accommodate lowering and raising cooling tower components from their installed location to the base of cooling tower supports.

1. Cooling tower components serviceable by hoisting assembly shall include, but not be limited to, fan stack, fan, fan drive, and fan motor.
2. Hoisting assembly shall be designed to accommodate heaviest single component plus a safety factor of [**1.5**]<**Insert value**>.
3. Construct cooling tower structural supports and reinforcing to accommodate lifting heaviest load

with safety factor.

B. Pedestal Base:

1. Equip each cooling tower cell with a pedestal base to accommodate an easily removable davit arm and winch assembly.
2. Position pedestal base at a location on cooling tower for hoisting assembly coverage to fan, fan motor, and fan drive assembly.
3. Pedestal base design shall be open-socket, or comparable, design that is configured to accept and secure an inserted portable davit arm.
4. Fit each pedestal base with an easily removable cap or plug designed to seal the open top of the base when the davit arm is not installed.
5. Fasten pedestal base to cooling tower using threaded hardware.
6. Construct pedestal base of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

C. Davit Arm:

1. Each cooling tower [**cell**]shall have a davit arm.
2. Davit arm shall be an adjustable telescoping design with angular adjustment to accommodate varying lifting conditions required by the application.
3. Davit arm assembly shall be portable and capable of being relocated to any cooling tower cell pedestal base.
4. Construct davit arm of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

D. Winch:

1. Each davit arm shall have [**an electric-**][**or**][**a hand-**]operated winch.

   a. Electric winch shall include a power cord and plug for connection to a field-installed, weatherproof, 20-A receptacle with 120-V, single-phase, 60-Hz field power supply.
   b. Hand-operated winch with gear mechanism to limit force on handle to not more than **80 lb (36 kg)** when lifting the heaviest component.

2. Coat winch body and exposed components with corrosion-resistant finish that is rated for outdoor duty in a highly corrosive environment and exposed to direct sunlight.
3. Winch cable shall be stainless steel and terminated with a stainless-steel hook and quick disconnecting mechanism. Cable length shall be at least 1.5 times actual length required for application.

E. Hardware: [**304**][**or**][**316**] series stainless steel.

F. Nameplate:

1. Stamped or engraved aluminum or stainless-steel nameplate with rated load capacity on each davit arm and pedestal.
2. Letter size legible from a distance **60 inches (1500 mm)** and not less than **1/2 inch (13 mm)**.
3. Fasten nameplate at multiple points with stainless-steel rivets or screws.

2.18 CAPACITIES AND CHARACTERISTICS

A. Number of Cells: <**Insert quantity**>.

B. Air-Inlet Arrangement: All sides.

C. Maximum Drift Loss: [**0.005**]<**Insert number**> percent of design water flow.

D. Waterside:

1. Design Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Minimum Water Flow per Cell: <**Insert gpm (L/s)**>.
3. Water Pressure Drop: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

E. Airside:

1. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
2. Altitude: <**Insert value**>.
3. Airflow per Cell: <**Insert cfm (L/s)**>.

F. Economizer-Mode Performance:

1. Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Entering-Water Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
4. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

G. Fan Drive Assembly:

1. Type: [**Belt**][**direct**][**or**][**gear**].
2. Fan Motor:

   a. Type: [**Single speed**][**Two speed, single winding**][**Two speed, two winding**][**Variable speed**].
   b. Motor Size per Cell: <**Insert number**> hp.
   c. Full-Load Ampacity: <**Insert value**>.
   d. Minimum Circuit Ampacity: <**Insert value**>.
   e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
   f. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.

H. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**>[**when measured according to CTI ATC 128**].

I. Collection Basin Heater:

1. Basin Water Temperature: [**40 deg F (5 deg C)**]<**Insert temperature**>.
2. Outdoor Ambient Temperature: [**0 deg F (Minus 18 deg C)**][**Minus 20 deg F (Minus 29 deg C)**]<**Insert temperature**>.
3. Capacity per Cell: <**Insert kilowatts**>.
4. Full-Load Ampacity: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection Device: <**Insert amperage**>.
7. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.
8. Capacity per Cell: <**Insert MBtu/h (kW)**>.
9. Coil Fluid Type: [**Water**]<**Insert fluid type**>.
10. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
11. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
12. Fluid Flow Rate: <**Insert gpm (L/s)**>.
13. Fluid Pressure Drop: <**Insert psig (kPa)**>.
14. Capacity per Cell: <**Insert MBtu/h (kW)**>.
15. Steam Flow: <**Insert lb/h (L/s)**>.

16. Steam Pressure: <**Insert psig (kPa)**>.

2.19 SOURCE QUALITY CONTROL

A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

B. Seismic Performance Testing: Shake table tested by an independent[**or a factory-certified**] laboratory to certify performance complies with seismic requirements indicated.

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Functional Tests:

1. Test collection and distribution basins after assembly, and prove free of leaks.
2. Test factory-installed electric/electronic water-level controls for proper operation.
3. Test factory-installed electric basin heaters for proper operation.
4. Test factory-installed fan and drive assemblies for proper operation.
5. Test factory-installed control package for proper operation.
6. Test access doors to ensure smooth operation and proper fit.
7. <**Insert additional functional test requirements**>.
8. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
9. Submit report documenting tests performed and results within one week of test date.

D. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include round-trip coach airfare, out of town hotel accommodations, out of town meals (breakfast, lunch, and dinner), out of town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [**one**][**two**]<**Insert value**> Owner representative(s) with origin of <**Insert city, state, and country**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices, and accessories furnished by manufacturer, with cooling tower, that are not factory mounted.

1. Loose components shall be installed by [**manufacturer's factory-trained service personnel**][**Contractor under supervision of manufacturer's factory-trained service personnel**].

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains, to sanitary sewage system.

F. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, flow

meter, and drain connection with valve and union.

G. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

H. Equalizer Piping:

1. Piping requirements to match supply and return piping.
2. Connect an equalizer pipe, full size of cooling tower connection, between tower cells.
3. Connect to cooling tower with shutoff valve and drain connection with valve.
4. Make connections to cooling tower with a flange.

I. Basin Heater Hot-Water Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve, strainer, control valve thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
4. Make connections with a flange, union, or mechanical coupling.

J. Basin Heater Steam and Condensate Piping:

1. Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
2. Connect steam supply connection with shutoff valve, strainer, control valve, pressure gage, and flow meter.
3. Connect to condensate connection with shutoff valve, strainer, and an appropriate steam trap assembly.
4. Make connections with a flange or union.

K. Basin Sweeper Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve, flow meter, and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve, flow meter, and drain connection with valve.
4. Make connections with a flange or union.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and control system for HVAC for remote monitoring and control of cooling towers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section.**>

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identifying products and installations.

3.6 FIELD TESTING PROVISIONS

A. Include provisions for cooling tower future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

B. Include provisions in field piping for future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

3.7 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Comply with [**ASME PTC 23**][**CTI ATC 105**].

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.
h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.9 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating set point.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than [**8**]<**Insert value**> hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Perform instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 23 65 14 13

SECTION 23 65 14 14 - OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes factory-assembled, open-circuit, induced-draft, crossflow cooling towers.

1.2 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at basin heater supply piping connections.
6. Pressure required at collection basin sweeper supply piping connections.
7. Drift loss as percent of design flow rate.
8. Volume of water in suspension for purposes of sizing remote storage.
9. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

10. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    b. Varying ambient wet-bulb temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    c. Varying water flow rates from design to minimum in increments of [**10**]<**Insert number**> percent of flow rate difference between design and minimum flow rates.
    d. Varying fan operation from design to minimum speed in [**5**][**10**]<**Insert number**> percent speed increments, and with fan off.

11. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
12. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
13. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation[**and seismic controls**].
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**][**and wind restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   a. Structural supports.
   b. Piping roughing-in requirements.
   c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
   d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances on drawings.

2. Drawings showing plans, sections, and elevation views, drawn to scale of at least <**Insert scale**>.
3. Each view to show screened background with the following:

   a. Structural grids.
   b. Adjacent walls, floors, and roofs.
   c. Equipment and products of other trades that are located in vicinity of cooling towers and are part of final installation, such as, controls, power, lighting, fire-suppression systems, and plumbing systems.

B. Seismic Qualification Data: Certificates, for cooling towers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their

installation requirements.

C. Product Certificates: For certification required in "Quality Assurance" Article.

D. Field Test Reports: Include startup service reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts:

1. Furnish [**one**]<**Insert number**> set(s) of matching belts for each unique belt configuration and size furnished.

B. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **1/2 inch (13 mm)** high.

C. Touchup Coating: [**32-oz. (1-L)**]<**Insert volume**> container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: [**Certified by CTI**][**An NRTL**].

B. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

C. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include assembly instructions for complete cooling tower.

C. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Fan assembly including fan, drive, and motor.
3. **<Insert components requiring extended warranty>**.
4. Warranty Period: [**Five**]**<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amcot Cooling Tower Corp.**]
2. [**Baltimore Aircoil Company**]
3. [**EVAPCO, Inc**]
4. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Amcot Cooling Tower Corp.**]
2. [**Baltimore Aircoil Company**]
3. [**EVAPCO, Inc**]
4. [**Marley; a brand of SPX Cooling Technologies, Inc.**]
5. **<Insert manufacturer's name>**

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**][**and wind**

restraints], including comprehensive engineering analysis.

B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [**ASCE/SEI 7**][**the IBC**][**governing codes**]<**Insert requirement**>.

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: <**Insert value**>.
4. Component Response Modification Factor: <**Insert value**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.3 DESIGN ARRANGEMENT

A. Crossflow design with airflow from two sides and induced-draft, top-mounted axial fan and gravity distribution basin.

B. Crossflow design with airflow from one side and induced-draft, top-mounted axial fan and gravity distribution basin.

C. Crossflow design with airflow from one side and induced-draft, side-mounted axial fan and gravity distribution basin.

2.4 CASING AND FRAME

A. Casing Material: [**FRP with UV inhibitors**][**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.

B. Frame Material: [**FRP with UV inhibitors**][**galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**stainless steel, Grade 304**][**stainless steel, Grade 316**][**or**][**materials to match casing**]<**Insert material**>.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight[**by continuous welds**].

2.5 COLLECTION BASIN

A. Field-Constructed Collection Basin: Configure tower without a factory-assembled collection basin for installation and operation with a field-constructed collection basin.

B. Factory-Assembled Collection Basin:

1. Material: [**FRP with UV inhibitors**][**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
2. Hardware: [**Galvanized**][**or**][**stainless**] steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight[**by continuous welds**].
5. Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
9. Removable equalization flume plate between adjacent cells of multiple-cell towers.
10. Equalizer connection for field-installed equalizer piping configured to mate to ASME B16.5, Class 150 flange.
11. Basin Sweeper Distribution Piping and Nozzles:

    a. Pipe Material: [**PVC**][**or**][**CPVC**]<**Insert material**>, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
    b. Nozzle Material: [**Plastic**]<**Insert material**>.
    c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
    d. Basin penetrations sealed watertight.
    e. Field Connections: Threaded or flanged depending on pipe size. Thread for sizes through <**Insert pipe size**> and flanged for larger sizes.

2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosures: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to [**control makeup-water valve**][**control makeup-water valve and low-level alarm**][**control makeup-water valve and low- and high-level alarms**][**control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level**].
3. Electrode Probes: Stainless steel.

4. Water Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**Galvanized steel**][**PVC pipe**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
5. Makeup-Water Valve:

    a. Slow closing[**with stainless-steel body**].
    b. Actuator controlled and powered through level controller in response to water-level set point.
    c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    d. Fail Position: [**Closed**][**Open**][**Last**].
    e. Action: [**Two position**][**or**][**modulating**].

6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

C. Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Controller:

    a. Ultrasonic level sensor/transmitter with local display of measured value.
    b. Factory wired to terminal strip.
    c. Control make-up water valve in response to water-level set point.
    d. Adjustable level, alarm signal through relay closure[**for connection to control system**].
    e. Signal continuous level indication through a 4- to 20-mA signal[**for connection to control system**].

3. Water Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**Galvanized steel**][**PVC pipe**][**Stainless steel**]<**Insert material**>.
4. Makeup-Water Valve:

    a. Slow closing[**with stainless-steel body**].
    b. Valve actuator controlled and powered through level controller in response to water-level set point.
    c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    d. Fail Position: [**Closed**][**Open**][**Last**].
    e. Action: [**Two position**][**or**][**modulating**].

5. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.7 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**]<**Insert Type**>.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**] and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except connections to each electric basin heater shall be liquidtight conduit.

a. Raceway shall be corrosion-resistant [**stainless steel**][**or**][**PVC coated steel**].

B. Hot-Water-Coil Heater: Manufacturer's standard heater with indicated capacity.

C. Steam-Coil Heater: Manufacturer's standard heater with indicated capacity.

D. Steam-Injector Heater: Manufacturer's standard offering heater with indicated capacity.

2.8 GRAVITY WATER DISTRIBUTION BASIN

A. Design: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Material: [**FRP with UV inhibitors**][**galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**or**][**stainless steel**]<**Insert material**>.
2. Location: Over each bank of fill with easily replaceable [**plastic**]<**Insert material**> spray nozzles mounted in bottom of basin.
3. Inlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
4. Fasteners: [**Galvanized**][**or**][**stainless**] steel.
5. Joints and Seams: Sealed watertight.
6. Welded Connections: Sealed watertight[**by continuous welds**].
7. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing and achieve proper operation while operating throughout the flow range indicated.

   a. Manufacturer has option to use individual nozzle cups in lieu of partitioning dams to achieve operation within flow range (design to minimum) indicated.

8. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable [**corrosion-resistant**][**stainless-steel**] hardware. Panels reinforced to accommodate service personnel walking on the panels without resulting in permanent deflection and damage.
9. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
10. Single-Inlet, Field Pipe Connection: [**Galvanized-steel**][**PVC**] pipe arranged to achieve balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the [**bottom**][**side**] unless otherwise indicated.

2.9 FILL

A. Materials: PVC, with maximum flame-spread index of [**5**][**25**]<**Insert value**> according to ASTM E84.

B. Minimum Thickness: [**15 mils (0.4 mm)**][**20 mils (0.5 mm)**]<**Insert value**>, before forming.

C. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.

D. Fill Material Operating Temperature: Suitable for entering-water temperatures up through [**120 deg F (49 deg C)**]<**Insert temperature**>.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.10 DRIFT ELIMINATORS

A. Material: [**FRP**][**PVC**][**FRP or PVC**]<**Insert material**>; with maximum flame-spread index of [**5**][**25**]<**Insert value**> according to ASTM E84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Configuration: Multipass, designed and tested to reduce water carryover to [**0.005**]<**Insert number**> percent of design flow rate indicated.

D. Location: [**Integral to**][**Separate and removable from**] fill.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.11 AIR INLET

A. Air-Intake Louvers:

1. Material: [**FRP**][**PVC**][**Matching casing**]<**Insert material**>.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
4. Location: [**Integral to**][**Separate from**] fill.

B. [**Removable**]Air-Intake Screens:

1. [**Galvanized**][**Polymer-coated, galvanized**][**Stainless**]-steel wire mesh with openings of size sufficient to not restrict airflow or impact performance.
2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.12 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory[**after assembly**].

1. Blade Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
2. Hub Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
3. Blade Pitch: Field adjustable.
4. Fan Shaft: [**Corrosion resistant**][**Stainless steel**]<**Insert material**>.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**. Bearings designed for an L-10 life of [**40,000**][**50,000**][**100,000**]<**Insert value**> hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

B. Belt Drive:

1. Service Factor: [**1.5**]<**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.

3. Belt:

   a. Multiple V-belt design with a matched set of[**cogged**] belts.
   b. One-piece, multigrooved, solid-back belt.

4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
5. Belt-Drive Guard: Comply with OSHA regulations.
6. Two-Motor, Single-Fan Drive:

   a. Two single-speed motors per fan, one sized for full speed and load and the other sized for [**67**]<**Insert number**> percent of full-load speed.
   b. Each motor shall have belt drive and be configured for operation when other motor fails.
   c. Controls and wiring same as two-speed, two-winding motor.

C. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

D. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.

1. Gear Drive and Coupling Service Factor: [**2.0**]<**Insert value**> based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse. Able to operate throughout entire speed range from design speed indicated down to [**10**][**20**]<**Insert value**> of design speed.
5. Drive-to-Motor Connection: [**Close coupled to motor using a flexible coupling.**][**Connected to motor located outside of cooling tower casing by a full-floating drive shaft.**]
6. Drive Shaft Material: [**Corrosion resistant**][**Stainless steel**], and fitted with flexible couplings on both ends.
7. Drive Guards: Exposed shaft and couplings shall have guards according to OSHA regulations.
8. Extend oil fill, drain, and vent to outside of cooling tower casing using [**galvanized-steel**][**or**][**stainless-steel**] piping. Include oil-level sight glass.

E. Fan Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Totally enclosed**][**Totally enclosed air-over (TEAO)**][**Totally enclosed fan-cooled (TEFC)**][**and with epoxy or polyurethane finish**].
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.
8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
12. Severe-Duty Rating:

a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C.).)**
c. Internal Heater: Automatically energized when motor is de-energized.
d. Complying with IEEE 841.

13. Motor Base: Adjustable, or other suitable provision[**for adjusting belt tension**].
14. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than [**0.5**]<**Insert number**> percent of motor nameplate horsepower.

F. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.13 AIR DISCHARGE

A. Low-Profile Fan Discharge Stack:

1. Manufacturer's standard low-profile design.
2. Material: [**Material to match casing**][**FRP**][**Galvanized steel**][**Polymer-coated, galvanized steel**][**Stainless steel**]<**Insert material**>.
3. Stack Extension: Fabricated to extend above fan deck <**Insert distance**> unless otherwise indicated.
4. Stack Termination: Wire-mesh, [**galvanized-steel**][**polymer-coated, galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> screens; segmented into multiple removable pie sections and complying with OSHA regulations.

B. Velocity Recovery Fan Discharge Stack:

1. Design: Tapered and expanded for velocity recovery and improved energy efficiency.
2. Material: FRP or material matching casing.
3. Stack Height: Fabricated to extend above fan deck at least [**5 feet (1.5 m)**]<**Insert dimension**> unless otherwise indicated.
4. Service Access: Fabricated of multiple segments to facilitate removal of fan and drive components from overhead.
5. Stack Termination: Wire-mesh, [**galvanized-steel**][**polymer-coated, galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> screens; segmented into multiple removable pie sections and complying with OSHA regulations.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.14 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor.

B. Factory Install: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

a. Minimum Conduit Size: [**0.75 inch (20 mm)**]<**Insert size**>.
b. Materials: Corrosion resistant[**and constructed of stainless steel or PVC coated steel**].
c. Motor Termination: Liquidtight conduit, not to exceed **36 inches (900 mm)** long.
d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].
e. Wire:

1) Copper, rated for 600-V, solid wire for size [**No. 10 AWG**]<**Insert wire size**> and smaller and stranded wire for larger sizes.
2) Minimum Wire Size: [**No. 12 AWG**]<**Insert wire size**>.
3) Each circuit shall have a ground wire.
4) Install wire in conduit.

f. Boxes, Condulets, and Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

C. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, [**fused**][**or**][**nonfused**].
3. 600 V rated.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Disconnect switch shall have a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors as indicated.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
4. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
5. SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
2. Enclosure: Unit mounted, NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
3. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
9. Operating Requirements:

    a. Input AC Voltage Tolerance: [**10**]<**Insert number**> percent.
    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
    c. Capable of driving full motor load, without derating.
    d. Minimum Efficiency: 96 percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 95 percent.
    f. Overload Capability: 1.05 times the full-load current for 7 seconds.
    g. Starting Torque: As required by fan and motor drive assembly.
    h. Speed Regulation: 1 percent.
    i. Speed Range: 10:1 speed range.
    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
    k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.
    m. <**Insert features**>.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption

and before shutting down for manual reset or fault correction.
b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

a. Power on.
b. Run.
c. Overcurrent and overvoltage.
d. Motor speed (percent).
e. Various faults with alarm status.
f. Input kilovolt amperes.
g. Power factor.
h. Input kilowatts and kilowatt-hours.
i. Three-phase input and output voltage.
j. Three-phase input and output current.
k. Output frequency.
l. Elapsed operating time (hours).
m. Diagnostic and service parameters.
n. <**Insert conditions**>.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of [**two**]<**Insert value**> analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**]<**Insert value**> programmable digital inputs.
17. Bypass Controller:

a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
c. Include "Bypass/VFC" manual selector switch on face of enclosure for local operator control of preferred controller.
d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
e. Install bypass controller in same enclosure as variable-frequency controller.

2.15 CONTROLS

A. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Switch shall have manual-reset button hardwired connection to fan motor electrical circuit.
4. Switch shall have field connection to a control system hardwired connection to fan motor electrical circuit.
5. Switch shall, on sensing excessive vibration,[**signal an alarm for connection to control system and**] shut down the fan.

B. Vibration Transmitter with Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.

2. Display: Local display of measured value, power, and alarm.
3. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point.

    a. Cooling tower manufacturer shall select range that is suitable for cooling tower and recommend switch set point for proper operation and protection.

4. Transmitter: Continuous vibration level indication through a 4- to 20-mA signal for connection to control system.
5. Switch:

    a. Relay and switch with manual-reset button for field connection to control system and hardwired connection to fan motor electrical circuit.
    b. Switch shall, on sensing excessive vibration, signal an alarm to control system and shut down the fan.

6. Mounting: Locate out of cooling tower discharge airstream and mount in a location that is accessible[**and where display is easily viewable**].
7. Field Electrical Connection Requirements: 120 V, single phase, 60 Hz.

C. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch[**for connection to control system**].

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm[**through control system**].

D. Control Package:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**] enclosure with removable internally mount backplate.
3. Control-circuit transformer with primary and secondary side fuses.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Collection basin level controller complying with requirements in [**"Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve"**][**"Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve"**] Paragraph in "Collection Basin Makeup-Water Assembly" Article.
8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
10. Oil-level switch for each fan with a gear drive, complying with requirements in "Gear-Drive, Oil-Level Switch" Paragraph.
11. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**][**for each cooling tower cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Include variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

12. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.

13. Visual indication of status and alarm[**with momentary test push button**] for each motor.
14. Audible alarm and silence switch.
15. Visual indication of elapsed run time, graduated in hours for each motor.
16. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Cooling tower leaving-fluid temperature.
    c. Fan vibration alarm.
    d. Oil-level alarm.
    e. Collection basin [**high**][**low**][**high- and low**]-water-level alarms.
    f. <**Insert conditions to be monitored**>.

2.16 SERVICE ACCESS

A. Doors:

1. Large enough for personnel to access cooling tower internal components from both cooling tower end walls.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.
4. Hinges and handles shall be [**corrosion resistant**][**stainless steel**]<**Insert material**>.

B. External Ladders with Safety Cages: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

C. External Platforms with Handrails: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

D. External Motor Platforms with Handrails: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

E. Fan Deck Floor between Cooling Tower Cells:

1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
2. Floor materials shall match adjacent cooling tower cell fan deck.
3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
4. Frame shall be constructed of same materials as cooling tower frame.

F. Handrail: [**Aluminum**][**FRP**][**galvanized steel**][**or**][**stainless steel**]<**Insert material**> complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

G. Internal Platforms: [**Aluminum**][**FRP**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

1. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.
3. <**Insert platform locations**>.

H. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.17 HOISTING ASSEMBLY

A. Hoisting assembly consisting of pedestal base, davit arm, and winch to accommodate lowering and raising cooling tower components from their installed location to the base of cooling tower supports.

1. Cooling tower components serviceable by hoisting assembly shall include, but not be limited to, fan stack, fan, fan drive, and fan motor.
2. Hoisting assembly shall be designed to accommodate heaviest single component plus a safety factor of [**1.5**]<**Insert value**>.
3. Construct cooling tower structural supports and reinforcing to accommodate lifting heaviest load with safety factor.

B. Pedestal Base:

1. Equip each cooling tower cell with a pedestal base to accommodate an easily removable davit arm and winch assembly.
2. Position pedestal base at a location on cooling tower fan (top) deck for hoisting assembly coverage to fan, fan motor, and fan drive assembly.
3. Pedestal base design shall be open-socket, or comparable, design that is configured to accept and secure an inserted portable davit arm.
4. Fit each pedestal base with an easily removable cap or plug designed to seal the open top of the base when the davit arm is not installed.
5. Fasten pedestal base to cooling tower using threaded hardware.
6. Construct pedestal base of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

C. Davit Arm:

1. Each cooling tower [**cell**]shall have a davit arm.
2. Davit arm shall be an adjustable telescoping design with angular adjustment to accommodate varying lifting conditions required by the application.
3. Davit arm assembly shall be portable and capable of being relocated to any cooling tower cell pedestal base.
4. Construct davit arm of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

D. Winch:

1. Each davit arm shall have [**an electric-**][**or**][**a hand-**]operated winch.

   a. Electric winch shall include a power cord and plug for connection to a field-installed, weatherproof, 20-A receptacle with 120-V, single-phase, 60-Hz field power supply.
   b. Hand-operated winch with gear mechanism to limit force on handle to not more than **80 lb (36 kg)** when lifting the heaviest component.

2. Coat winch body and exposed components with corrosion-resistant finish that is rated for outdoor duty in a highly corrosive environment and exposed to direct sunlight.
3. Winch cable shall be stainless steel and terminated with a stainless-steel hook and quick disconnecting mechanism. Cable length shall be at least 1.5 times actual length required for application.

E. Hardware: [**304**][**or**][**316**] series stainless steel.

F. Nameplate:

1. Stamped or engraved aluminum or stainless-steel nameplate with rated load capacity on each davit arm and pedestal.
2. Letter size legible from a distance of **60 inches (1500 mm)** and not less than **1/2 inch (13 mm)**.
3. Fasten nameplate at multiple points with stainless-steel rivets or screws.

2.18 CAPACITIES AND CHARACTERISTICS

A. Number of Cells: <**Insert quantity**>.

B. Air-Inlet Arrangement: [**Single side**][**Two sides**].

C. Maximum Drift Loss: [**0.005**]<**Insert number**> percent of design water flow.

D. Waterside:

1. Design Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Minimum Water Flow per Cell: <**Insert gpm (L/s)**>.
3. Water Pressure Drop: <**Insert psig (kPa)**>.
4. Entering-Water Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

E. Airside:

1. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
2. Altitude: <**Insert value**>.
3. Airflow per Cell: <**Insert cfm (L/s)**>.

F. Economizer-Mode Performance:

1. Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Entering-Water Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
4. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

G. Fan Drive Assembly:

1. Type: [**Belt**][**direct**][**or**][**gear**].
2. Fan Motor:

   a. Type: [**Single speed**][**Two speed, single winding**][**Two speed, two winding**][**Variable speed**].
   b. Motor Size per Cell: <**Insert number**> hp.
   c. Full-Load Ampacity: <**Insert value**>.
   d. Minimum Circuit Ampacity: <**Insert value**>.
   e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
   f. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.

H. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**>[**when measured according to CTI ATC 128**].

I. Collection Basin Heater:

1. Basin Water Temperature: [**40 deg F (5 deg C)**]<**Insert temperature**>.

2. Outdoor Ambient Temperature: [**0 deg F (Minus 18 deg C)**][**Minus 20 deg F (Minus 29 deg C)**]<**Insert temperature**>.
3. Capacity per Cell: <**Insert kilowatts**>.
4. Full-Load Ampacity: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection Device: <**Insert amperage**>.
7. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.
8. Capacity/Cell: <**Insert MBtu/h (kW)**>.
9. Coil Fluid Type: [**Water**]<**Insert fluid type**>.
10. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
11. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
12. Fluid Flow Rate: <**Insert gpm (L/s)**>.
13. Fluid Pressure Drop: <**Insert psig (kPa)**>.
14. Capacity/Cell: <**Insert MBtu/h (kW)**>.
15. Steam Flow: <**Insert lb/h (L/s)**>.
16. Steam Pressure: <**Insert psig (kPa)**>.

2.19 SOURCE QUALITY CONTROL

A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

B. Seismic Performance Testing: Shake table tested by an independent [**or a factory-certified**]laboratory to certify performance complies with seismic requirements indicated.

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Functional Tests:

1. Test collection and distribution basins after assembly, and prove free of leaks.
2. Test factory-installed electric/electronic water-level controls for proper operation.
3. Test factory-installed electric basin heaters for proper operation.
4. Test factory-installed fan and drive assemblies for proper operation.
5. Test factory-installed control package for proper operation.
6. Test access doors to ensure smooth operation and proper fit.
7. <**Insert additional functional test requirements**>.
8. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
9. Submit report documenting tests performed and results within one week of test date.

D. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include round-trip coach airfare, out of town hotel accommodations, out of town meals (breakfast, lunch, and dinner), out of town ground transportation, and all associated taxes and fees.

3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [**one**][**two**]<**Insert value**> Owner representative(s) with origin of <**Insert city, state, and country**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices and accessories furnished by manufacturer, with cooling tower, that are not factory mounted.

1. Loose components shall be installed by [**manufacturer's factory-trained service personnel**][**Contractor under supervision of manufacturer's factory-trained service personnel**].

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains, to sanitary sewage system.

F. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, flow meter, and drain connection with valve and union.

G. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

H. Equalizer Piping:

1. Piping requirements to match supply and return piping.
2. Connect an equalizer pipe, full size of cooling tower connection, between tower cells.
3. Connect to cooling tower with shutoff valve and drain connection with valve.
4. Make connections to cooling tower with a flange.

I. Basin Heater Hot-Water Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve, strainer, control valve thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
4. Make connections with a flange, union, or mechanical coupling.

J. Basin Heater Steam and Condensate Piping:

1. Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
2. Connect steam supply connection with shutoff valve, strainer, control valve, pressure gage, and flow meter.
3. Connect to condensate connection with shutoff valve, strainer, and an appropriate steam trap assembly.
4. Make connections with a flange or union.

K. Basin Sweeper Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve[**, flow meter,**] and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve,[**flow meter,**] and drain connection with valve.
4. Make connections with a [**flange**][**or**][**union**].

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and control system for HVAC for remote monitoring and control of cooling towers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section.**>

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identifying products and installations.

3.6 FIELD TESTING PROVISIONS

A. Include provisions for cooling tower future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

B. Include provisions in field piping for future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

3.7 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Comply with [**ASME PTC 23**][**CTI ATC 105**].

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.
h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.9 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating set point.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than [**8**]<**Insert value**> hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Perform instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 23 65 14 14

SECTION 23 65 14 16 - CLOSED-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes factory-assembled, closed-circuit, induced-draft, counterflow cooling towers.

1.2 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at basin heater supply piping connections.
6. Pressure required at collection basin sweeper supply piping connections.
7. Drift loss as percent of design flow rate.
8. Volume of water in suspension for purposes of sizing remote storage.
9. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

10. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    b. Varying ambient wet-bulb temperatures from design to minimum in [**one**][**five**]<**Insert number**>-degree temperature increments.
    c. Varying water flow rates from design to minimum in increments of [**10**]<**Insert number**> percent of flow rate difference between design and minimum flow rates.
    d. Varying fan operation from design to minimum speed in [**5**][**10**]<**Insert number**> percent speed increments, and with fan off.

11. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
12. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
13. Pump flow rate, head, brake horsepower, and efficiency.
14. Pump motor electrical characteristics including, but not limited to, speed, voltage, phase hertz,

amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
15. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation[**and seismic controls**].
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**][**and wind restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Structural supports.
b. Piping roughing-in requirements.
c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances.

2. Drawings showing plans, sections, and elevation views, drawn to scale of at least <**Insert scale**>.
3. Each view to show screened background with the following:

a. Structural grids.
b. Adjacent walls, floors, and roofs.
c. Equipment and products of other trades that are located in vicinity of cooling towers and are part of final installation, such as controls, power, lighting, fire-suppression systems, and plumbing systems.

B. Seismic Qualification Data: Certificates, for cooling towers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For certification required in "Quality Assurance" Article.

D. Field Test Reports: Include startup service reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts:

1. Furnish [**one**]<**Insert number**> set(s) of matching belts for each unique belt configuration and size furnished.

B. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least **1 inch (25 mm)** high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least **1/2 inch (13 mm)** high.

C. Touchup Coating: [**32-oz. (1-L)**]<**Insert volume**> container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: [**Certified by CTI**][**An NRTL**].

B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure

Vessel Code: Section VIII, Division 1.

C. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

D. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.
2. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Fan assembly including fan, drive, and motor.
3. <**Insert components requiring extended warranty**>.
4. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CLOSED-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Baltimore Aircoil Company**]
2. [**EVAPCO, Inc**]
3. [**Recold**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Baltimore Aircoil Company**]
2. [**EVAPCO, Inc**]
3. [**Recold**]
4. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**][**and wind restraints**], including comprehensive engineering analysis.

B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [**ASCE/SEI 7**][**the IBC**][**governing code**]<**Insert requirement**>.

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: <**Insert value**>.
4. Component Response Modification Factor: <**Insert value**>.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.3 DESIGN ARRANGEMENT

A. Counterflow design with airflow from all sides and induced-draft, top-mounted axial fan and pressurized pipe distribution.

2.4 CASING AND FRAME

A. Casing Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.

B. Frame Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**polymer-coated galvanized steel**][**stainless steel, Grade 304**][**stainless steel, Grade 316**][**or**][**materials to match**

casing]<**Insert material**>.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight[**by continuous welds**].

2.5 COLLECTION BASIN

A. Factory-Assembled Collection Basin:

1. Material: [**Galvanized steel, ASTM A653/A653M, G235 (Z700) coating**][**Polymer-coated galvanized steel**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
2. Hardware: [**Galvanized**][**or**][**stainless**] steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight[**by continuous welds**].
5. Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
9. Basin Sweeper Distribution Piping and Nozzles:

   a. Pipe Material: [**PVC**]<**Insert material**>, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
   b. Nozzle Material: [**Plastic**]<**Insert material**>.
   c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
   d. Basin penetrations sealed watertight.
   e. Field Connections: Threaded or flanged depending on pipe size. Threaded for sizes through <**Insert pipe size**> and flanged for larger sizes.

2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosures: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to [**control makeup-water valve**][**control makeup-water valve and low-level alarm**][**control makeup-water valve and low- and high-level alarms**][**control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level**].
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: [**Corrosion-resistant material**][**FRP**][**Galvanized steel**][**PVC pipe**][**Stainless steel, Grade 304**][**Stainless steel, Grade 316**]<**Insert material**>.
5. Makeup-Water Valve:

   a. Slow closing[**with stainless-steel body**].
   b. Valve actuator controlled and powered through level controller in response to water-level set point.

c. Actuator Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
d. Fail Position: [**Closed**][**Open**][**Last**].
e. Action: [**Two position**][**or**][**modulating**].

6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.7 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**]<**Insert Type**>.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**] and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

a. Raceway shall be corrosion-resistant [**stainless steel**][**or**][**PVC coated steel**].

2.8 PRESSURIZED DISTRIBUTION NETWORK

A. Main header and lateral branch piping designed for even distribution over heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, nonclogging spray nozzles.

B. Pipe Material: [**Schedule 40 PVC**]<**Insert material**>.

C. Spray Nozzle Material: [**Plastic**][**Polypropylene**][**or**][**PVC**]<**Insert material**>.

D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.9 HEAT-EXCHANGER COILS

A. Tube and Tube Sheet Materials: [**Copper tube with stainless-steel tube sheet**][**stainless-steel tube and tube sheet**][**or**][**carbon-steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication**].

B. Heat-Exchanger Arrangement:

1. [**Serpentine tubes**][**Serpentine tubes with removable cover plate on inlet and outlet headers**][**or**][**straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube**]; sloped for complete drainage of fluid by gravity.
2. Tubes with extended surface fins if required to achieve performance indicated.

3. Multiple Separate Circuits: Separate circuits to achieve multiple isolated loops as required by application.

C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; sloped for complete drainage of fluid by gravity.

D. Field Piping Connections: Vent, supply, and return[**suitable for mating to ASME B16.5, Class 150 flange**].

2.10 DRIFT ELIMINATORS

A. Material: [**PVC**]<**Insert material**>; with maximum flame-spread index of [**5**][**25**]<**Insert number**> according to ASTM E84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Arrangement: Multiple, easily removable sections.

D. Configuration: Multipass, designed and tested to reduce water carryover to [**0.001**]<**Insert number**> percent of design flow rate indicated.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.11 AIR INLET

A. Air-Intake Louvers:

1. Material: [**PVC**]<**Insert material**>.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

B. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.12 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory[**after assembly**].

1. Blade Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
2. Hub Material: [**Aluminum**][**FRP**][**or**][**galvanized steel**]<**Insert material**>.
3. Blade Pitch: Field adjustable.
4. Fan Shaft: [**Corrosion resistant**][**Stainless steel**]<**Insert material**>.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**. Bearings designed for an L-10 life of [**40,000**][**50,000**][**100,000**]<**Insert value**> hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
7. Automatic Bearing Greasing System:

a. Manufacturer designed system to provide an as needed supply of new grease to bearings while reducing the need for periodic bearing maintenance and associated greasing problems.
b. Easily replaceable storage container filled with recommended grease and located in an easily accessible location on cooling tower exterior. Container capacity of sufficient size to provide grease for [**one year**]<**Insert time period**>.

B. Belt Drive:

1. Service Factor: [**1.5**]<**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt:

a. Multiple V-belt design with a matched set of[**cogged**] belts.
b. One-piece, multigrooved, solid-back belt.

4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
5. Belt-Drive Guard: Comply with OSHA regulations.
6. Two-Motor, Single-Fan Drive:

a. Two single-speed motors per fan, one sized for full speed and load and the other sized for [**67**]<**Insert number**> percent of full-load speed.
b. Each motor shall have belt drive and be configured for operation when other motor fails.
c. Controls and wiring same as two-speed, two-winding motor.

C. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

D. Fan Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Open dripproof with weather protective cover**][**totally enclosed**][**totally enclosed air-over (TEAO)**][**or**][**totally enclosed fan-cooled (TEFC)**][**with epoxy or polyurethane finish**].
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.
8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
12. Severe-Duty Rating:

a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**.
c. Internal Heater: Automatically energized when motor is de-energized.
d. Complying with IEEE 841.

13. Motor Base: Adjustable, or other suitable provision[**for adjusting belt tension**].
14. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than [**0.5**]<**Insert value**> percent of motor nameplate horsepower.

E. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.13 AIR DISCHARGE

A. Fan Discharge Stack:

1. Manufacturer's standard low-profile design.
2. Material: [**Material to match casing**]<**Insert material**>.
3. Stack Extension: Fabricated to extend above fan deck <**Insert distance**> unless otherwise indicated.
4. Stack Termination: Wire-mesh, [**galvanized-steel**][**polymer-coated, galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> screens; segmented into multiple removable pie sections and complying with OSHA regulations.

B. Discharge Hood:

1. Hood Configuration: [**Tapered**][**Straight**]; totally surrounding heat exchanger, pressurized distribution system and drift eliminators; constructed of same material as casing; and having factory-installed [**insulation and**]access doors.
2. Discharge Dampers: Positive-closure, automatic, isolation dampers constructed of [**aluminum**][**galvanized steel**][**stainless steel**]<**Insert material**> with corrosion-resistant linkages and electric actuators with NEMA 250, Type 4X enclosure.

    a. If not provided with factory controls, field-connect provisions for electrical power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

3. Capacity-Control Dampers: [**Aluminum**][**Galvanized-steel**][**Stainless-steel**]<**Insert material**> dampers, with corrosion-resistant linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

    a. If not provided with factory controls, provide field power and controls to operate dampers when pump is energized and close dampers when pump and fan is de-energized.

C. Hardware: [**Galvanized**][**or**][**stainless**] steel.

2.14 RECIRCULATING WATER DISTRIBUTION SYSTEM

A. Pump: Close-coupled, single-stage, [**bronze-fitted**]centrifugal pump; with mechanical seal and suitable for outdoor service. Factory install pump with following:

1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.
2. Flanges at pump connections to piping.
3. Strainer[**, with blowdown isolation valve,**] installed in piping on suction side of pump.

4. Flow balancing valve in piping on discharge side of pump.

B. Pump Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, [**Design B**]<**Insert design**>, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: [**Open dripproof**][**or**][**totally enclosed**][**and with epoxy or polyurethane finish**].
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: [**Comply with ASHRAE/IES 90.1**][**NEMA Premium Efficient**].
7. Service Factor: [**1.15**]<**Insert value**>.
8. Temperature Rise: [**Match**][**One class lower than**]<**Insert requirements**> insulation rating.
9. Insulation: [**Class F**][**Class H**]<**Insert class**>.
10. Severe-Duty Rating:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between **minus 20 and plus 300 deg F (minus 29 and plus 149 deg C)**.
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

C. Piping:

1. Interconnecting collection basin to pump and pressurization distribution system.

    a. Design delegated to manufacturer.
    b. External to and supported from cooling tower casing and frame.
    c. Material: [**Corrosion resistant**][**PVC**]<**Insert material**>.
    d. Install flanges at connections to collection basin and pressurized distribution system.
    e. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.

2. Field installed for connection to remotely installed pump and water storage that are not furnished with cooling tower.

2.15 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor and a [**disconnect switch**][**motor controller**] for each pump motor.

B. Factory Install: A [**disconnect switch**][**motor controller**][**variable-frequency controller**] for each fan motor and a [**disconnect switch**][**motor controller**] for each pump motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

    a. Minimum Conduit Size: [**0.75 inch (20 mm)**]<**Insert size**>.
    b. Materials: Corrosion resistant[**and constructed of stainless steel or PVC coated steel**].
    c. Motor Termination: Liquidtight conduit, not to exceed **36 inches (900 mm)** long.

d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].

e. Wire:

1) Copper, rated for 600-V, solid wire for size [**No. 10 AWG**]<**Insert wire size**> and smaller and stranded wire for larger sizes.
2) Minimum Wire Size: [**No. 12 AWG**]<**Insert wire size**>.
3) Each circuit shall have a ground wire.
4) Install wire in conduit.

f. Boxes, Condulets, and Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

C. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, [**fused**][**or**][**nonfused**].
3. 600 V rated.
4. Minimum SCCR: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Provide a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors as indicated.
3. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
4. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
5. SCCR shall be as required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.

2. Enclosure: Unit mounted, NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**or**][**Type 4X stainless steel**]<**Insert Type**>, with hinged full-front access door with lock and key.
3. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
4. Minimum SCCR shall be as required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert value**> A.
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
9. Operating Requirements:

    a. Input AC Voltage Tolerance: [**10**]<**Insert number**> percent.
    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
    c. Capable of driving full motor load, without derating.
    d. Minimum Efficiency: 96 percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 95 percent.
    f. Overload Capability: 1.05 times the full-load current for 7 seconds.
    g. Starting Torque: As required by fan and motor drive assembly.
    h. Speed Regulation: 1 percent.
    i. Speed Range: 10:1 speed range.
    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
    k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.
    m. <**Insert features**>.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
    b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

    a. Power on.
    b. Run.
    c. Overcurrent and overvoltage.
    d. Motor speed (percent).
    e. Various faults with alarm status.
    f. Input kilovolt amperes.
    g. Power factor.
    h. Input kilowatts and kilowatt-hours.
    i. Three-phase input and output voltage.
    j. Three-phase input and output current.
    k. Output frequency.
    l. Elapsed operating time (hours).
    m. Diagnostic and service parameters.
    n. <**Insert conditions**>.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of [**two**]<**Insert value**> analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**]<**Insert value**> programmable digital inputs.
17. Bypass Controller:

    a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
    b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
    c. Include "Bypass/VFC" manual selector switch on face of enclosure for local operator control of preferred controller.
    d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
    e. Install bypass controller in same enclosure as variable-frequency controller.

2.16 CONTROLS

A. Vibration Switch: For each fan drive.

    1. Enclosure: NEMA 250, [**Type 4**][**Type 4X**]<**Insert Type**>.
    2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
    3. Switch shall have manual-reset button hardwired connection to fan motor electrical circuit.
    4. Switch shall have field connection to a control system hardwired connection to fan motor electrical circuit.
    5. Switch shall, on sensing excessive vibration,[**signal an alarm for connection to control system and**] shut down the fan.

B. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

    1. Factory installed and wired, and functionally tested at factory before shipment.
    2. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**] enclosure with removable internally mount backplate.
    3. Control-circuit transformer with primary and secondary side fuses.

4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve" Paragraph in "Collection Basin Makeup-Water Assembly" Article.
8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
10. Single-point, field-power connection to a [**fused disconnect switch**][**nonfused disconnect switch**][**circuit breaker**][**for each cooling tower cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm[**with momentary test push button**] for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Cooling tower leaving-fluid temperature.
    c. Fan vibration alarm.
    d. Collection basin [**high**][**low**][**high- and low**]-water-level alarms.
    e. <**Insert conditions to be monitored**>.

2.17 WATER TREATMENT

A. Chemical-Free Water Treatment System: Complete factory-installed system consisting of the following:

1. Pulsed-power technology emitting high-frequency bursts of low energy electromagnetic fields to the recirculated water to control corrosion, bacteria, and scale.
2. Conductivity control of electrically operated valve designed to control totally dissolved solids levels and bleed rates.
3. Piping associated with system.
4. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.

B. Chemical Water Treatment System: Complete factory-installed system consisting of the following:

1. Microprocessor-controlled conductivity controller housed in NEMA 250, Type 4X enclosure.
2. Chemical metering pump housed in NEMA 250, Type 4X enclosure.
3. Electrically operated valve designed to control totally dissolved solids levels and bleed rates.
4. Piping associated with system.
5. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.

2.18 SERVICE ACCESS

A. Doors:

1. Large enough for personnel to access cooling tower internal components.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.
4. Hinges and handles shall be [**corrosion resistant**][**stainless steel**]<**Insert material**>.

B. External Ladders with Safety Cages: [**Aluminum**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

C. External Platforms with Handrails: [**Aluminum**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

D. External Motor Platforms with Handrails: [**Aluminum**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

E. Fan Deck Floor between Cooling Tower Cells:

1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
2. Floor materials shall match adjacent cooling tower cell fan deck.
3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
4. Frame shall be constructed of same materials as cooling tower frame.

F. Handrail: [**Aluminum**][**galvanized steel**][**or**][**stainless steel**]<**Insert material**> complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

G. Internal Platforms: [**Aluminum**][**galvanized-steel**][**or**][**stainless-steel**]<**Insert material**> bar grating.

1. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach.
3. <**Insert platform locations**>.

H. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.19 HOISTING ASSEMBLY

A. Hoisting assembly consisting of pedestal base, davit arm, and winch to accommodate lowering and raising cooling tower components from their installed location to the base of cooling tower supports.

1. Cooling tower components serviceable by hoisting assembly shall include, but not be limited to, fan stack, fan, fan drive, and fan motor.
2. Hoisting assembly shall be designed to accommodate heaviest single component plus a safety factor of [**1.5**]<**Insert value**>.
3. Construct cooling tower structural supports and reinforcing to accommodate lifting heaviest load

with safety factor.

B. Pedestal Base:

1. Equip each cooling tower cell with a pedestal base to accommodate an easily removable davit arm and winch assembly.
2. Position pedestal base at a location on cooling tower for hoisting assembly coverage to fan, fan motor, and fan drive assembly.
3. Pedestal base design shall be open-socket, or comparable, design that is configured to accept and secure an inserted portable davit arm.
4. Fit each pedestal base with an easily removable cap or plug designed to seal the open top of the base when the davit arm is not installed.
5. Fasten pedestal base to cooling tower using threaded hardware.
6. Construct pedestal base of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

C. Davit Arm:

1. Each cooling tower [**cell**]shall have a davit arm.
2. Davit arm shall be an adjustable telescoping design with angular adjustment to accommodate varying lifting conditions required by the application.
3. Davit arm assembly shall be portable and capable of being relocated to any cooling tower cell pedestal base.
4. Construct davit arm of [**hot-dip galvanized steel**][**or**][**300L series stainless steel**].

D. Winch:

1. Each davit arm shall have [**an electric-**][**or**][**a hand-**]operated winch.

   a. Electric winch shall include a power cord and plug for connection to a field-installed, weatherproof, 20-A receptacle with 120-V, single-phase, 60-Hz field power supply.
   b. Hand-operated winch with gear mechanism to limit force on handle to not more than **80 lb (36 kg)** when lifting the heaviest component.

2. Coat winch body and exposed components with corrosion-resistant finish that is rated for outdoor duty in a highly corrosive environment and exposed to direct sunlight.
3. Winch cable shall be stainless steel and terminated with a stainless-steel hook and quick disconnecting mechanism. Cable length shall be at least 1.5 times actual length required for application.

E. Hardware: [**304**][**or**][**316**] series stainless steel.

F. Nameplate:

1. Stamped or engraved aluminum or stainless-steel nameplate with rated load capacity on each davit arm and pedestal.
2. Letter size legible from a distance of **60 inches (1500 mm)** and not less than**1/2 inch (13 mm)**.
3. Fasten nameplate at multiple points with stainless-steel rivets or screws.

2.20 CAPACITIES AND CHARACTERISTICS

A. Number of Cells: <**Insert quantity**>.

B. Air-Inlet Arrangement: All sides.

C. Maximum Drift Loss: [**0.001**]<**Insert number**> percent of design water flow.

D. Heat Exchanger:

1. Fluid Type: [**Water**]<**Insert type**>.
2. Design Fluid Flow per Cell: <**Insert gpm (L/s)**>.
3. Minimum Fluid Flow per Cell: <**Insert gpm (L/s)**>.
4. Fluid Pressure Drop: <**Insert psig (kPa)**>.
5. Fluid Pressure Rating: <**Insert psig (kPa)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
9. Airflow per Cell: <**Insert cfm (L/s)**>.

E. Economizer-Mode Performance:

1. Fluid Flow per Cell: <**Insert gpm (L/s)**>.
2. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
4. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

F. Fan Drive Assembly:

1. Type: [**Belt**][**or**][**direct**].
2. Fan Motor:

   a. Type: [**Single speed**][**Two speed, single winding**][**Two speed, two winding**][**Variable speed**].
   b. Motor Size per Cell: <**Insert number**> hp.
   c. Full-Load Ampacity: <**Insert value**>.
   d. Minimum Circuit Ampacity: <**Insert value**>.
   e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
   f. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.

G. Pump and Motor:

1. Water Flow per Cell: <**Insert gpm (L/s)**>.
2. Motor Size per Cell: <**Insert number**> hp.
3. Full-Load Ampacity: <**Insert value**>.
4. Minimum Circuit Ampacity: <**Insert value**>.
5. Maximum Overcurrent Protection Device: <**Insert amperage**>.
6. Electrical Characteristics: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>-V ac, [**single**][**3**] phase, 60 Hz.

H. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**>[**when measured according to CTI ATC 128**].

I. Collection Basin Heater:

1. Basin Water Temperature: [**40 deg F (5 deg C)**]<**Insert temperature**>.
2. Outdoor Ambient Temperature: [**0 deg F (Minus 18 deg C)**][**Minus 20 deg F (Minus 29 deg C)**]<**Insert temperature**>.
3. Capacity/Cell: <**Insert kilowatts**>.
4. Full-Load Ampacity: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection Device: <**Insert amperage**>.

7. Electrical Characteristics: [**208**][**240**][**480**]<**Insert value**>-V ac, 3 phase, 60 Hz.

2.21 SOURCE QUALITY CONTROL

A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

B. Seismic Performance Testing: Shake table tested by an independent[**or a factory-certified**] laboratory to certify performance complies with seismic requirements indicated.

1. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Functional Tests:

1. Test collection and distribution basins after assembly, and prove free of leaks.
2. Test factory-installed electric/electronic water-level controls for proper operation.
3. Test factory-installed electric basin heaters for proper operation.
4. Test factory-installed fan and drive assemblies for proper operation.
5. Test factory-installed control package for proper operation.
6. Test access doors to ensure smooth operation and proper fit.
7. <**Insert additional functional test requirements**>.
8. Allow [**Owner**]<**Insert entity**> access to place where cooling towers are being tested. Notify Owner in writing at least [**30**]<**Insert number**> days in advance of testing.
9. Submit report documenting tests performed and results within one week of test date.

D. Heat-Exchanger Factory Pressure and Leak Tests:

1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
2. Test pressure equal to [**1.5**]<**Insert value**> times rated pressured, but not less than <**Insert psig (kPa)**>.
3. Submit report documenting test and results.

E. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include round-trip coach airfare, out of town hotel accommodations, out of town meals (breakfast, lunch, and dinner), out of town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [**one**][**two**]<**Insert value**> Owner representative(s) with origin of <**Insert city, state, and country**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices, and accessories furnished by manufacturer with cooling tower, that are not factory mounted.

1. Loose components shall be installed by [**manufacturer's factory-trained service personnel**][**Contractor under supervision of manufacturer's factory-trained service personnel**].

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve and union.

G. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering cooling tower connections with shutoff valve,[**strainer,**] balancing valve, thermometer, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve.
3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

H. Basin Sweeper Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to supply connections with shutoff valve[**, flow meter,**] and drain connection with valve.
3. Connect to return connections with shutoff valve, balancing valve,[**flow meter,**] and drain connection with valve.
4. Make connections with a [**flange**][**or**][**union**].

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least **1/2 inch (13 mm)** high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to

achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and [**DDC system**]<**Insert system description**> for remote monitoring and control of cooling towers. Comply with requirements in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section.**>

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identification products and installations.

3.6 FIELD TESTING PROVISIONS

A. Include provisions for cooling tower future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

B. Include provisions in field piping for future field-performance testing complying with [**ASME PTC 23**][**CTI ATC 105**].

3.7 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections: Comply with [**ASME PTC 23**][**CTI ATC 105**].

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.

c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Verify pump rotation for correct direction, vibration, cavitation, and flow and correct problems.
h. Adjust belts to proper alignment and tension.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.9 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating set point.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than [**8**]<**Insert value**> hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Perform instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 23 65 14 16

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Task	Specification	Specification Description
23 71 13 23	23 11 26 00	Facility Liquefied-Petroleum Gas Piping

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SECTION 23 72 13 00 - HEAT WHEEL AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heat wheel air-to-air energy recovery units.

B. Related Requirements:

1. Section 233119 "HVAC Casings" for customized housings used for air-to-air energy recovery units.
2. Section 237313.19 "Indoor, Custom Air-Handling Units" for custom housings used for air-to-air energy recovery units.
3. Section 237343.19 "Outdoor, Custom Air-Handling Units" for custom housings used for air-to-air energy recovery units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, details, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy recovery equipment.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Data: Certificates, for air-to-air energy recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wheel Belts: [**One**]<**Insert number**> set(s) of belts for each heat wheel.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE Compliance:

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment are to comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Air-to-air energy recovery equipment is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Exhaust Air:

1. Airflow: <**Insert value**> **cfm (L/s)**.
2. Face Velocity: <**Insert value**> **fpm (m/s)**.
3. Summer:

a. Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
b. Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
c. Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
d. Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

4. Winter:

a. Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
b. Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
c. Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
d. Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

5. Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

B. Supply Air:

1. Airflow: <**Insert value**> **cfm (L/s)**.
2. Face Velocity: <**Insert value**> **fpm (m/s)**.
3. Summer:

a. Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
b. Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
c. Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
d. Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

4. Winter:

a. Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
b. Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
c. Leaving-Air Temperature, Dry Bulb: <**Insert value**>**deg F (deg C)**.
d. Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

5. Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

C. Wheel Drive:

1. Motor Size: <**Insert horsepower**>.
2. Motor Electrical Characteristics:

a. Volts: [**120**][**208**][**230**]<**Insert value**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60 Hz.

D. Effectiveness: <**Insert percentage**>.

2.3 HEAT WHEEL AIR-TO-AIR ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AIRotor, LLC**]
2. [**Airxchange Inc.**]
3. [**Desiccant Rotors International, Inc.**]
4. [**Heatex, Inc.**]
5. [**Klingenburg**]
6. [**Novelaire Technologies**]
7. [**SEMCO, LLC; part of FlaktGroup**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AIRotor, LLC**]
2. [**Airxchange Inc.**]

3. [**Desiccant Rotors International, Inc.**]
4. [**Heatex, Inc.**]
5. [**Klingenburg**]
6. [**Novelaire Technologies**]
7. [**SEMCO, LLC; part of FlaktGroup**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain from single source from single manufacturer.

2.4 HEAT WHEELS

A. Casing:

1. Galvanized steel, stainless steel, or aluminum with standard factory finish.
2. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)**]<**Insert value**> differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings[**or permanently lubricated bearings**] with an [**L-10**]<**Insert bearing life**>[**400,000 hours**]<**Insert hours**>. Support horizontal rotors on tapered roller bearing.
5. Rotor:

   a. Aluminum or polymer segmented wheel strengthened with radial spokes[**, with nontoxic, noncorrosive, silica-gel desiccant coating**].
   b. Aluminum, metallic, or polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom, molecular-sieve desiccant coating.

B. Drive: Fractional horsepower motor and gear reducer[**, with speed changed by variable-frequency controller**] and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable-Frequency Controller: Factory mounted and wired, permitting input of field-connected 4- to 20-mA or 1- to 10-V control signal.
3. Variable-Frequency Controller with Exhaust-Air Sensor: Factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
4. Variable-Frequency Controller with Exhaust- and Outdoor-Air Sensors: Factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain[**exhaust temperature above freezing and**] air differential temperature above set point. Rotor speed is to increase to maximum when exhaust-air temperature is less than outdoor-air temperature.
5. Pilot-Light Indicator: Display rotor rotation and speed.
6. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
7. <**Insert additional control features**>.

2.5 SOURCE QUALITY CONTROL

A. AHRI 1060 Certification: Testing in accordance with AHRI 1060 and listed and labeled by AHRI.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HEAT WHEELS

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Install floor-mounted units on **4-inch- (100-mm-)** high concrete base[**designed to withstand, without damage to equipment, seismic force required by code**].

C. Equipment Mounting:

1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Install seismic restraints in accordance with manufacturers' written instructions.

E. Suspended Units: Suspend[**and brace**] units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

F. Install units with clearances for service and maintenance.

G. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to unit, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Condensate Drain Piping:

1. Pipe drains from drain pans to nearest floor drain; use **ASTM B88, Type L (ASTM B88M, Type B)**, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.
2. Pipe drains from drain pans to nearest floor drain; use ASTM D1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

E. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, wheel rotation, and smooth bearing operations. Reconnect motor drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.

3.8 ADJUSTING

A. Comply with requirements for air-handling system testing, adjusting, and balancing in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 13 00

SECTION 23 72 16 00 - HEAT PIPE AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heat-pipe heat exchangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy recovery equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Data: Certificates, for air-to-air energy recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breakage, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Pipe Energy Recovery Equipment: [**Two**]<**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NPFA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to detail fabrication and assembly of air-to-air energy recovery equipment.

F. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Exhaust Air:

1. Airflow: <**Insert number**> **cfm (L/s)**.
2. Face Velocity: <**Insert number**> **fpm (m/s)**.
3. Summer:

   a. Entering-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   b. Entering-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.

4. Winter:

   a. Entering-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   b. Entering-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.

5. Air Pressure Drop: <**Insert number**> **inches wg (Pa)**.

B. Supply Air:

1. Airflow: <**Insert number**> **cfm (L/s)**.
2. Face Velocity: <**Insert number**> **fpm (m/s)**.
3. Summer:

   a. Entering-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   b. Entering-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.

4. Winter:

   a. Entering-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   b. Entering-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert number**> **deg F (deg C)**.

5. Air Pressure Drop: <**Insert number**> **inches wg (Pa)**.

C. Tilt Motor:

1. Horsepower: <**Insert number**> hp.
2. Electrical Characteristics:

   a. Volts: <**Insert number**> V.
   b. Phase: <**Insert number**>.
   c. Hertz: [**60**]<**Insert number**> Hz.

D. Effectiveness: <**Insert percentage**>.

2.3 HEAT-PIPE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Engineered Air**]
2. [**Heat Pipe Technology, Inc.**]
3. [**Innergy Tech, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Engineered Air**]
2. [**Heat Pipe Technology, Inc.**]
3. [**Innergy Tech, Inc.**]
4. <**Insert manufacturer's name**>

C. Casing: [**Galvanized**][**Stainless**]-steel flanged casing, with airtight [**single**][**double**] partition between airstreams.

D. Refrigerant: [**ASHRAE 34, Safety Group 1**]<**Insert refrigerant**>.

E. Tubes:

1. Tube Diameter: <**Insert dimension**> diameter.
2. Tube Material: [**Aluminum**][**Copper**]<**Insert material**>.
3. Number of Tube Rows: As required to meet scheduled capacity conditions.

F. Fins: <**Insert material**>.

1. Fin Spacing: As required to meet scheduled capacity conditions.

2. Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].

G. Coating: [**None**][**Flexible epoxy polymer e-coating**][**Baked phenolic**]<**Insert coating**>; apply to supply and exhaust.

H. Control:

1. Integral plenum containing heat-pipe coil and gasketed, face-and-bypass, opposed-blade dampers with rods extended outside casing for damper operator and linkage.
2. Pivot center of bottom of heat-pipe coil on shaft and bearings to tilt coil. Include tilt controls with electronic controller, electric actuator and linkage, thermostats, sensors, and polyester fabric with PVC-coated flexible connector for automatic supply temperature regulation, summer/winter changeover, and frost protection.

2.4 SOURCE QUALITY CONTROL

A. AHRI Certification: Certified according to AHRI 410.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions.[**Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.**]

1. Install heat exchanger with clearance space for heat-pipe coil removal.
2. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
3. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.

B. Install floor-mounted units on **4-inch- (100-mm-)** high, concrete base[**designed to withstand, without damage to equipment, seismic force required by code**].

C. Equipment Mounting:

1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Install seismic restraints according to manufacturers' written instructions.

E. Install units with clearances for service and maintenance.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to unit, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Condensate Drain Piping:

1. Pipe drains from drain pans to nearest floor drain; use **ASTM B88, Type L (ASTM B88M, Type B)**, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.
2. Pipe drains from drain pans to nearest floor drain; use ASTM D1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

E. Condensate Drain Piping Installation: Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260529 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished with units, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper tilt control and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed.
4. Verify tilt mechanism operation.
5. Verify that moving parts are lubricated with factory-recommended lubricants.

B. Starting procedures for air-handling units include the following:

1. Energize actuator motor and verify proper operation of motor and tilt system.
2. Measure and record motor electrical values for voltage and amperage.
3. Operate bypass dampers from full closed to fully open position.

3.8 ADJUSTING

A. Adjust tilt mechanism for proper operation.

B. Adjust bypass dampers for proper operation.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-to-air heat recovery unit,[**and after completing startup service,**] clean unit to remove foreign material and construction dirt and dust.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heat pipe air-to-air energy recovery units.

END OF SECTION 23 72 16 00

Task	Specification	Specification Description
23 72 16 00	23 72 13 00	Heat Wheel Air-To-Air Energy Recovery Units

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SECTION 23 73 00 00 - INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, indirect, gas-fired heating and ventilating units.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each indoor, indirect, gas-fired heating and ventilating unit.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
c. Include unit dimensions and weight.
d. Include cabinet material, metal thickness, finishes, insulation, and accessories.
e. Fans:

1) Include certified fan-performance curves with system operating conditions indicated.
2) Include certified fan-sound power ratings.
3) Include fan construction and accessories.
4) Include motor ratings, electrical characteristics, and motor accessories.
5) Include fan speed controllers.

f. Include material thickness and finishes, including color charts.
g. Include filters with performance characteristics.
h. Include direct, gas-fired burners with performance characteristics.
i. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures

and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**, supports,**][**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**][**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for indoor, indirect, gas-fired heating and ventilating units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Startup service reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect, gas-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each unit.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than [**one**]<**Insert number**> year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**][**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Indoor, indirect gas-fired, heating and ventilating units shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Discharge Configuration: [**Horizontal**][**Vertical**].
2. Airflow: <**Insert cfm (L/s)**>.
3. Total Static Pressure: <**Insert number**> **inches wg (Pa)**.
4. External Static Pressure: <**Insert inches wg (kPa)**>.
5. Maximum RPM: <**Insert number**>.
6. Minimum Size: <**Insert inches (mm)**>.
7. Altitude: <**Insert ft. (m)**>.

B. Fan Motor:

1. Horsepower: <**Insert value**>.

2. RPM: <**Insert value**>.
3. Service Factor: <**Insert value**>.
4. Speed: [**Single**][**Two**].

C. Single-Point Electrical Connection:

1. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

D. Indirect-Fired Gas Burner:

1. Minimum Combustion Efficiency: <**Insert number**> percent.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Airflow: <**Insert cfm (L/s)**>.
5. Gas Input: <**Insert MBh (kW)**>.
6. Burner Output: <**Insert MBh (kW)**>.
7. Number of Stages: <**Insert value**>.
8. Minimum Inlet Pressure: <**Insert inches wg (Pa)**>.
9. Maximum Inlet Pressure: <**Insert inches wg (Pa)**>.
10. Gas Piping Connection Size: <**Insert NPS (DN)**>.
11. Vent Diameter: <**Insert inches (mm)**>.

E. Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance according to ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

2.3 INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]

3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Des Champs Technologies**]
9. [**Energy Jet U.S.**]
10. [**Engineered Air**]
11. [**Greenheck Fan Corporation**]
12. [**Hastings HVAC**]
13. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
14. [**Jackson & Church HVAC Global**]
15. [**LCSystems**]
16. [**Modine Manufacturing Company**]
17. [**Nortek Air Solutions**]
18. [**Powrmatic, Inc.**]
19. [**Rapid Engineering, Inc.**]
20. [**REZNOR, a brand of Nortek Global HVAC**]
21. [**Sterling HVAC Products; a Mestek company**]
22. [**Temprite, a brand of Mestek**]
23. [**Titan Air**]
24. [**Trane**]
25. [**Weather-Rite, a brand of Specified Air Solutions**]
26. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]
3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Des Champs Technologies**]
9. [**Energy Jet U.S.**]
10. [**Engineered Air**]
11. [**Greenheck Fan Corporation**]
12. [**Hastings HVAC**]
13. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
14. [**Jackson & Church HVAC Global**]
15. [**LCSystems**]
16. [**Modine Manufacturing Company**]
17. [**Nortek Air Solutions**]
18. [**Powrmatic, Inc.**]
19. [**Rapid Engineering, Inc.**]
20. [**REZNOR, a brand of Nortek Global HVAC**]
21. [**Sterling HVAC Products; a Mestek company**]
22. [**Temprite, a brand of Mestek**]
23. [**Titan Air**]
24. [**Trane**]
25. [**Weather-Rite, a brand of Specified Air Solutions**]
26. **<Insert manufacturer's name>**

C. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   c. Heating and Ventilating Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2. Configuration: [**Horizontal**][**Vertical**] unit with [**top**][**horizontal**][**bottom**] discharge for [**floor-mounted**][**suspended**] installation.

   a. Discharge Section, for Vertically Configured Units: [**Galvanized**][**Aluminized**]-steel assembly with [**gravity**][**individually adjustable, vaned,**][**two-position, motorized,**] parallel-blade dampers with nylon bushings.

      1) Pattern: [**Single**][**Double**] deflection.
      2) Leakage: [**Standard**][**Low**] leakage.

   b. Discharge Section, Cowls: Trapezoidal cowls with horizontal louvers.
   c. Discharge Section, Plenum: Plenum with [**two**][**four**] sides louvered.
   d. Discharge Section, Down-Discharge: Down-discharge plenum insulated with **1-inch (25-mm)**, **1.5-lb/cu. ft. (24.0-kg/cu. m)** fibrous glass.

3. Single-Wall Construction:

   a. Material: [**Galvanized-steel**][**or**][**aluminized-steel**]<**Insert material**> with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Floorplate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
   c. Insulation and Adhesive:

      1) Materials: [**ASTM C1071, Type I or Type II glass-fiber blanket or board insulation, neoprene coated or foil faced**]<**Insert insulation type**>.
      2) Insulation R-Value: Minimum <**Insert value**>.
      3) Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
      4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
      5) Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of [**complete unit**][**burner and fan sections only**].

         a) Insulation Adhesive: Comply with ASTM C916, Type I.
         b) Mechanical Fasteners: Galvanized steel suitable for adhesive, mechanical, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

4. Double-Wall Construction:

   a. Outside Casing Wall: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick, with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: [**Galvanized steel**]<**Insert material**>, solid, minimum [**14-gauge (0.759-mm)**]<**Insert number**> thick steel.
      2) Inside Casing, All Other Sections: [**Galvanized steel**]<**Insert**

material>[**solid**][**perforated**] steel.

c. Floor Plate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.

d. Casing Insulation:

1) Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**]<**Insert insulation type**>.
2) Casing Panel R-Value: Minimum <**Insert value**>.
3) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

e. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

5. Panels, Doors, and Windows:

a. Panels:

1) Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

b. Doors:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

c. Windows:

1) Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an air space between panes and sealed with interior and exterior rubber seals.
2) Size: Minimum [**6 inches (150 mm)**]<**Insert dimension**>, square or round.

d. Locations and Applications:

1) Fan Section: [**Inspection and access panels**][**Doors**][**, with windows**].
2) Access Section: Doors[**, with windows**].
3) Gas-Fired Burner Section: [**Inspection and access panels**][**Doors**].
4) Damper Section: [**Inspection and access panels**][**Doors**][**, with windows**].
5) Filter Section: [**Inspection and access panels**][**Doors**] large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors[**, with windows**].

e. Service Light: 100-W vaporproof fixture with switched junction box located [**outside**][**inside**] adjacent to door.

1) Locations: [**Each section accessed with door**][**Fan section**]<**Insert location**>.

D. Fan, Drive, and Motor:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.
b. Shaft Bearings: Heavy-duty[**, self-aligning, permanently lubricated ball bearings**][**, pillow-block bearings**] with an [**L50**]<**Insert bearing life rating**> rated life of [**100,000**]<**Insert number**> hours according to ABMA 9.
c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
d. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
e. Shaft Lubrication Lines: Extended to a location outside the casing.
f. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drive: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
d. Enclosure Materials: [**Cast iron**]<**Insert material**>.
e. Motor Bearings: <**Insert requirements**>.
f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.
2) Altitude: <**Insert ft. (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.
h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

E. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Cleanable Filters:

a. Cleanable metal mesh.

4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
5. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized-steel**]<**Insert material**> track.

1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

F. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed [**4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa), leakage Class 1**]<**Insert requirement**>[**, tested, rated, and labeled in accordance with AMCA 511**].
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
c. Operator Motors:

1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
f. Size dampers for running torque calculated as follows:

1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft. (49.6 kg-cm/sq. m)** of damper.
4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

g. Coupling: V-bolt and V-shaped, toothed cradle.
h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

G. Indirect-Fired Gas Burner:

1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].

a. Rated minimum turndown ratio: [**30 to 1**]<**Insert ratio**>.
b. Fuel: [**Natural**][**Propane**] gas.
c. Ignition: Electronically controlled electric spark with flame sensor.
d. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, [**hydraulic**][**electronic**]-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
f. High-Altitude Model Kit: For Project elevations more than **2000 ft. (610 m)** above sea level.

4. Venting, Gravity: Gravity vented.
5. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
6. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.
7. Heat Exchanger: [**Aluminized**][**Stainless**] steel.
8. Heat-Exchanger Drain Pan: Stainless steel.
9. Safety Controls:

    a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.
    b. Vent Flow Verification: [**Differential pressure switch to verify open vent**][**Flame rollout switch**].
    c. High Limit: Thermal switch or fuse to stop burner.
    d. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
    e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
    f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
    g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
    h. Control Transformer: 24 V ac.

H. Unit Control Panel:

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: [**Surface-mounted**][**Recessed, with trim ring,**] remote panel, with engraved plastic cover, and the following lights and switches:

    a. [**On-off**][**On-off-auto**] fan switch.
    b. Heat-vent-off switch.
    c. Supply-fan operation indicating light.
    d. Heating operation indicating light.
    e. Thermostat.
    f. Damper position potentiometer.
    g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
    h. Safety-lockout indicating light.
    i. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Explosion proof**].

I. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
2. Control Devices:

    a. Remote Thermostat: Adjustable room thermostat with temperature readout.
    b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
    c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than **75 deg F (24 deg C)** above normal maximum operating temperature.
    e. Timers, Seven Day:

        1) Programming-switch timer with synchronous-timing motor and seven-day dial.
        2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.

3) Multiple-switch trippers.
4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

f. Timers, Solid State:

1) Programmable time control with four separate programs.
2) 24-hour battery carryover.
3) Individual on-off-auto switches for each program.
4) 365-day calendar with 20 programmable holidays.
5) Choice of fail-safe operation for each program.
6) System fault alarm.

g. Ionization-Type Smoke Detectors:

1) 24 V dc, nominal.
2) Self-restoring.
3) Plug-in arrangement
4) Integral visual-indicating light.
5) Sensitivity that can be tested and adjusted in place after installation.
6) Integral addressable module.
7) Remote controllability.
8) Responsive to both visible and invisible products of combustion.
9) Self-compensating for changes in environmental conditions.
10) Located in supply[**and return**] air, shall stop fans when the presence of smoke is detected.

3. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Fan Control, Timer: Timer starts and stops indirect-fired heating and ventilating unit and exhaust fan(s).
5. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
6. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers shall modulate to supply minimum outdoor air as follows:

a. Minimum [**30**]<**Insert number**> percent outdoor air.
b. Outdoor-air quantity adjusted by potentiometer on control panel.
c. Outdoor-air quantity to maintain minimum building static pressure.

7. Temperature Control:

a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
b. Operates gas valve to maintain space temperature with wall-mounted, field-wired sensor[**with temperature adjustment,**][**and unit-mounted control adjustment**][**and adjustment on remote-control panel**].
c. Timer shall select remote setback thermostat to maintain space temperature at [**50 deg F (10 deg C)**]<**Insert temperature**>.
d. Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.
e. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

8. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the

DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

a. Hardwired Points:

1) Room temperature.
2) Discharge-air temperature.
3) Burner operating.

b. [**ASHRAE 135.1 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

2.4 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**Fan Sound Performance Rating: Factory test and rate fan sound performance rating in accordance with AMCA 300/301.**]

C. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

D. [**Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.**]

E. [**Fan Energy Index: Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.**]

F. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

G. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

2.5 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

A. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend[**and brace**] units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install gas-fired units in accordance with NFPA 54.

D. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors

complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.

C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCTWORK CONNECTIONS

A. Connect supply[**and return**] ducts to indirect, gas-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Inspect for visible damage to burner combustion chamber.
b. Inspect casing insulation for integrity, moisture content, and adhesion.
c. Verify that clearances have been provided for servicing.
d. Verify that controls are connected and operable.
e. Verify that filters are installed.
f. Purge gas line.
g. Inspect and adjust vibration isolators[**and seismic restraints**].

h. Verify bearing lubrication.
i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
j. Adjust fan belts to proper alignment and tension.

B. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
12. Verify drain-pan performance.
13. Verify outdoor-air damper operation.

3.8 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 23 73 00 00

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SECTION 23 73 00 00A - INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, direct-fired heating and ventilating units.

1.2 ACTION SUBMITTALS

A. Product Data: For each indoor, direct, gas-fired heating and ventilating unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

a. Include certified fan-performance curves with system operating conditions indicated.
b. Include certified fan-sound power ratings.
c. Include fan construction and accessories.
d. Include motor ratings, electrical characteristics, and motor accessories.
e. Include fan-speed controllers.

6. Include filters with performance characteristics.
7. Include direct, gas-fired burners with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each indoor, direct, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**, supports,**][**and seismic restraints**] indicated to

comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for indoor, direct, gas-fired heating and ventilating units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Startup service reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For direct, gas-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each unit.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than [**one**]<**Insert number**> year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**]<**Insert**

number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**][**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Indoor, indirect gas-fired, heating and ventilating units are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Discharge Configuration: [**Horizontal**][**Vertical**].
2. Airflow in CFM (L/s): <**Insert quantity**>.
3. Total Static Pressure: <**Insert number**> **inches wg (Pa)**.
4. External Static Pressure: <**Insert inches wg (kPa)**>.
5. Maximum RPM: <**Insert number**>.
6. Minimum Size: <**Insert inches (mm)**>.
7. Altitude: <**Insert feet (m)**>.

B. Fan Motor:

1. Horsepower: <**Insert value**>.
2. RPM: <**Insert value**>.
3. Service Factor: <**Insert value**>.
4. Speed: [**Single**][**Two**].

C. Single-Point Electrical Connection:

1. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

D. Direct-Fired Gas Burner:

1. Minimum Combustion Efficiency: <**Insert number**> percent.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Airflow: <**Insert cfm (L/s)**>.
5. Gas Input: <**Insert MBh (kW)**>.
6. Burner Output: <**Insert MBh (kW)**>.
7. Number of Stages: <**Insert value**>.
8. Minimum Inlet Pressure: <**Insert inches wg (Pa)**>.
9. Maximum Inlet Pressure: <**Insert inches wg (Pa)**>.
10. Gas Piping Connection Size: <**Insert NPS (DN)**>.
11. Vent Diameter: <**Insert inches (mm)**>.

E. Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters, Wide by High: <**Insert number**>.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, in accordance with ASHRAE 52.2.

2.3 INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AbsolutAire, Inc.**]
2. [**Advanced Climate Technologies, Inc.**]
3. [**Air Economy Corporation**]
4. [**Applied Air, a Mestek company**]
5. [**Bananza; a brand of Specified Air Solutions**]
6. [**BessamAire, Inc.**]

7. [**Cambridge Air Solutions**]
8. [**Cambridge Engineering, Inc**]
9. [**CaptiveAire Systems**]
10. [**Des Champs Technologies**]
11. [**E. K. Campbell Co.**]
12. [**Energy Jet U.S.**]
13. [**Engineered Air**]
14. [**Greenheck Fan Corporation**]
15. [**Hastings Industries**]
16. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
17. [**Jackson & Church HVAC Global**]
18. [**KING**]
19. [**LC Systems**]
20. [**Modine Manufacturing Company**]
21. [**Nortek Air Solutions**]
22. [**Powrmatic, Inc.**]
23. [**Rapid Engineering, Inc.**]
24. [**REZNOR, a brand of Nortek Global HVAC**]
25. [**Sterling Gas**]
26. [**Sterling HVAC Products; a Mestek company**]
27. [**Temprite, a brand of Mestek**]
28. [**Titan Air**]
29. [**Trane Inc.**]
30. [**Weather-Rite, a brand of Specified Air Solutions**]
31. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AbsolutAire, Inc.**]
2. [**Advanced Climate Technologies, Inc.**]
3. [**Air Economy Corporation**]
4. [**Applied Air, a Mestek company**]
5. [**Bananza; a brand of Specified Air Solutions**]
6. [**BessamAire, Inc.**]
7. [**Cambridge Air Solutions**]
8. [**Cambridge Engineering, Inc**]
9. [**CaptiveAire Systems**]
10. [**Des Champs Technologies**]
11. [**E. K. Campbell Co.**]
12. [**Energy Jet U.S.**]
13. [**Engineered Air**]
14. [**Greenheck Fan Corporation**]
15. [**Hastings Industries**]
16. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
17. [**Jackson & Church HVAC Global**]
18. [**KING**]
19. [**LC Systems**]
20. [**Modine Manufacturing Company**]
21. [**Nortek Air Solutions**]
22. [**Powrmatic, Inc.**]
23. [**Rapid Engineering, Inc.**]
24. [**REZNOR, a brand of Nortek Global HVAC**]
25. [**Sterling Gas**]
26. [**Sterling HVAC Products; a Mestek company**]
27. [**Temprite, a brand of Mestek**]

28. [**Titan Air**]
29. [**Trane Inc.**]
30. [**Weather-Rite, a brand of Specified Air Solutions**]
31. <**Insert manufacturer's name**>

C. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   c. Heating and Ventilating Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2. Configuration: Horizontal unit with [**top**][**horizontal**][**bottom**] discharge for [**floor-mounting**][**suspended**] installation.

   a. Discharge Section, Cowls: Trapezoidal cowls with horizontal louvers.
   b. Discharge Section, Plenum: Plenum with [**two**][**four**] sides louvered.
   c. Discharge Section, Down-Discharge: Down-discharge plenum insulated with **1-inch (25-mm)**, **1.5-lb/cu. ft. (24.0-kg/cu. m)** fibrous glass.

3. Single-Wall Construction:

   a. Material: [**Galvanized-steel**][**or**][**aluminized-steel**]<**Insert material**> with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Floorplate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
   c. Insulation and Adhesive:

      1) Materials: [**ASTM C1071, Type I or Type II glass-fiber blanket or board insulation, neoprene coated or foil faced**]<**Insert insulation type**>.
      2) Insulation R-Value: Minimum <**Insert value**>.
      3) Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
      4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
      5) Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of [**complete unit**][**burner and fan sections only**].

         a) Insulation Adhesive: Comply with ASTM C916, Type I.
         b) Mechanical Fasteners: Galvanized steel suitable for adhesive, mechanical, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

4. Double-Wall Construction:

   a. Outside Casing Wall: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick, with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: [**Galvanized steel**]<**Insert material**>, solid, minimum [**14-gauge (0.759-mm)**]<**Insert number**> thick steel.
      2) Inside Casing, All Other Sections: [**Galvanized steel**]<**Insert**

material>[**solid**][**perforated**] steel.

c. Floor Plate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
d. Casing Insulation:

1) Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**]<**Insert insulation type**>.
2) Casing Panel R-Value: Minimum <**Insert value**>.
3) Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

e. Airstream Surfaces: Surfaces in contact with airstream are to comply with requirements in ASHRAE 62.1.

5. Inspection and Access Panels and Access Doors:

a. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
b. Inspection and Access Panels:

1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against air-pressure differential.
2) Gasket: Neoprene, applied around entire perimeters of panel frames.
3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

c. Access Doors:

1) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
2) Gasket: Neoprene, applied around entire perimeters of panel frames.
3) Fabricate windows in [**fan section**]doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
4) Size: At least [**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**][**72 inches (1800 mm)**]<**Insert dimension**>.

d. Locations and Applications:

1) Fan Section: [**Inspection and access panels**][**Doors**][**Doors and inspection and access panels**].
2) Access Section: Doors.
3) Gas-Fired Burner Section: [**Inspection and access panels**][**Doors**].
4) Damper Section: [**Inspection and access panels**][**Doors**].
5) Filter Section: [**Inspection and access panels**][**Doors**] large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

e. Service Light: 100-W vaporproof fixture with switched junction box located [**outside**][**inside**] adjacent to door.

1) Locations: [**Each section accessed with door**][**Fan section**]<**Insert location**>.

D. Fan, Drive, And Motor:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, rated in accordance with AMCA 210; galvanized steel; mounted on solid-steel shaft.

   a. Shafts: With field-adjustable alignment.

      1) Turned, ground, and polished hot-rolled steel with keyway.

   b. Shaft Bearings: Heavy-duty[**, self-aligning, permanently lubricated ball bearings**][**, pillow-block bearings**] with an [**L50**]<**Insert bearing life rating**> rated life of [**100,000**]<**Insert number**> hours in accordance with ABMA 9.
   c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
   d. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
   e. Shaft Lubrication Lines: Extended to a location outside the casing.
   f. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

      1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

3. Drive: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

   a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
   b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
   c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

4. Motors:

   a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
   b. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   c. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
   d. Enclosure Materials: [**Cast iron**]<**Insert material**>.
   e. Motor Bearings: <**Insert requirements**>.
   f. Unusual Service Conditions:

      1) Ambient Temperature: <**Insert deg C**>.
      2) Altitude: <**Insert feet (m)**> above sea level.
      3) High humidity.
      4) <**Insert conditions**>.

   g. Efficiency: Premium efficient as defined in NEMA MG 1.

h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

E. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Cleanable Filters:

a. Cleanable metal mesh.

4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
5. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized-steel**]<**Insert material**> track.

1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

F. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate is not to exceed [**4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa), leakage Class 1**]<**Insert requirement**>[**, tested, rated, and labeled in accordance with AMCA 511**].
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
b. Electronic damper position indicator is to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
c. Operator Motors:

1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
f. Size dampers for running torque calculated as follows:

1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft. (49.6 kg-cm/sq. m)** of damper.
4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

g. Coupling: V-bolt and V-shaped, toothed cradle.
h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

G. Direct-Fired Gas Burner:

1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].

a. Rated Minimum Turndown Ratio: [**30 to 1**]<**Insert ratio**>.
b. Fuel: [**Natural**][**Propane**] gas.
c. Ignition: Electronically controlled electric spark with flame sensor.
d. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, [**hydraulic**][**electronic**]-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
f. High-Altitude Model Kit: For Project elevations more than **2000 feet (610 m)** above sea

level.

4. Heat-Exchanger and Drain Pan: Stainless steel.
5. Safety Controls:

    a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.
    b. Vent Flow Verification: [**Differential pressure switch to verify open vent**][**Flame rollout switch**].
    c. High Limit: Thermal switch or fuse to stop burner.
    d. Purge-period timer is to automatically delay burner ignition and bypass low-limit control.
    e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
    f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
    g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
    h. Control Transformer: 24 V ac.

H. Unit Control Panel:

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: [**Surface-mounted**][**Recessed, with trim ring,**] remote panel, with engraved plastic cover and the following lights and switches:

    a. [**On-off**][**On-off-auto**] fan switch.
    b. Heat-vent-off switch.
    c. Supply-fan operation indicating light.
    d. Heating operation indicating light.
    e. Thermostat.
    f. Damper position potentiometer.
    g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
    h. Safety-lockout indicating light.
    i. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Explosion proof**].

I. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
2. Control Devices:

    a. Remote Thermostat: Adjustable room thermostat with temperature readout.
    b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
    c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than **75 deg F (24 deg C)** above normal maximum operating temperature.
    e. Timers, Seven Day:

        1) Programming-switch timer with synchronous-timing motor and seven-day dial.
        2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.
        3) Multiple-switch trippers.
        4) Minimum of two and maximum of eight signals per day with two normally open and

two normally closed output contacts.

f. Timers, Solid State:

1) Programmable time control with four separate programs.
2) 24-hour battery carryover.
3) Individual on-off-auto switches for each program.
4) 365-day calendar with 20 programmable holidays.
5) Choice of fail-safe operation for each program.
6) System fault alarm.

g. Ionization-Type Smoke Detectors:

1) 24 V dc, nominal.
2) Self-restoring.
3) Plug-in arrangement
4) Integral visual-indicating light.
5) Sensitivity that can be tested and adjusted in place after installation.
6) Integral addressable module.
7) Remote controllability.
8) Responsive to both visible and invisible products of combustion.
9) Self-compensating for changes in environmental conditions.
10) Located in supply[**and return**] air, detectors are to stop fans when the presence of smoke is detected.

3. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Fan Control, Timer: Timer starts and stops direct gas-fired heating and ventilating unit and exhaust fan(s).
5. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper is to open when supply fan starts, and close when fan stops.
6. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers are to modulate to supply minimum outdoor air as follows:

a. Minimum [**30**]<**Insert number**> percent outdoor air.
b. Outdoor-air quantity adjusted by potentiometer on control panel.
c. Outdoor-air quantity to maintain minimum building static pressure.

7. Temperature Control:

a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
b. Timer is to select remote setback thermostat to maintain space temperature at [**50 deg F (10 deg C)**]<**Insert temperature**>.
c. Burner Control: Two or four steps of control using one or two burner sections in series.

8. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

a. Hardwired Points:

1) Room temperature.
2) Discharge-air temperature.
3) Burner operating.

b. [**ASHRAE 135.1 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel are to be available through the DDC system for HVAC.

2.4 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**Fan Sound Performance Rating: Factory test and rate fan sound performance rating in accordance with AMCA 300/301.**]

C. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

D. [**Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.**]

E. [**Fan Energy Index: Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.**]

F. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

G. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

2.5 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend[**and brace**] units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

C. Install gas-fired units in accordance with NFPA 54, "National Fuel Gas Code."

D. Install controls and equipment shipped by manufacturer for field installation with direct, gas-fired heating and ventilating units.

E. Install seismic restraints in accordance with manufacturer's written instructions.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCTWORK CONNECTIONS

A. Connect supply[**and return**] ducts to direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

a. Inspect for visible damage to burner combustion chamber.
b. Inspect casing insulation for integrity, moisture content, and adhesion.
c. Verify that clearances have been provided for servicing.
d. Verify that controls are connected and operable.
e. Verify that filters are installed.
f. Purge gas line.
g. Inspect and adjust vibration isolators[**and seismic restraints**].
h. Verify bearing lubrication.
i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
j. Adjust fan belts to proper alignment and tension.
k. Start unit in accordance with manufacturer's written instructions.

2. Complete startup sheets and attach copy with Contractor's startup report.
3. Inspect and record performance of interlocks and protective devices; verify sequences.
4. Operate unit for run-in period recommended by manufacturer.
5. Perform the following operations for both minimum and maximum firing and adjust burner for

peak efficiency:

a. Measure gas pressure at manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.
c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

6. Calibrate thermostats.
7. Adjust and inspect high-temperature limits.
8. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
9. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
10. Measure and record airflow. Plot fan volumes on fan curve.
11. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

12. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
13. Verify drain-pan performance.
14. Verify outdoor-air damper operation.

3.8 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

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SECTION 23 73 13 00 - INDOOR, BASIC AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, basic air-handling units.
2. Unit casings.
3. Fan, drive, and motor section.
4. Coil section.
5. Air filtration section.
6. Dampers.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type and configuration of indoor, basic, air-handling unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, basic air-handling units, as well as procedures and

diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**, supports,**][**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**][**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for indoor, basic air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each air-handling unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each air-handling unit fan.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, basic, air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer's standard, but not less than [**one**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels are to be self-supporting and capable of withstanding positive/negative [**4-inch wg (996 Pa)**]<**Insert value**> of internal static pressure, without exceeding a midpoint deflection of [**0.005 inches/inch (0.005 mm/mm)**]<**Insert value**> of panel span.

G. Seismic Performance: Air-handling units are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Supply Fan:

1. Type: [**DWDI, forward-curved centrifugal fan**][**SWSI, airfoil unhoused centrifugal plenum fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**].
3. Drive: [**V-belt**][**Direct**].

4. Number of Fan Wheels: [**One**]<**Insert number**>.
5. Fan Diameter: <**Insert number**> **inches (mm)**.
6. Airflow: <**Insert number**> **cfm (L/s)**.
7. Total Static Pressure: <**Insert number**> **inches wg (kPa)**.
8. External Static Pressure: <**Insert number**> **inches wg (kPa)**.
9. Speed: <**Insert rpm**>.
10. Maximum Outlet Velocity: <**Insert number**> **fpm (m/s)**.
11. Motor:

    a. Size: <**Insert horsepower**>.
    b. Speed: <**Insert rpm**>.
    c. Volts: [**208**][**230**][**460**]<**Insert value**> V.
    d. Phase: [**Three**]<**Insert number**>.
    e. Hertz: [**60**]<**Insert number**> Hz.
    f. Full-Load Amperes: <**Insert value**> A.
    g. Minimum Circuit Ampacity: <**Insert value**> A.
    h. Maximum Overcurrent Protection: <**Insert amperage**> A.

12. Fan Discharge Sound Power, dB:

    a. 1st Octave: <**Insert value**>.
    b. 2nd Octave: <**Insert value**>.
    c. 3rd Octave: <**Insert value**>.
    d. 4th Octave: <**Insert value**>.
    e. 5th Octave: <**Insert value**>.
    f. 6th Octave: <**Insert value**>.
    g. 7th Octave: <**Insert value**>.
    h. 8th Octave: <**Insert value**>.

B. Return Fan:

1. Type: [**DWDI, forward-curved centrifugal fan**][**SWSI, airfoil unhoused centrifugal plenum fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**].
3. Drive: [**V-belt**][**Direct**].
4. Number of Fan Wheels: [**One**]<**Insert number**>.
5. Fan Diameter: <**Insert number**> **inches (mm)**.
6. Airflow: <**Insert number**> **cfm (L/s)**.
7. Total Static Pressure: <**Insert number**> **inches wg (kPa)**.
8. External Static Pressure: <**Insert number**> **inches wg (kPa)**.
9. Speed: <**Insert rpm**>.
10. Maximum Outlet Velocity: <**Insert number**> **fpm (m/s)**.
11. Motor:

    a. Size: <**Insert value**> hp.
    b. Speed: <**Insert rpm**>.
    c. Volts: [**208**][**230**]<**Insert value**> V.
    d. Phase: [**Three**]<**Insert number**>.
    e. Hertz: [**60**]<**Insert number**> Hz.
    f. Full-Load Amperes: <**Insert value**> A.
    g. Minimum Circuit Ampacity: <**Insert value**> A.
    h. Maximum Overcurrent Protection: <**Insert amperage**> A.

12. Fan Inlet Sound Power, dB:

a. 1st Octave: <**Insert value**>.
b. 2nd Octave: <**Insert value**>.
c. 3rd Octave: <**Insert value**>.
d. 4th Octave: <**Insert value**>.
e. 5th Octave: <**Insert value**>.
f. 6th Octave: <**Insert value**>.
g. 7th Octave: <**Insert value**>.
h. 8th Octave: <**Insert value**>.

C. Preheat Coil:

1. Heat-Transfer Rate: <**Insert number**> **Btu/h (kW)**.
2. Entering-Air Temperature: <**Insert number**> **deg F (deg C)**.
3. Leaving-Air Temperature: <**Insert number**> **deg F (deg C)**.
4. Face Area: <**Insert number**> **sq. ft. (sq. m)**.
5. Maximum Face Velocity: <**Insert number**> **fpm (m/s)**.
6. Maximum Air-Side, Static-Pressure Drop: <**Insert number**> **inches wg (Pa)**.
7. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
8. Minimum Number of Rows: <**Insert number**>.
9. Water:

   a. Water Flow: <**Insert number**> **gpm (L/s)**.
   b. Maximum Water Pressure Drop: <**Insert number**> **feet of head (kPa)**.
   c. Entering-Water Temperature: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Water Temperature: <**Insert number**> **deg F (deg C)**.
   e. Tube Velocity: <**Insert number**> **fpm (L/s)**.

10. Steam:

   a. Steam Flow: <**Insert number**> **lb/h (g/s)**.
   b. Inlet Steam Pressure: <**Insert number**> **psig (kPa)**.
   c. Outer-Tube Diameter: <**Insert number**> **inches (mm)**.

D. Heating Coil:

1. Heat-Transfer Rate: <**Insert number**> **Btu/h (kW)**.
2. Entering-Air Temperature: <**Insert number**> **deg F (deg C)**.
3. Leaving-Air Temperature: <**Insert number**> **deg F (deg C)**.
4. Face Area: <**Insert number**> **sq. ft. (sq. m)**.
5. Maximum Face Velocity: <**Insert number**> **fpm (m/s)**.
6. Maximum Air-Side, Static-Pressure Drop: <**Insert number**> **inches wg (Pa)**.
7. Number of Rows: <**Insert number**>.
8. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
9. Water:

   a. Water Flow: <**Insert number**> **gpm (L/s)**.
   b. Maximum Water Pressure Drop: <**Insert number**> **feet of head (kPa)**.
   c. Entering-Water Temperature: <**Insert number**> **deg F (deg C)**.
   d. Leaving-Water Temperature: <**Insert number**> **deg F (deg C)**.
   e. Tube Velocity: <**Insert number**> **fpm (L/s)**.

10. Steam:

   a. Steam Flow: <**Insert number**> **lb/h (g/s)**.
   b. Inlet Steam Pressure: <**Insert number**> **psig (kPa)**.

E. Electric Heating Coil:

1. Heat-Transfer Rate: <**Insert number**> **Btu/h (kW)**.
2. Input: <**Insert kilowatts**>.
3. Volts: [**120**][**208**][**230**]<**Insert value**> V.
4. Phase: [**Single**][**Three**].
5. Full-Load Amperes: <**Insert value**> A.
6. Number of Steps: <**Insert number**>.

F. Cooling Coil:

1. Sensible Heat-Transfer Rate: <**Insert number**> **Btu/h (kW)**.
2. Total Heat-Transfer Rate: <**Insert number**> **Btu/h (kW)**.
3. Entering-Air, Dry-Bulb Temperature: <**Insert number**> **deg F (deg C)**.
4. Entering-Air, Wet-Bulb Temperature: <**Insert number**> **deg F (deg C)**.
5. Leaving-Air, Dry-Bulb Temperature: <**Insert number**> **deg F (deg C)**.
6. Leaving-Air, Wet-Bulb Temperature: <**Insert number**> **deg F (deg C)**.
7. Face Area: <**Insert number**> **sq. ft. (sq. m)**.
8. Maximum Face Velocity: <**Insert number**> **fpm (m/s)**.
9. Maximum Air-Side, Static-Pressure Drop: <**Insert number**> **inches wg (Pa)**.
10. Number of Rows: <**Insert number**>.
11. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
12. Water:

    a. Water Flow: <**Insert number**> **gpm (L/s)**.
    b. Maximum Water Pressure Drop: <**Insert number**> **feet of head (kPa)**.
    c. Entering-Water Temperature: <**Insert number**> **deg F (deg C)**.
    d. Leaving-Water Temperature: <**Insert number**> **deg F (deg C)**.
    e. Tube Velocity: <**Insert number**> **fpm (L/s)**.

13. Refrigerant:

    a. Refrigerant Type: <**Insert refrigerant type**>.

G. Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert number**> **inches by inches (mm by mm)**.
3. Depth: <**Insert number**> **inches (mm)**.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert number**> **fpm (m/s)**.
7. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
8. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value and Average Arrestance:

    a. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, in accordance with ASHRAE 52.2.

2.3 INDOOR, BASIC AIR-HANDLING UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtherm; a Mestek company**]
2. [**Buffalo Air Handling**]
3. [**Carrier Global Corporation**]
4. [**Daikin Applied**]
5. [**Dunham-Bush, Inc**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**Titus; brand of Johnson Controls International plc, Global Products**]
8. [**Trane**]
9. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Airtherm; a Mestek company**]
2. [**Buffalo Air Handling**]
3. [**Carrier Global Corporation**]
4. [**Daikin Applied**]
5. [**Dunham-Bush, Inc**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**Titus; brand of Johnson Controls International plc, Global Products**]
8. [**Trane**]
9. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
10. <**Insert manufacturer's name**>

C. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Joints: Sheet metal screws or pop rivets.
   c. Sealing: Seal all joints with water-resistant sealant. Hermetically seal at each corner and around entire perimeter.
   d. Base Rail:

      1) Material: [**Galvanized steel**]<**Insert material**>.
      2) Height: [**4 inches (150 mm)**]<**Insert dimension**>.

2. Single-Wall Construction:

   a. Material: [**Galvanized steel**]<**Insert material**> with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Floor Plate: [**Galvanized steel**]<**Insert material**>, [**treadplate,**]minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
   c. Insulation and Adhesive:

      1) Materials: [**ASTM C1071, Type I or Type II glass-fiber blanket or board insulation, neoprene coated or foil faced**]<**Insert insulation type**>.

2) Insulation R-Value: Minimum <**Insert value**>.
3) Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
5) Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface [**of all complete unit**][**, downstream from, and including, the cooling coil section**].

a) Liner Adhesive: Comply with ASTM C916, Type I.
b) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, or mechanical attachment, to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

3. Double-Wall Construction:

a. Outside Casing Wall: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick, with [**manufacturer's standard finish**]<**Insert special coating**>.
b. Inside Casing Wall: [**G90 (Z275) galvanized steel**]<**Insert material**>, [**solid**][**perforated**], minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
c. Floor Plate: [**G90 (Z275) galvanized steel**]<**Insert material**>, [**treadplate,**]minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
d. Casing Insulation:

1) Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**][**or**][**injected polyurethane foam insulation**].
2) Casing Panel R-Value: Minimum <**Insert value**>.
3) Insulation Thickness: [**1 inch (25 mm)**]<**Insert dimension**>.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

4. Airstream Surfaces: Surfaces in contact with airstream are to comply with requirements in ASHRAE 62.1.
5. Static-Pressure Classifications:

a. For Unit Sections Upstream of Fans: Minus [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert value**>.
b. For Unit Sections Downstream and Including Fans: [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert value**>.

6. Panels and Doors:

a. Panels:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against airflow.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**][**72 inches (1800 mm)**]<**Insert dimension**>.

b. Doors:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of frame.
4) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**]<**Insert dimension**>.

c. Locations and Applications:

1) Fan Section: [**Doors**][**Panels**].
2) Coil Section: Panels.
3) Access Section: [**Doors**][**Panels**].
4) Access Sections Immediately Upstream and Downstream of Coil Sections: [**Doors**][**Panels**].
5) Damper Section: [**Doors**][**Panels**].
6) Filter Section: [**Doors**][**Panels**] large enough to allow periodic removal and installation of filters.
7) Mixing Section: [**Doors**][**Panels**].

7. Condensate Drain Pans:

a. Location: Each type of cooling coil.
b. Construction:

1) Single-wall, [**galvanized-steel or noncorrosive polymer**][**stainless steel**] sheet.

c. Drain Connection:

1) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.
2) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**]<**Insert pipe size**>.

d. Slope: Minimum [**0.125 in./ft. (10 mm/mm)**]<**Insert dimension**> slope[**, to comply with ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers, and to direct water toward drain connection.
e. Length: Extend drain pan downstream from leaving face [**for distance to comply with ASHRAE 62.1**]<**Insert distance**>.
f. Width: Entire width of water producing device.
g. Depth: A minimum of [**2 inches (50 mm)**]<**Insert dimension**> deep.

D. Fan, Drive, and Motor Section:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an [**L-50**]<**Insert bearing life rating**> rated life of minimum [**100,000**]<**Insert number**> hours in accordance with ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
e. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; [**steel**][**aluminum**] hub swaged to backplate and fastened to shaft with setscrews.
f. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
g. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
h. Shaft Lubrication Lines: Extended to a location outside the casing.
i. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

3. Drive, Direct: Factory-mounted, direct drive.
4. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
d. Enclosure Materials: [**Cast iron**]<**Insert material**>.
e. Motor Bearings: <**Insert requirements**>.
f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.
h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
j. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

6. Comply with Section 262923 "Variable-Frequency Motor Controllers."
7. Variable-Frequency Motor Controller: Serving [**each fan individually**][**all fans combined**] in fan array.

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**]<**Insert application**> for [**Design A and Design B**][**inverter-duty**] motors.
b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.
c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
d) Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency motor controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) Proportional Integral Directive (PID) control interface.
8) DDC system for HVAC Protocols for Network Communications: [**ASHRAE 135**]<**Insert protocol type**>.

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. <**Insert features**>.

E. Coil Section:

1. General Requirements for Coil Section:

a. Comply with AHRI 410.
b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. Coils are not to act as structural component of unit.

2. Preheat Coils:

a. Electrical Coils: Comply with UL 1995.

1) Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
2) Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
3) Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
4) Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5) Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

a) [**Magnetic**][**Mercury**] contactor.
b) Solid-state, stepless pulse controller.
c) Toggle switches, one per step.
d) Step controller.
e) Time-delay relay.
f) Pilot lights, one per step.
g) Airflow proving switch.

b. Hot-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleanable**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Fin Type: Plate.
4) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
5) Fin Thickness: <**Insert number**> **inches (mm)**.
6) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
7) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.

c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

8) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
9) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
10) Coating: [**None**][**Corrosion-resistant coating**].

c. Steam Coils: [**Distributed**][**Single tube**].

1) Steam Outer-Tube Diameter: <**Insert number**> **inches (mm)**.
2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Thickness: <**Insert number**> **inches (mm)**.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].

3. Heating Coils:

a. Electrical Coils: Comply with UL 1995.

1) Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
2) Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
3) Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
4) Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5) Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

a) [**Magnetic**][**Mercury**] contactor.
b) Solid-state, stepless pulse controller.
c) Toggle switches, one per step.
d) Step controller.
e) Time-delay relay.
f) Pilot lights, one per step.
g) Airflow proving switch.

b. Hot-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleaning**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Fin Type: Plate.
4) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
5) Fin Thickness: <**Insert number**> **inches (mm)**.
6) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
7) Headers:

   a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
   b) Seamless copper tube with brazed joints, prime coated.
   c) Fabricated steel, with brazed joints, prime coated.
   d) Provide insulated cover to conceal exposed outside casings of headers.

8) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
9) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
10) Coating: [**None**][**Corrosion-resistant coating**].

c. Steam Coils: [**Distributed**][**Single tube**].

1) Steam Outer-Tube Diameter: <**Insert number**> **inches (mm)**.
2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Thickness: <**Insert number**> **inches (mm)**.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

   a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
   b) Seamless copper tube with brazed joints, prime coated.
   c) Fabricated steel, with brazed joints, prime coated.
   d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].

4. Cooling Coils:

a. Chilled-Water Coil: [**Continuous circuit**][**Self-draining**][**Cleanable**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Tube Thickness: <**Insert number**> **inches (mm)**.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Thickness: <**Insert number**> **inches (mm)**.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

   a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to**

exterior of unit].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
10) Coatings: [**None**][**Corrosion-resistant coating**].
11) Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.

b. Refrigerant Coil:

1) Tubes: [**Copper**]<**Insert material**>.
2) Fins:

a) Material: [**Aluminum**]<**Insert material**>.

3) Fin and Tube Joints: Mechanical bond.
4) Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
5) Frames: [**Galvanized steel**]<**Insert material frame**>.
6) Coatings: [**None**][**Corrosion-resistant coating**].
7) Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

a) Working Pressure: Minimum **300 psig (2070 kPa)**.

F. Air Filtration Section:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**High wet-strength beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
4. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized steel**]<**Insert material**> track.

1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

G. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** at **1-inch wg (250 Pa)** and **8 cfm/sq. ft. (40 L/s per sq. m)** at **4-inch wg (1.0 MPa)**[**, tested, rated, and labeled in accordance with AMCA 511**]).
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

    a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
    b. Electronic damper position indicator is to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
    c. Operator Motors:

        1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
        2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
        3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

    d. Nonspring-Return Motors for Dampers Larger Than **25 Sq. Ft. (2.3 sq. m)**: Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
    e. Spring-Return Motors for Dampers Larger Than **25 Sq. Ft. (2.3 sq. m)**: Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
    f. Size dampers for running torque calculated as follows:

        1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
        2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
        3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft. (49.6 kg-cm/sq. m)** of damper.
        4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
        5) Dampers with **2- to 3-Inch wg (500 to 750 Pa)** of Pressure Drop or Face Velocities of **1000 to 2500 fpm (5 to 13 m/s)**: Increase running torque by 1.5.
        6) Dampers with **3- to 4-Inch wg (750 to 1000 Pa)** of Pressure Drop or Face Velocities of **2500 to 3000 fpm (13 to 15 m/s)**: Increase running torque by 2.0.

    g. Coupling: V-bolt and V-shaped, toothed cradle.
    h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
    i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
    j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
    k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
    l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
    m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].

n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

5. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
6. Combination Filter and Mixing Section:

a. Cabinet support members are to hold [**2-inch- (50-mm-)**]<**Insert dimension**> thick, pleated, flat, permanent or throwaway filters.

H. Air Blenders:

1. Multiple-blade, air-mixer assembly is to mix air to prevent stratification, located immediately downstream of mixing box.

I. Materials:

1. Steel:

a. ASTM A36/A36M for carbon structural steel.
b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.
b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.
4. Aluminum: ASTM B209.
5. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
6. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

a. Standards:

1) ASTM B117 for salt spray.
2) ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
3) ASTM B3359 for cross hatch adhesion of 5B.

b. Application: [**Immersion**][**Spray**].
c. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

C. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

F. Water Coils: Factory tested to **300 psig (2070 kPa)** in accordance with AHRI 410 and ASHRAE 33.

G. Steam Coils: Factory tested to **300 psig (2070 kPa)**, and to **200 psig (1380 kPa)** underwater, in accordance with AHRI 410 and ASHRAE 33.

H. Refrigerant Coils: Factory tested to minimum **450-psig (3105-kPa)** internal pressure, and to minimum **300-psig (2070-kPa)** internal pressure while underwater, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDOOR, BASIC AIR-HANDLING UNITS

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend[**and brace**] units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters

used during construction and testing with new, clean filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using [**NPS 1-1/4 (DN 32)**]<**Insert pipe size**>, **ASTM B88, Type M (ASTM B88M, Type C)** copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection.

G. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[**Replace fan and motor pulleys as required to achieve design conditions.**]
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling unit and air-distribution systems, and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Air-handling unit and components will be considered defective if unit or components do not pass tests and inspections.
5. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13 00

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SECTION 23 73 13 00A - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, semi-custom air-handling units.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

a. Include certified fan-performance curves with system operating conditions indicated.
b. Include certified fan-sound power ratings.
c. Include fan construction and accessories.
d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**, supports,**][**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by

the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**][**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each air-handling unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each air-handling unit fan.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels are to be self-supporting and capable of withstanding positive/negative [**8-inch wg (2000 Pa)**]<**Insert value**> of internal static pressure, without exceeding a midpoint deflection of [**0.0042 inch/inch (0.0042 mm/mm)**]<**Insert dimensions**> of panel span.

G. Casing Leakage Performance: ASHRAE 111, [**Class 6 leakage**]<**Insert leakage class**> or better at [**plus or minus 8 inch wg (2000 Pa)**]<**Insert pressure**>.

H. Seismic Performance: Air-handling units are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Supply Fan:

1. Type: [**DWDI, backward-inclined centrifugal fan**][**DWDI, forward-curved centrifugal fan**][**DWDI, airfoil centrifugal fan**][**SWSI, airfoil unhoused centrifugal fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**][**Class III**].
3. Drive: [**V-belt**][**Direct**].
4. Number of Fan Wheels: <**Insert number**>.
5. Fan Diameter: <**Insert value**> **inches (mm)**.
6. Airflow: <**Insert value**> **cfm (L/s)**.
7. Total Static Pressure: <**Insert value**> **inches wg (kPa)**.
8. External Static Pressure: <**Insert value**> **inches wg (kPa)**.
9. Speed: <**Insert rpm**>.
10. Maximum Outlet Velocity: <**Insert value**> **fpm (m/s)**.

11. Motor:

    a. Size: <**Insert horsepower**>.
    b. Speed: <**Insert rpm**>.
    c. Volts: [**208**][**230**][**460**]<**Insert value**> V.
    d. Phase: [**Three**]<**Insert value**>.
    e. Hertz: [**60**]<**Insert number**> Hz.
    f. Full-Load Amperes: <**Insert value**> A.
    g. Minimum Circuit Ampacity: <**Insert value**> A.
    h. Maximum Overcurrent Protection: <**Insert amperage**> A.

12. Fan Discharge Sound Power, dB:

    a. 1st Octave: <**Insert value**>.
    b. 2nd Octave: <**Insert value**>.
    c. 3rd Octave: <**Insert value**>.
    d. 4th Octave: <**Insert value**>.
    e. 5th Octave: <**Insert value**>.
    f. 6th Octave: <**Insert value**>.
    g. 7th Octave: <**Insert value**>.
    h. 8th Octave: <**Insert value**>.

B. Fan: [**Return**][**Exhaust**].

1. Type: [**DWDI, backward-inclined centrifugal fan**][**DWDI, forward-curved centrifugal fan**][**DWDI, airfoil centrifugal fan**][**SWSI, airfoil unhoused centrifugal plenum fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**][**Class III**].
3. Drive: [**V-belt**][**Direct**].
4. Number of Fan Wheels: <**Insert value**>.
5. Fan Diameter: <**Insert value**> **inches (mm)**.
6. Airflow: <**Insert value**> **cfm (L/s)**.
7. Total Static Pressure: <**Insert value**> **inches wg (kPa)**.
8. External Static Pressure: <**Insert value**> **inches wg (kPa)**.
9. Speed: <**Insert rpm**>.
10. Maximum Outlet Velocity: <**Insert value**> **fpm (m/s)**.
11. Motor:

    a. Size: <**Insert horsepower**>.
    b. Speed: <**Insert rpm**>.
    c. Volts: [**208**][**230**][**460**]<**Insert value**> V.
    d. Phase: [**Three**]<**Insert number**>.
    e. Hertz: [**60**]<**Insert number**> Hz.
    f. Full-Load Amperes: <**Insert value**> A.
    g. Minimum Circuit Ampacity: <**Insert value**> A.
    h. Maximum Overcurrent Protection: <**Insert amperage**> A.

12. Fan Inlet Sound Power, dB:

    a. 1st Octave: <**Insert value**>.
    b. 2nd Octave: <**Insert value**>.
    c. 3rd Octave: <**Insert value**>.
    d. 4th Octave: <**Insert value**>.
    e. 5th Octave: <**Insert value**>.
    f. 6th Octave: <**Insert value**>.

g. 7th Octave: <**Insert value**>.
h. 8th Octave: <**Insert value**>.

C. Preheat Coil:

1. Heat-Transfer Rate: <**Insert value**> **Btu/h (kW)**.
2. Entering-Air Temperature: <**Insert value**> **deg F (deg C)**.
3. Leaving-Air Temperature: <**Insert value**> **deg F (deg C)**.
4. Face Area: <**Insert value**> **sq. ft. (sq. m)**.
5. Maximum Face Velocity: <**Insert value**> **fpm (m/s)**.
6. Maximum Air-Side, Static-Pressure Drop: <**Insert value**> **inches wg (Pa)**.
7. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
8. Minimum Number of Rows: <**Insert number**>.
9. Integral Face-and-Bypass Dampers: [**Horizontal**][**Vertical**], opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated**]steel operating rods rotating in sintered bronze or nylon bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**] frame, with operating rods connected with a common linkage. Meeting edges of blades are to have gaskets and edge seals, and blades are to be mechanically fastened.
10. Water:

    a. Water Flow: <**Insert value**> **gpm (L/s)**.
    b. Maximum Water Pressure Drop: <**Insert value**> **feet of head (kPa)**.
    c. Entering-Water Temperature: <**Insert value**> **deg F (deg C)**.
    d. Leaving-Water Temperature: <**Insert value**> **deg F (deg C)**.
    e. Tube Velocity: <**Insert value**> **fpm (L/s)**.

11. Steam:

    a. Steam Flow: <**Insert value**> **lb/h (g/s)**.
    b. Inlet Steam Pressure: <**Insert value**> **psig (kPa)**.
    c. Outer-Tube Diameter: <**Insert value**> **inches (mm)**.

D. Heating Coil:

1. Heat-Transfer Rate: <**Insert value**> **Btu/h (kW)**.
2. Entering-Air Temperature: <**Insert value**> **deg F (deg C)**.
3. Leaving-Air Temperature: <**Insert value**> **deg F (deg C)**.
4. Face Area: <**Insert value**> **sq. ft. (sq. m)**.
5. Maximum Face Velocity: <**Insert value**> **fpm (m/s)**.
6. Maximum Air-Side, Static-Pressure Drop: <**Insert value**> **inches wg (Pa)**.
7. Number of Rows: <**Insert number**>.
8. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
9. Water:

    a. Water Flow: <**Insert value**> **gpm (L/s)**.
    b. Maximum Water Pressure Drop: <**Insert value**> **feet of head (kPa)**.
    c. Entering-Water Temperature: <**Insert value**> **deg F (deg C)**.
    d. Leaving-Water Temperature: <**Insert value**> **deg F (deg C)**.
    e. Tube Velocity: <**Insert value**> **fpm (L/s)**.

10. Steam:

    a. Steam Flow: <**Insert value**> **lb/h (g/s)**.
    b. Inlet Steam Pressure: <**Insert value**> **psig (kPa)**.

E. Electric Heating Coil:

1. Heat-Transfer Rate: <**Insert value**> **Btu/h (kW)**.
2. Input: <**Insert kilowatts**>.
3. Volts: [**120**][**208**][**230**]<**Insert value**> V.
4. Phase: [**Single**][**Three**].
5. Full-Load Amperes: <**Insert value**> A.
6. Number of Steps: <**Insert number**>.

F. Cooling Coil:

1. Sensible Heat-Transfer Rate: <**Insert value**> **Btu/h (kW)**.
2. Total Heat-Transfer Rate: <**Insert value**> **Btu/h (kW)**.
3. Entering-Air, Dry-Bulb Temperature: <**Insert value**> **deg F (deg C)**.
4. Entering-Air, Wet-Bulb Temperature: <**Insert value**> **deg F (deg C)**.
5. Leaving-Air, Dry-Bulb Temperature: <**Insert value**> **deg F (deg C)**.
6. Leaving-Air, Wet-Bulb Temperature: <**Insert value**> **deg F (deg C)**.
7. Face Area: <**Insert value**> **sq. ft. (sq. m)**.
8. Maximum Face Velocity: <**Insert value**> **fpm (m/s)**.
9. Maximum Air-Side, Static-Pressure Drop: <**Insert value**> **inches wg (Pa)**.
10. Number of Rows: <**Insert number**>.
11. Fin Spacing: Maximum <**Insert number**> fins **per inch (per mm)**.
12. Water:

    a. Water Flow: <**Insert value**> **gpm (L/s)**.
    b. Maximum Water Pressure Drop: <**Insert value**> **feet of head (kPa)**.
    c. Entering-Water Temperature: <**Insert value**> **deg F (deg C)**.
    d. Leaving-Water Temperature: <**Insert value**> **deg F (deg C)**.
    e. Tube Velocity: <**Insert value**> **fpm (L/s)**.

13. Refrigerant:

    a. Refrigerant Type: <**Insert refrigerant type**>.

G. Prefilters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert value**> **inches by inches (mm by mm)**.
3. Depth: <**Insert value**> **inches (mm)**.
4. Number of Filters, Wide by High: <**Insert number**>.
5. Access Location: [**Front**][**Back**][**Side**][**Bottom**].
6. Maximum or Rated Face Velocity: <**Insert value**> **fpm (m/s)**.
7. Initial Resistance: <**Insert value**> **inches wg (Pa)**.
8. Recommended Final Resistance: <**Insert value**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value and Average Arrestance:

    a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, in accordance with ASHRAE 52.2.

H. Final Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert value**> **inches by inches (mm by mm)**.
3. Depth: <**Insert value**> **inches (mm)**.
4. Number of Filters, Wide by High: <**Insert number**>.
5. Access Location: [**Front**][**Back**][**Side**][**Bottom**].
6. Maximum or Rated Face Velocity: <**Insert value**> **fpm (m/s)**.
7. Initial Resistance: <**Insert value**> **inches wg (Pa)**.
8. Recommended Final Resistance: <**Insert value**> **inches wg (Pa)**.
9. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, in accordance with ASHRAE 52.2.

I. Dampers: [**Zone**][**Mixing dampers**][**Face and bypass**].

J. Sound Attenuators:

1. Configuration: [**Straight**][**Elbow**].
2. Shape: [**Rectangular**][**Round**].
3. Attenuation Mechanism: [**Acoustic glass fiber**][**Packless**].
4. Maximum Pressure Drop: <**Insert value**> **inches wg (Pa)**.
5. Length: <**Insert value**> **inches (mm)**.
6. Face Dimension: <**Insert value**> **inches (mm)** wide by <**Insert value**> **inches (mm)** high.
7. Face Velocity: <**Insert value**> **fpm (m/s)**.
8. Dynamic Insertion Loss:

    a. 1st Octave: <**Insert dBa**>.
    b. 2nd Octave: <**Insert dBa**>.
    c. 3rd Octave: <**Insert dBa**>.
    d. 4th Octave: <**Insert dBa**>.
    e. 5th Octave: <**Insert dBa**>.
    f. 6th Octave: <**Insert dBa**>.
    g. 7th Octave: <**Insert dBa**>.
    h. 8th Octave: <**Insert dBa**>.

9. Generated Noise:

    a. 1st Octave: <**Insert dBa**>.
    b. 2nd Octave: <**Insert dBa**>.
    c. 3rd Octave: <**Insert dBa**>.
    d. 4th Octave: <**Insert dBa**>.
    e. 5th Octave: <**Insert dBa**>.
    f. 6th Octave: <**Insert dBa**>.
    g. 7th Octave: <**Insert dBa**>.
    h. 8th Octave: <**Insert dBa**>.

K. Steam Grid Humidifier:

1. Humidification Rate: <**Insert value**> **lb/h (g/s)**.
2. Steam Supply Pressure: <**Insert value**> **psig (kPa)**.
3. Dry-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
4. Wet-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
5. Maximum Absorption Distance: <**Insert value**> **inches (mm)**.
6. Number of Distribution [**Tubes**][**Manifolds**]: <**Insert number**>.

L. Self-Contained Electric-Resistance Humidifier.

1. Humidification Rate: <**Insert value**> **lb/h (g/s)**.
2. Dry-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
3. Wet-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
4. Maximum Absorption Distance: <**Insert value**> **inches (mm)**.
5. Minimum Makeup Water Supply Pressure: <**Insert value**> **psig (kPa)**.
6. Electric-Resistance Evaporation Chamber:

    a. Power Input per Chamber: <**Insert number**> kW.
    b. Number of Chambers: <**Insert number**>.

M. Self-Contained Gas-Fired Humidifier:

1. Humidification Rate: <**Insert value**> **lb/h (g/s)**.
2. Dry-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
3. Wet-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
4. Maximum Absorption Distance: <**Insert value**> **inches (mm)**.
5. Minimum Makeup Water Supply Pressure: <**Insert value**> **psig (kPa)**.
6. Gas-Fired Generator:

    a. Fuel Input: <**Insert value**> **Btu/h (kW)**.
    b. Fuel Pressure: <**Insert value**> **inches wg (kPa)**.

7. Number of Distribution [**Tubes**][**Manifolds**]: <**Insert number**>.

N. Heat-Exchanger Humidifier:

1. Humidification Rate: <**Insert value**> **lb/h (g/s)**.
2. Dry-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
3. Wet-Bulb Air Temperature at Discharge: <**Insert value**> **deg F (deg C)**.
4. Maximum Absorption Distance: <**Insert value**> **inches (mm)**.
5. Minimum Makeup Water Supply Pressure: <**Insert value**> **psig (kPa)**.
6. Steam to Heat Exchanger:

    a. Supply Pressure at Control Valve: <**Insert value**> **psig (kPa)**.
    b. Condensing Rate: <**Insert value**> **lb/h (g/s)**.

O. Air-to-Air Energy Recovery:

1. Type: [**Heat-wheel air-to-air energy recovery**][**Fixed-plate air-to-air energy recovery**].
2. Exhaust Air:

    a. Airflow: <**Insert value**> **cfm (L/s)**.
    b. Face Velocity: <**Insert value**> **fpm (m/s)**.
    c. Summer:

        1) Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
        2) Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
        3) Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
        4) Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

    d. Winter:

        1) Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
        2) Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
        3) Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.

4) Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
5) Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

3. Supply Air:

a. Airflow: <**Insert value**> **cfm (L/s)**.
b. Face Velocity: <**Insert value**> **fpm (m/s)**.
c. Summer:

1) Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
2) Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
3) Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
4) Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.

d. Winter:

1) Entering-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
2) Entering-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
3) Leaving-Air Temperature, Dry Bulb: <**Insert value**> **deg F (deg C)**.
4) Leaving-Air Temperature, Wet Bulb: <**Insert value**> **deg F (deg C)**.
5) Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

e. Wheel Drive:

1) Motor Size: <**Insert horsepower**>.
2) Motor Electrical Characteristics:

a) Volts: [**120**][**208**][**230**]<**Insert value**> V.
b) Phase: [**Single**][**Three**].
c) Hertz: [**60**]<**Insert number**> Hz.

f. Effectiveness: <**Insert percentage**>.

4. Air Blender:

a. Airflow: <**Insert value**> **cfm (L/s)**.
b. Minimum Velocity: <**Insert value**> **fpm (m/s)**.
c. Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

5. Diffuser:

a. Airflow: <**Insert value**> **cfm (L/s)**.
b. Air Pressure Drop: <**Insert value**> **inches wg (Pa)**.

2.3 INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Buffalo Air Handling**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Daikin Applied**]

5. [**Dunham-Bush, Inc**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**Trane**]
8. [**USA Coil & Air**]
9. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Buffalo Air Handling**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Daikin Applied**]
5. [**Dunham-Bush, Inc**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**Trane**]
8. [**USA Coil & Air**]
9. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
10. <**Insert manufacturer's name**>

C. Unit Casings:

1. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
2. Base Rail:

   a. Material: [**Galvanized steel**][**Welded structural steel**]<**Insert material**>.
   b. Height: [**6 inches (150 mm)**]<**Insert dimension**>.

3. Casing Joints: Hermetically sealed at each corner and around entire perimeter.
4. Double-Wall Construction:

   a. Outside Casing Wall:

      1) Material, Galvanized Steel: Minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**]<**Insert value**> thick.
      2) Material, Aluminum: Minimum [**16 gauge (1.3 mm)**][**14 gauge (1.6 mm)**][**12 gauge (2.0 mm)**]<**Insert value**> thick.
      3) Material, Stainless Steel: Minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**]<**Insert value**> thick.
      4) Factory Finish: Provide [**manufacturer's standard finish**]<**Insert special coating**>.

   b. Inside Casing Wall:

      1) Material, Galvanized Steel: [**Solid**][**Perforated**], minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**]<**Insert value**> thick.
      2) Material, Aluminum: [**Solid**][**Perforated**], minimum [**16 gauge (1.3 mm)**][**14 gauge (1.6 mm)**]<**Insert value**> thick.
      3) Material, Stainless Steel: [**Solid**][**Perforated**], minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**]<**Insert value**> thick.
      4) Antimicrobial Coating: Applied during the manufacturing process. [**EPA approved**][**NSF approved**][**FDA listed**].

5. Floor Plate:

   a. Material, Galvanized Steel: [**Treadplate,**] minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.7 mm)**][**10 gauge (3.5 mm)**]<**Insert value**> thick.
   b. Material, Aluminum: [**Treadplate,**] minimum [**18 gauge (1.0 mm)**][**16 gauge (1.3 mm)**][**14 gauge (1.6 mm)**][**12 gauge (2.0 mm)**][**10 gauge (2.6 mm)**]<**Insert value**> thick.
   c. Material, Stainless Steel: [**Treadplate,**] minimum [**18 gauge (1.3 mm)**][**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**][**10 gauge (3.5 mm)**]<**Insert value**> thick.
   d. Antimicrobial Coating: Applied during the manufacturing process. [**EPA approved**][**NSF approved**][**FDA listed**].

6. Casing Insulation:

   a. Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**][**Injected polyurethane foam insulation**][**Glass-fiber insulation layered over injected foam in perforated interior casing sections to meet specified acoustic requirements**].
   b. Casing Panel R-Value: Minimum [**R-11**][**R-13**]<**Insert value**>.
   c. Insulation Thickness: [**2 inches (50 mm)**]<**Insert dimension**>.
   d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

7. Airstream Surfaces: Surfaces in contact with airstream are to comply with requirements in ASHRAE 62.1.
8. Static-Pressure Classifications:

   a. For Unit Sections Upstream of Fans: Minus [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**][**6-inch wg (1500 Pa)**]<**Insert value**>.
   b. For Unit Sections Downstream and Including Fans: [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**][**6-inch wg (1500 Pa)**]<**Insert value**>.

9. Panels, Doors, and Windows:

   a. Panels:

      1) Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
      2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against airflow
      3) Gasket: Neoprene, applied around entire perimeters of panel frames.
      4) Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**][**72 inches (1800 mm)**]<**Insert dimension**>.

   b. Doors:

      1) Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
      2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
      3) Gasket: Neoprene, applied around entire perimeters of panel frames.
      4) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**][**24 inches**

(600 mm)]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [60 inches (1500 mm)][72 inches (1800 mm)]<**Insert dimension**>.

c. Windows:

1) Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
2) Size: Minimum [6 inches (150 mm)]<**Insert dimension**>, square or round.

d. Locations and Applications:

1) Fan Section: [**Doors**][**Panels**][**, with windows**].
2) Coil Section: [**Panels**].
3) Access Section: [**Doors**][**Panels**][**, with windows**].
4) Access Sections Immediately Upstream and Downstream of Coil Sections: [**Doors**][**Panels**][**, with windows**].
5) Damper Section: [**Doors**][**Panels**][**, with windows**].
6) Filter Section: [**Doors**][**Panels**] large enough to allow periodic removal and installation of filters.
7) Access Sections Immediately Upstream and Downstream of Filter Sections: [**Doors**][**Panels**][**, with windows**].
8) Mixing Section: [**Doors**][**Panels**][**, with windows**].
9) Humidifier Section: [**Doors**][**Panels**][**, with windows**].

e. Service Lights: <**Insert number of watts**>[**LED**]<**Insert lamp type**> vaporproof luminaire with individual switched junction box located [**outside**][**inside**], adjacent to each access door and panel.

1) Locations: [**Each section accessed with door or panel**][**Fan section**]<**Insert location**>.

f. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.

1) Locations: [**Each section accessed with a door or panel**][**Fan section**]<**Insert location**>.

10. Condensate Drain Pans:

a. Construction:

1) Single-wall, [**galvanized-steel or noncorrosive polymer**][**stainless steel**] sheet.
2) Double-wall, [**galvanized-steel or noncorrosive polymer**][**stainless steel**] sheet with space between walls filled with foam insulation and moisture-tight seal.

b. Drain Connection:

1) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.
2) Minimum Connection Size: [NPS 1 (DN 25)][NPS 2 (DN 50)]<**Insert pipe size**>.

c. Slope: Minimum [0.125-in./ft. (10-mm/mm)]<**Insert value**> slope[**, to comply with ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct

water toward drain connection.

d. Length: Extend drain pan downstream from leaving face [**for distance to comply with ASHRAE 62.1**]<**Insert distance**>.

e. Width: Entire width of water producing device.

f. Depth: A minimum of [**2 inches (50 mm)**]<**Insert dimension**> deep.

g. [**Formed sections**][**Integral part of floor plating**].

h. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.

i. Units with stacked coils are to have an intermediate drain pan to collect condensate from top coil.

D. Fan, Drive, And Motor Section:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

2. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an [**L-50**]<**Insert bearing life rating**> rated life of [**200,000**]<**Insert number**> hours in accordance with ABMA 9.

2) Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an [**L-50**]<**Insert bearing life rating**> rated life of [**200,000**]<**Insert number**> hours in accordance with ABMA 11.

3) Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an [**L-50**]<**Insert bearing life rating**> rated life of [**200,000**]<**Insert number**>.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.

e. Plenum Fan Arrays: [**Contained**][**Uncontained**] as defined in AHRI 430. Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide [**backdraft**][**motorized**] dampers at each fan to prevent short circuiting of flow if one fan is not operating.

f. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; [**steel**][**aluminum**] hub riveted to backplate and fastened to shaft with setscrews.

g. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; [**steel**][**aluminum**] hub swaged to backplate and fastened to shaft with setscrews.

h. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange

and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

i. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

j. Shaft Lubrication Lines: Extended to a location outside the casing.

k. Flexible Connector: Factory fabricated with a fabric strip minimum [**3-1/2 inches (89 mm)**][**5-3/4 inches (146 mm)**]<**Insert dimension**> wide, attached to two strips of minimum [**2-3/4-inch- (70-mm-) wide**]<**Insert dimension**> by [**0.028-inch- (0.7-mm-) thick, galvanized-steel sheet**][**0.032-inch- (0.8-mm-) thick, aluminum sheets**].

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

a) Fabric Minimum Weight: **26 oz./sq. yd. (880 g/sq. m)**.

b) Fabric Minimum Tensile Strength: **480 lbf/inch (84 N/mm)** in the warp and **360 lbf/inch (63 N/mm)** in the filling.

c) Fabric Minimum Service Temperature Range: **Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C)**.

3. Drive, Direct: Factory-mounted, direct drive.

4. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

c. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.

d. Enclosure Materials: [**Cast iron**]<**Insert material**>.

e. Motor Bearings: <**Insert requirements**>.

f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.

2) Altitude: <**Insert feet (m)**> above sea level.

3) High humidity.

4) <**Insert conditions**>.

g. Efficiency: Premium Efficient motors as defined in NEMA MG 1.

h. NEMA Design: <**Insert designation**>.

i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

j. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

k. <**Insert unique motor characteristics**>.
l. Mount unit-mounted disconnect switches on [**exterior**][**interior**] of unit.

6. Comply with Section 262923 "Variable-Frequency Motor Controllers."
7. Variable-Frequency Motor Controller: Serving [**each fan individually**][**all fans combined**] in fan array.

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**]<**Insert application**> for [**Design A and Design B**][**inverter-duty**] motors.
b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.
c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
d) Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency motor controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) Proportional Integral Directive (PID) control interface.
8) DDC system for HVAC Protocols for Network Communications: [**ASHRAE 135**]<**Insert protocol type**>.

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**].

2) Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors[**and isolating switch**].
3) Bypass Controller, Three-Contactor Style: With bypass and input and output isolating contactors[**and isolating switch**].
4) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

E. Coil Section:

1. General Requirements for Coil Section:

a. Comply with AHRI 410.
b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
d. Coils are not to act as structural component of unit.

2. Preheat Coils:

a. Electrical Coils, Controls, and Accessories: Comply with UL 1995.

1) Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
2) Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
3) Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
4) Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5) Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

a) [**Magnetic**][**Mercury**] contactor.
b) Solid-state, stepless pulse controller.
c) Toggle switches, one per step.
d) Step controller.
e) Time-delay relay.
f) Pilot lights, one per step.
g) Airflow proving switch.

b. Hot-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleanable**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Fin Type: Plate.
4) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
5) Fin Spacing: Maximum [**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.
6) Fin Thickness: <**Insert value**> **inches (mm)**.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].

b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, [**0.052-inch- (1.3-mm-) thick, galvanized steel**][**0.064-inch- (1.6-mm-) thick, galvanized steel**][**0.079-inch- (2.0-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, stainless steel**]<**Insert thickness**><**Insert material**>.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].
12) Integral Face-and-Bypass Dampers: [**Horizontal**][**Vertical**], opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated**]steel operating rods rotating in sintered bronze or nylon bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**] frame, with operating rods connected with a common linkage. Meeting edges of blades are to have gaskets and edge seals, and blades are to be mechanically fastened.

c. Steam Coils: [**Distributed**][**Single tube**].

1) Steam Outer-Tube Diameter: <**Insert value**> **inches (mm)**.
2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Spacing: Maximum [**8**][**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.
7) Fin Thickness: <**Insert value**> **inches (mm)**.
8) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
9) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

10) Frames: Channel frame, [**0.052-inch- (1.3-mm-) thick, galvanized steel**][**0.064-inch- (1.6-mm-) thick, galvanized steel**][**0.079-inch- (2.0-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, stainless steel**]<**Insert thickness**><**Insert material**>.
11) Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.
12) Coating: [**None**][**Corrosion-resistant coating**].
13) Integral Face-and-Bypass Dampers: [**Horizontal**][**Vertical**], opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated**]steel operating rods rotating in sintered bronze or nylon bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**] frame, with operating rods connected with a common linkage. Meeting edges of blades are to have gaskets and edge seals, and blades are to be mechanically fastened.

3. Heating Coils:

a. Electrical Coils, Controls, and Accessories: Comply with UL 1995.

1) Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
2) Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent

chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

3) Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
4) Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5) Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

    a) [**Magnetic**][**Mercury**] contactor.
    b) Solid-state, stepless pulse controller.
    c) Toggle switches, one per step.
    d) Step controller.
    e) Time-delay relay.
    f) Pilot lights, one per step.
    g) Airflow proving switch.

b. Hot-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleaning**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Fin Type: Plate.
4) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
5) Fin Spacing: Maximum [**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.
6) Fin Thickness: <**Insert value**> **inches (mm)**.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

    a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
    b) Seamless copper tube with brazed joints, prime coated.
    c) Fabricated steel, with brazed joints, prime coated.
    d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, [**0.052-inch- (1.3-mm-) thick, galvanized steel**][**0.064-inch- (1.6-mm-) thick, galvanized steel**][**0.079-inch- (2.0-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, stainless steel**]<**Insert thickness**><**Insert material**>.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].

c. Steam Coils: [**Distributed**][**Single tube**].

1) Steam Outer-Tube Diameter: <**Insert value**> **inches (mm)**.
2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Spacing: Maximum [**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.
7) Fin Thickness: <**Insert value**> **inches (mm)**.
8) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
9) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

10) Frames: Channel frame, [**0.052-inch- (1.3-mm-) thick, galvanized steel**][**0.064-inch- (1.6-mm-) thick, galvanized steel**][**0.079-inch- (2.0-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, stainless steel**]<**Insert thickness**><**Insert material**>.
11) Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.
12) Coating: [**None**][**Corrosion-resistant coating**].

4. Cooling Coils:

a. Chilled-Water Coil: [**Continuous circuit**][**Self-draining**][**Cleanable**].

1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
2) Tube Material: [**Copper**]<**Insert material**>.
3) Tube Thickness: <**Insert value**> **inches (mm)**.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Spacing: [**0.125 inch (3.18 mm)**][**0.091 inch (2.31 mm)**][**0.071 inch (1.80 mm)**][**0.067 inch (1.70 mm)**][**0.056 inch (1.42 mm)**][**0.0075 inch (0.19 mm)**]<**Insert fins per inch (mm)**>.
7) Fin Thickness: <**Insert value**> **inches (mm)**.
8) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
9) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

10) Frames: Channel frame, [**0.052-inch- (1.3-mm-) thick, galvanized steel**][**0.064-inch- (1.6-mm-) thick, galvanized steel**][**0.079-inch- (2.0-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, galvanized steel**][**0.0625-inch- (1.58-mm-) thick, stainless steel**].
11) Coatings: [**None**][**Corrosion-resistant coating**].
12) Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.

b. Refrigerant Coil:

1) Tubes: [**Copper**]<**Insert material**>.
2) Fins:

a) Material: [**Aluminum**][**Copper**]<**Insert material**>.
b) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert spacing**> fins per **inch (mm)**.

3) Fin and Tube Joints: Mechanical bond.
4) Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
5) Frames: [**Galvanized steel**][**Stainless steel**]<**Insert material frame**>.

6) Coatings: [**None**][**Corrosion-resistant coating**].
7) Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

a) Working Pressure: Minimum **300 psig (2070 kPa)**.

F. Air Filtration Section:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. High-efficiency particulate air (HEPA) filtration is specified in Section 234133 "High-Efficiency Particulate Air Filtration."
3. Gas-phase air filtration is specified in Section 234200 "Gas-Phase Air Filtration."
4. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

5. Bag Filters:

a. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.
b. Filter Unit Class: UL 900.
c. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.
d. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

6. Cartridge Filters:

a. Description: Factory-fabricated, [**adhesive-coated**]disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.
d. Filter Media Frame: [**Galvanized steel**]<**Insert material**>.

7. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
8. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
9. Front- or Back-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: [**Galvanized-steel**][**Aluminum**] framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

1) Prefilters: Incorporate a separate [**2-inch- (50-mm-)**]<**Insert dimension**> thick track[**with spring clips**], with same access as primary filter.
2) Sealing: Full periphery foam gaskets.

b. HEPA Filter Frames: [**Aluminum**][**Stainless steel**] framing members, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation operation. Bolted filter-sealing mechanism is to mount and continuously seal each individual filter.

1) Prefilters: Incorporate a separate [**2-inch- (50-mm-)**][**4-inch- (50-mm-)**]<**Insert dimension**> thick track[**with spring clips**] with same access as primary filter.
2) Sealing: [**Gasketed**][**or**][**gel**], hand-crank locking mechanism to provide positive-sealing for each filter to ensure seal between filter elements to prevent bypass of unfiltered air.

c. Gas-Phase Air Filter Frames: [**Galvanized-steel**][**Aluminum**] framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

1) Prefilters: Incorporate a separate [**2-inch- (50-mm-)**]<**Insert dimension**> thick track[**with spring clips**].
2) Sealing: [**Full periphery foam gaskets**][**Positive-sealing-device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air**].

10. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized steel**][**Aluminum**] track.

1) Prefilters: Incorporate an integral [**2-inch- (50-mm-)**]<**Insert dimension**> thick track with same access as primary filter.
2) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

b. HEPA Filter Frames:

1) Frames: Match inner casing and outer casing material, and insulation thickness. [**Aluminum**][**Stainless steel**] track.
2) Prefilters: Incorporate an integral [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**]<**Insert dimension**> thick track,
3) Sealing: Incorporate positive-sealing clamping device on each filter between [**gasket**][**gel**] seal on all sides of filter cartridge frames to prevent bypass of unfiltered air.

c. Gas-Phase Air Filter Frames:

1) Frames: Matching inner casing and outer casing material, and insulation thickness. [**Galvanized-steel**][**Aluminum**] track.
2) Prefilters: Incorporate an integral [**2-inch- (50-mm-)**]<**Insert dimension**> thick track.
3) Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

G. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers with compressible jamb seals

and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**stainless steel sleeve**][**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate is not to exceed [**4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa), leakage Class 1**]<**Insert requirement**>[**, tested, rated, and labeled in accordance with AMCA 511**].

3. Face-and-Bypass Dampers: Opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated**]steel operating rods rotating in sintered bronze or nylon bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**] frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
4. Zone Dampers: Two single-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert materials**> dampers offset 90 degrees from each other on [**zinc-plated**]steel operating rod rotating in sintered bronze or nylon bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
5. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
6. Electronic Damper Operators:

    a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
    b. Electronic damper position indicator is to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
    c. Operator Motors:

        1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
        2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
        3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

    d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
    e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
    f. Size dampers for running torque calculated as follows:

        1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
        2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
        3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft (49.6 kg-cm/sq. m)** of damper.
        4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
        5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
        6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

    g. Coupling: V-bolt and V-shaped, toothed cradle.

h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

7. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
8. Combination Filter and Mixing Section:

a. Cabinet support members are to hold [**2-inch- (50-mm-)**]<**Insert dimension**> thick, pleated, flat, permanent or throwaway filters.

9. Multiple-blade, air-mixer assembly is to mix air to prevent stratification, located immediately downstream of mixing box.

H. Sound Attenuators:

1. General Requirements:

a. Factory fabricated.
b. Fire Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50, ASTM E84.
c. Airstream Surfaces: Surfaces in contact with the airstream are to comply with ASHRAE 62.1.

2. Shape: [**Rectangular, straight**][**Round, straight**][**Rectangular, elbow**][**Round, elbow**].
3. Rectangular Silencer Outer Casing: [**Galvanized steel**]<**Insert material**>.
4. Round Silencer Outer Casing: [**Galvanized steel**]<**Insert material**>.
5. Inner Casing and Baffles: [**Galvanized steel**]<**Insert material**>.
6. Principal Sound-Absorbing Mechanism:

a. Packless Type: Controlled impedance membranes and broadly tuned resonators without adsorptive media.
b. Dissipative Type: [**Polymer film-lined**]absorptive fill material.

1) Fill Material: [**Inert and vermin-proof fibrous material**]<**Insert material type**>.

c. Joints: Lock formed and sealed, continuously welded or flanged.

I. Humidifiers:

1. Direct-steam-injection humidifiers are specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."
2. Self-contained humidifiers are specified in Section 238413.29 "Self-Contained Humidifiers."
3. Heat-exchanger humidifiers are specified in Section 238413.36 "Heat Exchanger Humidifiers."

J. Air-To-Air Energy Recovery Units:

1. Heat Wheels:

   a. Casing:

      1) Galvanized steel, stainless steel, or aluminum with manufacturer's standard finish.
      2) Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400-Pa and 0.20 percent at 1000-Pa)**]<**Insert values**> differential pressure.
      3) Casing seals on periphery of rotor, on duct divider, and on purge section.
      4) Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.

   b. Rotor, Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[**, with nontoxic, noncorrosive, silica-gel desiccant coating**].
   c. Rotor - Aluminum, Metallic, or Polymer: Segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.
   d. Drive: Fractional horsepower motor and gear reducer[**, with speed changed by variable-frequency controller**]. Permanently lubricated wheel bearings with an [**L-10**]<**Insert bearing life**>[**400,000 hours**]<**Insert hours**>.
   e. Controls:

      1) Starting relay, factory mounted and wired, and manual motor starter for field wiring.
      2) Variable-frequency controller, factory mounted and wired, permitting input of field connected 4- to 20-mA or 1- to 10-V control signal.
      3) Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
      4) Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain [**exhaust temperature above freezing and**]air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
      5) Pilot-Light Indicator: Display rotor rotation and speed.
      6) Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

2. Fixed-Plate Sensible Heat Exchangers:

   a. Casing: [**Aluminum**][**Galvanized steel**]<**Insert material**>.
   b. Plates: Evenly spaced and sealed and arranged for [**counter**][**cross**] airflow.
   c. Plate Material: [**Embossed aluminum**][**Stainless steel**][**High-density plastic**].
   d. Plate Coating: [**Epoxy**]<**Insert coating**>.
   e. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
   f. Heat-Exchanger Prefilters: [**1 inch (25 mm) thick, disposable**][**2 inches (50 mm) thick, disposable**]<**Insert type**>[**MERV 6**]<**Insert MERV**>.

K. Air Blenders:

1. Description: Static air mixer device to provide mixing of two airstreams to within [**plus/minus 6 deg F (3 deg C)**]<**Insert mixing differential**>.
2. Material: [**Galvanized steel**][**Aluminum**]<**Insert material**>.
3. Coating: [**None**][**Corrosion-resistant coating**].

L. Diffusers:

1. Description: Velocity profile equalizer device for providing equalized airflow profile downstream of Type DWDI fans.
2. Material: [**Galvanized steel**][**Aluminum**]<**Insert material**>.

M. UV-C Lamp Systems:

1. Description:

   a. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
   b. Factory installed and preengineered.

2. Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted.
3. Lamps: High output, hot cathode.
4. Lamp-Holder Construction:

   a. UV- and moisture-resistant materials and designed to connect the lamp to the plug.
   b. Adjustable positioning.

5. Lamp-Clamp Construction:

   a. UV- and moisture-resistant materials, water-tight connection.
   b. Adjustable positioning.

6. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
7. Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution.
8. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.
9. Power Supply: UL-listed, single-point electrical connection[**with service disconnect**].
10. Power Consumption: Maximum of [**15 W/sq. ft. (161 W/sq. m)**]<**Insert value**>.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: **ASTM B 09 (ASTM B209M)**.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a

[**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

   a. ASTM B117 for salt spray.
   b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
   c. ASTM B3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.5 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.

C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

D. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

G. Water Coils: Factory tested to **300 psig (2070 kPa)** in accordance with AHRI 410 and ASHRAE 33.

H. Steam Coils: Factory tested to **300 and 200 psig (2070 and 1380 kPa)** underwater in accordance with AHRI 410 and ASHRAE 33.

I. Refrigerant Coils: Factory tested to minimum **450-psig (3105-kPa)** internal pressure and to minimum **300-psig (2070-kPa)** internal pressure while underwater, in accordance with AHRI 410 and ASHRAE 33.

J. Witnessed Casing Leakage Tests:

   1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
   2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend[**and brace**] units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

E. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using [**NPS 1-1/4 (DN 32)**]<**Insert pipe size**>, **ASTM B88, Type M (ASTM B88M, Type C)** copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

G. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is

installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[**Replace fan and motor pulleys as required to achieve design conditions.**]
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**][**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections

for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. HEPA Filters: Pressurize housing to a minimum of **3-inch wg (750 Pa)** or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
5. HEPA Filters, Critical Applications: Pressurize housing to a minimum of **3-inch wg (750 Pa)** or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks in accordance with ASME AG-1, pressure-decay method.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13 00A

Task	Specification	Specification Description
23 73 13 00	07 72 00 00	Roof Accessories
23 73 13 00	23 73 00 00	Indoor, Indirect, Gas-Fired Heating and Ventilating Units
23 73 13 00	23 73 00 00a	Indoor, Direct-Fired Heating and Ventilating Units

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SECTION 23 74 16 13 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, large-capacity, rooftop air-conditioning units.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.3 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include factory selection calculations for each antimicrobial UV lamp installation.
10. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each packaged, large-capacity, rooftop air-conditioning unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For RTU supports, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: [**Wind-**][**and**][**seismic-**]detail fabrication and attachment of[**wind and**] seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Sustainable Design Submittals:

1. Product Data: Showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance. Comply with efficiency requirements in IgCC/ASHRAE 189.1, which supersede requirements in ASHRAE/IES 90.1.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
5. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
6. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
7. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
8. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality control reports.

E. System startup reports.

F. Field quality control reports.

G. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) of filters for each unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of packaged, large-capacity, rooftop air-conditioning unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and Startup."

D. ASHRAE 15 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. UL Compliance: Comply with UL 1995.

G. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.

1. Design RTU supports to comply with [**wind**][**and**][**seismic**] performance requirements.

H. Wind-Restraint Performance:

1. RTUs, accessories, and components are to withstand the effects of wind. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building classification criteria.

I. Seismic Performance: RTUs, accessories, and components are to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified"[**and the unit will be fully operational after the seismic event**].
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Supply-Air Fan:

1. Fan Type: [**Belt drive**][**Direct drive**], [**double width**][**single width**], [**forward curved**][**backward inclined**], centrifugal[**, plenum**].
2. Airflow: <**Insert cfm (L/s)**>.
3. External Static Pressure: <**Insert inches wg (kPa)**>.
4. Fan Speed: [**Variable**]<**Insert rpm**>.
5. Motor Characteristics:

a. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
b. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
c. Horsepower: <**Insert horsepower**>.
d. Motor Speed: [**Multispeed**][**ECM**][**Constant**]<**Insert rpm**>.
e. Volts: [**115**][**208**][**230**][**460**]<**Insert value**> V.
f. Phase: [**Single**][**Three**].
g. Hertz: 60.
h. Full-Load Amperes: <**Insert value**> A.
i. Minimum Circuit Ampacity: <**Insert value**> A.
j. Maximum Overcurrent Protection: <**Insert value**> A.

B. Return/Relief-Air Fan:

1. Fan Type: [**Belt drive**][**Direct drive**], [**double width**][**single width**], [**forward curved**][**backward inclined**], centrifugal[**, plenum**].
2. Airflow: <**Insert cfm (L/s)**>.
3. External Static Pressure: <**Insert inches wg (kPa)**>.

4. Fan Speed: <**Insert rpm**>.
5. Motor Characteristics:

    a. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
    b. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
    c. Horsepower: <**Insert horsepower**>.
    d. Motor Speed: <**Insert rpm**>.
    e. Volts: [**115**][**208**][**230**][**460**]<**Insert value**> V.
    f. Phase: [**Single**][**Three**].
    g. Hertz: 60.
    h. Full-Load Amperes: <**Insert value**> A.
    i. Minimum Circuit Ampacity: <**Insert value**> A.
    j. Maximum Overcurrent Protection: <**Insert value**> A.

C. Outdoor-Air-Refrigerant Coil Fan:

1. Fan Type: [**Direct-drive propeller**][**Belt drive**][**Direct drive**], [**double width**][**single width**], [**forward curved**][**backward inclined**], centrifugal, [**scroll**][**plenum**] fan.
2. Airflow: <**Insert cfm (L/s)**>.
3. Static Pressure: <**Insert inches wg (kPa)**>.
4. Fan Speed: <**Insert rpm**>.
5. Motor Characteristics:

    a. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
    b. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
    c. Horsepower: <**Insert horsepower**>.
    d. Motor Speed: [**Multispeed**][**ECM**][**Constant**]<**Insert rpm**>.
    e. Volts: [**115**][**208**][**230**][**460**]<**Insert value**> V.
    f. Phase: [**Single**][**Three**].
    g. Hertz: 60.
    h. Full-Load Amperes: <**Insert value**> A.
    i. Minimum Circuit Ampacity: <**Insert value**> A.
    j. Maximum Overcurrent Protection: <**Insert value**> A.

D. Rotary Heat Exchanger:

1. Effectiveness: <**Insert percentage**>.
2. Intake:

    a. Intake Airflow: <**Insert cfm (L/s)**>.
    b. Pressure Differential: <**Insert inches wg (kPa)**>.
    c. Entering Supply-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    d. Entering Supply-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    e. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    f. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

3. Exhaust:

    a. Exhaust Airflow: <**Insert cfm (L/s)**>.
    b. Entering Exhaust-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    c. Entering Exhaust-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    d. Leaving Exhaust-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.

e. Leaving Exhaust-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

E. Supply-Air Refrigerant Coil:

1. Total Cooling Capacity: <**Insert Btu/h (kW)**>.
2. Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.
3. Entering-Air Cooling Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Refrigerant Type: <**Insert refrigerant type**>.
6. Total Heating Capacity: <Insert **Btu/h (kW)**.
7. Entering-Air Heating Dry-Bulb Temperature: <Insert **deg F (deg C)**.

F. Hot-Water Coil:

1. Coil Face Dimensions:

   a. Finned Length: <**Insert inches (mm)**>.
   b. Finned Width: <**Insert inches (mm)**>.

2. Minimum Fin Spacing: [**0.125 inch (3.18 mm)**][**0.091 inch (2.31 mm)**][**0.071 inch (1.81 mm)**][**0.067 inch (1.70 mm)**][**0.056 inch (1.41 mm)**][**0.0075 inch (0.19 mm)**]<**Insert dimension**>.
3. Tube Diameter: [**0.375 inch (9.5 mm)**][**0.50 inch (12.7 mm)**][**0.625 inch (15.9 mm)**][**0.75 inch (19.0 mm)**][**1.0 inch (25.4 mm)**]<**Insert dimension**>.
4. Number of Rows: <**Insert number**>.
5. Serpentine: [**Single**][**Half**][**Full**].
6. Mounting: [**Slip in**][**Flanged**].
7. Air Side:

   a. Flow Rate: <**Insert cfm (L/s)**>.
   b. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
   c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
   d. Total Capacity: <**Insert Btu/h (kW)**>.
   e. Entering Temperature: <**Insert deg F (deg C)**>.
   f. Leaving Temperature: <**Insert deg F (deg C)**>.

8. Water Side:

   a. Flow Rate: <**Insert gpm (L/s)**>.
   b. Tube Velocity: <**Insert fpm (m/s)**>.
   c. Glycol Type: [**Ethylene**][**Propylene**].
   d. Aqueous Glycol Solution Concentration: <**Insert percentage**>.
   e. Pressure Drop: <**Insert feet (kPa)**>.
   f. Entering Temperature: <**Insert deg F (deg C)**>.
   g. Leaving Temperature: <**Insert deg F (deg C)**>.

G. Steam Heating Coil:

1. Minimum Fin Spacing: [**0.125 inch (3.18 mm)**][**0.091 inch (2.31 mm)**][**0.071 inch (1.81 mm)**][**0.067 inch (1.70 mm)**][**0.056 inch (1.41 mm)**][**0.0075 inch (0.19 mm)**]<**Insert dimension**>.
2. Tube Diameter: [**0.50 inch (12.7 mm)**][**0.625 inch (15.9 mm)**][**0.75 inch (19.0 mm)**]<**Insert dimension**>.
3. Number of Rows: [**One**][**Two**]<**Insert number**>.

4. Air Side:

   a. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
   b. Total Capacity: <**Insert Btu/h (kW)**>.
   c. Entering Temperature: <**Insert deg F (deg C)**>.
   d. Leaving Temperature: <**Insert deg F (deg C)**>.

5. Steam Side:

   a. Inlet Pressure: <**Insert psig (kPa)**>.
   b. Tube Type: [**Single**][**Distributing**].
   c. Condensing Capacity: <**Insert lb/h (g/s)**>.
   d. Pressure Drop: <**Insert psig (kPa)**>.

H. Outdoor-Air Refrigerant Coil:

1. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
2. Coating: [**Baked phenolic**][**Cathodic epoxy**].
3. Fan Motor: <**Insert value**>.
4. Number of Fans: <**Insert number**>.
5. Refrigerant Type: <**Insert refrigerant type**>.

I. Hot-Gas Reheat Coil:

1. Heating Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Air-Temperature Rise: <**Insert deg F (deg C)**>.
4. Refrigerant Type: <**Insert refrigerant type**>.

J. Electric-Resistance Heating Coil:

1. Capacity: <**Insert kilowatts**>.
2. Number of Steps: <**Insert number**>.

K. Compressors:

1. Number of Refrigerant Circuits: [**One**][**Two**]<**Insert number**>.
2. Compressor Speed: [**Single**][**Variable**].
3. Suction Temperature: <**Insert deg F (deg C)**>.
4. Power Input: <**Insert kilowatts**>.
5. Seasonal Energy Efficiency Ratio (SEER): <**Insert value**>.

L. Gas Furnace:

1. Airflow: <**Insert cfm (L/s)**>.
2. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
3. Minimum AFUE: <**Insert number**> percent.
4. Minimum Thermal Efficiency: <**Insert number**> percent.
5. Minimum Combustion Efficiency: <**Insert number**> percent.
6. Input: <**Insert Btu/h (kW)**>.
7. Output: <**Insert Btu/h (kW)**>.
8. Entering-Air Temperature: <**Insert deg F (deg C)**>.
9. Air-Temperature Rise: <**Insert deg F (deg C)**>.

M. Dampers:

1. Outdoor-Air Damper: Linked galvanized-steel damper blades mechanically fastened to galvanized-steel axels and operating rod, for zero to [**25**][**30**]<**Insert number**> percent outdoor air[**, with electric motorized damper operator**][**, 115 V**][**, 24 V**].
2. Outdoor- and Return-Air Mixing Dampers: [**Parallel-**][**Opposed-**]blade galvanized-steel dampers mechanically fastened to galvanized-steel axels and operating rod in reinforced cabinet. Connect operating rods with common linkage[**or gears**] and interconnect so dampers operate simultaneously. [**Include 24 V motorized damper operators.**][**Include 115 V motorized damper operators.**]
3. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IES 90.1.

N. Recirculating-Air Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

    a. MERV Rating and Corresponding Average Arrestance: [**MERV 4**]<**Insert MERV rating**>, and corresponding average arrestance in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**][**MERV 13A**]<**Insert value**>, in accordance with ASHRAE 52.2.

O. Outdoor-Air Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

    a. MERV Rating and Corresponding Average Arrestance: [**MERV 4**]<**Insert MERV rating**>, and corresponding average arrestance in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**][**MERV 13A**]<**Insert value**>, in accordance with ASHRAE 52.2.

P. Vibration Isolation and Seismic-Control Devices: <**Insert device type**>, with <**Insert value**> minimum deflection.

Q. Electrical Characteristics for Single-Point Connection:

1. Voltage: [**115**][**208**][**230**][**460**]<**Insert value**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: [**60**]<**Insert value**>.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

R. Attenuator Insertion Loss Rating (ILR):

1. 1st Octave: <**Insert value**> dB.
2. 2nd Octave: <**Insert value**> dB.
3. 3rd Octave: <**Insert value**> dB.
4. 4th Octave: <**Insert value**> dB.
5. 5th Octave: <**Insert value**> dB.
6. 6th Octave: <**Insert value**> dB.
7. 7th Octave: <**Insert value**> dB.
8. 8th Octave: <**Insert value**> dB.

2.3 PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAON**]
2. [**Addison**]
3. [**Allied Commercial**]
4. [**Daikin Applied**]
5. [**Duplicate Carrier Global Corporation**]
6. [**Engineered Air**]
7. [**Lennox**]
8. [**Rheem Manufacturing Company; Heating and Cooling Products**]
9. [**Trane**]
10. [**WaterFurnace International, Inc.**]
11. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAON**]
2. [**Addison**]
3. [**Allied Commercial**]
4. [**Daikin Applied**]
5. [**Duplicate Carrier Global Corporation**]
6. [**Engineered Air**]
7. [**Lennox**]
8. [**Rheem Manufacturing Company; Heating and Cooling Products**]
9. [**Trane**]
10. [**WaterFurnace International, Inc.**]
11. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
12. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged, large-capacity, rooftop air-conditioning units from single manufacturer.

D. Unit Casings:

1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Double-Wall Construction:

   a. Outside Casing Wall: [**ASTM A653/A653M galvanized steel**]<**Insert material**>, minimum [**18 gauges (1.3 mm)**]<**Insert value**> thick with [**manufacturer's standard finish**][**corrosion-resistant coating**]<**Insert special coating**>, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   b. Inside Casing Wall: **G90 (Z275)** coated, ASTM A653/A653M galvanized steel, [**0.034 inch (0.86 mm)**][**0.028 inch (0.7 mm)**]<**Insert dimension**> thick[**, perforated 40 percent free area**].
   c. Floor Plate: [**G90 (Z275), ASTM A653/A653M galvanized steel**]<**Insert material**>,[**treadplate,**] minimum [**18 gauges (1.3 mm)**]<**Insert value**> thick.
   d. Casing Insulation:

      1) Materials: [**Injected polyurethane foam**][**fiberglass**] insulation.
      2) Casing Panel R-Value: Minimum <**Insert value**>.
      3) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
      4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

3. Airstream Surfaces: Surfaces in contact with airstream to comply with requirements in ASHRAE 62.1.
4. Static-Pressure Classifications:

   a. For Unit Sections Upstream of Fans: Minus [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**]<**Insert value**>.
   b. For Unit Sections Downstream and Including Fans: [**2-inch wg (500 Pa)**][**3-inch wg (750 Pa)**][**4-inch wg (1000 Pa)**]<**Insert value**>.

5. Panels and Doors:

   a. Access Panels:

      1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
      2) Fasteners: Two or more camlock types for panel lift-out operation. Arrangement to allow panels to be opened against air-pressure differential.
      3) Gasket: Neoprene, applied around entire perimeters of panel frames.
      4) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least [**18 inches (450 mm)**][**24 inches (600 mm)**]<**Insert dimension**> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**][**72 inches (1800 mm)**]<**Insert dimension**>.

   b. Doors:

      1) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinges and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
      2) Gasket: Neoprene, applied around entire perimeters of panel frames.
      3) Size: Large enough to allow inspection and maintenance of air-handling unit's

internal components.

c. Locations and Applications: Provide access doors to all locations indicated below unless limited dimensions of location make access door impractical. If door is impractical, provide panel.

1) Fan Section: [**Inspection and access panels**][**and**][**doors**].
2) Access Section: Doors.
3) Coil Section: Inspection and access panels.
4) Damper Section: [**Inspection and access panels**][**Doors**].
5) Filter Section: [**Inspection and access panels**][**and**][**doors**]. Provide access door or panel large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

d. Service Light: 100 W vaporproof fixture with switched junction box located [**outside**][**inside**] adjacent to door.

1) Locations: [**Each section accessed with door**][**Fan section**]<**Insert location**>.

6. Condensate Drain Pans:

a. Location: Each type of [**cooling coil**][**rotary heat exchanger**].
b. Construction:

1) Single-wall, [**ASTM A653/A653M galvanized-steel or noncorrosive polymer**][**stainless steel**] sheet.
2) Double-wall, [**ASTM A653/A653M galvanized-steel or noncorrosive polymer**][**ASTM A240/A240M stainless steel**] sheet with space between walls filled with foam insulation and moisture-tight seal.

c. Drain Connection:

1) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.
2) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**]<**Insert pipe size**>.

d. Slope: Minimum [**0.125-in./ft. (10-mm/mm)**]<**Insert value**> slope[**, to comply with ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
e. Length: Extend drain pan downstream from leaving face [**for distance to comply with ASHRAE 62.1**]<**Insert distance**>.
f. Width: Entire width of water producing device.
g. Depth: A minimum of [**2 inches (50 mm)**]<**Insert dimension**> deep.
h. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
i. Units with stacked coils are to have an intermediate drain pan to collect condensate from top coil, with piped drain to lower pan to prevent splashing.

E. Fans, Drives, and Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Supply-Air Fans: Centrifugal, rated in accordance with AMCA 210/ASHRAE 51; galvanized or painted steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an [**L-50**]<**Insert bearing life rating**> rated life of minimum [**100,000**]<**Insert number**> hours in accordance with ABMA 9.

c. Housings, Scroll Fans: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
d. Bracing: Steel angle or channel supports for mounting and supporting[**fan scroll,**] wheel, motor, and accessories.
e. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
f. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
g. Shaft Lubrication Lines: Extended to a location outside the casing.
h. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, [**galvanized-steel**][**aluminum**] sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

3. Drives, Direct: Factory-mounted, direct drive.
4. Drives, Belt: Factory-mounted, V-belt drive; with adjustable alignment and belt tensioning and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Outdoor-Air-Refrigerant-Coil Fan: Propeller fan mounted on shaft of permanently lubricated [**two-speed**][**three-speed**][**ECM**] motors.
6. Relief-Air Fan: [**Propeller**][**Forward curved**][**Backward inclined**], shaft mounted on permanently lubricated motor.
7. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
d. Enclosure Materials: [**Cast iron**]<**Insert material**>.
e. Motor Bearings: <**Insert requirements**>.
f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.
h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
j. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

F. Rotary Heat Exchangers:

1. Casing:

a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory finish.
b. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400 Pa and 0.20 percent at 1000 Pa)**]<**Insert values**> differential pressure.
c. Casing seals on periphery of rotor, on duct divider, and on purge section.
d. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings. Support horizontal rotors on tapered roller bearing.

2. Rotor - Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[**, with nontoxic, noncorrosive, silica-gel desiccant coating**].
3. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.
4. Drive: Fractional horsepower motor and gear reducer[**, with speed changed by variable-frequency controller**]. Permanently lubricated wheel bearings with an [**L-10**]<**Insert bearing life**>[**400,000 hours**]<**Insert hours**>.
5. Controls:

a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
b. Variable-frequency controller, factory mounted and wired, permitting input of field-connected 4- to 20 mA or 1- to 10 V control signal.
c. Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
d. Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain[**exhaust temperature above freezing and**] air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
e. Control energy recovery to permit air economizer operation.

1) Bypass dampers to assist energy recovery control.

f. Pilot-Light Indicator: Display rotor rotation and speed.
g. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
h. Defrost cycle.
i. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400 Pa and 0.20 percent at 1000 Pa)**]<**Insert value**> differential pressure.

G. Coils:

1. General Requirements for Coils:

   a. Comply with AHRI 410.
   b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
   c. Coils are to not act as structural component of unit.

2. Supply-Air Refrigerant Coil:

   a. Tubes: [**Copper**]<**Insert material**>.
   b. Fins:

      1) Fin Spacing: Maximum [**8**][**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.

   c. Fin and Tube Joints: Mechanical bond.
   d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
   e. Frames: [**Galvanized steel**][**Stainless steel**]<**Insert material frame**>.
   f. Coatings: [**None**][**Corrosion-resistant coating**].
   g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

      1) Working Pressure: Minimum **300 psig (2070 kPa)**.

3. Supply-Air Hydronic Heating Coil:

   a. Hot-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleaning**].

      1) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
      2) Tube Material: [**Copper**]<**Insert material**>.
      3) Fin Type: Plate.
      4) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
      5) Fin Thickness: <**Insert inches (mm)**>.
      6) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
      7) Headers:

         a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
         b) Seamless copper tube with brazed joints, prime coated.
         c) Fabricated steel, with brazed joints, prime coated.
         d) Provide insulated cover to conceal exposed outside casings of headers.

      8) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
      9) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
      10) Coating: [**None**][**Corrosion-resistant coating**].

4. Steam Heating Coil:

   a. Steam Coils: [**Distributed**][**Single tube**].

      1) Steam Outer-Tube Diameter: <**Insert inches (mm)**>.

2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Thickness: <**Insert inches (mm)**>.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
8) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, minimum **0.052-inch- (1.3-mm-)** thick galvanized steel.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].

5. Outdoor-Air Refrigerant Coil:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**8**][**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized steel**][**Stainless steel**]<**Insert material frame**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum **300 psig (2070 kPa)**.

6. Hot-Gas Reheat Refrigerant Coil:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**8**][**10**][**12**]<**Insert spacing**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized steel**][**Stainless steel**]<**Insert material frame**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum **300 psig (2070 kPa)**.

h. Suction-discharge bypass valve.

7. Electric-Resistance Heating Coils: Comply with UL 1995.

a. Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
e. Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

1) [**Magnetic**][**Mercury**] contactor.
2) Solid-state, stepless pulse controller.
3) Toggle switches, one per step.
4) Step controller.
5) Time-delay relay.
6) Pilot lights, one per step.
7) Airflow proving switch.

H. Refrigerant Circuit Components:

1. Number of Refrigerant Circuits: [**One**][**Two**]<**Insert number**>.
2. Compressor: Hermetic,[**variable speed**] scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief[**, and crankcase heater**].
3. Refrigeration Specialties:

a. Refrigerant: [**R-454B**]<**Insert refrigerant type**>.
b. Expansion valve with replaceable thermostatic element.
c. Refrigerant filter/dryer.
d. Manual-reset high-pressure safety switch.
e. Automatic-reset low-pressure safety switch.
f. Minimum off-time relay.
g. Automatic-reset compressor motor thermal overload.
h. Brass service valves installed in compressor suction and liquid lines.
i. Low-ambient kit high-pressure sensor.
j. Hot-gas reheat solenoid valve [**single stage**][**modulating**] with a replaceable magnetic coil.
k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
l. Four-way reversing solenoid valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

1) Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
2) Seat: PTFE.
3) End Connections: Threaded.
4) Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with **1/2-inch (16-mm)** conduit adaptor, and [**24**][**115**][**208**] Vac coil.
5) Working Pressure Rating: [**400 psig (2760 kPa)**]<**Insert pressure**>.
6) Maximum Operating Temperature: [**240 deg F (116 deg C)**]<**Insert temperature**>.

I. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**], factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Bag Filter:

a. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.
b. Filter Unit Class: UL 900.
c. Media: Fibrous material, with antimicrobial coating, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.
d. Filter-Media Frame: [**Galvanized steel**]<**Insert material**>.

4. Cartridge Filters:

a. Description: Factory-fabricated,[**adhesive-coated**] disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Fibrous material, with antimicrobial coating, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.
d. Filter Media Frame: [**Galvanized steel**]<**Insert material**>.
e. Adhesive: As recommended by adhesive manufacturer and with a VOC content of 80 g/L or less.

J. Gas Furnaces:

1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: Stainless steel.

a. Rated Minimum Turndown Ratio: [**30 to 1**]<**Insert ratio**>.
b. Fuel: [**Natural**][**Propane**] gas.
c. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
d. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
e. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
f. High-Altitude Model Kit: For Project elevations more than **2000 ft. (610 m)** above sea level.

4. Heat-Exchanger and Drain Pan: Stainless steel.
5. Venting, Gravity: Gravity vented[**with vertical extension**].
6. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve[**with vertical extension**].
7. Safety Controls:

a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.

K. Antimicrobial UV Lamp System:

1. Description:

a. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
b. Factory installed and preengineered.

2. Standard: UL Category Control Number ABQK, HVAC accessories, air-duct mounted.
3. Lamps: High output, hot cathode.
4. Lamp-Holder Construction:

a. UV- and moisture-resistant materials and designed to connect the lamp to the plug.
b. Adjustable positioning.

5. Lamp-Clamp Construction:

a. UV- and moisture-resistant materials, watertight connection.
b. Adjustable positioning.

6. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
7. Lamp Output: UV-C energy, primarily at the 254 nm wavelength with a 360-degree energy distribution.
8. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.
9. Power Supply: UL-listed, single-point electrical connection[**with service disconnect**].
10. Power Consumption: Maximum of [**15 W/sq. ft. (161 W/sq. m)**]<**Insert value**>.

L. Sound-Attenuator Section:

1. General Requirements:

a. Factory fabricated.
b. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50; ASTM E84.
c. Airstream Surfaces: Surfaces in contact with airstream to comply with ASHRAE 62.1.

2. Shape: [**Rectangular, straight**][**Round, straight**][**Rectangular, elbow**][**Round, elbow**].
3. Rectangular Silencer Outer Casing: [**Galvanized steel**]<**Insert material**>.
4. Round Silencer Outer Casing: [**Galvanized steel**]<**Insert material**>.
5. Inner Casing and Baffles: [**Galvanized steel**]<**Insert material**>.
6. Principal Sound-Absorbing Mechanism:

a. Dissipative Type:[**Polymer film-lined**] absorptive fill material.

1) Fill Material: [**Inert and vermin-proof fibrous material**]<**Insert material type**>.

b. Joints: Lock formed and sealed, continuously welded or flanged.

M. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge

seals in [**opposed**][**parallel**]-blade arrangement with[**zinc-plated**] steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate must not exceed [**4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa)**]<**Insert requirement**> rated in accordance with AMCA 500-D.

3. Barometric relief dampers.
4. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
5. Electronic Damper Operators:

   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator to have visual scale indicating percent of travel and 2 to 10 V dc, feedback signal.
   c. Operator Motors:

      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains are completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
   f. Size dampers for running torque calculated as follows:

      1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
      2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
      3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft (49.6 kg-cm/sq. m)** of damper.
      4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

   g. Coupling: V-bolt and V-shaped, toothed cradle.
   h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
   j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**115 V ac**][**230 V ac**].
   k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
   l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
   m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
   n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

N. Electrical Power Connections:

1. RTU is to have a single connection of power to unit with[**unit-mounted disconnect switch accessible from outside unit and**] control-circuit transformer with built-in overcurrent protection.

O. Controls:

1. Control equipment is specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Sequence of operation is specified [**in Section 230993.11 "Sequence of Operations for HVAC DDC."**][**on Drawings.**]
3. Unit Controls:

   a. Control-voltage transformer.
   b. Wall-mounted thermostat or sensor with the following features:

      1) Heat-cool-off switch.
      2) Fan on-auto switch.
      3) Fan-speed switch.
      4) [**Manual**][**Automatic**] changeover.
      5) Adjustable deadband.
      6) [**Concealed**][**Exposed**] set point.
      7) [**Concealed**][**Exposed**] indication.
      8) [**Degree F**][**Degree C**] indication for the following:

         a) Space temperature.
         b) Supply-air temperature.
         c) Outdoor-air temperature.
         d) Space set point.

      9) Unoccupied-period-override push button.
      10) Data entry and access port to input temperature[**and humidity**] set points, occupied and unoccupied periods, and output room temperature[**and humidity**], supply-air temperature, operating mode, and status.

   c. Wall-mounted humidistat or sensor with the following features:

      1) [**Concealed**][**Exposed**] set point.
      2) [**Concealed**][**Exposed**] indication.

   d. Annunciator Panel for Each Unit:

      1) Configuration: [**Remote wall-**][**Unit**] mounted.
      2) Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
      3) DDC controller or programmable timer and interface with HVAC instrumentation and control system.
      4) Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

4. Controller: [**Electronic**][**DDC**].

a. Controller is to have volatile-memory backup.
b. Safety Control Operation:

1) Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
2) Firestats: Stop fan and close outdoor-air damper if air greater than [**130 deg F (54 deg C)**]<**Insert temperature**> enters unit. Provide additional contacts for alarm interface to fire-alarm control panel.
3) Fire-Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single- and Multiple-Station Alarms."**]
4) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than [**40 deg F (4 deg C)**]<**Insert temperature**>.
5) Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.

c. Scheduled Operation: Occupied and unoccupied periods on [**seven**][**365**]-day clock with a minimum of [**two**][**four**] programmable periods per day.
d. Unoccupied Period:

1) Heating Unoccupied: [**60 deg F (15.6 deg C)**]<**Insert unoccupied temperature**>.
2) Cooling Unoccupied: [**78 deg F (25 deg C)**]<**Insert unoccupied temperature**>[**System off**].
3) Override Operation: [**Two**]<**Insert number**> hours.

e. Supply Fan Operation:

1) Occupied Periods: Run fan continuously.
2) Unoccupied Periods: Cycle fan to maintain heating unoccupied temperature.

f. Refrigerant Circuit Operation:

1) Occupied Periods: Cycle or stage compressors[**, and operate hot-gas bypass**] to match compressor output to cooling load to maintain [**room**][**discharge**] temperature[**and humidity**]. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
2) Unoccupied Periods: [**Compressors off**][**Cycle compressors and condenser fans to maintain heating unoccupied temperature**][**and**][**cycle compressors and condenser fans to maintain cooling unoccupied temperature**].
3) Switch reversing valve for heating or cooling mode on air-to-air heat pump.

g. Hot-Gas Reheat-Coil Operation:

1) Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
2) Unoccupied Periods: Reheat is not required.

h. Gas Furnace Operation:

1) Occupied Periods: [**Cycle**][**Stage**][**Modulate**] burner to maintain [**room**][**discharge**] temperature.
2) Unoccupied Periods: Cycle burner to maintain unoccupied heating temperature.
3) Operate supplemental gas furnace for heating with outdoor temperature below [**plus 25 deg F (minus 4 deg C)**]<**Insert temperature**>.

i. Electric-Heating-Coil Operation:

1) Occupied Periods: [**Cycle**][**Stage**][**Modulate**] coil to maintain [**room**][**discharge**] temperature.
2) Unoccupied Periods: Energize coil to maintain unoccupied heating temperature.
3) Operate supplemental electric heating coil with compressor for heating with outdoor temperature below [**plus 25 deg F (minus 4 deg C)**]<**Insert temperature**>.

j. Fixed Minimum Outdoor-Air Damper Operation:

1) Occupied Periods: Open to [**25**]<**Insert number**> percent.
2) Unoccupied Periods: Close the outdoor-air damper.

k. Economizer Outdoor-Air Damper Operation:

1) Economizer Cycle: Controller is to permit outdoor air-side economizer operation when [**outdoor-air temperature**][**outdoor-air enthalpy**] is lower than [**return-air temperature**][**return-air enthalpy**]. When this condition is untrue, outdoor damper is not permitted to open beyond minimum intake airflow setting. When air-side economizer cycle is in operation, outdoor-air volume is to be modulated to maintain mixed-air temperature no lower than [**unit supply-air temperature set point**]<**Insert temperature**>. Minimum outdoor airflow is not to be reduced below [**10 percent**][**25 percent**][**1000 cfm (472 L/s)**]<**Insert value**>.
2) Morning Warmup Cycle:

   a) For outdoor-air temperature lower than return-air temperature, close outdoor-air damper and open return-air damper.
   b) For outdoor-air temperature higher than return-air temperature, open outdoor-air damper and close return-air damper.

3) Morning Cool-Down Cycle:

   a) For outdoor-air [**temperature**][**enthalpy**] higher than return-air [**temperature**][**enthalpy**], close outdoor-air damper and open return-air damper.
   b) For outdoor-air [**temperature**][**enthalpy**] lower than return-air [**temperature**][**enthalpy**], open outdoor-air damper and close return-air damper.

4) Building Outdoor-Air Flush Cycle: Open outdoor-air damper and close return-air damper.
5) Occupied Periods: Open to [**10**][**25**]<**Insert number**> percent fixed minimum intake, and maximum 100 percent of fan capacity. Controller is to permit air-side economizer operation when [**outdoor-air temperature is less than return-air temperature**][**outdoor-air enthalpy is less than return-air enthalpy**][**outdoor-air temperature is less than 60 deg F (15 deg C)**]<**Insert temperature**>. Controller modulates outdoor-air and return-air dampers to maintain a mixed-air temperature of [**55 deg F (13 deg C)**]<**Insert temperature**>.
6) Relief-Air Fan: Start relief-air fan with end switch on outdoor-air damper.
7) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

l. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor to adjust for temperature, and output to range from [**2 to 10 V dc**][**4 to 20 mA**]<**Insert value**>.

m. Carbon Dioxide Sensor Operation:

1) Occupied Periods: Reset minimum outdoor-air ratio down to minimum [**10**]<**Insert number**> percent to maintain maximum [**1000 ppm**]<**Insert value**> concentration.
2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

n. Terminal-Unit Relays: Provide heating- and cooling-mode changeover relays compatible with terminal control system required in Section 233600 "Air Terminal Units" and Section 230923 "Direct Digital Control (DDC) System for HVAC."

5. Interface Requirements for HVAC Instrumentation and Control System:

a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
c. Provide [**BACnet**][**or**][**LonWorks**] compatible interface for central HVAC control workstation for the following:

1) Adjusting set points.
2) Monitoring supply fan start, stop, and operation.
3) Inquiring data to include the following:

a) Outdoor-air temperature[**and humidity**].
b) Outdoor-air damper position.
c) Supply-air temperature.
d) Mixed-air temperature.
e) Room-air temperature[**and humidity**].

4) Monitoring occupied and unoccupied operations.
5) Monitoring constant and variable motor loads.
6) Monitoring variable-frequency drive operation.
7) Monitoring cooling load.
8) Monitoring economizer cycles.
9) Monitoring air-distribution static pressure and ventilation air volume.

P. Roof Curbs:

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for wind-load requirements.
3. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C1071, Type I or II.
2) Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert thickness**>.

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when

applied as recommended by manufacturer and without causing leakage in cabinet.

3) Liner materials applied in this location to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

4. Curb Dimensions: Height of [**14 inches (355 mm)**][**24 inches (610 mm)**][**36 inches (910 mm)**]<**Insert height**>.[**Adaptable horizontal dimensions as required for existing roof openings.**]

Q. Accessories:

1. Electric heater with integral thermostat maintains minimum **50 deg F (10 deg C)** temperature in gas burner compartment.
2. Duplex, 115 V, ground-fault-interrupter outlet with 15 A overcurrent protection. Include transformer if required.[**Outlet is to be energized even if the unit main disconnect is open.**]
3. Low-ambient kit using [**staged**][**damper on**][**variable-speed**] condenser fans for operation down to [**35 deg F (1.7 deg C)**]<**Insert temperature**>.
4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
5. Remote potentiometer to adjust minimum economizer damper position.
6. Return-air bypass damper.
7. Factory- or field-installed, demand-controlled ventilation.
8. Safeties:

   a. Smoke detector.
   b. Condensate overflow switch.
   c. Phase-loss[**reversal**] protection.
   d. High[**and low**] pressure control.
   e. [**Gas furnace**][**Electric coil**] airflow-proving switch.

9. Coil guards of painted, galvanized-steel wire.
10. Hail guards of galvanized steel, painted to match casing.
11. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
12. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.
13. Door switches to disable heating or reset set point when open.
14. Outdoor-air intake weather hood[**with moisture eliminator**].
15. Service Lights and Switch: Factory installed in [**fan section**][**fan and coil sections**][**each accessible section**]<**Insert locations**> with weatherproof cover. Factory wire lights to a single-point field connection.

R. Corrosion-Resistant Coating:

1. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
2. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding [**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

   a. Standards:

      1) ASTM B117 for salt spray.
      2) ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
      3) ASTM D3359 for cross-hatch adhesion of 5B.

b. Application: [**Immersion**][**Spray**].
c. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Certification:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance in accordance with AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify in accordance with AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Roof Curb: Install on roof structure or concrete base, level and secure, in accordance with [**NRCA's "NRCA Roofing Manual: Membrane Roof Systems."**][**AHRI Guideline B.**] Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

1. Install normal-weight, **3000 psi (20.7 MPa)**, compressive strength (28-day) concrete mix inside roof curb, [**4 inches (100 mm)**]<**Insert dimension**> thick. Concrete, formwork, and reinforcement are specified with concrete.

B. Unit Support: Install unit level on structural [**curbs**][**steel supports**]. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Equipment Mounting:

1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to RTU, allow space for service and maintenance.

C. Connect piping to unit mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using [**NPS 1-1/4 (DN 32)**]<**Insert pipe size**>, **ASTM B88, Type M (ASTM B88M, Type C)** copper tubing. Extend to nearest equipment or roof drain. Construct deep trap[**of indicated depth**] at connection to drain pan and install cleanouts at changes in direction.

E. Gas Piping: Comply with applicable requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

F. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

G. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

H. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.5 ELECTRICAL CONNECTIONS

A. Connect electrical wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least **1/2 inch (13 mm)** high.
3. Locate nameplate where easily visible.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, coils, and fans.
5. Inspect internal insulation.
6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean all coils and inspect for construction debris.
11. Clean furnace flue and inspect for construction debris.
12. Connect and purge gas line.
13. Remove packing from vibration isolators.
14. Inspect operation of barometric relief dampers.
15. Verify lubrication on fan and motor bearings.
16. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
17. Adjust fan belts to proper alignment and tension.
18. Start unit in accordance with manufacturer's written instructions.

a. Start refrigeration system.
b. Do not operate below recommended low-ambient temperature.
c. Complete startup sheets and attach copy with Contractor's startup report.

19. Inspect and record performance of interlocks and protective devices; verify sequences of operation.
20. Operate unit for an initial period as recommended or required by manufacturer.
21. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

22. Calibrate thermostats.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
25. Start refrigeration system and measure and record the following when ambient is a minimum of **15 deg F (8 deg C)** above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

28. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

29. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

30. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.9 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain RTUs.

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SECTION 23 74 16 13A - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dedicated outdoor-air units.

B. Related Requirements:

1. [Section 284600 "Fire Detection and Alarm."][Section 284614 "Single- and Multiple-Station Alarms."][Section 284600 "Fire Detection and Alarm" and "Section 284614 "Single- and Multiple-Station Alarms."]

1.2 DEFINITIONS:

A. ECM: Electronically commutated motor.

B. ISCOP: Integrated Seasonal Coefficient of Performance.

C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.

D. MRC: Moisture Removal Capacity.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
c. Include unit dimensions and weight.
d. Include cabinet material, metal thickness, finishes, insulation, and accessories.
e. Fans:

1) Certified fan-performance curves with system operating conditions indicated.
2) Certified fan-sound power ratings.
3) Fan construction and accessories.
4) Motor ratings, electrical characteristics, and motor accessories.

f. Include certified coil-performance ratings with system operating conditions indicated.
g. Include filters with performance characteristics.
h. Include heat exchangers with performance characteristics.
i. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product Data: Showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
5. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
6. Product Data: Provide the following:

   a. Manufacturer cut sheet indicating water consumption.
   b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

C. Shop Drawings: For each dedicated outdoor-air unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For dedicated outdoor-air-unit supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators [**seismic restraints**][**and**][**wind restraints**], and for designing vibration isolation bases.
2. [**Wind-**][**and**][**Seismic-**]Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor/roof plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates, for dedicated outdoor-air units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in

"Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control reports.

F. Startup service reports.

G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.
2. Filters: [**One**]<**Insert number**> set(s) for each unit.
3. Gaskets: [**One**]<**Insert number**> set(s) for each access door.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Dedicated Outdoor-Air-Handling Units: [**Two**][**Three**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Compressors: [**Five**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Heat Exchangers: [**Five**][**10**]<**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Rotary Heat Exchangers: [**Five**]<**Insert number**> years from date of Substantial Completion.
5. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASHRAE 84 Compliance: Comply with capacity ratings for [**heat-wheel**][**fixed plate**] energy-recovery equipment.

G. UL Compliance:

1. Electric Coils: Comply with requirements in UL 1995.

H. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**vibration isolation**][**seismic restraints**][**and**][**wind restraints**].

I. Seismic Performance: Units are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

J. Wind-Restraint Performance:

1. See [**Section 230548 "Vibration and Seismic Controls for HVAC**][**Section 230548.13 "Vibration Controls for HVAC"**] for requirements.

2.2 CAPACITIES AND CHARACTERISTICS

A. Supply-Air Fan:

1. Type: [**DWDI, backward-inclined centrifugal fan**][**DWDI, forward-curved centrifugal fan**][**DWDI, airfoil centrifugal fan**][**SWSI, airfoil unhoused centrifugal fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**].
3. Airflow: <**Insert cfm (L/s)**>.
4. External Static Pressure: <**Insert inches wg (kPa)**>.
5. Size: <**Insert wheel size**>.
6. Design Fan Speed: <**Insert number**> rpm.
7. Motor Characteristics:

a. Horsepower: <**Insert number**> hp.
b. Motor Speed: [**Multispeed**][**ECM**][**Constant**]<**Insert number**> rpm.
c. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.

d. Phase: [**Single**][**Three**].
e. Hertz: 60.

8. Fan Discharge Sound Power, dB:

a. 1st Octave: <**Insert value**>.
b. 2nd Octave: <**Insert value**>.
c. 3rd Octave: <**Insert value**>.
d. 4th Octave: <**Insert value**>.
e. 5th Octave: <**Insert value**>.
f. 6th Octave: <**Insert value**>.
g. 7th Octave: <**Insert value**>.
h. 8th Octave: <**Insert value**>.

B. Relief (Exhaust)-Air Fan:

1. Type: [**DWDI, backward-inclined centrifugal fan**][**DWDI, forward-curved centrifugal fan**][**DWDI, airfoil centrifugal fan**][**SWSI, airfoil unhoused centrifugal fan**]<**Insert fan type**>.
2. Class: AMCA 99, Section 14, [**Class I**][**Class II**].
3. Airflow: <**Insert cfm (L/s)**>.
4. External Static Pressure: <**Insert inches wg (kPa)**>.
5. Design Fan Speed: <**Insert number**> rpm.
6. Motor Characteristics:

a. Horsepower: <**Insert number**> hp.
b. Motor Speed: [**Multispeed**][**ECM**][**Constant**]<**Insert number**> rpm.
c. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
d. Phase: [**Single**][**Poly**].
e. Hertz: 60.

7. Fan Inlet Sound Power, dB:

a. 1st Octave: <**Insert value**>.
b. 2nd Octave: <**Insert value**>.
c. 3rd Octave: <**Insert value**>.
d. 4th Octave: <**Insert value**>.
e. 5th Octave: <**Insert value**>.
f. 6th Octave: <**Insert value**>.
g. 7th Octave: <**Insert value**>.
h. 8th Octave: <**Insert value**>.

C. Condenser-Air Fan:

1. Motor Characteristics:

a. Horsepower: <**Insert number**> hp.
b. Motor Speed: [**Multispeed**][**ECM**][**Constant**]<**Insert number**> rpm.
c. Volts: [**120**][**208**][**230**][**460**]<**Insert value**> V.
d. Phase: [**Single**][**Poly**].
e. Hertz: 60.

D. Refrigerant Cooling Coil:

1. Capacity: <**Insert tons (kW)**>.
2. ISMRE: <**Insert number**>.
3. Condenser Ambient-Air Temperature: <**Insert deg F (deg C)**>.

4. Evaporator Coil:

    a. Sensible Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    b. Total Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    c. Entering-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    d. Entering-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    e. Leaving-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    f. Leaving-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    g. Face Area: <**Insert sq. ft. (sq. m)**>.
    h. Maximum Face Velocity: <**Insert fpm (m/s)**>.
    i. Maximum Air-Side, Static-Pressure Drop: <**Insert inches wg (Pa)**>.
    j. Fin Spacing: <**Insert fins per inch (cm)**>.
    k. Fin Thickness: <**Insert inches (mm)**>.
    l. Number of Rows: <**Insert number**>.

E. Hot-Gas Reheat Coil:

1. Heating Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Air-Temperature Rise: <**Insert deg F (deg C)**>.
4. Refrigerant Type: <**Insert refrigerant type**>.

F. Electric-Resistance Heating Coils:

1. Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Power Input: <**Insert number**> kW.
5. Volts: [**120**][**208**][**230**][**480**]<**Insert number**> V.
6. Phase: [**Single**][**Three**].
7. Hertz: 60.
8. Full-Load Amperes: <**Insert number**> A.
9. Maximum Overcurrent Protection: <**Insert number**> A.
10. Capacity Control: Number of Steps or SCR: <**Insert number or SCR**>.

G. Gas-Fired Furnace Heating:

1. Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Efficiency: [**80**]<**Insert number**> percent.
5. Fuel: [**Natural**][**Propane**] gas.
6. Burner: [**Modulating**][**Staged**].
7. Turndown Ratio: Minimum [**5:1**][**6:1**][**8:1**]<**Insert ratio**>.
8. Gas Heating Value: <**Insert Btu/cu. ft. (kJ/L)**>.
9. Gas Input: <**Insert cfh (mL/s)**>.
10. Gas Burner Electrical Characteristics:

    a. Power Input: <**Insert number**> kW.
    b. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
    c. Phase: [**Single**][**Three**].
    d. Hertz: 60.
    e. Full-Load Amperes: <**Insert number**> A.
    f. Minimum Circuit Ampacity: <**Insert number**> A.
    g. Maximum Overcurrent Protection: <**Insert number**> A.

H. Heating Coils: [**Hot Water**][**Steam**].

1. Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Face Area: <**Insert sq. ft. (sq. m)**>.
5. Maximum Face Velocity: <**Insert fpm (m/s)**>.
6. Maximum Air-Side, Static-Pressure Drop: <**Insert inches wg (Pa)**>.
7. Coil Type: [**Continuous circuit**][**Self-draining**][**Cleanable**][**Distributing**][**Single tube**].
8. Piping Connections: [**Threaded**][**Flanged**]; [**same end**][**opposite ends**] of coil.
9. Tube Thickness: <**Insert inches (mm)**>.
10. Fin Spacing: <**Insert fins per inch (cm)**>.
11. Fin Thickness: <**Insert inches (mm)**>.
12. Number of Rows: <**Insert number**>.
13. Coil Working-Pressure Ratings: [**200 psig (1380 kPa), 325 deg F (163 deg C)**]<**Insert value**>.
14. Fluid Flow: <**Insert gpm (L/s)**>.
15. Maximum Fluid-Pressure Drop: <**Insert feet of head (kPa)**>.
16. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
17. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
18. Fluid Velocity: <**Insert fpm (L/s)**>.
19. Steam Flow: <**Insert lb/h (g/s)**>.
20. Inlet Steam Pressure: <**Insert psig (kPa)**>.

I. Rotary Heat Exchanger:

1. Effectiveness: <**Insert number**> percent.
2. Intake Airflow: <**Insert cfm (L/s)**>.
3. Pressure Differential: <**Insert inches wg (kPa)**>.
4. Entering Supply-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Entering Supply-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
8. Relief/Exhaust Airflow: <**Insert cfm (L/s)**>.
9. Entering Relief/Exhaust-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
10. Entering Relief/Exhaust-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
11. Leaving Relief/Exhaust-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
12. Leaving Relief/Exhaust-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

J. Filters:

1. Type: [**Panel**]<**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

    a. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance, in accordance with ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 8**][**MERV 11**][**MERV 13**][**MERV 14**]<**Insert value**>, in

accordance with ASHRAE 52.2.

K. Electrical Characteristics for Single-Point Connection:

1. Volts: [**120**][**208**][**230**][**460**]<**Insert number**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert number**> A.
5. Minimum Circuit Ampacity: <**Insert number**> A.
6. Maximum Overcurrent Protection: <**Insert number**> A.

2.3 DEDICATED OUTDOOR-AIR UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AAON**]
2. [**Addison**]
3. [**Desert Aire**]
4. [**Munters Corporation**]
5. [**REZNOR, a brand of Nortek Global HVAC**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AAON**]
2. [**Addison**]
3. [**Desert Aire**]
4. [**Munters Corporation**]
5. [**REZNOR, a brand of Nortek Global HVAC**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

D. Unit Casing:

1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Configuration: Horizontal unit with [**top**][**horizontal**][**bottom**] discharge for [**roof-mounting**][**concrete-base**] installation.
3. Double-Wall Configuration:

   a. Outside Casing Wall: [**Galvanized steel**][**Stainless steel**][**, stainless steel in cooling coil section**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick with [**manufacturer's standard finish**][**corrosion-resistant coating**]<**Insert special coating**>, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: [**Galvanized steel**]<**Insert material**>, solid, minimum [**14-gauge- (0.759-mm-)**]<**Insert value**> thick steel.

2) Inside Casing, All Other Sections: [**Galvanized steel**]<**Insert material**>, [**solid**][**perforated**].
3) Antimicrobial Coating: Applied during the manufacturing process. Coating is to be [**EPA approved**][**NSF approved**][**FDA listed**].

c. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
d. Roof: Standing seam or membrane; sloped to drain water.
e. Casing Insulation:

1) Materials: Polyurethane foam insulation.
2) Casing Panel R-Value: Minimum [**R-6.5**][**R-11**][**R-13**]<**Insert value**>.
3) Insulation Thickness: [**1 inches (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

4. Airstream Surfaces: Surfaces in contact with airstream are to comply with requirements in ASHRAE 62.1.
5. Static-Pressure Classifications:

a. For Unit Sections Upstream of Fans: Minus [**2 inches wg (500 Pa)**][**3 inches wg (750 Pa)**]<**Insert value**>.
b. For Unit Sections Downstream and Including Fans: [**2 inches wg (500 Pa)**][**3 inches wg (750 Pa)**][**4 inches wg (1000 Pa)**]<**Insert value**>.

6. Panels and Doors:

a. Panels:

1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
2) Fasteners: Two or more camlock-type fasteners for panel lift-out operation. Arrangement is to allow panels to be opened against airflow.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

b. Doors:

1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.

c. Locations and Applications:

1) Fan Section: [**Panels**][**Doors**].
2) Access Section: Doors.
3) Gas-Fired Burner Section: [**Panels**][**Doors**].
4) Damper Section: [**Panels**][**Doors**].
5) Filter Section: [**Panels**][**Doors**] large enough to allow periodic removal and

installation of filters.
6) Relief Section: Doors.

7. Condensate Drain Pans:

a. Location: Each refrigerant coil[**and rotary heat exchanger**].
b. Construction:

1) Single-wall, [**galvanized-steel or noncorrosive polymer**][**stainless steel**] sheet.

c. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
d. Drain Connection:

1) Located on [**one end**][**both ends**] of pan, at lowest point of pan.
2) Terminated with threaded nipple.
3) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**]<**Insert pipe size**>.

e. Slope: Minimum [**0.125-inch/ft. (10-mm/m)**]<**Insert value**> slope[**, to comply with ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
f. Length: Extend drain pan downstream from leaving face [**for distance to comply with ASHRAE 62.1**]<**Insert distance**>.
g. Width: Entire width of water-producing device.
h. Depth: A minimum of [**2 inches (50 mm)**]<**Insert dimension**> deep.
i. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
j. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

E. Fans, Drives, And Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an [**L-50**]<**Insert bearing life rating**> rated life of minimum [**100,000**]<**Insert number**> hours in accordance with ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute

housing. Provide inlet screens for Type SWSI fans.

e. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; [**steel**][**aluminum**] hub riveted to backplate and fastened to shaft with setscrews.

f. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; [**steel**][**aluminum**] hub swaged to backplate and fastened to shaft with setscrews.

g. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

h. Mounting: For internal vibration isolation[**and seismic control**]. Factory mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

i. Shaft Lubrication Lines: Extended to a location outside the casing.

j. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** <**Insert dimension**> wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide <**Insert width**> by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

3. Drive, Direct: Factory-mounted direct drive.

4. Drive, Belt: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

b. Belts: Oil resistant, nonsparking and nonstatic; in matched sets for multiple-belt drives.

c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch (2.7 mm)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Condenser-Coil Fan: [**Variable-speed**]propeller, mounted on shaft of permanently lubricated [**multispeed**][**electronically commutated**] motors.

6. Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

c. Enclosure Type: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.

d. Enclosure Materials: [**Cast iron**]<**Insert material**>.

e. Motor Bearings: <**Insert requirements**>.

f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C (deg C)**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.

h. NEMA Design: <**Insert designation**>.

i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**> hp motors and smaller;

fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

j. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

k. <**Insert unique motor characteristics**>.

l. Mount unit-mounted disconnect switches on [**exterior**][**interior**] of unit.

7. Comply with Section 262923 "Variable-Frequency Motor Controllers."

8. Variable-Frequency Motor Controller: Serving [**each fan individually**][**all fans combined**] in fan array.

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**]<**Insert application**> for [**Design A and Design B**][**inverter-duty**] motors.

b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.

c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.

b) Maximum Speed: 80 to 100 percent of maximum rpm.

c) Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.

d) Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.

e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.

b) Loss of input signal protection.

c) Under- and overvoltage trips.

d) Variable-frequency motor controller and motor-overload/overtemperature protection.

e) Critical frequency rejection.

f) Loss-of-phase protection.

g) Reverse-phase protection.

h) Motor-overtemperature fault.

3) Bidirectional autospeed search.

4) Torque boost.

5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.

b) Historical logging information and displays.

c) Digital indicating devices.

6) Control Signal Interface: Electric.

7) Proportional Integral Directive (PID) control interface.

8) DDC system for HVAC Protocols for Network Communications: [**ASHRAE 135**]<**Insert protocol type**>.

d. Line Conditioning:

1) Input line conditioning.

2) Output filtering.

3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**].
2) Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors[**and isolating switch**].
3) Bypass Controller, Three-Contactor Style: With bypass and input and output isolating contactors[**and isolating switch**].
4) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

F. Coils:

1. General Requirements for Coils:

a. Comply with AHRI 410.
b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. Coils are not to act as structural component of unit.

2. Supply-Air Refrigerant Coils:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert spacing**> fins per **inch** **(mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized steel**]<**Insert material frame**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum **300 psig** **(2070 kPa)**.

3. Hot-Gas Reheat Refrigerant Coils:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert spacing**> fins per **inch** **(mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized steel**][**Stainless steel**]<**Insert material frame**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum **300 psig** **(2070 kPa)**.

h. Coating: [**None**][**Corrosion-resistant coating**].

i. Suction-discharge bypass valve.

4. Electric-Resistance Heating Coils: Comply with UL 1995.

a. Casing Assembly: [**Slip-in**][**Flanged**] type with galvanized-steel frame.
b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
e. Control Panel: [**Unit**][**Remote**] mounted with disconnecting means and overcurrent protection.

1) Magnetic contactor.
2) Solid-state, stepless pulse controller.
3) Toggle switches, one per step.
4) [**Step**][**SCR**] controller.
5) Time-delay relay.
6) Pilot lights, one per step.
7) Airflow proving switch.

5. Heating-Water Coils: [**Continuous circuit**][**Self-draining**][**Cleaning**].

a. Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
b. Tube Material: [**Copper**]<**Insert material**>.
c. Fin Type: Plate.
d. Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
e. Fin Thickness: <**Insert inches (mm)**>.
f. Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].
g. Headers:

1) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
2) Seamless copper tube with brazed joints, prime coated.
3) Fabricated steel, with brazed joints, prime coated.
4) Provide insulated cover to conceal exposed outside casings of headers.
5) Frames: Channel frame, minimum **0.052-inch (1.3-mm)** thick galvanized steel.
6) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.

h. Coating: [**None**][**Corrosion-resistant coating**].

6. Steam Heating Coils:

a. Steam Coils: [**Distributed**][**Single tube**].

1) Steam Outer-Tube Diameter: <**Insert inches (mm)**>.
2) Piping Connections: [**Threaded**][**Flanged**], [**same end**][**opposite ends**] of coil.
3) Tube Material: [**Copper**]<**Insert material**>.
4) Fin Type: Plate.
5) Fin Material: [**Aluminum**][**Copper**]<**Insert material**>.
6) Fin Thickness: <**Insert inches (mm)**>.
7) Fin and Tube Joint: [**Mechanical bond**][**Silver brazed**].

8) Headers:

a) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
b) Seamless copper tube with brazed joints, prime coated.
c) Fabricated steel, with brazed joints, prime coated.
d) Provide insulated cover to conceal exposed outside casings of headers.

9) Frames: Channel frame, minimum **0.052-inch (1.3-mm)** thick galvanized steel.
10) Coil Working-Pressure Ratings: [**200 psig (1380 kPa)**, **325 deg F (163 deg C)**]<**Insert value and temperature**>.
11) Coating: [**None**][**Corrosion-resistant coating**].

7. Condenser Refrigerant Coils:

a. Tube Material: [**Copper**]<**Insert material**>.
b. Fin Material: [**Aluminum**][**Copper**].
c. Fin and Tube Joint: Mechanical bond.
d. Coating: [**None**][**Corrosion-resistant**].

G. Refrigeration Circuit Components:

1. Compressors: Hermetic, [**variable-speed**] scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief[**, and crankcase heater**].
2. Refrigerant: [**R-410A**]<**Insert other available type**>.
3. Refrigeration Specialties:

a. Expansion valve with replaceable thermostatic element.
b. Refrigerant filter/dryer.
c. Manual-reset high-pressure safety switch.
d. Automatic-reset low-pressure safety switch.
e. Minimum off-time relay.
f. Automatic-reset compressor motor thermal overload.
g. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
h. Brass service valves installed in discharge and liquid lines.
i. Low-ambient kit high-pressure sensor.
j. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
k. [**Single stage**][**Modulating**] hot-gas reheat solenoid valve with a replaceable magnetic coil.
l. Heat-pipe heat exchanger, wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
m. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.

H. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, nonpleated**][**Pleated**] factory-fabricated, self-supported disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and

antimicrobial coating.
d. Filter-Media Frame: [**High wet-strength beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

I. Adhesive: As recommended by air-filter manufacturer and with a VOC content of [**80**]<**Insert number**> g/L or less.

1. Mounting Frames:

a. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters are to be removable from one side or from access plenum.
b. Cartridge filters arranged for flat orientation, removable from access plenum.
c. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks[**with space for prefilter**].

J. Rotary Heat Exchanger:

1. Casing:

a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
b. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)**]<**Insert values**> differential pressure.
c. Casing seals on periphery of rotor and on duct divider and purge section.
d. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings[**or permanently lubricated bearings**]. Support horizontal rotors on tapered roller bearings.

2. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
3. Drive: Fractional horsepower motor and gear reducer[**, with speed changed by variable-frequency controller**]. Provide permanently lubricated wheel bearings.
4. Controls:

a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
b. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
c. Control energy recovery to permit air economizer operation.

1) Bypass dampers to assist energy recovery control.

d. Pilot-Light Indicator: Display rotor rotation and speed.
e. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
f. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)**]<**Insert value**> differential pressure.
g. Defrost cycle.
h. <**Insert additional control features**>.

K. Indirect-Fired Gas Furnace Heating:

1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
2. CSA Approval: Designed and certified by and bearing label of CSA.

3. Burners:

   a. Heat-Exchanger Material: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].
   b. Fuel: [**Natural**][**Propane**] gas.
   c. Ignition: Electronically controlled electric spark with flame sensor.
   d. Gas Control Valve: [**Single stage**][**Two stage**][**Electronic modulating**].
   e. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
   f. High-Altitude Model Kit: For Project elevations of more than **2000 feet (610 m)** above sea level.

4. Venting, Gravity: Gravity vented.
5. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
6. Heat-Exchanger Drain Pan: Stainless steel.
7. Safety Controls:

   a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.
   b. Vent Flow Verification: [**Differential pressure switch to verify open vent**][**Flame rollout switch**].
   c. High Limit: Thermal switch or fuse to stop burner.
   d. Purge-period timer is to automatically delay burner ignition and bypass low-limit control.
   e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
   f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
   g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

L. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m)** at **1 inch wg (250 Pa)** and **8 cfm/sq. ft. (40 L/s per sq. m)** at **4 inches wg (1.0 MPa)**.
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator is to have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
   c. Operator Motors:

      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit

switches, auxiliary switches, or feedback potentiometer.

d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
f. Size dampers for running torque calculated as follows:

1) Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
2) Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
3) Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft. (49.6 kg-cm/sq. m)** of damper.
4) Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
5) Dampers with 2 to 3 Inches wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
6) Dampers with 3 to 4 Inches wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

g. Coupling: V-bolt and V-shaped, toothed cradle.
h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

M. Electrical Power Connections:

1. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices are to provide a [**single-point**]field power connection to unit [**except for service lights and convenience outlets, which are to be powered separately**].
2. Enclosure: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**]<**Insert type**>, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
3. Wiring: Numbered and color-coded to match wiring diagram.
4. Wiring Location: Install factory wiring outside an enclosure in a raceway.
5. Power Interface: Field power interface to be [**wire lugs**][**NEMA KS 1, heavy-duty, nonfused disconnect switch**].
6. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
b. NEMA KS 1, heavy-duty, nonfusible switch.
c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

7. Factory-Mounted, Overcurrent-Protection Service: For each motor.

8. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
9. Controls: Factory wire unit-mounted controls where indicated.

    a. Service Lights: <**Insert number of watts**>[**LED**]<**Insert lamp type**> vaporproof luminaire with individual switched junction box located [**outside**][**inside**], adjacent to each access door and panel.

        1) Locations: [**Each section accessed with door or panel**][**Fan section**]<**Insert location**>.

    b. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.

        1) Locations: [**Each section accessed with a door or panel**][**Fan section**]<**Insert location**>.

10. Control Relays: Auxiliary and adjustable time-delay relays.

N. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
2. Control Valves: Comply with requirements in Section 230923.11 "Control Valves."
3. Control Wiring: Factory wire connection for controls' power supply.
4. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves are to be manufacturer's standard items to accomplish indicated control functions.
5. Status Panel: [**Remote**][**Unit**] mounted.

    a. Cooling/Off/Heating Controls: Control operational mode.
    b. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
    c. Status Lights:

        1) Filter dirty.
        2) Fan operating.
        3) Cooling operating.
        4) Heating operating.
        5) Smoke alarm.
        6) General alarm.
        7) <**Insert points**>.

    d. Digital Numeric Display:

        1) Outdoor airflow.
        2) Supply airflow.
        3) Outdoor dry-bulb temperature.
        4) Outdoor dew point temperature.
        5) Space temperature.
        6) Supply temperature.
        7) Space relative humidity.
        8) Space carbon dioxide level.
        9) <**Insert points**>.

6. Refrigeration System Controls:

a. Unit-mounted enthalpy controller is to lock out refrigerant system when outdoor-air enthalpy is less than [**28 Btu/lb (65 kJ/kg)**]<**Insert value**> of dry air or outdoor-air temperature is less than **60 deg F (15 deg C)** <**Insert value**>.
b. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than **60 deg F (15 deg C)** <**Insert value**>.
c. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than [**50**]<**Insert value**> percent.

7. Furnace Controls:

a. [**Factory-mounted sensor in supply outlet**][**Remote sensor for field installation in supply-air duct**] with sensor adjustment located in control panel to modulate gas furnace burner to maintain space temperature.
b. Wall-mounted, space-temperature sensor with [**temperature adjustment**][**unit-mounted temperature adjustment**][**adjustment on remote-control panel**] to modulate gas furnace burner to maintain space temperature.
c. Remote Setback: Adjustable room thermostat selected by timer, set at [**50 deg F (10 deg C)**]<**Insert temperature**>; cycles supply fan and gas furnace burner to maintain space temperature.
d. Burner Control: [**Two**][**Four**][**steps of control**][**Modulating**].

8. Rotary Heat-Exchanger Control:

a. Sequence with refrigeration system controls and heating controls.
b. For operation of rotary heat exchanger itself, see "Rotary Heat Exchanger" Paragraph above.

9. Electric-Resistance Heat Controls:

a. [**Factory-mounted sensor in unit discharge**][**Remote sensor for field installation in supply-air duct**] with sensor adjustment located in control panel to control electric coil to maintain temperature.
b. Wall-mounted, space-temperature sensor with [**temperature adjustment**][**unit-mounted temperature adjustment**][**adjustment on remote-control panel**] to control electric coil to maintain temperature.
c. Capacity Controls: [**On/off**][**Multiple steps**][**Modulating SCR**]<**Insert type**>.

10. Hot-Water and Steam Coil Controls, Discharge Temperature Sensor: [**Factory-mounted sensor in unit discharge**][**Remote sensor for field installation in supply-air duct**] with sensor adjustment located in control panel to modulate factory-[**mounted**][**furnished**] coil control valve to maintain temperature.
11. Hot-Water and Steam Coil Controls, Space Temperature Sensor: With [**temperature adjustment**][**unit-mounted temperature adjustment**][**adjustment on remote-control panel**] to modulate factory-[**mounted**][**furnished**] coil control valve to maintain temperature.
12. Damper Controls: Space-pressure sensor modulates outdoor- and relief-air dampers to maintain a positive pressure in space at a minimum of [**0.05 inch wg (12.4 Pa)**]<**Insert value**> with respect to outdoor reference.
13. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module is to be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links are to include the following:

a. Start/stop interface relay and relay to notify DDC temperature-control system alarm condition.
b. Hardware interface or additional sensors for the following:

1) Room temperature.
2) Discharge-air temperature.
3) Refrigeration system operation.
4) Furnace operation.

14. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

a. Hardwired Points:

1) Monitoring: On-off status, [**common trouble alarm**]<**Insert monitoring point**>.
2) Control: On-off operation, [**space temperature set-point adjustment**][**supply temperature set-point adjustment**][**space humidity set-point adjustment**][**space pressure set-point adjustment**]<**Insert control point**>.

b. [**ASHRAE 135 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC is to enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel are to be available through the DDC system for HVAC.

15. <**Insert additional control sequences and requirements**>.

O. Roof Curbs:

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC." Roof curbs with vibration isolators and wind restraints are specified in Section 230548.13 "Vibration Controls for HVAC."
2. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with National Roofing Contractors Association manuals for the specific type of roofing applicable to the Project.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C1071, Type I or II.
2) Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
3) Liner materials applied in this location are to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service air velocity.

3. Curb Dimensions: Height of [**14 inches (355 mm)**][**24 inches (610 mm)**][**36 inches (910 mm)**]<**Insert dimension**>.[**Provide adaptable horizontal dimensions as required for existing roof openings.**]
4. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

P. Intake And Relief Openings:

1. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
2. Materials: Match material and finish of casing exterior.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: **ASTM B209 (ASTM B209M)**.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat [**casing**][**coils**][**and**][**fan guards**] with a corrosion-resistant coating capable of withstanding a [**3,000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil**]<**Insert measurement**>.
4. Gloss: Minimum gloss of 50 gloss units on a single angle 60-degree meter.

2.5 SOURCE QUALITY CONTROL

A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.

C. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.

1. [**Test and rate fan performance in accordance with AMCA 210.**]
2. [**AMCA Fan Aerodynamic Certification Rating: Test, rate, and label, in accordance with AMCA 211.**]

D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

F. Damper Leakage and Air Performance:

1. [**Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.**]
2. [**AMCA Damper Certification: Test, rate, and label in accordance with AMCA 511.**]

G. Water Coils: Factory tested to **300 psig (2070 kPa)** in accordance with AHRI 410 and ASHRAE 33.

H. Refrigerant Coils: Factory tested to minimum [**300 psig (2070 kPa)**][**450 psig (3105 kPa)**] internal pressure and to minimum **300 psig (2070 kPa)** internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DEDICATED OUTDOOR-AIR UNITS

A. Roof Curb: Install on roof structure or concrete base, level and secure, in accordance with [**NRCA's "The NRCA Roofing Manual: Membrane Roof Systems"**][**AHRI Guideline B**]<**Insert reference document**>. Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

B. Unit Support: Install unit level on structural [**curbs**][**steel supports**]. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of [**curbs**][**steel supports**] with actual equipment provided.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

F. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

G. Comply with requirements for gas-fired furnace installation in NFPA 54.

H. Install separate devices furnished by manufacturer and not factory installed.

I. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to units, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Hot-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

E. Steam and Steam Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and provide inverted bucket steam trap at condensate return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

G. Gas Piping: Comply with requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Provide AGA-approved flexible connectors.

1. Connect gas piping to furnace, full size of gas train inlet, and connect with union[**, pressure regulator,**] and shutoff valve with sufficient clearance for burner removal and service.
2. Install AGA-approved flexible connectors.

H. Hydronic Piping Connections:

1. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Install shutoff valve and union or flange on each supply connection, and install balancing valve

and union or flange on each return connection.

I. Steam Piping Connections:

1. Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
2. Install shutoff valve and union or flange on each supply connection.
3. Install, starting from the coil connection, union or flange, strainer, union, float and thermostatic trap, union, and shutoff valve.

J. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

a. Measure gas pressure at manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.

c. Measure flue-gas temperature at furnace discharge.
d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

   a. High-limit heat exchanger.
   b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:

   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke[**and interlock with return-air dampers**].
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Relief-air flow.
    c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.7 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain units.

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SECTION 23 74 23 00 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, indirect-fired, outdoor, heating-only makeup air units.

1.2 ACTION SUBMITTALS

A. Product Data: For each outdoor, indirect, gas-fired, heating-only, makeup air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Fans:

   a. Include certified fan-performance curves with system operating conditions indicated.
   b. Include certified fan-sound power ratings.
   c. Include fan construction and accessories.
   d. Include motor ratings, electrical characteristics, and motor accessories.

5. Include filters with performance characteristics.
6. Include direct, gas-fired burners with performance characteristics.
7. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each outdoor, indirect, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the

qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates, for outdoor, indirect, gas-fired, makeup air units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Startup service reports.

F. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect, gas-fired, makeup air units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.
3. Fan Belts: [**One**]<**Insert number**> set(s) for each unit.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than [**one**]<**Insert number**> year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Indoor, indirect gas-fired, heating and ventilating units shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Discharge Configuration: [**Horizontal**][**Vertical**].
2. Airflow in CFM (L/s): <**Insert quantity**>.
3. External Static Pressure: <**Insert inches wg (kPa)**>.
4. Maximum RPM: <**Insert number**>.
5. Minimum Size: <**Insert inches (mm)**>.
6. Altitude: <**Insert feet (m)**>.

B. Fan Motor:

1. Horsepower: <**Insert value**>.
2. RPM: <**Insert value**>.
3. Service Factor: <**Insert value**>.
4. Speed: [**Single**][**Two**].

C. Single-Point Electrical Connection:

1. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

D. Indirect-Fired Gas Burner:

1. Minimum Combustion Efficiency: <**Insert percentage**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Airflow: <**Insert cfm (L/s)**>.
5. Gas Input: <**Insert MBh (kW)**>.
6. Burner Output: <**Insert MBh (kW)**>.
7. Number of Stages: <**Insert value**>.
8. Minimum Inlet Pressure: <**Insert inches wg (Pa)**>.
9. Maximum Inlet Pressure: <**Insert inches wg (Pa)**>.
10. Gas Piping Connection Size: <**Insert NPS (DN)**>.
11. Vent Diameter: <**Insert inches (mm)**>.

E. Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters in Filter Bank: <**Insert number**> wide by <**Insert number**> high.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.
9. Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance according to ASHRAE 52.2.

10. Minimum Efficiency Reporting Value:

    a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

2.3 PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]
3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Des Champs Technologies**]
9. [**Energy Jet U.S.**]
10. [**Engineered Air**]
11. [**Greenheck Fan Corporation**]
12. [**Hastings HVAC**]
13. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
14. [**Jackson & Church HVAC Global**]
15. [**LCSystems**]
16. [**Modine Manufacturing Company**]
17. [**Nortek Air Solutions**]
18. [**Powrmatic, Inc.**]
19. [**Rapid Engineering, Inc.**]
20. [**REZNOR, a brand of Nortek Global HVAC**]
21. [**Sterling HVAC Products; a Mestek company**]
22. [**Temprite, a brand of Mestek**]
23. [**Titan Air**]
24. [**Trane Inc.**]
25. [**Weather-Rite, a brand of Specified Air Solutions**]
26. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]
3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Des Champs Technologies**]
9. [**Energy Jet U.S.**]
10. [**Engineered Air**]
11. [**Greenheck Fan Corporation**]
12. [**Hastings HVAC**]
13. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
14. [**Jackson & Church HVAC Global**]
15. [**LCSystems**]
16. [**Modine Manufacturing Company**]
17. [**Nortek Air Solutions**]
18. [**Powrmatic, Inc.**]
19. [**Rapid Engineering, Inc.**]
20. [**REZNOR, a brand of Nortek Global HVAC**]
21. [**Sterling HVAC Products; a Mestek company**]
22. [**Temprite, a brand of Mestek**]

23. [**Titan Air**]
24. [**Trane Inc.**]
25. [**Weather-Rite, a brand of Specified Air Solutions**]
26. **<Insert manufacturer's name>**

C. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   c. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2. Configuration: Horizontal unit with [**top**][**horizontal**][**bottom**] discharge for [**roof-mounting**][**concrete-base**] installation.
3. Double-Wall Construction:

   a. Outside Casing Wall: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick, with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: [**Galvanized steel**]<**Insert material**>, solid, minimum [**14-gauge (0.759-mm)**]<**Insert number**> thick steel.
      2) Inside Casing, All Other Sections: [**Galvanized steel**]<**Insert material**>[**solid**][**perforated**] steel.

   c. Floor Plate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
   d. Casing Insulation:

      1) Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**]<**Insert insulation type**>.
      2) Casing Panel R-Value: Minimum <**Insert value**>.
      3) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
      4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

   e. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

4. Panels and Doors:

   a. Panels:

      1) Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
      2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
      3) Gasket: Neoprene, applied around entire perimeters of panel frames.
      4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

b. Doors:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

c. Locations and Applications:

1) Fan Section: [**Inspection and access panels**][**Doors**][**Doors and inspection and access panels**].
2) Access Section: Doors.
3) Gas-Fired Burner Section: [**Inspection and access panels**][**Doors**].
4) Damper Section: [**Inspection and access panels**][**Doors**].
5) Filter Section: [**Inspection and access panels**][**Doors**] large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

d. Service Light: 100-W vaporproof fixture with switched junction box located [**outside**][**inside**] adjacent to door.

1) Locations: [**Each section accessed with door**][**Fan section**]<**Insert location**>.

D. Outdoor-Air Intake Hood:

1. Type: Manufacturer's standard hood or louver.
2. Materials: Match cabinet.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Filter: Aluminum, **1 inch (25 mm)** cleanable.
5. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

E. Roof Curbs:

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C 1071, Type I or Type II.
2) Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C 916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when

applied as recommended by manufacturer and without causing leakage in cabinet.

3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

3. Curb Height: [**14 inches (355 mm)**][**24 inches (610 mm)**][**36 inches (910 mm)**]<**Insert dimension**>.
4. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

F. Fans, Drives, and Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.
b. Shaft Bearings: Heavy-duty[**, self-aligning, permanently lubricated ball bearings**][**, pillow-block bearings**] with an [**L50**]<**Insert bearing life rating**> rated life of [**100,000**]<**Insert number**> hours according to ABMA 9.
c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
d. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
e. Shaft Lubrication Lines: Extended to a location outside the casing.
f. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drives: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
d. Enclosure Materials: [**Cast iron**]<**Insert material**>.

e. Motor Bearings: <**Insert requirements**>.
f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.
h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

G. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Cleanable Filters:

a. Cleanable metal mesh.

4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
5. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized steel**]<**Insert material**> track.

1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

H. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed **4 cfm/sq. ft. (20 L/s per sq. m)** at **1-inch wg (250 Pa)** and **8**

cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa) rated in accordance with AMCA 500D).

3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   c. Operator Motors:

      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
   f. Size dampers for running torque calculated as follows:

      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

   g. Coupling: V-bolt and V-shaped, toothed cradle.
   h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
   j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
   k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
   l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   m. Temperature Rating: [Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)][40 to 104 deg F (5 to 40 deg C)].
   n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

I. Indirect-Fired Gas Burner:

   1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].

    a. Rated Minimum Turndown Ratio: [**30 to 1**]<**Insert ratio**>.
    b. Fuel: [**Natural**][**Propane**] gas.
    c. Ignition: Electronically controlled electric spark with flame sensor.
    d. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
    e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, [**hydraulic**][**electronic**]-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
    f. High-Altitude Model Kit: For Project elevations more than **2000 feet (610 m)** above sea level.

4. Venting, Gravity: Gravity vented.
5. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
6. Heat Exchanger: [**Aluminized**][**Stainless**] steel.
7. Heat-Exchanger Drain Pan: Stainless steel.
8. Safety Controls:

    a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.
    b. Vent Flow Verification: [**Differential pressure switch to verify open vent**][**Flame rollout switch**].
    c. High Limit: Thermal switch or fuse to stop burner.
    d. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
    e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
    f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
    g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
    h. Control Transformer: 24 V ac.

J. Unit Control Panel:

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: [**Surface-mounted**][**Recessed, with trim ring,**] remote panel, with engraved plastic cover and the following lights and switches:

    a. [**On-off**][**On-off-auto**] fan switch.
    b. Heat-vent-off switch.
    c. Supply-fan operation indicating light.
    d. Heating operation indicating light.
    e. Thermostat.
    f. Damper position potentiometer.
    g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
    h. Safety-lockout indicating light.
    i. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Explosion proof**].

K. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.

2. Control Devices:

    a. Remote Thermostat: Adjustable room thermostat with temperature readout.
    b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
    c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than **75 deg F (24 deg C)** above normal maximum operating temperature.
    e. Timers, Seven Day:

        1) Programming-switch timer with synchronous-timing motor and seven-day dial.
        2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.
        3) Multiple-switch trippers.
        4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

    f. Timers, Solid State:

        1) Programmable time control with four separate programs.
        2) 24-hour battery carryover; individual on-off-auto switches for each program.
        3) 365-day calendar with 20 programmable holidays.
        4) Choice of fail-safe operation for each program.
        5) System fault alarm.

    g. Ionization-Type Smoke Detectors:

        1) 24-V dc, nominal.
        2) Self-restoring.
        3) Plug-in arrangement.
        4) Integral visual-indicating light.
        5) Sensitivity that can be tested and adjusted in place after installation.
        6) Integral addressable module.
        7) Remote controllability.
        8) Responsive to both visible and invisible products of combustion.
        9) Self-compensating for changes in environmental conditions.

3. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Fan Control, Timer: Timer starts and stops indirect-fired heating and ventilating unit and exhaust fan(s).
5. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
6. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers shall modulate to supply minimum outdoor air as follows:

    a. Minimum [**30**]<**Insert number**> percent outdoor air.
    b. Outdoor-air quantity adjusted by potentiometer on control panel.
    c. Outdoor-air quantity to maintain minimum building static pressure.

7. Temperature Control:

    a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.

b. Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor[**with temperature adjustment,**][**and unit-mounted control adjustment**][**and adjustment on remote-control panel**].
c. Timer shall select remote setback thermostat to maintain space temperature at [**50 deg F (10 deg C)**]<**Insert temperature**>.
d. Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.
e. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

8. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

a. Hardwired Points:

1) Room temperature.
2) Discharge-air temperature.
3) Burner operating.

b. [**ASHRAE 135.1 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

L. Accessories:

1. Electric heater with integral thermostat maintains minimum **50 deg F (10 deg C)** temperature in gas burner compartment.
2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.[**Outlet shall be energized even if the unit main disconnect is open.**]
3. Low-ambient kit using [**staged**][**damper on**][**variable-speed**] condenser fans for operation down to [**35 deg F (1.7 deg C)**]<**Insert temperature**>.
4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
5. Coil guards of painted, galvanized-steel wire.
6. Hail guards of galvanized steel, painted to match casing.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to [**NRCA's "NRCA Roofing Manual: Membrane Roof Systems."**][**AHRI Guideline B.**] Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment.

B. Unit Support: Install unit level on structural [**curbs**][**steel supports**]. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of [**curbs**][**steel supports**] with actual equipment provided.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install gas-fired units in accordance with NFPA 54.

D. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.

C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCTWORK CONNECTIONS

A. Duct Connections: Connect supply[**and return**] ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to burner combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators[**and seismic restraints**].
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
12. Verify drain-pan performance.
13. Verify outdoor-air damper operation.

3.8 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing makeup air unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

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SECTION 23 74 23 13 - PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, direct-fired, outdoor, heating-only makeup-air units.

1.2 ACTION SUBMITTALS

A. Product Data: For each outdoor, direct, gas-fired heating-only, makeup air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

   a. Include certified fan-performance curves with system operating conditions indicated.
   b. Include certified fan-sound power ratings.
   c. Include fan construction and accessories.
   d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include filters with performance characteristics.
7. Include direct, gas-fired burners with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each outdoor, direct, gas-fired, heating-only, makeup air unit.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation[**and seismic restraints**] indicated to comply with

performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for outdoor, direct, gas-fired, heating-only, makeup air units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Startup service reports.

F. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For direct, gas-fired, heating-only, makeup air units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) for each unit.
2. Gaskets: [**One**]<**Insert number**> set(s) for each access door.

3. Fan Belts: [**One**]<**Insert number**> set(s) for each unit.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than [**one**]<**Insert number**> year(s) from date of Substantial Completion.
2. Warranty Period for Burners: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Indoor, indirect gas-fired, heating and ventilating units shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Discharge Configuration: [**Horizontal**][**Vertical**].
2. Airflow in CFM (L/s): <**Insert quantity**>.
3. External Static Pressure: <**Insert inches wg (kPa)**>.

4. Maximum RPM: <**Insert number**>.
5. Minimum Size: <**Insert inches (mm)**>.
6. Altitude: <**Insert feet (m)**>.

B. Fan Motor:

1. Horsepower: <**Insert value**>.
2. RPM: <**Insert value**>.
3. Service Factor: <**Insert value**>.
4. Speed: [**Single**][**Two**].

C. Single-Point Electrical Connection:

1. Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**> A.
5. Minimum Circuit Ampacity: <**Insert value**> A.
6. Maximum Overcurrent Protection: <**Insert value**> A.

D. Direct-Fired Gas Burner:

1. Minimum Combustion Efficiency: <**Insert percentage**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Airflow: <**Insert cfm (L/s)**>.
5. Gas Input: <**Insert MBh (kW)**>.
6. Burner Output: <**Insert MBh (kW)**>.
7. Number of Stages: <**Insert value**>.
8. Minimum Inlet Pressure: <**Insert inches wg (Pa)**>.
9. Maximum Inlet Pressure: <**Insert inches wg (Pa)**>.
10. Gas Piping Connection Size: <**Insert NPS (DN)**>.
11. Vent Diameter: <**Insert inches (mm)**>.

E. Filters:

1. Type: <**Insert type**>.
2. Face Dimensions, Each: <**Insert inches by inches (mm by mm)**>.
3. Depth: <**Insert inches (mm)**>.
4. Number of Filters, Wide by High: <**Insert number**>.
5. Access Location: [**Side**]<**Insert location**>.
6. Maximum or Rated Face Velocity: <**Insert fpm (m/s)**>.
7. Initial Resistance: <**Insert inches wg (Pa)**>.
8. Recommended Final Resistance: <**Insert inches wg (Pa)**>.

F. Minimum Efficiency Reporting Value and Average Arrestance:

1. MERV Rating and Corresponding Average Arrestance: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**], and corresponding average arrestance according to ASHRAE 52.2.

G. Minimum Efficiency Reporting Value:

1. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

2.3 PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]
3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Energy Jet U.S.**]
9. [**Engineered Air**]
10. [**Greenheck Fan Corporation**]
11. [**Hastings HVAC**]
12. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
13. [**Jackson & Church HVAC Global**]
14. [**LCSystems**]
15. [**Modine Manufacturing Company**]
16. [**Powrmatic, Inc.**]
17. [**Rapid Engineering, Inc.**]
18. [**REZNOR, a brand of Nortek Global HVAC**]
19. [**Sterling HVAC Products; a Mestek company**]
20. [**Temprite, a brand of Mestek**]
21. [**Titan Air**]
22. [**Trane Inc.**]
23. [**Weather-Rite, a brand of Specified Air Solutions**]
24. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AbsolutAire, Inc.**]
2. [**Applied Air, a Mestek company**]
3. [**Bananza; a brand of Specified Air Solutions**]
4. [**BessamAire, Inc.**]
5. [**Cambridge Air Solutions**]
6. [**Cambridge Engineering, Inc**]
7. [**CaptiveAire Systems**]
8. [**Energy Jet U.S.**]
9. [**Engineered Air**]
10. [**Greenheck Fan Corporation**]
11. [**Hastings HVAC**]
12. [**I.C.E. Manufacturing Ltd.; Industrial Commercial Equipment - I.C.E. (US), Inc.**]
13. [**Jackson & Church HVAC Global**]
14. [**LCSystems**]
15. [**Modine Manufacturing Company**]
16. [**Powrmatic, Inc.**]
17. [**Rapid Engineering, Inc.**]
18. [**REZNOR, a brand of Nortek Global HVAC**]
19. [**Sterling HVAC Products; a Mestek company**]
20. [**Temprite, a brand of Mestek**]
21. [**Titan Air**]

22. [**Trane Inc.**]
23. [**Weather-Rite, a brand of Specified Air Solutions**]
24. <**Insert manufacturer's name**>

C. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   c. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2. Configuration: Horizontal unit with [**top**][**horizontal**][**bottom**] discharge for [**roof-mounting**][**concrete-base**] installation.
3. Double-Wall Construction:

   a. Outside Casing Wall: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick, with [**manufacturer's standard finish**]<**Insert special coating**>.
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: [**Galvanized steel**]<**Insert material**>, solid, minimum [**14-gauge- (0.759-mm-)**]<**Insert number**> thick steel.
      2) Inside Casing, All Other Sections: [**Galvanized steel**]<**Insert material**>[**solid**][**perforated**] steel.

   c. Floor Plate: [**Galvanized steel**]<**Insert material**>, minimum [**18 gauge (1.3 mm)**]<**Insert value**> thick.
   d. Casing Insulation:

      1) Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**]<**Insert insulation type**>.
      2) Casing Panel R-Value: Minimum <**Insert value**>.
      3) Insulation Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**].
      4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

   e. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

4. Panels and Doors:

   a. Panels:

      1) Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
      2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
      3) Gasket: Neoprene, applied around entire perimeters of panel frames.
      4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

b. Doors:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

c. Locations and Applications:

1) Fan Section: [**Inspection and access panels**][**Doors**][**Doors and inspection and access panels**].
2) Access Section: Doors.
3) Gas-Fired Burner Section: [**Inspection and access panels**][**Doors**].
4) Damper Section: [**Inspection and access panels**][**Doors**].
5) Filter Section: [**Inspection and access panels**][**Doors**] large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

d. Service Light: 100-W vaporproof fixture with switched junction box located [**outside**][**inside**] adjacent to door.

1) Locations: [**Each section accessed with door**][**Fan section**]<**Insert location**>.

D. Outdoor-Air Intake Hood:

1. Type: Manufacturer's standard hood or louver.
2. Materials: Match cabinet.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Filter: Aluminum, [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**> cleanable.
5. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

E. Roof Curbs:

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C1071, Type I or Type II.
2) Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when

applied as recommended by manufacturer and without causing leakage in cabinet.

3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

3. Curb Height: [**14 inches (355 mm)**][**24 inches (610 mm)**][**36 inches (910 mm)**]<**Insert dimension**>.
4. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

F. Fans, Drives, and Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.
b. Shaft Bearings: Heavy-duty[**, self-aligning, permanently lubricated ball bearings**][**, pillow-block bearings**] with an [**L50**]<**Insert bearing life rating**> rated life of [**100,000**]<**Insert number**> hours according to ABMA 9.
c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
d. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**]<**Insert dimension**>.
e. Shaft Lubrication Lines: Extended to a location outside the casing.
f. Flexible Connector: Factory fabricated with a fabric strip minimum **3-1/2 inches (89 mm)** wide, attached to two strips of minimum **2-3/4-inch- (70-mm-)** wide by **0.028-inch- (0.7-mm-)** thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drives: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with [**1.5**][**1.25**] service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146-inch- (2.7-mm-)**]<**Insert dimension**> thick, [**3/4-inch (20-mm)**]<**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame; prime coated.

4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**]<**Insert type**>.
d. Enclosure Materials: [**Cast iron**]<**Insert material**>.

e. Motor Bearings: <**Insert requirements**>.
f. Unusual Service Conditions:

1) Ambient Temperature: <**Insert deg C**>.
2) Altitude: <**Insert feet (m)**> above sea level.
3) High humidity.
4) <**Insert conditions**>.

g. Efficiency: Premium efficient as defined in NEMA MG 1.
h. NEMA Design: <**Insert designation**>.
i. Motor Pulleys: Adjustable pitch for use with [**5**]<**Insert number**>-hp motors and smaller; fixed pitch for use with motors larger than [**5**]<**Insert number**> hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

G. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

a. Description: [**Flat, non-pleated**][**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: [**Beverage board**]<**Insert material**> with perforated metal retainer, or metal grid, on outlet side.

3. Cleanable Filters:

a. Cleanable metal mesh.

4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
5. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [**Galvanized steel**]<**Insert material**> track.

1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

H. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**]<**Insert material**> dampers with compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement with [**zinc-plated**]steel operating rods rotating in [**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**]<**Insert material**> frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed **4 cfm/sq. ft. (20 L/s per sq. m)** at **1-inch wg (250 Pa)** and **8**

cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa) rated in accordance with AMCA 500D.

3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   c. Operator Motors:

      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
   f. Size dampers for running torque calculated as follows:

      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

   g. Coupling: V-bolt and V-shaped, toothed cradle.
   h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
   j. Power Requirements (Two-Position Spring Return): [**24 V dc**][**120 V ac**][**230 V ac**].
   k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
   l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   m. Temperature Rating: [**Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)**][**40 to 104 deg F (5 to 40 deg C)**].
   n. Run Time: [**12 seconds open, 5 seconds closed**][**30 seconds**][**60 seconds**][**120 seconds**].

I. Direct-Fired Gas Burner:

   1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: [**Aluminized steel with stainless steel inserts**][**Stainless steel**].

    a. Rated Minimum Turndown Ratio: [**30 to 1**]<**Insert ratio**>.
    b. Fuel: [**Natural**][**Propane**] gas.
    c. Ignition: Electronically controlled electric spark with flame sensor.
    d. Gas Control Valve: [**Single stage**][**Two stage**][**Modulating**].
    e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, [**hydraulic**][**electronic**]-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
    f. High-Altitude Model Kit: For Project elevations more than **2000 feet (610 m)** above sea level.

4. Safety Controls:

    a. Gas Manifold: Safety switches and controls complying with ANSI standards [**and**][**FM Global**]<**Insert insurer**>.
    b. Vent Flow Verification: [**Differential pressure switch to verify open vent**][**Flame rollout switch**].
    c. High Limit: Thermal switch or fuse to stop burner.
    d. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
    e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
    f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
    g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
    h. Control Transformer: 24 V ac.

J. Unit Control Panel:

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: [**Surface-mounted**][**Recessed, with trim ring,**] remote panel, with engraved plastic cover and the following lights and switches:

    a. [**On-off**][**On-off-auto**] fan switch.
    b. Heat-vent-off switch.
    c. Supply-fan operation indicating light.
    d. Heating operation indicating light.
    e. Thermostat.
    f. Damper position potentiometer.
    g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
    h. Safety-lockout indicating light.
    i. Enclosure: NEMA 250, [**Type 1**][**Type 3R**][**Type 4**][**Explosion proof**].

K. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
2. Control Devices:

    a. Remote Thermostat: Adjustable room thermostat with temperature readout.
    b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.

c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than **75 deg F (24 deg C)** above normal maximum operating temperature.
e. Timers, Seven Day:

1) Programming-switch timer with synchronous-timing motor and seven-day dial.
2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.
3) Multiple-switch trippers.
4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

f. Timers, Solid State:

1) Programmable time control with four separate programs.
2) 24-hour battery carryover.
3) Individual on-off-auto switches for each program.
4) 365-day calendar with 20 programmable holidays.
5) Choice of fail-safe operation for each program.
6) System fault alarm.

g. Ionization-Type Smoke Detectors:

1) 24-V dc, nominal.
2) Self-restoring.
3) Plug-in arrangement.
4) Integral visual-indicating light.
5) Sensitivity that can be tested and adjusted in place after installation.
6) Integral addressable module.
7) Remote controllability.
8) Responsive to both visible and invisible products of combustion.
9) Self-compensating for changes in environmental conditions.

3. Fan Control, Interlocked: Fan to start with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Fan Control, Timer: Timer starts and stops direct-fired heating and ventilating unit and exhaust fan(s).
5. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
6. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers shall modulate to supply minimum outdoor air as follows:

a. Minimum [**30**]<**Insert number**> percent outdoor air.
b. Outdoor-air quantity adjusted by potentiometer on control panel.
c. Outdoor-air quantity to maintain minimum building static pressure.

7. Temperature Control:

a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
b. Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor[**with temperature adjustment,**][**and unit-mounted control adjustment**][**and adjustment on remote-control panel**].

c. Timer shall select remote setback thermostat to maintain space temperature at [**50 deg F (10 deg C)**]<**Insert temperature**>.
d. Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.
e. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

8. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

a. Hardwired Points:

1) Room temperature.
2) Discharge-air temperature.
3) Burner operating.

b. [**ASHRAE 135.1 (BACnet)**][**LonTalk**][**Modbus**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

L. Accessories:

1. Electric heater with integral thermostat maintains minimum **50 deg F (10 deg C)** temperature in gas burner compartment.
2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.[**Outlet shall be energized even if the unit main disconnect is open.**]
3. Low-ambient kit using [**staged**][**damper on**][**variable-speed**] condenser fans for operation down to [**35 deg F (1.7 deg C)**]<**Insert temperature**>.
4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
5. Coil guards of painted, galvanized-steel wire.
6. Hail guards of galvanized steel, painted to match casing.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of piping and electrical connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to [**NRCA's "NRCA Roofing Manual: Membrane Roof Systems."**][**AHRI Guideline B.**] Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment.

B. Unit Support: Install unit level on structural [**curbs**][**steel supports**]. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of [**curbs**][**steel supports**] with actual equipment provided.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

D. Install controls and equipment shipped by manufacturer for field installation with direct-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.

C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCT CONNECTIONS

A. Duct Connections: Connect supply[**and return**] ducts to direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to burner combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators[**and seismic restraints**].
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
12. Verify drain-pan performance.
13. Verify outdoor-air damper operation.

3.8 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing makeup air unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 23 74 23 13

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Task	Specification	Specification Description
23 74 23 13	23 74 23 00	Packaged, Indirect-Fired, Outdoor, Heating-Only Makeup-Air Units

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SECTION 23 81 00 00 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: VRF HVAC systems.

1. VRF indoor units.
2. VRF outdoor units.
3. System controls.
4. System refrigerant and oil.
5. VRF system condensate drain piping.
6. System hydronic piping.
7. System refrigerant piping.
8. Metal hangers and supports.
9. Metal strut support systems.
10. Fastener systems.
11. Rooftop-mounted strut support systems.
12. Equipment stands, outdoor type.
13. Piping and tubing insulation.
14. System control cable.

1.2 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as "branch circuit controller," "branch selector box," "changeover box," "flow selector unit," "mode change unit," and other such terms.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from HVAC equipment.

G. Three-Pipe System Design: One high-pressure refrigerant vapor line, one low-pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

H. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high- and low-pressure refrigerant between indoor units.

I. VRF: Variable refrigerant flow.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert location**> .

1.4 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units [**and for HRCUs**] .
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit [**and HRCU**] control.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.

1. Include a Sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.

D. Delegated Design Submittals:

1. Include design calculations for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.
2. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
3. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
4. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

E. Sustainable Design Submittals:

1. Product Data: Indicating compliance with minimum energy performance requirements.
2. Product Data: For minimum energy performance.
3. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
4. Product data indicating compliance with ASHRAE/IES 90.1.
5. Air-Balance Report: Documentation indicating that the Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
6. TAB Report: Documentation indicating that the Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
7. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes v1.4, Section 3.1.2.4 - "IAQ during Construction."
8. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
9. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
10. Product Data for EA Credit "Optimize Energy Performance": Indicating that system complies with efficiency requirements.
11. Product Data for EA Credit "Enhanced Refrigerant Management": Indicating that products comply with requirements for refrigerant management.
12. Product Data for EA Credit "Enhanced Refrigerant Management": Indicating that products comply with requirements for refrigerant management.
13. Product Data: For continuous metering equipment for energy consumption.
14. Product Data for EA Credit "Advanced Energy Metering": For continuous metering equipment.
15. Product Data: For continuous metering equipment for energy consumption.
16. Product Data for EQ Credit "Acoustic Performance": Documentation indicating that systems and equipment comply.
17. Product Data for EQ Credit "Acoustic Performance": Documentation indicating that systems and equipment comply.
18. Thermal Comfort: Product data indicating that systems, equipment, and controls comply.
19. Thermal Comfort: Product data indicating that systems, equipment, and controls comply.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, [**ductwork,**] cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Service access panels.

B. Product Certificates: For VRF HVAC system components.

C. Product Test Reports: Where tests are required, for each product, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**or**][**a qualified testing agency**] .

D. Source Quality Control Reports: For specified tests and inspections.

E. Field Quality Control Reports: For specified tests and inspections.

F. Qualification Statements:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

    a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

G. Seismic Qualification Statements: Certificates, for equipment, <**Insert products,**> accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Equipment Anchorage Devices" Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

H. Sample Warranties: For specified special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.

4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**, from the same production run,**] to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. [**One**]<**Insert number**> set(s) for each unit with replaceable filters.
b. [**One**]<**Insert number**> set(s) for each unit type and unique size of washable filters.

2. Indoor Units: [**One**]<**Insert number**> for each unique size and type installed.
3. Controllers for Indoor Units: [**One**]<**Insert number**> for each unique controller type installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of [**five**][**10**]<**Insert number**> years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least [**three**][**five**]<**Insert number**> completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within <**Insert distance**> of Project.
3. Demonstrated past experience with products being installed for period within [**three**][**five**]<**Insert number**> consecutive years before time of bid.
4. Demonstrated past experience on [**five**]<**Insert number**> projects of similar complexity, scope, and value.

a. Each person assigned to Project must have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support ongoing system operation for a period of not less than [**five**]<**Insert number**> years after Substantial Completion.
8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's

corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee must be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification must be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project must have demonstrated past experience.

a. Demonstrated past experience with products being installed for period within [**three**][**five**]<**Insert number**> consecutive years before time of bid.
b. Demonstrated past experience on [**five**]<**Insert number**> projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer are to be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 MOCKUPS

A. Build mockups to set quality standards for materials and execution.

1. Build mockups to show a finished installation for each of the following applications:

a. For each different indoor unit type with exposed surfaces viewable by occupants.

2. Mockups are to be operational.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: [**Five**][**Seven**][**10**]<**Insert number**> year(s) from date of Substantial Completion.
b. For Parts, Including Controls: [**Five**][**Seven**][**10**]<**Insert number**> year(s) from date of Substantial Completion.
c. For Labor: [**Five**][**Seven**][**10**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional [**engineer**][**specialist**] , as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s).

1. Provide system refrigerant calculations.

a. Refrigerant concentration limits must be within allowable limits of ASHRAE 15 and governing codes.
b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
3. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units [**, HRCUs,**] and outdoor unit(s) in compliance with manufacturer requirements and requirements.
b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

4. System Controls:

a. Network arrangement.
b. Network interface with other building systems.

c. Product selection.
d. Sizing.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an **18-inch (450-mm)** reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated in accordance with manufacturer's written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.

1. Future changes to system(s) are indicated on Drawings.
2. Each branch circuit is to accommodate addition of [**one**][**two**]<**Insert number**> indoor unit(s) with unit capacity equal to [**largest**][**smallest**][**average**]<**Insert capacity requirement**> indoor unit connected to the branch circuit.
3. Each branch circuit is to accommodate deletion of [**one**][**two**]<**Insert number**> indoor unit(s) with unit capacity equal to [**largest**][**smallest**][**average**]<**Insert capacity requirement**> indoor unit connected to the branch circuit.

E. Isolation of Equipment: Provide isolation valves to isolate each [**HRCU,**] indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

F. System Capacity Ratio: The sum of connected capacity of all indoor units is to be within the following range of outdoor-unit rated capacity:

1. Not less than [**50**][**60**]<**Insert number**> percent.
2. Not more than [**130**][**150**]<**Insert number**> percent.
3. Range acceptable to manufacturer.

G. System Turndown: Stable operation down to [**20**]<**Insert number**> percent of outdoor-unit capacity.

H. System Auto Refrigerant Charge: Each system is to have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. AHRI Compliance: System and equipment performance certified in accordance with AHRI 1230 [**and**

products listed in AHRI directory] .

K. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1: For system and component energy efficiency.

L. UL Compliance: Comply with UL 1995.

M. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

   a. Design equipment and supports to withstand wind loads of governing code [**and ASCE/SEI 7**]<**Insert requirement**> .
   b. Design equipment and supports to withstand snow and ice loads of governing code [**and ASCE/SEI 7**]<**Insert requirement**> .
   c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

2. Maximum System Operating Outdoor Temperature: [**See Drawings**]<**Insert value**> .
3. Minimum System Operating Outdoor Temperature: [**See Drawings**]<**Insert value**> .

N. Seismic Performance: VRF HVAC system(s) is to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> .

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified [**and the system will be fully operational after the seismic event**] ."
2. Component Importance Factor: [**1.5**][**1.0**]<**Insert value**> .
3. Component Amplification Factor: <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**> .

O. Sound Performance: Sound levels generated by operating HVAC equipment must be within requirements indicated.

1. Indoor: [**See Drawings.**][**Within design guidelines of "2023 ASHRAE Handbook - HVAC Applications."**]<**Insert values.**>
2. Outdoor: [**See Drawings**][**Within ordinance of governing authorities**]<**Insert values**> .

P. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

Q. Capacities and Characteristics: As indicated on Drawings.

2.2 VRF HVAC SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]

2. [**Daikin Applied**]
3. [**Fujitsu General America, Inc.**]
4. [**Johnson Controls, Inc.**]
5. [**Lennox**]
6. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
7. [**Mitsubishi Electric Cooling and Heating**]
8. [**Panasonic Corporation of North America**]
9. [**Samsung HVAC**]
10. [**Trane Inc.**]
11. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Fujitsu General America, Inc.**]
4. [**Johnson Controls, Inc.**]
5. [**Lennox**]
6. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
7. [**Mitsubishi Electric Cooling and Heating**]
8. [**Panasonic Corporation of North America**]
9. [**Samsung HVAC**]
10. [**Trane Inc.**]
11. **<Insert manufacturer's name>**

C. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. HRCUs.
4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.

D. System Description: Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System is to consist of multiple indoor units, [**HRCUs,**] outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. [**Two-pipe**][**or**][**three-pipe**] system design.
2. System(s) operation, [**air conditioning**][**heat pump**][**or**][**heat recovery**] as indicated on Drawings.
3. Each system has one refrigerant circuit shared by all indoor units connected to system.

E. VRF Indoor Units:

1. VRF Indoor Unit - Concealed, Ceiling-Mounted Units for Ducting:

   a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
   b. Cabinet:

      1) Material: [**Galvanized**][**or**][**painted**] steel.

2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4) Mounting: Manufacturer-designed provisions for field installation.
5) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
d) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2) Efficiency: [**ASHRAE 52.2, MERV 7**][**ASHRAE 52.2, MERV 11**][**ASHRAE 52.2, MERV 13**]<**Insert efficiency**> .
3) Media: [**If more than one filter type is indicated, Contractor has option to**

choose.]

a) Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
b) Washable: Manufacturer's standard filter with antimicrobial treatment.

g. Unit Accessories:

1) Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
2) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

h. Unit Controls:

1) Enclosure: Metal, suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Unit inlet air temperature.
b) Coil entering refrigerant temperature.
c) Coil leaving refrigerant temperature.

4) Field-Customizable I/O Capability:

a) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
b) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
c) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

5) Features and Functions:

a) Self-diagnostics.
b) Time delay.
c) Auto-restart.
d) External static pressure control.
e) Auto operation mode.
f) Manual operation mode.
g) Filter service notification.
h) Power consumption display.
i) Drain-assembly, high-water-level safety shutdown and notification.
j) Run test switch.

6) Communication: Network communication with other indoor and outdoor units.
7) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

i. Unit Electrical:

1) Enclosure: Metal, suitable for indoor locations.
2) Field Connection: Single-point connection to power unit and integral controls.

3) Disconnecting Means: Factory-mounted circuit breaker or switch.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways.

2. VRF Indoor Unit - Concealed, Floor-Mounted Units For Ducting:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
b. Cabinet:

1) Material: [**Galvanized**][**or**][**painted**] steel.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4) Mounting: Manufacturer-designed provisions for field installation.
5) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Materials: Non-ferrous components or ferrous components with corrosion-resistant finish.
d) Statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2) Efficiency: [**ASHRAE 52.2, MERV 7**][**ASHRAE 52.2, MERV 11**][**ASHRAE 52.2, MERV 13**]<**Insert efficiency**> .
3) Media: [**If more than one filter type is indicated, Contractor has option to choose.**]

a) Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
b) Washable: Manufacturer's standard filter with antimicrobial treatment.

g. Unit Accessories:

1) Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
2) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

h. Unit Controls:

1) Enclosure: Metal, suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.

i. Factory-Installed Sensors:

1) Unit inlet air temperature.
2) Coil entering refrigerant temperature.
3) Coil leaving refrigerant temperature.

j. Field-Customizable I/O Capability:

1) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
2) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
3) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

k. Features and Functions:

1) Self-diagnostics.
2) Time delay, auto-restart.
3) External static pressure control.
4) Auto operation mode.
5) Manual operation mode.

6) Filter service notification.
7) Power consumption display.
8) Drain-assembly, high-water-level safety shutdown and notification.
9) Run test switch.

l. Communication: Network communication with other indoor units and outdoor unit(s).
m. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
n. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
o. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Field Connection: Single-point connection to power unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways.

3. VRF Indoor Unit - Exposed, Floor Mounted:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
b. Cabinet:

1) Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Gravity.

a) If a floor drain is not available at unit, provide unit with field-installed

condensate pump accessory.

3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Materials: Non-ferrous components or ferrous components with corrosion-resistant finish.
d) Statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Front, to accommodate filter replacement without the need for tools.
2) Efficiency: <**Insert efficiency**> .
3) Washable Media: Manufacturer's standard filter with antimicrobial treatment.

g. Grille Assembly: Manufacturer's standard discharge grille [**with field-adjustable air pattern**] mounted in top of unit cabinet.

h. Unit Accessories:

1) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2) Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

i. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Unit inlet air temperature.
b) Coil entering refrigerant temperature.
c) Coil leaving refrigerant temperature.

4) Field-Customizable I/O Capability:

a) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
b) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
c) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable

control strategies.

5) Features and Functions:

a) Self-diagnostics.
b) Time delay.
c) Auto-restart.
d) External static pressure control.
e) Auto operation mode.
f) Manual operation mode.
g) Filter service notification
h) Power consumption display.
i) Drain-assembly, high-water-level safety shutdown and notification.
j) Run test switch.

6) Communication: Network communication with other indoor units and outdoor unit(s).
7) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

j. Unit Electrical:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways.

4. VRF Indoor Unit - Exposed, Wall Mounted:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
b. Cabinet:

1) Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to

prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Gravity.

a) If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Front, to accommodate filter replacement without the need for tools.
2) Efficiency: <**Insert efficiency**> .
3) Washable Media: Manufacturer's standard filter with antimicrobial treatment.

g. Grille Assembly: Manufacturer's standard discharge grille [**with field-adjustable air pattern**] mounted in top [**or front face**] of unit cabinet.

h. Unit Accessories:

1) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2) Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

i. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors: [**Unit inlet air temperature**][**Coil entering refrigerant temperature**][**Coil leaving refrigerant temperature**]<**Insert sensor**> .

4) Field-Customizable I/O Capability:

a) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
b) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
c) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

5) Features and Functions: Self-diagnostics, time delay, auto-restart [**, external static pressure control**][**, auto operation mode**][**, manual operation mode**][**, filter service notification**][**, power consumption display**][**, drain-assembly, high-water-level safety shutdown and notification**][**, run test switch**]<**Insert function**> .
6) Communication: Network communication with other indoor units and outdoor unit(s).
7) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

j. Unit Electrical:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

5. VRF Indoor Unit - Recessed, Ceiling Mounted:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
b. Cabinet:

1) Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5) Internal Tubing: Copper tubing with brazed joints.
6) Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Bottom, to accommodate filter replacement without the need for tools.
2) Efficiency: [**ASHRAE 52.2, MERV 7**][**ASHRAE 52.2, MERV 11**][**ASHRAE 52.2, MERV 13**]<**Insert efficiency**> .
3) Media: [**If more than one filter type is indicated, Contractor has option to choose.**]

a) Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
b) Washable: Manufacturer's standard filter with antimicrobial treatment.

g. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1) Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
2) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
3) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
4) Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
5) Additional Branch Supply Duct Connection: Sheet metal knockout for optional

connection to one additional supply branch duct.

h. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.
i. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.
j. Unit Accessories:

1) Outdoor Air Ventilation Kit: Connection, motorized damper, and control to satisfy unit control sequence of operation indicated on Drawings.
2) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

k. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.

l. Factory-Installed Sensors: [**Unit inlet air temperature**][**Coil entering refrigerant temperature**][**Coil leaving refrigerant temperature**]<**Insert sensor**> .
m. Field-Customizable I/O Capability:

1) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
2) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
3) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

n. Features and Functions: Self-diagnostics, time delay, auto-restart [**, external static pressure control**][**, auto operation mode**][**, manual operation mode**][**, filter service notification**][**, power consumption display**][**, drain-assembly, high-water-level safety shutdown and notification**][**, run test switch**]<**Insert function**> .
o. Communication: Network communication with other indoor units and outdoor unit(s).
p. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
q. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
r. Unit Electrical:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

6. VRF Indoor Unit - Suspended, Ceiling-Mounted:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
b. Cabinet:

1) Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Internal Tubing: Copper tubing with brazed joints.
6) Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Gravity.

a) If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

e. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

f. Filter Assembly:

1) Access: Front, to accommodate filter replacement without the need for tools.

2) Efficiency: <**Insert efficiency**> .
3) Washable Media: Manufacturer's standard filter with antimicrobial treatment.

g. Discharge-Air Grille Assembly: Mounted in front of unit cabinet.

1) Discharge Pattern: One-way throw.
2) Discharge Pattern Adjustment: Field-adjustable limits for range of pattern.
3) Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

h. Return-Air Grille Assembly: Manufacturer's standard.
i. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.
j. Unit Accessories:

1) Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2) Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

k. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors: [**Unit inlet air temperature**][**Coil entering refrigerant temperature**][**Coil leaving refrigerant temperature**]<**Insert sensor**> .

l. Field-Customizable I/O Capability:

1) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
2) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
3) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

m. Features and Functions: Self-diagnostics, time delay, auto-restart [**, external static pressure control**][**, auto operation mode**][**, manual operation mode**][**, filter service notification**][**, power consumption display**][**, drain-assembly, high-water-level safety shutdown and notification**][**, run test switch**]<**Insert function**> .
n. Communication: Network communication with other indoor units and outdoor unit(s).
o. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
p. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
q. Unit Electrical:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA

70.

7. VRF Indoor Unit - Hydronic Heat Exchangers:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
b. Cabinet:

1) Material: [**Galvanized**][**or**][**painted**] steel.
2) Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Heat-Exchanger Assembly:

1) Single or dual, brazed plate heat exchanger with performance indicated on Drawings.
2) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
3) Internal Tubing: Copper tubing with brazed joints.
4) Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
5) Field Piping Connections: Manufacturer's standard.
6) Factory Charge: Dehydrated air or nitrogen.
7) Testing: Factory pressure tested and verified to be without leaks.
8) Drain: Hydronic side of assembly with drain connection at low point.

d. Unit Accessories:

1) Strainer: Y-pattern strainer for installation on entering hydronic piping to unit.

e. Unit Controls:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors: [**Unit entering refrigerant temperature**][**Unit leaving refrigerant temperature**][**Unit entering-water temperature**][**Unit leaving-water temperature**]<**Insert sensor**> .
4) Features and Functions: Self-diagnostics, time delay, auto-restart, hydronic pump interlock [**, auto operation mode**][**, manual operation mode**][**, run test switch**][**, leaving-water set-point control**][**, entering- or leaving-water set-point control**][**, automatic water temperature control reset based on outdoor temperature**][**, automatic water temperature control reset based on a remote signal**]<**Insert function**> .
5) Communication: Network communication with other indoor units and outdoor unit(s).
6) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.

2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

8. VRF Indoor Unit - Dedicated Outdoor Air Ventilation Units:

a. Description: Factory-assembled [**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

1) Specially designed for up to 100 percent outdoor air entering unit.

b. Cabinet:

1) Material: [**Galvanized**][**or**][**painted**] steel.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3) Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4) Mounting: Manufacturer-designed provisions for field installation.
5) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. DX Coil Assembly:

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7) Field Piping Connections: Manufacturer's standard.
8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

d. DX Coil Assembly for Reheat Applications: Provide units with a reheat coil where indicated on Drawings.

1) Coil Casing: Aluminum, galvanized, or stainless steel.
2) Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3) Coil Tubes: Copper, of diameter and thickness required by performance.
4) Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5) Unit Internal Tubing: Copper tubing with brazed joints.
6) Unit Internal Tubing Insulation: Manufacturer's standard insulation.
7) Field Piping Connections: Manufacturer's standard.

8) Factory Charge: Dehydrated air or nitrogen.
9) Testing: Factory pressure tested and verified to be without leaks.

e. Drain Assembly:

1) Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2) Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3) Field Piping Connection: Non-ferrous material [**with threaded NPT**] .

f. Fan and Motor Assembly:

1) Fan(s):

a) Direct-drive arrangement.
b) Single or multiple fans connected to a common motor shaft and driven by a single motor.
c) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

g. Filter Assembly:

1) Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2) Efficiency: [**ASHRAE 52.2, MERV 7**][**ASHRAE 52.2, MERV 11**][**ASHRAE 52.2, MERV 13**]<**Insert efficiency**> .
3) Replaceable Media: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

h. Unit Accessories:

1) Motorized Inlet Damper Kit: Low-leakage damper with spring return electric actuator to fail closed on loss of power. Damper controlled by unit to open when unit is operating and close when unit off.

i. Unit Controls:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors: [**Coil entering refrigerant temperature**][**Coil leaving refrigerant temperature**][**Unit entering-air temperature**][**Unit leaving-air temperature**][**Unit entering-air relative humidity**][**Unit leaving-air relative humidity**]<**Insert sensor**> .
4) Field-Customizable I/O Capability:

a) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable

control strategies.
b) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
c) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

5) Features and Functions: Self-diagnostics, time delay, auto-restart [**, external static pressure control**][**, auto operation mode**][**, manual operation mode**][**, filter service notification**][**, power consumption display**][**, drain-assembly, high-water-level safety shutdown and notification**][**, run test switch**]<**Insert function**> .
6) Communication: Network communication with other indoor units and outdoor unit(s).
7) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

j. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

9. VRF Indoor Unit - Energy Recovery Ventilator:

a. Description: Factory-assembled [**and -tested**] complete unit with components, wiring, and controls required for mating to ductwork, power, and controls field connections.
b. Cabinet:

1) Material: Galvanized steel.
2) Insulation: Manufacturer's standard internal insulation [**, complying with ASHRAE 62.1**] .
3) Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4) Mounting: Manufacturer-designed provisions for field installation.
5) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Damper Assemblies:

1) Outdoor Air Intake and Exhaust Air Discharge:

a) Low-leakage damper with spring return electric actuator to fail closed on loss of power.
b) Damper controlled by unit to open when unit is operating and close when unit off.

2) Energy Recovery Heat-Exchanger Bypass:

a) Low leakage damper with electric actuator with integral controls to bypass outdoor air around the energy recovery heat exchanger during times of favorable weather, and there is no energy-saving benefit to circulate air across the energy recovery heat exchanger.

d. Fan and Motor Assemblies: Separate fan and motor assemblies for supply and exhaust airstreams with control for equal airflow.

1) Fan(s):

a) Direct-drive arrangement.
b) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
c) Wheels statically and dynamically balanced.

2) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4) Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least [**50**]<**Insert number**> percent.
5) Vibration Control: Integral isolation to dampen vibration transmission.

e. Filter Assemblies: Separate filter assemblies for outdoor air and exhaust airstreams entering energy recovery heat exchanger.

1) Access: To accommodate filter replacement without the need for tools.
2) Efficiency: [**ASHRAE 52.2, MERV 7**]<**Insert efficiency**> .
3) Replaceable Media: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

f. Energy Recovery Heat Exchanger:

1) Total (sensible and latent) energy exchange between outdoor air and exhaust airstreams with performance indicated on Drawings.
2) Fixed element with no moving parts.
3) AHRI 1060 certified and bearing the AHRI labe1.

g. Unit Accessories:

1) Electric Duct Preheater:

a) Heater operation interlocked with energy recovery ventilator unit.
b) Heater with integral controls to control outdoor air temperature entering energy recovery ventilator unit to a temperature set-point determined by energy recovery ventilator unit manufacturer.
c) Listed and labeled.

h. Unit Controls:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Unit entering outdoor air temperature.
b) Unit leaving supply air temperature.
c) Unit entering exhaust air temperature.
d) Unit leaving exhaust air temperature.
e) Unit entering outdoor air relative humidity.
f) Unit leaving supply air relative humidity.
g) Unit entering exhaust air relative humidity.
h) Unit leaving exhaust air relative humidity.

4) Field-Customizable I/O Capability:

a) Analog Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
b) Digital Inputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.
c) Digital Outputs: [**Two**][**Three**][**Four**]<**Insert number**> for use in customizable control strategies.

5) Features and Functions: Self-diagnostics, time delay, auto-restart [**, external static pressure control**][**, local auto operation mode**][**, auto operation through remote signal**][**, manual operation mode**][**, filter service notification**][**, power consumption display**][**, run test switch**]<**Insert function**> .
6) Communication: Network communication with other indoor units and outdoor unit(s).
7) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

i. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

10. VRF Indoor Unit - Hydronic Heat Pump:

a. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1) Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2) Systems are to consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3) All units installed are to be from the same product development generation.

b. Cabinet:

1) Galvanized-steel construction.

2) Mounting: Manufacturer-designed provisions for field installation.
3) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
4) Internal Cabinet Cooling: Unit is to include integral cabinet cooling to maintain inside of cabinet within acceptable operating temperature for internal components.

a) If unit is not available with integral cooling, provide a field-installed indoor unit that is dedicated to provide cabinet cooling.

c. Compressor and Motor Assembly:

1) One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [**15**]<**Insert number**> percent of rated capacity.
2) Protection: Integral protection against the following:

a) High and low refrigerant pressure.
b) Low oil level.
c) High oil temperature.
d) Thermal and overload.
e) Voltage fluctuations.
f) Phase failure and phase reversal.
g) Short cycling.

3) Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4) Vibration Control: Integral isolation to dampen vibration transmission.
5) Oil management system to ensure safe and proper lubrication over entire operating range.
6) Crankcase heaters with integral control to maintain safe operating temperature.
7) Fusible plug.

d. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
e. Heat-Exchanger Assembly:

1) Brazed plate heat exchanger(s) with performance indicated on Drawings.
2) Testing: Factory pressure tested and verified to be without leaks.
3) Drain: Hydronic side of assembly with drain connection at low point.

f. Unit Accessories:

1) Strainer: Y-pattern strainer for installation on entering hydronic piping to unit.

g. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Entering-water temperature.
b) Leaving-water temperature.
c) Refrigerant suction temperature.
d) Refrigerant discharge temperature.

e) Outdoor air temperature.
f) Refrigerant high pressure.
g) Refrigerant low pressure.
h) Oil level.

4) Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, not less than 15 steps of capacity control, freeze protection sensor, proof of water flow [**, auto operation mode**][**, manual operation mode**][**, power consumption display**][**, run test switch**][**, automatic control through a remote signal**]<**Insert function**> .
5) Communication: Network communication with indoor units and other outdoor unit(s).
6) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

i. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for [**1000**]<**Insert number**> hours in accordance with ASTM B117.
j. Unit Piping:

1) Unit Tubing: Copper tubing with brazed joints.
2) Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3) Field Piping Connections: Manufacturer's standard.
4) Factory Charge: Dehydrated air or nitrogen.
5) Testing: Factory pressure tested and verified to be without leaks.

11. VRF Indoor Unit - Hydronic Heat Recovery:

a. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1) Specially designed for use in systems with simultaneous heating and cooling.
2) Systems are to consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3) All units installed are to be from the same product development generation.

b. Cabinet:

1) Galvanized-steel construction.

2) Mounting: Manufacturer-designed provisions for field installation.
3) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Internal Cabinet Cooling: Unit is to include integral cabinet cooling to maintain inside of cabinet within acceptable operating temperature for internal components.

1) If unit is not available with integral cooling, provide a field-installed indoor unit that is dedicated to provide cabinet cooling.

d. Compressor and Motor Assembly:

1) One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [**15**]<**Insert number**> percent of rated capacity.
2) Protection: Integral protection against the following:

a) High and low refrigerant pressure.
b) Low oil level.
c) High oil temperature.
d) Thermal and overload.
e) Voltage fluctuations.
f) Phase failure and phase reversal.
g) Short cycling.

3) Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4) Vibration Control: Integral isolation to dampen vibration transmission.
5) Oil management system to ensure safe and proper lubrication over entire operating range.
6) Crankcase heaters with integral control to maintain safe operating temperature.
7) Fusible plug.

e. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
f. Heat-Exchanger Assembly:

1) Brazed plate heat exchanger(s) with performance indicated on Drawings.
2) Testing: Factory pressure tested and verified to be without leaks.
3) Drain: Hydronic side of assembly with drain connection at low point.

g. Unit Accessories:

1) Strainer: Y-pattern strainer for installation on entering hydronic piping to unit.

h. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Entering-water temperature.
b) Leaving-water temperature.
c) Refrigerant suction temperature.

d) Refrigerant discharge temperature.
e) Outdoor air temperature.
f) Refrigerant high pressure.
g) Refrigerant low pressure.
h) Oil level.

4) Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, not less than 15 steps of capacity control, freeze protection sensor, proof of water flow [**, auto operation mode**][**, manual operation mode**][**, power consumption display**][**, run test switch**][**, automatic control through a remote signal**]<**Insert function**> .
5) Communication: Network communication with indoor units and other outdoor unit(s).
6) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

i. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

j. Unit Hardware: Zinc-plated steel, or stainless steel.
k. Unit Piping:

1) Unit Tubing: Copper tubing with brazed joints.
2) Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3) Field Piping Connections: Manufacturer's standard.
4) Factory Charge: Dehydrated air or nitrogen.
5) Testing: Factory pressure tested and verified to be without leaks.

12. VRF Indoor Unit - Heat Recovery Control Unit (HRCU):

a. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1) Specially designed for use in systems with simultaneous heating and cooling.
2) Systems are to consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

b. Cabinet:

1) Galvanized-steel construction.
2) Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.

3) Mounting: Manufacturer-designed provisions for field installation.
4) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
d. Refrigeration Assemblies and Specialties:

1) Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2) Each refrigerant branch circuit is to have refrigerant control valve(s) to control refrigerant flow.
3) Spares: Each heat recovery control unit is to include at least [**one**][**two**]<**Insert number**> branch circuit port(s) for future use.
4) Each system piping connection upstream of heat recovery unit is to be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5) Each branch circuit connection is to be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.

a) If not available as an integral part of the heat recovery control unit, isolation valves are to be field installed adjacent to the unit pipe connection.

e. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for indoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors: <**Insert sensor**> .
4) Features and Functions: Self-diagnostics, fuse protection, <**Insert function**> .
5) Communication: Network communication with indoor units and outdoor unit(s).
6) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

g. Unit Piping:

1) Unit Tubing: Copper tubing with brazed joints.
2) Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3) Field Piping Connections: Manufacturer's standard.

4) Factory Charge: Dehydrated air or nitrogen.
5) Testing: Factory pressure tested and verified to be without leaks.

F. VRF Outdoor Units:

1. VRF Outdoor Unit - Air-Source Heat Pump:

a. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1) Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2) Systems are to consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3) All units installed are to be from the same product development generation.

b. Cabinet:

1) Galvanized steel and coated with a corrosion-resistant finish.

a) Coating with documented salt spray test performance of [**1000**]<**Insert number**> hours in accordance with ASTM B117 surface scratch test (SST) procedure.

2) Mounting: Manufacturer-designed provisions for field installation.
3) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Compressor and Motor Assembly:

1) One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [**15**]<**Insert number**> percent of rated capacity.
2) Protection: Integral protection against the following:

a) High refrigerant pressure.
b) Low oil level.
c) High oil temperature.
d) Thermal and overload.
e) Voltage fluctuations.
f) Phase failure and phase reversal.
g) Short cycling.

3) Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4) Vibration Control: Integral isolation to dampen vibration transmission.
5) Oil management system to ensure safe and proper lubrication over entire operating range.
6) Crankcase heaters with integral control to maintain safe operating temperature.
7) Fusible plug.

d. Condenser Coil Assembly:

1) Plate Fin Coils:

a) Casing: Aluminum, galvanized, or stainless steel.
b) Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
c) Tubes: Copper, of diameter and thickness required by performance.

2) Aluminum Microchannel Coils:

a) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
b) Single- or multiple-pass arrangement.
c) Construct fins, tubes, and header manifolds of aluminum alloy.

3) Coating: [**None**][**Corrosion resistant**] .
4) Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

e. Condenser Fan and Motor Assembly:

1) Fan(s): Propeller type.

a) Direct-drive arrangement.
b) Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
c) Dynamically [**and statically**] balanced.

2) Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3) Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5) Speed Settings and Control: Variable speed with a speed range of least [**75**]<**Insert number**> percent.
6) Vibration Control: Integral isolation to dampen vibration transmission.

f. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
g. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Refrigerant suction temperature.
b) Refrigerant discharge temperature.
c) Outdoor air temperature.
d) Refrigerant high pressure.
e) Refrigerant low pressure.
f) Oil level.

h. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection [**, auto operation mode**][**, manual operation mode**][**, night setback control**][**, power consumption display**][**, run test switch**][**, equalize run time between multiple same components**]<**Insert function**> .

i. Communication: Network communication with indoor units and other outdoor unit(s).
j. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
k. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
l. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

m. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for [**1000**]<**Insert number**> hours in accordance with ASTM B117.
n. Unit Piping:

1) Unit Tubing: Copper tubing with brazed joints.
2) Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3) Field Piping Connections: Manufacturer's standard.
4) Factory Charge: Dehydrated air or nitrogen.
5) Testing: Factory pressure tested and verified to be without leaks.

2. VRF Outdoor Unit - Air-Source Heat Recovery:

a. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1) Specially designed for use in systems with simultaneous heating and cooling.
2) Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3) All units installed shall be from the same product development generation.

b. Cabinet:

1) Galvanized steel and coated with a corrosion-resistant finish.

a) Coating with documented salt spray test performance of [**1000**]<**Insert number**> hours in accordance with ASTM B117 surface scratch test (SST) procedure.

2) Mounting: Manufacturer-designed provisions for field installation.
3) Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

c. Compressor and Motor Assembly:

1) One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [**15**]<**Insert number**> percent of rated capacity.
2) Protection: Integral protection against the following:

   a) High refrigerant pressure.
   b) Low oil level.
   c) High oil temperature.
   d) Thermal and overload.
   e) Voltage fluctuations.
   f) Phase failure and phase reversal.
   g) Short cycling.

3) Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4) Vibration Control: Integral isolation to dampen vibration transmission.
5) Oil management system to ensure safe and proper lubrication over entire operating range.
6) Crankcase heaters with integral control to maintain safe operating temperature.
7) Fusible plug.

d. Condenser Coil Assembly:

   1) Plate Fin Coils:

      a) Casing: Aluminum, galvanized, or stainless steel.
      b) Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
      c) Tubes: Copper, of diameter and thickness required by performance.

   2) Aluminum Microchannel Coils:

      a) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
      b) Single- or multiple-pass arrangement.
      c) Construct fins, tubes, and header manifolds of aluminum alloy.

   3) Coating: [**None**][**Corrosion resistant**] .
   4) Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

e. Condenser Fan and Motor Assembly:

   1) Fan(s): Propeller type.

      a) Direct-drive arrangement.
      b) Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
      c) Dynamically [**and statically**] balanced.

   2) Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
   3) Motor(s): Brushless dc or electronically commutated with permanently lubricated

bearings and rated for outdoor duty.

4) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5) Speed Settings and Control: Variable speed with a speed range of least [**75**]<**Insert number**> percent.
6) Vibration Control: Integral isolation to dampen vibration transmission.

f. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

g. Unit Controls:

1) Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2) Factory-Installed Controller: Configurable digital control.
3) Factory-Installed Sensors:

a) Refrigerant suction temperature.
b) Refrigerant discharge temperature.
c) Outdoor air temperature.
d) Refrigerant high pressure.
e) Refrigerant low pressure.
f) Oil level.

4) Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection [**, auto operation mode**][**, manual operation mode**][**, night setback control**][**, power consumption display**][**, run test switch**][**, equalize run time between multiple same components**]<**Insert function**> .
5) Communication: Network communication with indoor units and other outdoor unit(s).
6) Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7) Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Unit Electrical:

1) Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2) Field Connection: Single-point connection to power entire unit and integral controls.
3) Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4) Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5) Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6) Raceways: Enclose line voltage wiring in [**metal**] raceways to comply with NFPA 70.

i. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for [**1000**]<**Insert number**> hours in accordance with ASTM B117.

j. Unit Piping:

1) Unit Tubing: Copper tubing with brazed joints.
2) Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3) Field Piping Connections: Manufacturer's standard.
4) Factory Charge: Dehydrated air or nitrogen.

5) Testing: Factory pressure tested and verified to be without leaks.

G. System Controls:

1. General Requirements:

a. Network: Indoor units [**, HRCUs,**] and outdoor units shall include integral controls and connect through a [**TIA-485A**][**or**][**manufacturer-selected**]<**Insert network type**> control network.
b. Network Communication Protocol: [**Manufacturer proprietary**][**or**][**open**] control communication between interconnected units.
c. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

1) Ethernet connection via RJ-45 connectors and port with transmission at [**100**]<**Insert value**> Mbps or higher.
2) Integration devices are to be connected to local uninterruptible power supply unit(s) to provide at least [**5 minutes**]<**Insert time**> of battery backup operation after a power loss.
3) Integration is to include [**control**][**monitoring**][**scheduling**][**change of value notifications**]<**Insert requirements**> .

d. Operator Interface:

1) Operator interface with system and unit controls is to be through the following:

a) Operator interfaces integral to controllers.
b) Owner-furnished PC connected to central controller(s).
c) Web interface through web browser software.
d) Integration with Building Automation System.

2) Users interface with controllers for indoor units control to extent privileges are to be enabled. Control features available to users are to include the following:

a) On/off control.
b) Temperature set-point adjustment.

2. VRF HVAC System Operator Software for PC:

a. Software offered by VRF HVAC system manufacturer is to provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
b. Software is to provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
c. Plan views are to show building plans with location of indoor units and identification superimposed on plans.
d. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller are to match those operation modes of controllers for indoor units.
e. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
f. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
g. Optimized start feature to start indoor units before scheduled time to reach temperature

set-point at scheduled time based on operating history.
h. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
i. Supports Multiple Languages: [**English**][**or**][**French**][**Spanish**]<**Insert language**> .
j. Supports Imperial and Metric Temperature Units: [**Fahrenheit**][**or**][**Celsius**][**Fahrenheit and Celsius**] .
k. Displays service notifications and error codes.
l. Monitors and displays up to [**3000**]<**Insert number**> item error history and [**10000**]<**Insert number**> item operation history for regular reporting and further archiving.
m. Monitors and displays cumulative operating time of indoor units.
n. Able to disable and enable operation of individual controllers for indoor units.
o. Information displayed on individual controllers shall also be available for display.
p. Information Displayed for Outdoor Units:

1) Refrigerant high and low pressures and percent capacity.

3. Central Controllers:

a. Centralized control for all indoor and outdoor units from a single central controller location.

1) Include multiple interconnected controllers as required.

b. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller are to match those operation modes of controllers for indoor units.
c. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

1) Sets schedule for daily, weekly, and annual events.
2) Schedule options available through central controller are to at least include the schedule options of controllers for indoor units.

d. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
e. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
f. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
g. Service diagnostics tool.
h. Able to disable and enable operation of individual controllers for indoor units.
i. Information displayed on individual controllers is to also be available for display through central controller.
j. Information Displayed for Outdoor Units:

1) Refrigerant high and low pressures and percent capacity.

k. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
l. Operator interface through a backlit, high-resolution color display touch panel [**and web accessible through standard web browser software**] .

4. Wired Controllers for Indoor Units:

a. Single controller capable of controlling multiple indoor units as group.
b. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
c. Multiple Language: [**English**][**or**][**French**][**Spanish**]<**Insert language**> .
d. Temperature Units: [**Fahrenheit**][**or**][**Celsius**][**Fahrenheit and Celsius**] .

e. On/Off: Turns indoor unit on or off.
f. Hold: Hold operation settings until hold is released.
g. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
h. Temperature Display: 1-degree increments.
i. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback modes. Adjustable in 1-degree increments between <**Insert temperature range**> .
j. Relative Humidity Display: 1 percent increments.
k. Relative Humidity Set-Point: Adjustable in 1 percent increments between <**Insert relative humidity range**> .
l. Fan Speed Setting: Select between available options furnished with the unit.
m. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
n. Seven-day programmable operating schedule with up to [**five**][**eight**]<**Insert number**> events per day. Operations are to include On/Off, Operation Mode, and Temperature Set-Point.
o. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
p. Occupancy detection.
q. Service Notification Display: "Filter" <**Insert notifications**> .
r. Service Run Tests: Limit use by service personnel to troubleshoot operation.
s. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
t. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
u. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
v. Low-voltage power required for controller is to be powered through non-polar connections to indoor unit.

5. Wireless Controllers for Indoor Units:

a. Wireless Communication:

1) Controller communicates to remote-mounted receiver that is wired to indoor unit(s).

a) Include receivers with wireless controllers as required to complete installation.
b) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.

2) One wireless controller is to be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.

b. Controller Battery Life: [**Three**]<**Insert number**> years.
c. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
d. Multiple Language: [**English**][**or**][**French**][**Spanish**]<**Insert language**> .
e. Temperature Units: [**Fahrenheit**][**or**][**Celsius**][**Fahrenheit and Celsius**] .
f. On/Off: Turns indoor unit on or off.
g. Hold: Hold operation settings until hold is released.
h. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
i. Temperature Display: 1-degree increments.
j. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback modes. Adjustable in 1-degree increments between <**Insert temperature range**> .
k. Relative Humidity Display: 1 percent increments.
l. Relative Humidity Set-Point: Adjustable in 1 percent increments between <**Insert relative humidity range**> .
m. Fan Speed Setting: Select between available options furnished with the unit.
n. Airflow Direction Setting: If applicable to unit, select between available options furnished

with the unit.

o. Seven-day programmable operating schedule with up to [**five**][**eight**]<**Insert number**> events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
p. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
q. Occupancy detection.
r. Service Notification Display: "Filter" <**Insert notifications**> .
s. Service Run Tests: Limit use by service personnel to troubleshoot operation.
t. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
u. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
v. Setting stored in non-volatile memory to ensure that settings are not lost if power is lost. Battery for date and time only.

H. System Refrigerant and Oil:

1. Refrigerant: As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

a. Classification: ASHRAE 34, <**Insert classification**> .
b. Type: <**Insert refrigerant type**> .

2. Oil: As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.3 VRF SYSTEM CONDENSATE DRAIN PIPING

A. See Section 232113 "Hydronic Piping" for VRF system condensate drain piping.

B. Copper Tube:

1. Drawn-Temper Tubing: Complying with [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**] or Type DWV complying with ASTM B306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux complying with ASTM B813.

C. CPVC Plastic Pipe: Complying with ASTM F441/F441M, Schedule 40, with socket-type pipe fittings complying with ASTM F438 and solvent cement complying with ASTM F493.

D. PVC Plastic Pipe: Complying with ASTM D1785, Schedule 40, with socket-type pipe fittings complying with ASTM D2466 and solvent cement in accordance with ASTM D2564, primer complying with ASTM F656.

2.4 SYSTEM HYDRONIC PIPING

A. Comply with requirements in Section 232113 "Hydronic Piping" for system piping requirements.

2.5 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping, Valves, and Fittings:

1. Copper Tube: [**ASTM B280, Type ACR**]<**Insert material**> .
2. Wrought-Copper Fittings, Brazed Joints: ASME B16.50.
3. Brazing Filler Metals: AWS A5.8/A5.8M.
4. Refrigerant Tubing Kits:

a. Furnished by VRF HVAC system manufacturer.
b. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
c. Standard one-piece length for connecting to indoor units.
d. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
e. Factory Charge: [**Dehydrated air or nitrogen**][**or**]<**Insert charge**> .

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer is to furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.

1. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
2. Valve Connections: Flare or sweat, depending on size.

2.6 METAL HANGERS AND SUPPORTS

A. See Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for metal hangers and supports.

B. Copper Tube Hangers: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

1. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized or copper-coated steel**][**stainless steel**]<**Insert material**> .

C. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized steel**][**stainless steel**]<**Insert material**> .

2.7 METAL STRUT SUPPORT SYSTEMS

A. Strut Support System - Metal, Rod Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]

b. [**Anvil; an ASC Engineered Solution**]
c. [**Atkore Unistrut**]
d. [**CADDY; brand of nVent Electrical plc**]
e. [**Carpenter & Paterson, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Empire Industries, Inc.**]
h. [**Flex-Strut Inc.**]
i. [**G-Strut**]
j. [**Haydon Corp.**]
k. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Anvil; an ASC Engineered Solution**]
c. [**Atkore Unistrut**]
d. [**CADDY; brand of nVent Electrical plc**]
e. [**Carpenter & Paterson, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Empire Industries, Inc.**]
h. [**Flex-Strut Inc.**]
i. [**G-Strut**]
j. [**Haydon Corp.**]
k. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
l. <**Insert manufacturer's name**>

3. Description: Factory-fabricated pipe-support assembly made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.
4. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
5. Struts: Continuous slotted [**carbon steel**][**stainless steel, Type 304**][**stainless steel, Type 316**][**extruded-aluminum**]<**Insert material**>[**channel with inturned lips**][**or**][**angle**]<**Insert strut type**> .
6. Strut Width: Selected for applicable load criteria.
7. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
8. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized steel**][**stainless steel**]<**Insert material**> .
9. Metallic Coating: [**Plain**][**Pregalvanized G90 (Z275)**][**Electroplated zinc**][**Hot-dip galvanized**][**Gold (yellow zinc dichromate) galvanized**] .
10. Paint Coating: [**Green epoxy, acrylic, or urethane**]<**Insert paint type**> .
11. Plastic Coating: [**PVC**]<**Insert plastic type**> .
12. Combination Coating: <**Insert combination coating**> .

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded, zinc-coated steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: [**Zinc-coated**][**or**][**stainless**] steel.
2. Outdoor Applications: Stainless steel.

2.9 ROOFTOP-MOUNTED STRUT SUPPORT SYSTEMS

A. Strut Support System - Rooftop-Mounted Pipe Stand, Compact:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**G-Strut**]
   b. [**MIRO Industries Inc.**]
   c. [**PHP Systems/Design**]
   d. [**RectorSeal HVAC; a CSW Industrials Company**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**G-Strut**]
   b. [**MIRO Industries Inc.**]
   c. [**PHP Systems/Design**]
   d. [**RectorSeal HVAC; a CSW Industrials Company**]
   e. <**Insert manufacturer's name**>

3. Description: Shop-fabricated assembly made of manufactured corrosion-resistant components to support rooftop-mounted piping.
4. Configuration: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
5. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
7. Hardware: Galvanized steel or polycarbonate.
8. Accessories: Protection pads.

B. Strut Support System - Rooftop-Mounted Pipe Stand, Single Base, Single Pipe, Low Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**G-Strut**]
   b. [**MIRO Industries Inc.**]
   c. [**PHP Systems/Design**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**G-Strut**]
b. [**MIRO Industries Inc.**]
c. [**PHP Systems/Design**]
d. <**Insert manufacturer's name**>

3. Description: Shop-fabricated assembly made of manufactured corrosion-resistant components to support rooftop-mounted piping.
4. Configuration: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
5. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
6. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
7. Vertical Members: Two [**galvanized-steel**][**stainless steel**] , continuous-thread **1/2-inch (12-mm)** rods.
8. Horizontal Member: Adjustable horizontal, [**galvanized-steel**][**stainless steel**] pipe support channels.
9. Pipe Supports: [**Roller**][**Strut clamps**][**Clevis hanger**][**Swivel hanger**] .
10. Hardware: [**Galvanized**][**Stainless**] steel.
11. Accessories: Protection pads.
12. Height: [**12 inches (300 mm) above roof**]<**Insert lesser dimension above roof**> .

C. Strut Support System - Rooftop-Mounted Pipe Stand, Single Base, Single Pipe, High Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]
   c. <**Insert manufacturer's name**>

3. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
4. Base: Single vulcanized rubber or molded polypropylene.
5. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
6. Vertical Members: Two [**galvanized-steel**][**stainless steel**] , continuous-thread **1/2-inch (12-mm)** rods.
7. Horizontal Member: One adjustable-height, [**galvanized-steel**][**or**][**stainless steel**] pipe support slotted channel or plate.
8. Pipe Supports: [**Roller**][**Clevis hanger**][**Swivel hanger**] .
9. Hardware: [**Galvanized**][**Stainless**] steel.
10. Accessories: Protection pads [**, 1/2-inch (12-mm) continuous-thread galvanized-steel rod**][**, 1/2-inch (12-mm) continuous-thread stainless steel rod**] .
11. Height: [**36 inches (900 mm) above roof**]<**Insert lesser dimension above roof**> .

D. Strut Support System - Rooftop-Mounted Pipe Stand, Multiple Pipe, High Profile:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MIRO Industries Inc.**]
   b. [**PHP Systems/Design**]
   c. <**Insert manufacturer's name**>

3. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
4. Bases: Two or more [**vulcanized rubber**][**molded polypropylene**]<**Insert material**> .
5. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
6. Vertical Members: Two or more [**galvanized-steel**][**stainless steel**] channels.
7. Horizontal Members: One or more adjustable-height, [**galvanized-steel**][**stainless steel**] pipe supports.
8. Pipe Supports: [**Roller**][**Strut clamps**][**Clevis hanger**][**Swivel hanger**] .
9. Hardware: [**Galvanized**][**Stainless**] steel.
10. Accessories: Protection pads [**, 1/2-inch (12-mm) continuous-thread rod**] .
11. Height: [**36 inches (900 mm) above roof**]<**Insert lesser dimension above roof**> .

E. Strut Support System - Rooftop-Mounted Pipe Stand, Curb-Mounted Type: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.10 EQUIPMENT STANDS, OUTDOOR TYPE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   1. [**DiversiTech Corp.**]
   2. [**MIRO Industries Inc.**]
   3. [**RectorSeal HVAC; a CSW Industrials Company**]
   4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**DiversiTech Corp.**]
   2. [**MIRO Industries Inc.**]
   3. [**RectorSeal HVAC; a CSW Industrials Company**]
   4. <**Insert manufacturer's name**>

C. Description: Individual foot supports with elevated adjustable channel cross bars and

clamps/fasteners/bolts for ground or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on-site.

D. Foot Material: Rubber or polypropylene.

E. Rails Material: Hot-dip galvanized carbon steel.

F. Wind/Sliding Load Resistance: Up to [**100 mph (44 m/s)**]<**Insert value**> minimum.

2.11 MISCELLANEOUS SUPPORT MATERIALS

A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

B. Structural Steel: ASTM A36/A36M, carbon steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.12 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Outdoors: [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**]<**Insert dimension**> thick.

2. Field-Applied Jacket:

a. Concealed: None required.
b. Indoors, Exposed to View: [**None required**][**PVC, 20 mils (0.5 mm) thick**][**PVC, color selected by Architect, 20 mils (0.5 mm) thick**]<**Insert jacket**> .
c. Outdoors, Exposed to View: [**None required**][**Aluminum, smooth, 0.020 inch (0.51 mm) thick**]<**Insert jacket**> .

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Pipe Insulation - Flexible Elastomeric:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: [**1 inch (25 mm)**]<**Insert dimension**> thick.
c. Outdoors: [**1 inch (25 mm)**]<**Insert dimension**> thick.

2. Field-Applied Jacket:

   a. Concealed: None required.
   b. Indoors, Exposed to View: [**None required**][**PVC, 20 mils (0.5 mm) thick**][**PVC, color selected by Architect, 20 mils (0.5 mm) thick**]<**Insert jacket**> .
   c. Outdoors, Exposed to View: [**None required**][**Aluminum, smooth, 0.020 inch (0.51 mm) thick**]<**Insert jacket**> .

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

F. Metal Jacket Flashing Sealants:

1. Materials are to be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
4. Color: Aluminum.
5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended

exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.13 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application in accordance with NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products in accordance with NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

a. Flame Travel Distance: **60 inches (1520 mm)** or less.
b. Peak Optical Smoke Density: 0.5 or less.
c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products in accordance with UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products in accordance with UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

a. One pair, twisted, 16 AWG, stranded (19x29) or 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
b. PVC insulation.
c. Braided or foil shielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

a. One pair, twisted, 16 AWG, stranded (19x29) or 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
b. PVC insulation.
c. Braided or foil shielded.
d. PVC jacket.
e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
f. Flame Resistance: Comply with NFPA 262.

3. Product Data: For each conductor and cable, indicating lead content of less than 300 ppm.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.

a. Paired, [**one pair**][**two pairs**] , twisted, 22 AWG, stranded (7x30) tinned-copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated Cable: NFPA 70, Type CMP.

a. Paired, [**one pair**][**two pairs**] , 22 AWG, stranded (7x30) tinned-copper conductors.
b. Fluorinated ethylene propylene insulation.
c. Unshielded.
d. Fluorinated ethylene propylene jacket.
e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
f. Flame Resistance: NFPA 262.

3. Product Data: For each conductor and cable, indicating lead content of less than 300 ppm.

D. Ethernet Network Cabling: TIA-568.2-D Category [**6**][**6a**]<**Insert category**> cable with [**RJ-45**]<**Insert connector type**> connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
3. Product Data: For each conductor and cable, indicating lead content of less than 300 ppm.
4. Shielding: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**] .
5. Cable Rating: By application.
6. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for cable raceways.

2.14 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**> -hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**] .
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**> .

4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.15 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

1. Equipment will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF VRF HVAC SYSTEMS, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components are to be installed by [**manufacturer's service representative**][**or**][**system Installer under supervision of manufacturer's service representative**] .

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF VRF HVAC SYSTEMS

A. Installation of VRF Indoor Units:

1. Install units to be level and plumb while providing a neat and finished appearance.
2. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of **3/8 inch (10 mm)**.
3. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
4. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
5. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
6. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
7. Provide lateral bracing if needed to limit movement of suspended units to not more than [**0.25 inch (13 mm)**]<**Insert dimension**> .
8. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
9. Floor-mounted units located in [**mechanical**]<**Insert room type**> rooms.
10. Install floor-mounted units on support structure indicated on Drawings.
11. Install floor-mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
12. Attachment: Install hardware for proper attachment to supported equipment.
13. Grouting: Place grout under equipment supports and make bearing surface smooth.

B. Installation of Duct, Accessories, and Air Outlets:

1. Where installing ductwork adjacent to equipment, allow space for service and maintenance.
2. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."
3. Comply with requirements for nonmetal ducts specified in Section 233116 "Nonmetal Ducts."
4. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."
5. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."
6. Comply with requirements for air diffusers specified in Section 233713.13 "Air Diffusers."
7. Comply with requirements for registers and grilles specified in Section 233713.23 "Registers and Grilles."

C. Installation of VRF Outdoor Units:

1. Install units to be level and plumb while providing a neat and finished appearance.
2. Install outdoor units on support structures indicated on Drawings.
3. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

    a. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
    b. Grouting: Place grout under equipment supports and make bearing surface smooth.

4. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, stainless steel fasteners.

3.4 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.5 INSTALLATION OF VRF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements in ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than [**one**][**two**]<**Insert number**> percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.6 INSTALLATION OF SYSTEM HYDRONIC PIPING

A. Comply with requirements for hydronic pipe and tubing specified in Section 232113 "Hydronic Piping."

B. Comply with requirements for hydronic specialties specified in Section 232116 "Hydronic Piping Specialties."

C. Comply with requirements for ball valves specified in Section 230523 "General-Duty Valves for HVAC Piping."

D. Comply with requirements for butterfly valves specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. Comply with requirements for check valves specified in Section 230523 "General-Duty Valves for HVAC Piping."

F. Install continuous-thread hanger rods and [**elastomeric**][**spring**] hangers of size required to support equipment weight.

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

G. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.

3.7 INSTALLATION OF SYSTEM REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing are to be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed [**5 ft. (1.5 m)**]<**Insert dimension**> . Minimum rod size, **1/4 inch (6.4 mm)**.
3. Prepare tubing ends and make mating connections to provide a pressure-tight and leak-free installation.

B. Install refrigerant piping in accordance with ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance are concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

B. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Install building attachments within concrete slabs or attach to structural steel.

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

I. Piping and Tubing Insulation:

1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.
2. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): **12 inches (305 mm)** long and **0.048 inch (1.22 mm)** thick.

J. Horizontal-Piping Hangers and Supports: Install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
2. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4 (DN 15 to DN 100)**, to allow off-center closure for hanger installation before pipe erection.
3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu of individual clevis hangers.
5. Pipe stands for horizontal pipes located outdoors.
6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

K. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. Sizes through NPS 3/4 (DN 20): Maximum span, **5 ft. (1.5 m)**; minimum rod size, **1/4 inch (6.4 mm)**.
2. NPS 1 (DN 25): Maximum span, **6 ft. (1.8 m)**; minimum rod size, **1/4 inch (6.4 mm)**.
3. NPS 1-1/4 (DN 32): Maximum span, **7 ft. (2.1 m)**; minimum rod size, **3/8 inch (10 mm)**.
4. NPS 1-1/2 (DN 40): Maximum span, **8 ft. (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
5. NPS 2 (DN 50): Maximum span, **8 ft. (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
6. NPS 2-1/2 (DN 65): Maximum span, **9 ft. (2.7 m)**; minimum rod size, **3/8 inch (10 mm)**.
7. NPS 3 (DN 80) and Larger: Maximum span, **10 ft. (3 m)**; minimum rod size, **3/8 inch (10 mm)**.

L. Plastic Pipe Hanger and Support Spacing:

1. Space hangers and supports in accordance with pipe manufacturer's written instructions for service conditions.
2. Maximum spacing, **5 ft. (1.5 m)**; minimum rod size, **1/4 inch (6.4 mm)**.

M. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

N. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed [**5 ft. (1.5 m)**][**10 ft. (3 m)**]<**Insert dimension**> .

O. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified.

P. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

Q. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

R. Trim excess length of continuous-thread hanger and support rods to [**1 inch (25 mm)**]<**Insert dimension**> .

S. Hanger-Rod Attachments: Install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to **6 inches (150 mm)** for heavy loads.
2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F (49 to 232 deg C)** piping installations.

T. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): **750 lb (340 kg)**.
    b. Medium (MSS Type 32): **1500 lb (680 kg)**.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF METAL STRUT SUPPORT SYSTEMS

A. Metal Strut Support System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

B. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

3.10 INSTALLATION OF FASTENER SYSTEMS

A. Fastener System Installation:

1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than **4 inches (100 mm)** thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners in accordance with powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.11 INSTALLATION OF ROOFTOP-MOUNTED STRUT SUPPORT SYSTEMS

A. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

3.12 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with **1-inch (25-mm)** overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended in writing by insulation manufacturer. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

3.13 ELECTRICAL CONNECTIONS

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power is to be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation is to be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated phenolic layers of black with engraved white letters. Letters at least **1/2 inch (13 mm)** high.
2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or revised in this Section.

H. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for box selection and installation requirements for boxes as supplemented or revised in this Section.

I. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems" for wireways selection and installation requirements for wireways as supplemented or revised in this Section.

1. Provide outlet boxes no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
2. Provide outlet boxes for cables no smaller than **4 inches (102 mm)** square by [**1-1/2 inches (38 mm)**][**2-1/8 inches (53 mm)**] deep with extension ring sized to bring edge of ring to within **1/8 inch (3.1 mm)** of the finished wall surface.
3. Flexible metal conduit is prohibited.

J. Comply with TIA-569-E for pull-box sizing and length of conduit and number of bends between pull points.

K. Install manufactured conduit sweeps and long-radius elbows if possible.

L. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.14 INSTALLATION OF SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with [**IT department**][**CIO**]<**Insert entity responsible for IT security**> .
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with [**IT department**][**CIO**]<**Insert entity responsible for IT security**> .
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.15 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

a. Within equipment and associated control enclosures.
b. In accessible ceiling spaces where open cable installation method may be used.
c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568.2-D.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables must be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire is to be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568.2-D.
2. Do not untwist balanced twisted-pair cables more than **1/2 inch (13 mm)** at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**30 inches (760 mm)**]<**Insert dimension**> apart.
2. Do not route cable through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-E recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.16 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping" and Section 078443 "Joint Firestopping."

B. Comply with TIA-569-E.

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.17 GROUNDING

A. For data communication wiring, comply with TIA-607-E and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.18 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical [**and controls**] components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Provide a unique tag for each cable.

3.19 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service must be performed by [**an employee**][**or**][**a factory-trained and -authorized service representative**] of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative must not provide assistance without manufacturer's employee supervision.

2. Manufacturer is to provide on-site visits during the course of construction at installation milestones indicated. System Installer is to coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately [**25**]<**Insert number**> percent completion of system(s).
c. Third Visit: At approximately [**50**]<**Insert number**> percent completion of system(s).
d. Fourth Visit: At approximately [**75**]<**Insert number**> percent completion of system(s).
e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:

a. Meeting is to include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
b. Meeting is to be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
c. Meeting is to cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit are to include the following:

    a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
    b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
    c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
    d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
    e. Issue a report for each visit, documenting the visit.

        1) Report to include name and contact information of individual making the visit.
        2) Date(s) and time frames while on-site.
        3) Names and contact information of people meeting with while on-site.
        4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

    a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed in accordance with manufacturer's requirements and ready for final inspection.
    b. All system equipment and operating components are to be inspected. If components are inaccessible for inspection, they are to be made accessible before the final inspection can be completed.
    c. Manufacturer is to provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection is to follow a detailed checklist specific to each equipment and operating component.
    d. Inspection reports for indoor units are to include, but not be limited to, the following:

        1) Unit designation on Drawings.
        2) Manufacturer model number.
        3) Serial number.
        4) Network address, if applicable.
        5) Each equipment setting.
        6) Mounting, supports, and restraints properly installed.
        7) Proper service clearance provided.
        8) Wiring and power connections correct.
        9) Line-voltage reading(s) within acceptable range.
        10) Wiring and controls connections correct.
        11) Low-voltage reading(s) within an acceptable range.
        12) Controller type and model controlling unit.
        13) Controller location.
        14) Temperature settings and readings within an acceptable range.
        15) Humidity settings and readings within an acceptable range.
        16) Condensate removal acceptable.
        17) Fan settings and readings within an acceptable range.
        18) Unit airflow direction within an acceptable range.
        19) If applicable, fan external static pressure setting.
        20) Filter type and condition acceptable.
        21) Noise level within an acceptable range.
        22) Refrigerant piping properly connected and insulated.

23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units are to include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Inspection reports for indoor, dedicated outdoor air ventilation units are to include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) Automatic dampers properly installed and operating.
24) Ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

g. Inspection reports for energy recovery ventilators are to include, but not be limited to, the

following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity readings.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Automatic dampers properly installed and operating.
22) Ductwork properly connected.
23) If applicable, external interlocks properly connected.
24) Remarks.

h. Inspection reports for hydronic units are to include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Condensate removal acceptable.
16) Noise level within an acceptable range.
17) Refrigerant piping properly connected and insulated.
18) Hydronic piping properly connected and insulated.
19) Proof of water flow checked for proper operation.
20) Condensate drain piping properly connected and insulated.
21) If applicable, external interlocks properly connected.
22) Remarks.

i. Installer is to provide manufacturer with the requested documentation and technical support during inspection.
j. Installer is to correct observed deficiencies found by the inspection.
k. Upon completing the on-site inspection, manufacturer is to provide a written report with

complete documentation describing each inspection step, the result, and any corrective action required.

l. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.

m. Final report is to indicate the system(s) inspected are installed in accordance with manufacturer's requirements and are ready for startup.

B. Perform tests and inspections with the assistance of manufacturer's service representative as follows:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than [**1.2**][**1.5**]<**Insert value**> times VRF HVAC system operating pressure, but not less than [**600 psig (4137 kPa)**]<**Insert value**> , using [**dry nitrogen**]<**Insert test medium**> .
3. Successful testing is to show test pressure is maintained for a continuous and uninterrupted period of [**24**]<**Insert number**> hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record information for each test as follows:

   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of [**500**]<**Insert value**> microns.
3. Successful testing is to show test pressure is maintained for a continuous and uninterrupted period of [**one**]<**Insert number**> hour(s) with no change.
4. Prepare test report to record information for each test as follows:

a. Name of person starting test, company name, phone number, and e-mail address.
b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
c. Detailed description of extent of tubing tested.
d. Date and time at start of test.
e. Test pressure at start of test.
f. Outdoor temperature at start of test.
g. Name of person ending test, company name, phone number, and e-mail address.
h. Date and time at end of test.
i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system is to be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer is to consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer is to charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging is to be witnessed by system manufacturer's representative.
4. Total refrigerant charge is to be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.20 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative is to be [**an employee**][**or**][**a factory-trained and -authorized service representative**] of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service in accordance with manufacturer's written instructions.

B. Startup checks are to include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit [**, HRCU,**] and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor [**and outdoor**] unit.

C. Installer is to accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer is to correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer is to issue a report for each separate system.
2. Report is to include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer is to electronically record not less than [**two**]<**Insert number**> hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters are to be included in the information submitted.

E. Witness:

1. Invite [**Architect**][**Owner**][**and**][**Commissioning Agent**] to witness startup service procedures.
2. Provide written notice not less than [**20**]<**Insert number**> business days before start of startup service.

3.21 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges in accordance with VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.22 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections are grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.23 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes [**12**]<**Insert duration**> months' full maintenance by [**skilled employees of system Installer**][**manufacturer's authorized service representative**] . Include [**two**][**four**]<**Insert number**> service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.24 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

1. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

C. Written Report: Prepare report after each update, documenting upgrades installed.

3.25 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's [**employed training instructor**][**or**][**factory-authorized service representative**] to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor is to be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
2. Instructor's credentials are to be submitted for review by [**Architect**][**Commissioning Agent**][**Owner**] before scheduling training.
3. Instructor(s) [**primary**][**sole**] job responsibility is to be Owner training.
4. Instructor(s) is to have not less than [**three**]<**Insert number**> years of training experience with VRF HVAC system manufacturer and past training experience on at least [**three**]<**Insert number**> projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least [**20**]<**Insert number**> business days before first training session.
2. Training is to occur before Owner occupancy.
3. Training is to be held at mutually agreed date and time during normal business hours.
4. Each training day is not to exceed [**eight**]<**Insert number**> hours of training. Daily training schedule is to allow time for [**one**]<**Insert number**> -hour lunch period and [**15**]<**Insert number**> -minute break after every [**two**]<**Insert number**> hours of training.
5. Perform not less than [**eight**][**16**][**24**]<**Insert number**> total hours of training.

D. Location: Owner is to provide a suitable on-site location to host classroom training.

E. Training Attendees: Estimate [**three**]<**Insert number**> people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules are to include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain [**Architect**][**Commissioning Agent**][**or**][**Owner**] written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 23 81 00 00

Task	Specification	Specification Description
23 81 13 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 13 11 - PACKAGED TERMINAL AIR-CONDITIONERS, THROUGH-WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, terminal air conditioners, through-wall units.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For packaged, terminal air-conditioners.

1. Include plans, elevations, sections, details for wall penetrations,[**seismic bracing,**] and attachments to other work.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

D. Sustainable Design Submittals:

1. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
4. Product Data: For energy performance.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For packaged, terminal air conditioners, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Seismic Qualification Certificates: For packaged terminal air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Provide detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged, terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion, including only components and excluding labor.
3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Packaged terminal air conditioners are to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PACKAGED, TERMINAL AIR CONDITIONERS, THROUGH-WALL UNITS

A. Packaged, Terminal Air Conditioners, Through-Wall Units:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Amana; Whirlpool Corporation**]
   b. [**ClimateMaster, Inc.**]
   c. [**Comfort-Aire; a division of Heat Controller, Inc.**]
   d. [**Friedrich Air Conditioning Company**]
   e. [**GE Appliances; Haier Group**]
   f. [**Ice Air LLC**]
   g. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   h. [**Suburban Manufacturing Company; a division of AIRXCEL, Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Amana; Whirlpool Corporation**]
   b. [**ClimateMaster, Inc.**]
   c. [**Comfort-Aire; a division of Heat Controller, Inc.**]
   d. [**Friedrich Air Conditioning Company**]
   e. [**GE Appliances; Haier Group**]
   f. [**Ice Air LLC**]
   g. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   h. [**Suburban Manufacturing Company; a division of AIRXCEL, Inc.**]
   i. <**Insert manufacturer's name**>

3. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system,[**heating,**] and temperature controls; fully charged with refrigerant and filled with oil; with [**cord-connected**][**hardwired**] chassis.
4. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
5. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
6. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.
7. UL listed and ETL performance certified.
8. Chassis:

   a. Cabinet: [**0.052-inch- (1.3-mm-)**]<**Insert dimension**> thick [**galvanized**][**powder-coated**] steel with removable front panel with concealed latches.

      1) Mounting: [**Wall with wall sleeve**][**Floor with subbase**].
      2) Top: [**Angled**][**Flat**].
      3) Discharge Grille: [**Punched-louver discharge grille allowing four-way discharge-air pattern**][**Extruded-aluminum discharge grille**][**Reversible-polycarbonate discharge grille allowing upward and horizontal airflow**], tamperproof, and carrying a flame test rating in accordance with UL 94.
      4) Louvers: [**Extruded aluminum with enamel finish**][**Stamped aluminum with clear-anodized finish**][**Stamped steel with enamel finish**]; [**white**][**bronze**][**brown**][**beige**]<**Insert color**> color.

5) Finish: [**Epoxy coating**][**Baked enamel**].
6) Access Door: Hinged door in top of cabinet for access to controls.
7) Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
8) Finish of Interior Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.
9) Electrical Subbase: Enameled steel with four adjustable leveling feet and adjustable end plates[**, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit**].
10) Hydronic Subbase: Enameled steel with six adjustable leveling feet and adjustable end plates with two-row **NPS 5/8 (DN 18)** copper tube, aluminum-plate finned coil for use with hot water or steam, [**normally open**][**normally closed**] low-voltage electric valve for [**hot water**][**steam**] and provision for mounting receptacle[**, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit**].
11) Wall Sleeves: [**Galvanized steel with polyester finish**][**Galvanized steel with powder-coated paint**][**Molded polymer**][**Molded fiberglass-reinforced polyester**].

b. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with vibration isolation and overload protection.

1) Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins[**with capillary tube distributor on indoor coil**].
2) Accumulator.
3) Constant-pressure expansion valve.
4) Reversing valve.
5) Refrigerant: [**R-32**][**R-454B**]<**Insert refrigerant type**>.

c. Indoor Fan: Forward curved, centrifugal; with [**single-**][**two-**]speed motor and positive-pressure ventilation damper with [**concealed manual**][**electric**] operator.
d. Filters: Washable polyurethane in molded plastic frame.
e. Condensate Drain: Drain pan [**to direct condensate to outdoor coil for re-evaporation**][**and piping to direct condensate to building waste and vent piping**].

1) Comply with ASHRAE 62.1 for drain pan construction and connections.

f. Outdoor Fan: [**Forward curved, centrifugal**][**Propeller**][**Forward curved, centrifugal or propeller**] type [**with separate**][**driven by indoor fan**] motor.

1) Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a) Fan Motors: Permanently lubricated split capacitor.
b) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

9. Heating:

a. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.
b. Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins with two-way modulating control valve and air vent.

c. Gas Heat:

1) General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.86/CSA 2.32, "Vented Gas-Fired Space Heating Appliances," and with NFPA 54.
2) Type of Gas: [**Natural**][**Propane**].
3) Heat Exchanger: [**Aluminized**][**Stainless**] steel.
4) Burner:

a) Gas Valve: 100 percent safety, single-stage main gas valve; main shutoff valve; pressure regulator; safety pilot with electronic flame sensor; limit control, transformer; and combination ignition/fan timer control board.
b) Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.

5) Gas-Burner Safety Controls:

a) Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
b) Flame Rollout Switch: Installed on burner box; prevents burner operation.
c) Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

6) Combustion-Air Inducer: Centrifugal fan prepurges heat exchanger and vents combustion products; thermally protected motor includes sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.
7) Furnace Controls: Solid-state board for integrating ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

10. Controls:

a. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:

1) Low-Ambient Lockout Control: Prevents cooling-cycle operation below **40 deg F (5 deg C)** outdoor air temperature.
2) Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above **40 deg F (5 deg C)** and to supplemental heating below **plus 25 deg F (minus 4 deg C)**.
3) Temperature-Limit Control: Prevents occupant from exceeding preset[**setback or**] setup temperature.
4) Building Automation System Interface: Allows remote on-off control with setback temperature control.
5) Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on [**indoor**][**outdoor**] coil and reverses unit to melt frost.

b. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage, adjustable thermostat with heat anticipator; [**heat-off-cool-auto**][**heat-off-cool**] switch; and[**on-auto**] fan switch.
c. Outdoor Air:

1) Motorized intake damper. Open intake when unit indoor-air fan runs.
2) Manual intake damper.

B. Capacities and Characteristics:

1. Airflow: <**Insert cfm (L/s)**>.
2. Outdoor-Air Intake Rate: <**Insert cfm (L/s)**>.
3. Cooling Capacity:

    a. Total: <**Insert Btu/h (kW)**>.
    b. Sensible: <**Insert Btu/h (kW)**>.
    c. Energy-Efficiency Ratio: <**Insert number**>.
    d. Indoor Coil Entering-Air Dry Bulb Temperature: <**Insert deg F (deg C)**>.
    e. Indoor Coil Entering-Air Wet Bulb Temperature: <**Insert deg F (deg C)**>.
    f. Indoor Coil Leaving-Air Dry Bulb Temperature: <**Insert deg F (deg C)**>.
    g. Indoor Coil Leaving-Air Wet Bulb Temperature: <**Insert deg F (deg C)**>.
    h. Outdoor Coil Entering-Air Temperature: <**Insert deg F (deg C)**>.

4. Heat-Pump Capacity:

    a. Total: <**Insert Btu/h (kW)**>.
    b. Outdoor Temperature: <**Insert deg F (deg C)**>.

5. Electric Heat Capacity: <**Insert Btu/h (kW)**>.
6. Hydronic Heat Capacity:

    a. Total: <**Insert Btu/h (kW)**>.
    b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
    c. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
    d. Water Flow: <**Insert gpm (L/s)**>.
    e. Entering-Water Temperature: <**Insert deg F (deg C)**>.
    f. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

7. Gas Heat Capacity:

    a. Input: <**Insert Btu/h (kW)**>.
    b. Output: <**Insert Btu/h (kW)**>.
    c. AFUE: [**80**]<**Insert number**> percent.

8. Sound:

    a. Indoor: <**Insert decibels**>.
    b. Outdoor: <**Insert decibels**>.

9. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase: [**Single**][**Three**].
    c. Hertz: 60.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

C. Source Quality Control

1. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."
2. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION OF PACKAGED, TERMINAL AIR CONDITIONERS, THROUGH-WALL UNITS

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for piping specified in Section 231123 "Facility Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Unit is level on base and is flashed in exterior wall.
4. Unit casing has no visible damage.
5. Compressor, air-cooled condenser coil, and fans have no visible damage.
6. Labels are clearly visible.
7. Controls are connected and operable.
8. Shipping bolts, blocks, and tie-down straps are removed.
9. Filters are installed and clean.
10. Drain pan and drain line are installed correctly.
11. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.
12. Installation: Perform startup checks in accordance with manufacturer's written instructions, including the following:

    a. Lubricate bearings on fan.
    b. Check fan-wheel rotation for correct direction without vibration and binding.

13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After operational test, change filters.

E. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain packaged, terminal air conditioners.

END OF SECTION 23 81 13 11

Task	Specification	Specification Description
23 81 13 11	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 13 13 - PACKAGED TERMINAL AIR-CONDITIONERS, OUTDOOR, WALL-MOUNTED UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged, terminal air-conditioners, outdoor, wall-mounted units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: For packaged, terminal air conditioners.

1. Include plans, elevations, sections, details for wall penetrations,[**seismic bracing,**] and attachments to other work.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For packaged, terminal air conditioners, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged, terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion, including only components and excluding labor.
3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Energy Recovery Ventilator: : Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED TERMINAL AIR-CONDITIONERS, OUTDOOR, WALL-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bard Manufacturing Company**]
2. [**Compu-Aire, Inc**]
3. [**Liebert; Vertiv Holdings Co.**]
4. [**Marvair**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bard Manufacturing Company**]
2. [**Compu-Aire, Inc**]
3. [**Liebert; Vertiv Holdings Co.**]
4. [**Marvair**]
5. <**Insert manufacturer's name**>

C. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system,[**heating,**] and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis and circuit breaker.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

G. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.

H. ASHRAE ERV Testing: Applicable requirements in ASHRAE 84.

I. AHRI Rating: Applicable requirements in AHRI 1060.

J. UL listed and ETL performance certified.

2.2 CHASSIS

A. Cabinet: Sloped top, [**0.052-inch- (1.32-mm-)**]<**Insert dimension**> thick [**steel**][**aluminum**] with removable front panel with concealed latches.

1. Mounting: On exterior wall.
2. Discharge Grille: [**Extruded-aluminum discharge grille**][**Supply-air acoustical plenum**].
3. Return Grille: [**Extruded-aluminum grille**][**Return-air acoustical plenum**].
4. Louvers: [**Extruded aluminum with enamel finish**][**Stamped aluminum with clear-anodized finish**]; [**medium bronze**][**dark bronze**] color.
5. Finish: [**Epoxy coating**][**Baked enamel**].
6. Access Door: Hinged door in top of cabinet for access to controls.
7. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
8. Insulation: Cooling and heating sections fully insulated with **1-inch (25-mm)**-thick fiberglass insulation.
9. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
10. Wall Sleeves: [**Galvanized steel with polyester finish**][**Molded polymer**][**Molded fiberglass-reinforced polyester**].

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed[**, soft-start**] scroll compressor with [**crankcase heater,**] liquid line filter dryer, externally equalized expansion valve, high-pressure switch, [**low-pressure switch,**][**low-pressure bypass timer,**][**fan cycle, control, common alarm,**][**fan cycle, variable speed control, common alarm,**][**fan cycle, control, lockout relay, common alarm,**][**fan cycle, variable speed control, lockout relay, common alarm,**] vibration isolation, and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins[**with capillary tube distributor on indoor coil**].
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: [**R-407C**][**R-410A**].

C. Indoor Fan: Forward curved, centrifugal; with [**single**][**twin**][**constant-**][**variable-**]speed motor(s) and positive-pressure ventilation damper with [**concealed manual**][**electric**] operator.

D. Filters: [**Washable polyurethane in molded plastic frame**][**2-inch (25-mm), pleated, disposable MERV 6**], serviceable from front of the unit.

E. Condensate Drain: Coated galvanized-steel drain pan [**to direct condensate to outdoor coil for re-evaporation**][**and piping to direct condensate to building waste and vent piping**].

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: [**High-ambient**][**Forward curved, centrifugal**][**Propeller**][**Forward curved, centrifugal, or propeller**] type [**with separate**][**driven by indoor fan**] motor.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Fan Motors: Permanently lubricated split capacitor.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

G. Energy Recovery Wheel:

1. Casing: Steel with standard factory-painted finish.
2. Casing seals on periphery of rotor and on duct divider.
3. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings[**or permanently lubricated bearings**]. Support horizontal rotors on tapered roller bearing.
4. Rotor: Polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
5. Drive: Fractional horsepower motor, gear reducer, and self-adjusting multilink belt around outside of rotor.

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

6. Controls: Starting relay, factory mounted and wired, and manual motor starter for field wiring.

2.3 HEATING

A. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

B. Gas Heat:

1. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.86/CSA 2.32, "Vented Gas-Fired Space Heating Appliances," and with NFPA 54.
2. Type of Gas: [**Natural**][**Propane**].
3. Heat Exchanger: [**Stainless**] steel.
4. Burner:

   a. Gas Valve: 100 percent safety, [**two-stage**][**modulating**] main gas valve; main shutoff valve; pressure regulator; safety pilot with electronic flame sensor; limit control; transformer; and combination ignition/fan timer control board.
   b. Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.
   c. Field conversion kit for high altitude.

5. Gas-Burner Safety Controls:

   a. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
   b. Flame Rollout Switch: Installed on burner box; prevents burner operation.
   c. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

6. Combustion-Air Inducer: Centrifugal fan prepurges heat exchanger and vents combustion products; thermally protected motor includes sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.
7. Furnace Controls: Solid-state board for integrating ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

2.4 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:

   1. Low-Ambient Lockout Control: Prevents cooling-cycle operation below **40 deg F (5 deg C)** outdoor air temperature.
   2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above **40 deg F (5 deg C)** and to supplemental heating below **plus 25 deg F (minus 4 deg C)**.
   3. Temperature-Limit Control: Prevents occupant from exceeding preset[**setback or**] setup temperature.
   4. Building Automation System Interface: Allows remote on-off control with setback temperature control.
   5. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on [**indoor**][**outdoor**] coil and reverses unit to melt frost.

B. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage, adjustable thermostat with heat anticipator; [**heat-off-cool-auto**][**heat-off-cool**] switch; and[**on-auto**] fan switch.

C. Outdoor Air:

   1. Motorized intake damper. Open intake when unit indoor-air fan runs.
   2. Manual intake damper.

D. Economizer Operation: Motorized intake-air damper controlled by an enthalpy sensor and a mixed-air sensor to provide natural cooling when the outdoor air temperature is favorable.

E. Dual Unit Control (DUC): Hinged cover with two-stage heat/cool thermostat with individual heat/cool setpoints, adjustable interstage differentials and bimetallic elements. The control shall feature a solid-state timer with 1-2-4-8 day sequence, unit lead selector, Unit 1 and 2 power-on LEDs, Unit 1 or 2 lead unit LEDs, 48-hour program save on loss of power, industry standard connections, and 24-volt power from each unit. The DUC shall provide auto sequencing and displays on status and operating status parameters.

F. Three-Phase Power Rotation Monitor: Three-phase monitoring to protect compressor from reverse rotation and to protect the unit from phase failure. Monitor manually reset.

G. Ventilation:

1. Extra Ventilation: Section internally mounted, allowing up to 50% outside air and exhaust air through the action of adjustable dampers.
2. Energy Recovery Ventilator: [**One**][**Two**] rotary washable desiccant wheel(s), insulated cassette frame with seals, three-speed drive motor and belt, and intake and exhaust blowers.

H. Dehumidification Circuit: Supply-air stream, independent heat exchanger using a separate humidistat, hot gas three-way valve, separate desuperheating condenser circuit, and back drain orifice inserted between the reheat coil and suction line.

2.5 CAPACITIES AND CHARACTERISTICS

A. Airflow: <**Insert cfm (L/s)**>.

B. Outdoor-Air Intake Rate: <**Insert cfm (L/s)**>.

C. Cooling Capacity:

1. Total: <**Insert Btu/h (kW)**>.
2. Sensible: <**Insert Btu/h (kW)**>.
3. Energy-Efficiency Ratio: <**Insert number**>.
4. Indoor Coil Entering-Air Dry Bulb Temperature: <**Insert deg F (deg C)**>.
5. Indoor Coil Entering-Air Wet Bulb Temperature: <**Insert deg F (deg C)**>.
6. Indoor Coil Leaving-Air Dry Bulb Temperature: <**Insert deg F (deg C)**>.
7. Indoor Coil Leaving-Air Wet Bulb Temperature: <**Insert deg F (deg C)**>.
8. Outdoor Coil Entering-Air Temperature: <**Insert deg F (deg C)**>.

D. Heat-Pump Capacity:

1. Total: <**Insert Btu/h (kW)**>.
2. Outdoor Temperature: <**Insert deg F (deg C)**>.

E. Electric Heat Capacity: <**Insert Btu/h (kW)**>.

F. Hydronic Heat Capacity:

1. Total: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Water Flow: <**Insert gpm (L/s)**>.
5. Entering-Water Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

G. Gas Heat Capacity:

1. Input: <**Insert Btu/h (kW)**>.
2. Output: <**Insert Btu/h (kW)**>.
3. AFUE: [**80**]<**Insert number**> percent.

H. Exhaust Air:

1. Airflow: <**Insert cfm (L/s)**>.
2. Face Velocity: <**Insert fpm (m/s)**>.

3. Summer:

   a. Entering-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   b. Entering-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.

4. Winter:

   a. Entering-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   b. Entering-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.

5. Air-Pressure Drop: <**Insert inches wg (Pa)**>.

I. Supply Air:

1. Airflow: <**Insert cfm (L/s)**>.
2. Face Velocity: <**Insert fpm (m/s)**>.
3. Summer:

   a. Entering-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   b. Entering-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.

4. Winter:

   a. Entering-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   b. Entering-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.
   c. Leaving-Air Temperature, Dry Bulb: <**Insert deg F (deg C)**>.
   d. Leaving-Air Temperature, Wet Bulb: <**Insert deg F (deg C)**>.

5. Air-Pressure Drop: <**Insert inches wg (Pa)**>.

J. Wheel Drive:

1. Motor Size: <**Insert horsepower**>.
2. Motor Electrical Characteristics:

   a. Volts: [**120**][**208**][**230**]<**Insert value**>.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.

K. Effectiveness: <**Insert percent**>.

L. Sound:

1. Indoor: <**Insert bels**>.
2. Outdoor: <**Insert bels**>.

M. Electrical Characteristics:

1. Volts: <**Insert value**>.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION OF PACKAGED TERMINAL AIR-CONDITIONERS, OUTDOOR, WALL-MOUNTED UNITS

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for piping specified in Section 231123 "Facility Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Unit is level on base and is flashed in exterior wall.
4. Unit casing has no visible damage.
5. Compressor, air-cooled condenser coil, and fans have no visible damage.
6. Labels are clearly visible.
7. Controls are connected and operable.
8. Shipping bolts, blocks, and tie-down straps are removed.
9. Filters are installed and clean.
10. Drain pan and drain line are installed correctly.
11. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.
12. Installation: Perform startup checks according to manufacturer's written instructions, including the following:

    a. Lubricate bearings on fan.
    b. Check fan-wheel rotation for correct direction without vibration and binding.

13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After performance test, change filters.

E. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain packaged, terminal air conditioners.

END OF SECTION 23 81 13 13

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Task	Specification	Specification Description
23 81 13 13	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems
23 81 16 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 23 00 - SMALL CAPACITY COMPUTER-ROOM AIR-CONDITIONERS FLOOR-MOUNTED UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Small capacity (6 tons (21 kw) and smaller), computer-room air-conditioners, floor-mounted units.

1.2 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
4. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for computer-room air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.
2. Filters: [**One**]<**Insert number**> set(s) of filters for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.2 SMALL CAPACITY (6 TONS (21 KW) AND SMALLER), COMPUTER-ROOM AIR-CONDITIONERS, FLOOR-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Stulz-ATS**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Stulz-ATS**]
6. <**Insert manufacturer's name**>

C. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan,

filters, and controls; for vertical floor mounting in upflow or downflow configuration.

D. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with **1-inch- (25-mm-)** thick duct liner.

1. Floor Stand: Welded tubular steel, <**Insert required height**> high, with adjustable legs and vibration isolation pads[**with turning vanes mounted within the stand**].
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Unit with [**two**][**three**][**four**]-way, powder-coated insulated air distribution plenum.

E. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.

F. Refrigeration System:

1. Compressor: [**Digital**] Scroll, [**variable capacity,**]with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit:

   a. Low-pressure switch.
   b. Manually reset, high-pressure switch.
   c. Thermal-expansion valve with external equalizer.
   d. Sight glass with moisture indicator.
   e. Service shutoff valves.
   f. Charging valves.
   g. Hot-gas bypass.
   h. Refrigerant charge.

3. Refrigerant: [**R-407C**][**or**][**R-410A**]<**Insert type**>.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
5. Refrigerant line sets.
6. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

   a. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

7. Integral, Water-Cooled Refrigerant Condenser: Brazed-plate type with liquid-line stop valve and head-pressure-actuated, two-way regulating valve.

   a. Cooling Medium: [**Water**][**Glycol solution**].

8. Remote Air-Cooled Refrigerant Condenser:

   a. Integral, copper-tube aluminum-fin coil.
   b. Condenser with surge protection device (SPD) and locking disconnect in the enclosed electrical panel section.

9. Fan:

   a. Direct-drive, [**single**][**variable**]-speed propeller type.
   b. Belt-drive, single propeller type.

c. Direct-drive, [**single**][**variable**]-speed centrifugal type.
d. Belt-drive, single-speed centrifugal type.

10. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

G. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating [**two**][**three**]-way control valve and flow switch.

1. Cooling Medium: [**Water**][**Glycol solution**].
2. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

H. Hot-Water Reheat: Copper-tube, aluminum-fin coil with two-way, modulating control valve, and cleanable Y-strainer.

I. Remote Air-Cooled, Glycol-Solution Cooler:

1. Corrosion-resistant cabinet.
2. Copper-tube, aluminum-fin coil.
3. Head-pressure-actuated, three-way, water-regulating valve.
4. Motorized ball valve.
5. Direct-drive propeller fan with fan guards.
6. Single-phase motors with internal overload protection.
7. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Glycol-Solution Pump Package:

1. Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing [**one**][**two**] centrifugal pump(s) with mechanical seal(s)[**and lead/lag control**].
2. Piping: Interconnecting piping, from suction to discharge, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
3. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of **minus 40 deg F (minus 40 deg C)**.
4. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

K. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor and high-temperature-limit switches.
2. SCR to proportionally control the reheat elements providing precise temperature control.

L. Pre-Filter: [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable, pleated, glass-fiber media.

M. Filter: [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable, pleated, glass-fiber media.

1. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
2. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
3. Pre-Filter Minimum Efficiency Reporting Value and Average Arrestance:

a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**]<**Insert value**> and corresponding average arrestance according to ASHRAE 52.2.

4. Pre-Filter Minimum Efficiency Reporting Value:

   a. [**MERV 6**]<**Insert value**> according to ASHRAE 52.2.

5. Filter Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**> according to ASHRAE 52.2.

N. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and located in bypass airstream; with flush-cycle timer and solenoid drain valve.

O. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

P. Ultrasonic Steam Humidifier: Self-contained, microprocessor-controlled unit with nebulizing modules, piezoelectric transducer, printed circuit control board, and fitted nebula distribution device cover.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, high and low water floats, heat sink dissipater, and drain with integral air gap.
2. Control: [**On/off**][**Proportional to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity**].
3. Drain Cycle: Field-adjustable drain duration and drain interval. If the humidifier is idle for 72 hours an automatic drain cycle shall occur.
4. Boost fan.
5. Vertical mounting rack.

Q. Disconnect Switch:

1. [**Locking**][**Non-locking**] disconnect with handle accessible with the door closed.
2. Non-locking, non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

R. Control System:

1. Microprocessor [**unit**][**remote**]-mounted panel.
2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.
5. Control transformer with circuit breaker.
6. Solid-state temperature-[**and humidity-**]control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.

11. High-temperature thermostat.
12. Solid-state, wall-mounted control panel with start-stop switch[**, adjustable humidity set point,**][**remote temperature sensors**][**remote humidity sensors**] and adjustable temperature set point.
13. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

S. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
4. <**Insert unique motor characteristics**>.

2.3 CAPACITIES AND CHARACTERISTICS

A. Unit Configuration: [**Draw**][**Blow**] through.

B. Supply-Air Fan:

1. Number of Fans: [**One**][**Two**]<**Insert number**>.
2. Airflow: <**Insert cfm (L/s)**>.
3. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
4. Motor Size: <**Insert number**> hp.

C. Refrigeration System:

1. Unit Energy Efficiency: [**COP**][**EER**].
2. Refrigerant Compressor:

   a. Total Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   c. Number of Compressors: [**One**][**Two**]<**Insert number**>.
   d. Motor Size: <**Insert number**> hp.

3. Refrigerant Evaporator Coil:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   c. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
   d. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   e. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Water-Cooled Refrigerant Condenser:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Condenser-Water Flow: <**Insert gpm (L/s)**>.
   c. Cooling Medium: [**Water**][**Glycol solution**].
   d. Entering-Water Temperature: <**Insert deg F (deg C)**>.
   e. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

5. Air-Cooled Refrigerant Condenser:

    a. Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
    c. Number of Condenser Fan Motors: <**Insert number**>.
    d. Condenser Fan Motors: <**Insert number**> hp.

D. Hydronic Cooling Coil:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
6. Fluid Flow: <**Insert gpm (L/s)**>.
7. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Cooling Medium: [**Water**][**Glycol solution**].

E. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Glycol Flow: <**Insert gpm (L/s)**>.
5. Entering-Glycol Temperature: <**Insert deg F (deg C)**>.
6. Number of Fans: <**Insert number**>.
7. Fan Motors: <**Insert number**> hp.
8. Number of Pumps: <**Insert number**>.
9. Pump Motors: <**Insert number**> hp.

F. Hydronic Reheating Coil:

1. Total: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Water Flow: <**Insert gpm (L/s)**>.
5. Entering-Water Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
7. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

G. Electric-Resistance Reheating Coil:

1. Total Capacity: <**Insert kilowatts**>.
2. Stages of Heating: [**1**][**2**]<**Insert number**>.

H. Humidifier:

1. Total: <**Insert lb/h (kg/h)**>.
2. Input: <**Insert Btu/h (kW)**>.

I. Electrical Characteristics:

1. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.[**Install according to AHRI Guideline B.**]

D. Computer-Room Air-Conditioner Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

E. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**] Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

F. Air-Cooled Refrigerant Condenser Mounting: Install using [**elastomeric pads**][**elastomeric**

mounts][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

G. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

H. Glycol-Solution Pump Package Mounting: Install using [**elastomeric pads**][**elastomeric mounts**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Hot-Water Heating Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to heating coils.

E. Condenser-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in water inlet and outlet piping on water-cooled units.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature[**and humidity**] set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 23 81 23 00

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SECTION 23 81 23 00A - COMPUTER-ROOM AIR-CONDITIONERS, CONSOLE UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-room air-conditioners, console units.

1.2 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
4. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers

of the items involved.

B. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.
2. Filters: [**One**]<**Insert number**> set(s) of filters for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room air-conditioners, console units shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when

subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.2 COMPUTER-ROOM AIR-CONDITIONERS, CONSOLE UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Compu-Aire, Inc**]
2. [**Data Aire Inc**]
3. [**Liebert; Vertiv Holdings Co.**]
4. [**Stulz-ATS**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Compu-Aire, Inc**]
2. [**Data Aire Inc**]
3. [**Liebert; Vertiv Holdings Co.**]
4. [**Stulz-ATS**]
5. <**Insert manufacturer's name**>

C. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.

D. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.

1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.

F. Refrigeration System:

1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension

system, and crankcase heater.

2. Refrigeration Circuit:

   a. Filter/dryer.
   b. Manual-reset high-pressure switch.
   c. Thermal-expansion valve with external equalizer.
   d. Sight glass with moisture indicator.
   e. Service shutoff valves.
   f. Charging valves.
   g. Hot-gas bypass.
   h. Refrigerant charge.

3. Refrigerant: [**R-407C**][**or**][**R-410A**]<**Insert type**>.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
5. Refrigerant line sets precharged in lengths of [**15 feet (4.5 m)**][**30 feet (9.0 m)**].
6. Refrigerant line sweat adapter kit to permit field brazing of refrigerant lines.

   a. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

7. Integral, Water-Cooled Refrigerant Condenser: [**Coaxial, counter-flow, tube-in-tube**][**Brazed-plate**] type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.
8. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, [**propeller**][**centrifugal**] fan.
9. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

G. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve.

1. Cooling Medium: [**Water**][**Glycol solution**].
2. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

H. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Corrosion-resistant cabinet.
2. Copper-tube aluminum-fin coil.
3. Direct-drive propeller fan with fan guards.
4. Single-phase motor with internal overload protection.
5. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Glycol-Solution Pump Package:

1. Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing [**one**][**two**] centrifugal pump(s) with mechanical seal(s)[**and lead/lag control**].
2. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
3. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of **minus 40 deg F (minus 40 deg C)**.

4. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor and high-temperature-limit switches.
2. SCR to proportionally control the reheat elements providing precise temperature control.

K. Filter, Cleanable: Polypropylene monofilament over expanded aluminum with aluminum frame.

L. Filter, Disposable: **1-inch- (25-mm-)** thick, disposable, glass-fiber media.

1. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
2. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
3. Pre-Filter Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**]<**Insert value**> and corresponding average arrestance according to ASHRAE 52.2.

4. Pre-Filter Minimum Efficiency Reporting Value:

   a. [**MERV 6**]<**Insert value**> according to ASHRAE 52.2.

5. Filter Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**> according to ASHRAE 52.2.

M. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

N. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

O. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V ac input power.

P. Control System:

1. Microprocessor, wall-mounted panel interfacing with the unit controls.
2. Contactors.
3. Control transformer with circuit breaker.
4. Solid-state, temperature-[**and humidity-**]control modules.
5. Solid-state, unit-mounted control panel with start-stop switch[**, adjustable humidity set point,**] and adjustable temperature set point.
6. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

Q. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
4. <**Insert unique motor characteristics**>.

2.3 CAPACITIES AND CHARACTERISTICS

A. Unit Configuration: [**Draw**][**Blow**] through.

B. Supply-Air Fan:

1. Airflow: <**Insert cfm (L/s)**>.
2. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
3. Motor Size: <**Insert number**> hp.

C. Refrigeration System:

1. Unit Energy Efficiency: [**COP**][**EER**].
2. Refrigerant Compressor:

   a. Total Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   c. Number of Compressors: [**One**][**Two**]<**Insert number**>.
   d. Motor Size: <**Insert number**> hp.

3. Refrigerant Evaporator Coil:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   c. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
   d. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   e. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Water-Cooled Refrigerant Condenser:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Condenser Water Flow: <**Insert gpm (L/s)**>.
   c. Cooling Medium: [**Water**][**Glycol solution**].
   d. Entering-Water Temperature: <**Insert deg F (deg C)**>.
   e. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

5. Air-Cooled Refrigerant Condenser:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
   c. Number of Condenser Fan Motors: <**Insert number**>.
   d. Condenser Fan Motors: <**Insert number**> hp.

D. Hydronic Cooling Coil:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
6. Fluid Flow: <**Insert gpm (L/s)**>.
7. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Cooling Medium: [**Water**][**Glycol solution**].

E. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Glycol Flow: <**Insert gpm (L/s)**>.
5. Entering-Glycol Temperature: <**Insert deg F (deg C)**>.
6. Number of Fans: <**Insert number**>.
7. Fan Motors: <**Insert number**> hp.
8. Number of Pumps: <**Insert number**>.
9. Pump Motors: <**Insert number**> hp.

F. Electric-Resistance Reheating Coil:

1. Total Capacity: <**Insert kilowatts**>.
2. Stages of Heating: [**1**][**2**]<**Insert number**>.

G. Humidifier:

1. Total: <**Insert lb/h (kg/h)**>.
2. Input: <**Insert Btu/h (kW)**>.

H. Electrical Characteristics:

1. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be

installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMPUTER-ROOM AIR-CONDITIONERS, CONSOLE UNITS

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.[**Install according to AHRI Guideline B.**]

D. Computer-Room Air-Conditioner Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

E. Air-Cooled Refrigerant Condenser Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

F. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

G. Glycol-Solution Pump Package Mounting: Install using [**elastomeric pads**][**elastomeric mounts**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Condenser-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in water inlet and outlet piping on water/glycol-cooled units.

E. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature[**and humidity**] set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 23 81 23 00A

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SECTION 23 81 23 00B - COMPUTER-ROOM, RACK-COOLING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-room, rack-cooling equipment.
2. Central refrigeration unit.
3. Horizontally mounted rack-cooling module.
4. Overhead-mounted rack-cooling module.
5. Rear-mounted rack-cooling module.
6. Top-mounted rack-cooling module.
7. Fan module.
8. Refrigerant.
9. Motors.

1.2 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room, rack-cooling equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
4. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings: For central refrigeration units and rack-cooling units.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinets and discharge grille and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Certificates: For computer-room rack-cooling equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room, rack-cooling equipment to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan: [**One**]<**Insert number**>.
2. Pump: [**One**]<**Insert number**>.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room, rack-cooling equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPUTER-ROOM, RACK-COOLING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Liebert; Vertiv Holdings Co.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Liebert; Vertiv Holdings Co.**]
3. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room, rack-cooling equipment shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 CENTRAL REFRIGERATION UNIT

A. Description: Packaged, factory assembled, wired, and piped; consisting of cabinet, refrigeration system, heat exchanger, and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame.

C. Pumps: [**One**][**Two**], factory piped and wired.

D. Heat Exchanger: Brazed plate, Type 316 stainless-steel plates.

E. Chilled-Water Valve: Modulating, two-way valve, responding to room dew point temperature changes to optimize the supply water temperature to avoid condensation.

F. Compressor: Scroll type with a suction gas-cooled motor, vibration isolators, thermal overloads, manual reset high-pressure switch, and pump down low-pressure switch.

G. Control System:

1. Unit-mounted microprocessor panel interfacing with the unit controls consisting of contactors, control transformer with circuit breaker, solid-state temperature-[**and humidity-**]control modules and start-stop switch, [**adjustable humidity set point,**]and adjustable temperature set point.
2. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

H. Capacities and Characteristics:

1. Refrigeration System:

a. Unit Energy Efficiency: [**COP**][**EER**].
b. Refrigerant Compressor:

1) Total Unit Cooling Capacity: <**Insert Btu/h (kW)**>.

c. Sensible Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
d. Number of Compressors: [**One**][**Two**]<**Insert number**>.
e. Motor Size: <**Insert number**> hp.
f. Refrigerant Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Entering-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
3) Leaving-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
4) Entering-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.

g. Water-Cooled Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Primary Water Flow: <**Insert gpm (L/s)**>.
3) Cooling Medium: [**Water**][**Glycol solution**].
4) Entering-Water Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Water Temperature: <**Insert deg F (deg C)**>.
6) Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

2. Electrical Characteristics:

a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 HORIZONTALLY MOUNTED RACK-COOLING MODULE

A. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet cooling coil and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame.

C. Cooling Coil: Aluminum microchannel with drip pan.

D. Electrical Components:

1. Each module shall be equipped with two sets of two **10-foot (3-m)** power cords with automatic switching, primary and secondary, attached with IEC connectors to the rear of the unit.
2. Each cord shall have a NEMA 5-15P (IEC 320-C14) plug at the end.
3. CE-listed version of the unit shall have permanently attached power cords.

E. Refrigerant Piping: ACR copper tubing with brazed joints. Factory-installed piping shall be leak tested and pressure tested prior to shipment from the factory. Factory-supplied pipe connections for field piping.

F. Discharge Diffusers: Mounted on the unit front, discharging to one or both sides.

G. Control System:

1. Factory-installed control boards and condensate detection for the drip pan.
2. Module with connection points (dry contacts) in the electrical box for connection of outgoing alarm cables for condensate detection, fan failure, and remote shutdown.

H. Capacities and Characteristics:

1. Supply-Air Fan:

a. Number of Fans: [**Six**]<**Insert number**> axial fans with finger guards.
b. Airflow: <**Insert cfm (L/s)**>.
c. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
d. Refrigerant Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Entering-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
3) Entering-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.
4) Leaving-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.

2. Electrical Characteristics:

a. Motor Size: <**Insert number**> hp.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 OVERHEAD-MOUNTED RACK-COOLING MODULE

A. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet cooling coil and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame.

C. Cooling Coil: Aluminum microchannel with drip pan.

D. Electrical Components:

1. 20-A, 120-V ac receptacle.
2. Lighting fixture mounting capable.

E. Refrigerant Piping: ACR copper tubing with brazed joints. Factory-installed piping shall be leak tested and pressure tested prior to shipment from the factory. Factory-supplied pipe connections for field piping.

F. Capacities and Characteristics:

1. Supply-Air Fan:

a. Number of Fans: [**Six**]<**Insert number**> axial fans with finger guards.
b. Airflow: <**Insert cfm (L/s)**>.
c. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
d. Refrigerant Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Entering-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
3) Entering-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.
4) Leaving-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.

2. Electrical Characteristics:

a. Motor Size: <**Insert number**> hp.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

2.6 REAR-MOUNTED RACK-COOLING MODULE

A. Description: Packaged, factory assembled, prewired, consisting of cabinet, refrigeration coils and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame with self-locking door latch.

C. Cooling Coils: Two aluminum microchannels with drip pan.

D. Dual power cords with 20-A, 120-V ac receptacle.

E. Refrigerant Piping: ACR copper tubing with brazed joints. Factory-installed piping shall be leak tested and pressure tested prior to shipment from the factory. Factory-supplied pipe connections for field piping.

F. Rack Mounting Kit: Black painted steel.

G. Capacities and Characteristics:

1. Supply-Air Fan:

a. Number of Fans: [**Six**]<**Insert number**> axial fans with finger guards.
b. Airflow: <**Insert cfm (L/s)**>.
c. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
d. Refrigerant Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Entering-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
3) Entering-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.
4) Leaving-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.

2. Electrical Characteristics:

a. Motor Size: <**Insert number**> hp.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

2.7 TOP-MOUNTED RACK-COOLING MODULE

A. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet cooling coil and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame.

C. Cooling Coil: Aluminum microchannel with drip pan.

D. Electrical Components:

1. Each module shall be equipped with two sets of two **10-foot (3-m)** power cords with automatic switching, primary and secondary, attached with IEC connectors to the rear of the unit.
2. Each cord shall have a NEMA 5-15P (IEC 320-C14) plug at the end.
3. CE-listed version of the unit shall have permanently attached power cords.

E. Refrigerant Piping: ACR copper tubing with brazed joints. Factory-installed piping shall be leak tested and pressure tested prior to shipment from the factory. Factory-supplied pipe connections for field piping.

F. Discharge Diffusers: Mounted on the unit front, discharging to one or both sides.

G. Capacities and Characteristics:

1. Supply-Air Fan:

a. Number of Fans: [**Six**]<**Insert number**> axial fans with finger guards.
b. Airflow: <**Insert cfm (L/s)**>.
c. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
d. Refrigerant Heat Exchanger:

1) Cooling Capacity: <**Insert Btu/h (kW)**>.
2) Entering-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
3) Entering-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.
4) Leaving-Primary Refrigerant Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Secondary Refrigerant Temperature: <**Insert deg F (deg C)**>.

2. Electrical Characteristics:

a. Motor Size: <**Insert number**> hp.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

2.8 FAN MODULE

A. Description: Packaged, factory assembled, prewired, consisting of cabinet, fans and controls.

B. Cabinet and Frame: Powder-painted cabinet, hinged doors, and welded tubular steel frame.

C. Dual power cords with 20-A, 120-V ac receptacle.

D. Capacities and Characteristics:

1. Supply-Air Fan:

a. Number of Fans: [**Six**]<**Insert number**> axial fans with finger guards.
b. Airflow: <**Insert cfm (L/s)**>.
c. Minimum Static Pressure: <**Insert inches wg (kPa)**>.

2. Electrical Characteristics:

a. Motor Size: <**Insert number**> hp.
b. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
c. Phase: [**Single**][**Three**].
d. Hertz: 60.
e. Full-Load Amperes: <**Insert value**>.
f. Minimum Circuit Ampacity: <**Insert value**>.
g. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 REFRIGERANT

A. Refrigerant Type: [**R-134A**]<**Insert type**>.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
3. <**Insert unique motor characteristics**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for refrigeration piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMPUTER-ROOM, RACK-COOLING EQUIPMENT

A. Layout and install computer-room rack-cooling equipment and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room, rack-cooling equipment level and plumb, maintaining manufacturer's recommended clearances.[**Install according to AHRI Guideline B.**]

C. Suspended Units: Install using continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of computer-room, rack-cooling equipment.

1. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**] Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room rack-cooling equipment, allow space for service and maintenance.

C. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room rack-cooling equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room, rack-cooling equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature[**and humidity**] set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain computer-room, rack-cooling equipment.

END OF SECTION 23 81 23 00B

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Task	Specification	Specification Description
23 81 23 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 23 12 - LARGE CAPACITY (7 TONS (25 KW) AND LARGER), COMPUTER-ROOM AIR-CONDITIONERS, FLOOR-MOUNTED UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Large capacity (7 tons (25 kW) and larger), computer-room air-conditioners, floor-mounted units.

1.2 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
4. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for computer-room air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.
2. Filters: [**One**]<**Insert number**> set(s) of filters for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LARGE CAPACITY (7 TONS (25 KW) AND LARGER), COMPUTER-ROOM AIR-CONDITIONERS, FLOOR-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]
4. [**HUNTAIR; A Nortek Air Solutions Company**]
5. [**Liebert; Vertiv Holdings Co.**]
6. [**Stulz-ATS**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]
4. [**HUNTAIR; A Nortek Air Solutions Company**]
5. [**Liebert; Vertiv Holdings Co.**]
6. [**Stulz-ATS**]
7. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

B. Cabinet and Frame: Welded tubular-steel frame with removable [**single**][**double**]-thick steel panels and insulated with [**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**] thick duct liner.

1. Floor Stand: Welded tubular steel, [**4 inches (100 mm)**][**6 inches (150 mm)**]<**Insert dimension**> high, with adjustable legs and vibration isolation pads[**with turning vanes mounted within the stand**].
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Unit with [**two**][**three**][**four**]-way, powder-coated insulated air distribution plenum.

C. Supply-Air Fan:

1. Forward curved, double width, double inlet, centrifugal, with adjustable V-belt drive.
2. Plenum, single inlet, direct drive, electronically commutated, and variable speed.

D. Refrigeration System:

1. Compressor: [**Semihermetic**][**Scroll**][**Digital scroll**], [**variable capacity**]with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit:

a. Two independent circuits with hot-gas mufflers.
b. Low-pressure switch.
c. Manually reset, high-pressure switch.
d. Thermal-expansion valve with external equalizer.
e. Sight glass with moisture indicator.
f. Service shutoff valves.
g. Charging valves.
h. Hot-gas bypass.
i. Refrigerant charge.

3. Refrigerant: [**R-407C**][**or**][**R-410A**]<**Insert type**>.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.

a. Mount stainless-steel drain pan[**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

5. Integral, Water-Cooled Refrigerant Condenser: Brazed-plate type with liquid-line stop valve and head-pressure-actuated, two-way regulating valve.

a. Cooling Medium: [**Water**][**Glycol solution**].

6. Remote Air-Cooled Refrigerant Condenser:

a. Integral, copper-tube aluminum-fin coil.
b. Condenser with surge protection device (SPD) and locking disconnect in the enclosed

electrical panel section.

7. Fan:

   a. Direct-drive, [**single**][**variable**]-speed propeller type.
   b. Belt-drive, single-speed propeller type.
   c. Direct-drive, [**single**][**variable**]-speed centrifugal type.
   d. Belt-drive, single-speed centrifugal type.

8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

E. Hydronic Cooling Coil: Seamless [**copper**][**copper nickel**] tubes expanded into aluminum fins[**having polymeric coating**], modulating [**two**][**three**]-way control valve, and flow switch.

1. Cooling Medium: [**Water**][**Glycol solution**].
2. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

F. Hot-Gas Reheat: Copper-tube, aluminum-fin coil with three-way solenoid valve and refrigerant check valve.

G. Hot-Water Reheat: Copper-tube, aluminum-fin coil with two-way, modulating control valve and cleanable Y-strainer.

H. Remote Air-Cooled, Glycol-Solution Cooler:

1. Corrosion-resistant cabinet.
2. Copper-tube aluminum-fin coil.
3. Head-pressure-actuated, three-way, water-regulating valve.
4. Motorized ball valve.
5. Direct-drive propeller fan with fan guards.
6. Single-phase motors with internal overload protection.
7. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Glycol-Solution Pump Package:

1. Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing [**one**][**two**] centrifugal pump(s) with mechanical seal(s)[**and lead/lag control**].
2. Piping: Interconnecting piping, from suction to discharge, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
3. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of **minus 40 deg F (minus 40 deg C)**.
4. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor and high-temperature-limit switches.
2. SCR to proportionally control the reheat elements providing precise temperature control.

K. Pre-Filter: [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable, pleated, glass-fiber media.

L. Final Filter: [**2-inch- (50-mm-)**][**4-inch- (100-mm-)**] thick, disposable, pleated, glass-fiber media.

1. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
2. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
3. Pre-Filter Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**]<**Insert value**> and corresponding average arrestance according to ASHRAE 52.2.

4. Pre-Filter Minimum Efficiency Reporting Value:

   a. [**MERV 6**]<**Insert value**> according to ASHRAE 52.2.

5. Filter Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**> according to ASHRAE 52.2.

M. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

N. Ultrasonic Steam Humidifier: Self-contained, microprocessor-controlled unit with nebulizing modules, piezoelectric transducer, printed circuit control board and fitted nebula distribution device cover.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, high and low water floats, heat sink dissipater, and drain with integral air gap.
2. Control: [**On/off**][**Proportional to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity**].
3. Drain Cycle: Field-adjustable drain duration and drain interval. If the humidifier is idle for 72 hours, an automatic drain cycle shall occur.
4. Boost fan.
5. Vertical mounting rack.

O. Disconnect Switch:

1. [**Locking**][**Non-locking**] disconnect with handle accessible with the door closed.
2. Non-locking, non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

P. Control System:

1. Microprocessor [**unit**][**remote**]-mounted panel.
2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.

5. Control transformer with circuit breaker.
6. Solid-state temperature-[**and humidity-**]control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.
11. High-temperature thermostat.
12. Solid-state, wall-mounted control panel with start-stop switch[**, adjustable humidity set point,**][**remote temperature sensors**][**remote humidity sensors**] and adjustable temperature set point.
13. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.
14. Sequential load activation, periodic hot-water-reheat coil flushing, and self-diagnostics.

Q. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
4. Type: [**Open dripproof**][**Totally enclosed fan cooled**].

R. <**Insert unique motor characteristics**>.

2.4 CAPACITIES AND CHARACTERISTICS

A. Unit Configuration: [**Draw**][**Blow**] through.

B. Supply-Air Fan:

1. Number of Fans: [**One**][**Two**]<**Insert number**>.
2. Airflow: <**Insert cfm (L/s)**>.
3. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
4. Motor Size: <**Insert number**> hp.

C. Refrigeration System:

1. Unit Energy Efficiency: [**COP**][**EER**].
2. Refrigerant Compressor:

   a. Total Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
   c. Number of Compressors: [**One**][**Two**]<**Insert number**>.
   d. Motor Size: <**Insert number**> hp.

3. Refrigerant Evaporator Coil:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   c. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
   d. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   e. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Water-Cooled Refrigerant Condenser:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Condenser Water Flow: <**Insert gpm (L/s)**>.
   c. Cooling Medium: [**Water**][**Glycol solution**].
   d. Entering-Water Temperature: <**Insert deg F (deg C)**>.
   e. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

5. Air-Cooled Refrigerant Condenser:

   a. Cooling Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
   c. Number of Condenser Fan Motors: <**Insert number**>.
   d. Condenser Fan Motors: <**Insert number**> hp.

D. Hydronic Cooling Coil:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
6. Fluid Flow: <**Insert gpm (L/s)**>.
7. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Cooling Medium: [**Water**][**Glycol solution**].

E. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Glycol Flow: <**Insert gpm (L/s)**>.
5. Entering-Glycol Temperature: <**Insert deg F (deg C)**>.
6. Number of Fans: <**Insert number**>.
7. Fan Motors: <**Insert number**> hp.
8. Number of Pumps: <**Insert number**>.
9. Pump Motors: <**Insert number**> hp.

F. Hydronic Reheating Coil:

1. Total: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Water Flow: <**Insert gpm (L/s)**>.
5. Entering-Water Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
7. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

G. Electric-Resistance Reheating Coil:

1. Total Capacity: <**Insert kilowatts**>.
2. Stages of Heating: [**1**][**2**]<**Insert number**>.

H. Humidifier:

1. Total: <**Insert lb/h (kg/h)**>.
2. Input: <**Insert Btu/h (kW)**>.

I. Electrical Characteristics:

1. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.[**Install according to AHRI Guideline B.**]

D. Computer-Room Air-Conditioner Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

E. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**] Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

F. Air-Cooled Refrigerant Condenser Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

G. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

H. Glycol-Solution Pump Package Mounting: Install using [**elastomeric pads**][**elastomeric mounts**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Hot-Water Heating Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to heating coils.

E. Condenser-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in water inlet and outlet piping on water-cooled units.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and

inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature[**and humidity**] set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 23 81 23 12

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Task	Specification	Specification Description
23 81 23 12	23 81 23 00	Small Capacity Computer-Room Air-Conditioners Floor-Mounted Units
23 81 23 12	23 81 23 13	Computer-Room Air-Conditioners, Ceiling-Mounted Units
23 81 23 12	23 81 23 00a	Computer-Room Air-Conditioners, Console Units
23 81 23 12	23 81 23 00b	Computer-Room, Rack-Cooling Equipment
23 81 23 12	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 23 13 - COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Computer-room air conditioners, ceiling-mounted units.

1.2 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon-controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
3. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components,

from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-driven fan.
2. Filters: [**One**]<**Insert number**> set(s) of filters for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**five**][**10**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than [**three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]

4. [**Liebert; Vertiv Holdings Co.**]
5. [**Stulz-ATS**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Compu-Aire, Inc**]
3. [**Data Aire Inc**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Stulz-ATS**]
6. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room air-conditioners, ceiling-mounted units shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.

1. Mounting Configuration:

a. Exposed in the space.
b. Fit T-bar in lay-in ceiling opening.
c. Concealed above a hard ceiling.

B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with **1/2-inch-(13-mm-)** thick duct liner, and mounting bracket attached to the unit.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of **24 by 48 inches (610 by 1220 mm)**, with filter.
2. Unit with supply and return collars for ducting in the field.
3. Unit with **24-by-48-inch (610-by-1220-mm)** air distribution plenum, with integral MERV 8 filter and three-way air distribution.
4. Unit with two-speed, centrifugal direct-drive fan.
5. Unit with single-speed, centrifugal belt-driven fan.
6. Unit with high static blower assembly consisting of field-attached blower box with double-inlet, centrifugal belt-driven fan; with single-speed motor mounted on an adjustable base, and providing up to **2 inches wc (500 Pa)** of external pressure.
7. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Supply-Air Fan:

1. Forward curved, double width, double inlet, centrifugal, with adjustable V-belt drive.
2. Plug/plenum, single inlet, direct drive, electronically commutated, and variable speed.

D. Refrigeration System:

1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit Components:

    a. Low-pressure switch.
    b. Manually reset, high-pressure switch.
    c. Thermal-expansion valve with external equalizer.
    d. Sight glass with moisture indicator.
    e. Service shutoff valves.
    f. Charging valves.
    g. Hot-gas bypass.
    h. Refrigerant charge.

3. Refrigerant: [**R-407C**][**or**][**R-410A**]<**Insert type**>.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
5. Refrigerant line sets precharged in lengths of [**15 feet (4.6 m)**][**30 feet (9.0 m)**] and of sufficient length to serve the unit from its condensing unit.
6. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

    a. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

7. Integral, Water-Cooled Refrigerant Condenser: [**Coaxial, counterflow, tube-in-tube**][**Brazed-plate**] type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.

    a. Cooling Medium: [**Water**][**Glycol solution**].

8. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, [**propeller**][**centrifugal**] fan.
9. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.

1. Cooling Medium: [**Water**][**Glycol solution**].
2. Mount stainless-steel drain pan [**complying with ASHRAE 62.1**][**and**][**having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir**] under coil assembly.

F. Hot-Water Reheat: Copper-tube, aluminum-fin coil with two-way, modulating control valve and cleanable Y-strainer.

G. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Corrosion-resistant cabinet.
2. Copper-tube aluminum-fin coil.
3. Direct-drive propeller fan with fan guards.
4. Single-phase motors with internal overload protection.

H. Glycol-Solution Pump Package:

1. Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
2. Piping: Interconnecting piping, to and from remote, air-cooled glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
3. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of **minus 40 deg F (minus 40 deg C)**.

I. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor.
2. Dehumidification relay.
3. High-temperature-limit switches.
4. SCR to proportionally control the reheat elements providing precise temperature control.

J. Filter: **1-inch- (25-mm-)** thick, disposable, glass-fiber media.

1. Initial Resistance: <**Insert number**> **inches wg (Pa)**.
2. Recommended Final Resistance: <**Insert number**> **inches wg (Pa)**.
3. Pre-Filter Minimum Efficiency Reporting Value and Average Arrestance:

   a. MERV Rating: [**MERV 1**][**MERV 2**][**MERV 3**][**MERV 4**]<**Insert value**> and corresponding average arrestance according to ASHRAE 52.2.

4. Pre-Filter Minimum Efficiency Reporting Value:

   a. [**MERV 6**]<**Insert value**> according to ASHRAE 52.2.

5. Filter Minimum Efficiency Reporting Value:

   a. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**> according to ASHRAE 52.2.

K. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.

2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

L. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

M. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.

N. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V input power.

O. Control System:

1. Microprocessor [**unit**][**remote**]-mounted panel.
2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.
5. Control transformer with circuit breaker.
6. Solid-state temperature-[**and humidity-**]control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.
11. Filter clog switch.
12. Alarm contacts.
13. High-temperature thermostat.
14. Solid-state, wall-mounted control panel with start-stop switch[**, adjustable humidity set point,**][**remote temperature sensors**][**remote humidity sensors**] and adjustable temperature set point.
15. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

P. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   c. <**Insert unique motor characteristics**>.

2.4 CAPACITIES AND CHARACTERISTICS

A. Supply-Air Fan:

1. Airflow: <**Insert cfm (L/s)**>.
2. Minimum Static Pressure: <**Insert inches wg (kPa)**>.
3. Motor Size: <**Insert number**> hp.

B. Refrigeration System:

1. Unit Energy Efficiency: [**COP**][**EER**].
2. Refrigerant Compressor:

    a. Total Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Sensible Unit Cooling Capacity: <**Insert Btu/h (kW)**>.
    c. Number of Compressors: [**One**][**Two**]<**Insert number**>.
    d. Motor Size: <**Insert number**> hp.

3. Refrigerant Evaporator Coil:

    a. Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    c. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    d. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    e. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Water-Cooled Refrigerant Condenser:

    a. Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Condenser Water Flow: <**Insert gpm (L/s)**>.
    c. Cooling Medium: [**Water**][**Glycol solution**].
    d. Entering-Water Temperature: <**Insert deg F (deg C)**>.
    e. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

5. Air-Cooled Refrigerant Condenser:

    a. Cooling Capacity: <**Insert Btu/h (kW)**>.
    b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
    c. Number of Condenser Fan Motors: <**Insert number**>.
    d. Condenser Fan Motors: <**Insert number**> hp.

C. Hydronic Cooling Coil:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
6. Fluid Flow: <**Insert gpm (L/s)**>.
7. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Cooling Medium: [**Water**][**Glycol solution**].

D. Remote, Air-Cooled, Glycol-Solution Cooler:

1. Cooling Coil Capacity: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
4. Glycol Flow: <**Insert gpm (L/s)**>.
5. Entering-Glycol Temperature: <**Insert deg F (deg C)**>.
6. Number of Fans: <**Insert number**>.
7. Fan Motors: <**Insert number**> hp.
8. Number of Pumps: <**Insert number**>.
9. Pump Motors: <**Insert number**> hp.

E. Hydronic Reheating Coil:

1. Total: <**Insert Btu/h (kW)**>.
2. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
3. Leaving-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
4. Water Flow: <**Insert gpm (L/s)**>.
5. Entering-Water Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Water Temperature: <**Insert deg F (deg C)**>.
7. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.

F. Electric-Resistance Reheating Coil:

1. Total Capacity: <**Insert kilowatts**>.
2. Stages of Heating: [**1**][**2**]<**Insert number**>.

G. Humidifier:

1. Total: <**Insert lb/h (kg/h)**>.
2. Input: <**Insert Btu/h (kW)**>.

H. Electrical Characteristics:

1. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
2. Phase: [**Single**][**Three**].
3. Hertz: 60.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended

clearances.[**Install according to AHRI Guideline B.**]

D. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**] of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**] Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

E. Air-Cooled Refrigerant Condenser Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

F. Remote, Air-Cooled, Glycol-Solution Cooler Mounting: Install using [**elastomeric pads**][**elastomeric mounts**][**restrained spring isolators**]<**Insert device**> on concrete base. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

1. Minimum Deflection: [**1/4 inch (6 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

G. Glycol-Solution Pump Package Mounting: Install using [**elastomeric pads**][**elastomeric mounts**]<**Insert device**>. Comply with requirements for vibration isolation devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Hot-Water Heating Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to heating coils.

E. Condenser-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Provide shutoff valves in water inlet and outlet piping on water-cooled units.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature[**and humidity**] set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 23 81 23 13

Task	Specification	Specification Description
23 81 23 13	23 81 23 00	Small Capacity Computer-Room Air-Conditioners Floor-Mounted Units
23 81 23 13	23 81 23 00a	Computer-Room Air-Conditioners, Console Units
23 81 23 13	23 81 23 00b	Computer-Room, Rack-Cooling Equipment
23 81 23 13	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 26 00 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split-system air-conditioners.

   a. Indoor unit, **5 tons (18 kW)** or less.
   b. Indoor unit, **6 tons (21 kW)** or more.
   c. Indoor, remote unit, **6 tons (21 kW)** or more - water-cooled (refrigerant-to-water), compressor-condenser.
   d. Outdoor unit, **5 tons (18 kW)** or less.
   e. Outdoor unit, **6 tons (21 kW)** or more.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for building seismic and wind criteria.

1.2 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: For split-system air-conditioners.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include detail of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams and details of refrigerant piping and tubing showing installation requirements.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For split-system air-conditioners including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: [**Wind-**][**and**][**seismic-**] detail fabrication and attachment of [**wind and**][**seismic**] restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
4. Refrigerant Piping Design and Sizing: Sizing and detailed layout of refrigerant piping serving split system air conditioners.

D. Sustainable Design Submittals:

1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

2. Product Data: For refrigerants, indicating refrigerant type, GWP, amount in system and total GWP.

3. Product data indicating compliance with ASHRAE/IES 90.1.

4. Product Data: For energy performance.

5. Inventory List: For all refrigerant-containing equipment present in Project, confirming that specified low- or no-refrigerant options have been installed.

6. Product Data: For heat or energy recovery system, demonstrating 70 percent enthalpy recovery ratio or 75 percent sensible heat recovery ratio.

7. Product Data for Automated Demand Response Controls: For automated demand response controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For delegated design engineer.

B. Seismic Qualification Data: Certificate, for split-system air-conditioners, from manufacturer. Submit certification that specified equipment will withstand wind forces identified in Section 018123 "Facility Seismic and Wind Criteria" and coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality Control Reports: For specified tests and inspections.

D. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**] set(s) for each air-handling unit.
2. Gaskets: [**One**] set(s) for each access door.
3. Fan Belts: [**One**] set(s) for each air-handling unit fan.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15 and ASHRAE 34.

2. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. AHRI Certification: Certify split system air conditioners in accordance with [**AHRI 210/240**][**AHRI 340/360**][**AHRI 365**] .

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: [**One**][**Five**] year(s) from date of Substantial Completion.
b. For Parts: [**One**][**Five**] year(s) from date of Substantial Completion.
c. For Labor: [**One**][**Five**] year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, at a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment and design of vibration mounts [**and seismic restraints**] .

B. Wind-Restraint Performance:

1. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building classification criteria.

C. Seismic Performance: Split system air conditioners to withstand the effects of earthquake motions. See Section 230548 "Vibration and Seismic Controls for HVAC" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**] ."

2. Component Importance Factor: [**1.5**][**1.0**].

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SPLIT-SYSTEM AIR-CONDITIONERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Carrier Global Corporation**]
2. [**Coleman Company Inc. (The)**]
3. [**First Operations LP**]
4. [**Friedrich Air Conditioning Company**]
5. [**Goodman; a member of Daiken Group**]
6. [**Lennox**]
7. [**Mitsubishi Electric Cooling and Heating**]
8. [**Rheem Manufacturing Company; Heating and Cooling Products**]
9. [**Samsung HVAC**]
10. [**Trane**]
11. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]

B. Source Limitations: Obtain split-system air-conditioners from single manufacturer.

C. Description: Split-system, indoor, direct-expansion refrigerant cooling fan and filter unit with auxiliary heating options and outdoor air-cooled or remote indoor water-cooled condensing unit.

D. Indoor Unit, 5 Tons (18 kW) or Less:

1. Concealed Evaporator-Fan Components:

a. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
b. Insulation: Faced, glass-fiber duct liner.

c. Refrigerant: [**R-454B**][**R-32**].
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750/751.

e. Heating Coil - Water: Copper tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**; leak tested to **300 psig (2070 kPa)** underwater; with a two-position control valve.
f. Heating Coil - Electric: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow-proving device, and one-time fuses in terminal box for overcurrent protection.
g. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
h. Fan Motors:

1) Type: [**Single speed**][**Variable-speed, electronically commutated motor (ECM)**] .
2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
3) Multitapped, multispeed with internal thermal protection and permanent lubrication.
4) Wiring Terminations: Connect motor to chassis wiring with plug connection.

i. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.
j. Condensate Drain Pans:

1) Fabricated with minimum **0.125 inch per ft. (10 mm per m)** slope from the horizontal toward the drain outlet or are to be otherwise designed so that the water drains freely from the pan whether the fan is operating or not, to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

a) Length: Extend drain pan downstream from leaving face [**to comply with ASHRAE 62.1**].
b) Depth: A minimum of [**2 inches (50 mm)**] deep.

2) Single-wall, [**galvanized-steel sheet**][**stainless steel sheet**][**composite**] .
3) Double-wall, [**galvanized-**][**stainless**] steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connections: Normal and secondary drain connection. Terminate with threaded nipple on [**one end**][**both ends**] of pan.

a) Minimum Connection Size: [**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**].

5) Pan-Top Surface Coating: Asphaltic waterproofing compound.

2. Floor-Mounted, Evaporator-Fan Components:

   a. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, as directed by the Owner.

      1) Discharge Grille: [**Steel with surface-mounted frame**][**Welded steel bars forming a linear grille and welded into supporting panel**] .
      2) Insulation: Faced, glass-fiber duct liner.
      3) Drain Pans: [**Galvanized steel**][**Stainless steel**], with connection for drain; insulated.

   b. Refrigerant: [**R-454B**][**R-32**].
   c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750/751.

   d. Heating Coil - Water: Copper tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**; leak tested to **300 psig (2070 kPa)** underwater; with a two-position control valve.
   e. Heating Coil - Electric: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow-proving device, and one-time fuses in terminal box for overcurrent protection.
   f. Fan: Direct drive, centrifugal [**with power-induced outside air**] .
   g. Fan Motors:

      1) Type: [**Single speed**][**Variable-speed, electronically commutated motor (ECM)**] .
      2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
      3) Multitapped, multispeed with internal thermal protection and permanent lubrication.

   h. Air-Filtration Section:

      1) General Requirements for Air-Filtration Section:

         a) Comply with NFPA 90A.
         b) Minimum MERV in accordance with ASHRAE 52.2.
         c) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters are to be removable from one side or lifted out from access plenum.

      2) Permanent, Cleanable Filters:

         a) Factor-fabricated, pleated metal mesh, flat panel cleanable filters with expanded metal retainer/faceguard on each side.
         b) Thickness: [**1/2 inch (12 mm)**][**1 inch (25 mm)**].
         c) MERV in Accordance with ASHRAE 52.2: [**6**].
         d) Media: Pleated [**galvanized steel**][**aluminum**][**stainless steel**] mesh with expanded metal retainer/faceguard on each side.

         e) Frame: [**Galvanized steel**][**Aluminum**][**Stainless steel**] .

      3) Disposable Panel Filters:

         a) Factory-fabricated, viscous-coated, flat-panel type.

b) Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**] .
c) MERV in accordance with ASHRAE 52.2: [**6**].
d) Media: Interlaced glass fibers sprayed with nonflammable adhesive [**and antimicrobial agent**] .
e) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

4) Extended-Surface, Disposable Panel Filters:

a) Factory-fabricated, dry, extended-surface type.
b) Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**] .
c) MERV in accordance with ASHRAE 52.2: [**8**].
d) Media: Fibrous material formed into deep-V-shaped pleats [**with antimicrobial agent**] and held by self-supporting wire grid.
e) Media-Grid Frame: [**Nonflammable cardboard**][**Galvanized steel**].
f) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

3. Wall-Mounted, Evaporator-Fan Components:

a. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection, as directed by the Owner.
b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750/751.

c. Supplemental Heating Coil - Electric: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow-proving device, and one-time fuses in terminal box for overcurrent protection.
d. Fan: Direct drive, centrifugal.

e. Fan Motors:

1) Type: [**Single speed**][**Variable-speed, electronically commutated motor (ECM)**] .
2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
3) Multitapped, multispeed with internal thermal protection and permanent lubrication.

4) Enclosure Type: Totally enclosed, fan cooled.
5) NEMA Premium efficient motors as defined in NEMA MG 1.
6) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

7) Disconnect Switches Location: Mount unit-mounted disconnect switches on [**exterior**][**interior**] of unit.

f. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.
g. Condensate Drain Pans:

1) Fabricated with minimum **0.125 inch per ft. (10 mm per m)** slope from the horizontal toward the drain outlet or are to be otherwise designed so that the water drains freely from the pan whether the fan is operating or not, to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

a) Length: Extend drain pan downstream from leaving face [**to comply with ASHRAE 62.1**].
b) Depth: A minimum of [**1 inch (25 mm)**] deep.

2) Single-wall, [**galvanized steel sheet**][**stainless steel sheet**][**composite**] .
3) Double-wall, [**galvanized-**][**stainless**] steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.
5) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**].

6) Pan-Top Surface Coating: Asphaltic waterproofing compound.

h. Air-Filtration Section:

1) General Requirements for Air-Filtration Section:

a) Comply with NFPA 90A.
b) Minimum MERV in accordance with ASHRAE 52.2.
c) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters are to be removable from one side or lifted out from access plenum.

2) Permanent, Cleanable Filters:

a) Factor-fabricated, pleated metal mesh, flat panel cleanable filters with expanded metal retainer/faceguard on each side.
b) Thickness: [**1/2 inch (12 mm)**][**1 inch (25 mm)**].
c) MERV in accordance with ASHRAE 52.2: [**6**].
d) Media: Pleated [**galvanized steel**][**aluminum**][**stainless steel**] mesh with expanded metal retainer/faceguard on each side.

3) Disposable Panel Filters

a) Factory-fabricated, viscous-coated, flat-panel type.
b) Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**] .
c) MERV in accordance with ASHRAE 52.2: [**5**].
d) Media: Interlaced glass fibers sprayed with nonflammable adhesive [**and antimicrobial agent**] .
e) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

E. Indoor Unit, 6 Tons (21 kW) or More:

1. Concealed Evaporator-Fan Components:

a. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
b. Insulation: Faced, glass-fiber duct liner.

c. Refrigerant: [**R-454B**][**R-32**].
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750/751.

e. Heating Coil - Water: Copper tube, with mechanically bonded aluminum fins spaced no

closer than **0.1 inch (2.5 mm)**; leak tested to **300 psig (2070 kPa)** underwater; with a two-position control valve.

f. Heating Coil - Electric: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, [**built-in magnetic contactors,**][**SCR control,**] manual-reset thermal cutout, airflow-proving device, and one-time fuses in terminal box for overcurrent protection.

g. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

h. Fan Motors:

1) Type: [**Single**][**Variable**] speed.
2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
3) Multitapped, multispeed with internal thermal protection and permanent lubrication.
4) Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection.
5) Wiring Terminations: Connect motor to chassis wiring with plug connection.

i. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.

j. Filters: [**1 inch (25 mm) thick, in fiberboard frames**][**Permanent, cleanable**] .

k. Condensate Drain Pans:

1) Fabricated with minimum **0.125 inch per ft. (10 mm per m)** slope from the horizontal toward the drain outlet or are to be otherwise designed so that the water drains freely from the pan whether the fan is operating or not, to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

a) Length: Extend drain pan downstream from leaving face [**to comply with ASHRAE 62.1**].
b) Depth: A minimum of [**2 inches (50 mm)**] deep.

2) Single-wall, [**galvanized-steel sheet**][**stainless steel sheet**][**composite**] .
3) Double-wall, [**galvanized-**][**stainless**] steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.

a) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**].

5) Pan-Top Surface Coating: Asphaltic waterproofing compound.
6) Units with stacked coils are to have an intermediate drain pan to collect condensate from top coil.

2. Floor-Mounted, Evaporator-Fan Components:

a. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, as directed by the Owner.

1) Discharge Grille: [**Steel with surface-mounted frame**][**Welded steel bars forming a linear grille and welded into supporting panel**] .
2) Insulation: Faced, glass-fiber duct liner.

b. Condensate Drain Pans:

1) Fabricated with minimum **0.125 inch per ft. (10 mm per m)** slope from the horizontal toward the drain outlet or are to be otherwise designed so that the water drains freely from the pan whether the fan is operating or not, to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

   a) Length: Extend drain pan downstream from leaving face [**to comply with ASHRAE 62.1**].
   b) Depth: A minimum of [**2 inches (50 mm)**] deep.

2) Single-wall, [**galvanized-**][**stainless**] steel sheet.
3) Double-wall, [**galvanized-**][**stainless**] steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**][**both ends**] of pan.

   a) Minimum Connection Size: [**NPS 1 (DN 25)**][**NPS 2 (DN 50)**].

5) Pan-Top Surface Coating: Asphaltic waterproofing compound.
6) Units with stacked coils are to have an intermediate drain pan to collect condensate from top coil.

c. Refrigerant: [**R-454B**][**R-32**].
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750/751.

e. Heating Coil - Water: Copper tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**; leak tested to **300 psig (2070 kPa)** underwater; with a two-position control valve.
f. Heating Coil - Electric: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow-proving device, and one-time fuses in terminal box for overcurrent protection.
g. Fan: Direct drive, centrifugal [**with power-induced outside air**] .

h. Fan Motors:

   1) Type: [**Single**][**Variable**] speed.
   2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
   3) Multitapped, multispeed with internal thermal protection and permanent lubrication.

   4) Enclosure Type: Totally enclosed, fan cooled.
   5) NEMA Premium efficient motors as defined in NEMA MG 1.
   6) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

   7) Disconnect Switches Location: Mount unit-mounted disconnect switches on [**exterior**][**interior**] of unit.

i. Air-Filtration Section:

   1) General Requirements for Air-Filtration Section:

a) Comply with NFPA 90A.
b) Minimum MERV in accordance with ASHRAE 52.2.
c) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters are to be removable from one side or lifted out from access plenum.

2) Disposable Panel Filters:

a) Factory-fabricated, viscous-coated, flat-panel type.
b) Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**] .
c) MERV in accordance with ASHRAE 52.2: [**5**].
d) Media: Interlaced glass fibers sprayed with nonflammable adhesive [**and antimicrobial agent**] .
e) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

3) Extended-Surface, Disposable Panel Filters:

a) Factory-fabricated, dry, extended-surface type.
b) Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**] .
c) MERV in accordance with ASHRAE 52.2: [**7**].
d) Media: Fibrous material formed into deep-V-shaped pleats [**with antimicrobial agent**] and held by self-supporting wire grid.
e) Media-Grid Frame: [**Nonflammable cardboard**][**Galvanized steel**].
f) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

3. Variable-Frequency Controllers:

a. Description: NEMA ICS 2, insulated-gate bipolar transistor, pulse width modulation, variable-frequency controller; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, three-phase induction motor by adjusting output voltage and frequency.
b. Output Rating: Three-phase; 6 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**][**120 Hz, with horsepower constant throughout speed range**] .
c. Unit Operating Requirements:

1) Input ac voltage tolerance of [**208 V, plus or minus 5**][**380 to 500 V, plus or minus 10**][**525 to 575 V, plus or minus 10**] percent.
2) Input-frequency tolerance of 06/11 Hz, plus or minus 6 percent.
3) Minimum Efficiency: 96 percent at 60 Hz, full load.
4) Minimum Displacement Primary-Side Power Factor: 96 percent.
5) Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6) Starting Torque: 100 percent of rated torque.
7) Speed Regulation: Plus or minus 1 percent.

d. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
e. Internal Adjustability Capabilities:

1) Minimum Speed: 5 to 25 percent of maximum rpm.
2) Maximum Speed: 80 to 100 percent of maximum rpm.
3) Acceleration: 2 seconds to a minimum of 22 seconds.
4) Deceleration: 2 seconds to a minimum of 22 seconds.

5) Current Limit: 50 percent to a minimum of 110 percent of maximum rating.

f. Self-Protection and Reliability Features:

1) Input transient protection by means of surge protection devices (SPDs).
2) Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3) Adjustable motor overload relays capable of NEMA ICS 2, [**Class 10**][**Class 20**][**Class 30**] performance.
4) Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5) Instantaneous line-to-line and line-to-ground overcurrent trips.
6) Loss-of-phase protection.
7) Reverse-phase protection.
8) Short-circuit protection.
9) Motor overtemperature fault.

g. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search is to be capable of starting into rotating loads, spinning in either direction, and returning motor to set speed in proper direction, without damage to controller, motor, or load.

h. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

i. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

j. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back, based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

k. Door-mounted, digital status lights indicate the following conditions:

1) Power on.
2) Run.
3) Overvoltage.
4) Line fault.
5) Overcurrent.
6) External fault.

l. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed-time meter.

m. Meters and Digital Readout Devices and Selector Switches: Connected and mounted flush in controller door and. indicating the following controller parameters:

1) Output frequency (hertz).
2) Motor speed (rpm).
3) Motor status (running, stop, fault).
4) Motor current (amperes).
5) Motor torque (percent).
6) Fault or alarming status (code).
7) Proportional-integral-derivative feedback signal (percent).
8) DC-link voltage (volts dc).
9) Set-point frequency (hertz).
10) Motor output voltage (volts).

n. Control Signal Interface:

1) Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
2) Remote Signal Inputs: Are to be capable of accepting any of the following speed-setting input signals from the control system:

   a) 0 to 10 V dc.
   b) 0-20 or 4-20 mA.
   c) Potentiometer using up/down digital inputs.
   d) Fixed frequencies using digital inputs.
   e) RS-485.
   f) Keypad display for local hand operation.

3) Output signal interface with a minimum of one analog output signal (0/4-20 mA), which can be programmed to any of the following:

   a) Output frequency (hertz).
   b) Output current (load).
   c) DC-link voltage (volts dc).
   d) Motor torque (percent).
   e) Motor speed (rpm).
   f) Set-point frequency (hertz).

4) Remote indication interface with a minimum of two dry circuit relay outputs (120 V ac, 1 A) for remote indication of the following:

   a) Motor running.
   b) Set-point speed reached.
   c) Fault and warning indication (overtemperature or overcurrent).
   d) High- or low-speed limits reached.

o. Communications: RS-485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface allows all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

p. Integral Disconnecting Means: [**UL 489, instantaneous-trip circuit breaker**][**UL 489, molded-case switch**][**NEMA KS 1, nonfusible switch**][**NEMA KS 1, fusible switch**] with lockable handle.

q. Accessories:

1) Devices are to be factory installed in controller enclosure unless otherwise indicated.
2) Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
3) Standard Displays:

   a) Output frequency (hertz).
   b) Set-point frequency (hertz).
   c) Motor current (amperes).
   d) DC-link voltage (volts dc).
   e) Motor torque (percent).
   f) Motor speed (rpm).
   g) Motor output voltage (volts).

F. Indoor, Remote Unit 6 Tons (21 kW) or More - Water-Cooled (Refrigerant-to-Water), Compressor-Condenser:

1. Remote, Water-Cooled (Refrigerant-to-Water), Compressor-Condenser Components:

   a. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls and mounting holes in base. Provide brass service valves, fittings, and gauge ports on exterior of casing, as directed by the Owner.
   b. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor is to have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

      1) Compressor Type: Scroll.

      2) Compressor Motor: [**Two-speed**][**Variable-speed**] compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

   c. Refrigerant: [**R-454B**][**R-32**].
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 750751.

   e. Heat-Pump Components: Reversing valve.
   f. Heat Exchanger: Copper tubes in copper tube or in steel shell, with water-temperature-actuated, water-regulating valve.

G. Outdoor Unit, 5 Tons (18 kW) or Less:

1. Air-Cooled, Compressor-Condenser Components:

   a. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gauge ports on exterior of casing, as directed by the Owner.
   b. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor is to have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

      1) Compressor Type: Scroll.

      2) Compressor Motor: [**Two-speed**][**Variable-speed**] compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

      3) Refrigerant: [**R-454B**][**R-32**].
      4) Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 750/751.

   c. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
   d. Fan: Aluminum-propeller type, directly connected to motor.
   e. Motor: Permanently lubricated, with integral thermal-overload protection.
   f. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C)**.
   g. Mounting Base: Polyethylene.

H. Outdoor Unit 6 Tons (21 kW) or More:

1. Air-Cooled, Compressor-Condenser Components:

   a. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base.

Provide brass service valves, fittings, and gauge ports on exterior of casing, as directed by the Owner.

b. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor is to have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1) Compressor Type: Scroll.

2) Compressor Motor: [**Two-speed**][**Variable-speed**] compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

3) Refrigerant: [**R-454B**][**R-32**].

4) Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 750/751.

c. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

d. Fan: Aluminum-propeller type, directly connected to motor.

e. Motor: Permanently lubricated, with integral thermal-overload protection.

f. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C)**.

g. Mounting Base: Polyethylene.

I. Accessories:

1. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

2. Thermostat:

a. Low voltage with subbase to control compressor and evaporator fan.

b. Wireless Infrared Thermostat: Functions to remotely control compressor and evaporator fan, with the following features:

1) Compressor time delay.

2) 24-hour time control of system stop and start.

3) Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

4) Fan-speed selection including auto setting.

3. Automatic-reset timer to prevent rapid cycling of compressor.

4. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

5. Drain Hose: For condensate.

6. Monitoring:

a. Monitor constant and variable motor loads.

b. Monitor variable-frequency-drive operation.

c. Monitor economizer cycle.

d. Monitor cooling load.

e. Monitor air distribution static pressure and ventilation air volumes.

J. Capacities and Characteristics:

1. Cooling Capacity:

a. SEER: [**10.0**][**12.0**][**13.0**][**14.0**][**16.0**].

b. EER: [**10.0**][**12.0**][**13.0**][**14.0**][**16.0**].

2. Heating Capacity:

a. Type: [**Electric**][**Natural gas**] .
b. Heating Season Performance Factor: [**7.7**][**8.0**].
c. Electric Heating Coil:

1) Volts: [**120**][**208**][**230**][**460**] V ac.
2) Phase: [**Single**][**Poly**] .
3) Frequency: 60 Hz.
4) Steps: [**One**][**Two**][**Three**].

3. Auxiliary Heating Capacity:

a. Type: [**Electric**][**Natural gas**][**Propane**] .
b. Volts: [**120**][**208**][**230**][**460**] V ac.
c. Phase: [**Single**][**Poly**] .
d. Hertz: 60.
e. Steps: [**One**][**Two**][**Three**].

4. Indoor Unit:

a. Fan Motor Electrical Characteristics:

1) Volts: [**120**][**208**][**230**][**460**].
2) Phase: [**Single**][**Poly**] .
3) Hertz: 60.

5. Outdoor Unit:

a. Type: [**Air cooled**][**Water cooled**] .
b. Electrical Characteristics:

1) Volts: [**120**][**208**][**230**][**460**].
2) Phase: [**Single**][**Poly**] .
3) Hertz: 60.

PART 3 - EXECUTION

3.1 INSTALLATION OF SPLIT-SYSTEM AIR-CONDITIONERS

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Install indoor remote compressor-condenser unit on concrete housekeeping pad securely fastened to structure.

E. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply [**and return**] ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections [**with the assistance of a factory-authorized service**

representative] .

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Controls and Safeties Test: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning split-system air-conditioning units and retest as specified above.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] the Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26 00

Task	Specification	Specification Description
23 81 26 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems
23 81 26 13	23 81 26 00	Split-System Air-Conditioners
23 81 26 13	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems
23 81 26 16	23 81 26 00	Split-System Air-Conditioners
23 81 26 16	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems
23 81 43 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 81 46 00 - WATER-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water-source unitary heat pumps larger than 6 tons (21 kW).
2. Water-source unitary heat pumps, 6 tons (21 kW) and smaller.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each water-source unitary heat pump.
2. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
3. Product Data: For energy performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For water-source unitary heat pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of water-source unitary heat pump, signed by product manufacturer.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-source unitary heat pumps to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. [**One**]<**Insert number**> spare heat-pump unit(s) of each size and model furnished.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water-source unitary heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period: [**Four**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance:

1. ASHRAE 15.

B. Comply with NFPA 70.

C. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.

2.2 WATER-SOURCE UNITARY HEAT PUMPS, 6 TONS (21 kW) AND SMALLER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

C. Description: Packaged water-source unitary heat pump with temperature controls; factory assembled, piped, wired, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Cabinet Insulation: Glass-fiber liner, minimum [**1/2 inch (13 mm)**], [**3/4 inch (19 mm)**] thick, complying with UL 181, ASTM C1071, and ASTM G21.

E. Water Circuits:

1. Refrigerant-to-Water Heat Exchangers:

a. Source-side coaxial heat exchangers with [**copper**][**cupronickel**][**internal vented double wall**] water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side.
b. Load-side coaxial heat exchangers with [**copper**][**cupronickel**] water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side.
c. Stainless-steel, brazed-plate heat exchanger is leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
d. Hot-water generator, [**copper water tube**][**vented double wall copper tube**] with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side, pump, circuit breaker, high water temperature and low water refrigerant cutoffs, and tank connection.

F. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor:

a. Scroll.

b. [**Single stage**][**Two stage**][**Variable speed**].
c. Installed on vibration isolators and mounted on a structural steel base plate and full-length channel stiffeners.
d. Exterior of compressor shall be wrapped with a high-density sound-attenuating blanket and housed in an acoustically treated enclosure.
e. Factory-Installed Safeties:

1) Antirecycle timer.
2) High-pressure cutout.
3) Low-pressure cutout or loss of charge switch.
4) Internal thermal-overload protection.
5) Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
6) Water-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.
8. Refrigerant Metering Device:

a. Thermal-expansion valve.
b. Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.

G. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

H. Controls:

1. Basic Unit Control Modes and Devices:

a. Unit shutdown on high or low refrigerant pressures.
b. Unit shutdown on low water temperature.
c. Low- and high-voltage protection.
d. Overcurrent protection for compressor.
e. Random time delay, three to 10 seconds, start on power-up.
f. Time delay override for servicing.
g. Control voltage transformer.
h. Water-coil freeze protection (selectable for water or antifreeze).
i. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
j. Ability to defeat time delays for servicing.
k. Digital display to indicate high pressure, low pressure, low voltage, and high voltage.
l. The low-pressure switch shall not be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
m. Remote fault-type indication at thermostat.
n. Selectable 24-V dc or pilot duty dry contact alarm output.
o. 24-V dc output to cycle a motorized water valve with compressor contactor.
p. Service test mode for troubleshooting and service.
q. Unit-performance sentinel warns when heat pump is running inefficiently.
r. Compressor soft start.

2. Thermostat:

   a. Wall-Mounted Thermostat:

      1) Heat-cool-off switch.
      2) [**Five day**][**Seven day**], programmable.
      3) [**Manual**][**Automatic**] changeover.
      4) [**Concealed**][**Exposed**] temperature set point.
      5) [**Concealed**][**Exposed**] temperature indication.
      6) Deg [**F**][**C**] indication.

   b. Wall-mounted temperature sensor.
   c. Duct-mounted temperature sensor
   d. Unoccupied period override push button.
   e. Digital display to indicate fault condition at heat pump.
   f. Data entry and access port.

      1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
      2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

   a. Scheduled operation for occupied and unoccupied periods on [**seven**][**365**]-day clock with minimum of four programmable periods per day.
   b. [**Two**]<**Insert number**>-hour unoccupied override period.
   c. Remote-control panel to contain programmable timer and digital display for fault condition.
   d. Compressor-disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
   e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
   f. Backup for volatile memory.

4. DDC interface requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

   a. Interface relay for scheduled operation.
   b. Interface relay to provide indication of fault at central workstation.
   c. Provide [**BAC-net**][**or**][**LonWorks**] interface for central DDC workstation for the following functions:

      1) Set-point adjustment.
      2) Start/stop and operating status of heat-pump unit.
      3) Data inquiry to include supply-air and room-air temperature and humidity, and entering-water temperature.
      4) Occupied and unoccupied schedules.

I. Electrical Connection: Single electrical connection[**with fused disconnect**].

J. Capacities and Characteristics:

1. Source-Side Water Supply:

   a. Water Flow: <**Insert gpm (L/s)**>.
   b. Pressure Loss: <**Insert feet wg (kPa)**>.

c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

2. Load-Side Water Supply:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

a. Total Capacity: <**Insert Btu/h (kW)**>.
b. Sensible Capacity: <**Insert Btu/h (kW)**>.
c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.

4. Heating:

a. Capacity: <**Insert Btu/h (kW)**>.
b. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Electrical Characteristics for Single Connection:

a. Volts: [**120**][**208**][**230**]<**Insert number**> V.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes (FLA): <**Insert number**> A.
e. Maximum Circuit Amperage (MCA): <**Insert number**> A.
f. Maximum Overcurrent Protection (MOCP): <**Insert number**> A.

2.3 WATER-SOURCE UNITARY HEAT PUMPS LARGER THAN 6 TONS (21 kW)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]

3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane**]
7. [**WaterFurnace International, Inc.**]
8. **<Insert manufacturer's name>**

C. Description: Packaged water-source unitary heat pump with temperature controls; factory assembled, piped, wired, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

D. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Cabinet Insulation: Glass-fiber liner, minimum [**1/2 inch (13 mm)**], [**3/4 inch (19 mm)**] thick, complying with UL 181, ASTM C1071, and ASTM G21.

E. Water Circuits:

1. Refrigerant-to-Water Heat Exchangers:

a. Source-side coaxial heat exchangers with [**copper**][**cupronickel**][**internal vented double wall**] water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side.
b. Load-side coaxial heat exchangers with [**copper**][**cupronickel**] water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side.
c. Stainless-steel, brazed-plate heat exchanger is leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
d. Hot-water generator, [**copper water tube**][**vented double wall copper tube**] with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side, pump, circuit breaker, high water temperature and low water refrigerant cutoffs, and tank connection.

F. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor:

a. Scroll.
b. [**Single stage**][**Two stage**][**Variable speed**].
c. Installed on vibration isolators and mounted on a structural steel base plate and full-length channel stiffeners.
d. Exterior of compressor shall be wrapped with a high-density sound-attenuating blanket and housed in an acoustically treated enclosure.

e. Factory-Installed Safeties:

1) Antirecycle timer.
2) High-pressure cutout.
3) Low-pressure cutout or loss of charge switch.
4) Internal thermal-overload protection.
5) Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
6) Water-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.
8. Refrigerant Metering Device:

a. Thermal-expansion valve.
b. Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.

G. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

H. Controls:

1. Basic Unit Control Modes and Devices:

a. Unit shutdown on high or low refrigerant pressures.
b. Unit shutdown on low water temperature.
c. Low- and high-voltage protection.
d. Overcurrent protection for compressor.
e. Random time delay, three to 10 seconds, start on power-up.
f. Time delay override for servicing.
g. Control voltage transformer.
h. Water-coil freeze protection (selectable for water or antifreeze).
i. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
j. Ability to defeat time delays for servicing.
k. Digital display to indicate high pressure, low pressure, low voltage, and high voltage.
l. The low-pressure switch shall not be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
m. Remote fault-type indication at thermostat.
n. Selectable 24-V dc or pilot duty dry contact alarm output.
o. 24-V dc output to cycle a motorized water valve with compressor contactor.
p. Service test mode for troubleshooting and service.
q. Unit-performance sentinel warns when heat pump is running inefficiently.
r. Compressor soft start.

2. Thermostat:

a. Wall-Mounted Thermostat:

1) Heat-cool-off switch.
2) [**Five day**][**Seven day**], programmable
3) [**Manual**][**Automatic**] changeover.
4) [**Concealed**][**Exposed**] temperature set point.
5) [**Concealed**][**Exposed**] temperature indication.
6) Deg [**F**][**C**] indication.

b. Wall-mounted temperature sensor.
c. Duct-mounted temperature sensor
d. Unoccupied period override push button.
e. Digital display to indicate fault condition at heat pump.
f. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

a. Scheduled operation for occupied and unoccupied periods on [**seven**][**365**]-day clock with minimum of four programmable periods per day.
b. [**Two**]<**Insert number**>-hour unoccupied override period.
c. Remote-control panel to contain programmable timer and digital display for fault condition.
d. Compressor-disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
f. Backup for volatile memory.

4. DDC interface requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Provide [**BAC-net**][**or**][**LonWorks**] interface for central DDC workstation for the following functions:

1) Set-point adjustment.
2) Start/stop and operating status of heat-pump unit.
3) Data inquiry to include supply-air and room-air temperature and humidity, and entering-water temperature.
4) Occupied and unoccupied schedules.

I. Electrical Connection: Single electrical connection[**with fused disconnect**].

J. Capacities and Characteristics:

1. Source-Side Water Supply:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

2. Load-Side Water Supply:

   a. Water Flow: <**Insert gpm (L/s)**>.
   b. Pressure Loss: <**Insert feet wg (kPa)**>.
   c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
   d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
   e. Antifreeze Protection Chemical: <**Insert chemical name**>.
   f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

   a. Total Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Capacity: <**Insert Btu/h (kW)**>.
   c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.

4. Heating:

   a. Capacity: <**Insert Btu/h (kW)**>.
   b. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Electrical Characteristics for Single Connection:

   a. Volts: [**120**][**208**][**230**]<**Insert number**> V.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes (FLA): <**Insert number**> A.
   e. Maximum Circuit Amperage (MCA): <**Insert number**> A.
   f. Maximum Overcurrent Protection (MOCP): <**Insert number**> A.

2.4 ACCESSORIES

A. Hose Kits: Tag hose kits to equipment designations.

1. Minimum Working Pressure: **400 psig (2758 kPa)**.
2. Operating Temperatures: From **33 to 211 deg F (1 to 100 deg C)**.
3. Hose Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
4. Minimum Hose Diameter: Equal to water-source unitary heat-pump piping connection.
5. Hose Material: Braided stainless steel with adapters for pipe connections.
6. Isolation Valves: Two-piece, bronze-body ball valves with stainless-steel ball and stem, standard-port threaded connections, and galvanized-steel lever handle. Valves shall be factory installed on supply and return connections of both load-side and source-side heat exchangers. If balancing valve is combination shutoff type with memory stop, the isolation valve may be omitted on the return.
7. Strainer: Y-pattern with blowdown valve in supply connections of both load and source side of heat exchangers.
8. Balancing Valves: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.

   a. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a pressure range of **2 to 80 psig (13.8 to 552 kPa)**.
   b. Manual, calibrated-orifice balancing valve with memory stop.
   c. Manual, venturi-type balancing valve with memory stop.

9. Water-Regulating Valve Assemblies: A direct acting valve regulates discharge pressure during

the cooling cycle, and a reverse acting valve regulates the suction pressure during the heating cycle. Valves shall close when heat-pump compressor is not running.

10. Motorized Water Valve: Stop water flow through the unit when compressor is off. Slow-acting, 24-V dc valve with threaded connections is installed between isolation valves and heat exchanger.

B. Hose Kit Assemblies:

1. Minimum Working Pressure: **400-psig (2758-kPa)**.
2. Operating Temperatures: From **33 to 211 deg F (1 to 100 deg C)**.
3. Hose Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
4. Minimum Hose Diameter: Equal to water-source unitary heat-pump piping connection.
5. Hose Material: Braided stainless steel with adapters for pipe connections.
6. Supply and return hoses having ball valve with pressure-temperature port.
7. Supply hose having ball valve with pressure-temperature port; return hose having automatic flow regulator valve with pressure-temperature ports and ball valve.
8. Supply hose having Y-pattern strainer with blowdown valve and ball valve with pressure-temperature port; return hose having automatic flow regulator with pressure-temperature ports and ball valve.
9. Supply hose having Y-pattern strainer with blowdown valve and ball valve with pressure-temperature port; return hose having ball valve with pressure-temperature port.

C. Loop Controller: Six stages; two stages for heating and four stages for cooling.

D. Pump Module:

1. Minimum [**1/6-hp**]<**Insert motor size**>, [**230-V**][**120-V**], single-phase pump, rated for at least [**16 gpm (1 L/s)**]<**Insert value**> at [**20 feet of head (59 kPa)**]<**Insert value**>.
2. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
3. Include pump module hose kit with thread to barb fittings, hose, and hose clamps.
4. Three-way brass shut-off/flushing/purging valve.
5. Include controls to operate pump as required to maintain room temperature and ventilation set points.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electric installations for water-source unitary heat pumps to verify actual locations of piping connections and electrical conduits before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WATER-SOURCE UNITARY HEAT PUMPS

A. Equipment Mounting:

1. Install water-source, unitary heat pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration-isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration-isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspend water-source, unitary heat pumps from structure with all-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**]. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

C. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Connect supply and return hydronic piping to heat pump with [**unions and shutoff valves**][**hose kits**].

B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

C. Install piping adjacent to machine to allow space for service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections:

1. After installing water to water heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Heat pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect for visible damage to unit casing.

3. Inspect for visible damage to compressor and coils.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Adjust vibration isolators.
9. Start unit according to manufacturer's written instructions.
10. Complete startup sheets and attach copy with Contractor's startup report.
11. Inspect and record performance of interlocks and protective devices; verify sequences.
12. Operate unit for an initial period as recommended or required by manufacturer.
13. Verify thermostat calibration.
14. Inspect controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain water-source unitary heat pumps.

END OF SECTION 23 81 46 00

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SECTION 23 81 46 00A - WATER-TO-AIR HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed water-source heat pumps, 6 tons (21 kW) and smaller.
2. Concealed water-source heat pumps larger than 6 tons (21 kW).
3. Vertical-stack, water-source heat pumps.
4. Exposed, console water-source heat pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, furnished specialties, and accessories for each model.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For energy performance.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include diagrams for power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of unit indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which heat pumps are attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.

d. Sprinklers.
e. Access panels.
f. <**Insert item**>.

B. Product Certificates: For each type of water-source unitary heat pump, signed by product manufacturer.

C. Seismic Qualification Data: Submit certification that water-source heat pumps, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified, and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-to-air heat pumps to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. [**One**]<**Insert number**> set(s) of matched fan belts for each belt-driven fan.
2. [**One**]<**Insert number**> set(s) of filters for each unit.
3. [**One**]<**Insert number**> spare heat-pump unit(s) of each size and model furnished.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. ASHRAE 15.
2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating,

Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

D. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.

E. Comply with safety requirements in UL 1995 for duct-system connections.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period: [**Four**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS (21 kW) AND SMALLER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

C. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
4. Cabinet Insulation: Glass-fiber liner, minimum **1/2 inch (13 mm)** thick, complying with UL 181, ASTM C1071, and ASTM G21.
5. Units field convertible for various discharge configurations.
6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.

    a. Condensate Overflow Protection Switch: Solid state electronic; mechanical float switch not permitted.

7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Sound Attenuation Package: Provide one or more of the following:

    a. Minimum **0.598-inch- (1.5-mm-)** thick compressor enclosure and front panel. Minimum **0.0937-inch- (2.38-mm-)** thick foam gasket around the compressor and perimeter of end panel.
    b. Sound attenuating blanket over compressor.
    c. Hot-gas muffler.
    d. <**Insert method**>.

E. Fan: Direct driven, centrifugal, with multispeed motor resiliently mounted in fan inlet and with inlet rings to allow wheel removal from one side without removing housing.

1. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
2. Motor: Multispeed, permanently lubricated, [**permanent split capacitor**][**ECM**] motor.

F. Water Circuit:

1. Refrigerant-to-Water Heat Exchangers:

    a. Coaxial heat exchangers with [**copper**][**cupronickel**] water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
    b. Stainless-steel, brazed-plate heat exchanger is leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

2. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
3. Motorized Water Valve: Stop water flow through the unit when compressor is off.

G. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to **450 psig (3102 kPa)**.

H. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.

3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic [**rotary**][**reciprocating**][**scroll**], [**single-stage**][**two-stage**] compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.
    d. Internal thermal-overload protection.
    e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
    f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
    g. Water-coil, low-temperature switch.
    h. Air-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.
8. Refrigerant Metering Device:

    a. Thermal-expansion valve.
    b. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.

9. Hot-Gas Reheat Valve: Pilot-operated, sliding-type valve with replaceable magnetic coil.

I. Electric Heating Coil: Helix-wound, nickel-chromium, wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than [**25 deg F (minus 4 deg C)**][**40 deg F (5 deg C)**][**60 deg F (15 deg C)**]<**Insert temperature**>.

J. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

K. Filters:

1. Disposable, glass-fiber, flat type, [**1 inch (25 mm)**]<**Insert dimension**> thick, treated with adhesive, and having a minimum efficiency reporting value of 5 according to ASHRAE 52.2.
2. Disposable, pleated type, [**1 inch (25 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 7 according to ASHRAE 52.2.
3. Electronic air cleaner type; **1 inch (25 mm)**; cleanable.
4. Disposable, pleated type, [**4 inches (100 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 13 according to ASHRAE 52.2.
5. Disposable, pleated type, [**2 inches (50 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 11 according to ASHRAE 52.2.

L. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

M. Controls:

1. Basic Unit Control Modes and Devices:

    a. Dehumidification mode.
    b. Unit shutdown on high or low refrigerant pressures.
    c. Unit shutdown on low water temperature.
    d. Low- and high-voltage protection.
    e. Overcurrent protection for compressor and fan motor.
    f. Random time delay, three to ten seconds, start on power-up.
    g. Time delay override for servicing.
    h. Control voltage transformer.
    i. Water-coil freeze protection (selectable for water or antifreeze).
    j. Air-coil freeze protection (check filter switch).
    k. Condensate overflow shutdown switch.
    l. Option to reset unit at thermostat or disconnect.
    m. Fault type shall be retained in memory if reset at thermostat.
    n. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
    o. Ability to defeat time delays for servicing.
    p. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
    q. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
    r. Remote fault-type indication at thermostat.
    s. Selectable 24-V dc or pilot duty dry contact alarm output.
    t. 24-V dc output to cycle a motorized water valve with compressor contactor.
    u. Electric heat output to control two stages of electric heat (emergency heat).
    v. Service test mode for troubleshooting and service.
    w. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:

    a. Wall-Mounted Thermostat:

        1) Heat-cool-off switch.
        2) Fan on-auto switch.
        3) [**Manual**][**Automatic**] changeover.
        4) [**Concealed**][**Exposed**] temperature set point.
        5) [**Concealed**][**Exposed**] temperature indication.
        6) Deg [**F**][**C**] indication.

    b. Wall-Mounted Humidistat: [**Concealed**][**Exposed**].

        1) Temperature set point.
        2) Temperature indication.

    c. Wall-mounted temperature sensor.
    d. Unoccupied period override push button.
    e. LED to indicate fault condition at heat pump.
    f. Data entry and access port.

        1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
        2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

   a. Scheduled operation for occupied and unoccupied periods on [**seven**][**365**]-day clock with minimum of four programmable periods per day.
   b. [**Two**]<**Insert number**>-hour unoccupied override period.
   c. Remote-control panel to contain programmable timer and LED for fault condition.
   d. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
   e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
   f. Return-air temperature high-limit (firestat). Stop unit on high temperature.
   g. Backup for volatile memory.
   h. Differential pressure switch to indicate fan status. Fan failure alarm.
   i. Differential pressure switch to indicate filter status. Dirty filter alarm.

4. Interface with DDC system for HVAC requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

   a. Interface relay for scheduled operation.
   b. Interface relay to provide indication of fault at central workstation.
   c. Provide [**BAC-net**][**or**][**LonWorks**] interface for central DDC system for HVAC workstation for the following functions:

      1) Set-point adjustment for set points identified in this Section.
      2) Start/stop and operating status of heat-pump unit.
      3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
      4) Occupied and unoccupied schedules.

N. Electrical Connection: Single electrical connection[**with fused disconnect**].

O. Capacities and Characteristics:

1. Fan:

   a. Airflow: <**Insert cfm (L/s)**>.
   b. External Static Pressure: <**Insert inches wg (kPa)**>.
   c. Fan Speed: <**Insert rpm**>.
   d. Motor Speed: <**Insert rpm**>.
   e. Motor Horsepower: <**Insert value**>.

2. Water Supply:

   a. Water Flow: <**Insert gpm (L/s)**>.
   b. Pressure Loss: <**Insert feet wg (kPa)**>.
   c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
   d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
   e. Antifreeze Protection Chemical: <**Insert chemical name**>.
   f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

   a. Total Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Capacity: <**Insert Btu/h (kW)**>.
   c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.

d. Entering-Air Temperature Dry Bulb: <**Insert deg F (deg C)**>.
e. Entering-Air Temperature Wet Bulb: <**Insert deg F (deg C)**>.

4. Heating:

a. Capacity: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air Temperature Rise: <**Insert deg F (deg C)**>.
d. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Electric Heating Coil (Optional Feature):

a. Capacity: <**Insert Btu/h (kW)**>.
b. Number of Steps: <**Insert number**>.

6. Filters:

a. Face Area: <**Insert sq. ft. (sq. m)**>.
b. Maximum Face Velocity: <**Insert fpm (m/s)**>.

7. Electrical Characteristics for Single Connection:

a. Volts: [**120**][**208**][**230**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes (F.L.A.): <**Insert value**>.
e. Maximum Circuit Amperage (MCA): <**Insert value**>.
f. Maximum Overcurrent Protection (MOCP): <**Insert amperes**>.

2.2 CONCEALED WATER-SOURCE HEAT PUMPS LARGER THAN 6 TONS (21 kW)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**ClimateMaster, Inc.**]
3. [**FHP Manufacturing Inc.**]
4. [**Hydro-Temp Corporation, Inc.**]
5. [**Mammoth; a brand of Nortek Air Solutions**]
6. [**Trane Inc.**]
7. [**WaterFurnace International, Inc.**]

8. <**Insert manufacturer's name**>

C. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
4. Cabinet Insulation: Glass-fiber liner, minimum **1/2 inch (13 mm)** thick, complying with UL 181, ASTM C1071, and ASTM G21.
5. Units field convertible for various discharge configurations.
6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.

   a. Condensate Overflow Protection Switch: Solid state electronic; mechanical float switch not permitted.

7. Airstream Surfaces: Surfaces lined with one-half-thick, foil-backed fiber insulation in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Sound Attenuation Package: Provide one or more of the following:

   a. Minimum **0.598-inch- (1.5-mm-)** thick compressor enclosure and front panel. Minimum **0.0937-inch- (2.38-mm-)** thick foam gasket around the compressor and perimeter of end panel.
   b. Sound attenuating blanket over compressor.
   c. Hot-gas muffler.
   d. <**Insert method**>.

E. Fan: Belt driven, centrifugal, with motor installed on an adjustable fan base resiliently mounted in chassis and with inlet rings to allow wheel removal from one side without removing housing.

1. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
2. Motor: Single-speed, permanently lubricated, ECM motor.

F. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger:

   a. [**Coaxial**][**Coil-in-shell**][**Shell-and-tube**] heat exchanger with [**copper**][**cupronickel**] water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
   b. Stainless-steel, brazed-plate heat exchanger is leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

2. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

3. Motorized Water Valve: Stop water flow through the unit when compressor is off.

G. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to **450 psig (3102 kPa)**.

H. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Minimum of two circuits required for units [**10 tons (35 kW)**]<**Insert value**> and larger. Intertwine circuits in refrigerant to air coil.

   a. Charge with R-410A refrigerant.

2. Filter-Dryer: Factory installed to clean and dehydrate each refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: [**Hermetic reciprocating**][**Scroll**][**Single-stage**][**Two-stage**] compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss of charge switch.
   d. Internal thermal-overload protection.
   e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
   f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
   g. Water-coil, low-temperature switch.
   h. Air-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
8. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from **25 to 125 deg F (minus 4 to plus 52 deg C)**.
9. Hot-Gas Reheat Valve: Pilot-operated, sliding-type valve with replaceable magnetic coil.

I. Electric Heating Coil: Helix-wound, nickel-chromium, wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than [**25 deg F (minus 4 deg C)**][**40 deg F (5 deg C)**][**60 deg F (15 deg C)**]<**Insert temperature**>.

J. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

K. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.

L. Filters:

1. Disposable, glass-fiber, flat type, [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**]<**Insert dimension**> thick, treated with adhesive, and having a minimum efficiency reporting value of 5 according to ASHRAE 52.2.

2. Disposable, pleated type, [**1 inch (25 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 7 according to ASHRAE 52.2.
3. Disposable, pleated type, [**2 inches (50 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 11 according to ASHRAE 52.2.
4. Disposable, pleated type, [**4 inches (100 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 13 according to ASHRAE 52.2.

M. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

N. Controls:

1. Basic Unit Control Modes and Devices:

   a. Dehumidification mode.
   b. Unit shutdown on high or low refrigerant pressures.
   c. Unit shutdown on low water temperature.
   d. Low- and high-voltage protection.
   e. Overcurrent protection for compressor and fan motor.
   f. Random time delay, three to ten seconds, start on power-up.
   g. Time delay override for servicing.
   h. Control voltage transformer.
   i. Water-coil freeze protection (selectable for water or antifreeze).
   j. Air-coil freeze protection (check filter switch).
   k. Condensate overflow shutdown switch.
   l. Option to reset unit at thermostat or disconnect.
   m. Fault type shall be retained in memory if reset at thermostat.
   n. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
   o. Ability to defeat time delays for servicing.
   p. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
   q. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
   r. Remote fault-type indication at thermostat.
   s. Selectable 24-V dc or pilot duty dry contact alarm output.
   t. 24V dc output to cycle a motorized water valve with compressor contactor.
   u. Electric heat output to control two stages of electric heat (emergency heat).
   v. Service test mode for troubleshooting and service.
   w. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:

   a. Wall-Mounted Thermostat:

      1) Heat-cool-off switch.
      2) Fan on-auto switch.
      3) [**Manual**][**Automatic**] changeover.
      4) [**Concealed**][**Exposed**] temperature set point.
      5) [**Concealed**][**Exposed**] temperature indication.
      6) Deg [**F**][**C**] indication.
      7) [**One**][**Two**]-stage heating.
      8) [**One**][**Two**]-stage cooling.

   b. Wall-Mounted Humidistat: [**Concealed**][**Exposed**].

1) Temperature set point.
2) Temperature indication.

c. Wall-mounted temperature sensor.
d. Unoccupied period override push button.
e. LED to indicate fault condition at heat pump.
f. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

a. Scheduled operation for occupied and unoccupied periods on [**seven**][**365**]-day clock with minimum of four programmable periods per day.
b. [**Two**]<**Insert number**>-hour unoccupied override period.
c. Remote-control panel to contain programmable timer and LED for fault condition.
d. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
f. Return-air temperature high-limit (firestat). Stop unit on high temperature.
g. Smoke alarm with smoke detector installed in [**supply**][**return**][**supply and return**] air. Stop unit on smoke detection.
h. Backup for volatile memory.
i. Differential pressure switch to indicate fan status. Fan failure alarm.
j. Differential pressure switch to indicate filter status. Dirty filter alarm.

4. Interface with DDC system for HVAC requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Provide [**BAC-net**][**or**][**LonWorks**] interface for central DDC system for HVAC workstation for the following functions:

1) Set-point adjustment for set points identified in this Section.
2) Start/stop and operating status of heat-pump unit.
3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
4) Occupied and unoccupied schedules.

O. Electrical Connection: Single electrical connection[**with fused disconnect**].

P. Capacities and Characteristics:

1. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Fan Speed: <**Insert rpm**>.
d. Motor Speed: <**Insert rpm**>.

e. Motor Horsepower: <**Insert value**>.

2. Water Supply:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

a. Total Capacity: <**Insert Btu/h (kW)**>.
b. Sensible Capacity: <**Insert Btu/h (kW)**>.
c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.
d. Entering-Air Temperature Dry Bulb: <**Insert deg F (deg C)**>.
e. Entering-Air Temperature Wet Bulb: <**Insert deg F (deg C)**>.

4. Heating:

a. Capacity: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air Temperature Rise: <**Insert deg F (deg C)**>.
d. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Electric Heating Coil (Optional Feature):

a. Capacity: <**Insert Btu/h (kW)**>.
b. Number of Steps: <**Insert number**>.

6. Filters:

a. Face Area: <**Insert sq. ft. (sq. m)**>.
b. Maximum Face Velocity: <**Insert fpm (m/s)**>.

7. Electrical Characteristics for Single Connection:

a. Volts: [**120**][**208**][**230**]<**Insert value**>.
b. Phase: [**Single**][**Three**].
c. Hertz: 60.
d. Full-Load Amperes (F.L.A.): <**Insert value**>.
e. Maximum Circuit Amperage (MCA): <**Insert value**>.
f. Maximum Overcurrent Protection (MOCP): <**Insert amperes**>.

2.3 VERTICAL-STACK, WATER-SOURCE HEAT PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ClimateMaster, Inc.**]
2. [**Trane Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**ClimateMaster, Inc.**]
2. [**Trane Inc.**]
3. **<Insert manufacturer's name>**

C. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Cabinet and Chassis: Manufacturer's standard galvanized-steel casing with the following features:

1. Return-air opening with access panel for access to internal components.
2. Knockouts for electrical and piping connections.
3. Cabinet Insulation: Glass-fiber liner, minimum **1/2 inch (13 mm)** thick, complying with UL 181, ASTM C1071, and ASTM G21.
4. Sound Attenuation Package: Provide one or more of the following.

   a. Minimum **0.598-inch- (1.5-mm-)** thick compressor enclosure and front panel. Minimum **0.0937-inch (2.38-mm)** thick foam gasket around the compressor and perimeter of end panel.
   b. **<Insert method>**.

5. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting to unit exterior and complying with ASHRAE 62.1.

   a. Condensate Overflow Protection: Solid state electronic; mechanical float switch not permitted.

6. Discharge Grille: Double deflection grille for adjustable discharge air pattern.
7. Discharge and Return Grille Color: Selected by Architect from manufacturer's [**standard**][**custom**] color selection.
8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Fan: Direct driven, centrifugal, with multispeed motor mounted on a removable fan-motor board and with inlet rings to allow wheel removal from one side without removing housing.
10. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
11. Motor: Multispeed, permanently lubricated, [**permanent split capacitor**][**ECM**].

E. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger: [**Coaxial**][**Coil-in-shell**] heat exchanger with [**copper**][**cupronickel**] water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** on refrigerant side and **400 psig (2758 kPa)** on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
2. Risers: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M Type C)**] copper pipe with hose and ball valve for system flushing.

F. Refrigerant-to-Air Coil: Copper tubes with aluminum fins, leak tested to **450 psig (3102 kPa)**.

G. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic [**rotary**][**scroll**] compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.
    d. Internal thermal-overload protection.
    e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
    f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
    g. Water-coil, low-temperature switch.
    h. Air-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.
8. Refrigerant Metering Device: Thermal-expansion valve to allow specified operation with entering-water temperatures from [**65 to 100 deg F (minus 18 to plus 38 deg C)**]<**Insert temperature range**>.

H. Filters:

1. Disposable, glass-fiber, flat type, [**1 inch (25 mm)**]<**Insert dimension**> thick, treated with adhesive, and having a minimum efficiency reporting value of 5 according to ASHRAE 52.2.
2. Disposable, pleated type, [**1 inch (25 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 7 according to ASHRAE 52.2.

I. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

J. Controls:

1. Basic Unit Control Modes and Devices:

    a. Dehumidification mode.
    b. Unit shutdown on high or low refrigerant pressures.
    c. Unit shutdown on low water temperature.
    d. Low- and high-voltage protection.
    e. Overcurrent protection for compressor and fan motor.
    f. Random time delay, three to ten seconds, start on power-up.
    g. Time delay override for servicing.
    h. Control voltage transformer.
    i. Water-coil freeze protection (selectable for water or antifreeze).
    j. Air-coil freeze protection (check filter switch).
    k. Condensate overflow shutdown switch.
    l. Option to reset unit at thermostat or disconnect.

m. Fault type shall be retained in memory if reset at thermostat.
n. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
o. Ability to defeat time delays for servicing.
p. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
q. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
r. Remote fault-type indication at thermostat.
s. Selectable 24-V dc or pilot duty dry contact alarm output.
t. 24-V dc output to cycle a motorized water valve with compressor contactor.
u. Electric heat output to control two stages of electric heat (emergency heat).
v. Service test mode for troubleshooting and service.
w. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:

a. Wall-Mounted Thermostat:

1) Heat-cool-off switch.
2) Fan on-auto switch.
3) [**Manual**][**Automatic**] changeover.
4) [**Concealed**][**Exposed**] temperature set point.
5) [**Concealed**][**Exposed**] temperature indication.
6) Deg [**F**][**C**] indication.

3. Terminal Controller:

a. Scheduled operation for occupied and unoccupied periods on seven-day clock with minimum four periods per day.
b. [**Two**]<**Insert number**>-hour unoccupied override period.
c. Backup for volatile memory.

K. Electrical Connection: Single electrical connection[**with fused disconnect**].

L. Capacities and Characteristics:

1. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Fan Speed: <**Insert rpm**>.
d. Motor Speed: <**Insert rpm**>.
e. Motor Horsepower: <**Insert value**>.

2. Water Supply:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

   a. Total Capacity: <**Insert Btu/h (kW)**>.
   b. Sensible Capacity: <**Insert Btu/h (kW)**>.
   c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.
   d. Entering-Air Temperature Dry Bulb: <**Insert deg F (deg C)**>.
   e. Entering-Air Temperature Wet Bulb: <**Insert deg F (deg C)**>.

4. Heating:

   a. Capacity: <**Insert Btu/h (kW)**>.
   b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
   c. Air Temperature Rise: <**Insert deg F (deg C)**>.
   d. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Filters:

   a. Face Area: <**Insert sq. ft. (sq. m)**>.
   b. Maximum Face Velocity: <**Insert fpm (m/s)**>.

6. Electrical Characteristics for Single Connection:

   a. Volts: [**120**][**208**][**230**]<**Insert value**>.
   b. Phase: [**Single**][**Three**].
   c. Hertz: 60.
   d. Full-Load Amperes (F.L.A.): <**Insert value**>.
   e. Maximum Circuit Amperage (MCA): <**Insert value**>.
   f. Maximum Overcurrent Protection (MOCP): <**Insert amperes**>.

2.4 EXPOSED, CONSOLE WATER-SOURCE HEAT PUMPS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Carrier Global Corporation**]
   2. [**ClimateMaster, Inc.**]
   3. [**FHP Manufacturing Inc.**]
   4. [**Hydro-Temp Corporation, Inc.**]
   5. [**Mammoth; a brand of Nortek Air Solutions**]
   6. [**Trane Inc.**]
   7. [**WaterFurnace International, Inc.**]
   8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**Carrier Global Corporation**]
   2. [**ClimateMaster, Inc.**]
   3. [**FHP Manufacturing Inc.**]
   4. [**Hydro-Temp Corporation, Inc.**]
   5. [**Mammoth; a brand of Nortek Air Solutions**]
   6. [**Trane Inc.**]
   7. [**WaterFurnace International, Inc.**]
   8. <**Insert manufacturer's name**>

C. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Cabinet and Chassis: Manufacturer's [**standard**][**low**][**standard- and low**]-height, [**flat**][**sloped**]-top, [**extended**]galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Cabinet Insulation: Glass-fiber liner, minimum **1/2 inch (13 mm)** thick, complying with UL 181, ASTM C1071, and ASTM G21.
4. Cabinet Insulation, Fibrous Glass Duct Liner Standard: Glass-fiber liner, minimum **1/2 inch (13 mm)** thick, complying with ASTM C1071 and NAIMA AH124, "Fibrous Glass Duct Liner Standard."
5. Sound Attenuation Package: Provide one or more of the following:

   a. Minimum **0.598-inch- (1.5-mm-)** thick compressor enclosure and front panel. Minimum **0.0937-inch (2.38-mm)** thick foam gasket around the compressor and perimeter of end panel.
   b. <**Insert method**>.

6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting to unit exterior and complying with ASHRAE 62.1.

   a. Condensate Overflow Protection: Solid state electronic; mechanical float switch not permitted.

7. Discharge Grille: Steel, aluminum, or plastic grille for adjustable discharge air pattern.
8. Color: Selected by Architect from manufacturer's [**standard**][**custom**] color selection.
9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Fan: Direct driven, centrifugal, with multispeed motor mounted on a removable fan-motor board.

1. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
2. Motor: Multispeed, permanently lubricated, [**permanent split capacitor**][**ECM**].

F. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger: Coaxial heat exchanger with [**copper**][**cupronickel**] water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to **450 psig (3102 kPa)** for refrigerant side and **400 psig (2758 kPa)** for water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
2. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

G. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to **450 psig (3102 kPa)**.

H. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic rotary compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.
    d. Internal thermal-overload protection.
    e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [**35 deg F (2 deg C)**]<**Insert temperature**>.
    f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
    g. Water-coil, low-temperature switch.
    h. Air-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum **3/8-inch- (10-mm-)** thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
8. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from [**25 to 125 deg F (minus 4 to 52 deg C)**]<**Insert temperature range**>.
9. Hot-Gas Reheat Valve: Pilot-operated, sliding-type valve with replaceable magnetic coil.

I. Electric Heating Coil: Energized on call for heating when entering-water-loop temperature is less than [**60 deg F (15 deg C)**]<**Insert temperature**>.

J. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when [**remote**][**unit-mounted**] humidistat calls for dehumidification.

K. Outdoor-Air Damper: Two-position, [**manual**][**motorized**] outdoor-air damper for fixed minimum intake up to 25 percent of fan capacity.

L. Filters:

1. Disposable, glass-fiber, flat type, [**1 inch (25 mm)**]<**Insert dimension**> thick, treated with adhesive, and having a minimum efficiency reporting value of 5 according to ASHRAE 52.2.
2. Disposable, pleated type, [**1 inch (25 mm)**]<**Insert dimension**> thick and with a minimum efficiency reporting value of 7 according to ASHRAE 52.2.

M. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

N. Controls:

1. Basic Unit Control Modes and Devices:

    a. Dehumidification mode.
    b. Unit shutdown on high or low refrigerant pressures.
    c. Unit shutdown on low water temperature.
    d. Low- and high-voltage protection.

e. Overcurrent protection for compressor and fan motor.
f. Random time delay, three to ten seconds, start on power-up.
g. Time delay override for servicing.
h. Control voltage transformer.
i. Water-coil freeze protection (selectable for water or antifreeze).
j. Air-coil freeze protection (check filter switch).
k. Condensate overflow shutdown switch.
l. Option to reset unit at thermostat or disconnect.
m. Fault type shall be retained in memory if reset at thermostat.
n. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
o. Ability to defeat time delays for servicing.
p. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
q. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
r. Remote fault-type indication at thermostat.
s. Selectable 24-V dc or pilot duty dry contact alarm output.
t. 24V dc output to cycle a motorized water valve with compressor contactor.
u. Electric heat output to control two stages of electric heat (emergency heat).
v. Service test mode for troubleshooting and service.
w. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:

a. [**Wall**][**Unit**]-Mounted Thermostat:

1) Heat-cool-off switch.
2) Fan on-auto switch.
3) [**Manual**][**Automatic**] changeover.
4) [**Concealed**][**Exposed**] temperature set point.
5) [**Concealed**][**Exposed**] temperature indication.
6) Deg [**F**][**C**] indication.

b. [**Wall**][**Unit**]-Mounted Humidistat: [**Concealed**][**Exposed**].

1) Temperature set point.
2) Temperature indication.

c. [**Wall**][**Unit**]-mounted temperature sensor.
d. Unoccupied period override push button.
e. LED to indicate fault condition at heat pump.
f. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

a. Scheduled operation for occupied and unoccupied periods on [**seven**][**365**]-day clock with minimum of four programmable periods per day.
b. [**Two**]<**Insert number**>-hour unoccupied override period.

c. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
d. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
e. Backup for volatile memory.
f. Differential pressure switch to indicate fan status. Fan failure alarm.
g. Differential pressure switch to indicate filter status. Dirty filter alarm.

4. Interface with DDC system for HVAC requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Provide [**BAC-net**][**or**][**LonWorks**] interface for central DDC system for HVAC workstation for the following functions:

1) Set-point adjustment for set points identified in this Section.
2) Start/stop and operating status of heat-pump unit.
3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
4) Occupied and unoccupied schedules.

O. Electrical Connection: Single electrical connection[**with fused disconnect**].

P. Capacities and Characteristics:

1. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Fan Speed: <**Insert rpm**>.
d. Motor Speed: <**Insert rpm**>.
e. Motor Horsepower: <**Insert value**>.

2. Water Supply:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature (Cooling): <**Insert deg F (deg C)**>.
d. Entering-Water Temperature (Heating): <**Insert deg F (deg C)**>.
e. Antifreeze Protection Chemical: <**Insert chemical name**>.
f. Antifreeze Concentration: <**Insert percentage**>.

3. Cooling:

a. Total Capacity: <**Insert Btu/h (kW)**>.
b. Sensible Capacity: <**Insert Btu/h (kW)**>.
c. Minimum Energy-Efficiency Ratio (EER): <**Insert value**>.
d. Entering-Air Temperature Dry Bulb: <**Insert deg F (deg C)**>.
e. Entering-Air Temperature Wet Bulb: <**Insert deg F (deg C)**>.

4. Heating:

a. Capacity: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.

c. Air Temperature Rise: <**Insert deg F (deg C)**>.
d. Minimum Coefficient of Performance (COP): <**Insert value**>.

5. Electric Heating Coil (Optional Feature):

a. Capacity: <**Insert Btu/h (kW)**>.
b. Number of Steps: <**Insert number**>.

6. Filters:

a. Face Area: <**Insert sq. ft. (sq. m)**>.
b. Maximum Face Velocity: <**Insert fpm (m/s)**>.

7. Electrical Characteristics for Single Connection:

a. Volts/Phase/Hertz: <**Insert values**>.
b. Full-Load Amperes (F.L.A.): <**Insert value**>.
c. Maximum Circuit Amperage (MCA): <**Insert value**>.
d. Maximum Overcurrent Protection (MOCP): <**Insert amperes**>.

2.5 HOSE KITS

A. General: Hose kits shall be designed for minimum **400-psig (2758-kPa)** working pressure and operating temperatures from **33 to 211 deg F (0.5 to 99 deg C)**. Tag hose kits to equipment designations.

B. Hose: Length [**24 inches (600 mm)**][**36 inches (900 mm)**] braided stainless steel, complete with adapters, <**Insert dimension**>. Minimum diameter, equal to water-source, heat-pump connection size.

C. Isolation Valves: Two-piece, bronze-body ball valves with stainless-steel, standard-port ball and stem with normal pipe thread (NPT) connections, and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.

E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.

1. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a 40:1 differential pressure range of **2 to 80 psig (13.8 to 552 kPa)**.
2. Manual, calibrated-orifice balancing valve.
3. Manual, venturi-type balancing valve.

F. Motorized Water Valve: Slow-acting, 24-V dc, with NPT connections.

2.6 HOSE KIT ASSEMBLIES

A. Supply and return hoses having ball valve with pressure temperature port.

B. Supply hose having ball valve with pressure temperature port; return hose having automatic flow regulator valve with pressure temperature ports, and ball valve.

C. Supply hose having "Y" strainer with blowdown valve, and ball valve with pressure temperature port; return hose having automatic flow regulator with PT ports, and ball valve.

D. Supply hose having "Y" strainer with blowdown valve, and ball valve with pressure temperature port.

E. Return hose having ball valve with pressure temperature port.

2.7 PUMP MODULE

A. Minimum [**1/6**]<**Insert value**>-hp, 230-V, single-phase pump rated to move at least [**16 gpm (1 L/s)**]<**Insert value**> at [**20-feet wg (59-kPa)**]<**Insert value**> head pressure.

1. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."

B. Include pump module hose kit with thread to barb fittings, hose, and hose clamps.

C. Three-way brass shut-off/flushing/purging valve.

D. Include controls to operate pump as required to maintain room temperature and ventilation set points.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduits before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install water-source heat pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230923.27 "Temperature Instruments," Section 230923.19 "Moisture Instruments," and Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Connect supply and return hydronic piping to heat pump with [**unions and shutoff valves**][**hose kits**].
2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:

1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections:

1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Heat pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.

3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Inspect operation of barometric dampers.
10. Verify bearing lubrication on fan.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit according to manufacturer's written instructions.
14. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Verify thermostat and humidistat calibration.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
20. Start refrigeration system, and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

21. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.7 CLEANING

A. Replace filters used during construction prior to air balance or Substantial Completion.

B. After completing installation of exposed, factory-finished, water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust,

operate, and maintain water-source heat pumps.

END OF SECTION 23 81 46 00A

Task	Specification	Specification Description
23 81 46 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems
23 81 49 00	23 81 26 00	Split-System Air-Conditioners
23 81 49 00	23 81 00 00	Variable-Refrigerant-Flow HVAC Systems

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SECTION 23 82 00 00 - CHILLED BEAMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Passive chilled beams.
2. Active chilled beams.
3. Multiservice chilled beams.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chilled beams.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for chilled beams.
c. Submit sufficient information needed for direct comparison to each entry scheduled on Drawings.
d. Submit manufacturer's velocity and temperature profiles beneath passive chilled beams under conditions obtained in accordance with BS EN 14518 test procedures to show compliance.

B. Shop Drawings: For chilled beams.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Chilled-Beam Finishes: <**Insert size**>.

E. Product Schedule: For chilled beams.[**Use same designations indicated on Drawings.**]

F. Delegated Design Submittals: For chilled beams.

1. Include design calculations for selecting mounting[**and seismic restraints**].

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for chilled beams, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Shipped chilled-beam products with similar requirements to those indicated for a continuous period of [**five**][**10**]<**Insert number**> years within time of bid.
2. Chilled-beam products that have been successfully tested and in use on at least [**three**][**five**]<**Insert number**> completed projects.
3. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
4. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting.
e. Owner training.

B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build mockups to show a finished installation for each of the following applications:

a. For each different chilled beam type indicated on Drawings.
b. <**Insert mockup item**>.

2. Mockups are to be fully operational.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Chilled beams are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Capacities and Characteristics: See Drawings.

2.2 PASSIVE CHILLED BEAMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Halton Company**]
2. [**Price Industries Limited**]
3. [**SEMCO, LLC; part of FlaktGroup**]
4. [**Swegon Inc.**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Halton Company**]
2. [**Price Industries Limited**]
3. [**SEMCO, LLC; part of FlaktGroup**]
4. [**Swegon Inc.**]
5. [**Titus; brand of Johnson Controls International plc, Global Products**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain chilled beams from single manufacturer.

D. Description: Sheet metal casing with discharge grille, cooling hydronic coil assembly, [**and**]mounting brackets[**, and accessories**] suitable for location and mounting arrangement indicated on Drawings.

E. Performance:

1. ASHRAE 55 Compliance: Location and performance of passive chilled beams indicated on Drawings are to result in environmental space conditions in compliance with ASHRAE 55.

F. Components:

1. Casing:

   a. Materials, Exposed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
   b. Materials, Recessed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
   c. Mounting Brackets: Factory installed along long side of units, with not less than four supports located near corners of units; field adjustable.

2. Discharge Air Grille:

   a. [**Perforated face with 50 percent free area**][**or**][**linear bars, extending full length of long dimension, spaced not more than 1/2 inch (13 mm) o.c.**][**See Drawings for face type**]<**Insert requirements**>.
   b. Hinged on [**one**][**or**][**two**] sides to open from room side.
   c. Removable from room side[**without use of tools**].

3. Hydronic Coil: Copper tube mechanically bonded to aluminum fins and mounted in a galvanized-steel coil casing; rated for minimum working pressure of [**300 psig (2069 kPa)**]<**Insert pressure**>.

   a. Tube Thickness: Minimum [**0.0016-inch (0.4-mm)**]<**Insert thickness**> thick.
   b. Fluid Tube Velocity (at Chilled-Water Design Flow Rate):

      1) Maximum: [**4 fps (1.2 m/s)**]<**Insert velocity**>.
      2) Minimum: [**1 fps (0.3 m/s)**]<**Insert velocity**>.

   c. Fin Thickness: Minimum [**0.006-inch (0.15-mm)**]<**Insert thickness**> thick.
   d. Fin Spacing: No closer than [**10**][**12**]<**Insert spacing**> fins per inch.
   e. Field Piping Connections: [**Press**][**Push-on**][**Solder**][**Threaded**] ends with terminations oriented for field connection, as indicated on Drawings.
   f. Include coil with manual air vent [**and drain fitting**][**and drain fitting with valve**].
   g. Include coil face with removable lint screen that is easily accessible for inspection and cleaning from room side.
   h. Include vertical-oriented coil(s) with drain pan constructed of [**galvanized**]steel and sloped at least 1 percent toward a **NPS 1/2 (DN 13)** capped drain connection.

4. Factory Piping: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**]<**Insert type**> copper tube with ASME B16.22 wrought-copper fittings.

G. Finish: [**Baked enamel**][**Powder coat**][**See Drawings**]<**Insert finish**>.

1. Color: Manufacturer's [**standard**][**custom**] paint color, as selected by Architect.
2. Appearance of Finished Work: Variations in same piece are unacceptable.[**Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.**]

H. Accessories:

1. Hoses: **NPS 1/2 (DN 13)**; [**18 inches (450 mm)**][**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert length**> long; PTFE-lined flexible hose wrapped in a stainless steel braided jacket and fitted with NPT threaded swivel ends; rated for **300 psig (2069 kPa)**.
2. <**Insert accessory**>.

I. Source Quality Control:

1. Capacity: Tested and certified by manufacturer in accordance with BS EN 14518 to comply with scheduled performance.

2.3 ACTIVE CHILLED BEAMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dadanco USA**]
2. [**Halton Company**]
3. [**Price Industries Limited**]
4. [**SEMCO, LLC; part of FlaktGroup**]
5. [**Swegon Inc.**]
6. [**Titus; brand of Johnson Controls International plc, Global Products**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dadanco USA**]
2. [**Halton Company**]
3. [**Price Industries Limited**]
4. [**SEMCO, LLC; part of FlaktGroup**]
5. [**Swegon Inc.**]
6. [**Titus; brand of Johnson Controls International plc, Global Products**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain chilled beams from single manufacturer.

D. Description: Sheet metal casing with primary-air, secondary-air, and mixed-air plenums; air nozzles; air inlet grille; supply-air discharge slot(s); cooling[**and heating**] hydronic coil assembly; [**and**]mounting brackets[**; and accessories**] suitable for location and mounting arrangement indicated on Drawings.

1. Maximum Overall Height (Exposed Units): [**See Drawings**]<**Insert dimension**>.
2. Maximum Overall Height (Recessed Units): [**See Drawings**]<**Insert dimension**>.

E. Components:

1. Casing:

a. Materials, Exposed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
b. Materials, Recessed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
c. Mounting Brackets: Factory installed along long side of units, with not less than four supports located near corners of units; field adjustable.
d. Commissioning Ports: Equip chilled beams with commissioning ports for field measurement of static pressure differential between primary-air plenum and room. Include an airflow calibration chart attached to each chilled beam.
e. Casing Leakage: Factory seal casing joints, seams, and penetrations of casing positive-pressure plenums to be airtight. Leakage in primary-air plenum is not to exceed [**5**]<**Insert number**> percent of airflow rate indicated on Drawings.
f. Primary-Air Plenum Duct Connections: Round or oval collar of sufficient length to accommodate a slip-on field-installed duct. Size as indicated on Drawings

g. Insulation: Exterior or interior portions of casing capable of forming surface condensation are not to be insulated with [**mineral-fiber**][**or**][**fiber-free**] insulation to prevent condensation.
h. Blank (Filler) Sections: Where indicated on Drawings, chilled-beam manufacturer is to furnish blank (filler) sections to match external appearance of adjoining active portions.
i. Multiple Section Mating and Alignment: Where multiple sections are required to join end to end to make a longer contiguous unit, manufacturer to provide means to join multiple sections, so they appear as a single unit with no obvious obstructions or visual cues of multiple sections.

2. Air Nozzles: Quantity, size, and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings. Primary air supplied through nozzles is to induce room (secondary) air across hydronic coil, and two air steams are to mix to supply conditioned air to room.

   a. Material: [**Metal**][**or**][**plastic, complying with NFPA 90A and UL 94 V-0**].
   b. Field replaceable[**with different size nozzles to accommodate changes to performance**].

3. Inlet Air Grille: Mounted on face of chilled beam and arranged for room (secondary) air to enter grille and hydronic coil before mixing with primary air.

   a. [**Perforated face with 50 percent free area**][**or**][**linear bars, extending full length of long dimension, spaced not more than 1/2 inch (13 mm) o.c.**][**See Drawings for face type**]<**Insert requirements**>.
   b. Hinged on [**one**][**or**][**two**] sides to open from room side.
   c. Removable from room side[**without use of tools**].

4. Supply-Air Discharge Slot(s): Size and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings.

   a. Material: Extruded aluminum or formed steel.
   b. Field-Adjustable Discharge-Air Pattern: Include field-adjustable air pattern control to adjust the direction of the discharge air.

5. Hydronic Coil: Copper tube mechanically bonded to aluminum fins and mounted in a galvanized-steel coil casing; rated for minimum working pressure of [**300 psig (2069 kPa)**]<**Insert pressure**>.

   a. Tube Thickness: Minimum [**0.016-inch (0.4-mm)**]<**Insert thickness**> thick.
   b. Fluid Tube Velocity (at Chilled-Water Design Flow Rate):

      1) Maximum: [**4 fps (1.2 m/s)**]<**Insert velocity**>.
      2) Minimum: [**1 fps (0.3 m/s)**]<**Insert velocity**>.

   c. Fin Thickness: Minimum [**0.006-inch (0.15-mm)**]<**Insert thickness**> thick.
   d. Fin Spacing: No closer than [**10**][**12**]<**Insert spacing**> fins per inch.
   e. Field Piping Connections: [**Press**][**Push-on**][**Solder**][**Threaded**] ends with terminations oriented for field connection, as indicated on Drawings.
   f. Piping Arrangement: Two pipe[**or four pipe, as indicated on Drawings.**]
   g. Include coil with manual air vent [**and drain fitting**][**and drain fitting with valve**].
   h. Include coil face with removable lint screen that is easily accessible for inspection and cleaning from room side.
   i. Include vertical-oriented coil(s) with drain pan constructed of [**galvanized**]steel and sloped at least 1 percent toward a **NPS 1/2 (DN 13)** capped drain connection.

6. Factory Piping: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**]<**Insert type**> copper tube with ASME B16.22 wrought-copper fittings.

F. Finish: [**Baked enamel**][**Powder coat**][**See Drawings**]<**Insert finish**>.

1. Color: Manufacturer's [**standard**][**custom**] paint color, as selected by Architect.
2. Appearance of Finished Work: Variations in same piece are unacceptable.[**Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.**]

G. Accessories:

1. Hoses: **NPS 1/2 (DN 13)**; [**18 inches (450 mm)**][**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert length**> long; PTFE-lined flexible hose wrapped in a stainless steel braided jacket and fitted with NPT threaded swivel ends; rated for **300 psig (2069 kPa)**.
2. Primary Airflow Automated Dampers: Modulating inlet damper with low-voltage electric actuator for connection to external controls.
3. Primary Airflow Manual Dampers: Integral damper assembly with locking handle for field adjustment.
4. Primary Airflow Regulators: Factory set to airflow rate indicated on Drawings; capable of maintaining constant airflow rate within [**10**]<**Insert number**> percent of set point.
5. <**Insert accessory**>.

H. Source Quality Control: Comply with ASHRAE 200, AHRI 1240, and AHRI 1241.

1. Rate capacity of coils in accordance with AHRI 410, with capacities established in accordance with ASHRAE 200.

2.4 MULTISERVICE CHILLED BEAMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Halton Company**]
2. [**Price Industries Limited**]
3. [**Titus; brand of Johnson Controls International plc, Global Products**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Halton Company**]
2. [**Price Industries Limited**]
3. [**Titus; brand of Johnson Controls International plc, Global Products**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain chilled beams from single manufacturer.

D. Description: Sheet metal casing with primary-air, secondary-air, and mixed-air plenums; air nozzles; air inlet grille; supply-air discharge slot(s); cooling[**and heating**] hydronic coil assembly; [**and**]mounting-bracket supports [**and accessories**]suitable for location and mounting arrangement indicated on Drawings.

1. Maximum Overall Height (Exposed Units): [**See Drawings**]<**Insert dimension**>.

2. Maximum Overall Height (Recessed Units): [**See Drawings**]<**Insert dimension**>.

E. Components:

1. Casing:

   a. Materials, Exposed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
   b. Materials, Recessed Units: Minimum [**0.0375-inch- (0.95-mm-)**]<**Insert thickness**> thick, [**galvanized-**]steel sheet.
   c. Mounting Brackets: Factory installed along long side of units, with not less than four supports located near corners of units; field adjustable.
   d. Commissioning Ports: Equip chilled beams with commissioning ports for field measurement of static pressure differential between primary air plenum and room. Include with commissioning ports an airflow calibration chart attached to each chilled beam.
   e. Casing Leakage: Factory seal casing joints, seams, and penetrations of casing positive-pressure plenums to be airtight. Leakage in primary-air plenum is not exceed [**5**]<**Insert number**> percent of airflow rate indicated on Drawings.
   f. Primary-Air Plenum Duct Connections: Round or oval collar of sufficient length to accommodate a slip-on field-installed duct. Size as indicated on Drawings
   g. Insulation: Exterior or interior portions of casing capable of forming surface condensation are to be insulated with [**mineral-fiber**][**or**][**fiber-free**] insulation to prevent condensation.
   h. Blank (Filler) Sections: Where indicated on Drawings, chilled-beam manufacturer is to furnish blank (filler) sections to match external appearance of adjoining active portions.
   i. Multiple Section Mating and Alignment: Where multiple sections are required to join end to end to make a longer contiguous unit, manufacturer to provide means to join multiple sections, so they appear as a single unit with no obvious obstructions or visual cues of multiple sections.

2. Air Nozzles: Quantity, size, and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings. Primary air supplied through nozzles is to induce room (secondary) air across hydronic coil, and two air steams are to mix to supply conditioned air to room.

   a. Material: [**Metal**][**or**][**plastic, complying with NFPA 90A and UL 94 V-0**].
   b. Field replaceable[**with different size nozzles to accommodate changes to performance**].

3. Inlet Air Grille: Mounted on face of chilled beam and arranged for room (secondary) air to enter grille and hydronic coil before mixing with primary air.

   a. [**Perforated face with 50 percent free area**][**or**][**linear bars, extending full length of long dimension, spaced not more than 1/2 inch (13 mm) o.c.**][**See Drawings for face type**]<**Insert requirements**>.
   b. Hinged on [**one**][**or**][**two**] sides to open from room side.
   c. Removable from room side[**without use of tools**].

4. Supply-Air Discharge Slot(s): Size and arrangement selected by chilled-beam manufacturer for performance indicated on Drawings.

   a. Material: Extruded aluminum or formed steel.
   b. Field-Adjustable Discharge-Air Pattern: Include field-adjustable air pattern control to adjust the direction of the discharge air.

5. Hydronic Coil: Copper tube mechanically bonded to aluminum fins and mounted in a galvanized-

steel coil casing; rated for minimum working pressure of [**300 psig (2069 kPa)**]<**Insert pressure**>.

a. Tube Thickness: Minimum [**0.016-inch (0.4-mm)**]<**Insert thickness**> thick.
b. Fluid Tube Velocity (at Chilled-Water Design Flow Rate):

1) Maximum: [**4 fps (1.2 m/s)**]<**Insert velocity**>.
2) Minimum: [**1 fps (0.3 m/s)**]<**Insert velocity**>.

c. Fin Thickness: Minimum [**0.006-inch (0.15-mm)**]<**Insert thickness**> thick.
d. Fin Spacing: No closer than [**10**][**12**]<**Insert spacing**> fins per inch.
e. Field Piping Connections: [**Press**][**Push-on**][**Solder**][**Threaded**] ends with terminations oriented for field connection, as indicated on Drawings.
f. Piping Arrangement: Two pipe[**or four pipe, as indicated on Drawings.**]
g. Include coil with manual air vent [**and drain fitting**][**and drain fitting with valve**].
h. Include coil face with removable lint screen that is easily accessible for inspection and cleaning from room side.
i. Include vertical-oriented coil(s) with drain pan constructed of [**galvanized**]steel and sloped at least 1 percent toward a **NPS 1/2 (DN 13)** capped drain connection.

6. Factory Piping: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88M, Type C)**]<**Insert type**> copper tube with ASME B16.22 wrought-copper fittings.

F. Finish: [**Baked enamel**][**Powder coat**][**See Drawings**]<**Insert finish**>.

1. Color: Manufacturer's [**standard**][**custom**] paint color, as selected by Architect.
2. Appearance of Finished Work: Variations in same piece are unacceptable.[**Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.**]

G. Other Building Services Integrated into Chilled Beams:

1. Fire Alarm System Devices:

a. Notification Appliances, Audible: <**Insert requirement**>.
b. Notification Appliances, Visual: <**Insert requirement**>.
c. Heat Detectors: <**Insert requirement**>.
d. Smoke Detectors: <**Insert requirement**>.

2. Sprinklers: <**Insert requirement**>.
3. Lighting: <**Insert requirement**>.
4. Occupancy Sensors: <**Insert requirement**>.
5. Speakers: <**Insert requirement**>.
6. Video Cameras: <**Insert requirement**>.
7. <**Insert building service**>.

H. Accessories:

1. Hoses: **NPS 1/2 (DN 13)**; [**18 inches (450 mm)**][**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert length**> long; PTFE-lined flexible hose wrapped in a stainless steel braided jacket and fitted with NPT threaded swivel ends; rated for **300 psig (2069 kPa)**.
2. Primary Airflow Automated Dampers: Modulating inlet damper with low-voltage electric actuator for connection to external controls.
3. Primary Airflow Manual Dampers: Integral damper assembly with locking handle for field adjustment.
4. Primary Airflow Regulators: Factory set to airflow rate indicated on Drawings; capable of

maintaining constant airflow rate within [**10**]<**Insert number**> percent of set point.

5. <**Insert accessory**>.

I. Source Quality Control: Comply with ASHRAE 200, AHRI 1240, and AHRI 1241.

1. Rate capacity of coils in accordance with AHRI 410, with capacities established in accordance with ASHRAE 200.

2.5 GENERAL PROTECTION REQUIREMENTS

A. Protect finishes on exposed surfaces from damage by applying a removable, temporary protective covering at the factory before shipping.

B. Protect coil and piping openings with removable end caps before shipping.

C. Protect duct connection openings with removable end caps before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive chilled beams for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**duct,**]piping and wiring to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CHILLED BEAMS

A. Install chilled beams level and plumb.

B. Coordinate layout and installation of chilled beams and suspension-system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communications system, security system, and partition assemblies.

C. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

E. Install continuous-thread hanger rods of size required to support chilled-beam weight. Laterally brace chilled beams to prevent movement.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116

"Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for general-duty valves specified in Section 230523 "General-Duty Valves for HVAC Piping."

C. Make piping connections to chilled-beam units at locations indicated on Drawings.

D. Where installing piping adjacent to chilled beams, allow space for service and maintenance.

3.4 DUCT CONNECTIONS

A. Comply with requirements for ductwork specified in [**Section 233113 "Metal Ducts."**][**and**][**Section 233346 "Flexible Ducts."**] Drawings indicate general arrangement of ductwork.

B. Make ductwork connections to chilled-beam units at locations indicated on Drawings.

C. Where installing ductwork adjacent to chilled beams, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Comply with NECA 1.

D. Wiring Method: Install concealed cables in raceways and cable trays. Do not install cable within consoles, cabinets, desks, and counters.[**In accessible ceiling spaces and in gypsum board partitions, unenclosed wiring method may be used.**][**Conceal conductors and cables in accessible ceilings, walls, and floors.**] Do not conceal raceways and cables in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems.
3. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.6 CONTROLS

A. Comply with requirements for controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC[**and Section 230993.11 "Sequence of Operations for HVAC DDC**]."

3.7 MULTISERVICE CHILLED-BEAM CONNECTIONS

A. Fire Alarm System Devices: Comply with requirements for fire alarm system installation in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and "Section 284614 "Single- and Multiple-**

Station Alarms."]

B. Sprinklers: Comply with requirements for sprinkler head installation in Section 211000 "Water-Based Fire-Suppression Systems."

C. Lighting: Comply with requirements for lighting-fixture installation in Section 265119 "LED Interior Lighting."

D. Occupancy Sensors: Comply with the requirements for occupancy sensor installation in Section 260923 "Lighting Control Devices."

E. Speakers: Comply with requirements for speaker installation in Section 275116 "Public Address Systems."

F. Video Cameras: Comply with requirements for video camera installation in Section 282000 "Video Surveillance."

3.8 IDENTIFICATION

A. Identify electrical system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify hydronic piping and valves. Comply with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.9 CLEANING AND PROTECTION

A. Protect exposed surfaces of chilled beams from damage with factory-installed protective covering. Maintain covering in place until start of unit testing and balancing.

B. Protect chilled beam water connections with factory-installed protective covers, and keep them covered until making final field piping connections.

C. Protect chilled-beam air connections with factory-installed protective covers and keep them covered until making final field duct connections.

D. Clean chilled beams inside and out to a factory-new condition.

E. Reject damaged chilled beams and replace with new units.

F. Only if acceptable to the Owner, minor damage to finishes may be repaired as required to restore beams to factory-new appearance. Any variation in visual appearance between factory and repaired finish is to be rejected.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, fill system with water under [**design**]pressure and test for leaks. Repair leaks and retest until no leaks exist.

E. Chilled beam will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain chilled beams.

END OF SECTION 23 82 00 00

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Task	Specification	Specification Description
23 82 16 00	23 82 00 00	Chilled Beams

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SECTION 23 82 16 11 - HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic air coils.
2. Integral face-and-bypass hot-water coils.

B. Related Requirements:

1. Section 238216.12 "Steam Air Coils" for air coils using steam as the heating medium.
2. Section 238216.13 "Refrigerant Air Coils" for air coils using refrigerants as the medium.
3. Section 238216.14 "Electric-Resistance Air Coils" for electric air coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: <**Insert feet (m)**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: [**200 psig (1380 kPa)/300 deg F (149 deg C)**]<**Insert value and temperature**>.

D. Select cooling coils for no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

E. Hot-Water Coil Capacities and Characteristics:

1. Coil Face Dimensions:

a. Finned Length: <**Insert inches (mm)**>.
b. Finned Width: <**Insert inches (mm)**>.

2. Number of Rows: <**Insert number**>.
3. Coating: <**Insert manufacturer; product**>.
4. Serpentine: [**Half**][**Full**].
5. Integral Face-and-Bypass Coil: [**Yes**][**No**].
6. Air Side:

a. Flow Rate: <**Insert cfm (L/s)**>.
b. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
d. Total Capacity: <**Insert Btu/h (kW)**>.
e. Entering Temperature: <**Insert deg F (deg C)**>.
f. Leaving Temperature: <**Insert deg F (deg C)**>.

7. Water Side:

a. Flow Rate: <**Insert gpm (L/s)**>.
b. Tube Velocity: <**Insert fpm (m/s)**>.
c. Glycol Type: [**Ethylene**][**Propylene**].
d. Aqueous Glycol Solution Concentration: [**None**]<**Insert percentage**>[**by weight**][**by volume**].
e. Pressure Drop: <**Insert feet (kPa)**>.
f. Entering Temperature: <**Insert deg F (deg C)**>.
g. Leaving Temperature: <**Insert deg F (deg C)**>.

F. Chilled-Water Coil Capacities and Characteristics:

1. Coil Face Dimensions:

a. Finned Length: <**Insert inches (mm)**>.
b. Finned Width: <**Insert inches (mm)**>.

2. Number of Rows: <**Insert number**>.
3. Coating: <**Insert manufacturer; product**>.
4. Serpentine: [**Half**][**Full**][**Double**].
5. Air Side:

    a. Flow Rate: <**Insert cfm (L/s)**>.
    b. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
    c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
    d. Total Capacity: <**Insert Btu/h (kW)**>.
    e. Sensible Capacity: <**Insert Btu/h (kW)**>.
    f. Entering Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    g. Entering Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
    h. Leaving Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
    i. Leaving Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

6. Water Side:

    a. Flow Rate: <**Insert gpm (L/s)**>.
    b. Tube Velocity: <**Insert fpm (m/s)**>.
    c. Glycol Type: [**Ethylene**][**Propylene**].
    d. Aqueous Glycol Solution Concentration: [**None**]<**Insert percentage**>[**by weight**][**by volume**].
    e. Pressure Drop: <**Insert feet (Pa)**>.
    f. Entering Temperature: <**Insert deg F (deg C)**>.
    g. Leaving Temperature: <**Insert deg F (deg C)**>.

2.2 HYDRONIC AIR COILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Greenheck Fan Corporation**]
5. [**Modine Manufacturing Company**]
6. [**RAE Coils; a division of RAE Corporation**]
7. [**Super Radiator Coils**]
8. [**Trane**]
9. [**USA Coil & Air**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Greenheck Fan Corporation**]
5. [**Modine Manufacturing Company**]
6. [**RAE Coils; a division of RAE Corporation**]
7. [**Super Radiator Coils**]
8. [**Trane**]
9. [**USA Coil & Air**]

10. **<Insert manufacturer's name>**

C. Source Limitations: Obtain hydronic coils from single source from single manufacturer.

D. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid.

E. Tubes:

1. Material: [**Copper**][**aluminum**][**carbon steel**][**90/10 cupronickel alloy**][**stainless steel**]<**Insert material**>.
2. Nominal Diameter: Minimum [**1/2 inch (13 mm)**][**or**][**5/8 inch (16 mm)**]<**Insert nominal diameter**> before expanding, selected to provide performance indicated.
3. Nominal Wall Thickness: As required by performance, minimum [**0.020 inch (0.508 mm)**][**0.025 inch (0.635 mm)**][**0.035 inch (0.889 mm)**][**0.049 inch (1.245 mm)**]<**Insert dimension**> thick.
4. Return Bends: 180-degree bends; material[**, wall thickness,**] and nominal diameter to match tubes.
5. Fluid Velocity at Design Flow Rate:

   a. Maximum: [**6 fps (1.8 m/s)**]<**Insert velocity**>.
   b. Minimum: [**3 fps (0.9 ms)**]<**Insert velocity**>.

6. Features: [**Cleanable**][**Individually drainable**].

F. Fins:

1. Type: Plate.
2. Materials:

   a. Aluminum: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   b. Copper: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   c. 90/10 Cupronickel: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   d. <**Insert fin material and thickness**>.

3. Spacing: Maximum [**12 fins per inch (2.1 mm)**]<**Insert maximum fin spacing**>.
4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: [**Flat-face fins**][**Wave-, corrugated-, or waffle-face fins**][**Fin type as required by performance requirements**]<**Insert fin type**>.
6. Fin and Tube Joint: [**Mechanical bond**][**or**][**silver brazed**].

G. Headers:

1. Material: [**Carbon steel**][**Copper**]<**Insert material**>[**, removable for cleaning and inspection of tubes**].
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced-header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Drains: Include low point of [**supply**][**supply and return**] header with a [**NPS 1/2 (DN 13)**]<**Insert pipe size**> drain connection.
5. Vents: Include high point of [**return**][**supply and return**] header with a [**NPS 1/2 (DN 13)**]<**Insert pipe size**> vent connection.
6. Supply and Return Connections: [**Copper**][**Carbon steel**][**Red brass**] pipe;

[**threaded**][**or**][**flanged**], [**same end**][**opposite ends**] of coil.

7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.
8. Fluid Velocity at Design Flow Rate: Maximum of [**6 fps (1.8 m/s)**]<**Insert velocity**>.

H. Casings and Tube Sheets:

1. Depth: Extend coil casing and tube sheets a minimum of [**1/2 inch (13 mm)**]<**Insert dimension**> beyond face of fins on both entering and leaving sides.
2. Materials:

   a. Stainless steel, [**Type 304**]<**Insert type**>, No. 2D finish, ASTM A240/A240M.
   b. Galvanized steel, ASTM A653/A653M, **G90 (Z275)** coating.
   c. Copper, ASTM B152/B152M.

I. Top and Bottom Casings:

1. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>; double-flange edge for rigidity and ease of removal with secondary flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
2. Thickness:

   a. Coils with Fin Length of Up to [**72 Inches (1800 mm)**]<**Insert dimension**>: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.
   b. Coils with Fin Length Exceeding [**72 Inches (1800 mm)**]<**Insert dimension**>: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

J. End Tube Sheets:

1. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>.
3. Thickness: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

K. Intermediate Tube Sheets:

1. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2. Space intermediate tube sheets a maximum of [**48 inches (1200 mm)**]<**Insert dimension**> o.c. and locate to provide equal spacing between tube sheet across coil tube length.
3. Flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
4. Thickness: Minimum of [**16 gauge (1.6 mm)**]<**Insert thickness**> thick.

L. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

M. Hardware: Use hex-head bolts, nuts, and washers constructed of [**Type 304**][**or**][**Type 316**] stainless steel.

N. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. Coil fin length.

7. Coil fin height.
8. Coil weight with fluid/without fluid.
9. Coil casing material and thickness.
10. Coil fin material and thickness.
11. Coil tube material and thickness.
12. Coil header material and thickness.
13. <**Insert requirements**>.

O. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

P. Coating: [**None**][**Corrosion resistant**]<**Insert manufacturer; product name**>.

2.3 HOT-WATER HEATING COILS WITH INTEGRAL FACE-AND-BYPASS DAMPERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**LJ Wing; a Mestek Technology, Inc. company**]
2. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**LJ Wing; a Mestek Technology, Inc. company**]
2. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain integral face-and-bypass coils from single source from single manufacturer.

D. Description: Hydronic coil with [**horizontal**][**or**][**vertical**] tube arrangement[**as indicated on Drawings**] with integral face-and-bypass dampers and controls installed to control modulating dampers, to achieve discharge air temperature set point. Design includes alternating arrangement of active coil segments and dampers.

E. Performance:

1. Each coil capable of maintaining constant discharge air temperature, regardless of variations in entering-air temperature with constant water flow through coil.
2. Portioning of air across and around heating element to result in uniform temperature within 5 deg F (3 deg C) of average temperature when measured anywhere across a vertical plane located [**24 inches (600 mm)**][**36 inches (900 mm)**] downstream of leaving face of coil.

F. Casing: [**Galvanized steel**][**or**][**stainless steel**], minimum of 16 gauge (1.6 mm) thick.

G. Fins: Rectangular shape, constructed of minimum [**0.010-inch- (0.25-mm-)**]<**Insert dimension**> thick aluminum, with spacing of not closer than [**12 fins per inch (2.1 mm)**]<**Insert fin spacing**>.

H. Headers: [**Carbon steel**][**or**][**copper**], selected by manufacturer for flow, pressure, and temperature encountered; drain connections at low points, vent connections at high points, and supply and return connections located on discharge face of coil.

1. Insulation: Insulate headers with mineral-fiber insulation covered by a metal jacket.
2. Supply and Return Connections:

   a. Terminate ends with MNPT.
   b. Connections [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**> and larger shall have thread-on flanges. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.

I. Tubes:

1. Materials: [**Copper**][**90/10 cupronickel**][**or**][**carbon steel**].
2. Nominal Diameter: **5/8 inch (16 mm)**.
3. Nominal Wall Thickness: As required by performance, minimum of [**0.035 inch (0.9 mm)**][**0.049 inch (1.2 mm)**] thick.

J. Dampers: Clamshell design arranged to modulate airflow across or around individual heating elements.

1. Material: [**Galvanized steel**][**or**][**stainless steel**], minimum of 16 gauge (1.6 mm) thick.
2. Actuator: [**Face**][**or side**] mounted; electric motor for proportional control, failing in last position.

K. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together; high-temperature brazing alloy with more than 30 percent silver when brazing ferrous to non-ferrous materials.

L. Hardware: Use hex-head bolts, nuts, and washers constructed of [**zinc-plated carbon steel**][**or**][**stainless steel**].

M. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. <**Insert requirements**>.

N. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

O. Coating: [**None**][**Corrosion resistant**]<**Insert manufacturer; product name**>.

2.4 MATERIALS

A. Aluminum: **ASTM B209 (ASTM B209M)**.

B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.

C. Copper Sheet: ASTM B152.

D. 90/10 Cupronickel Alloy: ASTM B122/ASTM B122M.

E. Steel:

1. Pipe Connections: ASTM A53/A53M.

F. Corrosion-Resistant Coating: Where indicated on Drawings, coat coils with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in. lb (11.3 N m)**.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.5 SOURCE QUALITY CONTROL

A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than [**300-psig (2070-kPa)**]<**Insert pressure**> internal pressure.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install [**galvanized-steel**][**stainless steel**] drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION 23 82 16 11

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Task	Specification	Specification Description
23 82 16 11	23 82 00 00	Chilled Beams

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SECTION 23 82 16 12 - STEAM AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steam air coils.
2. Integral face-and-bypass steam coils.

B. Related Requirements:

1. Section 238216.11 "Hydronic Air Coils" for air coils using water as the heating or cooling medium.
2. Section 238216.13 "Refrigerant Air Coils" for air coils using refrigerants as the medium.
3. Section 238216.14 "Electric Resistance Air Coils" for electric air coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: <**Insert feet (m)**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: [**100 psig (690 kPa)/400 deg F (204 deg C)**]<**Insert value and temperature**>.

D. Capacities and Characteristics:

1. Coil Face Dimensions:

a. Finned Length: <**Insert inches (mm)**>.
b. Finned Width: <**Insert inches (mm)**>.

2. Number of Rows: <**Insert number**>.
3. Coating: <**Insert manufacturer; product**>.
4. Integral Face-and-Bypass Coil: [**Yes**][**No**].
5. Air Side:

a. Flow Rate: <**Insert cfm (L/s)**>.
b. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
d. Total Capacity: <**Insert Btu/h (kW)**>.
e. Entering Temperature: <**Insert deg F (deg C)**>.
f. Leaving Temperature: <**Insert deg F (deg C)**>.

6. Steam Side:

a. Inlet Pressure: <**Insert psig (kPa)**>.
b. Tube Type: [**Single**][**Distributing**].
c. Condensing Capacity: <**Insert lb/h (g/s)**>.
d. Pressure Drop: <**Insert psig (kPa)**>.

2.2 STEAM AIR COILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Dunham-Bush, Inc**]
5. [**Greenheck Fan Corporation**]
6. [**Heatcraft Refrigeration Products LLC**]
7. [**RAE Coils; a division of RAE Corporation**]
8. [**Super Radiator Coils**]

9. [**Trane**]
10. [**USA Coil & Air**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Dunham-Bush, Inc**]
5. [**Greenheck Fan Corporation**]
6. [**Heatcraft Refrigeration Products LLC**]
7. [**RAE Coils; a division of RAE Corporation**]
8. [**Super Radiator Coils**]
9. [**Trane**]
10. [**USA Coil & Air**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain steam air coils from single source from single manufacturer.

D. Description: Plate fin coils constructed of tubes mechanically expanded into continuous collars that are die-formed into plate fins and specially designed for thermal expansion and contraction of the tubes during coil operation.

1. Distributing-type steam coils of a tube-in-tube design for uniform steam distribution along the entire length of each tube, to ensure a consistent temperature rise across the full coil face and accelerate condensate removal.
2. Non-distributing-type steam coils of a single tube design for uniform steam distribution across the entire header and each tube

E. Tubes:

1. Material: [**Copper**]<**Insert material**>.
2. Nominal Diameter: Minimum [**5/8 inch (16 mm)**][**1 inch (25 mm)**][**outside tube**]<**Insert nominal diameter**> before expanding, selected to provide performance indicated.
3. Nominal Wall Thickness: As required by performance, minimum of [**0.035 inch (0.889 mm)**][**0.049 inch (1.245 mm)**]<**Insert dimension**> thick.
4. [**Features: Individually drainable.**]

F. Fins:

1. Type: Plate.
2. Materials:

   a. Aluminum: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   b. Copper: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   c. 90/10 Cupronickel: [**0.0060 inch (0.15 mm)**]<**Insert dimension**> thick.
   d. <**Insert fin material and thickness**>.

3. Spacing: Maximum [**12 fins per inch (2.1 mm)**]<**Insert maximum fin spacing**>.
4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: [**Flat-face fins**][**Wave-, corrugated-, or waffle-face fins**][**Fin type as required by performance requirements**]<**Insert fin type**>.
6. Fin and Tube Joint: [**Mechanical bond**][**or**][**silver brazed**].

G. Headers:

1. Material: [**Carbon steel**][**Copper**]<**Insert material**>[**, removable for cleaning and inspection of tubes**].
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Drains: Include low point of [**supply**][**supply and return**] header with a [**NPS 1/2 (DN 13)**]<**Insert pipe size**> drain connection.
5. Vents: Include high point of [**return**][**supply and return**] header with a [**NPS 1/2 (DN 13)**]<**Insert pipe size**> vent connection.
6. Supply and Condensate Return Connections: [**Copper**][**Carbon steel**][**Red brass**] pipe; [**threaded**][**or**][**flanged**], [**same end**][**opposite ends**] of coil.
7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.

H. Casings and Tube Sheets:

1. Depth: Extend coil casing and tube sheets a minimum of [**1/2 inch (13 mm)**]<**Insert dimension**> beyond face of fins on both entering and leaving sides.
2. Materials:

   a. Stainless steel, [**Type 304**]<**Insert type**>, No. 2D finish.
   b. Galvanized steel, **G90 (Z275)** coating.
   c. Copper.

I. Top and Bottom Casings:

1. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>; double-flange edge for rigidity and ease of removal with secondary flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
2. Thickness:

   a. Coils with Fin Length of Up to [**72 Inches (1800 mm)**]<**Insert dimension**>: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.
   b. Coils with Fin Length Exceeding [**72 Inches (1800 mm)**]<**Insert dimension**>: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

J. End Tube Sheets:

1. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>.
3. Thickness: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

K. Intermediate Tube Sheets:

1. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2. Space intermediate tube sheets a maximum of [**48 inches (1200 mm)**]<**Insert dimension**> o.c. and locate to provide equal spacing between tube sheet across coil tube length.
3. Flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
4. Thickness: Minimum of [**16 gauge (1.6 mm)**]<**Insert thickness**> thick.

L. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil

installation.

M. Hardware: Use hex-head bolts, nuts, and washers constructed of [**Type 304**][**or**][**Type 316**] stainless steel.

N. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. Coil fin length.
7. Coil fin height.
8. Coil weight with fluid/without fluid.
9. Coil casing material and thickness.
10. Coil fin material and thickness.
11. Coil tube material and thickness.
12. Coil header material and thickness.
13. <**Insert requirements**>.
14. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

O. Coating: [**None**][**Corrosion resistant**]<**Insert manufacturer; product name**>.

2.3 STEAM HEATING COILS WITH INTEGRAL FACE-AND-BYPASS DAMPERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**LJ Wing; a Mestek Technology, Inc. company**]
3. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**LJ Wing; a Mestek Technology, Inc. company**]
3. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain integral face-and-bypass coils from single source from single manufacturer.

D. Description: Steam coil with [**horizontal**][**or**][**vertical**] tube arrangement[**as indicated on Drawings**] with integral face-and-bypass dampers and controls installed to control modulating dampers to achieve discharge air temperature set point. Design includes alternating arrangement of active coil segments and dampers.

E. Performance:

1. Each coil capable of maintaining constant discharge air temperature regardless of variations in

entering-air temperature with constant water flow through coil.

2. Portioning of air across and around heating element to result in uniform temperature within 5 deg F (3 deg C) of average temperature when measured anywhere across a vertical plane located [**24 inches (600 mm)**][**36 inches (900 mm)**] downstream of leaving face of coil.

F. Casing: [**Galvanized steel**][**or**][**stainless steel**], minimum of 16 gauge (1.6 mm) thick.

G. Fins: Rectangular shape, constructed of minimum [**0.010-inch- (0.25-mm-)**]<**Insert dimension**> thick aluminum, with spacing of not closer than [**12 fins per inch (2.1 mm)**]<**Insert fin spacing**>.

H. Headers: [**Carbon steel**][**or**][**copper**], selected by manufacturer for flow, pressure, and temperature encountered; drain connections at low points, vent connections at high points, and supply and return connections located on discharge face of coil.

1. Insulation: Insulate headers with mineral-fiber insulation covered by a metal jacket.
2. Supply and Return Connections:

a. Terminate ends with MNPT.
b. Connections [**NPS 2-1/2 (DN 65)**]<**Insert pipe size**> and larger shall have thread-on flanges. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.

I. Tubes:

1. Materials: [**Copper**][**90/10 cupronickel**][**or**][**carbon steel**].
2. Nominal Diameter: **5/8 inch (16 mm)**.
3. Nominal Wall Thickness: As required by performance, minimum of [**0.035 inch (0.9 mm)**][**0.049 inch (1.2 mm)**] thick.

J. Dampers: Clamshell design arranged to modulate airflow across or around individual heating elements.

1. Material: [**Galvanized steel**][**or**][**stainless steel**], minimum of 16 gauge (1.6 mm) thick.
2. Actuator: [**Face**][**or side**] mounted; electric motor for proportional control, failing in last position.

K. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together; high-temperature brazing alloy with more than 30 percent silver when brazing ferrous to non-ferrous materials.

L. Hardware: Use hex-head bolts, nuts, and washers constructed of [**zinc-plated carbon steel**][**or**][**stainless steel**].

M. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. <**Insert requirements**>.

N. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

O. Coating: [**None**][**Corrosion resistant**]<**Insert manufacturer; product name**>.

2.4 MATERIALS

A. Aluminum: **ASTM B209 (ASTM B209M)**.

B. Copper Tube: ASTM B75/B75M annealed temper or ASTM B280 drawn temper.

C. Copper Sheet: ASTM B152.

D. Galvanized Steel: ASTM A653/A653M.

E. 90/10 Cupronickel Alloy: ASTM B122/B122M.

F. Stainless Steel: ASTM A240/A240M.

G. Steel:

1. Pipe Connections: ASTM A53/A53M.

H. Corrosion-Resistant Coating: Where indicated on Drawings, coat coils with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in. lb (11.3 N m)**.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.5 SOURCE QUALITY CONTROL

A. Steam Coils: Factory tested to **300 psig (2070 kPa)**.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232213 "Steam and Condensate Heating Piping."

END OF SECTION 23 82 16 12

Task	Specification	Specification Description
23 82 16 12	23 82 00 00	Chilled Beams
23 82 16 12	23 82 16 11	Hydronic Air Coils

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SECTION 23 82 16 13 - REFRIGERANT AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant air coils.

B. Related Requirements:

1. Section 238216.11 "Hydronic Air Coils" for air coils using water as the heating or cooling medium.
2. Section 238216.12 "Steam Air Coils" for air coils using steam as the medium.
3. Section 238216.14 "Electric Resistance Air Coils" for electric air coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data for EA Prerequisite 3, "Fundamental Refrigerant Management": For refrigerants, indicating compliance with refrigerant management practices.
3. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
4. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: <**Insert feet (m)**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: [**200 psig (1380 kPa)/300 deg F (149 deg C)**]<**Insert value and temperature**>.

D. Select cooling coils for no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

E. Capacities and Characteristics:

1. Coil Face Dimensions:

a. Finned Length: <**Insert inches (mm)**>.
b. Finned Width: <**Insert inches (mm)**>.

2. Number of Rows: <**Insert number**>.
3. Coating: <**Insert manufacturer; product**>.
4. Air Side:

a. Flow Rate: <**Insert cfm (L/s)**>.
b. Finned Area Face Velocity: <**Insert fpm (m/s)**>.
c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
d. Total Capacity: <**Insert Btu/h (kW)**>.
e. Sensible Capacity: <**Insert Btu/h (kW)**>.
f. Entering Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
g. Entering Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
h. Leaving Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
i. Leaving Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

5. Refrigerant Side:

a. Refrigerant Type: [**R-410A**][**HFC-134a**]<**Insert type**>.
b. Saturated Suction Temperature: <**Insert deg F (deg C)**>.

2.2 REFRIGERANT AIR COILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Greenheck Fan Corporation**]
5. [**RAE Coils; a division of RAE Corporation**]

6. [**Super Radiator Coils**]
7. [**Trane**]
8. [**USA Coil & Air**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aerofin**]
2. [**Carrier Global Corporation**]
3. [**Coil Company, LLC**]
4. [**Greenheck Fan Corporation**]
5. [**RAE Coils; a division of RAE Corporation**]
6. [**Super Radiator Coils**]
7. [**Trane**]
8. [**USA Coil & Air**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain refrigerant coils from single source from single manufacturer.

D. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into plate fins. Coils are to be counterflow circuited and equipped with pressure-type distributors, and distributor tubes are to be of equal length, to ensure equal distribution of refrigerant to each circuit.

E. Circuiting: [**Face**][**Row**][**Interlaced**][**Interlaced and face control**][**Indicated on Drawings**]<**Insert circuiting type**>.

F. Tubes:

1. Material: [**Copper**]<**Insert material**>.
2. Nominal Diameter: Selected for performance indicated.
3. Nominal Wall Thickness: As required by performance, minimum of [**0.020 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.035 inch (0.9 mm)**]<**Insert dimension**> thick.
4. Return Bends: 180-degree bends; material[**, wall thickness,**] and nominal diameter to match tubes.
5. Brazing: High-temperature brazing alloy with not less than 5 percent silver.

G. Fins:

1. Type: Plate.
2. Materials:

   a. Aluminum: [**0.0060 inch (0.15 mm)**][**0.0075 inch (0.19 mm)**][**0.0095 inch (0.24 mm)**]<**Insert dimension**> thick.
   b. Copper: [**0.0060 inch (0.15 mm)**][**0.0075 inch (0.19 mm)**][**0.0095 inch (0.24 mm)**]<**Insert dimension**> thick.
   c. 90/10 Cupronickel: [**0.0060 inch (0.15 mm)**][**0.0075 inch (0.19 mm)**][**0.0095 inch (0.24 mm)**]<**Insert dimension**> thick.
   d. <**Insert material and fin thickness**>.

3. Spacing: Maximum [**12 fins per inch (2.1 mm)**]<**Insert maximum fin spacing**>.
4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: [**Flat-face fins**][**Wave, corrugated, or waffle-face fins**][**Fin type as required by performance requirements**]<**Insert fin type**>.

6. Fin and Tube Joint: Silver brazed.

H. Headers:

1. Material: [**Seamless copper**]<**Insert material**>.
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Protect openings to prevent entry of dirt into coil.

I. Casings and Tube Sheets:

1. Depth: Extend coil casing and tube sheets a minimum of [**1/2 inch (13 mm)**]<**Insert dimension**> beyond face of fins on both entering and leaving sides.
2. Materials:

   a. Stainless steel, [**Type 304**]<**Insert type**>, No. 2D finish.
   b. Galvanized steel, **G90 (Z275)** coating.
   c. Copper.
   d. Aluminum.

3. Top and Bottom Casings:

   a. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>; double-flange edge for rigidity and ease of removal with secondary flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
   b. Thickness: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

4. End Tube Sheets:

   a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
   b. Flange face minimum of [**1-1/2 inches (68 mm)**]<**Insert dimension**>.
   c. Thickness: Minimum of [**16 gauge (1.6 mm)**][**14 gauge (2.0 mm)**][**12 gauge (2.8 mm)**] thick.

5. Intermediate Tube Sheets:

   a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
   b. Space intermediate tube sheets a maximum of [**48 inches (1200 mm)**]<**Insert dimension**> o.c. and locate to provide equal spacing between tube sheet across coil tube length.
   c. Flange face minimum of [**1/2 inch (13 mm)**]<**Insert dimension**>.
   d. Thickness: Minimum of [**16 gauge (1.6 mm)**]<**Insert thickness**> thick.

J. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

K. Hardware: Use hex-head bolts, nuts, and washers constructed of [**Type 304**][**or**][**Type 316**] stainless steel.

L. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. Coil fin length.
7. Coil fin height.
8. Coil weight with fluid/without fluid.
9. Coil casing material and thickness.
10. Coil fin material and thickness.
11. Coil tube material and thickness.
12. Coil header material and thickness.
13. <**Insert requirements**>.

M. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

N. Coating: [**None**][**Corrosion resistant**]<**Insert manufacturer; product name**>.

2.3 MATERIALS

A. Aluminum: **ASTM B209 (ASTM B209M)**.

B. Copper Sheet: ASTM B152.

C. Copper Tube: ASTM B75/75M annealed temper or ASTM B280 drawn temper.

D. Galvanized Steel: ASTM A653/A653M.

E. Stainless Steel: ASTM A240/A240M.

F. Steel: ASTM A53/A53M.

G. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**]<**Insert time**>-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in lb (11.3 N m)**.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert value**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. Refrigerant Coils: Factory tested using dry nitrogen while coil is completely submerged underwater to design pressure indicated, but not less than [**400-psig (2758-kPa)**]<**Insert pressure**> internal pressure.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install [**galvanized-steel**][**stainless steel**] drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect refrigerant piping according to Section 232300 "Refrigerant Piping."

END OF SECTION 23 82 16 13

Task	Specification	Specification Description
23 82 16 13	23 82 00 00	Chilled Beams
23 82 16 13	23 82 16 11	Hydronic Air Coils

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SECTION 23 82 16 14 - ELECTRIC-RESISTANCE AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric-resistance air coils.

B. Related Requirements:

1. Section 238216.11 "Hydronic Air Coils" for air coils using water as the heating or cooling medium.
2. Section 238216.12 "Steam Air Coils" for air coils using steam as the medium.
3. Section 238216.13 "Refrigerant Air Coils" for air coils using refrigerants as the medium.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: <**Insert feet (m)**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Coil Assembly: Comply with UL 1995.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

E. Equally balance heater electrical load for each step across all electrical phases.

F. Part-Load Operation: Provide arrangement with operation staged for uninterrupted operation over the full range of airflow down to the minimum airflow indicated.

G. Capacities and Characteristics:

1. Coil Face Dimensions:

a. Length: <**Insert inches (mm)**>.
b. Height: <**Insert inches (mm)**>.

2. Mounting: [**Slip in**][**Flanged**].
3. Air Side:

a. Flow Rate: <**Insert cfm (L/s)**>.
b. Face Velocity: <**Insert fpm (m/s)**>.
c. Static Pressure Drop: <**Insert inches wg (Pa)**>.
d. Total Capacity: <**Insert Btu/h (kW)**>.
e. Entering Temperature: <**Insert deg F (deg C)**>.
f. Leaving Temperature: <**Insert deg F (deg C)**>.

4. Electrical Characteristics:

a. Capacity: <**Insert kilowatts**>.
b. Number of Steps: <**Insert number**>.
c. Volts: <**Insert value**>.
d. Phase: <**Insert value**>.
e. Hertz: <**Insert value**>.
f. Full-Load Amperes: <**Insert value**>.
g. Minimum Circuit Ampacity: <**Insert value**>.
h. Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 ELECTRIC-RESISTANCE AIR COILS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brasch Manufacturing Co., Inc**]
2. [**Chromalox, Inc.**]
3. [**INDEECO**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Brasch Manufacturing Co., Inc**]
2. [**Chromalox, Inc.**]
3. [**INDEECO**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain electric-resistance air coils from single source from single manufacturer.

D. Heating Elements:

1. Open Elements:

   a. Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in a frame.
   b. Safety Screens: Install safety screens to protect operators from accidentally coming into direct connect with elements.

2. Finned Tubular Elements:

   a. Coiled resistance wire of 80 percent nickel and 20 percent chromium; center-mounted and surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
   b. Finish finned tubular elements with a baked-on aluminum paint, and mount in a frame.
   c. Each element individually removable from terminal box.
   d. Use threaded stainless steel element terminals and hardware.

E. Frame: [**Galvanized**][**stainless**][**or**][**aluminized**] steel; minimum [**0.052 inch (1.3 mm)**][**0.064 inch (1.6 mm)**][**0.079 inch (2.0 mm)**]<**Insert thickness**> thick for [**slip-in**][**flanged**] mounting. Include intermediate element support brackets equally spaced at a maximum of [**36 inches (900 mm)**]<**Insert distance**> o.c. across electric-resistance air coil.

F. Terminal Box/Control Panel: [**Unit mounted**][**Remote mounted**][**Unit or remote mounting arrangement indicated on Drawings**]; with disconnection means and overcurrent protection.

1. Enclosure: NEMA 250, [**Type 1**][**or**][**Type 12**]<**Insert type**> enclosure complying with UL 50.
2. Full-face-hinged door[**with lock and key latching device(s)**].
3. Factory insulate terminal box to prevent condensation from occurring within box.
4. Install a laminated elementary wiring diagram on inside face of heater control panel door or in another protected location than visible be service personnel. Wiring diagram to match installation.

G. Controls:

1. Safety Controls: Each heater is to be provided with the following factory-mounted safety controls:

   a. Disk-type thermal cutout switch with automatic reset.
   b. Primary linear thermal limit cutout switch with automatic reset.
   c. Secondary linear thermal limit cutout switch with local manual reset.
   d. Airflow Proving Switch: Pressure differential type; with pressure range selected to ensure reliable operation throughout full range of air-handling unit airflow down to minimum airflow indicated.

2. Staging Control: Magnetic contactors for switching stages of heat.
3. SCR Control: Silicone-controlled rectifier (SCR) for 100 percent stepless capacity control.

4. Remote Monitoring and Control: Include control devices necessary to interface with remote-control signals, including the following:

    a. Heater on/off control.
    b. Monitoring heater on/off status.
    c. High-temperature alarm.
    d. Low-airflow alarm.
    e. Heater capacity control.
    f. <**Insert requirement**>.

H. Electrical:

1. Single-Point Field Power Connection: Install and wire the heater to accommodate a single field electrical connection for electrical power.
2. Disconnecting Means: Provide each heater with a main electrical power connection, door mounted and interlocking, and disconnecting means to prevent access into panel, unless switched to the off position.

    a. [**Fused disconnect switch**][**Nonfused disconnect switch**][**Circuit breaker**] with lockable handle.
    b. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than [**42,000**][**65,000**]<**Insert number**> A.

3. Factory install and wire branch circuit fusing or circuit breakers in accordance with NFPA 70.
4. Pilot Lights: Include labeled pilot lights on face of control panel for the following:

    a. Power on.
    b. Low-airflow alarm.
    c. High-temperature alarm.
    d. One for each stage on.
    e. <**Insert requirement**>.

5. Terminations: Wire terminations and field interface terminations to labeled terminal strips.
6. Control Transformer: Size control circuit transformer for load.
7. Labeling: Label each electrical device with a laminated phenolic tag.
8. Use only NRTL-labeled electrical components.

I. Nameplate: Include the following data:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. <**Insert requirements**>.

J. See Section 230923.27 "Temperature Instruments" for thermostat.

K. Thermostats: Wall-mounted thermostats, with temperature range from **50 to 90 deg F (10 to 32 deg C)**, and **2.5 deg F (1.4 deg C)** throttling range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch (13 mm)**]<**Insert dimension**> high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Prepare test and inspection reports.

END OF SECTION 23 82 16 14

Task	Specification	Specification Description
23 82 16 14	23 82 00 00	Chilled Beams

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SECTION 23 82 19 00 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductless fan coil units.
2. Ducted fan coil units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of fan coil unit indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which fan coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.

d. Sprinklers.
e. Access panels.
f. <**Insert item**>.

6. Perimeter moldings.

B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Coil Unit Filters: Furnish <**Insert number**> spare filters for each filter installed.
2. Fan Belts: Furnish <**Insert number**> spare fan belts for each unit installed.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other

construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Compressor failure.
b. Condenser coil leak.

2. Warranty Period: [**Four**][**Five**][**10**]<**Insert number**> years from date of Substantial Completion.
3. Warranty Period (Compressor Only): [**Five**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtherm; a Mestek company**]
2. [**Carrier Global Corporation**]
3. [**Daikin Applied**]
4. [**Dunham-Bush, Inc**]
5. [**Engineered Air**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**First Company Products**]
8. [**Greenheck Fan Corporation**]
9. [**IEC (International Environmental Corporation); LSB Industries**]
10. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
11. [**Nailor Industries Inc**]
12. [**Rosemex Products**]
13. [**Superior Rex**]
14. [**Titus; brand of Johnson Controls International plc, Global Products**]
15. [**Trane Inc.**]
16. [**USA Coil & Air**]

17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Airtherm; a Mestek company**]
2. [**Carrier Global Corporation**]
3. [**Daikin Applied**]
4. [**Dunham-Bush, Inc**]
5. [**Engineered Air**]
6. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
7. [**First Company Products**]
8. [**Greenheck Fan Corporation**]
9. [**IEC (International Environmental Corporation); LSB Industries**]
10. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
11. [**Nailor Industries Inc**]
12. [**Rosemex Products**]
13. [**Superior Rex**]
14. [**Titus; brand of Johnson Controls International plc, Global Products**]
15. [**Trane Inc.**]
16. [**USA Coil & Air**]
17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. **<Insert manufacturer's name>**

C. Fan Coil Unit Configurations: [**Row**][**Face**] split.

1. Number of Heating Coils: [**One**]**<Insert number>** with two-pipe system.
2. Number of Cooling Coils: [**One**][**Three**] with [**two**][**four**]-pipe system.

D. Coil Section Insulation:

1. [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**]**<Insert dimension>** thick, [**coated glass fiber**][**foil-covered, closed-cell foam**][**matte-finish, closed-cell foam**] complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
2. Insulate coil section according to Section 230716 "HVAC Equipment Insulation."
3. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Drain Pans: [**Main and Auxiliary**][**Plastic**][**Stainless steel**][**Insulated galvanized steel with plastic liner**]. Fabricate pans and drain connections to comply with ASHRAE 62.1.[**Drain pans shall be removable.**]

F. Chassis: Galvanized steel where exposed to moisture[**, with baked-enamel finish and removable access panel**][**, with powder-coat finish and removable access panel**]. Floor-mounting units shall have leveling screws.

G. Cabinet: Steel with [**factory prime coating, ready for field painting**][**baked-enamel finish in manufacturer's standard paint color as selected by Architect**][**baked-enamel finish in manufacturer's custom paint color as selected by Architect**].

1. Vertical Unit Front Panels: Removable, steel, with [**integral stamped**][**polyethylene**][**steel**] discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with [**integral stamped**][**cast-aluminum**] discharge grilles.
3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's [**standard**][**custom**] colors. Return grille shall provide maintenance access to fan coil unit.
4. Steel recessing flanges for recessing fan coil units into ceiling or wall.

H. Outdoor-Air Wall Box: Minimum **0.1265-inch- (3.2-mm-)** thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: [**Horizontal**][**Vertical**], rain-resistant louver.
2. Louver Material: [**Aluminum**][**Steel**].
3. Bird Screen: **1/2-inch (13-mm)** mesh screen on interior side of louver.
4. Decorative Grille: On outside of intake.
5. Finish: [**Anodized aluminum**][**Baked enamel**], color as selected by Architect from manufacturer's [**standard**][**custom**] colors.

I. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with [**electronic**][**pneumatic**], [**two-position**][**modulating**] actuators.

J. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

1. MERV Rating: [**6**][**13**]<**Insert number**> when tested according to ASHRAE 52.2.
2. Washable Foam: 70 percent arrestance and MERV[**3**].
3. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV[**5**].
4. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV[**7**].

K. Hydronic Coils: Copper tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**, rated for a minimum working pressure of **200 psig (1378 kPa)** and a maximum entering-water temperature of **220 deg F (104 deg C)**. Include manual air vent and drain valve.

L. Indoor Refrigerant Coils: [**Copper**][**Stainless-steel**] tube[**with corrosion-resistant coating**], with mechanically bonded [**aluminum**][**stainless-steel**] fins spaced no closer than **0.1 inch (2.5 mm)** and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum **450 psig (3105 kPa)** for a minimum **300-psig (2070-kPa)** working pressure. Include thermal expansion valve.

M. Steam Coils: Copper[**distributing**] tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**, rated for a minimum working pressure of **75 psig (517 kPa)**.

N. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant coating capable of withstanding a [**3,000**]<**Insert time**>-hour salt-spray test according to ASTM B117.

1. Standards:

   a. ASTM B117 for salt spray.
   b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m).)**
   c. ASTM D3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil**]<**Insert measurement**>.
4. Gloss: Minimum gloss of 50 gloss units on a single angle 60 degree meter.

5. UV Protection: Spray applied topcoat.

O. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

P. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230500 "Common Work Results for HVAC."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

Q. Factory, Hydronic Piping Package: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88MType C)**] copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for dual-temperature coil.
2. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for chilled-water coil.
3. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for hot-water heating coil.
4. [**Two**][**Three**]-way [**two-position**][**modulating**] control valve for hot-water reheat coil.
5. Hose Kits: Minimum **400-psig (2758-kPa)** working pressure and operating temperatures from **33 to 211 deg F (0.5 to 99 deg C)**. Tag hose kits to equipment designations.

   a. Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
   b. Minimum Diameter: Equal to fan coil unit connection size.

6. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and **600-psig (4140-kPa)** minimum CWP rating and blowout-proof stem.
7. Calibrated-Orifice Balancing Valves: Bronze body, ball type; **125-psig (860-kPa)** working pressure, **250 deg F (121 deg C)** maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
8. Automatic Flow-Control Valve: Brass or ferrous-metal body; **300-psig (2070-kPa)** working pressure at **250 deg F (121 deg C)**; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of **2 to 80 psig (13.8 to 552 kPa)**.
9. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); **125-psig (860-kPa)** working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum **NPS 1/2 (DN 15)** hose-end, full-port, ball-type blowdown valve in drain connection.
10. Wrought-Copper Unions: ASME B16.22.
11. Risers: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88MType C)**] copper pipe with hose and ball valve for system flushing.

R. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

S. Basic Unit Controls:

1. Control voltage transformer.
2. [**Wall-mounting**][**Unit-mounted**] thermostat with the following features:

a. Heat-cool-off switch.
b. Fan on-auto switch.
c. Fan-speed switch.
d. [**Manual**][**Automatic**] changeover.
e. Adjustable deadband.
f. [**Concealed**][**Exposed**] set point.
g. [**Concealed**][**Exposed**] indication.
h. [**Degree F**][**Degree C**] indication.

3. [**Wall-mounting**][**Unit-mounted**] humidistat.

   a. [**Concealed**][**Exposed**] set point.
   b. [**Concealed**][**Exposed**] indication.

4. [**Wall-mounting**][**Unit-mounted**] temperature sensor.
5. Unoccupied-period-override push button.
6. Data entry and access port.

   a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
   b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

T. Terminal Controller:[**DDC.**]

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied-Period-Override Operation: [**Two**]<**Insert number**> hours.
3. Unit Supply-Air Fan Operation:

   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

   a. Occupied Periods: [**Open**][**Modulate**] control valve to maintain room temperature.
   b. Unoccupied Periods: Close control valve.

5. Refrigerant-Coil Operation:

   a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
   b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.

6. Heating-Coil Operation:[**Supplemental.**]

   a. Occupied Periods: [**Open control valve**][**Modulate control valve**][**Energize electric-resistance coil**] to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and [**open control valve**][**modulate control valve**][**energize electric-resistance coil**] if room temperature falls below setback temperature.
   c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below [**25 deg F (4 deg C)**]<**Insert temperature**>.

7. Dual-Temperature Hydronic-Coil Operation:

a. Occupied Periods: When chilled water is available, [**open**][**modulate**] control valve if room temperature exceeds thermostat set point. When hot water is available, open control valve if temperature falls below thermostat set point.
b. Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, [**open**][**modulate**] control valve if room temperature falls below thermostat setback temperature.

8. Reheat-Coil Operation:

a. Humidity Control for Occupied Periods:

1) Humidistat [**opens control valve**][**modulates control valve**][**energizes electric-resistance coil**] to provide heating. As space temperature rises above set point, cooling-coil valve [**opens**][**modulates**] to maintain room temperature.

b. Humidity Control for Unoccupied Periods: [**Close control valve**][**De-energize**].
c. Occupied Periods:

1) Heating Operations: [**Open control valve**][**Modulate control valve**][**Energize electric-resistance coil**] to provide heating if room temperature falls below thermostat set point.
2) Humidity-Control Operations: Humidistat [**opens control valve**][**modulates control valve**][**energizes electric-resistance coil**] to provide heating. As space temperature rises above set point, cooling-coil valve [**opens**][**modulates**] to maintain room temperature.

d. Unoccupied Periods: Start fan and [**open control valve**][**modulate control valve**][**energize electric-resistance coil**] if room temperature falls below setback temperature. Humidity control is not available.

9. Outdoor-Air Damper Operation, Fixed, Minimum Outdoor-Air Intake:

a. Occupied Periods: Open damper to fixed position for [**25**]<**Insert number**> percent outdoor air.
b. Unoccupied periods: Close damper.

10. Outdoor-Air Damper Operation, Outdoor-Air Economizer Cycle:

a. Occupied Periods:

1) Outdoor-Air Temperature below Room Temperature: If room temperature is above thermostat set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below thermostat set point, position damper to fixed minimum position.
2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for [**25**]<**Insert number**> percent outdoor air.

b. Unoccupied Periods: Close damper.

11. Outdoor-Air Damper Operation (Enthalpy Based):

a. Occupied Periods:

1) Outdoor-Air Enthalpy below Room Enthalpy: If room temperature is above room-temperature set point, modulate outdoor-air damper to maintain room temperature

(outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum position for [**25**]<**Insert number**> percent outdoor air.

2) Outdoor-Air Enthalpy above Room Enthalpy: Position damper to fixed minimum position for [**25**]<**Insert number**> percent outdoor air.

b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

12. Controller shall have volatile-memory backup.

U. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide [**BACnet**][**or**][**LonWorks**] interface for central DDC system for HVAC workstation for the following functions:

a. Adjust set points.
b. Fan coil unit start, stop, and operating status.
c. Data inquiry, including [**outdoor-air damper position,**]supply- and room-air temperature[**and humidity**].
d. Occupied and unoccupied schedules.

V. Electrical Connection: Factory wire motors and controls for a single electrical connection.

W. Capacities and Characteristics:

1. Fan:

a. Airflow: <**Insert cfm (L/s)**>.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Fan Speed: <**Insert rpm**>.
d. Motor Speed: <**Insert rpm**>.
e. Motor Horsepower: <**Insert horsepower**>.
f. Drive: [**Direct**][**Belt**].

2. Cooling Capacity:

a. Total: <**Insert Btu/h (kW)**>.
b. Sensible: <**Insert Btu/h (kW)**>.
c. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
d. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

3. Chilled-Water Coil:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Water-Side Pressure Loss: <**Insert feet wg (kPa)**>.
c. Entering-Water Temperature: <**Insert deg F (deg C)**>.
d. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.

4. Refrigerant Coil:

a. Air-Side Pressure Loss: <**Insert inches wg (kPa)**>.
b. Suction Temperature: <**Insert deg F (deg C)**>.

5. Heating Capacity:

a. Output: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air-Temperature Rise: <**Insert deg F (deg C)**>.

6. Hot-Water Heating Coil:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Water-Side Pressure Loss: <**Insert feet wg (kPa)**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.
d. Entering-Water Temperature: <**Insert deg F (deg C)**>.

7. Steam Heating Coil:

a. Inlet Steam Pressure: <**Insert psig (kPa)**>.
b. Condensing Capacity: <**Insert lb/h (g/s)**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.

8. Electric-Resistance Heating Coil:

a. Capacity: <**Insert kilowatts**>.
b. Number of Steps: <**Indicate number**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.

9. Reheat Capacity:

a. Output: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air-Temperature Rise: <**Insert deg F (deg C)**>.

10. Filters:

a. Face Area: <**Insert sq. ft. (sq. m)**>.
b. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

11. Electrical Characteristics for Single-Point Connection:

a. Voltage/Phase/Hertz: <**Insert values**>.
b. Full-Load Amperes: <**Insert value**>.
c. Maximum Circuit Amperes: <**Insert value**>.
d. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 DUCTED FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Engineered Air**]
5. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]

6. [**First Company Products**]
7. [**Greenheck Fan Corporation**]
8. [**IEC (International Environmental Corporation); LSB Industries**]
9. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
10. [**Nailor Industries Inc**]
11. [**Rosemex Products**]
12. [**Superior Rex**]
13. [**Titus; brand of Johnson Controls International plc, Global Products**]
14. [**Trane Inc.**]
15. [**USA Coil & Air**]
16. [**Williams Comfort Products**]
17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carrier Global Corporation**]
2. [**Daikin Applied**]
3. [**Dunham-Bush, Inc**]
4. [**Engineered Air**]
5. [**ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America**]
6. [**First Company Products**]
7. [**Greenheck Fan Corporation**]
8. [**IEC (International Environmental Corporation); LSB Industries**]
9. [**Marlo Heat Transfer Solutions; part of Leonardo DRS, Inc.**]
10. [**Nailor Industries Inc**]
11. [**Rosemex Products**]
12. [**Superior Rex**]
13. [**Titus; brand of Johnson Controls International plc, Global Products**]
14. [**Trane Inc.**]
15. [**USA Coil & Air**]
16. [**Williams Comfort Products**]
17. [**YORK; brand of Johnson Controls International plc, Building Solutions North America**]
18. <**Insert manufacturer's name**>

C. Fan Coil Unit Configurations: [**Row**][**Face**] split.

1. Number of Heating Coils: [**One**] with two-pipe system.
2. Number of Cooling Coils: [**One**][**Three**] with [**two**][**four**]-pipe system.

D. Coil Section Insulation:

1. [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**]<**Insert dimension**> thick, [**coated**][**foil-faced**] glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
2. Insulate coil section according to Section 230716 "HVAC Equipment Insulation."
3. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Drain Pans: [**Main and Auxiliary**][**Plastic**][**Stainless steel**][**Insulated galvanized steel with plastic liner**]. Fabricate pans and drain connections to comply with ASHRAE 62.1.

F. Chassis: Galvanized steel where exposed to moisture[**, with baked-enamel finish and removable access panel**][**, with powder-coat finish and removable access panel**]. Floor-mounting units shall have leveling screws.

G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis[**with mill-finish, aluminum, double-deflection grille**].
2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

I. MERV Rating: [**6**][**13**]<**Insert number**> when tested according to ASHRAE 52.2.

1. Washable Foam: 70 percent arrestance and MERV[**3**].
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV[**5**].
3. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV[**7**].

J. Hydronic Coils: Copper tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**, rated for a minimum working pressure of **200 psig (1378 kPa)** and a maximum entering-water temperature of **220 deg F (104 deg C)**. Include manual air vent and drain.

K. Indoor Refrigerant Coils: Copper tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)** and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum **450 psig (3105 kPa)** for a minimum **300-psig (2070-kPa)** working pressure. Include thermal expansion valve.

L. Steam Coils: Copper tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)**, rated for a minimum working pressure of **75 psig (517 kPa)**.

M. Corrosion-Resistant Coating: Coat [**coils**][**and**][**fan guards**] with a corrosion-resistant coating capable of withstanding a [**3,000**]<**Insert time**>-hour salt-spray test according to ASTM B117.

1. Standards:

   a. ASTM B117 for salt spray.
   b. ASTM D2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**
   c. ASTM D3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil**]<**Insert measurement**>.
4. Gloss: Minimum gloss of 50 gloss units on a single angle 60 degree meter.
5. UV Protection: Spray applied topcoat.

N. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

O. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."

P. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."

Q. Factory, Hydronic Piping Package: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88MType C)**] copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for chilled-water coil.
2. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for heating coil.
3. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for dual-temperature coil.
4. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve for reheat coil.
5. Hose Kits: Minimum **400-psig (2758-kPa)** working pressure and operating temperatures from **33 to 211 deg F (0.5 to 99 deg C)**. Tag hose kits to equipment designations.

   a. Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
   b. Minimum Diameter: Equal to fan coil unit connection size.

6. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and **600-psig (4140-kPa)** minimum CWP rating and blowout-proof stem.
7. Calibrated-Orifice Balancing Valves: Bronze body, ball type; **125-psig (860-kPa)** working pressure, **250 deg F (121 deg C)** maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
8. Automatic Flow-Control Valve: Brass or ferrous-metal body; **300-psig (2070-kPa)** working pressure at **250 deg F (121 deg C)**; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of **2 to 80 psig (13.8 to 552 kPa)**.
9. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); **125-psig (860-kPa)** working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum **NPS 1/2 (DN 15)** hose-end, full-port, ball-type blowdown valve in drain connection.
10. Wrought-Copper Unions: ASME B16.22.

R. Remote condensing units are specified in Section 236200 "Packaged Compressor and Condenser Units."

S. Control devices and operational sequence are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

T. Basic Unit Controls:

1. Control voltage transformer.
2. [**Wall-mounting**][**Unit-mounted**] thermostat with the following features.

   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.

d. [**Manual**][**Automatic**] changeover.
e. Adjustable deadband.
f. [**Concealed**][**Exposed**] set point.
g. [**Concealed**][**Exposed**] indication.
h. [**Degree F**][**Degree C**] indication.

3. [**Wall-mounting**][**Unit-mounted**] humidistat.

a. [**Concealed**][**Exposed**] set point.
b. [**Concealed**][**Exposed**] indication.

4. [**Wall-mounting**][**Unit-mounted**] temperature sensor.
5. Unoccupied-period-override push button.
6. Data entry and access port.

a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

U. Terminal Controller:[**DDC.**]

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied-Period-Override Operation: [**Two**]<**Insert number**> hours.
3. Unit Supply-Air Fan Operation:

a. Occupied Periods: Fan runs continuously.
b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

a. Occupied Periods: [**Open**][**Modulate**] control valve to maintain room temperature.
b. Unoccupied Periods: Close control valve.

5. Refrigerant-Coil Operation:

a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.

6. Heating-Coil Operation:[**Supplemental.**]

a. Occupied Periods: [**Open control valve**][**Modulate control valve**][**Energize electric-resistance coil**] to provide heating if room temperature falls below thermostat set point.
b. Unoccupied Periods: Start fan and [**open control valve**][**modulate control valve**][**energize electric-resistance coil**] if room temperature falls below setback temperature.
c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below [**25 deg F (4 deg C)**]<**Insert temperature**>.

7. Dual-Temperature Hydronic-Coil Operation:

a. Occupied Periods: When chilled water is available, [**open**][**modulate**] control valve if room temperature exceeds thermostat set point. When hot water is available, [**open**][**modulate**]

control valve if temperature falls below thermostat set point.

b. Unoccupied Periods: When chilled water is available, close valve. When hot water is available, [**open**][**modulate**] control valve if room temperature falls below thermostat setback temperature.

8. Reheat-Coil Operation:

a. Humidity Control for Occupied Periods:

1) Humidistat [**opens control valve**][**modulates control valve**][**energizes electric-resistance coil**] to provide heating. As room temperature rises above set point, cooling-coil valve [**opens**][**modulates**] to maintain room temperature.

b. Humidity Control for Unoccupied Periods: [**Close control valve**][**De-energize**].

c. Occupied Periods:

1) Heating Operations: [**Open control valve**][**Modulate control valve**][**Energize electric-resistance coil**] to provide heating if room temperature falls below thermostat set point.

2) Humidity-Control Operations: Humidistat [**opens control valve**][**modulates control valve**][**energizes electric-resistance coil**] to provide heating. As room temperature rises above set point, cooling-coil valve [**opens**][**modulates**] to maintain room temperature.

d. Unoccupied Periods: Start fan and [**open control valve**][**modulate control valve**][**energize electric-resistance coil**] if room temperature falls below setback temperature. Humidity control is not available.

9. Outdoor-Air Damper Operation, Fixed, Minimum Outdoor-Air Intake:

a. Occupied Periods: Open damper to fixed position for [**25**]<**Insert number**> percent outdoor air.

b. Unoccupied Periods: Close damper.

10. Outdoor-Air Damper Operation, Outdoor-Air Economizer Cycle:

a. Occupied Periods:

1) Outdoor-Air Temperature below Room Temperature: If room temperature is above room-temperature set point, modulate outdoor- and return-air dampers to maintain room temperature set point (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum setting.

2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for [**25**]<**Insert number**> percent outdoor air.

b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

11. Outdoor-Air Damper Operation (Enthalpy Based):

a. Occupied Periods:

1) Outdoor-Air Enthalpy below Room Enthalpy: If room temperature is above room-temperature set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum position for [**25**]<**Insert number**> percent outdoor air.

2) Outdoor-Air Enthalpy above Room Enthalpy: Position damper to fixed minimum

position for [**25**]<**Insert number**> percent outdoor air.

b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

12. Controller shall have volatile-memory backup.

V. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide [**BACnet**][**or**][**LonWorks**] interface for central DDC system for HVAC workstation for the following functions:

   a. Adjust set points.
   b. Fan coil unit start, stop, and operating status.
   c. Data inquiry, including [**outdoor-air damper position,**]supply- and room-air temperature[**and humidity**].
   d. Occupied and unoccupied schedules.

W. Electrical Connection: Factory wire motors and controls for a single electrical connection.

X. Capacities and Characteristics:

1. Fan:

   a. Airflow: <**Insert cfm (L/s)**>.
   b. Static Pressure: <**Insert inches wg (kPa)**>.
   c. Fan Speed: <**Insert rpm**>.
   d. Motor Speed: <**Insert rpm**>.
   e. Motor Horsepower: <**Insert horsepower**>.
   f. Drive: [**Direct**][**Belt**].

2. Cooling Capacity:

   a. Total: <**Insert Btu/h (kW)**>.
   b. Sensible: <**Insert Btu/h (kW)**>.
   c. Entering-Air Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
   d. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

3. Chilled-Water Coil:

   a. Water Flow: <**Insert gpm (L/s)**>.
   b. Water-Side Pressure Loss: <**Insert feet wg (kPa)**>.
   c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.
   d. Entering-Water Temperature: <**Insert deg F (deg C)**>.

4. Refrigerant Coil:

   a. Air-Side Pressure Loss: <**Insert inches wg (kPa)**>.
   b. Suction Temperature: <**Insert deg F (deg C)**>.

5. Heating Capacity:

   a. Output: <**Insert Btu/h (kW)**>.

b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air-Temperature Rise: <**Insert deg F (deg C)**>.

6. Hot-Water Heating Coil:

a. Water Flow: <**Insert gpm (L/s)**>.
b. Water-Side Pressure Loss: <**Insert feet wg (kPa)**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.
d. Entering-Water Temperature: <**Insert deg F (deg C)**>.

7. Steam Heating Coil:

a. Inlet Steam Pressure: <**Insert psig (kPa)**>.
b. Condensing Capacity: <**Insert lb/h (g/s)**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.

8. Electric-Resistance Heating Coil:

a. Capacity: <**Insert kilowatts**>.
b. Number of Steps: <**Insert number**>.
c. Air-Side Pressure Drop: <**Insert inches wg (kPa)**>.

9. Reheat Capacity:

a. Output: <**Insert Btu/h (kW)**>.
b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
c. Air-Temperature Rise: <**Insert deg F (deg C)**>.

10. Filters:

a. Face Area: <**Insert sq. ft. (sq. m)**>.
b. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**>.

11. Electrical Characteristics for Single-Point Connection:

a. Voltage/Phase/Hertz: <**Insert values**>.
b. Full-Load Amperes: <**Insert values**>.
c. Maximum Circuit Amperes: <**Insert values**>.
d. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN COIL UNITS

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices [**48 inches (1220 mm)**][**60 inches (1525 mm)**]<**Insert dimension**> above finished floor.

E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.

   a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 23 82 19 00

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Task	Specification	Specification Description
23 82 19 00	23 82 00 00	Chilled Beams

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SECTION 23 82 29 00 - RADIATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes flat-pipe steel radiators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Indicate location and size of each field connection.
4. Indicate location and arrangement of piping valves and specialties.
5. Indicate location and arrangement of integral controls and other accessories.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For radiators with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which radiators will be attached.
2. Method of attaching radiators to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 FLAT-PIPE STEEL RADIATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Quincy Hydronic Technology Inc**]
2. [**Runtal North America, Inc.**]
3. [**Zehnder Group, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Quincy Hydronic Technology Inc**]
2. [**Runtal North America, Inc.**]
3. [**Zehnder Group, Inc.**]
4. <**Insert manufacturer's name**>

C. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of **0.109 inch (2.76 mm)**. Include threaded piping and air-vent connections.

1. Working Pressure:

   a. **56 psig (386 kPa)**; **0.048 inch (1.22 mm)**.
   b. **85 psig (585 kPa)**; **0.058 inch (1.47 mm)**.
   c. **128 psig (881 kPa)**; **0.078 inch (1.98 mm)**.

2. Tube Height: <**Insert inches (mm)**>.
3. Tube Depth: <**Insert inches (mm)**>.
4. Tube Length: <**Insert inches (mm)**>.
5. Number of Tubes High: <**Insert number**>.
6. Number of Tubes Deep: <**Insert number**>.
7. Room Air Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
8. Heat Output: <**Insert Btu/h (W)**>.
9. Average Water Temperature: [**180 deg F (82 deg C)**]<**Insert temperature**>.
10. Temperature Drop: [**10 deg F (5.56 deg C)**][**20 deg F (11.1 deg C)**][**30 deg F (16.6 deg C)**]<**Insert temperature**>.
11. Pressure Loss: <**Insert feet wg (kPa)**>.

D. Mounting: [**Wall brackets**][**Floor pedestals**] with maximum spacing of **36 inches (914 mm)**.

E. Finish: Baked-enamel finish in manufacturer's [**standard**][**custom**] color as selected by Architect.

F. Accessories:

1. Steel piping covers finished to match radiator finish.
2. Flexible Expansion Compensation Hoses: Minimum **400-psig (2758-kPa)** working pressure, and operating temperatures from **33 to 211 deg F (0.5 to 99.5 deg C)**.

   a. Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
   b. Minimum Diameter: Equal to connection size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiators for compliance with requirements for installation tolerances and

other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of radiators.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb.

B. Install expansion compensation hoses.

C. Install piping covers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect radiators and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Section 230923.11 "Control Valves."

D. Install piping adjacent to radiators to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 82 29 00

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Task	Specification	Specification Description
23 82 29 00	23 82 00 00	Chilled Beams
23 82 29 00	23 82 33 00	Convectors

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SECTION 23 82 33 00 - CONVECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Convectors - electric.
2. Convectors - hot water.
3. Convectors - steam.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For units with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Field quality control reports.

PART 2 - PRODUCTS

2.1 CONVECTORS

A. Convectors - Electric :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Chromalox, Inc.**]
   b. [**INDEECO**]
   c. [**Markel Products Company; a subsidiary of TPI Corporation**]
   d. [**Marley Engineered Products**]
   e. [**Ouellet Canada Inc**]
   f. [**STELPRO DESIGN INC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Chromalox, Inc.**]
   b. [**INDEECO**]
   c. [**Markel Products Company; a subsidiary of TPI Corporation**]
   d. [**Marley Engineered Products**]
   e. [**Ouellet Canada Inc**]
   f. [**STELPRO DESIGN INC**]
   g. <**Insert manufacturer's name**>

3. Description: Factory-packaged units constructed in accordance with UL 499, UL 1030, and UL 2021.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of element. Element supports to eliminate thermal expansion noise.

   a. Volts: <**Insert value**>.
   b. Phase: <**Insert value**>.
   c. Hertz: <**Insert value**>.
   d. Heat Output: [**300**][**500**][**750**][**1000**][**1250**][**1500**][**1750**][**2000**][**2250**][**2500**]<**Insert number**> W.

6. Front and Top Panel: Minimum [**0.0528-inch- (1.35-mm-)**][**0.0677-inch- (1.7-mm-)**]<**Insert dimension**> thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
7. Wall-Mounted Back and End Panels: Minimum **0.0428-inch- (1.1-mm-)** thick steel.
8. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum **36-inch (914-mm)** spacing. Pedestal-mounted back panel to be solid panel matching front panel.
9. Support Brackets: Locate at maximum **36-inch (914-mm)** spacing to support front panel and element.
10. Insulation: **1/2-inch- (13-mm-)** thick, fibrous glass on inside of the back of the enclosure.

11. Finish: Baked-enamel finish in manufacturer's [**standard**][**custom**] color as selected by Architect.
12. Damper: Knob-operated internal damper.
13. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size **6 by 7 inches (150 by 175 mm)**, integral with enclosure.
14. Enclosure Style: [**Sloped**][**Flat**] top.

    a. Front Inlet Grille:

        1) Punched louver; painted to match enclosure.
        2) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
            c) Painted to match enclosure.

    b. Outlet Grille:

        1) Location: [**Top**][**Front**].
        2) Punched louver; painted to match enclosure.
        3) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
            c) Painted to match enclosure.

    c. Enclosure Height: <**Insert inches (mm)**>.
    d. Enclosure Depth: <**Insert inches (mm)**>.
    e. Enclosure Length: <**Insert inches (mm)**>.

15. Unit Controls: Integral [**line-voltage thermostat with minimum range of 60 to 90 deg F (15 to 32 deg C)**][**low-voltage relay and control transformer for remote thermostat**].
16. Accessories: Integral disconnect switch, recessing flanges finished to match enclosure or overlapping front cover for fully recessed units, and rubber gaskets to seal cabinet at wall.

B. Convectors - Hot Water :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Engineered Air**]
    b. [**Slant/Fin Corp**]
    c. [**Sterling HVAC Products; a Mestek company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Engineered Air**]
    b. [**Slant/Fin Corp**]
    c. [**Sterling HVAC Products; a Mestek company**]
    d. <**Insert manufacturer's name**>

3. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-[**iron**][**or**][**brass**] headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum **100 psig (690 kPa)**.

    a. Element Height: <**Insert inches (mm)**>.
    b. Element Depth: <**Insert inches (mm)**>.
    c. Element Length: <**Insert inches (mm)**>.
    d. Entering-Air Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
    e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
    f. Average Water Temperature: [**180 deg F (82 deg C)**]<**Insert temperature**>.
    g. Temperature Drop: [**10 deg F (5.56 deg C)**][**20 deg F (11.1 deg C)**][**30 deg F (16.6 deg C)**]<**Insert temperature**>.
    h. Pressure Loss: <**Insert ft. wg (kPa)**>.

4. Front and Top Panel: Minimum [**0.0528-inch- (1.35-mm-)**][**0.0677-inch- (1.7-mm-)**]<**Insert dimension**> thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
5. Wall-Mounted Back and End Panels: Minimum **0.0428-inch- (1.1-mm-)** thick steel.
6. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum **36-inch (914-mm)** spacing. Pedestal-mounted back panel to be solid panel matching front panel.
7. Support Brackets: Locate at maximum **36-inch (914-mm)** spacing to support front panel and element.
8. Insulation: **1/2-inch- (13-mm-)** thick, fibrous glass on inside of the back of the enclosure.
9. Finish: Baked-enamel finish in manufacturer's [**standard**][**custom**] color as selected by Architect.
10. Damper: Knob-operated internal damper.
11. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size **6 by 7 inches (150 by 175 mm)**, integral with enclosure.
12. Enclosure Style: [**Sloped**][**Flat**] top.

    a. Front Inlet Grille:

        1) Punched louver; painted to match enclosure.
        2) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
            c) Painted to match enclosure.

    b. Outlet Grille:

        1) Location: [**Top**][**Front**].
        2) Punched louver; painted to match enclosure.
        3) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
            c) Painted to match enclosure.

    c. Enclosure Height: <**Insert inches (mm)**>.
    d. Enclosure Depth: <**Insert inches (mm)**>.
    e. Enclosure Length: <**Insert inches (mm)**>.

C. Convectors - Steam :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Engineered Air**]
    b. [**Slant/Fin Corp**]
    c. [**Sterling HVAC Products; a Mestek company**]
    d. [**Trane**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Engineered Air**]
    b. [**Slant/Fin Corp**]
    c. [**Sterling HVAC Products; a Mestek company**]
    d. [**Trane**]
    e. <**Insert manufacturer's name**>

3. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-[**iron**][**or**][**brass**] headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum **100 psig (690 kPa)**.

    a. Element Height: <**Insert inches (mm)**>.
    b. Element Depth: <**Insert inches (mm)**>.
    c. Element Length: <**Insert inches (mm)**>.
    d. Entering-Air Temperature: [**65 deg F (18 deg C)**]<**Insert temperature**>.
    e. Heat Output: <**Insert sq. ft. EDR (W)**>.
    f. Entering Steam Pressure: [**1 psig (6.9 kPa)**]<**Insert value**>.

4. Front and Top Panel: Minimum [**0.0528-inch- (1.35-mm-)**][**0.0677-inch- (1.7-mm-)**]<**Insert dimension**> thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
5. Wall-Mounted Back and End Panels: Minimum **0.0428-inch- (1.1-mm-)** thick steel.
6. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum **36-inch (914-mm)** spacing. Pedestal-mounted back panel to be solid panel matching front panel.
7. Support Brackets: Locate at maximum **36-inch (914-mm)** spacing to support front panel and element.
8. Insulation: **1/2-inch- (13-mm-)** thick, fibrous glass on inside of the back of the enclosure.
9. Finish: Baked-enamel finish in manufacturer's [**standard**][**custom**] color as selected by Architect.
10. Damper: Knob-operated internal damper.
11. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size **6 by 7 inches (150 by 175 mm)**, integral with enclosure.
12. Enclosure Style: [**Sloped**][**Flat**] top.
13. Front Inlet Grille:

    a. Punched louver; painted to match enclosure.
    b. Extruded-aluminum linear bar grille; pencil-proof bar spacing.

        1) Mill-finish aluminum.
        2) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
        3) Painted to match enclosure.

14. Outlet Grille:

    a. Location: [**Top**][**Front**].
    b. Punched louver; painted to match enclosure.
    c. Extruded-aluminum linear bar grille; pencil-proof bar spacing.

        1) Mill-finish aluminum.
        2) Anodized finish, color as selected by Architect from manufacturer's [**standard**][**custom**] colors.
        3) Painted to match enclosure.

15. Enclosure Height: <**Insert inches (mm)**>.
16. Enclosure Depth: <**Insert inches (mm)**>.
17. Enclosure Length: <**Insert inches (mm)**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convectors for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**hydronic-piping**][**steam-piping**][**electrical**] connections to verify actual locations before installation of convector.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONVECTORS

A. Install convectors level and plumb.

B. Install valves within reach of access door provided in enclosure.

C. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

D. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in [**Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."**][**Section 232213 "Steam and Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."**] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water convectors and components to piping in accordance with Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

    1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Connect steam convectors and components to piping in accordance with Section 232213 "Steam and

Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

1. Install shutoff valve on inlet; install strainer, steam trap, and shutoff valve on outlet.

D. Install control valves as required by Section 230923.11 "Control Valves."

E. Install piping adjacent to convectors to allow service and maintenance.

F. Ground electric convectors in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start convectors to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Convectors will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 82 33 00

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Task	Specification	Specification Description
23 82 33 00	23 82 00 00	Chilled Beams

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SECTION 23 82 36 00 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Baseboard radiation heaters - electric.
2. Baseboard radiation heaters - hot water.
3. Finned-tube radiation heaters - electric.
4. Finned-tube radiation heaters - hot water.
5. Finned-tube radiation heaters - steam.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For baseboard and finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which baseboard and finned-tube radiation heaters will be attached.
2. Method of attaching baseboard and finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality control reports.

PART 2 - PRODUCTS

2.1 BASEBOARD RADIATION HEATERS

A. Baseboard Radiation Heaters - Electric: <**Insert drawing designation**>

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain electric baseboard radiation heaters from single manufacturer.
3. Description: Factory-packaged units constructed in accordance with UL 499, UL 1030, and UL 2021.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports are to eliminate thermal expansion noise.

    a. Volts: <**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Heat Output: <**Insert W/ft. (W/m)**>.

6. Enclosures:

    a. Minimum [**18 gauge**] [**20 gauge**] <**Insert gauge**> [**steel**] [**galvanized steel**] <**Insert material**> with removable front cover.
    b. Full-height back.
    c. Full-length damper.
    d. End panel.
    e. [**Plastic end**] [**End**] caps.
    f. Inside and outside corners.
    g. Joiner pieces to snap together.
    h. Enclosure Height: <**Insert inches (mm)**>.
    i. Enclosure Depth: <**Insert inches (mm)**>.
    j. Finish: Powder-coated finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
    k. Element Brackets: Primed and painted steel to support front panel and element.

7. Unit Controls: [**Integral line-voltage thermostat**] [**Integral electronic thermostat**] [**Remote electronic thermostat**] [**Remote line-voltage thermostat**] <**Insert thermostat type**>.
8. Accessories:

    a. Blank filler sections without a heating element matching the adjacent enclosure.
    b. Straight-Blade-Type Receptacles: Comply with FED W-C-596H, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

B. Baseboard Radiation Heaters - Hot Water: <**Insert drawing designation**>

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain hot water baseboard radiation heaters from single manufacturer.
3. Performance Ratings: Rate baseboard radiation heaters in accordance with Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

4. Heating Elements, Copper Tubing: Mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube will be belled.

   a. Tube Diameter: [**NPS 1/2 (DN 15)**] [**NPS 3/4 (DN 20)**] [**NPS 1 (DN 25)**] [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
   b. Fin Size: [**2-1/2 by 2-1/2 inches (63 by 63 mm)**] [**3 by 3 inches (76 by 76 mm)**] <**Insert dimensions**>.
   c. Fin Spacing: [**40 per ft. (131 per m)**] [**50 per ft. (164 per m)**] [**58 per ft. (190 per m)**] <**Insert value**>.
   d. Number of Tiers: <**Insert number**>.
   e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
   f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
   g. Average Water Temperature: [**180 deg F (82 deg C)**] <**Insert temperature**>.
   h. Minimum Water Velocity: [**1/2 fps (0.15 m/s)**] <**Insert value**>.

5. Heating Elements, Steel Tubing: Mechanically expanded into flanged collars of evenly spaced steel fins resting on polypropylene element glides. Tube ends will be threaded.

   a. Tube Diameter: [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
   b. Fin Size: Nominal [**2-1/2 by 2-1/2 inches (64 by 64 mm)**] [**3 by 3 inches (76 by 76 mm)**] <**Insert dimensions**>.
   c. Fin Spacing: [**52 per ft. (171 per m)**] [**52 per ft. (171 per m)**] <**Insert value**>.
   d. Number of Tiers: <**Insert number**>.
   e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
   f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
   g. Average Water Temperature: [**180 deg F (82 deg C)**] <**Insert temperature**>.
   h. Minimum Water Velocity: [**1/2 fps (0.15 m/s)**] <**Insert value**>.

6. Enclosure: Minimum [**18 gauge**] [**20 gauge**] <**Insert gauge**> [**steel**] [**galvanized steel**] <**Insert material**> with removable front cover.

   a. Full-height back.
   b. Full-length damper.
   c. End panel.
   d. End caps.
   e. Inside and outside corners.
   f. Valve access door.
   g. Joiner pieces to snap together.
   h. Enclosure Height: <**Insert inches (mm)**>.
   i. Enclosure Depth: <**Insert inches (mm)**>.
   j. Finish: [**Baked-enamel**] [**or**] [**powder-coated**] finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
   k. Element Brackets: Primed and painted steel to support front panel and element.

2.2 FINNED-TUBE RADIATION HEATERS

A. Finned-Tube Radiation Heaters - Electric: <**Insert drawing designation**>

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain electric finned-tube radiation heaters from single manufacturer.
3. Description: Factory-packaged units constructed in accordance with UL 499, UL 1030, and UL 2021.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports will eliminate thermal expansion noise.

    a. Volts: <**Insert value**>.
    b. Phase: <**Insert value**>.
    c. Hertz: <**Insert value**>.
    d. Heat Output: <**Insert W/ft. (W/m)**>.

6. Front Panel: Minimum [**18 gauge**] [**20 gauge**] <**Insert gauge**> [**steel**] [**ASTM A653/A653M, G60 (Z180) galvanized steel**] <**Insert material**> with removable front cover.
7. Wall-Mounted Back Panel: Minimum [**18 gauge**] [**20 gauge**] <**Insert gauge**> thick steel, full height, with full-length channel support for front panel without exposed fasteners.
8. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum 36-inch (914-mm) spacing. Pedestal-mounted back panel is to be solid panel matching front panel.
9. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
10. Finish: [**Baked-enamel**] [**Baked-epoxy**] [**Powder-coated**] finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
11. Damper: Knob-operated internal damper at enclosure outlet.
12. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
13. Enclosure Style: [**Sloped**] [**Flat**] top.

    a. Front Inlet Grille:

        1) Punched louver; painted to match enclosure.
        2) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
            c) Painted to match enclosure.

    b. Outlet Grille:

        1) Location: [**Top**] [**Front**].
        2) Punched louver; painted to match enclosure.
        3) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
            c) Painted to match enclosure.

    c. Enclosure Height: <**Insert inches (mm)**>.
    d. Enclosure Depth: <**Insert inches (mm)**>.

14. Unit Controls: Integral [**line-voltage thermostat with minimum range of 60 to 90 deg F (15 to 32 deg C)**] [**low-voltage relay and control transformer for remote thermostat**].
15. Accessories: Integral disconnect switch, blank filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

B. Finned-Tube Radiation Heaters - Hot Water:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain hot water finned tube radiation heaters from single manufacturer.
3. Performance Ratings: Rate finned-tube radiation heaters in accordance with Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
4. Heating Elements, Copper Tubing: Mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube will be belled.

    a. Tube Diameter: [**NPS 3/4 (DN 20)**] [**NPS 1 (DN 25)**] [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
    b. Fin Size: [**3 by 3 inches (76 by 76 mm)**] [**4 by 4 inches (102 by 102 mm)**] <**Insert dimensions**>.
    c. Fin Spacing: [**40 per ft. (131 per m)**] [**50 per ft. (164 per m)**] [**58 per ft. (190 per m)**] <**Insert value**>.
    d. Number of Tiers: <**Insert number**>.
    e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
    f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
    g. Average Water Temperature: [**180 deg F (82 deg C)**] <**Insert temperature**>.
    h. Minimum Water Velocity: [**1/2 fps (0.15 m/s)**] <**Insert value**>.

5. Heating Elements, Steel Tubing: Mechanically expanded into flanged collars of evenly spaced steel fins resting on element supports. Tube ends will be threaded.

    a. Tube Diameter: [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
    b. Fin Size: [**4 by 4 inches (102 by 102 mm)**] <**Insert dimensions**>.
    c. Fin Spacing: [**52 per ft. (171 per m)**] <**Insert value**>.
    d. Number of Tiers: <**Insert number**>.
    e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
    f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
    g. Average Water Temperature: [**180 deg F (82 deg C)**] <**Insert temperature**>.
    h. Minimum Water Velocity: [**1/2 fps (0.15 m/s)**] <**Insert value**>.

6. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

    a. Front Inlet Grille:

        1) Punched louver; painted to match enclosure.
        2) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
            c) Painted to match enclosure.

    b. Outlet Grille:

        1) Location: [**Top**] [**Front**].
        2) Punched louver; painted to match enclosure.
        3) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

            a) Mill-finish aluminum.
            b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
            c) Painted to match enclosure.

    c. Enclosure Height: <**Insert inches (mm)**>.

d. Enclosure Depth: <**Insert inches (mm)**>.

7. Accessories: Blank filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

C. Finned-Tube Radiation Heaters - Steam:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain steam finned-tube radiation heaters from single manufacturer.
3. Performance Ratings: Rate finned-tube radiation heaters in accordance with Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
4. Heating Elements, Copper Tubing: Mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube is to be belled.

   a. Tube Diameter: [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
   b. Fin Size: [**3 by 3 inches (76 by 76 mm)**] <**Insert dimensions**>.
   c. Fin Spacing: [**40 per ft. (131 per m)**] [**48 per ft. (157 per m)**] [**50 per ft. (164 per m)**] [**58 per ft. (190 per m)**] <**Insert value**>.
   d. Number of Tiers: <**Insert number**>.
   e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
   f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
   g. Entering Steam Pressure: [**1 psig (6.9 kPa)**] <**Insert value**>.

5. Heating Elements, Steel Tubing: Mechanically expanded into flanged collars of evenly spaced steel fins resting on element supports. Tube ends are to be threaded.

   a. Tube Diameter: [**NPS 1-1/4 (DN 32)**] <**Insert pipe size**>.
   b. Fin Size: [**3 by 3 inches (76 by 76 mm)**] <**Insert dimensions**>.
   c. Fin Spacing: [**52 per ft. (171 per m)**] <**Insert value**>.
   d. Number of Tiers: <**Insert number**>.
   e. Heat Output: <**Insert Btu/h per ft. (W/m)**>.
   f. Entering-Air Temperature: [**65 deg F (18 deg C)**] <**Insert temperature**>.
   g. Entering Steam Pressure: [**1 psig (6.9 kPa)**] <**Insert value**>.

6. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
7. Front Panel: Minimum [**16 gauge**] [**18 gauge**] [**20 gauge**] <**Insert gauge**> [**steel**] [**ASTM A653/A653M, G60 (Z180) galvanized steel**] <**Insert material**> with removable front cover.
8. Wall-Mounted Back Panel: Minimum 20 gauge steel, full height, with full-length channel support for front panel without exposed fasteners.
9. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch (914-mm) spacing. Pedestal-mounted back panel is to be solid panel matching front panel. Provide stainless steel escutcheon for floor openings at pedestals.
10. Support Brackets: Locate at maximum 36-inch (914-mm) spacing to support front panel and element.
11. Finish: [**Baked-enamel**] [**Baked-epoxy**] [**Powder-coated**] finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
12. Damper: Knob-operated internal damper at enclosure outlet.
13. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches (150 by 175 mm), integral with enclosure.
14. Enclosure Style: [**Sloped**] [**Flat**] top.

    a. Front Inlet Grille:

1) Punched louver; painted to match enclosure.
2) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

a) Mill-finish aluminum.
b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
c) Painted to match enclosure.

b. Outlet Grille:

1) Location: [**Top**] [**Front**].
2) Punched louver; painted to match enclosure.
3) Extruded-aluminum linear bar grille; pencil-proof bar spacing.

a) Mill-finish aluminum.
b) Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
c) Painted to match enclosure.

c. Enclosure Height: <**Insert inches (mm)**>.
d. Enclosure Depth: <**Insert inches (mm)**>.

15. Accessories: Blank filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 - EXECUTION

3.1 INSTALLATION OF BASEBOARD RADIATION HEATERS - ELECTRIC

A. Examine areas to receive electric baseboard radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before installation of electric baseboard radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install units level and plumb.

E. Install enclosure continuously around corners, using outside and inside corner fittings.

F. Join sections with splice plates and blank filler pieces to provide continuous enclosure.

G. Install enclosure continuously from wall to wall.

H. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

I. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

3.2 INSTALLATION OF BASEBOARD RADIATION HEATERS - HOT WATER

A. Examine areas to receive hot water baseboard radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hot water connections to verify actual locations before installation of hot water baseboard radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install units level and plumb.

E. Install enclosure continuously around corners, using outside and inside corner fittings.

F. Join sections with splice plates and blank filler pieces to provide continuous enclosure.

G. Install access doors for access to valves.

H. Install enclosure continuously from wall to wall.

I. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

J. Install valves within reach of access door provided in enclosure.

K. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

L. Install piping within pedestals for freestanding units.

3.3 INSTALLATION OF FINNED-TUBE RADIATION HEATERS - ELECTRIC

A. Examine areas to receive electric finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electric connections to verify actual locations before installation of electric finned-tube radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install units level and plumb.

E. Install enclosure continuously around corners, using outside and inside corner fittings.

F. Join sections with splice plates and blank filler pieces to provide continuous enclosure.

G. Install enclosure continuously from wall to wall.

H. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

I. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

3.4 INSTALLATION OF FINNED-TUBE RADIATION HEATERS - HOT WATER

A. Examine areas to receive hot water finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hot water finned-tube radiation heaters for compliance with requirements for installation tolerances of hot water finned-tube radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install units level and plumb.

E. Install enclosure continuously around corners, using outside and inside corner fittings.

F. Join sections with splice plates and blank filler pieces to provide continuous enclosure.

G. Install access doors for access to valves.

H. Install enclosure continuously from wall to wall.

I. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

J. Install valves within reach of access door provided in enclosure.

K. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

L. Install piping within pedestals for freestanding units.

3.5 INSTALLATION OF FINNED-TUBE RADIATION HEATERS - STEAM

A. Examine areas to receive steam finned-tube radiation heaters for compliance with requirements for installation tolerance and other conditions affecting performance of the Work.

B. Examine roughing-in for steam finned-tube radiation heaters for compliance with requirements for installation tolerances of steam finned-tube radiation heaters.

C. Install units level and plumb.

D. Install enclosure continuously around corners, using outside and inside corner fittings.

E. Join sections with splice plates and blank filler pieces to provide continuous enclosure.

F. Install access doors for access to valves.

G. Install enclosure continuously from wall to wall.

H. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

I. Install valves within reach of access door provided in enclosure.

J. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

K. Install piping within pedestals for freestanding units.

3.6 PIPING CONNECTIONS

A. Piping installation requirements are specified in [**Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."**] [**Section 232213 "Steam and Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."**] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot water [**baseboard**] [**and**] [**finned-tube**] radiation heaters and components to piping in accordance with Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Connect steam finned-tube radiation heaters and components to piping in accordance with Section 232213 "Steam and Condensate Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

1. Install shutoff valve on inlet; install strainer, steam trap, and shutoff valve on outlet.

D. Install control valves as required by Section 230923.11 "Control Valves."

E. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

3.7 ELECTRICAL CONNECTIONS

A. Ground electric finned-tube radiation heaters in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 82 36 00

Task	Specification	Specification Description
23 82 36 00	23 82 00 00	Chilled Beams
23 82 36 00	23 82 33 00	Convectors
23 82 39 00	23 82 00 00	Chilled Beams

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SECTION 23 82 39 13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cabinet unit heaters with centrifugal fans and hot-water, steam, or electric-resistance heating coils.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. DDC: Direct digital control.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

F. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. <**Insert item**>.

6. Perimeter moldings for exposed or partially exposed cabinets.

B. Seismic Qualification Data: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish [**one**]<**Insert number**> spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtherm; a Mestek company**]
2. [**Berko; Marley Engineered Products**]
3. [**Carrier Global Corporation**]
4. [**Chromalox, Inc.**]
5. [**Dunham-Bush, Inc**]
6. [**Engineered Air**]
7. [**IEC (International Environmental Corporation); LSB Industries**]
8. [**INDEECO**]
9. [**Markel Products Company; a subsidiary of TPI Corporation**]
10. [**Marley Engineered Products**]
11. [**Ouellet Canada Inc**]
12. [**QMark; Marley Engineered Products**]
13. [**Rosemex Products**]
14. [**Trane**]
15. [**USA Coil & Air**]
16. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Airtherm; a Mestek company**]
2. [**Berko; Marley Engineered Products**]
3. [**Carrier Global Corporation**]
4. [**Chromalox, Inc.**]
5. [**Dunham-Bush, Inc**]
6. [**Engineered Air**]
7. [**IEC (International Environmental Corporation); LSB Industries**]
8. [**INDEECO**]
9. [**Markel Products Company; a subsidiary of TPI Corporation**]
10. [**Marley Engineered Products**]
11. [**Ouellet Canada Inc**]
12. [**QMark; Marley Engineered Products**]
13. [**Rosemex Products**]
14. [**Trane**]
15. [**USA Coil & Air**]
16. <**Insert manufacturer's name**>

C. Heaters: Factory-assembled and -tested unit complying with AHRI 440.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with UL 2021.

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Cabinet unit heaters are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.3 COIL SECTION INSULATION

A. Insulation Materials:

1. Duct-Liner-Type, Glass-Fiber Insulation: ASTM C1071; surfaces exposed to airstream are to have [**aluminum-foil facing**][**erosion-resistant coating**] to prevent erosion of glass fibers.

a. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**].
b. Thermal Conductivity (k-Value): **0.26 Btu x in./h x sq. ft. at 75 deg F (0.037 W/m x K at 24 deg C)** mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested in accordance with ASTM E84.
d. Adhesive: Comply with ASTM C916 and with NFPA 90A or NFPA 90B.
e. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

2. Flexible Elastomeric Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C534, Type II, except for density.

a. Thickness: [**3/8 inch (9 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
b. Thermal Conductivity (k-Value): **0.24 Btu x in./h x sq. ft. at 75 deg F (0.034 W/m x K at 24 deg C)** mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested in accordance with ASTM C411.
d. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
e. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

2.4 CABINETS

A. Material: Steel with [**factory prime coating, ready for field painting**][**baked-enamel finish with manufacturer's standard paint, in color selected by Architect**][**baked-enamel finish with manufacturer's custom paint, in color selected by Architect**].

1. Vertical Unit, Exposed Front Panels: Minimum [**0.0528-inch- (1.35-mm-)**][**0.0677-inch- (1.7-mm-)**] thick [**galvanized**]sheet steel, removable panels with channel-formed edges secured with

tamperproof cam fasteners.

2. Horizontal Unit, Exposed Bottom Panels: Minimum [**0.0528-inch- (1.35-mm-)**][**0.0677-inch- (1.7-mm-)**] thick [**galvanized**]sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum **0.0528-inch- (1.35-mm-)** thick steel, finished to match cabinet, [**4 inches (100 mm)**][**6 inches (150 mm)**]<**Insert dimension**> high with leveling bolts.
6. Extended Piping Compartment: [**8-inch- (200-mm-)**]<**Insert dimension**> wide piping end pocket.
7. False Back: Minimum **0.0428-inch- (1.1-mm-)** thick steel, finished to match cabinet.
8. Outdoor-Air Wall Box: Minimum **0.1265-inch- (3.2-mm-)** thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen; aluminum louver with [**anodized**][**baked-enamel**] finish in color selected by Architect from manufacturer's [**standard**][**custom**] colors.

    a. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with [**manual**][**electronic**][**pneumatic**], two-position actuators.

2.5 FILTERS

A. Minimum Efficiency Reporting Value and Average Arrestance: In accordance with ASHRAE 52.2.

B. Minimum Efficiency Reporting Value: In accordance with ASHRAE 52.2.

C. Material:

1. Washable Foam, [**MERV 3**]<**Insert value**>.
2. Glass fiber treated with adhesive, [**MERV 5**]<**Insert value**>.
3. Pleated cotton-polyester media, [**MERV 7**]<**Insert value**>.

2.6 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)** and rated for a minimum working pressure of **200 psig (1378 kPa)** and a maximum entering-water temperature of **220 deg F (104 deg C)**. Include manual air vent and drain.

B. Steam Coil: Copper[**distributing**] tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)** and rated for a minimum working pressure of **75 psig (517 kPa)**.

C. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless steel machine-staked terminals secured with stainless steel hardware.

2.7 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, [**high static,**]double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230500 "Common Work Results for HVAC."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Factory, Hot-Water Piping Package: [**ASTM B88, Type L (ASTM B88M, Type B)**][**ASTM B88, Type M (ASTM B88MType C)**] copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. [**Two**][**Three**]-way, [**two-position**][**modulating**] control valve.[**Three-way valve packages include bypass line with manually adjustable balance device.**]
2. Hose Kits: Minimum **400-psig (2758-kPa)** working pressure, and operating temperatures from **33 to 211 deg F (0.5 to 99 deg C)**. Tag hose kits to equipment designations.

   a. Length: [**24 inches (600 mm)**][**36 inches (900 mm)**]<**Insert dimension**>.
   b. Minimum Diameter: Equal to cabinet unit-heater connection size.

3. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and **600-psig (4140-kPa)** minimum CWP rating and blowout-proof stem.
4. Calibrated-Orifice Balancing Valves: Bronze body, ball type, **125-psig (860-kPa)** working pressure, **250 deg F (121 deg C)** maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
5. Automatic Flow-Control Valve: Brass or ferrous-metal body, **300-psig (2068-kPa)** working pressure at **250 deg F (121 deg C)**, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow within plus or minus 10 percent of differential pressure range of **2 to 80 psig (13.8 to 552 kPa)**.
6. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A126, Class B); **125-psig (860-kPa)** minimum working pressure; with threaded connections, bolted cover, perforated stainless steel basket, and bottom drain connection. Include minimum **NPS 1/2 (DN 15)** threaded pipe and full-port ball valve in strainer drain connection.
7. Wrought-Copper Unions: ASME B16.22.

C. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

D. Basic Unit Controls:

1. Control voltage transformer.
2. [**Wall**][**Unit**]-mounted thermostat with the following features:

   a. Heat-off switch.
   b. Fan on-auto switch.
   c. Manual fan-speed switch.
   d. Adjustable deadband.
   e. [**Concealed**][**Exposed**] set point.
   f. [**Concealed**][**Exposed**] indication.
   g. **Deg F (Deg C)** indication.

3. [**Wall**][**Unit**]-mounted temperature sensor.
4. Unoccupied period override push button.
5. Data entry and access port.

   a. Input data includes room temperature and occupied and unoccupied periods.
   b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

E. Terminal Controller:[**DDC.**]

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of

four programmable periods per day.
2. Unoccupied Period Override: [**Two**]<**Insert number**> hours.
3. Unit Supply-Air Fan Operations:

   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain setback room temperature.

4. Heating-Coil Operations:

   a. Occupied Periods: [**Open control valve**][**Modulate control valve**][**Energize electric-resistance coil**] to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and [**open control valve**][**modulate control valve**][**energize electric-resistance coil**] if room temperature falls below setback temperature.

5. Outdoor-Air Damper Operation:

   a. Occupied Periods: Open dampers. Delay damper opening if room temperature is more than three degrees below set point.
   b. Unoccupied Periods: Close damper.

6. Controller is to have volatile-memory backup.

F. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface is to be [**BAC-net**][**or**][**LonWorks**] compatible for central DDC system for HVAC workstation and include the following functions:

   a. Adjust set points.
   b. Cabinet unit-heater start, stop, and operating status.
   c. Data inquiry, including [**outdoor-air damper position and**]supply-air and room-air temperature.
   d. Occupied and unoccupied schedules.

G. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.8 CAPACITIES AND CHARACTERISTICS

A. Cabinet:

1. Vertical, Surface Mounted, Upflow:

   a. Top: [**Flat**][**Sloped**][**Flat or sloped**].
   b. Air Inlet: [**Open bottom**][**Front, punched louver**][**Front, extruded-aluminum bar grille**].
   c. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

2. Vertical, Surface Mounted, Downflow:

   a. Top: [**Flat**][**Sloped**][**Flat or sloped**].
   b. Air Inlet: [**Front**][**Top**][**Front or top**], [**punched louver**][**extruded-aluminum bar grille**].
   c. Air Outlet: Front, [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

3. Vertical, Semirecessed, Upflow:

   a. Air Inlet: [**Open bottom**][**Front, punched louver**][**Front, extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

4. Vertical, Semirecessed, Downflow:

   a. Air Inlet: [**Front**][**Top**][**Front or top**], [**punched louver**][**extruded-aluminum bar grille**].
   b. Air Outlet: Front, [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

5. Vertical, Fully Recessed: [**Upflow**][**Downflow**].

   a. Air Inlet: [**Front**][**Duct connection**], [**punched louver**][**extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Duct connection**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

6. Horizontal, Surface Mounted:

   a. Air Inlet: [**Bottom**][**Front**][**Bottom or front**], [**punched louver**][**extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

7. Horizontal, Semirecessed:

   a. Air Inlet: [**Bottom**][**Front**][**Bottom or front**], [**punched louver**][**extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

8. Horizontal, Fully Recessed:

   a. Air Inlet: [**Front**][**Duct connection**], [**punched louver**][**extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Duct connection**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

B. Concealed Unit Heater:

1. Vertical: [**Upflow**][**Downflow**].

   a. Air Inlet: [**Open bottom**][**Front, punched louver**][**Front, extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

2. Horizontal: Upflow.

   a. Air Inlet: [**Open bottom**][**Front, punched louver**][**Front, extruded-aluminum bar grille**].
   b. Air Outlet: [**Front**][**Top**][**Front or top**], [**quad louver**][**punched louver**][**extruded-aluminum bar grille**].

C. Fan:

1. Airflow: <**Insert cfm (L/s)**>.

2. External Static Pressure: <**Insert inches wg (Pa)**>.
3. Fan Speed: <**Insert rpm**>.
4. Motor Horsepower: <**Insert value**>.

D. Heating Capacity:

1. Output: <**Insert Btu/h (kW)**>.
2. Entering-Air Temperature: <**Insert deg F (deg C)**>.
3. Air-Temperature Rise: <**Insert deg F (deg C)**>.

E. Hot-Water Heating Coil:

1. Water Flow: <**Insert gpm (L/s)**>.
2. Water-Side Pressure Loss: <**Insert feet wg (kPa)**>.
3. Entering-Water Temperature: <**Insert deg F (deg C)**>.

F. Steam Heating Coil:

1. Inlet Steam Pressure: <**Insert psig (kPa)**>.
2. Condensing Capacity: <**Insert lb/h (g/s)**>.

G. Electric-Resistance Heating Coil:

1. Capacity: <**Insert kilowatts**>.
2. Number of Steps: <**Insert number**>.

H. Filters:

1. Face Area: <**Insert sq. ft. (sq. m)**>.
2. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

I. Electrical Characteristics for Single-Point Connection:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**piping and**]electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINET UNIT HEATERS

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers[**and seismic restraints**]. Vibration isolators[**and seismic restraints**] are specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 "Hydronic Piping Specialties," Section 232213 "Steam and Condensate Heating Piping," and Section 232216 "Steam and Condensate Heating Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of cabinet unit heater. Steam specialties are specified in Section 232216 "Steam and Condensate Heating Piping Specialties."

H. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

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SECTION 23 82 39 16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Propeller unit heaters with hot-water, steam, or electric-resistance heating coils.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which propeller unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. <**Insert item**>.

B. Seismic Qualification Data: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Airtherm; a Mestek company**]
2. [**CCI Thermal Technologies, Inc**]
3. [**Engineered Air**]
4. [**Rosemex Products**]
5. [**Trane**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Airtherm; a Mestek company**]
2. [**CCI Thermal Technologies, Inc**]
3. [**Engineered Air**]

4. [**Rosemex Products**]
5. [**Trane**]
6. <**Insert manufacturer's name**>

C. Heaters: Assembly including casing, coil, fan, and motor in [**vertical**][**and**][**horizontal**] discharge configuration with adjustable discharge louvers.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with UL 2021.

F. Comply with UL 823.

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Propeller unit heaters are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.3 HOUSINGS

A. Finish: Manufacturer's [**standard**][**custom**] baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

A. General Coil Requirements: Test and rate [**hot-water**][**steam**] propeller unit-heater coils in accordance with ASHRAE 33.

B. Hot-Water Coil:

1. Copper tube, minimum **0.025-inch (0.635-mm)** wall thickness, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)** and rated for a minimum working pressure of **200 psig (1380 kPa)** and a maximum entering-water temperature of **325 deg F (163 deg C)**, with manual air vent. Test for leaks to **350 psig (2413 kPa)** underwater.
2. Cupronickel tube, minimum **0.031-inch (0.78-mm)** wall thickness, with mechanically bonded aluminum fins spaced no closer than **0.1 inch (2.5 mm)** and rated for a minimum working pressure of **400 psig (2760 kPa)** and a maximum entering-water temperature of **450 deg F (232**

deg C), with manual air vent. Test for leaks to 600 psig (4137 kPa) underwater.

3. Red-brass tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 260 psig (1793 kPa) and a maximum entering-water temperature of 390 deg F (199 deg C), with manual air vent. Test for leaks to 390 psig (2689 kPa) underwater.
4. Steel tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 400 psig (2760 kPa) and a maximum entering-water temperature of 450 deg F (232 deg C), with manual air vent. Test for leaks to 600 psig (4137 kPa) underwater.
5. Vertical steel tube, minimum 0.065-inch (1.65-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 400 psig (2760 kPa) and a maximum entering-water temperature of 450 deg F (232 deg C), with steel headers at top and bottom. Test for leaks to 600 psig (4137 kPa) underwater.

C. Steam Coil:

1. Copper tube, minimum 0.025-inch (0.635-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 75 psig (520 kPa).
2. Red-brass tube, minimum 0.049-inch (1.24-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 75 psig (520 kPa).
3. Vertical steel tube, minimum 0.065-inch (1.65-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of [100 psig (690 kPa)][200 psig (1380 kPa)], with steel headers at top and bottom.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends are to be enclosed in terminal box. Fin surface temperature is not to exceed 550 deg F (288 deg C) at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless steel or corrosion-resistant material.

2.5 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, [**explosion proof**][**multispeed**][**variable speed**]. Comply with requirements in Section 230500 "Common Work Results for HVAC."

2.6 CONTROLS

A. Control Devices:

1. [**Unit**][**Wall**]-mounted, [**variable**]fan-speed switch.
2. [**Unit**][**Wall**]-mounted thermostat.

2.7 CAPACITIES AND CHARACTERISTICS

A. Heating Capacity:

1. Heat Output: <**Insert Btu/h (kW)**>.
2. Length of Throw: <**Insert feet (m)**>.
3. Mounting Height: <**Insert feet (m)**>.

B. Water Coil:

1. Entering-Water Temperature: <**Insert deg F (deg C)**>.
2. Temperature Difference: <**Insert deg F (deg C)**>.
3. Water Flow: <**Insert gpm (L/s)**>.
4. Water-Side Pressure Drop: <**Insert feet (kPa)**>.

C. Steam Coil:

1. Inlet Pressure: <**Insert psig (kPa)**>.
2. Condensing Capacity: <**Insert lb/h (g/s)**>.

D. Electric Coil:

1. Heating Capacity: <**Insert kilowatts**>.
2. Number of Steps: <**Insert number**>.

E. Supply Air:

1. Airflow: <**Insert cfm (L/s)**>.
2. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.

F. Fan Motor:

1. High Speed: <**Insert rpm**>.
2. Motor Size: <**Insert horsepower**>.

G. Electrical Characteristics for Single-Point Connection:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Amperes: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**piping and**]electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PROPELLER UNIT HEATERS

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and [**elastomeric hangers**][**spring hangers**][**spring hangers with vertical-limit stop**]. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in [**Section 230548 "Vibration and Seismic Controls for HVAC."**][**Section 230548.13 "Vibration Controls for HVAC."**]

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:

1. Section 232113 "Hydronic Piping."
2. Section 232116 "Hydronic Piping Specialties."
3. Section 232213 "Steam and Condensate Heating Piping."
4. Section 232216 "Steam and Condensate Heating Piping Specialties."

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

F. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of propeller unit heater. Steam specialties are specified in Section 232216 "Steam and Condensate Piping Specialties."

G. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor

rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 23 82 39 16

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Task	Specification	Specification Description
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SECTION 23 82 39 19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Wall and ceiling unit heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL AND CEILING UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Berko; Marley Engineered Products**]

2. [**Chromalox, Inc.**]
3. [**Glen Dimplex Americas**]
4. [**INDEECO**]
5. [**Markel Products Company; a subsidiary of TPI Corporation**]
6. [**Marley Engineered Products**]
7. [**Ouellet Canada Inc**]
8. [**QMark; Marley Engineered Products**]
9. [**Trane**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Berko; Marley Engineered Products**]
2. [**Chromalox, Inc.**]
3. [**Glen Dimplex Americas**]
4. [**INDEECO**]
5. [**Markel Products Company; a subsidiary of TPI Corporation**]
6. [**Marley Engineered Products**]
7. [**Ouellet Canada Inc**]
8. [**QMark; Marley Engineered Products**]
9. [**Trane**]
10. <**Insert manufacturer's name**>

C. Heaters: Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CABINET

A. Front Panel: [**Stamped-steel louver**][**Extruded-aluminum bar grille**], with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's [**standard**][**custom**] color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.3 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware, and limit controls for high-temperature protection.[**Provide integral circuit breaker for overcurrent protection.**]

2.4 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated[**, multispeed**]. Comply with requirements in Section 230500 "Common Work Results for HVAC."

2.5 CONTROLS

A. Controls: Unit-mounted thermostat.[**Low-voltage relay with transformer kit.**]

B. Electrical Connection: Factory wire motors and controls for a single field connection[**with disconnect switch**].

2.6 CAPACITIES AND CHARACTERISTICS

A. Airflow: <**Insert cfm (L/s)**>.

B. Fan Speed: <**Insert rpm**>.

C. Heating Coil: <**Insert kilowatts**>.

D. Electrical Characteristics for Single-Point Connection:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WALL AND CEILING UNIT HEATERS

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and

room details before installation.

D. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39 19

Task	Specification	Specification Description
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SECTION 23 83 13 00 - RADIANT-HEATING ELECTRIC CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electric heating cables for ceiling or floor radiant heating, snow and ice melting on pavement, and freezer-floor frost-heave prevention with the following electric heating cables:

1. Mineral insulated, series resistance.
2. Plastic insulated, series resistance.
3. Self-regulating, parallel resistance.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 220533 "Heat Tracing for Plumbing Piping."
3. Section 230533 "Heat Tracing for HVAC Piping."
4. Section 238213 "Valance Heating and Cooling Units" for factory-fabricated electric heating panels for ceiling and wall applications.
5. Section 238323 "Radiant-Heating Electric Panels."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, sections, details, and attachments to other work.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Items installed in finished ceiling, including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

g. **<Insert item>**.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: [**10**][**15**]**<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR ELECTRIC HEATING CABLES

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MINERAL-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Chromalox, Inc.**]
2. [**Delta-Therm Corporation**]
3. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
4. [**Nelson; Emerson Electric Co., Automation Solutions**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**Trasor Corp.**]
7. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Chromalox, Inc.**]
2. [**Delta-Therm Corporation**]
3. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
4. [**Nelson; Emerson Electric Co., Automation Solutions**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**Trasor Corp.**]
7. **<Insert manufacturer's name>**

C. Comply with UL 1673.

D. Heating Element: Single- or dual-conductor resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

E. Electrical Insulating Mineral: Magnesium oxide.

F. Cable Cover: Copper-nickel alloy[**and high-density polyethylene outer jacket**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Capacities and Characteristics:

1. Maximum Heat Output: [**6 W/ft. (19.7 W/m)**][**7.5 W/ft. (24.6 W/m)**]<**Insert value**>.
2. Spacing: <**Insert inches (mm)**>.
3. Electrical Characteristics for Single-Circuit Connection:

a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Delta-Therm Corporation**]
2. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
3. [**NUHEAT; brand of nVent Electrical plc**]
4. [**Orbit Manufacturing**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**SunTouch; A Watts Water Technologies Company**]
7. [**WarmlyYours Radiant, Inc.**]
8. [**Warmup Inc.**]
9. [**Warmzone Premier Radiant Heating**]
10. [**WATTS; A Watts Water Technologies Company**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Delta-Therm Corporation**]
2. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
3. [**NUHEAT; brand of nVent Electrical plc**]
4. [**Orbit Manufacturing**]
5. [**RAYCHEM; brand of nVent Electrical plc**]
6. [**SunTouch; A Watts Water Technologies Company**]
7. [**WarmlyYours Radiant, Inc.**]
8. [**Warmup Inc.**]
9. [**Warmzone Premier Radiant Heating**]
10. [**WATTS; A Watts Water Technologies Company**]

11. <**Insert manufacturer's name**>

C. Comply with UL 1673.

D. Heating Element: Single resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

E. Electrical Insulating Jacket: Minimum **4.0-mil (0.10-mm)** Kapton with silicone or Tefzel.

F. Cable Cover: [**Aluminum**][**Stainless-steel**][**Nickel**] braid[**with silicone or Hylar outer jacket**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Cable-Heated Mats: Factory-fabricated cable and fiberglass or plastic mesh with uniform [**1-1/2-inch (38-mm)**][**3-inch (76-mm)**]<**Insert dimension**> cable spacing, in [**18-inch (457-mm)**][**36-inch (914-mm)**]<**Insert dimension**> widths.

I. Capacities and Characteristics:

1. Maximum Heat Output (Cable): [**6 W/ft. (19.7 W/m)**][**7.5 W/ft. (24.6 W/m)**]<**Insert value**>.
2. Maximum Heat Output (Mat): [**12 W/sq. ft. (129 W/sq. m)**][**16 W/sq. ft. (172 W/sq. m)**]<**Insert value**>.
3. Spacing: <**Insert inches (mm)**>.
4. Electrical Characteristics for Single-Circuit Connection:

   a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
   b. Phase: <**Insert value**>.
   c. Hertz: <**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BriskHeat**]
2. [**Chromalox, Inc.**]
3. [**Delta-Therm Corporation**]
4. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
5. [**Nelson; Emerson Electric Co., Automation Solutions**]
6. [**RAYCHEM; brand of nVent Electrical plc**]
7. [**Thermon, Inc.**]
8. [**Trasor Corp.**]
9. [**Warmup Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BriskHeat**]
2. [**Chromalox, Inc.**]

3. [**Delta-Therm Corporation**]
4. [**EasyHeat; Emerson Electric Co., Commercial and Residential Solutions**]
5. [**Nelson; Emerson Electric Co., Automation Solutions**]
6. [**RAYCHEM; brand of nVent Electrical plc**]
7. [**Thermon, Inc.**]
8. [**Trasor Corp.**]
9. [**Warmup Inc.**]
10. <**Insert manufacturer's name**>

C. Comply with UL 1673.

D. Heating Element: Pair of parallel [**No. 16**][**No. 18**] AWG, [**tinned**][**nickel-coated**], stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Cable Cover: [**Tinned-copper**][**Stainless-steel**] braid[**with polyolefin outer jacket with ultraviolet inhibitor**].

G. Maximum Operating Temperature: [**300 deg F (150 deg C)**]<**Insert temperature**>.

H. Cable-Heated Mats: Factory-fabricated cable and fiberglass or plastic mesh with uniform [**1-1/2-inch (38-mm)**][**3-inch (76-mm)**]<**Insert dimension**> cable spacing, in [**18-inch (457-mm)**][**36-inch (914-mm)**]<**Insert dimension**> widths.

I. Capacities and Characteristics:

1. Maximum Heat Output (Cable): [**3 W/ft. (9.8 W/m)**][**5 W/ft. (16.4 W/m)**][**8 W/ft. (26 W/m)**][**10 W/ft. (32.8 W/m)**][**12 W/ft. (39.4 W/m)**]<**Insert value**>.
2. Maximum Heat Output (Mat): [**6 W/sq. ft. (65 W/sq. m)**][**12 W/sq. ft. (129 W/sq. m)**][**16 W/sq. ft. (172 W/sq. m)**][**24 W/sq. ft. (260 W/sq. m)**]<**Insert value**>.
3. Spacing: <**Insert inches (mm)**>.
4. Electrical Characteristics for Single-Circuit Connection:

   a. Volts: [**120**][**208**][**240**][**277**][**480**]<**Insert value**>.
   b. Phase: <**Insert value**>.
   c. Hertz: <**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.5 CONTROLS

A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control devices and sequence of operations for radiant-heating electric cables.

B. Wall-Mounted Thermostats for Ceiling and Floor Heating Cables:

1. Minimum temperature range from [**50 to 90 deg F (10 to 32 deg C)**]<**Insert temperature range**>.
2. Manually operated with on-off switch.

C. Precipitation and Temperature Sensor for Snow Melting on Pavement:

1. [**Microprocessor-based**][**Automatic**] control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to energize the cable as follows:

   a. Temperature Span: [**34 to 44 deg F (1 to 7 deg C)**]<**Insert temperature range**>.
   b. Adjustable Delay-Off Span: [**30 to 90**]<**Insert time**> minutes.
   c. Energize Cables: Following [**two**]<**Insert time**>-minute delay if ambient temperature is below set point and precipitation is detected.
   d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to energize cable or close other contactors.
5. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.6 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Embedded Heating-Cable Identification:

1. Flush-mounted cast-iron boxes with identification on lid according to NFPA 70.
2. Mechanically fastened [**metal**][**plastic**] signage with identification according to NFPA 70 and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
3. Mechanically fastened [**metal**][**plastic**][**concrete**] post-mounted signage with identification according to NFPA 70 and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables or cable-heated mats for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces in contact with electric heating cables or cable-heated mats are free of burrs and sharp protrusions.
2. Ensure surfaces and substrates are level and plumb.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Ceiling Radiant Heating: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
2. Floor Radiant Heating: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
3. Snow and Ice Melting on Pavement: [**Mineral-insulated, series-resistance**][**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.
4. Freezer-Floor Frost-Heave Prevention: [**Plastic-insulated, series-resistance**][**Self-regulating, parallel-resistance**] heating cable.

3.3 INSTALLATION

A. Install electric heating cable or cable-heated mats across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Do not energize cables embedded in concrete or plaster until those assemblies are cured.

C. Electric Heating-Cable Installation for Ceiling Radiant Heating: Install heating cable or cable-heated mat with heat-conductive fill materials such as plaster to ensure direct contact with finished radiant surfaces.

D. Electric Heating-Cable Installation for Floor Radiant Heating: Install heating cable or cable-heated mat with heat-conductive fill materials such as concrete to ensure direct contact with finished radiant surfaces.

E. Electric Heating-Cable or Cable-Heated-Mat Installation for Snow and Ice Melting in Pavement:

1. Install heating cable or cable-heated mat with heat-conductive fill materials such as asphalt or concrete to ensure direct contact with finished radiant surfaces.
2. Install cables or cable-heated mats after applying bituminous binder course to lower base; ensure that second bituminous binder course is applied to cables or mats before pouring finish topping.
3. Install embedded electric heating-cable or cable-heated-mat identification box where indicated in pavement before pavement work is completed.
4. Stamp concrete with embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."
5. Mount precipitation sensor in pavement.

F. Electric Heating-Cable Installation for Freezer-Floor Frost-Heave Prevention: Install electric heating cable or cable-heated mat below insulation in subsoil.

1. Install embedded electric heating-cable or cable-heated-mat identification box where indicated.
2. Install embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 on adjacent structure and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
3. Install embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 on [**metal**][**wood**][**concrete**] post and complying with requirements in [**Section 101416 "Plaques."**][**Section 101419 "Dimensional Letter Signage."**][**Section 101423 "Panel Signage."**]
4. Stamp concrete with embedded electric heating-cable or cable-heated-mat identification according to NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying finished surface on heating cables.

E. Radiant-heating electric cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged radiant-heating electric cables and cable-heated mats.

END OF SECTION 23 83 13 00

Task	Specification	Specification Description
23 83 13 13	21 05 33 00	Heat Tracing for Fire-Suppression Piping
23 83 13 13	22 05 33 00	Heat Tracing for Plumbing Piping
23 83 13 13	23 05 33 00	Heat Tracing for HVAC Piping
23 83 13 13	23 83 13 00	Radiant-Heating Electric Cables

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SECTION 23 84 13 16 - WETTED-ELEMENT HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wetted-element humidifiers.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which humidifiers will be attached.
2. Size and location of initial access modules.

B. Seismic Qualification Data: Certificates, for humidifiers, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AHRI 640.

C. Comply with UL 900, [**Class I**][**or**][**Class II**].

D. Comply with <**Insert standard**>.

E. Seismic Performance: Wetted-element humidifiers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means the "unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

F. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Entering Dry-Bulb Air Temperature: <**Insert deg F (deg C)**>.
3. Entering Wet-Bulb Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving Dry-Bulb Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving Wet-Bulb Air Temperature: <**Insert deg F (deg C)**>.
6. Duct/Plenum Height: <**Insert inches (mm)**>.
7. Duct/Plenum Width: <**Insert inches (mm)**>.
8. Number of Media Control Stages: <**Insert number**>.
9. Maximum Absorption Distance: <**Insert inches (mm)**>.
10. Cooling Efficiency Required: <**Insert number**> percent.
11. Media Water Pump:

    a. Number of Pumps: <**Insert number**>.

b. Motor Horsepower (Each): <**Insert hp (W)**>.

12. Drain Pump:

a. Number of Pumps: <**Insert number**>.
b. Motor Horsepower: <**Insert hp (W)**>.

13. Electrical Characteristics: Single point of connection.

a. Volts: <**Insert number**> V.
b. Phase: [**Single**][**Three**] phase.
c. Hertz: <**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A
f. Maximum Overcurrent Protection: <**Insert number**> A.

G. Water Type: Suitable for use with [**tap**][**softened**][**reverse osmosis**][**deionized**] water.

2.2 WETTED-ELEMENT HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**DriSteem**]
2. [**Neptronic; National Environmental Products, Inc.**]
3. [**Nortec Industries Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**DriSteem**]
2. [**Neptronic; National Environmental Products, Inc.**]
3. [**Nortec Industries Inc.**]
4. <**Insert manufacturer's name**>

C. Piping and Fittings, **ASTM A269 (ASTM A269M):)** [**Stainless-steel**][**Stainless-steel, type 304**][**Stainless-steel, type 316**] pipe and fittings.

D. Piping and Fittings, **ASTM B88 (ASTM B88M)**: type L copper pipe and wrought-copper fittings with brazed joints.

E. Media Water Pump:

1. [**Stainless-steel**][**Bronze**] pump body and [**single**][**variable**]-speed motor.
2. [**One pump**][**One solenoid valve**][**One pump or solenoid valve**] for each media stage.

F. Drain Pump: [**Stainless-steel**][**Bronze**] pump body and single-speed motor.

G. Media:

1. Inorganic and inflammable.

H. Reservoir, Header, and Frame:

1. Stainless steel.
2. Reservoir designed, so it drains and dries completely.

I. Mist Eliminator: Mounted to a stainless-steel frame with removable panels.

J. Water Treatment:

1. Ultraviolet disinfection system.
2. Silver-ion antibacterial cartridge.
3. [**5-micron**]<**Insert value**> pre-filter.

K. Control Panel:

1. NEMA 250, [**type 3R**][**type 4X**]<**Insert type**>, to comply with environmental conditions at installed location.
2. Material: [**Galvanized**][**Powder-coated**][**Stainless**] steel <**Insert material**>.

L. Controls:

1. [**Cycle**][**Vary speed of**] motor [**and**][**sequence solenoid valve stages**] to satisfy humidistat.
2. Multilevel probe and supply solenoid to maintain tank water level.
3. Conductivity drain controls manage the total dissolved solids concentration in the reservoir.
4. Building Automation System Interface:

   a. For Each Control Zone, Provide Points for the Following:

      1) Start/stop.
      2) Status indication.
      3) <**Insert other points**>.

   b. Full Communication Interface: [**Modbus**][**BACnet**]<**Insert interface type**>.

M. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return duct**] mounted.
2. High-Limit [**Humidistat**][**Humidity Sensor**]: Supply duct mounted.
3. Airflow switch prevents humidifier operation without airflow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance.[**Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.**]

B. Seal all duct and plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install [**galvanized**][**stainless**]-steel drain pan under each manifold.

1. Construct drain pans with connection for drain; insulated[**and complying with ASHRAE 62.1**].
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than that required by ASHRAE 62.1.

E. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.

B. Install devices and piping specialties furnished by manufacturer but not factory mounted.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least **1/2-inch (13-mm)** high.
3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between humidity sensors, high-limit humidity sensors, and [**DDC control system**]<**Insert system description**>.

C. Connect control wiring between humidistats and controlled devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Humidifier will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 84 13 16

SECTION 23 84 13 23 - DIRECT-STEAM-INJECTION HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct-steam-injection distributer tube humidifiers.
2. Direct-steam-injection panel distribution manifold humidifiers.
3. Area-type direct-steam-injection humidifiers.
4. Condensate drain coolers.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, distributer tubes/manifolds, and attachments to other work.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which humidifiers will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for humidifiers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate location and installation of humidifiers with distributer tubes/manifolds in ducts and plenums or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AHRI 640.

C. Comply with <**Insert standard**>.

D. Seismic Performance: Direct-steam-injection humidifiers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

E. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**]<**Insert value**> or less.

2. Smoke-Developed Index: [**50**]<**Insert value**> or less.

2.2 DIRECT-STEAM-INJECTION DISTRIBUTER TUBE HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]
9. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Steam Supply Pressure: <**Insert psig (kPa)**>.
3. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
5. Maximum Absorption Distance: <**Insert inches (mm)**>.
6. Number of Distributer Tubes: <**Insert number**>.

D. Steam Distributer Tube(s): Single or multiple, steam-jacketed tubes suitable for pressurized steam applications.

E. Material: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

F. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

G. Steam Separator: [**Cast iron**][**Stainless steel, type 304**][**Stainless steel, type 316**].

H. Humidifier Control Valve:

1. Actuator:

a. [**Pneumatic**][**Electric**] modulating with spring return.
b. As specified in Section 230923.11 "Control Valves."

2. Body: [**Bronze**][**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

I. Steam Trap:

1. Material: [**Cast iron**][**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].
2. Type: [**Inverted-bucket**][**or**][**Float and thermostatic**].
3. Capacity: Sized for a minimum of [**3 times**]<**Insert value**> the maximum rated condensate flow of humidifier at [**1/2-psig (3.4-kPa)**]<**Insert value**> differential pressure.

J. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return-duct**] mounted.
2. Duct-mounted high-limit [**humidistat**][**humidity sensor**].
3. [**Aquastat**][**Temperature sensor**] mounted on steam condensate return piping to prevent cold operation of humidifier.
4. In-Line Strainer, Y-Pattern: [**Stainless-steel**][**Stainless-steel, type 304**][**Stainless-steel, type 316**][**Cast-iron**] body with [**20**]<**Insert number**>-mesh [**type 304**][**type 316**] stainless-steel screen.
5. Airflow switch for preventing humidifier operation without airflow.
6. Humidifier Controller:

   a. Digital, with keypad and display.
   b. Building Automation System Interface:

      1) Full Communication Interface: [**BACnet**][**Modbus**][**Lontalk**][**Ethernet**][**Johnson Controls N2**]<**Insert interface type**>.

2.3 DIRECT-STEAM-INJECTION PANEL DISTRIBUTION MANIFOLD HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]

9. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Steam Supply Pressure: <**Insert psig (kPa)**>.
3. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
5. Maximum Absorption Distance: <**Insert inches (mm)**>.
6. Number of Distribution Manifolds: <**Insert number**>.

D. Panel Distribution Manifold:

1. Prefabricated steam dispersion grid assembly.
2. Designed for short absorption distance.
3. Suitable for pressurized steam applications.
4. Extending the full width and height of duct or plenum.
5. [**Horizontal**][**or**][**vertical**] header with multiple [**vertical**][**or**][**horizontal**], [**nonsteam-jacketed**][**steam-jacketed**] tubes, designed for dry-steam injection, within short absorption distance.
6. [**Nozzles/metered orifices in conjunction with nonsteam-jacketed manifolds**][**or**][**punched orifices/no nozzles in conjunction with steam-jacketed manifolds**] spaced evenly along manifold tubes and providing dry and uniform steam distribution.
7. Headers and Distribution Tubes:

   a. Material: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].
   b. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

E. Steam Separator: External separator, or separator/baffles integral to header, to provide condensate-free steam to the distribution tubes.

1. Material: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

F. Humidifier Control Valve:

1. Actuator:

   a. [**Pneumatic**][**Electric**] modulating with spring return.
   b. As specified in Section 230923.11 "Control Valves."

2. Body: [**Bronze**][**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

G. Steam Trap:

1. Material: [**Cast iron**][**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].
2. Type: [**Inverted-bucket**][**or**][**Float and thermostatic**].
3. Capacity: Sized for a minimum of [**3**]<**Insert number**> times the maximum rated condensate flow of humidifier at [**1/2-psig (3.4-kPa)**]<**Insert value**> differential pressure.

H. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return-duct**] mounted.
2. Duct-mounted, high-limit [**humidistat**][**humidity sensor**].
3. [**Aquastat**][**Temperature sensor**] mounted on steam condensate return piping to prevent cold operation of humidifier.
4. In-Line Strainer, Y-Pattern: [**Stainless steel**][**Stainless steel, type 304**][**Cast iron**] body with

[**20**]<**Insert number**>-mesh [**stainless steel**][**stainless steel, type 304**][**stainless steel, type 316**] screen.

5. Airflow switch for preventing humidifier operation without airflow.
6. Humidifier Controller:

    a. Digital, with keypad and display.
    b. Building Automation System Interface:

        1) Full Communication Interface: [**BACnet**][**Modbus**][**Lontalk**][**Ethernet**][**Johnson Controls N2**]<**Insert interface type**>.

2.4 DIRECT-STEAM-INJECTION AREA HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Hygromatik; Spirax Sarco**]
4. [**Pure Humidifier Company**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Hygromatik; Spirax Sarco**]
4. [**Pure Humidifier Company**]
5. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Steam Supply Pressure: <**Insert psig (kPa)**>.
3. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
5. Maximum Absorption Distance: <**Insert inches (mm)**>.
6. Dispersion Fan:

    a. Airflow: <**Insert cfm (L/s)**>.
    b. Motor Horsepower: <**Insert hp (W)**>.

7. Electrical Characteristics: Single point of connection.

    a. Volts: <**Insert number**> V.
    b. Phase: [**Single**][**Three**] phase.
    c. Hertz: [**60**]<**Insert number**> Hz.
    d. Full-Load Amperes: <**Insert number**> A.
    e. Minimum Circuit Ampacity: <**Insert number**> A.
    f. Maximum Overcurrent Protection: <**Insert number**> A.

D. Discharge Nozzle and Dispersion Fan:

1. Steam-jacketed discharge nozzle, aluminum blade propeller fan with finger guard, and motor interlocked to operate with humidifier.
2. Fan Mounting: Above and behind discharge outlet on bracket integral to discharge outlet.
3. Steam Separator: External separator, or separator/baffles integral to the nozzle assembly, to provide condensate-free steam to the discharge nozzle.
4. Dispersion Nozzle Material: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

E. Humidifier Control Valve:

1. Actuator:

a. [**Pneumatic**][**Electric**] modulating with spring return.
b. As specified in Section 230923.11 "Control Valves."

2. Body: [**Bronze**][**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**].

F. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: Wall mounted.
2. In-Line Strainer, Y-Pattern: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**][**Cast iron**] body with [**20**]<**Insert number**>-mesh [**stainless steel**][**stainless steel, type 304**][**stainless steel, type 316**] screen.
3. Humidifier Controller:

a. Digital, with keypad and display.
b. Building Automation System Interface:

1) Full Communication Interface: [**BACnet**][**Modbus**][**Lontalk**][**Ethernet**][**Johnson Controls N2**]<**Insert interface type**>.

2.5 CONDENSATE DRAIN COOLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Neptronic; National Environmental Products, Inc.**]
4. [**Nortec Industries Inc.**]
5. [**Pure Humidifier Company**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Neptronic; National Environmental Products, Inc.**]
4. [**Nortec Industries Inc.**]
5. [**Pure Humidifier Company**]
6. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Hot Condensate in: <**Insert gpm (L/s)**>.
2. Hot Condensate Temperature: <**Insert deg F (deg C)**>.
3. Cold Water in <**Insert gpm (L/s)**>.
4. Cold Water Temperature: <**Insert deg F (deg C)**>.
5. Tempered Water out <**Insert gpm (L/s)**>.
6. Tempered Water Temperature: <**Insert deg F (deg C)**>.

D. Description: Mixes hot condensate with a cold water supply to reduce the drain temperature, as required by state and local codes.

E. Cold Water Tempering Valve: Bronze body, [**thermostatic self-actuated with aquastat**][**24 V ac electric actuated with temperature sensor**].

F. Drain Temperature Set-Point Range: Field adjustable between **115 deg F (46 deg C)** and **140 deg F (60 deg C)**. Drain sensor to control cold water tempering valve to limit drain discharge temperature to set point.

G. Reservoir Body Material: [**Stainless steel**][**Stainless steel, type 304**][**Stainless steel, type 316**][**Cast iron or carbon steel**].

H. Mounting: Suitable for [**wall**][**floor**][**suspended**] mounting.

I. Vacuum breaker or air vent connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance.[**Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.**]

B. Seal all duct and plenum penetrations with flange.

C. Install humidifier assemblies in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install [**galvanized**][**stainless**]-steel drain pan under each manifold mounted in duct.

1. Construct drain pans with connection for drain; insulated[**and complying with ASHRAE 62.1**].
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from humidifier tube(s)/manifold a minimum distance

recommended by manufacturer but not less than that required by ASHRAE 62.1.

E. Install drip leg upstream from steam trap a minimum of [**12 inches (300 mm)**]<**Insert height**> tall for proper operation of trap.

F. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Where condensate drain cooler is used, install shutoff valve, strainer, backflow preventer, and union in tempering water makeup piping.

B. Install piping specialties furnished by manufacturer but not factory mounted.

C. Provide P-trap in atmospheric drain piping serving area humidifiers in accordance with manufacturer recommendations.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least **1/2 inch (13 mm)**high.
3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between humidity sensors, high-limit humidity sensors, condensate temperature sensors, and [**DDC control system**]<**Insert system description**>.

C. Connect control wiring between humidistats, thermostats, and control devices.

D. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Humidifier will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 84 13 23

SECTION 23 84 13 29 - SELF-CONTAINED STEAM HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-contained electric-resistance humidifiers.
2. Self-contained electrode humidifiers.
3. Self-contained gas-fired humidifiers.
4. Condensate drain coolers.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, distributer tubes/manifolds, and attachments to other work.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which humidifiers will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for humidifiers, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.8 COORDINATION

A. Coordinate location and installation of humidifiers with distributer tubes/manifolds in ducts and plenums or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AHRI 640.

C. Comply with UL 998.

D. Listed and labeled by [**CE**][**ETL**][**CSA**][**, as complying with applicable AGA/CGA standards**].

E. Listed and labeled by [**ETL**]<**Insert option**>.

F. Seismic Performance: Self-contained steam humidifiers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

G. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**]<**Insert value**> or less.
2. Smoke-Developed Index: [**50**]<**Insert value**> or less.

2.2 SELF-CONTAINED ELECTRIC-RESISTANCE HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Herrmidifier; a brand of Trion**]
5. [**Hygromatik; Spirax Sarco**]
6. [**Neptronic; National Environmental Products, Inc.**]
7. [**Nortec Industries Inc.**]
8. [**Pure Humidifier Company**]
9. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
3. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Maximum Absorption Distance: <**Insert inches (mm)**>.
5. Minimum Makeup Water Supply Pressure: <**Insert psig (kPa)**>.
6. Electric-Resistance Evaporation Chamber:

a. Power Input per Chamber: <**Insert number**> kW.
b. Number of Chambers: <**Insert number**>.

7. Steam Distribution Method - Atmospheric Distributer Tube:

a. Number of Distributer Tubes: <**Insert number**>.

8. Steam Distribution Method - Atmospheric Panel Distribution Manifold:

a. Number of Distribution Manifolds: <**Insert number**>.

9. Steam Distribution Method - Area Dispersion:

a. Number of Distributer Tubes: <**Insert number**>.
b. Fan Airflow: <**Insert cfm (L/s)**>.
c. Fan Motor Horsepower: <**Insert hp (watts)**>.
d. Fan Electrical Characteristics:

1) Volts: <**Insert number**> V.
2) Phase: [**Single**][**Three**] phase.
3) Hertz: [**60**]<**Insert number**> Hz.
4) Full-Load Amperes: <**Insert number**> A.
5) Minimum Circuit Ampacity: <**Insert number**> A.
6) Maximum Overcurrent Protection: <**Insert number**> A.

D. Water Type: Suitable for use with [**tap**][**softened**][**reverse osmosis**][**deionized**] water.

E. Immersion Heating:

1. Evaporation Chamber: Cleanable, [**stainless steel**][**stainless steel, Type 304 or stainless steel, Type 316**].
2. Elements: Incoloy-sheathed, stainless-steel sheathed, or alloy-sheathed aluminum.

F. Cabinet:

1. [**Stainless-steel**][**or**][**painted-steel**] enclosure[**, factory-insulated for safe operating surface temperature,**] for housing heater cylinder, electrical wiring, components, controls, and control panel.
2. Hinged or removable cover, keyed to restrict unauthorized access.
3. Plumbing and electrical components housed in separate parts of the cabinet.
4. Threaded outlet in bottom of cabinet for drain piping.

G. Weatherproof Outdoor Enclosure:[**Insulated, with automatically controlled heating and ventilating system to maintain minimum operating conditions within the enclosure.**]

H. Control Panel:

1. Microprocessor-based control system for [**modulating**][**cycling**] control.
2. Factory-wired disconnect switch.
3. Liquid-crystal display.
4. Programmable keypad.
5. Low-voltage control circuit, with fused transformer.
6. Diagnostic, maintenance, alarm, and status features.
7. Safety switch interlocked to shut off heaters when cabinet is open.
8. Internal electrical controls prewired to appropriately marked terminals for field connection.

9. Electrical terminals for connection to each controlling device and alarm.
10. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**Type 12**]<**Insert type**>, to comply with environmental conditions at installed locations.
11. Material: [**Galvanized**][**Powder-coated**][**Stainless**] steel <**Insert material**>.
12. Building Automation System Interface:

    a. Full Communication Interface: [**Modbus**][**BACnet**][**LonWorks**]<**Insert interface type**>.
    b. [**Web-based remote factory online monitoring with same functionality as local keypad/display.**]

I. Controls:

1. Solenoid Fill Valve Maintains Water Level: [**Stainless steel**][**Bronze**], including fill tee with built-in air gap to prevent back siphoning. Include [**stainless-steel**][**bronze**] inlet strainer.
2. Field-adjustable [**timer**][**conductivity controller**] to control drain cycle for flush duration and interval.[**Automatic flush is not required for reverse osmosis or deionized water applications.**]
3. Controls shall drain tanks if no demand for humidification for more than 72 hours.
4. Set-point adjustment.
5. [**Tri-conductivity sensor probes**][**Stainless-steel float switches**] for water-level control.
6. Low-water switch shuts down heater to protect elements.
7. Over-temperature switch shuts down heater.
8. Aquastat maintains minimum water temperature in tank during short periods of no demand.
9. Foaming detection and correction.

J. Area Dispersion Accessory: Stainless-steel tube, with integral fan that discharges vapor directly into occupied space. Designed for [**remote mounting**][**integral mounting onto humidifier cabinet**].

K. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

1. Material: [**Stainless steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
2. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

L. Atmospheric Steam Panel Distribution Manifold:

1. Prefabricated steam dispersion grid assembly.
2. Designed for short absorption distance.
3. Suitable for atmospheric steam applications.
4. Extending the full width and height of duct or plenum.
5. [**Horizontal**][**or**][**vertical**] header with multiple [**vertical**][**or**][**horizontal**] tubes designed for dry steam injection within short absorption distance.
6. Nozzles/metered orifices, spaced evenly along distribution tubes, provide dry and uniform steam distribution.
7. Distribution panel extending the full width and height of duct or plenum.
8. Headers and Distribution Tubes:

    a. Material: [**Stainless steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
    b. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

9. Steam Separator: Separators/baffles, integral to the header, provide condensate-free steam to distribution tubes.

M. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return-duct**] mounted.
2. Duct-mounted, high-limit [**humidistat**][**humidity sensor**].
3. Airflow switch prevents humidifier operation without airflow.
4. Steam and Condensate Hoses: For interconnection of humidifier to distributer tube(s)/manifold.

2.3 SELF-CONTAINED ELECTRODE HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**Carnes Company**]
4. [**DriSteem**]
5. [**Herrmidifier; a brand of Trion**]
6. [**Hygromatik; Spirax Sarco**]
7. [**Nortec Industries Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**Carnes Company**]
4. [**DriSteem**]
5. [**Herrmidifier; a brand of Trion**]
6. [**Hygromatik; Spirax Sarco**]
7. [**Nortec Industries Inc.**]
8. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
3. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Maximum Absorption Distance: <**Insert inches (mm)**>.
5. Minimum Makeup Water Supply Pressure: <**Insert psig (kPa)**>.
6. Electrode Cylinder:

   a. Power Input Cylinder: <**Insert number**> kW.
   b. Number of Cylinders: <**Insert number**>.

7. Steam Distribution Method - Atmospheric Distributer Tube:

   a. Number of Distributer Tubes: <**Insert number**>.

8. Steam Distribution Method - Atmospheric Panel Distribution Manifold:

   a. Number of Distribution Manifolds: <**Insert number**>.

9. Steam Distribution Method - Area Dispersion:

a. Number of Distributer Tubes: <**Insert number**>.
b. Fan Airflow: <**Insert cfm (L/s)**>.
c. Fan Motor Horsepower: <**Insert hp (watts)**>.
d. Fan Electrical Characteristics:

1) Volts: <**Insert value**> V.
2) Phase: [**Single**][**Three**] phase.
3) Hertz: [**60**]<**Insert value**> Hz.
4) Full-Load Amperes: <**Insert value**>. A
5) Minimum Circuit Ampacity: <**Insert value**> A.
6) Maximum Overcurrent Protection: <**Insert value**> A.

D. Water Type: Suitable for use with tap water.

E. Cylinders: [**Replaceable**][**or**][**cleanable**] plastic humidifier water reservoir, steel electrode assembly, suitable for use with tap water.

F. Cabinet:

1. [**Baked-enamel**][**,**][**Powder-coated-steel**][**,**][**or**][**stainless-steel**] enclosure houses heater cylinder, electrical wiring, components, controls, and control panel.[**Cabinet is factory insulated for safe operating surface temperature.**]
2. Hinged or removable cover, keyed to restrict unauthorized access.
3. Plumbing and electrical components housed in separate compartments of the cabinet.
4. Threaded outlet in bottom of cabinet for drain piping.

G. Weatherproof Outdoor Enclosure: Insulated, with automatically controlled heating and ventilating system to maintain minimum operating conditions within the enclosure.

H. Control Panel:

1. Microprocessor-based control system for [**modulating**][**cycling**] control.
2. Factory-wired disconnect switch.
3. Liquid-crystal display.
4. Programmable keypad.
5. Low-voltage control circuit.
6. Diagnostic, maintenance, alarm, and status features.
7. Safety switch interlocked to shut off heaters when cabinet is open.
8. Internal electrical controls prewired to appropriately marked terminals for field connection.
9. Electrical terminals for connection to each controlling device and alarm.
10. NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**][**Type 12**]<**Insert type**>, to comply with environmental conditions at installed locations.
11. Building Automation System Interface:

a. Full communication interface: [**Modbus**][**BACnet**][**LonWorks**]<**Insert interface type**>.
b. [**Web-based remote factory online monitoring with same functionality as local keypad/display.**]

I. Controls:

1. Solenoid fill valve and automatic drain valve or drain pump maintain water level. Include bronze inlet strainer, bronze solenoid fill valve with flow regulator, bronze solenoid drain valve or drain pump, and fill tee with built-in air gap to prevent back siphoning.
2. Controls shall drain tanks if no demand for humidification for more than 72 hours.
3. Set-point adjustment.
4. Electrode current shutdown upon sensing unsafe condition (e.g., drain system malfunction, fill

system malfunction, or overcurrent malfunction).
5. Tri-conductivity sensor probes for water-level control.
6. Foaming detection and correction.

J. Area Dispersion Accessory: Stainless-steel tube, with integral fan that discharges vapor directly into occupied space. Designed for [**remote mounting**][**integral mounting onto humidifier cabinet**].

K. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

1. Material: [**Stainless steel**][**Stainless steel, Type 304**].
2. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

L. Atmospheric Steam Panel Distribution Manifold:

1. Prefabricated steam dispersion grid assembly.
2. Designed for short absorption distance.
3. Suitable for atmospheric steam applications.
4. Extending the full width and height of duct or plenum.
5. [**Horizontal**][**or**][**vertical**] header with multiple [**vertical**][**or**][**horizontal**] tubes designed for dry steam injection within short absorption distance.
6. Nozzles/metered orifices, spaced evenly along distribution tubes, provide dry and uniform steam distribution.
7. Distribution panel extending the full width and height of duct or plenum.
8. Headers and Distribution Tubes:

   a. Material: [**Stainless steel**][**Stainless steel, Type 304**].
   b. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

9. Steam Separator: Separators/baffles, integral to the header, provide condensate-free steam to distribution tubes.

M. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return-duct**] mounted.
2. Duct-mounted, high-limit [**humidistat**][**humidity sensor**].
3. Airflow switch prevents humidifier operation without airflow.
4. Steam and Condensate Hoses: For interconnection of humidifier to distributer tube(s)/manifold.

2.4 SELF-CONTAINED GAS-FIRED HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Neptronic; National Environmental Products, Inc.**]
5. [**Nortec Industries Inc.**]
6. [**Pure Humidifier Company**]
7. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**Carel USA, LLC**]
3. [**DriSteem**]
4. [**Neptronic; National Environmental Products, Inc.**]
5. [**Nortec Industries Inc.**]
6. [**Pure Humidifier Company**]
7. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Humidification Rate: <**Insert lb/h (g/s)**>.
2. Dry-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
3. Wet-Bulb Air Temperature at Discharge: <**Insert deg F (deg C)**>.
4. Maximum Absorption Distance: <**Insert inches (mm)**>.
5. Minimum Makeup Water Supply Pressure: <**Insert psig (kPa)**>.
6. Gas-Fired Generator:

   a. Fuel Input: <**Insert Btu/h (kW)**>.
   b. Fuel Pressure: <**Insert inches wg (kPa)**>.

7. Steam Distribution Method - Atmospheric Distributer Tube:

   a. Number of Distributer Tubes: <**Insert number**>.

8. Steam Distribution Method - Atmospheric Panel Distribution Manifold:

   a. Number of Distribution Manifolds: <**Insert number**>.

9. Steam Distribution Method - Area Dispersion:

   a. Number of Distributer Tubes: <**Insert number**>.
   b. Fan Airflow: <**Insert cfm (L/s)**>.
   c. Fan Motor Horsepower: <**Insert HP (watts)**>.
   d. Fan Electrical Characteristics:

      1) Volts: <**Insert number**> V.
      2) Phase: [**Single**][**Three**]<**Insert value**> phase.
      3) Hertz: [**60**]<**Insert number**> Hz.
      4) Full-Load Amperes: <**Insert number**> A.
      5) Minimum Circuit Ampacity: <**Insert number**> A.
      6) Maximum Overcurrent Protection: <**Insert number**> A.

D. Water Type: Suitable for use with [**tap**][**softened**][**reverse osmosis**][**deionized**] water.

E. Burner and Heat Exchanger:

1. Description: Produces atmospheric steam.
2. Burner Type: [**Natural-gas**][**Propane**] fired with modulating, low-NOx infrared burner, minimum [**80**]<**Insert number**> percent efficient.
3. Gas Train: Safety shutoff valves, gas cock, strainer, and pressure-regulating valve.
4. Ignition: Hot-surface ignition with flame safety system.
5. Combustion Chamber: Sealed with outdoor-air and flue-vent connections.
6. Heat-Exchanger Tank: Cleanable, [**stainless steel**][**stainless steel, Type 304**][**stainless steel,**

Type 316] with corrosion-resistant coating.

F. Cabinet:

1. [**Painted-steel**][**,**][**Powder-coated-steel**][**,**][**Painted-aluminum**][**,**][**or**][**stainless-steel**] enclosure.[**Cabinet is factory insulated for safe operating surface temperature.**]
2. Enclosure houses internal components, controls, and control panel.
3. Hinged or removable cover, keyed to restrict unauthorized access.
4. Weatherproof outdoor enclosure, with automatically controlled heating and ventilating system to maintain minimum operating conditions within the enclosure.

G. Control Panel:

1. Microprocessor-based control system for [**modulating**][**cycling**] control.
2. Factory-wired disconnect switch.
3. Liquid-crystal display.
4. Programmable keypad.
5. Low-voltage control circuit.
6. Diagnostic, maintenance, alarm, and status features.
7. Internal electrical controls prewired to appropriately marked terminals for field connection.
8. Electrical terminals for connection to each controlling device and alarm.
9. NEMA 250, [**Type 3R**][**Type 4**][**Type 12**]<**Insert type**>, to comply with environmental conditions at installed location.
10. Building Automation System Interface:

    a. Full Communication System Interface: [**BACnet**]<**Insert interface type**>.
    b. [**Web-based remote factory online monitoring with same functionality as local keypad/display.**]

H. Controls:

1. Solenoid fill valve and automatic drain valves maintain water level. Include [**stainless-steel**][**bronze**] inlet strainer, [**stainless-steel**][**bronze**] solenoid valve with flow regulator, and fill tee with built-in air gap to prevent back siphoning.
2. Field-adjustable [**timer**][**conductivity controller**] to control drain/fill cycle for flush duration and interval.[**Automatic flush is not required for reverse osmosis or deionized water applications.**]
3. Controls shall drain tanks if no demand for humidification for more than 72 hours.
4. Set-point adjustment.
5. [**Tri-conductivity sensor probes**][**Float switches**] for water-level control and to shutdown heat exchanger upon low-water condition.
6. Over-temperature heater shutdown.
7. Aquastat maintains minimum water temperature in tank during short periods of no demand.
8. Thermal safety switch monitors stack temperature for shutdown on overheating.
9. Foaming detection and correction.

I. Area Dispersion Accessory: Stainless-steel tube with integral fan that discharges vapor directly into occupied space.

J. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

1. Material: [**Stainless steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
2. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

K. Atmospheric Panel Steam Distribution Manifold:

1. Prefabricated steam dispersion grid assembly.
2. Designed for short absorption distance.
3. Suitable for atmospheric steam applications.
4. Extending the full width and height of duct or plenum.
5. [**Horizontal**][**or**][**vertical**] header with multiple [**vertical**][**or**][**horizontal**] tubes designed for dry steam injection within short absorption distance.
6. Nozzles/metered orifices, spaced evenly along distribution tubes, and provide dry and uniform steam distribution.
7. Distribution panel extending the full width and height of duct or plenum.
8. Headers and Distribution Tubes:

   a. Material: [**Stainless steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
   b. Insulation: [**Uninsulated**][**Insulated**][**Insulated, minimum R-0.5**].

9. Steam Separator: Separators/baffles, integral to the header, provide condensate-free steam to distribution tubes.

L. Accessories:

1. [**Humidistat**][**Humidity Sensor**]: [**Wall**][**Return-duct**] mounted.
2. Duct-mounted, high-limit [**humidistat**][**humidity sensor**].
3. Airflow switch prevents humidifier operation without airflow.
4. Steam and Condensate Hoses: For interconnection of humidifier to distributer tube(s)/manifold.

2.5 CONDENSATE DRAIN COOLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Neptronic; National Environmental Products, Inc.**]
4. [**Nortec Industries Inc.**]
5. [**Pure Humidifier Company**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong International, Inc**]
2. [**DriSteem**]
3. [**Neptronic; National Environmental Products, Inc.**]
4. [**Nortec Industries Inc.**]
5. [**Pure Humidifier Company**]
6. <**Insert manufacturer's name**>

C. Capacities and Characteristics:

1. Hot Condensate in: <**Insert gpm (L/s)**>.
2. Hot Condensate Temperature: <**Insert deg F (deg C)**>.
3. Cold Water in <**Insert gpm (L/s)**>.
4. Cold Water Temperature: <**Insert de F (deg C)**>.

5. Tempered Water out <**Insert gpm (L/s)**>.
6. Tempered Water Temperature: <**Insert deg F (deg C)**>.

D. Description: Mixes hot condensate with a cold water supply to reduce the drain temperature as required by state and local codes.

E. Cold Water Tempering Valve: Bronze body, [**thermostatic self-actuated with aquastat**][**24 VAC electric-actuated with temperature sensor**].

F. Drain Temperature Set-Point Range: Field adjustable between **115 deg F (46 deg C)** and **140 deg F (60 deg C)**. Drain sensor to control cold water tempering valve to limit drain discharge temperature to set point.

G. Reservoir Body Material: [**Stainless steel**][**Cast iron or carbon steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].

H. Mounting: Suitable for [**wall**][**floor**][**suspended**] mounting.

I. Vacuum breaker or air vent connection.

J. Condensate drain cooler built into the humidifier cabinet and offered as the humidifier manufacturer's standard product is acceptable in lieu of a separate product by the listed manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance.[**Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.**]

B. Seal all duct and plenum penetrations with flange.

C. Install humidifier assemblies in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install [**galvanized**][**stainless**]-steel drain pan under each manifold mounted in duct.

1. Construct drain pans with connection for drain; insulated[**and complying with ASHRAE 62.1**].
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from tube(s)/manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.

E. Install tube(s)/manifold supply piping pitched to drain condensate back to humidifier or as recommended by manufacturer.

F. Equipment Mounting:

1. Install floor-mounted humidifiers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. Install gas-fired steam generators according to NFPA 54.

H. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest floor drain.

D. Connect gas piping full size to steam-generator, gas-train inlet with union. Gas piping materials and specialties are specified in [**Section 231123 "Facility Natural-Gas Piping."**][**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**]

E. Connect breeching full size to steam-generator outlet. Venting materials are specified in Section 235123 "Gas Vents."

F. Connect combustion-air inlet to intake terminal using PVC piping with solvent-cemented joints. Run from boiler connection to outside and terminate adjacent to flue termination.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring according to Section 260523 "Control Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service agent**]:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Humidifier will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 84 13 29

SECTION 23 84 16 16 - INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, mechanical dehumidification units.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Product Data: Showing compliance with ASHRAE 62.1.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For insulation, indicating compliance with the VOC emissions evaluation.
5. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
6. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
7. Product Data: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

C. Shop Drawings: For each indoor, mechanical dehumidification unit.

1. Include plans, elevations, sections and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of dehumidification units.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For indoor, mechanical dehumidification units.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to

structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for indoor, mechanical dehumidification units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each indoor, mechanical dehumidification unit, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) of each type of filter specified.
2. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-drive fan.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indoor, mechanical dehumidification units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**two**][**five**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Seismic Performance: Dehumidification units are to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

E. ASHRAE 15 Compliance: "Safety Standard for Refrigeration Systems."

F. Capacities and Characteristics:

1. Airflow through Unit:

a. Supply Air: <**Insert cfm (L/s)**>.
b. Outside Air: <**Insert cfm (L/s)**>.
c. Exhaust/Return Air: <**Insert cfm (L/s)**>.

2. Supply Fan:

a. Speed: <**Insert number**> rpm.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Motor Size: <**Insert number**> hp.

3. Exhaust and Return Fan:

a. External Static Pressure: <**Insert inches wg (kPa)**>.
b. Speed: <**Insert number**> rpm.
c. Motor Size: <**Insert number**> hp.

4. Refrigeration System:

    a. Sensible Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    b. Total Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    c. Energy-Efficiency Ratio: <**Insert number**>.
    d. Dehumidification Capacity: <**Insert lb of water/h (kg/h)**>.
    e. Evaporator Coil Conditions:

        1) Entering-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
        2) Entering-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
        3) Entering-Air, Dew-Point Temperature: <**Insert deg F (deg C)**>.
        4) Leaving-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
        5) Leaving-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
        6) Leaving-Air, Dew-Point Temperature: <**Insert deg F (deg C)**>.

5. Energy Recovery Heat Exchanger (Pool Heater):

    a. Water Flow Rate: <**Insert gpm (L/s)**>.
    b. Water Pressure Loss: <**Insert feet of head (kPa)**>.
    c. Entering-Water Temperature: <**Insert deg F (deg C)**>.
    d. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

6. Filters:

    a. Thickness or Depth: <**Insert inches (mm)**>.

7. Hydronic Heating Coil:

    a. Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
    c. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
    d. Water:

        1) Water Flow: <**Insert gpm (L/s)**>.
        2) Maximum Water Pressure Drop: <**Insert feet of head (kPa)**>.
        3) Entering-Water Temperature: <**Insert deg F (deg C)**>.
        4) Leaving-Water Temperature: <**Insert deg F (deg C)**>.

8. Steam Heating Coil:

    a. Steam Flow: <**Insert lb/h (g/s)**>.
    b. Inlet Steam Pressure: <**Insert psig (kPa)**>.

9. Electric Heating Coil:

    a. kW: <**Insert number**> kW.
    b. Volts: [**120**][**208**][**230**]<**Insert number**> V ac.
    c. Phase: [**Single**][**Three**] Ph.
    d. Hertz: [**60**]<**Insert number**> Hz.
    e. Full-Load Amperes: <**Insert number**> A.
    f. Number of Steps: <**Insert number**>.

10. Electrical Characteristics:

    a. Volts: [**120**][**208**][**230**]<**Insert number**> V ac.

b. Phase: [**Single**][**Three**] phase.
c. Hertz: [**60**]<**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A.
f. Maximum Overcurrent Protection: <**Insert number**> A.

2.2 INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dectron Internationale**]
2. [**Dehumidifier Corporation of America**]
3. [**Desert Aire**]
4. [**DryAire Systems**]
5. [**MSP Technology, LLC**]
6. [**PoolPak Technologies Corporation**]
7. [**Thermoplus Air Inc**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dectron Internationale**]
2. [**Dehumidifier Corporation of America**]
3. [**Desert Aire**]
4. [**DryAire Systems**]
5. [**MSP Technology, LLC**]
6. [**PoolPak Technologies Corporation**]
7. [**Thermoplus Air Inc**]
8. <**Insert manufacturer's name**>

C. Casings:

1. Casing: [**Single**][**Double**]-wall construction with [**interior corrosion-resistant coating and**] exterior [**baked-enamel**][**powder-coated**] steel or aluminum, stainless steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.

   a. Access: [**Removable panels**][**Hinged access doors**] with neoprene compression gaskets and cam latches.
   b. Insulation: Minimum **2-inch- (50-mm-)** thick, glass-fiber-insulation fill or closed cell foam, with thermal breaks.
   c. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.

2. Drain Pan and Connection: [**Stainless steel**]<**Insert material**>; insulated[**and complying with ASHRAE 62.1**].

D. Fans:

1. Supply Fans:

   a. Blades: [**Forward curved**][**Backward inclined**].
   b. Type: [**Housed**][**Unhoused plenum type**], centrifugal.

c. Blade and Housing Material: Galvanized steel with [**baked-enamel**][**powder-coated**] finish.
d. Drive: [**Direct-driven with keyed motor shaft**][**Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit**].

2. Exhaust and Return Fans:

a. Blades: [**Forward curved**][**Backward inclined**].
b. Type: [**Housed**][**Unhoused plenum type**], centrifugal.
c. Blade and Housing Material: Galvanized steel with [**baked-enamel**][**powder-coated**] finish.
d. Drive: [**Direct-driven with keyed motor shaft**][**Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit**].

3. Fan Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Enclosure Type: Totally enclosed, fan cooled.

4. Variable-frequency motor controller complies with Section 262923 "Variable-Frequency Motor Controllers."
5. Variable-Frequency Motor Controller:

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**]<**Insert application**> for [**Design A and Design B motors**][**inverter-duty motors**].
b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.
c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
d) Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interfaces: [**Electric**][**Pneumatic**].
7) Proportional-integral-derivative control interface.
8) DDC system for HVAC Protocols for Network Communications: [**ASHRAE 135**]<**Insert protocol type**>.

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**].
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors[**and isolating switch**].
b) Three-contactor style, with bypass and input and output isolating contactors[**and isolating switch**].

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

E. Filters:

1. Pleated:

a. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**][**Manufacturer's standard depth**].
b. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

F. Refrigeration System:

1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.
2. Refrigerant Coils with Multiple Refrigerant Circuits:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized-steel**][**Stainless steel**]<**Insert material**> frame.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
h. Source Quality Control: Factory test to minimum **450-psig (3105-kPa)** internal pressure and to minimum **300-psig (2070-kPa)** internal pressure while underwater.

3. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

    a. Minimum Number of Refrigerant Circuits: Two for compressor capacities of more than **7-1/2 tons (26.4 kW)**.
    b. Refrigerant: [**R-134a**][**R-407C**][**R-410A**][**R-134a, R-407C, or R-401A**].
    c. Capacity Control:

        1) Hot-gas bypass valve and piping on one compressor.
        2) Cycle compressor.

    d. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
    e. High-Pressure Cutout: Manual reset.
    f. Compressor Motor Overload Protection: Manual reset.
    g. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
    h. Defrost Cycle: Adjustable timer shuts off supply fan. Compressor cycles until suction-line temperature confirms thawed evaporator coil.[**Timer limits defrost time to 10 minutes.**]
    i. <**Insert additional control features**>.

4. Energy Recovery Heat Exchanger (Pool Heater): Cupronickel, coaxial, vented, double-wall construction for potable-water service.

G. Remote-Mounted, Air-Cooled Condenser Unit:

1. Casing: Steel, [**baked-enamel**]<**Insert finish type**> finish; with access doors or removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Refrigerant Coil:

    a. Copper tube with mechanically bonded aluminum fins; with liquid subcooler.
    b. Coating: [**None**][**Corrosion-resistant coating**].

3. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.
4. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as **0 deg F (minus 18 deg C)** by cycling condenser fans and controlling speed of last fan of each circuit.
5. Mounting Base: [**Same material as unit base**]<**Insert material**>.

H. Heating Coils:

1. Hot-Water Coil: Continuous circuit coil.

    a. Tubes: [**Copper**]<**Insert material**>.
    b. Fins:

        1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
        2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

    c. Fin and Tube Joints: Mechanical bond.
    d. Headers: [**Cast iron**]<**Insert material**> with drain and air vent tappings.
    e. Frames: [**Galvanized-steel channel, minimum 0.052 inch (1.3 mm)**]<**Insert material**>.
    f. Coatings: [**None**][**Corrosion-resistant coating**].
    g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working-Pressure Ratings: Minimum **200 psig (1380 kPa)**, **325 deg F (163 deg C)**.

h. Source Quality Control: Test to minimum **300 psig (2070 kPa)** internal pressure.

2. Steam Coil: Distribution header coil fabricated according to AHRI 410, with threaded steam supply and condensate connections.

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Cast iron**]<**Insert material**> with drain and air vent tappings.
e. Frames: [**Galvanized-steel channel, minimum 0.052 inch (1.3 mm)**]<**Insert material**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working-Pressure Ratings: Minimum **100 psig (690 kPa)**, **400 deg F (205 deg C)**.

h. Source Quality Control: Test to **200-psig (1380-kPa)**.

3. Electric-Resistance Heating Coil: Comply with UL 1995.

a. Heating Element:

1) Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated steel fins continuously brazed to sheath.
2) Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.

b. Coatings: [**None**][**Corrosion-resistant coating**].
c. Overtemperature Protection: Disk-type, automatic-reset, thermal-cutout safety device; serviceable through terminal box without removing heater from unit.
d. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.
e. Control: Disconnecting means, overcurrent protection, and airflow proving switch.

I. Dampers:

1. Outdoor-Air Dampers: Opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers with [**zinc-plated-steel**]<**Insert material**> operating rod rotating in sintered bronze or nylon bearings. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod. Size for 0 to 25 percent outdoor air, with [**manual**][**motorized**] operator and filter.
2. Face-and-Bypass Dampers: Opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated-steel**]<**Insert material**> operating rods rotating in sintered bronze or nylon bearings with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
3. Standard Duty Dampers: [**Outdoor and return air**][**Outdoor, return, and exhaust air**].

a. Parallel-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers.

b. Mechanically fastened to [**zinc-plated-steel**]<**Insert material**> operating rod in reinforced cabinet.
c. Connect operating rods with common linkage and interconnect linkages, so dampers operate simultaneously.

4. Low-Leakage Dampers: [**Outdoor and return air**][**Outdoor, return, and exhaust air**].

a. Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers.
b. Compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement.
c. [**Zinc-plated-steel**]<**Insert material**> operating rods rotating in [**stainless steel sleeve**][**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> frame.
d. Operating rods connected with a common linkage.
e. Leakage rate is not to exceed **5 cfm/sq. ft. (0.22 L/s per sq. m)** at **1-inch wg (250 Pa)** and **9 cfm/sq. ft. (0.4 L/s per sq. m)** at **4-inch wg (1.0 MPa)**.

5. Damper Operator: [**115**][**24**] V ac, close coupled, with gear train sealed in oil and with spring return.

J. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and in Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
3. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms.
4. Operating Control, Ice Rinks: Space humidistat cycles the compressor. Humidistat is to incorporate fan on-off-auto switch.
5. Operating Control, Indoor Pool Units: Factory-installed microprocessor controller, capable of being remotely mounted.

a. Display the following on the face of controller:

1) System on.
2) System dehumidifying mode.
3) System air-conditioning mode.
4) System outdoor-air (economizer) mode.
5) System heating pool water.
6) Auxiliary space heat is operating.
7) Unit requires service.
8) Return-air (space) temperature.
9) Return-air (space) humidity.
10) Pool-water temperature.
11) Outdoor-air temperature.

b. Indicate the following sensor failures on panel:

1) Airflow: Dirty air filter, blocked airflow, and fan failure.
2) Refrigerant high and low pressure.
3) High water temperature.

4) High and low evaporator temperature.
5) Low water flow.
6) Communication fault.
7) System off.
8) Antishort cycle delay.
9) Power failure.

c. Provide access to the following set points on panel:

1) Space temperature.
2) Space relative humidity.
3) Outdoor ventilation/air-conditioning changeover temperature.
4) Airflow alarm.

d. Provide the following displays on panel:

1) Space temperature.
2) Space relative humidity.
3) Outdoor-air temperature.
4) Supply-air temperature.
5) Return-air temperature.
6) Airflow rating.
7) Air-off evaporator temperature.
8) Return-air relative humidity.
9) Service codes.

e. Provide the following controls on panel:

1) System on-off, fan continues to run.
2) Fan on-off.
3) Service code access.
4) System dehumidifying mode.
5) System air-conditioning mode.
6) System outdoor-air (economizer) mode.
7) Auxiliary space heat is operating.
8) Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
9) Outdoor enthalpy digital display.
10) Filter pressure drop digital display.
11) Status: Airflow, fans, system, unit operation, and operating mode.
12) Alarm digital display.

6. Operating Control, Factory-Installed Microprocessor Controller:

a. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.
b. Integral clock.
c. Personal computer interface.
d. Integral LAN for direct connection to [**BACnet**][**LonWorks**][**MODBUS**]<**Insert other communication protocol**>.
e. Factory programmed.
f. Unit-Mounted Sensors:

1) Airflow switch.
2) Compressor-discharge temperature.
3) Evaporator-air temperature.

4) Pool-water-out temperature.
5) Pool-water-in temperature.
6) Relative humidity.
7) Return-air temperature.
8) Supply-air temperature.

g. Integral diagnostics.
h. Nonvolatile memory.
i. IP or SI display.
j. Provide the following status and alarm functions:

1) System: On-off.
2) Power failure.
3) Fan: Off, overload.
4) Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
5) Evaporator damper closed.
6) Pool: Low water flow, heating on.
7) Dehumidification: Call for, on.
8) Air Conditioning: Call for, on.
9) System outdoor-air (economizer) mode.
10) Auxiliary space heat on.
11) Alarms: Firestat, freezestat, and filters.

k. Provide the following controls via operator panel:

1) Compressor auto-off.
2) Fan auto-off.
3) Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
4) Sensor calibration.

K. Accessories:

1. Water-Cooling Heat Exchanger: Coaxial, vented, double-wall construction; with three-way refrigerant control valve.
2. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

a. Operating Voltage: 24 V dc, nominal.
b. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
c. Plug-in Arrangement: Detector and associated electronic components mounted in module with tamper-resistant connection to fixed base with twist-locking plug. Terminals in fixed base accept building wiring.
d. Integral Visual-Indicating Light: Digital-display type indicating detector operation.
e. Sensitivity can be tested and adjusted in-place after installation.
f. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire-alarm control panel.
g. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
h. Detector Sensitivity: Between **2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm)** of smoke obscuration when tested according to UL 268A.
i. Integral Thermal Detector: Fixed-temperature type with **135 deg F (57 deg C)** setting.

3. Electrical Convenience Outlet: 115 V ac fused, duplex, straight-blade receptacles, separately fused and located inside control panel.

2.3 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3,000**]<**Insert time**>-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in./lb (11.3 N/m)**.
c. ASTM B3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert measurement**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Factory test and rate dehumidification units according to AHRI 910.

B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to AHRI 575.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**hot-water**][**steam**][**refrigerant**] piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

A. Equipment Mounting:

1. Install dehumidification units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.

B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

C. Connect condensate drain pans using minimum **NPS 1-1/4 (DN 32)** copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

E. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect to supply coil tappings with shutoff valve, return coil tappings with balancing valve, and union or flange at each connection.

F. Steam and Condensate Piping: Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Heating Piping Specialties." Connect with shutoff valve and union or flange.

G. Duct installation requirements are specified in [**Section 233113 "Metal Ducts."**][**Section 233113 "Nonmetal Ducts.**][**Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."**] Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure, and insulate the space between roof and bottom of dehumidification unit.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553

"Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.
3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

D. Connect smoke detector to fire alarm system.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Dehumidification unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.

B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust initial temperature and humidity set points.

3.9 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform the following final checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Check lubrication of bearings, pulleys, belts, and other moving parts.
6. Set outside- and return-air mixing dampers to minimum outside-air setting.
7. Install clean filters.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for dehumidification units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
2. Measure and record motor's electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing of dehumidification unit.

E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

END OF SECTION 23 84 16 16

SECTION 23841616 - INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, mechanical dehumidification units.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Product Data: Showing compliance with ASHRAE 62.1.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For insulation, indicating compliance with the VOC emissions evaluation.
5. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
6. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
7. Product Data: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.

C. Shop Drawings: For each indoor, mechanical dehumidification unit.

1. Include plans, elevations, sections and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of dehumidification units.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For indoor, mechanical dehumidification units.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to

structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for indoor, mechanical dehumidification units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each indoor, mechanical dehumidification unit, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: [**One**]<**Insert number**> set(s) of each type of filter specified.
2. Fan Belts: [**One**]<**Insert number**> set(s) for each belt-drive fan.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indoor, mechanical dehumidification units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [**two**][**five**]<**Insert number**> years from date of Substantial Completion.
2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than [**five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Seismic Performance: Dehumidification units are to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

E. ASHRAE 15 Compliance: "Safety Standard for Refrigeration Systems."

F. Capacities and Characteristics:

1. Airflow through Unit:

a. Supply Air: <**Insert cfm (L/s)**>.
b. Outside Air: <**Insert cfm (L/s)**>.
c. Exhaust/Return Air: <**Insert cfm (L/s)**>.

2. Supply Fan:

a. Speed: <**Insert number**> rpm.
b. External Static Pressure: <**Insert inches wg (kPa)**>.
c. Motor Size: <**Insert number**> hp.

3. Exhaust and Return Fan:

a. External Static Pressure: <**Insert inches wg (kPa)**>.
b. Speed: <**Insert number**> rpm.
c. Motor Size: <**Insert number**> hp.

4. Refrigeration System:

    a. Sensible Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    b. Total Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    c. Energy-Efficiency Ratio: <**Insert number**>.
    d. Dehumidification Capacity: <**Insert lb of water/h (kg/h)**>.
    e. Evaporator Coil Conditions:

        1) Entering-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
        2) Entering-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
        3) Entering-Air, Dew-Point Temperature: <**Insert deg F (deg C)**>.
        4) Leaving-Air, Dry-Bulb Temperature: <**Insert deg F (deg C)**>.
        5) Leaving-Air, Wet-Bulb Temperature: <**Insert deg F (deg C)**>.
        6) Leaving-Air, Dew-Point Temperature: <**Insert deg F (deg C)**>.

5. Energy Recovery Heat Exchanger (Pool Heater):

    a. Water Flow Rate: <**Insert gpm (L/s)**>.
    b. Water Pressure Loss: <**Insert feet of head (kPa)**>.
    c. Entering-Water Temperature: <**Insert deg F (deg C)**>.
    d. Leaving-Water Temperature: <**Insert deg F (deg C)**>.

6. Filters:

    a. Thickness or Depth: <**Insert inches (mm)**>.

7. Hydronic Heating Coil:

    a. Heat-Transfer Rate: <**Insert Btu/h (kW)**>.
    b. Entering-Air Temperature: <**Insert deg F (deg C)**>.
    c. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
    d. Water:

        1) Water Flow: <**Insert gpm (L/s)**>.
        2) Maximum Water Pressure Drop: <**Insert feet of head (kPa)**>.
        3) Entering-Water Temperature: <**Insert deg F (deg C)**>.
        4) Leaving-Water Temperature: <**Insert deg F (deg C)**>.

8. Steam Heating Coil:

    a. Steam Flow: <**Insert lb/h (g/s)**>.
    b. Inlet Steam Pressure: <**Insert psig (kPa)**>.

9. Electric Heating Coil:

    a. kW: <**Insert number**> kW.
    b. Volts: [**120**][**208**][**230**]<**Insert number**> V ac.
    c. Phase: [**Single**][**Three**] Ph.
    d. Hertz: [**60**]<**Insert number**> Hz.
    e. Full-Load Amperes: <**Insert number**> A.
    f. Number of Steps: <**Insert number**>.

10. Electrical Characteristics:

    a. Volts: [**120**][**208**][**230**]<**Insert number**> V ac.

b. Phase: [**Single**][**Three**] phase.
c. Hertz: [**60**]<**Insert number**> Hz.
d. Full-Load Amperes: <**Insert number**> A.
e. Minimum Circuit Ampacity: <**Insert number**> A.
f. Maximum Overcurrent Protection: <**Insert number**> A.

2.2 INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dectron Internationale**]
2. [**Dehumidifier Corporation of America**]
3. [**Desert Aire**]
4. [**DryAire Systems**]
5. [**MSP Technology, LLC**]
6. [**PoolPak Technologies Corporation**]
7. [**Thermoplus Air Inc**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dectron Internationale**]
2. [**Dehumidifier Corporation of America**]
3. [**Desert Aire**]
4. [**DryAire Systems**]
5. [**MSP Technology, LLC**]
6. [**PoolPak Technologies Corporation**]
7. [**Thermoplus Air Inc**]
8. <**Insert manufacturer's name**>

C. Casings:

1. Casing: [**Single**][**Double**]-wall construction with [**interior corrosion-resistant coating and**] exterior [**baked-enamel**][**powder-coated**] steel or aluminum, stainless steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.

   a. Access: [**Removable panels**][**Hinged access doors**] with neoprene compression gaskets and cam latches.
   b. Insulation: Minimum **2-inch- (50-mm-)** thick, glass-fiber-insulation fill or closed cell foam, with thermal breaks.
   c. Airstream Surfaces: Surfaces in contact with the airstream are to comply with requirements in ASHRAE 62.1.

2. Drain Pan and Connection: [**Stainless steel**]<**Insert material**>; insulated[**and complying with ASHRAE 62.1**].

D. Fans:

1. Supply Fans:

   a. Blades: [**Forward curved**][**Backward inclined**].
   b. Type: [**Housed**][**Unhoused plenum type**], centrifugal.

c. Blade and Housing Material: Galvanized steel with [**baked-enamel**][**powder-coated**] finish.
d. Drive: [**Direct-driven with keyed motor shaft**][**Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit**].

2. Exhaust and Return Fans:

a. Blades: [**Forward curved**][**Backward inclined**].
b. Type: [**Housed**][**Unhoused plenum type**], centrifugal.
c. Blade and Housing Material: Galvanized steel with [**baked-enamel**][**powder-coated**] finish.
d. Drive: [**Direct-driven with keyed motor shaft**][**Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit**].

3. Fan Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

a. Enclosure Type: Totally enclosed, fan cooled.

4. Variable-frequency motor controller complies with Section 262923 "Variable-Frequency Motor Controllers."
5. Variable-Frequency Motor Controller:

a. Manufactured Units: Pulse-width modulated; [**constant torque**][**and**][**variable torque**]<**Insert application**> for [**Design A and Design B motors**][**inverter-duty motors**].
b. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.
c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
d) Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interfaces: [**Electric**][**Pneumatic**].
7) Proportional-integral-derivative control interface.
8) DDC system for HVAC Protocols for Network Communications: [**ASHRAE 135**]<**Insert protocol type**>.

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

e. Bypass Systems:

1) Bypass Mode: [**Manual operation only**][**Field-selectable automatic or manual**].
2) Bypass Controller:

a) Two-contactor style, with bypass and output isolating contactors[**and isolating switch**].
b) Three-contactor style, with bypass and input and output isolating contactors[**and isolating switch**].

3) Bypass Contactor Configuration: [**Full-voltage (across the line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

E. Filters:

1. Pleated:

a. Thickness: [**1 inch (25 mm)**][**2 inches (50 mm)**][**4 inches (100 mm)**][**Manufacturer's standard depth**].
b. MERV Rating: [**MERV 6**][**MERV 13**]<**Insert value**>, according to ASHRAE 52.2.

F. Refrigeration System:

1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.
2. Refrigerant Coils with Multiple Refrigerant Circuits:

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Seamless-copper headers with brazed connections**]<**Insert material and connections**>.
e. Frames: [**Galvanized-steel**][**Stainless steel**]<**Insert material**> frame.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
h. Source Quality Control: Factory test to minimum **450-psig (3105-kPa)** internal pressure and to minimum **300-psig (2070-kPa)** internal pressure while underwater.

3. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

    a. Minimum Number of Refrigerant Circuits: Two for compressor capacities of more than **7-1/2 tons (26.4 kW)**.
    b. Refrigerant: [**R-134a**][**R-407C**][**R-410A**][**R-134a, R-407C, or R-401A**].
    c. Capacity Control:

        1) Hot-gas bypass valve and piping on one compressor.
        2) Cycle compressor.

    d. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
    e. High-Pressure Cutout: Manual reset.
    f. Compressor Motor Overload Protection: Manual reset.
    g. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
    h. Defrost Cycle: Adjustable timer shuts off supply fan. Compressor cycles until suction-line temperature confirms thawed evaporator coil.[**Timer limits defrost time to 10 minutes.**]
    i. <**Insert additional control features**>.

4. Energy Recovery Heat Exchanger (Pool Heater): Cupronickel, coaxial, vented, double-wall construction for potable-water service.

G. Remote-Mounted, Air-Cooled Condenser Unit:

1. Casing: Steel, [**baked-enamel**]<**Insert finish type**> finish; with access doors or removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Refrigerant Coil:

    a. Copper tube with mechanically bonded aluminum fins; with liquid subcooler.
    b. Coating: [**None**][**Corrosion-resistant coating**].

3. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.
4. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as **0 deg F (minus 18 deg C)** by cycling condenser fans and controlling speed of last fan of each circuit.
5. Mounting Base: [**Same material as unit base**]<**Insert material**>.

H. Heating Coils:

1. Hot-Water Coil: Continuous circuit coil.

    a. Tubes: [**Copper**]<**Insert material**>.
    b. Fins:

        1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
        2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

    c. Fin and Tube Joints: Mechanical bond.
    d. Headers: [**Cast iron**]<**Insert material**> with drain and air vent tappings.
    e. Frames: [**Galvanized-steel channel, minimum 0.052 inch (1.3 mm)**]<**Insert material**>.
    f. Coatings: [**None**][**Corrosion-resistant coating**].
    g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working-Pressure Ratings: Minimum **200 psig (1380 kPa)**, **325 deg F (163 deg C)**.

h. Source Quality Control: Test to minimum **300 psig (2070 kPa)** internal pressure.

2. Steam Coil: Distribution header coil fabricated according to AHRI 410, with threaded steam supply and condensate connections.

a. Tubes: [**Copper**]<**Insert material**>.
b. Fins:

1) Material: [**Aluminum**][**Copper**]<**Insert material**>.
2) Fin Spacing: Maximum [**12**][**10**][**8**]<**Insert number**> fins per **inch (mm)**.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: [**Cast iron**]<**Insert material**> with drain and air vent tappings.
e. Frames: [**Galvanized-steel channel, minimum 0.052 inch (1.3 mm)**]<**Insert material**>.
f. Coatings: [**None**][**Corrosion-resistant coating**].
g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working-Pressure Ratings: Minimum **100 psig (690 kPa)**, **400 deg F (205 deg C)**.

h. Source Quality Control: Test to **200-psig (1380-kPa)**.

3. Electric-Resistance Heating Coil: Comply with UL 1995.

a. Heating Element:

1) Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated steel fins continuously brazed to sheath.
2) Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.

b. Coatings: [**None**][**Corrosion-resistant coating**].
c. Overtemperature Protection: Disk-type, automatic-reset, thermal-cutout safety device; serviceable through terminal box without removing heater from unit.
d. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.
e. Control: Disconnecting means, overcurrent protection, and airflow proving switch.

I. Dampers:

1. Outdoor-Air Dampers: Opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers with [**zinc-plated-steel**]<**Insert material**> operating rod rotating in sintered bronze or nylon bearings. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod. Size for 0 to 25 percent outdoor air, with [**manual**][**motorized**] operator and filter.
2. Face-and-Bypass Dampers: Opposed-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**] dampers with [**zinc-plated-steel**]<**Insert material**> operating rods rotating in sintered bronze or nylon bearings with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
3. Standard Duty Dampers: [**Outdoor and return air**][**Outdoor, return, and exhaust air**].

a. Parallel-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers.

b. Mechanically fastened to [**zinc-plated-steel**]<**Insert material**> operating rod in reinforced cabinet.
c. Connect operating rods with common linkage and interconnect linkages, so dampers operate simultaneously.

4. Low-Leakage Dampers: [**Outdoor and return air**][**Outdoor, return, and exhaust air**].

a. Low-leakage, double-skin, airfoil-blade, [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> dampers.
b. Compressible jamb seals and extruded-vinyl blade edge seals in [**opposed**][**parallel**]-blade arrangement.
c. [**Zinc-plated-steel**]<**Insert material**> operating rods rotating in [**stainless steel sleeve**][**sintered bronze or nylon**]<**Insert material**> bearings mounted in a single [**galvanized-steel**][**aluminum**][**extruded-aluminum**]<**Insert material**> frame.
d. Operating rods connected with a common linkage.
e. Leakage rate is not to exceed **5 cfm/sq. ft. (0.22 L/s per sq. m)** at **1-inch wg (250 Pa)** and **9 cfm/sq. ft. (0.4 L/s per sq. m)** at **4-inch wg (1.0 MPa)**.

5. Damper Operator: [**115**][**24**] V ac, close coupled, with gear train sealed in oil and with spring return.

J. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and in Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
3. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms.
4. Operating Control, Ice Rinks: Space humidistat cycles the compressor. Humidistat is to incorporate fan on-off-auto switch.
5. Operating Control, Indoor Pool Units: Factory-installed microprocessor controller, capable of being remotely mounted.

a. Display the following on the face of controller:

1) System on.
2) System dehumidifying mode.
3) System air-conditioning mode.
4) System outdoor-air (economizer) mode.
5) System heating pool water.
6) Auxiliary space heat is operating.
7) Unit requires service.
8) Return-air (space) temperature.
9) Return-air (space) humidity.
10) Pool-water temperature.
11) Outdoor-air temperature.

b. Indicate the following sensor failures on panel:

1) Airflow: Dirty air filter, blocked airflow, and fan failure.
2) Refrigerant high and low pressure.
3) High water temperature.

4) High and low evaporator temperature.
5) Low water flow.
6) Communication fault.
7) System off.
8) Antishort cycle delay.
9) Power failure.

c. Provide access to the following set points on panel:

1) Space temperature.
2) Space relative humidity.
3) Outdoor ventilation/air-conditioning changeover temperature.
4) Airflow alarm.

d. Provide the following displays on panel:

1) Space temperature.
2) Space relative humidity.
3) Outdoor-air temperature.
4) Supply-air temperature.
5) Return-air temperature.
6) Airflow rating.
7) Air-off evaporator temperature.
8) Return-air relative humidity.
9) Service codes.

e. Provide the following controls on panel:

1) System on-off, fan continues to run.
2) Fan on-off.
3) Service code access.
4) System dehumidifying mode.
5) System air-conditioning mode.
6) System outdoor-air (economizer) mode.
7) Auxiliary space heat is operating.
8) Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
9) Outdoor enthalpy digital display.
10) Filter pressure drop digital display.
11) Status: Airflow, fans, system, unit operation, and operating mode.
12) Alarm digital display.

6. Operating Control, Factory-Installed Microprocessor Controller:

a. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.
b. Integral clock.
c. Personal computer interface.
d. Integral LAN for direct connection to [**BACnet**][**LonWorks**][**MODBUS**]<**Insert other communication protocol**>.
e. Factory programmed.
f. Unit-Mounted Sensors:

1) Airflow switch.
2) Compressor-discharge temperature.
3) Evaporator-air temperature.

4) Pool-water-out temperature.
5) Pool-water-in temperature.
6) Relative humidity.
7) Return-air temperature.
8) Supply-air temperature.

g. Integral diagnostics.
h. Nonvolatile memory.
i. IP or SI display.
j. Provide the following status and alarm functions:

1) System: On-off.
2) Power failure.
3) Fan: Off, overload.
4) Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
5) Evaporator damper closed.
6) Pool: Low water flow, heating on.
7) Dehumidification: Call for, on.
8) Air Conditioning: Call for, on.
9) System outdoor-air (economizer) mode.
10) Auxiliary space heat on.
11) Alarms: Firestat, freezestat, and filters.

k. Provide the following controls via operator panel:

1) Compressor auto-off.
2) Fan auto-off.
3) Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
4) Sensor calibration.

K. Accessories:

1. Water-Cooling Heat Exchanger: Coaxial, vented, double-wall construction; with three-way refrigerant control valve.
2. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

a. Operating Voltage: 24 V dc, nominal.
b. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
c. Plug-in Arrangement: Detector and associated electronic components mounted in module with tamper-resistant connection to fixed base with twist-locking plug. Terminals in fixed base accept building wiring.
d. Integral Visual-Indicating Light: Digital-display type indicating detector operation.
e. Sensitivity can be tested and adjusted in-place after installation.
f. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire-alarm control panel.
g. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
h. Detector Sensitivity: Between **2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm)** of smoke obscuration when tested according to UL 268A.
i. Integral Thermal Detector: Fixed-temperature type with **135 deg F (57 deg C)** setting.

3. Electrical Convenience Outlet: 115 V ac fused, duplex, straight-blade receptacles, separately fused and located inside control panel.

2.3 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3,000**]<**Insert time**>-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of **100 in./lb (11.3 N/m)**.
c. ASTM B3359 for cross hatch adhesion of 5B.

2. Application: [**Immersion**][**Spray**].
3. Thickness: [**1 mil (0.025 mm)**]<**Insert measurement**>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Factory test and rate dehumidification units according to AHRI 910.

B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to AHRI 575.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**hot-water**][**steam**][**refrigerant**] piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF INDOOR, MECHANICAL DEHUMIDIFICATION UNITS

A. Equipment Mounting:

1. Install dehumidification units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.

B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

C. Connect condensate drain pans using minimum **NPS 1-1/4 (DN 32)** copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

E. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect to supply coil tappings with shutoff valve, return coil tappings with balancing valve, and union or flange at each connection.

F. Steam and Condensate Piping: Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Heating Piping Specialties." Connect with shutoff valve and union or flange.

G. Duct installation requirements are specified in [**Section 233113 "Metal Ducts."**][**Section 233113 "Nonmetal Ducts.**][**Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."**] Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure, and insulate the space between roof and bottom of dehumidification unit.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553

"Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.
3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

D. Connect smoke detector to fire alarm system.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Dehumidification unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.

B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust initial temperature and humidity set points.

3.9 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform the following final checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Check lubrication of bearings, pulleys, belts, and other moving parts.
6. Set outside- and return-air mixing dampers to minimum outside-air setting.
7. Install clean filters.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for dehumidification units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
2. Measure and record motor's electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing of dehumidification unit.

E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

END OF SECTION 23841616

Task	Specification	Specification Description
26 01 00 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 10 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 10 91	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 20 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 20 91	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 50 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 50 51	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 51	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 50 52	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 52	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 50 53	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 53	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 01 50 81	01 00 00 00MOD000	Supplemental Requirements for Electrical

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SECTION 26 05 00 00 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Sealants.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
3. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of raceways, electrical power cabling, and communications cabling referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

3. Standard Features:

    a. Referenced Standard: ASTM A53/A53M, Type E, Grade B.
    b. Dimensions: Schedule 40; sized so outer diameter of sleeve matches inner diameter of penetration hole.
    c. Corrosion Resistance: Coated with [**Zinc**][**or**][**Gal-vo-plast**] .
    d. Configuration: Plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe.
b. Configuration: Plain ends and integral waterstop.

C. PVC Pipe Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Referenced Standard: ASTM D1785.
b. Dimensions: Schedule 40.

D. PVC Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

3. Standard Features: With nailing flange for attaching to wooden forms.

E. PE or PP Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Galvanized-steel sheet; thickness not less than **0.0239 inch (0.6 mm)**; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than **50 inch (1270 mm)** and with no side larger than **16 inch (400 mm)**, thickness must be **0.052 inch (1.3 mm)**.
2) For sleeve cross-section rectangle perimeter not less than **50 inch (1270 mm)** or with one or more sides larger than **16 inch (400 mm)**, thickness must be **0.138 inch (3.5 mm)**.

2.3 SLEEVE-SEAL SYSTEMS

A. Sleeve-Seal System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]
f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]

f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

3. Standard Features:

a. Modular Sealing Device: Designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
b. Sealing Elements: [**EPDM**][**Nitrile (Buna N)**] rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
c. Pressure Plates: [**Carbon steel**][**Fiber-reinforced plastic**][**Stainless steel**] .
d. Connecting Bolts and Nuts: [**Carbon steel, with corrosion-resistant coating,**][**Stainless steel,**] of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Sleeve-Seal Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall.
b. Waterstop Collar: Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Grout for Sealing Penetrations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Nonshrinking grout; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
b. Referenced Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
c. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
d. Packaging: Premixed and factory packaged.

2.6 SEALANTS

A. Pourable Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
b. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

4. Sustainability Characteristics:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

B. Foam Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Innovative Chemical Products (Building Solutions Group)**]
   b. [**The Dow Chemical Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Innovative Chemical Products (Building Solutions Group)**]
   b. [**The Dow Chemical Company**]
   c. <**Insert manufacturer's name**>

3. Standard Features:

   a. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
   b. Foam Expansion: Must not damage cables or crack penetrated structure.

4. Sustainability Characteristics:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.

8. Work in ITE Rooms: NFPA 75.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies: Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Interfaces with Other Work:

1. Identification: Provide labels for penetrations and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Grounding and Bonding:

a. Bonding of Metal Sleeve for Metal Raceway Penetrations: Bond metal raceway to metal sleeve on both sides of penetration.
b. Bonding of Metal Sleeve for Cable Penetrations: Bond equipment grounding conductor for electrical power cables, or cable shield for communications cables, to metal sleeve on both sides of penetration.
c. Bonding is not required for nonmetallic sleeves.
d. Grounding of communications cables entering buildings from outside must be provided at the penetration.

3. Hangers and Supports:

a. Support of Raceways and Cables in Sleeve: Comply with manufacturer's published instructions for supporting raceways or cables on both sides of penetration. Sleeve sealing products are typically not rated for supporting the weight of raceways and cables.

3.2 INSTALLATION OF ROUND SLEEVES

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide [**1/4 inch (6.4 mm)**]<**Insert dimension**> annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed [**or seismic criteria require different clearance**] .

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors [**2 inch (50 mm)**]<**Insert dimension**> above finished floor level. Install sleeves during erection of floors.
6. Seal space outside of sleeves with approved joint compound for wall assemblies.

B. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

C. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [**steel**][**cast-iron**] pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for **1 inch (25 mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.

D. Underground, Exterior-Wall and Floor Penetrations:

1. Install [**steel**][**cast-iron**] pipe sleeves with integral waterstops. Size sleeves to allow for **1 inch (25 mm)** annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for **1 inch (25 mm)** annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.3 INSTALLATION OF RECTANGULAR SLEEVES

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 00 00

SECTION 26 05 13 00 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cables.
2. Connectors.
3. Solid terminations.
4. Separable insulated connectors.
5. Splice kits.
6. Medium-voltage tapes.
7. Arc-proofing materials.
8. Fault indicators.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

B. Samples: **16 inch (400 mm)** lengths for each type of cable specified.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For solvents and adhesives, indicating VOC content.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Material Certificates: For each type of cable and accessory.

C. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

D. Source quality-control reports.

E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

C. Cable Type: [**Type MV 90**][**Type MV 105**].

D. Conductor Insulation: [**Crosslinked polyethylene**][**Ethylene-propylene rubber**].

1. Voltage Rating: [**5**][**8**][**15**][**25**][**35**] kV.
2. Insulation Thickness: [**100**][**133**] percent insulation level.

E. Conductor: [**Copper**][**Aluminum**].

F. Comply with UL 1072, AEIC CS8[**, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682**][**, and ICEA S-94-649**].

G. Conductor Stranding: [**Compact round, concentric lay, Class B**][**Concentric lay, Class B**].

H. Strand Filling: Conductor interstices are filled with impermeable compound.

I. Lead Content: Less than 300 parts per million.

J. Shielding: [**Copper tape**][**Solid copper wires**], helically applied over semiconducting insulation shield.

K. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

L. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together[**with ground conductors**].

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

M. Cable Sheath: [**Interlocked aluminum**][**Interlocked galvanized steel**][**Corrugated aluminum tube**] applied over cable.

N. Cable Jacket: [**Sunlight-resistant PVC**][**Chlorosulfonated polyethylene**].

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

D. Copper-Conductor Connectors: [**Copper barrel crimped**][**Aluminum barrel crimped**][**Copper shear bolt**] connectors.

2.4 SOLID TERMINATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal-body, metal-clad cable terminator for metal-clad cable [**with**][**without**] external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

D. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations:

   a. Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
   b. Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
   c. Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
   d. Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

2. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
3. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

D. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

E. Load-Break Cable Terminators: Elbow-type units with 200 A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

F. Dead-Break Cable Terminators: Elbow-type unit with [**200 A**][**600 A**] continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

G. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

H. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

I. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

D. Standard: Comply with IEEE 404.

E. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5. Separable multiway splice system with all components for the required splice configuration.

2.7 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]

4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]
4. <**Insert manufacturer's name**>

D. Ethylene/propylene rubber-based, **30 mil (0.76 mm)** splicing tape, rated for 130 deg C operation. Minimum **3/4 inch (20 mm)** wide.

E. Silicone rubber-based, **12 mil (0.30 mm)** self-fusing tape, rated for 130 deg C operation. Minimum **1-1/2 inch (38 mm)** wide.

F. Insulating-putty, **125 mil (3.175 mm)** elastic filler tape. Minimum **1-1/2 inch (38 mm)** wide.

2.8 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. <**Insert manufacturer's name**>

D. Tape for First Course on Metal Objects: **10 mil (250 micrometer)** thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

E. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to **0.3 inch (8 mm)** thick, and compatible with cable jacket.

F. Glass-Cloth Tape: Pressure-sensitive adhesive type, **1 inch (25 mm)** wide.

2.9 FAULT INDICATORS

A. Indicators: [**Automatically**][**Manually**] reset fault indicator[**with inrush restraint feature**], arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.10 SOURCE QUALITY CONTROL

A. Test and inspect cables according to [**ICEA S-97-682**][**ICEA S-94-649**] before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of **5 psig (35 kPa)**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by **48 to 72 inch (1200 to 1800 mm)** on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Install direct-buried cables on leveled and tamped bed of **3 inch (75 mm)** thick, clean sand. Separate cables crossing other cables or piping by a minimum of **2 inch (50 mm)** of tamped earth, plus an additional **2 inch (50 mm)** of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

G. Install "buried-cable" warning tape **12 inch (305 mm)** above cables.

H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

I. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

J. Install cable splices at pull points and elsewhere as indicated; use standard kits.[**Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.**]

K. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

L. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with **10 mil (250 micrometer)** pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of **1 inch (25 mm)** wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

N. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

O. Install fault indicators on each phase where indicated.

P. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

Q. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

R. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 05 13 00

Task	Specification	Specification Description
26 05 13 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 13 16	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 05 13 16	26 05 13 00	Medium-Voltage Cables
26 05 13 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 13 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 19 00 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Thermoset-insulated wire.
3. Nonmetallic underground conduit with conductors.
4. Metallic sheathed cable.
5. Photovoltaic single-conductor cable.
6. Nonmetallic jacketed cable.
7. Connectors and splices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
6. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
10. Section 260536 "Cable Trays for Electrical Systems" specifies cable tray installation referenced by this Section.
11. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
12. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
13. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
14. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS

A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

A. Product Schedule: Indicate type, use, location, and termination locations.

B. Product Data: For each type of product.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.
4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZLGR - Type THHN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

C. UL ZLGR - Type THHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Encore Wire Corporation**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Encore Wire Corporation**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.

g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

D. UL ZLGR - Type THW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.

e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

E. UL ZLGR - Type THW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

F. UL ZLGR - Type THWN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 75 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

G. UL ZLGR - Type THWN-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   g. Marked "VW-1," indicating compliance with special vertical flame test.
   h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

H. UL ZLGR - Type TW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alpha Wire; brand of Belden, Inc.**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Encore Wire Corporation**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Service Wire Co.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 60 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

I. UL ZLGR - Type FEP Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: None.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 90 deg C for dry and damp locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

J. UL ZLGR - Type FEPB Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: Glass or other suitable braid material.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 200 deg C for dry locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

K. UL ZLGR - Type Z Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.

b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

L. UL ZLGR - Type ZW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**60 deg C**][**75 deg C**][**85 deg C**][**90 deg C**][**150 deg C**][**200 deg C**][**250 deg C**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

M. UL ZLGR - Type ZW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

N. UL ZLGR - Type TBS Insulated Switchboard Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. [**Southwire Company, LLC**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. [**Southwire Company, LLC**]
   d. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic and Fibrous Outer Braid: Also investigated in accordance with UL 83B.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

O. UL ZLGR - Thermoplastic-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type THW.
d. Insulation Temperature Rating: 75 deg C.
e. Conductor Material: Copper.
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

2.3 THERMOSET-INSULATED WIRE

A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZKST - Type RHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
    i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance

with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

C. UL ZKST - Type RHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 75 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings**].

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.

d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL ZKST - Type RHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

E. UL ZKST - Type SA Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**200 deg C for special applications**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

F. UL ZKST - Type XHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

G. UL ZKST - Type XHHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   g. Marked "VW-1," indicating compliance with special vertical flame test.
   h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

H. UL ZKST - Type XHHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]

h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   g. Marked "VW-1," indicating compliance with special vertical flame test.
   h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

I. UL ZKST - Type SIS Insulated Switchboard and Switchgear Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

J. UL ZKST - Thermoset-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. [**Service Wire Co.**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Service Wire Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type RHW-2.
d. Insulation Temperature Rating: 90 deg C.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.4 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS

A. Nonmetallic Underground Conduit with Conductors, Type NUCC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth-wall raceway with a circular cross section.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Type NUCC Conduit with Conductors: UL CCN QQRK, including UL 1990.

5. Standard Features:

a. Referenced Standard: Article 354 of NFPA 70.
b. Conduit Material: [**HDPE-40**][**HDPE-80**][**EPEC-B**].
c. Conduit Sizes: As indicated on the Drawings.
d. Preinstalled Conductors: Provide insulated conductors as indicated on the Drawings.

2.5 METALLIC SHEATHED CABLE

A. UL PJAZ - Metal-Clad Cable, Type MC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.

5. Standard Features:

   a. Referenced Standard: Article 330 of NFPA 70.
   b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
   c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
   d. Ground Conductor: [**Bare**][**Insulated**][**None**].
   e. Conductor Insulation:

      1) Type TFN/THHN/THWN-2. Comply with UL 83.
      2) Type XHHW-2. Comply with UL 44.
      3) <**Insert type and standard**>.

   f. Armor: [**Steel**][**Aluminum**], interlocked.
   g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

   a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

B. UL AWEZ - Armored Cable, Type AC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Alpha Wire; brand of Belden, Inc.**]
   c. [**Belden Inc.**]
   d. [**Encore Wire Corporation**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Okonite Company (The)**]

g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Encore Wire Corporation**]
e. [**General Cable; Prysmian Group North America**]
f. [**Okonite Company (The)**]
g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Armored Cable: UL CCN AWEZ, including UL 4.

5. Standard Features:

a. Referenced Standard: Article 320 of NFPA 70.
b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Armor: [**Steel**][**Aluminum**], interlocked.

6. Other Available Features Required by the Project:

a. Marked "LS" or "For Use in Cable Trays," indicating compliance with UL 1685 flame and limited smoke test.

C. UL PPKV and FHJR - Fire-Resistant Mineral-Insulated Metal-Sheathed Cable, Type MI, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

3. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Mineral-Insulated Metal-Sheathed Cable: UL CCN PPKV, including UL Subject 504.
   b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

   a. Referenced Standard: Article 332 of NFPA 70.
   b. Fire-Resistance Rating: [**1 h**][**2 h**].
   c. Conductors: Copper, complying with ASTM B3 for bare annealed copper.
   d. Insulation: [**Compressed magnesium oxide**]<**Insert material**>.
   e. Sheath: [**Copper**]<**Insert material**>.

D. UL PJAZ and FHJR - Fire-Resistant Metal-Clad Cable, Type MC, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.
   b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

   a. Referenced Standard: Article 330 of NFPA 70.

b. Fire-Resistance Rating: [**1 h**][**2 h**].
c. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
d. Conductors: [**Copper**][**Copper-clad aluminum**].
e. Ground Conductor: [**Bare**][**Insulated**][**None**].
f. Armor: [**Steel**][**Aluminum**], interlocked.
g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

2.6 PHOTOVOLTAIC SINGLE-CONDUCTOR CABLE

A. Photovoltaic Single-Conductor Cable, Type PV :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

3. Description: Flexible, insulated and uninsulated, drawn-copper current-carrying conductor with an overall insulation layer or jacket, or both, rated [**2000**][**600**] V.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photovoltaic Wire: UL CCN ZKLA, including UL 4703.

5. Standard Features:

a. Referenced Standard: Article 609 of NFPA 70.
b. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

2.7 NONMETALLIC JACKETED CABLE

A. UL PWVX - Nonmetallic-Sheathed Cable, Type NM-B and Type NMC-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Copperweld**]
   d. [**Encore Wire Corporation**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Republic Wire Inc.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Copperweld**]
   d. [**Encore Wire Corporation**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Republic Wire Inc.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type NM-B and Type NMC-B Cables: UL CCN PWVX, including UL 719.

4. Standard Features:

   a. Referenced Standard: Article 334 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

   f. Cable Covering:

      1) Type NM-B: Flame retardant and moisture resistant.
      2) Type NMC-B: Flame retardant, moisture resistant, fungus resistant, and corrosion resistant.

B. UL YDUX - Underground Feeder and Branch-Circuit Cable, Type UF and Type UF-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type UF and Type UF-B Cables: UL CCN YDUX, including UL 493.

4. Standard Features:

   a. Referenced Standard: Article 340 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating:

      1) Type UF: 60 deg C.
      2) Type UF-B: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.

   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

   f. Cable Covering: Flame retardant, moisture resistant, fungus resistant, corrosion resistant, and suitable for direct burial in the earth.

C. UL TYLZ - Service-Entrance Cable, Type SE, Type USE, and Type USE-2 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
   e. [**Okonite Company (The)**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Service-Entrance Cable: UL CCN TYLZ, including UL 854.

4. Standard Features:

   a. Referenced Standard: Article 338 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: Not in excess of rating for insulation type specified below:

      1) Type THWN: 75 deg C, dry and wet locations.
      2) Type THWN-2: 90 deg C, dry and wet locations.
      3) Type RHW: 75 deg C, dry and wet locations.
      4) Type XHHW: 90 deg C, dry and damp locations; 75 deg C, wet locations.
      5) Type RHW-2: 90 deg C, dry and wet locations.
      6) Type XHHW-2: 90 deg C, dry and wet locations.

   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Style R," indicating that cable assembly includes uninsulated equipment ground conductor with insulated conductors.
b. Marked "Style U," indicating that cable assembly includes uninsulated equipment ground conductor helically wrapped over insulated conductors.
c. Marked "-HF," indicating that combustible materials are halogen-free when tested in accordance with UL Subject 2885.

1) Marked "-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL QPOR - Power and Control Tray Cable, Type TC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Power and Control Tray Cable: UL CCN QPOR, including UL 1277.

5. Standard Features:

a. Comply with NEMA WC 57/ICEA S-73-532 for Type TC cables used for control, thermocouple extension, and instrumentation.
b. Comply with NEMA WC 70/ICEA S-95-658 for Type TC cables used for power distribution.

c. Conductors: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Conductor Insulation: Type XHHW-2. Comply with UL 44.

6. Other Available Features Required by the Project:

a. Marked "TC-ER," indicating that cable is designed for use with ASDs, with oversized crosslinked polyethylene insulation, [**spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire**][**dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires**], and sunlight- and oil-resistant outer PVC jacket.

1) Marked "TC-ER-JP," indicating that cable is also suitable for pulling through structural members in accordance with Article 336.10(9) of NFPA 70.
2) Marked "TC-ER-HL," indicating that cable is also suitable for use in hazardous (classified) environments.

b. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
c. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.8 CONNECTORS AND SPLICES

A. UL PJOX - Armored and Metal-Clad Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]
e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]

e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type AC and Type MC Cable Connectors: UL CCN PJOX, including UL 514B.

4. Standard Features: For steel and aluminum sheathed cables, designed to connect conductors specified in this Section.

B. UL PPYT - Mineral-Insulated Metallic-Sheathed Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**TEC International**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**TEC International**]
   b. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type MI Cable Fittings: UL CCN PPYT, including UL 514B.

4. Standard Features: For copper sheathed cables, designed to connect conductors specified in this Section.

C. UL ZMVV - Wire Connectors and Soldering Lugs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Installation Products**]
   b. [**Amphenol TPC Wire & Cable**]
   c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Eaton**]
   e. [**Fastenal Co.**]

f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Amphenol TPC Wire & Cable**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Eaton**]
e. [**Fastenal Co.**]
f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Wire Connectors and Soldering Lugs: UL CCN ZMVV, including UL 486A-486B or UL 486C.

4. Standard Features:

a. One piece, seamless, designed to terminate conductors specified in this Section.
b. Material: [**Copper**][**Aluminum**][**Bronze**].
c. Type: [**One**][**Two**] hole with [**standard**][**long**] barrels.
d. Termination: [**Compression**][**Crimp**].

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper, aluminum, or copper-clad aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. PV Circuits: [**Copper**][**Aluminum**][**Copper-clad aluminum**]; Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Type USE, single conductor in raceway**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Multiconductor cable, Type SE**].

B. Exposed Feeders: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground feeder cable, Type UF**].

E. Feeders Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

F. Feeders in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

G. Exposed Branch Circuits, Including in Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground branch-circuit cable, Type UF**].

J. Branch Circuits Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

K. Branch Circuits in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

M. ASD Output Circuits: [**Type XHHW-2 in metal conduit**][**Type TC-ER cable with braided shield**][**Type TC-ER cable with dual tape shield**].

N. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.

O. PV Circuits, Type PV: For PV source circuits rated at [**600**][**1000**][**2000**] V.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:

   a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

b. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].

1) Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

9. Wiring at Outlets: Install conductor at each outlet, with at least [**6 inch (150 mm)**][**12 inch (300 mm)**] of slack.

D. Interfaces with Other Work:

1. Identification:

a. Identify and color-code conductors and cables.
b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. After installing conductors and cables and before electrical circuitry has been energized, test [**service entrance and feeder conductors**][**and**][**conductors**] feeding the following critical equipment and services for compliance with requirements:

a. <**Insert, in separate subparagraphs, critical equipment and services to be tested**>.

4. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
b. Test bolted connections for high resistance using one or more of the following:

   1) A low-resistance ohmmeter.
   2) Calibrated torque wrench.
   3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

E. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

A. Infrared Scanning of Splices: Two months after Substantial Completion, perform infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.

1. Follow-On Infrared Scanning: Perform follow-up infrared scan of splices at 11 months after Substantial Completion.
2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 05 19 00

Task	Specification	Specification Description
26 05 19 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 13	26 05 39 00	Underfloor Raceways For Electrical Systems
26 05 19 13	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 16	26 05 13 00	Medium-Voltage Cables
26 05 19 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 16	26 05 23 00	Control-Voltage Electrical Power Cables
26 05 19 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 16	27 11 00 00	Communications Equipment Room Fittings
26 05 19 16	27 13 13 00	Communications Copper Backbone Cabling
26 05 19 16	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 23 00 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.

7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: **60 inch (1520 mm)** or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 BACKBOARDS

A. Description: Plywood, [**fire-retardant treated,**]**3/4 by 48 by 96 inch (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with [**flat**][**eggshell**][**black**]<**Insert color**>[**latex**][**alkyd**] paint. Comply with requirements in Section 099123 "Interior Painting."

1. Lead Content: Less than 300 parts per million.

2.3 CATEGORY 5e BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100 ohm, No. 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

2.4 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]

11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. **<Insert manufacturer's name>**

D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]**<Insert color>** thermoplastic.

2.5 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with TIA-568-C.2 for Category 6a cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.6 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]

18. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. **<Insert manufacturer's name>**

D. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**][**Category 6**][**Category 6a**][**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables must be terminated with connecting hardware of same category or higher.

E. Source Limitations: [**Obtain balanced twisted pair cable hardware from single source from single manufacturer**][**Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source**].

F. Connecting Blocks: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**]. Provide blocks for the number of cables terminated on the block, plus [**25**]**<Insert number>** percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**]**<Insert number>** for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

3. Number of Jacks per Field: One for each four-pair [**cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in [**36 inch (900 mm)**][**48 inch (1200 mm)**]<**Insert length**>lengths; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.
2. Patch cords must have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:

   a. Category 5e, unshielded balanced twisted pair cable must comply with IEC 60603-7-2.
   b. Category 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
   c. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
   d. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.
   e. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.
   f. Category 6a, shielded balanced twisted pair cable must comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

L. Faceplate:

1. [**Two**][**Four**][**Six**] port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**][**10**][**12**] port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
4. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.
7. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.
7. Lead Content: Less than 300 parts per million.

2.8 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. PVC-Jacketed, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. Polypropylene insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. PVC jacket.

6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. NFPA 70 Type: Type CM.
8. Flame Resistance: Comply with UL 1581.

D. Plenum-Type, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. PE insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. Fluorinated ethylene propylene jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, [**one pair**][**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, [**one pair**][**two pairs**], No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.10 CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

C. Class 1 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type THW, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**Type TC, complying with UL 1277 in raceway**][**Type MC, complying with UL 1569**].

D. Class 2 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**].

E. Class 3 Remote-Control and Signal Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**][**Type TW or Type TF, complying with UL 83, in raceway**].

F. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.
2. <**Insert list of critical circuits that require CI cable**>.

2.12 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]

4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

C. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Lead Content: Less than 300 parts per million.

D. Signaling Line Circuits: Twisted, shielded pair, [**not less than**][**No. 18 AWG**]<**Insert wire size**>[**size as recommended by system manufacturer**].

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

E. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[**with outer jacket**] with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

B. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems" for raceway selection and installation requirements for wireways as supplemented or modified in this Section.

C. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than **2 inch (50 mm)** wide, **3 inch (75 mm)** high, and **2-1/2 inch (64 mm)** deep.
2. Outlet boxes for cables must be no smaller than **4 inch (102 mm)** square by [**1-1/2 inch (38 mm)**][**2-1/8 inch (53 mm)**] deep with extension ring sized to bring edge of ring to within **1/8 inch (3.1 mm)** of the finished wall surface.
3. Flexible metal conduit must not be used.

D. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows if possible.

F. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits [**3 inch (75 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96 inch (2440 mm)** dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than **1/2 inch (12 mm)** at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**30 inch (760 mm)**]<**Insert dimension**> apart.
3. Cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of [**72 inch (1830 mm)**]<**Insert dimension**> of cable in a coil not less than [**12 inch (305 mm)**]<**Insert dimension**> in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **5 inch (127 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **12 inch (305 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **24 inch (600 mm)**.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **2-1/2 inch (64 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **6 inch (150 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **12 inch (305 mm)**.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **3 inch (75 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **6 inch (150 mm)**.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of **48 inch (1200 mm)**.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inch (127 mm)**.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; [**No 14 AWG**]<**Insert wire size**>.
2. Class 2 low-energy, remote-control, and signal circuits; [**No. 16 AWG**]<**Insert wire size**>.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; [**No 12 AWG**]<**Insert wire size**>.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

   a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 05 23 00

Task	Specification	Specification Description
26 05 23 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 26 00 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connectors.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification and grounding and bonding of communications equipment, raceways, boxes, and cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

   a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
   b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
   c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for

submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

a. Grounding electrode access enclosures.
b. Grounding electrodes.
c. Grounding arrangements and connections for separately derived systems.
d. <**Insert items**>.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

1) Grounding electrode access enclosures.
2) Grounding electrodes.
3) Grounding arrangements and connections for separately derived systems.
4) <**Insert items**>.

b. Instructions for periodic testing and inspection of grounding features at [**test wells**][**ring electrodes**][**grounding connections for separately derived systems**]<**Insert locations**> based on [**NETA MTS**][**NFPA 70B**]<**Insert reference**>.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical

tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."

B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed [**25 Ω**][**10 Ω**]<**Insert resistance value**> resistance to ground (earth).

1. Contact Architect for resolution if 25 Ω specified resistance to ground (earth) is not attained after complying with prescriptive requirements in Article 250 of NFPA 70.
2. Contact Architect for resolution if [**10 Ω**]<**Insert resistance value**> specified resistance to ground (earth) is not attained after second attempt to increase effectiveness of grounding (earthing) electrode.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Complying with one or more of the following:

   a. Soft or Annealed Copper Wire: ASTM B3.
   b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
   c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
   d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

4. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Armored Grounding Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**LS Cable & System USA; subsidiary of LS Corp.**]
   b. [**Southwire Company, LLC**]
   c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**LS Cable & System USA; subsidiary of LS Corp.**]
   b. [**Southwire Company, LLC**]
   c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

4. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
5. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDSH - Protector Grounding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features:

a. Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
b. Color: [**Light olive gray**][**or**][**green**].

5. Sustainable Design Features:

a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**ERICO; brand of nVent Electrical plc**]
   g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   h. [**Greaves Corp.; Essex Products Group, Inc.**]
   i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
   k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   l. [**Panduit Corp**]
   m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

   a. Two pieces with [**zinc-plated**][**stainless steel**] bolts.
   b. Clamp Material: [**Silicon bronze**][**Die-cast zinc alloy**][**Aluminum**][**Brass**][**Tinned brass**].
   c. Listed for outdoor use.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

a. Clamp Material: [**Aluminum**][**Brass**][**Tinned brass**].
b. Listed for outdoor use.

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

   a. Clamp Material: [**Aluminum**][**Copper**][**Tinned copper**][**Galvanized steel**].
   b. Listed for outdoor use.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Beam Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Exothermically Welded Connection :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Raised-Floor Signal Reference Grid Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, stamped-steel terminal with hex head screw.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. UL KDER - Bonding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Grounding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 GROUNDING AND BONDING HUBS

A. UL KDER - Grounding and Bonding Hub :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Greaves Corp.; Essex Products Group, Inc.**]
   f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Greaves Corp.; Essex Products Group, Inc.**]
   f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Insulated, gasketed, watertight hub with mechanical-type wire terminal.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 GROUNDING AND BONDING CONNECTORS

A. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, [**aluminum**][**copper rated for direct burial**] terminal with set screw.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on **5/8 or 1 inch (16 or 25 mm)** centers for two-bolt connection to busbar.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Panduit Corp**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Panduit Corp**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

   a. [**Copper**][**Copper alloy**][**Tinned copper**], C and H shaped.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**Greaves Corp.; Essex Products Group, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**Greaves Corp.; Essex Products Group, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened.

a. [**Copper**][**Copper alloy**][**Tinned copper**].

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Signal Reference Grid Grounding and Bonding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.7 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.

B. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
b. [**Madison Electric Products; business of Southwire Company, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
b. [**Madison Electric Products; business of Southwire Company, LLC**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: Zinc-alloy one-piece construction; six terminating points; gangable.
5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: [**Zinc-alloy**][**Copper**] body and polycarbonate cover; four terminating points.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.8 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

B. UL KDER - Equipment Room Grounding and Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**allG Fabrication (formerly ALT)**]
   b. [**Chatsworth Products, Inc.**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
   i. [**Panduit Corp**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**allG Fabrication (formerly ALT)**]
   b. [**Chatsworth Products, Inc.**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
   i. [**Panduit Corp**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

   a. Bus: Rectangular bar of annealed copper.
   b. Mounting Stand-Off Insulators: Lexan or PVC.

      1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

a. Dimensions: [**1/4 by 4 inch (6.3 by 100 mm)**]<**Insert dimensions**> in cross section; length as indicated on the Drawings.

b. Predrilled Hole Pattern: [**Complying with BICSI N3 and TIA-607**][**9/32 inch (7.14 mm) holes spaced 1-1/8 inch (28 mm) apart**][**Suitable for installing specified grounding and bonding connectors**].

c. Mounting Hardware: Stand-off brackets that provide [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**> clearance to access rear of bus. Brackets and bolts must be stainless steel.

C. UL KDER - Rack and Cabinet Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

   a. Bus: Rectangular bar of hard-drawn solid copper.
   b. Horizontal Mounting Dimensions: Designed for mounting in [**19 inch (483 mm)**][**23 inch (584 mm)**] wide equipment racks or cabinets.
   c. Vertical Mounting Dimensions: Designed for mounting in [**72 inch (1827 mm)**][**36 inch (914 mm)**] high equipment racks or cabinets.
   d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
   e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.9 SIGNAL REFERENCE GRIDS

A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

B. UL KDER - Mesh-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive metal wire mesh for field-fabrication of grid.

   a. Wire Size: [**8 AWG**][**6 AWG**][**4 AWG**][**2 AWG**].
   b. Wire Material: [**Copper**][**Copper-clad steel**].
   c. Spacing: [**4 inch (102 mm)**][**8 inch (203 mm)**][**12 inch (305 mm)**][**24 inch (610 mm)**].
   d. Welded or brazed intersections.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Tape-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**ERICO; brand of nVent Electrical plc**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**ERICO; brand of nVent Electrical plc**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive copper tape for field-fabrication of grid.

    a. Copper Tape Dimensions: [**16 mil (0.4 mm) (26 ga.) thick by 2 inch (51 mm) wide**][**40 mil (1 mm) (18 ga.) thick by 1.6 inch (40 mm) wide**]<**Insert dimensions**>.
    b. Spacing: [**24 inch (610 mm)**]<**Insert dimension**>.
    c. Welded or brazed fittings for intersections.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.10 GROUNDING (EARTHING) ELECTRODES

A. UL KDER - Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**ERICO; brand of nVent Electrical plc**]
    e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**ERICO; brand of nVent Electrical plc**]
    e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft (19 mm by 3 m)**][**5/8 inch by 8 ft (16 mm by 2.4 m)**].
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Chemically Charged Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**allG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**allG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Copper tube, straight or L-shaped, charged electrode enhancement material.

a. Termination: Factory-attached 4/0 AWG bare conductor at least **48 inch (1200 mm)** long.
b. Backfill Material: Electrode manufacturer's recommended material.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

   a. Electrode Enhancement Material: [**Nonhazardous electrolytic chemical salts**]<**Insert enhancement material**>.

C. UL KDER - Plate Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ALLTEC LLC**]
   b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ALLTEC LLC**]
   b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: **1/4 inch (6 mm)** thick, hot-dip galvanized.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.11 GROUNDING ELECTRODE ENCLOSURES

A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

B. Grounding Electrode Access Well Enclosure :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ERICO; brand of nVent Electrical plc**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ERICO; brand of nVent Electrical plc**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Standard Features:

a. Well Material: [**Concrete**][**HDPE**][**Schedule 40 PVC**].
b. Cover Material: [**Cast iron**][**Concrete**][**HDPE**][**Plastic**][**Steel**].
c. Cover Strength: [**Sidewalk or turf use**][**Driveway use**]<**Insert rating**>.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Material Reuse: Product is salvaged, refurbished, or reused.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Round:

1) Nominal Diameter: [**8 inch (200 mm)**][**9 inch (230 mm)**][**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**]<**Insert dimension**>.
2) Nominal Height: [**10 inch (250 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**][**36 inch (910 mm)**][**48 inch (1220 mm)**]<**Insert dimension**>.
3) Slotted sides for installation after grounding connections made.

b. Rectangular:

1) Nominal Width: [**2 inch (50 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**36 inch (910 mm)**]<**Insert dimension**>.
2) Nominal Length: [**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**36 inch (910 mm)**][**42 inch (1070 mm)**]<**Insert dimension**>.
3) Nominal Height: [**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**]<**Insert dimension**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for [**8 AWG**]<**Insert wire size**> and smaller, and stranded conductors for [**6 AWG**]<**Insert wire size**> and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
7. Underground Grounding Conductors: Install bare [**tinned-**]copper conductor, [**2/0 AWG**]<**Insert wire size**> minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.

a. Install [**8 AWG**][**6 AWG**]<**Insert wire size from fault calculation**> bonding conductors below grade in a grid pattern on **2 ft (600 mm)** centers. Bond grid conductors with exothermic welds where they cross each other.
b. Grid must fill entire area inside equipment yard fence, and extend minimum **6.5 ft (2 m)** outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
c. Bond each metal fence post and gate post to at least two grid conductors.
d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:

a. Tape mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, [**12 inch (300 mm)**][**24 inch (610 mm)**] spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Ring Electrode: Buried at least **30 inch (760 mm)** below grade and at least **24 inch (610 mm)** from base of tower or mounting.
2. Bond each tower base and metallic frame of dish to ring electrode, buried at least **18 inch (460 mm)** below grade.
3. Bond ring electrode and antenna bonding conductors to equipment room PBB or SBB, buried at least **30 inch (760 mm)** below grade.

4. Bond metal fences located within **6 ft (1.8 m)** of towers and antennas to ring electrode, buried at least **18 inch (460 mm)** below grade.
5. Special Requirements for Roof-Mounted Towers:

    a. Roof Ring: Meet requirements for ring electrode except conductors must comply with NFPA 780.
    b. Bond tower base footings steel, SBB in equipment room, and antenna support guys to roof ring.
    c. Connect roof ring to perimeter conductors of lightning protection system.

6. Special Requirements for Waveguides and Coaxial Cable:

    a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
    b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.5 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
12. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

    a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
    b. Underground Grounding Conductors:

        1) Bury at least **30 inch (750 mm)** below grade.
        2) Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or

electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

    1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
    2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
    3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. Grounding and Bonding for Piping:

    1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
    3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [**tinned**]bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 ft (18 m)** apart.

3. Grounding and Bonding Busbars:

    a. Install busbar horizontally, on insulated spacers **2 inch (50 mm)** minimum from wall, **6 inch (150 mm)** above finished floor unless otherwise indicated.
    b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

    a. Ground Rods: Drive rods until tops are **2 inch (50 mm)** below finished floor or final grade unless otherwise indicated.

        1) Interconnect ground rods with grounding electrode conductor below grade and as

otherwise indicated. Make connections without exposing steel or damaging coating if any.

2) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least [**three**]<**Insert number**> rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.

c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least **12 inch (300 mm)** deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each [**steel column**][**indicated item**], extending around perimeter of [**building**][**area or item indicated**].

1) Install tinned-copper conductor not less than [**2/0 AWG**]<**Insert wire size**> for ring electrode and for taps to building steel.

2) Bury ring electrode not less than [**24 inch (600 mm)**]<**Insert dimension**> from building's foundation.

e. Concrete-Encased Electrode (Ufer Ground):

1) Fabricate in accordance with NFPA 70; use minimum of [**20 ft (6 m)**]<**Insert dimension**> of bare copper conductor not smaller than [**4 AWG**]<**Insert wire size**>.

a) If concrete foundation is less than [**20 ft (6 m)**]<**Insert dimension**> long, coil excess conductor within base of foundation.

b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least **20 ft (6.0 m)** long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

5. Grounding at Service:

a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.

6. Grounding Separately Derived Systems:

a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.

7. Grounding Underground Distribution System Components:

a. Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

b. Comply with IEEE C2 grounding requirements.
c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inch (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inch (50 mm)** above to **6 inch (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than **6 inch (150 mm)** from foundation.

8. Equipment Grounding and Bonding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1) Feeders and branch circuits.
2) Lighting circuits.
3) Receptacle circuits.
4) Single-phase motor and appliance branch circuits.
5) Three-phase motor and appliance branch circuits.
6) Flexible raceway runs.
7) Armored and metal-clad cable runs.
8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway

and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.

h. Metallic Fences: Comply with requirements of IEEE C2.

1) Grounding Conductor: Bare[**, tinned**] copper, not less than [**8 AWG**]<**Insert wire size**>.

2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.

3) Barbed Wire: Strands must be bonded to grounding conductor.

9. Fence Grounding:

a. Grounding Method: At each grounding location, drive grounding rod vertically until top is **6 inch (150 mm)** below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.

b. Fences greater than **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**1500 ft (450 m)**]<**Insert lesser distance if grounding resistance is high**>.

c. Fences within **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**750 ft (225 m)**]<**Insert lesser distance if grounding resistance is high**>.

1) Gates and Other Fence Openings: Ground fence on each side of opening.

a) Bond metal gates to gate posts by connecting bonding jumper between gate post and gate frame.

b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least **18 inch (460 mm)** below finished grade.

d. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of power line crossing and at maximum distance of **150 ft (45 m)** on each side of crossing.

e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[**, at ground test wells**][**, and at individual ground rods**]. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [**10 Ω**]<**Insert ohms**>.
    b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [**5 Ω**]<**Insert ohms**>.
    c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [**3 Ω**]<**Insert ohms**>.
    d. Power Distribution Units or Panelboards Serving Electronic Equipment: [**1 Ω**][**3 Ω**]<**Insert ohms**>.
    e. Substations and Pad-Mounted Equipment: [**5 Ω**]<**Insert ohms**>.
    f. Manhole Grounds: [**10 Ω**]<**Insert ohms**>.
    g. <**Insert application and maximum ground-resistance**>.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 26 00

Task	Specification	Specification Description
26 05 26 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 29 00 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
5. Section 055000 "Metal Fabrications" specifies site-fabricated metal supports referenced by this Section.
6. [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**and**][**Section 099600 "High-Performance Coatings"**] specify cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal referenced by this Section.
7. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration controls, seismic restraints, and wind restraints referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.

f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.
j. <**Insert product type**>.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.6 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 018123 "Facility Seismic and Wind Criteria."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT SYSTEMS

A. Steel Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Atkore Unistrut**]
   d. [**CADDY; brand of nVent Electrical plc**]
   e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   f. [**Flex-Strut Inc.**]
   g. [**G-Strut**]
   h. [**Gripple Inc.**]
   i. [**Haydon Corporation**]
   j. [**Metal Ties Innovation**]
   k. [**MIRO Industries Inc.**]
   l. [**Rocket Rack; Robroy Industries**]
   m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Atkore Unistrut**]
   d. [**CADDY; brand of nVent Electrical plc**]
   e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   f. [**Flex-Strut Inc.**]
   g. [**G-Strut**]
   h. [**Gripple Inc.**]
   i. [**Haydon Corporation**]
   j. [**Metal Ties Innovation**]
   k. [**MIRO Industries Inc.**]
   l. [**Rocket Rack; Robroy Industries**]
   m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
   n. <**Insert manufacturer's name**>

3. Standard Features: Preformed steel channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center in at least one surface.

   a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
   b. Material for Channel, Fittings, and Accessories: [**Galvanized steel**][**Plain steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
   c. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
   d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Unistrut**]
c. [**Eaton**]
d. [**Flex-Strut Inc.**]
e. [**Haydon Corporation**]
f. [**MKT Metal Manufacturing**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Unistrut**]
c. [**Eaton**]
d. [**Flex-Strut Inc.**]
e. [**Haydon Corporation**]
f. [**MKT Metal Manufacturing**]
g. <**Insert manufacturer's name**>

3. Standard Features: Extruded-aluminum channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center in at least one surface.

a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
b. Channel Material: 6063-T5 aluminum alloy.
c. Fittings and Accessories Material: 5052-H32 aluminum alloy.
d. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]

b. [**Atkore Unistrut**]
c. [**Champion Fiberglass, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Fabco Plastics Wholesale Limited**]
f. [**G-Strut**]
g. [**Haydon Corporation**]
h. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Atkore Unistrut**]
c. [**Champion Fiberglass, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Fabco Plastics Wholesale Limited**]
f. [**G-Strut**]
g. [**Haydon Corporation**]
h. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]
i. <**Insert manufacturer's name**>

3. Standard Features: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center, in at least one surface.

a. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
b. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
c. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
d. Fitting and Accessory Materials: Same as those for channels and angles[**, except metal items may be stainless steel**].
e. Rated Strength: Selected to suit applicable load criteria.
f. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices:

1. Standard Features: [**Steel**][**Steel and malleable-iron**][**Stainless steel**][**Glass-fiber-resin**] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit:

1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Powder-Actuated Fasteners :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hilti, Inc.**]
   b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   c. [**MKT Fastening, LLC**]
   d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Hilti, Inc.**]
   b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   c. [**MKT Fastening, LLC**]
   d. **<Insert manufacturer's name>**

3. Standard Features: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Empire Industries, Inc.**]
   c. [**Hilti, Inc.**]
   d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   e. [**MKT Fastening, LLC**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Empire Industries, Inc.**]
   c. [**Hilti, Inc.**]
   d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   e. [**MKT Fastening, LLC**]
   f. **<Insert manufacturer's name>**

3. Standard Features: Insert-wedge-type, [**zinc-coated**][**stainless**] steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

C. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

D. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

E. Through Bolts:

1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, **Grade A325 (Grade A325M)**.

F. Toggle Bolts:

1. Standard Features: [**All**][**Stainless**] steel springhead type.

G. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as [**required by**][**scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in**] NFPA 70. Minimum rod size must be **1/4 inch (6 mm)** in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [**or other**]support system, sized so capacity can be increased by at least [**25**]<**Insert number**> percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with [**two-bolt conduit clamps**][**single-bolt conduit clamps**][**single-bolt conduit clamps using spring friction action for retention in support channel**].

C. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2 inch (38 mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Hot Work: NFPA 51B.

3. Work in Confined Spaces: NFPA 350.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Installation of Steel Conduit: NECA NEIS 101.
6. Installation of Aluminum Conduit: NECA NEIS 102.
7. Installation of Metal Cable Tray Systems: NECA NEIS 105.
8. Installation of Nonmetallic Cable Tray Systems: NECA NEIS 111.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Raceway Support Methods: In addition to methods described in NECA NEIS 1, [**EMT**][**IMC**][**and**][**ERMC**] may be supported by openings through structure members, in accordance with NFPA 70.
2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus **200 lb (90 kg)**.
3. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

   a. To Wood: Fasten with lag screws or through bolts.
   b. To New Concrete: Bolt to concrete inserts.
   c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   d. To Existing Concrete: Expansion anchor fasteners.
   e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inch (100 mm)** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inch (100 mm)** thick.
   f. To Steel: [**Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts**][**Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69**][**Spring-tension clamps**].
   g. To Light Steel: Sheet metal screws.
   h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[**by means that comply with seismic-restraint strength and anchorage requirements**].

4. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Provide [**vibration**][**and**][**seismic**] controls with hangers and supports.
2. Touchup Finishes:

   a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

      1) Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.

   b. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of

shop paint on miscellaneous metal.

c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3. Installation of Fabricated Metal Supports:

   a. Provide site-fabricated metal supports.
   b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

4. Installation of Concrete Bases:

   a. Provide concrete bases of dimensions indicated, but not less than **4 inch (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
   b. Use [**3000 psi (20.7 MPa)**]<**Insert value**>, 28-day compressive-strength concrete.
   c. Anchor equipment to concrete base as follows:

      1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      2) Install anchor bolts to elevations required for proper attachment to supported equipment.
      3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 26 05 29 00

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Task	Specification	Specification Description
26 05 29 00	05 40 00 00	Cold-Formed Metal Framing
26 05 29 00	05 50 00 00	Metal Fabrications
26 05 29 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 33 13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC duct raceways, elbows, couplings, and nipples.
5. Type FMC duct raceways.
6. Type FMT duct raceways.
7. Type IMC duct raceways.
8. Type LFMC duct raceways.
9. Type LFNC duct raceways.
10. Type PVC duct raceways and fittings.
11. Type RTRC duct raceways and fittings.
12. Fittings for conduit, tubing, and cable.
13. Joint compounds.
14. Solvent cements.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
5. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
7. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
9. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for installation of conduits for communications cabling.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.

4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

A. UL FJMX - Aluminum Electrical Metal Tubing (EMT-A) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
   b. [**Patriot Aluminum Products, LLC**]
   c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
   b. [**Patriot Aluminum Products, LLC**]
   c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FJMX; including UL 797A.

4. Standard Features:

   a. Material: Aluminum.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL FJMX - Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Calconduit; Atkore International**]
   b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Calconduit; Atkore International**]
   b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FJMX; including UL 797A.

4. Standard Features:

   a. Material: Stainless steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797.

4. Standard Features:

a. Material: Steel.
b. Exterior Coating: [**Zinc**][**Alternate corrosion-resistant coating**].
c. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
d. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.3 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKHU; including UL 1653.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

5. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade**

size 3/4)].

b. Fittings:

1) Mechanically Attached Fittings: UL 1653.
2) Solvent-Attached Fittings: UL 651.

2.4 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

B. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. UL EAZX - Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Type A.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. UL EAZX - Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN EAZX; including UL 651A.

4. Standard Features:

   a. Dimensional Specifications: Type B.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.5 TYPE ERMC DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. UL DYWV - Aluminum Electrical Rigid Metal Conduit (ERMC-A), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Aluminum.
b. Protective Coating: Provide protective coating for [**use in concrete**][**direct burial**][**use in severely corrosive environment**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DYWV - Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Stainless steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYIX; including UL 6.

4. Standard Features:

a. Exterior Coating: Zinc.
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]
e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]

e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DYIX; including UL 6.

4. Standard Features:

   a. Exterior Coating: PVC complying with NEMA RN 1.
   b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
   c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.
   b. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
   c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.6 TYPE FMC DUCT RACEWAYS

A. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co.**]
   e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]

f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co.**]
   e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   f. [**Topaz Lighting & Electric**]
   g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXUZ; including UL 1.

4. Standard Features:

   a. Material: Steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

B. UL DXUZ - Aluminum Flexible Metal Conduit (FMC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]

b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXUZ; including UL 1.

4. Standard Features:

a. Material: Aluminum.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.7 TYPE FMT DUCT RACEWAYS

A. UL ILJW - Steel Flexible Metallic Tubing (FMT):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN ILJW; including UL Subject 1652.

4. Standard Features:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.8 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYBY; including UL 1242.

4. Standard Features:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

2.9 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXHR; including UL 360.

4. Standard Features:

   a. Material: Steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate

scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

B. UL DXHR - Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXHR; including UL 360.

4. Standard Features:

   a. Material: Stainless steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

2.10 TYPE LFNC DUCT RACEWAYS

A. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Electri-Flex Company**]
   c. [**Topaz Lighting & Electric**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Electri-Flex Company**]
   c. [**Topaz Lighting & Electric**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

   a. Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
   c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DXOQ - Corrugated (Type C) Liquidtight Flexible Nonmetallic Conduit (LFNC-C):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type C conduit with corrugated internal and external surfaces without integral reinforcement within conduit wall.

b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.11 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZYR - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Southern Pipe, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Southern Pipe, Inc.**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZYR; including UL 651.

4. Standard Features:

   a. Dimensional Specifications: Type A.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZYR - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**JM Eagle**]
   b. [**Southern Pipe, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**JM Eagle**]
   b. [**Southern Pipe, Inc.**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZYR; including UL 651.

4. Standard Features:

   a. Dimensional Specifications: Type EB.
   b. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.12 TYPE RTRC DUCT RACEWAYS AND FITTINGS

A. UL DZKT - Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-HW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion Fiberglass, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Champion Fiberglass, Inc**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZKT; including UL 2515.

4. Standard Features:

   a. Additional Characteristics: Type AG-HW.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZKT - Standard Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-SW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion Fiberglass, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZKT; including UL 2515.

4. Standard Features:

a. Additional Characteristics: Type SW.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZKT - Extra Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-XW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZKT; including UL 2515 and UL 2515A.

4. Standard Features:

   a. Additional Characteristics: Type AG-XW.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZKT - Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion Fiberglass, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Champion Fiberglass, Inc**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DZKT; including UL 2420.

4. Standard Features:

   a. Additional Characteristics: Type BG.

b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.13 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. UL EBMB - Duct Fittings for Hazardous (Classified) Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EBMB; including UL 1203.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Konkore Fittings; Atkore International**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Southwire Company, LLC**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Konkore Fittings; Atkore International**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
   g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Southwire Company, LLC**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DWTT; including UL 514B.

4. Standard Features:

   a. Material: [**Steel**][**Die cast**].
   b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].

c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKAV; including UL 514B.

4. Standard Features:

   a. Material: [**Steel**][**Die cast**].
   b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
   c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Fittings Corp. (AMFICO)**]
   b. [**Liquid Tight Connector Co.**]
   c. [**Southwire Company, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Fittings Corp. (AMFICO)**]
   b. [**Liquid Tight Connector Co.**]
   c. [**Southwire Company, LLC**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN ILNR; including UL 514B.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXAS; including UL 514B.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.14 JOINT COMPOUNDS

A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FOIZ; including UL Subject 2419.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.15 SOLVENT CEMENTS

A. UL VBEW - Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Solvent Cements: UL CCN VBEW; including UL 340.
   b. Solvent Cement Compatibility with PVC Conduit Fittings: UL CCN DWTT; including UL 514B. Follow solvent manufacturer's published instructions.
   c. Solvent Cement Compatibility with Rigid PVC Conduit: UL CCN DZYR; including UL 651. Follow solvent manufacturer's published instructions.
   d. Solvent Cement Compatibility with Rigid EPEC and HDPE Underground Conduit: UL CCN EAZX; including UL 651A. Follow solvent manufacturer's published instructions.

4. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE[**and EPEC**] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE[**and Type EPEC**] underground conduits are not permitted to be used aboveground on the Project.

C. Outdoors:

   1. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
   2. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**].
   3. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**PVC-80**][**RTRC-AG**].

4. Concealed Aboveground: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
5. Direct Buried: [**PVC-80**][**PVC-40**][**HDPE-80**][**HDPE-40**][**RTRC-BG**].
6. Concrete Encased Not in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**RTRC-BG**].
7. Concrete Encased in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**PVC-EB**][**HDPE-80**][**HDPE-40**][**EPEC-A**][**EPEC-B**][**RTRC-BG**].
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**LFNC-A**][**LFNC-B**].

D. Indoors:

1. Hazardous Classified Locations: [**ERMC**][**IMC**].
2. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
3. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**].
4. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**RTRC-AG**].
5. Concealed in Ceilings and Interior Walls and Partitions: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
6. Damp or Wet Locations: [**ERMC**][**IMC**][**RTRC-AG**][**Corrosion-resistant EMT**].
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**FMC**][**LFNC-A**][**LFNC-B**].
8. Circuits Operating Above 60 Hz: [**EMT-A**][**ERMC-A**][**RTRC-AG**]. Provide nonmetallic sleeve where aluminum duct raceways pass through concrete.

E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.

22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.
b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft (0.6 m)** above finished floor.
c. Install no more than equivalent of three 90-degree bends in conduit run[**except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted**]. Support within **12 inch (300 mm)** of changes in direction.
d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within **12 inch (300 mm)** of enclosures to which attached.
g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2) Where an underground service duct raceway enters a building or structure.
3) Conduit extending from interior to exterior of building.
4) Conduit extending into pressurized duct raceway and equipment.
5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
j. Do not install conduits within **2 inch (50 mm)** of the bottom side of a metal deck roof.
k. Keep duct raceways at least **6 inch (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb (90 kg)** tensile strength. Leave at least **12 inch (300 mm)** of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.[**Install insulated throat metal grounding bushings on service conduits**].

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

a. Provide a maximum of [**36 inch (915 mm)**][**72 inch (1830 mm)**] of flexible conduit for [**recessed and semirecessed luminaires,**]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds [**122 deg F (50 deg C)**]<**Insert temperature**>. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.
c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds [**230 deg F (110 deg C)**]<**Insert temperature**>.
8. Duct Raceways Embedded in Slabs:

a. [**Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab**][**Run duct raceways larger than metric designator 27 (trade size) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft (3 m) intervals**].
b. Arrange duct raceways to cross building expansion joints with expansion fittings at right

angles to the joint.

c. Arrange duct raceways to ensure that each is surrounded by minimum of [**1 inch (25 mm)**][**2 inch (50 mm)**]<**Insert dimension**> of concrete without voids.

d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

e. Change from ENT to [**PVC-80**][**PVC-40**][**ERMC**][**or**][**IMC**] before rising above floor.

9. Stub-ups to Above Recessed Ceilings:

a. Provide EMT, IMC, or ERMC for duct raceways.

b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.[**Install insulated throat metal grounding bushings on service conduits**].

11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

b. EMT: Provide [**setscrew**][**compression**], [**steel**][**cast-metal**] fittings. Comply with NEMA FB 2.10.

c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

12. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed **30 deg F (17 deg C)** and that have straight-run length that exceeds **25 ft (7.6 m)**. Install in runs of aboveground ERMC[**and EMT**] conduit that are located where environmental temperature change may exceed **100 deg F (55 deg C)** and that have straight-run length that exceeds **100 ft (30 m)**.

b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

2) Outdoor Locations Exposed to Direct Sunlight: [**155 deg F (86 deg C)**]<**Insert temperature**> temperature change.

3) Indoor Spaces Connected with Outdoors without Physical Separation: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

4) Attics: [**135 deg F (75 deg C)**]<**Insert temperature**> temperature change.

5) <**Insert location and corresponding temperature change**>.

c. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.

d. Install expansion fittings at locations where conduits cross building or structure expansion joints.

e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty[**or firestopping**].
14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

    a. Provide warning signs.

15. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.
2. Provide conduit hangers and supports.
3. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch (300 mm)** long mandrel equal to duct size minus **1/4 inch (6 mm)**. If obstructions are indicated, remove obstructions and retest.
3. Conduit Placement:

   a. Verify that center-line location and offsets are in accordance with the Drawings.
   b. Verify that hangers and supports for conduits are attached to structure [**in accordance with the Drawings**][**as directed by qualified structural engineer**].
   c. Verify that nuts on bolts or hanger rods are secure.
   d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
   e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
   f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
   g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

4. Document all changes on Record Drawings.

F. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33 13

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Task	Specification	Specification Description
26 05 33 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 33 13	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 13	27 11 00 00	Communications Equipment Room Fittings
26 05 33 13	27 13 13 00	Communications Copper Backbone Cabling
26 05 33 13	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 33 16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification of communications equipment and cabling.

1.2 DEFINITIONS

A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.

B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

1. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
2. Concrete Box: A box intended for use in poured concrete.
3. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
4. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

5. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
6. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
7. Device Box: A box with provisions for mounting a wiring device directly to the box.
8. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
9. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
10. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
11. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
12. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
13. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
14. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
15. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
16. Raised-Floor Box: A floor box intended for use in raised floors.
17. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
18. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
19. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
20. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
21. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

C. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

D. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness [**at location**]where boxes are embedded in

concrete floors and underfloor clearances where boxes are installed in raised floors.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.

D. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

G. Security Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

H. Fire-Alarm Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [**I**][**II**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

B. UL QCIT - Metallic Outlet Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Pass & Seymour; Legrand North America, LLC**]
k. [**Patriot Aluminum Products, LLC**]
l. [**Plasti-Bond; Robroy Industries**]

m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Spring City Electrical Manufacturing Company**]
o. [**Topaz Lighting & Electric**]
p. [**Wiremold; Legrand North America, LLC**]
q. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Pass & Seymour; Legrand North America, LLC**]
k. [**Patriot Aluminum Products, LLC**]
l. [**Plasti-Bond; Robroy Industries**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Spring City Electrical Manufacturing Company**]
o. [**Topaz Lighting & Electric**]
p. [**Wiremold; Legrand North America, LLC**]
q. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features:

a. Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
b. Material: [**Sheet steel**][**Sheet aluminum**][**Cast metal**].
c. Sheet Metal Depth: Minimum [**1.5 inch (38 mm)**][**2 inch (50 mm)**][**2.5 inch (65 mm)**][**2.8 inch (70 mm)**][**3.5 inch (90 mm)**].
d. Cast-Metal Depth: Minimum [**1.8 inch (44.5 mm)**][**2.4 inch (60.3 mm)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing [**up to 50 lb (23 kg)**][**more than 50 lb (23 kg) and marked with maximum allowable weight**].
b. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to **70 lb (32 kg)**.

C. UL QCIT - Metallic Conduit Bodies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Patriot Aluminum Products, LLC**]
h. [**Plasti-Bond; Robroy Industries**]
i. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Topaz Lighting & Electric**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Patriot Aluminum Products, LLC**]
h. [**Plasti-Bond; Robroy Industries**]
i. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Topaz Lighting & Electric**]
k. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL QCIT - Metallic Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Arlington Industries, Inc.**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    h. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    i. [**Patriot Aluminum Products, LLC**]
    j. [**Plasti-Bond; Robroy Industries**]
    k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    l. [**Topaz Lighting & Electric**]
    m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Arlington Industries, Inc.**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    h. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]

i. [**Patriot Aluminum Products, LLC**]
j. [**Plasti-Bond; Robroy Industries**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Topaz Lighting & Electric**]
m. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features:

   a. Box with provisions for mounting wiring device directly to box.
   b. Material: [**Sheet steel**][**Sheet aluminum**][**Cast metal**].
   c. Sheet Metal Depth: minimum [**1.5 inch (38 mm)**][**2 inch (50 mm)**][**2.5 inch (65 mm)**][**2.8 inch (70 mm)**][**3.5 inch (90 mm)**].
   d. Cast-Metal Depth: minimum [**1.8 inch (44.5 mm)**][**2.4 inch (60.3 mm)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL QCIT - Metallic Extension Rings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Topaz Lighting & Electric**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL QCIT - Metallic Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**AFC Cable Systems; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   e. [**FSR Inc.**]
   f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

h. [**Leviton Manufacturing Co., Inc.**]
i. [**Pass & Seymour; Legrand North America, LLC**]
j. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Wiremold; Legrand North America, LLC**]
l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**AFC Cable Systems; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**FSR Inc.**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**Pass & Seymour; Legrand North America, LLC**]
j. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Wiremold; Legrand North America, LLC**]
l. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL QCIT - Metallic Raised-Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Wiremold; Legrand North America, LLC**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Wiremold; Legrand North America, LLC**]
d. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

H. UL QCIT - Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**FSR Inc.**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**ABB, Electrification Business**]
b. [**FSR Inc.**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

I. UL QCIT - Metallic Concrete Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**Topaz Lighting & Electric**]
   f. [**Wiremold; Legrand North America, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]

b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Topaz Lighting & Electric**]
f. [**Wiremold; Legrand North America, LLC**]
g. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box intended for use in poured concrete.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

   a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

B. UL QCMZ - Nonmetallic Outlet Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]

c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Cantex Inc.**]
g. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
h. [**Ericson Manufacturing Company**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Intermatic, Inc**]
l. [**JM Eagle**]
m. [**Leviton Manufacturing Co., Inc.**]
n. [**Panduit Corp**]
o. [**Pass & Seymour; Legrand North America, LLC**]
p. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
q. [**Topaz Lighting & Electric**]
r. [**Wiremold; Legrand North America, LLC**]
s. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Cantex Inc.**]
g. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
h. [**Ericson Manufacturing Company**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Intermatic, Inc**]
l. [**JM Eagle**]
m. [**Leviton Manufacturing Co., Inc.**]
n. [**Panduit Corp**]
o. [**Pass & Seymour; Legrand North America, LLC**]
p. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
q. [**Topaz Lighting & Electric**]
r. [**Wiremold; Legrand North America, LLC**]
s. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly

to box.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL QCMZ - Nonmetallic Conduit Bodies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Topaz Lighting & Electric**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Topaz Lighting & Electric**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies

are listed in accordance with outlet box requirements.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL QCMZ - Nonmetallic Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box with provisions for mounting wiring device directly to box.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL QCMZ - Nonmetallic Extension Rings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Cantex Inc.**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Cantex Inc.**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL QCMZ - Nonmetallic Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Cantex Inc.**]
e. [**JM Eagle**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Wiremold; Legrand North America, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Cantex Inc.**]
e. [**JM Eagle**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Wiremold; Legrand North America, LLC**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL QCMZ - Nonmetallic Raised-Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

H. UL QCMZ - Nonmetallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

I. UL QCMZ - Nonmetallic Floor Nozzles:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Enclosure intended primarily as housing for receptacle, provided with means, such as collar, for surface-mounting on floor, which may or may not include stem to support it above floor level, and is sealed against the entrance of scrub water at floor level.
5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

J. UL QCMZ - Nonmetallic Concrete Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Leviton Manufacturing Co., Inc.**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Leviton Manufacturing Co., Inc.**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box intended for use in poured concrete.
5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 JUNCTION BOXES AND PULL BOXES

A. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**FSR Inc.**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Milbank Manufacturing Company**]
   i. [**N J Sullivan Company**]
   j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Spring City Electrical Manufacturing Company**]
   m. [**Square D; Schneider Electric USA**]
   n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**FSR Inc.**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Milbank Manufacturing Company**]
   i. [**N J Sullivan Company**]
   j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Spring City Electrical Manufacturing Company**]
   m. [**Square D; Schneider Electric USA**]
   n. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or

cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL BGUZ - Indoor Cast-Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL BGUZ - Indoor Polymeric Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**FSR Inc.**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**Milbank Manufacturing Company**]
   i. [**N J Sullivan Company**]
   j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Spring City Electrical Manufacturing Company**]
   m. [**Square D; Schneider Electric USA**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**FSR Inc.**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

h. [**Milbank Manufacturing Company**]
i. [**N J Sullivan Company**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Spring City Electrical Manufacturing Company**]
m. [**Square D; Schneider Electric USA**]
n. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]

c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL BGUZ - Outdoor Polymeric Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Cantex Inc.**]
   d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**JM Eagle**]
   f. [**Robroy Enclosures; Robroy Industries**]
   g. [**Topaz Lighting & Electric**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]

b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 COVER PLATES FOR DEVICE BOXES

A. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Intermatic, Inc**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Panduit Corp**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
m. [**Topaz Lighting & Electric**]
n. [**Wiremold; Legrand North America, LLC**]
o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Intermatic, Inc**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Panduit Corp**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
m. [**Topaz Lighting & Electric**]
n. [**Wiremold; Legrand North America, LLC**]
o. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

a. Cover plate-Securing Screws: Metal with head color to match cover plate finish.
b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
c. Cover Plate Material: [**0.032 inch (0.8 mm) thick, Type 302/304 non-magnetic stainless steel with brushed finish**][**0.040 inch (1.0 mm) thick aluminum, anodized or lacquered to prevent corrosion**][**0.04 inch (1 mm) thick, brushed brass with factory polymer finish**][**Steel with white baked enamel, suitable for field painting**][**0.04 inch (1 mm) thick steel with chrome-plated finish**][**Galvanized steel**][**Cast aluminum**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Intermatic, Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Panduit Corp**]
l. [**Pass & Seymour; Legrand North America, LLC**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Topaz Lighting & Electric**]
o. [**Wiremold; Legrand North America, LLC**]
p. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Intermatic, Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Panduit Corp**]

l. [**Pass & Seymour; Legrand North America, LLC**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Topaz Lighting & Electric**]
o. [**Wiremold; Legrand North America, LLC**]
p. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

   a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
   b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
   c. Cover Plate Material: [**0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device**][**As indicated on architectural Drawings**].
   d. Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL QCIT or QCMZ - Illuminating Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Leviton Manufacturing Co., Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

   a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
   b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
   c. Cover Plate Material: [**0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device**][**As indicated on architectural Drawings**].
   d. Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 HOODS FOR OUTLET BOXES

A. UL QCIT or QCMZ - Retractable or Reattachable Hoods for Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

4. Standard Features:

a. Mounts to box using fasteners different from wiring device.
b. Provides [**clear**][**gray**][**white**], weatherproof, "while-in-use" cover.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
d. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Intermatic, Inc**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]

e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Intermatic, Inc**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
   b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

4. Standard Features:

   a. Mounts to box using fasteners different from wiring device.
   b. Marked "Extra-Duty" in accordance with UL 514D.
   c. Provides [**clear**][**gray**][**white**], weatherproof, "while-in-use" cover.
   d. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

   1. Outdoors:

      a. [**Type 3**][**Type 3R**][**Type 4**] unless otherwise indicated.
      b. Locations Exposed to Hosedown: [**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].
      c. Locations Subject to Potential Flooding: Type 6P.
      d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.

e. Locations in-Ground or Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**][**Type 3RX**].
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: [**Type 12**][**Type 2**][**Type 4**][**Type 5**].
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: [**Type 12**][**Type 12K**].
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: [**Type 4**][**Type 6**].
f. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
g. Locations Exposed to Brief Submersion: [**Type 6**][**Type 6P**].
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**].
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. [**Provide cast-metal boxes**][**Boxes with knockouts or unprotected openings are prohibited**].
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [**center**][**top**][**bottom**] of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same

vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for cover plates and covers.

14. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF BOXES AND COVERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to

administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

D. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

E. Acceptance Testing Preparation:

1. <**Insert requirements**>.

F. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

G. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

H. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

I. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from boxes before installing cover plates, covers, and hoods.

3.5 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33 16

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Task	Specification	Specification Description
26 05 33 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 16	26 27 26 00	Wiring Devices

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SECTION 26 05 33 23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface metal raceways and fittings.
2. Surface nonmetallic raceways.
3. Strut-type channel raceways and fittings.
4. Wireways and auxiliary gutters.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies warning signs referenced by this Section.
6. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment

data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SURFACE METAL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RJBT - Surface Metal Raceways and Fittings with Metal Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**MonoSystems, Inc**]
c. [**Wiremold; Legrand North America, LLC**]

d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**MonoSystems, Inc**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RJBT; including UL 5.

4. Standard Features:

   a. [**Galvanized steel**][**Aluminum**] base with snap-on covers.
   b. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].
   c. Wiring Channels: [**Single**][**Dual**][**Triple**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RJBT - Surface Metal Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Union Products International, Inc.**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Union Products International, Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RJBT; including UL 5.

4. Standard Features:

   a. UL 94, V-0 requirements for self-extinguishing characteristics.
   b. [**Galvanized steel**][**Aluminum**] base with snap-on covers.
   c. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.
   d. Wiring Channels: [**Single**][**Dual**][**Triple**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 SURFACE NONMETALLIC RACEWAYS

A. Source Quality Control:

1. Samples:

   a. Surface Nonmetallic Raceway Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RJTX - Surface Nonmetallic Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**HellermannTyton**]

b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Panduit Corp**]
e. [**Wiremold; Legrand North America, LLC**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**HellermannTyton**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Panduit Corp**]
e. [**Wiremold; Legrand North America, LLC**]
f. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN RJTX; including UL 5A.
b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

a. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.
b. Wiring Channels: [**Single**][**Dual**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RJTX - Surface Nonmetallic Raceways and Fittings with Metallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RJTX; including UL 5A.
   b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

   a. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].
   b. Wiring Channels: [**Single**][**Dual**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

   a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RIUU - Strut-Type Channel Raceways and Fittings with Metallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Unistrut**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Power-Strut; Atkore International**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Unistrut**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Power-Strut; Atkore International**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RIUU; including UL 5B.

4. Standard Features:

   a. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RIUU - Strut-Type Channel Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RIUU; including UL 5B.
   b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

   a. UL 94, V-0 requirements for self-extinguishing characteristics.
   b. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 WIREWAYS AND AUXILIARY GUTTERS

A. Source Quality Control:

1. Samples:

   a. Nonmetallic Wireway and Auxiliary Gutter Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL ZOYX - Metal Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABB, Electrification Business**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hoffman; brand of nVent Electrical plc**]
d. [**MonoSystems, Inc**]
e. [**Square D; Schneider Electric USA**]
f. [**Wiegmann; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hoffman; brand of nVent Electrical plc**]
d. [**MonoSystems, Inc**]
e. [**Square D; Schneider Electric USA**]
f. [**Wiegmann; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN ZOYX; including UL 870.

4. Standard Features:

a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
b. Finish: Manufacturer's standard enamel finish.
c. Wireway Covers: [**Hinged type**][**Screw-cover type**][**Flanged-and-gasketed type**] unless otherwise indicated.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Degree of Protection: [**Type 1**][**Type 3R**][**Type 4**][**Type 12**]<**Insert type**> unless otherwise

indicated.

C. UL ZOYX - Nonmetallic Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hoffman; brand of nVent Electrical plc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hoffman; brand of nVent Electrical plc**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN ZOYX; including UL 870.
   b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

   a. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings must match and mate with wireways as required for complete system.
   b. PVC Solvents and Adhesives: As recommended by wireway manufacturer.
   c. Material:

      1) Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover must be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections must be flanged and have stainless steel screws and oil-resistant gaskets.
      2) PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Confined Spaces: NFPA 350.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Auxiliary Gutters: Article 366 of NFPA 70.
8. Surface Metal Raceway: Article 386 of NFPA 70.
9. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install surface raceways only where indicated on Drawings.
2. Install surface raceway with a minimum **2 inch (50 mm)** radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inch (1200 mm)** and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.
4. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for surface raceways and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Provide warning signs.

2. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL OF SURFACE RACEWAYS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

E. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.3 CLEANING

A. Remove construction dust and debris from surface raceways before installing covers.

3.4 PROTECTION

A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33 23

Task	Specification	Specification Description
26 05 33 23	26 05 39 00	Underfloor Raceways For Electrical Systems
26 05 33 23	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 36 00 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal cable trays.
2. Nonmetallic cable trays.
3. Cable tray accessories.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

C. Products Installed, but Not Furnished, under This Section:

1. Section 078413 "Penetration Firestopping" specifies firestopping products installed under this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding products installed under this Section.
3. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metal cable trays.
2. Nonmetallic cable trays.
3. Cable tray accessories.

B. Shop Drawings:

1. Cable tray fabrication drawings, diagrams, and supporting documents.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.

2. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 METAL CABLE TRAYS

A. Description: This product category covers metal cable trays and metal cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN CYNW; including NEMA VE 1 and suitability for use as equipment grounding conductors in accordance with Sections 392.60(A) and 392.60(B) of NFPA 70.

C. UL CYNW - Ladder Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**BASOR Electric**]
d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. [**Niedax Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**BASOR Electric**]
d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. [**Niedax Inc.**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

    a. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
    b. Radius-Fitting Rung Spacing: **9 inch (225 mm)** at center of tray's width.
    c. Minimum Cable-Bearing Surface for Rungs: **7/8 inch (22 mm)** width with radius edges.
    d. No portion of the rungs must protrude below the bottom plane of side rails.
    e. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
    f. Splicing Assemblies: Bolted type using serrated flange locknuts.
    g. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

    a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
    b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
    c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
    d. Finish:

        1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
        2) Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
        3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
        4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

            a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
            b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
            c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

        5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
        6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
        7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

    a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
    b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
    c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

   a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
   b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

   a. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**][**36 inch (900 mm)**] unless otherwise indicated on Drawings.
   b. Minimum Usable Load Depth: [**3 inch (75 mm)**][**4 inch (100 mm)**][**5 inch (125 mm)**][**6 inch (150 mm)**].
   c. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**][**20 ft (6.0 m)**][**24 ft (7.4 m)**], except where shorter lengths are required to facilitate tray assembly.
   d. Rung Spacing: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**] on center.
   e. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**][**36 inch (900 mm)**][**48 inch (1200 mm)**].
   f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
   g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

D. UL CYNW - Wire-Mesh Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Cope**]
   b. [**BASOR Electric**]
   c. [**Cablofil; Legrand North America, LLC**]
   d. [**Chalfant Manufacturing Company**]
   e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   f. [**Enduro Composites Inc.**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**MonoSystems, Inc**]
   i. [**MP Husky USA Cable Tray & Cable Bus**]
   j. [**Niedax Inc.**]
   k. [**Snaketray**]
   l. [**WBT LLC**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Cope**]
   b. [**BASOR Electric**]
   c. [**Cablofil; Legrand North America, LLC**]

d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**MP Husky USA Cable Tray & Cable Bus**]
j. [**Niedax Inc.**]
k. [**Snaketray**]
l. [**WBT LLC**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

   a. Configuration: [**Galvanized-**]steel wire mesh, complying with NEMA VE 1.
   b. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
   c. Splicing Assemblies: Bolted type using serrated flange locknuts.
   d. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

   a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
   b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
   d. Finish:

      1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
      2) Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
      3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
      4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

         a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
         b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
         c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

      5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
      6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
      7) <**Insert finish**>.

6. Options:

a. Width: [**2 inch (50 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**][**8 inch (200 mm)**][**12 inch (300 mm)**][**16 inch (400 mm)**][**18 inch (450 mm)**][**20 inch (500 mm)**][**24 inch (600 mm)**] unless otherwise indicated on Drawings.
b. Minimum Usable Load Depth: [**1 inch (25 mm)**][**2 inch (50 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**].
c. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
d. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.

E. UL CYNW - Single-Rail Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Cope**]
   b. [**Cable Management Solutions, Inc.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MonoSystems, Inc**]
   e. [**MP Husky USA Cable Tray & Cable Bus**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Cope**]
   b. [**Cable Management Solutions, Inc.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MonoSystems, Inc**]
   e. [**MP Husky USA Cable Tray & Cable Bus**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

   a. Configuration: An extruded-aluminum assembly, consisting of a single longitudinal center rail with transverse rungs arranged symmetrically about the center rail complying with NEMA VE 1.
   b. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
   c. Radius-Fitting Rung Spacing: **9 inch (225 mm)** at center of tray's width.
   d. Support Point: Splice fittings must be hanger support point.
   e. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
   f. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
   g. Splicing Assemblies: Bolted type using serrated flange locknuts.
   h. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
   i. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

5. Materials: Aluminum alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
6. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].

    a. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Options:

    a. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**] unless otherwise indicated on Drawings.
    b. Minimum Usable Load Depth: [**3 inch (75 mm)**][**4 inch (100 mm)**][**5 inch (125 mm)**][**6 inch (150 mm)**].
    c. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
    d. Rung Spacing: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**] on center.
    e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
    f. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

F. UL CYNW - Solid-Bottom Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Atkore Cope**]
    c. [**BASOR Electric**]
    d. [**Chalfant Manufacturing Company**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**MonoSystems, Inc**]
    g. [**MP Husky USA Cable Tray & Cable Bus**]
    h. [**Niedax Inc.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Atkore Cope**]
    c. [**BASOR Electric**]
    d. [**Chalfant Manufacturing Company**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**MonoSystems, Inc**]
    g. [**MP Husky USA Cable Tray & Cable Bus**]
    h. [**Niedax Inc.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. General Characteristics:

    a. Configuration: Two longitudinal side rails with a nonventilated continuous bottom.
    b. No portion of the continuous bottom must protrude below the bottom plane of side rails.
    c. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
    d. Splicing Assemblies: Bolted type using serrated flange locknuts.
    e. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

    a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
    b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
    c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
    d. Finish:

        1) Mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
        2) Electrogalvanized before fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
        3) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
        4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

            a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
            b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
            c) Epoxy-Resin Topcoat: Cold-cured epoxy gloss, MPI# 77.

        5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
        6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
        7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

    a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
    b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
    c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

    a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
    b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM

F593 and ASTM F594.

8. Options:

a. Width: [6 inch (150 mm)][9 inch (225 mm)][12 inch (300 mm)][18 inch (450 mm)][24 inch (600 mm)][30 inch (750 mm)][36 inch (900 mm)] unless otherwise indicated on Drawings.
b. Minimum Usable Load Depth: [3 inch (75 mm)][4 inch (100 mm)][5 inch (125 mm)][6 inch (150 mm)].
c. Straight Section Lengths: [10 ft (3.0 m)][12 ft (3.7 m)][20 ft (6.0 m)][24 ft (7.4 m)], except where shorter lengths are required to facilitate tray assembly.
d. Fitting Minimum Radius: [12 inch (300 mm)][24 inch (600 mm)][36 inch (900 mm)][48 inch (1200 mm)].
e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
f. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

G. UL CYNW - Trough Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cablofil; Legrand North America, LLC**]
c. [**Chalfant Manufacturing Company**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**MonoSystems, Inc**]
f. [**MP Husky USA Cable Tray & Cable Bus**]
g. [**Niedax Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cablofil; Legrand North America, LLC**]
c. [**Chalfant Manufacturing Company**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**MonoSystems, Inc**]
f. [**MP Husky USA Cable Tray & Cable Bus**]
g. [**Niedax Inc.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Splicing Assemblies: Bolted type using serrated flange locknuts.
b. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish:

1) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
2) Hot-dip mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

a. Configuration:

1) A [**flat**][**corrugated**] bearing surface with a [**solid**][**ventilated**] bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.
2) Single, formed sheet with a [**solid**][**ventilated**] bottom, complying with NEMA VE 1.

b. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**][**36 inch (900 mm)**] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [**3 inch (75 mm)**][**4 inch (100 mm)**][**5 inch (125 mm)**][**6 inch (150 mm)**].
d. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.6 m)**][**20 ft (6.0 m)**][**24 ft (7.4 m)**], except where shorter lengths are required to facilitate tray assembly.
e. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**][**36 inch (900 mm)**][**48 inch (1200 mm)**].
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

H. UL CYNW - Channel Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Cope**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MP Husky USA Cable Tray & Cable Bus**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Cope**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MP Husky USA Cable Tray & Cable Bus**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

   a. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
   b. Splicing Assemblies: Bolted type using serrated flange locknuts.
   c. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
   b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

d. Finish:

1) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**Stainless steel, Type 316**] hardware.
2) Hot-dip mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

a. Configuration: Single, formed sheet with a [**solid**][**ventilated**] bearing surface, complying with NEMA VE 1.
b. Width: [**3 inch (75 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [**1-1/4 inch (30 mm)**][**2 inch (50 mm)**].
d. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
e. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**][**36 inch (900 mm)**][**48 inch (1200 mm)**].
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.

g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

2.2 NONMETALLIC CABLE TRAYS

A. Description: This product category covers nonmetallic, including fiberglass (fiberglass-reinforced plastic), cable trays and cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN CYOV; including UL 568.

C. UL CYOV - Fiberglass Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Atkore Cope**]
d. [**Cablofil; Legrand North America, LLC**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Atkore Cope**]
d. [**Cablofil; Legrand North America, LLC**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Configuration: Two longitudinal members with rounded edges and smooth surfaces, supporting a bearing surface, complying with NEMA FG 1.

b. Temperature Rating: Reduce the load rating of trays exposed to temperatures above **75 deg F (24 deg C)** in accordance with Table 4-3, "Working Loads," in NEMA FG 1.
c. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates must be furnished with straight sections and fittings.
d. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
e. Fasteners: Fiberglass-encapsulated, ASTM F593 and ASTM F594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation must not be damaged when torqued to manufacturer's recommended value.

5. Options:

a. Materials: Straight section structural elements; side rails, rungs, and splice plates must be pultruded from glass-fiber-reinforced [**polyester**][**vinyl ester**] resin, complying with NEMA FG 1 and UL 568.
b. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**][**36 inch (900 mm)**] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [**1 inch (25 mm)**][**2 inch (50 mm)**][**3 inch (75 mm)**][**5 inch (125 mm)**][**7 inch (175 mm)**] in accordance with NEMA FG 1.
d. Straight Section Lengths: [**10 ft (3.0 m)**][**20 ft (6.0 m)**].
e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
f. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**].
g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

D. UL CYOV - Fiberglass Channel Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Enduro Composites Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Enduro Composites Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Temperature Rating: Reduce the load rating of trays exposed to temperatures above **75 deg F (24 deg C)** in accordance with Table 4-3, "Working Loads," in NEMA FG 1.
b. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates must be furnished with straight sections and fittings.
c. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
d. Fasteners: Fiberglass-encapsulated, ASTM F593 and ASTM F594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation must not be damaged when torqued to manufacturer's recommended value.

5. Options:

a. Configuration: Two longitudinal members with rounded edges and smooth surfaces, supporting a [**solid**][**ventilated**] bearing surface, complying with NEMA FG 1.
b. Materials: Straight section structural elements; side rails, rungs, and splice plates must be pultruded from glass-fiber-reinforced [**polyester**][**vinyl ester**] resin, complying with NEMA FG 1 and UL 568.
c. Width: [**3 inch (75 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**] unless otherwise indicated on Drawings.
d. Minimum Usable Load Depth: [**1-1/4 inch (30 mm)**][**2 inch (50 mm)**].
e. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
g. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**].
h. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

2. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate cable trays.
3. Factory Tests and Inspections: Perform the following tests and inspections on cable trays, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

    a. Test and inspect cable trays in accordance with [**NEMA FG 1**][**NEMA VE 1**].

4. Nonconforming Work:

    a. Equipment that does not pass tests and inspections will be considered defective.

5. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following for each cable tray system:

1. Cable Tray Fabrication Drawings, Diagrams, and Supporting Documents:

    a. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
    b. Include load calculations to show that dead and live loads do not exceed manufacturer's rating for tray and its support elements.
    c. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

        1) Vertical and horizontal offsets and transitions.
        2) Clearances for access above and to sides of cable trays.
        3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.

3.2 INSTALLATION OF CABLE TRAYS

A. Install cable tray and support systems in accordance with [**NEMA FG 1**][**NEMA VE 2**].

B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

F. Fasten cable tray supports to building structure[**and install seismic restraints**].

G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of **200 lb (90 kg)**. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."[**Comply with seismic-restraint details in accordance with Section 260548.16 "Seismic Controls for Electrical Systems."**]

H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with [**center support hangers**][**trapeze hangers**][**wall brackets**].

N. Support [**center support hangers**][**trapeze hangers**] for wire-basket trays with [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**] diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps in accordance with applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers.

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers[**and cover clamps**], if used, after installing cable.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.3 CABLE TRAY GROUNDING

A. Ground cable trays in accordance with NFPA 70 unless additional grounding is specified.

B. Cable trays with electrical power conductors must be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors must be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at **72 inch (1800 mm)** intervals. The grounding conductor must be sized in accordance with Article 250 and Article 392 of NFPA 70.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized in accordance with Article 250 of NFPA 70.

3.4 INSTALLATION OF CABLES

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every **18 inch (450 mm)**.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure must be no more than **72 inch (1800 mm)**.

E. Tie mineral-insulated cables down every **36 inch (900 mm)** where required to provide a two-hour fire rating and every **72 inch (1800 mm)** elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.5 FABRICATION OF CONNECTION POINTS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays in accordance with requirements in NEMA VE 2 and NEMA FG 1.

3.6 INSTALLATION OF CABLE TRAY MARKINGS AND SIGNS

A. Trays Containing Cables Operating Over 600 V: Provide hazard markings in accordance with Section 392.18 of NFPA 70 and with NEMA Z535.4.

1. Legend: "DANGER - HIGH VOLTAGE - KEEP AWAY."

B. Ladder Cable Trays: Provide warning signs to prevent use as personnel ladder.

1. Lettering: [**1-1/2 inch (40 mm)**]<**Insert dimension**> high.
2. Legend: "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ω.

D. Nonconforming Work:

1. Cable tray will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.8 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and must remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 05 36 00

Task	Specification	Specification Description
26 05 36 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 39 00 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underfloor raceway products.
2. Underfloor raceway fittings.
3. Maintenance material items.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. [**Section 013100 "Project Management and Coordination"**] specifies preinstallation conference procedures.
3. Section 033000 "Cast-in-Place Concrete" specifies installation of concrete surrounding underfloor raceways.
4. Section 034100 "Precast Structural Concrete" specifies precast concrete units used as cellular concrete floor raceways.
5. Section 053100 "Steel Decking" specifies rough-in of underfloor duct distribution system.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of wiring for the Work specified in this Section.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies installation of grounding and bonding for the Work specified in this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies installation of cover plates for outlet, device, and junction boxes.
9. Section 260553 "Identification for Electrical Systems" specifies installation of labels and warning signs for the Work specified in this Section.
10. Section 262726 "Wiring Devices" specifies installation of receptacles and connectors.
11. Section 271513 "Communications Copper Horizontal Cabling" specifies installation of twisted pair jacks, outlets, assemblies, and cover plates.
12. Section 271523 "Communications Optical Fiber Horizontal Cabling" specifies installation of optical fiber jacks, outlets, assemblies, and cover plates.
13. Section 271533 "Communications Coaxial Horizontal Cabling" specifies installation of coaxial jacks, outlets, assemblies, and cover plates.

1.2 DEFINITIONS

A. Activation: Nomenclature used by some manufacturers for a service fitting.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For coordination of structural, electrical, and interior finishes Work for installation of underfloor raceways. Conduct meeting(s) [**at the Project site**][**as web conference**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner]** of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents Detailing Fabrication and Assembly of Underfloor Raceways:

a. Include floor plans, elevations, sections, and details.
b. Identify components and accessories, such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
c. Detail preparation and installation methods and instructions.
d. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
e. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept. Provide separate charts for power and communication conductors and cables.
f. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements, including slab reinforcement, floor finish work, permanent partitions, expansion joints [**architectural module lines**][**and pretensioning or post-tensioning components**] .
g. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
h. Indicate thickening of slabs where required for adequate encasement of raceway components.
i. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
j. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
k. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.

l. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:

1) Power.
2) Voice.
3) Data.
4) Signal.
5) Communications.

C. Samples for Verification: For each underfloor raceway product, in specified finish, including the following:

1. Service fittings and flush and recessed outlet and junction-box covers.
2. A section of each service raceway configuration, with specified preset insert and service fitting installed.
3. A junction box of each size and type for use with underfloor raceway.
4. A section of each header raceway configuration, complete with provisions for connection with service raceway.
5. A section of trench-type raceway, complete with cover and required trim.
6. A junction box of each size and type for use with trench-type raceway, complete with cover and trim.

D. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For each type of specified product.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For underfloor raceways.

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Manufacturer's published instructions for locating preset inserts and for installing afterset inserts.
b. Dimensioned locations for all ducts, junction boxes, and preset inserts. Typical spacing designation must be accepted only for preset insert spacing along a continuous length of duct.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] .

2. Component Importance Factor (Ip): [**1.0**][**1.5**] .

3. Component Amplification Factor (ap): [**1.0**][**2.5**].

4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 UNDERFLOOR RACEWAY PRODUCTS

A. Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MonoSystems, Inc**]
b. [**Square D; Schneider Electric USA**]
c. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

    a. Product Reference Standard(s): Article 390 of NFPA 70.
    b. Configuration: Steel, rectangular, flat-top, single-channel raceways with premanufactured inserts.
    c. Materials: One-piece, continuous weld, minimum **0.0598 inch (1.5 mm)** thick steel, with [**corrosion-resistant**][**galvanized**] coating inside and out after welding.
    d. Cross-Section Shape: Rectangular, with rounded corners.

    e. Number of Longitudinal Channels: [**Two**][**Three**][**Four**] , separated by steel wall(s).

    f. Number of Levels: [**One**][**Two**] .

    g. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

    a. Nominal Multichannel Underfloor Raceway Dimensions:

        1) Depth: **1-3/8 inch (35 mm)**.
        2) Overall Width: [**6 inch (150 mm)**][**10 inch (250 mm)**][**15 inch (375 mm)**].
        3) Power Service Channel Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].
        4) Communication Service Channel Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**].

    b. Nominal Single-Channel Underfloor Raceway Dimensions:

        1) Depth: **1-1/2 inch (38 mm)**.
        2) Power Service Raceway Width: **3-1/4 inch (81 mm)**.
        3) Communication Service Raceway Width: [**3-1/4 inch (81 mm)**][**6 inch (150 mm)**] .

        4) Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**][**Four**][**Five**] unless otherwise indicated.

    c. Preset Inserts: [**Rectangular**][**Round**] .

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center.

            a) Rectangular Insert Size: Rectangular dimensions as required to accommodate mounting and connection of flush- and surface-mounted, [**single-**][**and multiple-**] outlet service fittings or to connect to wiring extensions for feeding wall outlets for [**power**][**communications**][**power and**

communications].

b) Round Insert Size: [**2 inch (50 mm)**] in diameter.

2) Equip each insert with a disposable cover, and select insert height so cover is **1/8 inch (3 mm)** below surface of concrete.

3) Arrange insert for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to [**flush**][**surface**] outlet-mounting connector, jack, and receptacle devices.

6. Header Raceways: [**Single-**][**Multi**] channel, without preset inserts (blank raceway).

a. Nominal Raceway Dimensions:

1) Depth: [**Same as service raceways**][**2-1/2 inch (63 mm)**][**2-3/4 inch (69 mm)**][**3 inch (75 mm)**][**3-1/2 inch (88 mm)**] .

2) Power Header Raceway Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].

3) Communication Header Raceway Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**] .

b. Arrangement: [**In same plane as**][**Below**] service raceways.

c. Connections: Arranged to connect with service raceways at [**single**][**two**] -level junction boxes.

B. Flush, Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.

3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: [**Single**][**multichannel**] underfloor raceways installed on floor slab with top of raceway flush with concrete topping added hereafter, and then covered with finish material.

b. Material: Steel.

c. Cross-Section Shape: Rectangular, [**single channel**][**and**][**multichannel, separated by steel wall(s)**] .

d. Listed and labeled for installation with top flush with concrete floor.

e. Number of Levels: One.

5. Service Raceways: Fitted with preset inserts.

    a. Number of Longitudinal Channels per Multichannel Raceway: [**Two**][**Three**] .

    b. Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**] unless otherwise indicated.
    c. Nominal Channel Dimensions: **3 inch (75 mm)** wide by **1-1/4 inch (31 mm)** deep.
    d. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center, full length of each service raceway.
        2) Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
        3) Size: **1-5/8 inch (41 mm)** diameter.

6. Trench Duct Crossunder: Fitting attached to underside of trench duct.

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: Offset by depth of trench duct.
    c. Connections: Arranged to connect trench duct to flush duct through factory-cut, grommeted openings.

7. Header Raceways: Raceways same as service raceways, except without preset inserts (blank raceway).

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: In same plane as service raceways.
    c. Connections: Arranged to connect with service raceways at junction boxes.

C. Cellular Metal, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ASC Steel Deck; ASC Profiles, LLC**]
    b. [**Dennis Filges Company, Inc**]
    c. [**Epic Metals Corporation**]
    d. [**HH Robertson**]
    e. [**United Steel Deck, Inc.**]
    f. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: Multichannel, cellular, underfloor service raceways installed on floor slab with top of raceway flush concrete topping added hereafter, and then covered with finish material.
b. Material:

1) Galvanized-steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)** minimum, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2) Galvanized- and shop-primed steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.

c. Number of Longitudinal Cells: Three, separated by steel walls.
d. Nominal Dimensions of Cells:

1) Overall Depth: **1-1/4 inch (31 mm)** unless otherwise indicated.
2) Cross-Sectional Area of Cells: Power cells: **5-1/2 sq. inch (34.4 sq. cm)**; communication system cells: **16 sq. inch (100 sq. cm)**.

e. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

a. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts must be provided throughout the entire length of each such raceway.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-outlet service fitting.
3) Include mounting and connecting provisions for a surface, single- or multiple-outlet service fitting.
4) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
5) Equip each insert with a disposable cover plate arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

6. Header Assembly: A junction box and raceway arrangement positioned to feed wires and cables to service raceways.

a. Three-compartment junction box connecting blank, [**multicell cellular**][**flat-top, multichannel**] header raceway (no inserts) with cellular service raceways at right angles to header raceway.
b. Cellular header raceway must be made of the same material and have the same nominal dimensions as service raceways.
c. Provide capability for service raceways to be run in both perpendicular directions at the intersection with header raceway.

D. Trench-Type, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Dennis Filges Company, Inc**]
b. [**HH Robertson**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Square D; Schneider Electric USA**]
e. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

   a. Configuration: Trench-type raceways used as header or feeder raceways to serve service raceways.
   b. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:

      1) Slab Depth Adjustment: Minimum of minus **1/8 inch (3 mm)** to plus **5/8 inch (17 mm)** before and during concrete placement.
      2) Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
      3) Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
      4) Trim Strip: Select to accommodate floor finish material.
      5) Partitions: Arranged to separate channels and isolate wiring of different systems.

      6) Grommeted openings in active floor cells or service raceways.
      7) Manufacturer's standard corrosion-resistant finish, applied after fabrication.

   c. Cover Plates: Removable, steel plates, **1/4 inch (6 mm)** thick, each weighing **60 lb. (27 kg)** or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to [**15 inch (375 mm)**] or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

2.3 UNDERFLOOR RACEWAY FITTINGS

A. Electrical Connection Components for Cellular Steel Floor Decks:

1. Source Limitations for Electrified Cellular Steel Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular steel floor-deck manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Preset Inserts: Rectangular metal-housing assemblies.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Size: As required to provide electrical outlet access to each cell of each group of three cells that is designated for electrical service raceway use.
3) Equip each insert with a disposable cover arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable cover.

4) Include housing and connecting provisions for a [**flush or recessed**][**surface**] service fitting, [**single**][**double**][**triple**] outlet.
5) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.

B. Electrical Connection Components for Cellular Concrete Floor Decks:

1. Source Limitations for Electrified Cellular Concrete Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular concrete floor-deck manufacturer or from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Afterset Inserts: Round metal-nipple assembly with internal and external threading, arranged to screw into plug driven into **1-7/8 inch (47 mm)** hole drilled through floor fill, where present, and deck-cell wall into floor raceway cell.

1) Inserts must be compatible with floor-mounting service fittings.
2) Inserts must provide wiring path from cell to [**power**][**communication**][**power and communication**]
[**wall**][**and**][**ceiling**] outlets.
3) Inserts must provide wiring path from cell to header raceway.

C. Underfloor Raceway Service Fittings/Activations:

1. Source Limitations: Obtain underfloor raceway service fittings and hardware for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Exposed Parts Finish: [**Brass**][**Brushed aluminum**].

c. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.

1) Connector, Jack, and Receptacle Devices: Single modular type.
2) Power Receptacle Outlet: Suitable for 20 A, 120 V device.

d. Flush System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.

1) System Type: [**Single**][**multiple**] .
2) Connector, Jack, and Receptacle Devices: Modular type.
3) Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.

4) Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies.

e. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.

1) Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
2) Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
3) Communication-outlet, double-faced, surface-mounted unit.

a) Include bushed openings on both sides; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly on both sides.
c) Include provisions for modular dual jack-connector assembly, rated for [**Category 5**][**Category 5e**][**Category 6**] on both sides.

4) Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
5) Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.

a) Include bushed opening; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly.
c) Include provisions for modular dual jack-connector assembly, rated for

[**Category 5**][**Category 5e**][**Category 6**] .

6) Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and must include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush covers, recessed to suit floor finish material.

7) Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of [**ERMC**][**FMC**][**ENT**][**Type MC cable**] for power extensions, and [**ERMC**][**FMC**][**ENT**][**optical fiber/communication cable raceway**] for communication system extensions.

D. Underfloor Raceway Adapter Fittings:

1. Source Limitations: Obtain underfloor raceway adapter fittings for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

   a. Product Reference Standard(s): Article 390 of NFPA 70.
   b. Description: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.
   c. Compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.

E. Underfloor Raceway Supports and Hardware:

1. Source Limitations: Obtain underfloor raceway supports and hardware components for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

   a. Product Reference Standard(s): Article 390 of NFPA 70.
   b. Supports and hardware must be compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.
   c. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.

F. Underfloor Raceway Junction Boxes:

1. Configuration: Raceway manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:

   a. Mounting brackets.
   b. Escutcheons and holders to accommodate surrounding floor covering.
   c. Means for leveling and height adjustment more than **3/8 inch (10 mm)** before and after concrete is placed.
   d. Boxes must withstand a minimum [**300 lb (136 kg)**] concentrated load. Internal supports must be provided as needed to meet this requirement.
   e. All boxes must provide **2 inch (50 mm)** minimum bend radius for data and communication cables.
   f. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.

   g. Covers must have appropriate depth recess to receive specific floor finish material.
   h. Partitions to separate wiring of different systems.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to the Owner spare parts, for repairing underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Afterset Inserts:

   a. Furnish quantity equal to [**10**] percent of service fittings installed, but no fewer than units.
   b. Furnish quantity equal to [**5**] percent of each type of preset insert installed, but no fewer than units.

2. Service Fittings: Furnish [**three**] of each type of service fitting indicated for each **100 ft (30 m)** of distribution raceway or active-floor-cell length.
3. Outlet Blanking Covers: Furnish quantity equal to [**10**] percent of each type of floor opening installed for outlets.

B. Special Tools: Furnish to the Owner proprietary or special equipment required to operate, maintain, repair, adjust, or implement future changes to underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Electronic Instruments: Furnish [**one**] electronic instrument(s) and accessories, in accordance with underfloor raceway manufacturer's published instructions for detecting, locating, and uncovering preset inserts in metal raceway under floor covering and up to **3/8 inch (10 mm)** of concrete fill.
2. Electric Drill: Furnish [**one**] variable-speed electric drill(s), **1/2 inch (13 mm)** capacity.

3. Hole Saw: Furnish [**one**] diamond bit hole saw(s), for dry concrete, [**2 inch (50 mm)**] size.
4. Afterset Insert Installation Tool: Furnish [**one**] installation tool(s) selected in accordance with manufacturer's published instructions for installing afterset inserts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.
8. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
12. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
13. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for underfloor raceway products and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

   d. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.

      1) Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
      2) Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
      3) Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
      4) Use another distinctive screw head to identify third system, such as special-purpose wiring.

2. Grounding and Bonding:

a. Equipment Grounding Conductors: Provide and route insulated equipment grounding conductors with other feeder or branch circuit conductors. Bond equipment grounding conductor to underfloor raceway products using provided hardware in accordance with manufacturer's published instructions.
b. Equipment Bonding Conductors: Provide equipment bonding straps or jumpers where additional bonding is indicated on the Drawings between underfloor raceway products and adjacent metallic equipment, enclosures, piping, or building structure. Route bonding conductors along shortest and straightest paths possible unless otherwise indicated or required by NFPA 70. Avoid obstructing access panels or placing conductors where they may be subjected to strain, impact, or damage.

3. Coordinate installation of new underfloor raceway products with existing conditions.
4. Coordinate installation of underfloor raceway products with installation of concrete.

3.3 INSTALLATION OF UNDERFLOOR RACEWAY PRODUCTS

A. Install underfloor raceway products aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.

B. Maintain arrangement of conductor services throughout the raceway system.

C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top **1 inch (25 mm)** of concrete.

D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth.

E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed **60 inch (1500 mm)**, to prevent movement during concrete pour.

F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

G. Underfloor Raceway Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of the Work.

H. Install preset inserts per manufacturer's instructions.

I. Adjust supports to maintain a **1/8 to 3/8 inch (3.0 to 10 mm)** finished concrete cover over preset inserts.

J. Remove burrs, sharp edges, dents, and mechanical defects.

K. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

L. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.

M. Ground and bond underfloor raceway components to create a continuous bonding path.

N. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints or seal with compound, in accordance with underfloor raceway manufacturer's published instructions.

O. Install concrete surrounding underfloor raceways.

P. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.

Q. Wiring must comply with NFPA 70 requirements for wet locations.

1. Install wiring from outlet insert toward junction boxes, then to termination at panel.
2. Splices: All splices and taps must be made in junction boxes. No splices or taps must be made in raceways or outlet inserts.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections, including Grounding:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field QC tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**], as directed by the Owner.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform visual inspection of interior of each [**junction box**][**section of trench raceway**] to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
3. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.

   a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 Ω.
   b. Comply with NETA Acceptance Testing Specification about safety, suitability of test equipment, test instrument calibration, and test report and records.

D. Nonconforming Work:

1. Underfloor raceway products will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field QC Reports: Collect, assemble, and submit test and inspection reports.

3.5 CLEANING

A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

3.6 PROTECTION

A. Protect underfloor raceway products from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps must be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction must be replaced.

END OF SECTION 26 05 39 00

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Task	Specification	Specification Description
26 05 39 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 43 00 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.
4. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
5. Section 260553 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For concrete and steel used in precast concrete [**manholes**][**and**][**handholes**], also include product certificates as required by ASTM C858.

B. Sustainable Design Product Data:

1. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Electric Utility Duct Banks and Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Indicate locations of private property boundaries and utility easements.
c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Precast or Factory-Fabricated Concrete Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include [**ladder**][**step**] details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
h. Include joint details.

3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

B. Field Reports:

1. Factory Test Reports: For handholes and boxes.
2. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651A and UL CCN EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. **<Insert manufacturer's name>**

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. **<Insert manufacturer's name>**

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type B.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.2 TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6A and UL CCN DYWV.

B. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Material: Stainless steel.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Colors: As indicated on Drawings.

2.3 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Allied Tube & Conduit; Atkore International**]
   b. [**Calconduit; Atkore International**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**Patriot Aluminum Products, LLC**]
   f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
   g. [**Topaz Lighting & Electric**]
   h. [**Western Tube; Zekelman Industries**]
   i. [**Wheatland Tube; Zekelman Industries**]
   j. **<Insert manufacturer's name>**

2. Exterior Coating: Zinc.
3. Options:

   a. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
   c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Bluesteel Services LLC**]
   c. [**Calbond; Atkore International**]
   d. [**KorKap; Robroy Industries**]
   e. [**Perma-Cote; Robroy Industries**]
   f. [**Plasti-Bond; Robroy Industries**]
   g. **<Insert manufacturer's name>**

2. Additional Characteristics:
3. Fittings for PVC-Coated Conduit:

   a. Minimum coating thickness of **0.040 inch**, with overlapping sleeves protecting threaded joints.
   b. Conduit bodies must be Form 8 with effective seal and positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig

(positive) and 25 inch Hg (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.

c. Form **2 inch** long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
d. PVC coating on outside of conduit couplings must be protected from tool damage during installation.
e. Female threads on fittings and couplings must be protected by urethane coating.
f. Fittings must be from same manufacturer as conduit.
g. Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover exposed portions of threads.

4. Options:

a. Exterior Coating: PVC complying with NEMA RN 1[**and marked ETL Verified PVC-001**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.
e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.4 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Topaz Lighting & Electric**]
f. [**Western Tube; Zekelman Industries**]
g. [**Wheatland Tube; Zekelman Industries**]
h. **<Insert manufacturer's name>**

2. Options:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.

2.5 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Calconduit; Atkore International**]
   c. [**JM Eagle**]
   d. [**NAPCO; Westlake Chemical Corp.**]
   e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
   f. [**Topaz Lighting & Electric**]
   g. **<Insert manufacturer's name>**

2. Dimensional Specifications: Schedule 40.
3. Options:

   a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
   b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Calconduit; Atkore International**]
   c. [**JM Eagle**]
   d. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
   e. [**Topaz Lighting & Electric**]
   f. **<Insert manufacturer's name>**

2. Dimensional Specifications: Schedule 80.
3. Options:

   a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
   b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Southern Pipe, Inc.**]
b. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type EB.
3. Options:

a. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

2.6 TYPE RTRC-BG RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

B. Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Konkore Fittings; Atkore International**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. **<Insert manufacturer's name>**

2. General Characteristics: UL 514B and UL CCN DWTT.
3. Options:

a. Material: [**Steel**][**Die cast**].
b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.8 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. **<Insert manufacturer's name>**

2.9 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:

a. VOC Content: [**510**][**490**]<**Insert value**> g/L or less for [**PVC**][**CPVC**] conduit and fittings.
b. Low-Emitting Material Requirements: As recommended by solvent and adhesive manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Solvent Cements for Type PVC Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

2.11 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Cast-in-Place Concrete Manholes:

1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

2. Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."

2.12 SOURCE QUALITY CONTROL

A. Factory Tests for Handholes and Boxes:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified structural testing agency to evaluate handholes and boxes.

a. Tests of materials must be performed by independent testing agency.
b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified testing laboratory's**] certification of system compliance.

a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

3. Nonconforming Work:

a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in [**single duct run or duct bank**][**on Project**] must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.

4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than **3/4 inch**.
6. Curves and Bends:

    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**], both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**]. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.

7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

    a. Install insulated grounding bushings on steel raceway terminations that are less than **12 inch** below grade or floor level and do not terminate in hubs.

8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above **104 deg F**. Where environmental temperatures are calculated to rise above **104 deg F**, and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of **104 deg F**.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inch** o.c. for **5 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to end-bell spacing **10 ft** from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.

10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately **6 inch** o.c. for **4 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to terminator spacing **10 ft** from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least **10 ft** outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15 psig** hydrostatic pressure.
14. Pulling Cord: Install **200 lbf** test nylon cord in empty ducts.
15. Concrete-Encased Ducts and Duct Bank:

    a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes **6 inch** or less in nominal diameter.
    b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
    c. Depth: Install so top of duct envelope is at least **24 inch** below finished grade in areas not subject to deliberate traffic, and at least **30 inch** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
    d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
    e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    f. Minimum Space between Ducts: **3 inch** between edge of duct and exterior envelope wall, **2 inch** between ducts for like services, and **4 inch** between power and communications ducts.
    g. Elbows:

        1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
        2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of equipment base.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and minimum **3 inch** from conduit side to edge of slab.

    i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and no less than **3 inch** from conduit side to edge of slab.

    j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
    k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
    l. Concrete Cover: Install minimum of **3 inch** of concrete cover between edge of duct to exterior envelope wall, **2 inch** between duct of like services, and **4 inch** between power and communications ducts.
    m. Place minimum **6 inch** of engineered fill above concrete encasement of duct.
    n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
2) If more than one pour is necessary, terminate each pour in vertical plane and install **3/4 inch** reinforcing-rod dowels extending minimum of **18 inch** into concrete on both sides of joint near corners of envelope.

o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

16. Direct-Buried Duct and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inch** in nominal diameter.
b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
c. Depth: Install top of duct at least **36 inch** below finished grade unless otherwise indicated.
d. Set elevation of top of duct bank below frost line.
e. Place minimum **3 inch** of sand as bed for duct. Place sand to minimum of **6 inch** above top level of duct.
f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
h. Install duct with minimum of **3 inch** between ducts for like services and **6 inch** between power and communications duct.
i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.

1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete.
2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of base. Install insulated grounding bushings on terminations at equipment.

a) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inch above**] finished base and minimum **3 inch** from conduit side to edge of base.

3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.
4) Stub-ups through interior floors must [**terminate in coupling installed flush**

with][**be minimum 4 inch above**] finished floor and no less than **3 inch** from conduit side to edge of equipment pad or floor slab.

k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inch** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

17. Warning Planks: Bury warning planks approximately **12 inch** above direct-buried duct, placing them **36 inch** o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional planks **12 inch** apart, horizontally across width of ducts.
18. Underground-Line Warning Tape: Bury [**nonconducting**][**conducting**] underground line specified in Section 260553 "Identification for Electrical Systems" no less than **12 inch** above concrete-encased duct and duct banks[**and approximately 12 inch below grade**]. Align tape parallel to and within **3 inch** of centerline of duct bank. Provide additional warning tape for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional tapes **12 inch** apart, horizontally across width of ducts.
19. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.2 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:

   a. Finish interior surfaces with smooth-troweled finish.
   b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inch** thick, arranged as indicated.
   c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

2. Precast Concrete Handholes and Manholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from **1 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3. Elevations:

a. Manhole Roof: Install with rooftop at least **15 inch** below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch** above finished grade.
c. Install handholes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.

a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
b. Install chimney, constructed of [**precast concrete**][**cast-iron**] collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.

6. Waterproofing: Apply waterproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Waterproofing materials and installation are specified in [**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**]<**Insert waterproofing Section**>. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [**and**]cable arms, [**and insulators,**]as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inch** for manholes and **2 inch** for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing

conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. <**Insert reference standard**> for <**Insert reason**>.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from **1/2 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
4. Install handholes and boxes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in [**asphalt paving**][**and**]<**Insert material**> and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on [**compacted earth**]<**Insert material**>.

   a. Concrete: **3000 psi**, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
   b. Dimensions: [**10 inch wide by 12 inch deep**]<**Insert dimensions**>.

8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing**

related Work>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch** long mandrel equal to duct size minus **1/4 inch**. If obstructions are indicated, remove obstructions and retest.
3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

D. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

END OF SECTION 26 05 43 00

Task	Specification	Specification Description
26 05 43 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 05 43 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 43 00	26 05 33 13	Conduits for Electrical Systems
26 05 43 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 43 00	27 11 00 00	Communications Equipment Room Fittings
26 05 43 00	27 13 13 00	Communications Copper Backbone Cabling
26 05 43 00	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 46 00 - POLES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting standards.
2. Lighting standard accessories.
3. Utility poles.
4. Utility pole accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding components referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. [**Section 262726 "Wiring Devices"**][**Section 262726.31 "General-Grade Single Straight-Blade Receptacles"**][**and**][**Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles"**] specify receptacles referenced by this Section.
9. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.
5. Product Certificates: Include product certificate, signed by manufacturers of poles, certifying that products are designed for indicated load requirements in accordance with AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification must be based on design calculations signed and sealed by a professional engineer.
6. Include manufacturer's sample extended warranty language.

B. Samples: Submit finish samples for each exposed lighting pole, standard, and luminaire-supporting

device and for each color and texture specified.

C. Shop Drawings: Prepare and submit the following:

1. Plans, elevations, sections, and [**mounting**][**and**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Details of fabrication and assembly of [**poles**][**and**][**pole accessories**].
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's published installations.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. For each foundation component, by qualified testing laboratory.
2. For each pole, by qualified testing laboratory.

B. Soil test reports.

C. Manufacturer's published instructions.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period, including materials that corrode, fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Warranty Period for Corrosion Resistance: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
3. Warranty Period for Color Retention: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Description: <**Insert brief description of desired system, assembly, or equipment**>.

B. Performance Criteria:

1. Regulatory Requirements:

a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Utility Approval: Comply with <**Insert name of utility**> requirements.
3. General Characteristics:

a. Structural Characteristics: Comply with AASHTO LTS-6-M.
b. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied in accordance with AASHTO LTS-6-M.
c. Live Load: Single load of **500 lb** distributed in accordance with AASHTO LTS-6-M.
d. Ice Load: Load of **3 lb/ft2**, applied in accordance with AASHTO LTS-6-M for applicable areas on the Ice Load Map.
e. Wind Load for Poles Exceeding 50 ft (15 m) Height:

1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
3) Minimum Design Life: [**50 years**]<**Insert value from AASHTO LTS-6-M**>.
4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

f. Wind Load for Poles Not Exceeding 50 ft (15 m) Height:

1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
3) Minimum Design Life: [**25 years**]<**Insert value from AASHTO LTS-6-M**>.
4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

g. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of [**1.1**]<**Insert number**> to obtain the EPA used in pole selection strength analysis.
h. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
i. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.2 LIGHTING STANDARDS

A. Steel Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American LitePole**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Bridgewell Resources**]
d. [**Cooper Lighting Solutions; Signify North America Corp.**]
e. [**E-conolight**]
f. [**H.E. Williams**]
g. [**Hapco**]
h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**LSI Industries**]
l. [**Millerbernd Manufacturing Company**]
m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
n. [**RAB Lighting**]
o. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
p. [**Union Metal Industries Corp.**]
q. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Carbon Steel Poles: Comply with ASTM A500/A500M, Grade B carbon steel with a minimum yield of **46,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Stainless Steel Poles: Comply with [**ASTM A240/A240M**][**ASTM A666**], stainless steel with a minimum yield of **55,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

f. Steel Mast Arms: [**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.

g. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

h. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.

i. Grounding and Bonding Lugs: Welded **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

j. Steps: Fixed steel, with nonslip treads.

1) For climbing positions, install at **15 inch** vertical spacing, alternating on opposite sides of lighting standard, oriented 180 degrees from each other; first step must be at an elevation **10 ft** above finished grade.
2) For working positions, install steps on opposite side of lighting standard, oriented 180 degrees from each other at the same elevation.

k. Handhole: Oval shaped, with minimum clear opening of **2-1/2-by-5 inch**, with cover secured by stainless steel captive screws.

l. Intermediate Handhole and Cable Support: Weatherproof, **3-by-5 inch** handhole located at midpoint of lighting standard, with cover for access to internal welded attachment lug for electric cable support grip.

m. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

n. Platform for Lamp Ballast Servicing: Factory fabricated of steel, with finish matching that of lighting standard.

o. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

p. Galvanized Finish: After fabrication, hot-dip galvanize in accordance with ASTM A123/A123M.

q. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

r. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder-coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder Coat: Comply with AAMA 2604.

a) Electrostatic-applied powder coating; single application and cured to a minimum **2.5 to 3.5 mil** dry film thickness. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

B. Aluminum Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American LitePole**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Bridgewell Resources**]
d. [**Cooper Lighting Solutions; Signify North America Corp.**]
e. [**E-conolight**]
f. [**H.E. Williams**]
g. [**Hapco**]
h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**LSI Industries**]
l. [**Lyte Poles; brand of DWM Holdings, Inc.**]
m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
n. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
o. [**Sentry Electric, LLC**]

p. [**Union Metal Industries Corp.**]
q. [**Valmont Industries, Inc.**]
r. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. [**Seamed**][**Seamless**], extruded structural tube complying with ASTM B221, [**Alloy 6063-T6**][**Alloy 6061-T6**], with access handhole in in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Mast Arms: [**Aluminum**][**Steel**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.
f. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

g. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.
h. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
i. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
j. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
k. Aluminum Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3) Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin;

Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

4) Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

l. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

m. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder coat must comply with AAMA 2604.

a) Electrostatic applied powder coating; single application with a minimum **2.5 to 3.5 mil** dry film thickness; cured in accordance with manufacturer's published instructions. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

C. Fiberglass Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alliance; a division of GEOTEK**]
b. [**Bridgewell Resources**]
c. [**CMT; a Valmont Company**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**PLP Composite Technologies, Inc**]
f. [**Shakespeare; a Valmont Company**]
g. [**Valmont Industries, Inc.**]
h. [**Whately; a Valmont Company**]
i. [**Wood Preservers, Inc.**]
j. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole.
e. Not less than 65 percent by weight of fiberglass roving, with resin and pigment making up the remainder.
f. Roving must be continuously applied with uniform tension, with multiple layers placed to meet axial and compressive strength requirements.
g. Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
h. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
i. Surface Finish: Smooth and uniform along surface of lighting standard.
j. Paint Finish: Pigmented polyurethane, with a minimum dry film thickness of **1.5 mil**. Polyurethane may be omitted if the surface layer of the lighting standard is inherently UV inhibited.
k. Mast Arms: [**Aluminum**][**Steel**][**Fiberglass**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate. Adaptor plate must be steel hot-dip galvanized in accordance with ASTM A153/A153M or Alloy 6061-T6 aluminum encased within fiberglass roving, allowing the mast arm adaptor to be bolted to the lighting standard.
l. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor Fitting: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded within fiberglass roving, allowing the bracket to be bolted to the lighting standard-mounted adapter. Bolt together with [**stainless steel**][**galvanized-steel**] bolts; use anti-seize compound when bolting dissimilar metals.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

m. Pole-Top Tenons: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded to the fiberglass shaft. Fabricated to support luminaire or luminaires and brackets indicated.
n. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
o. Grounding: Bare, stranded copper, 6 AWG, [**suspended inside of lighting standard**][**inside 3/4 inch conduit fastened to the interior of the lighting standard**], connected to luminaire(s), ground lug near handhole, and ground rod.
p. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

4. Other Available Features Required by the Project:

a. Resin Color: [**Black**][**Dark**][**Bronze**]<**Insert color**>; uniform coloration throughout entire wall thickness.
b. Anchor Base: Integral galvanized-steel or aluminum casting, enclosing and permanently bonded to the exterior of the fiberglass shaft.
c. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

D. Laminated Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bell Lumber and Pole Company**]
b. [**Hughes Brothers, Inc.**]
c. [**Laminated Wood Systems, Inc.**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**McFarland Cascade**]
f. [**Timber Technologies, LLC**]
g. [**TimberWood Products; J.H. Baxter & Co.**]
h. [**Valmont Industries, Inc.**]
i. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Species and Grades for Structural Laminated Timber: Complying with APA A190.1. Use [**Southern pine**][**Douglas fir**][**Alaska cedar**][**any species listed in APA 117**], engineered and fabricated to withstand indicated structural loads without exceeding allowable design working stresses in accordance with [**APA 117**][**AWPA/ANSI O5.2**].
e. Features include [**wood bracket**][**wood crossarm**][**lighting standard-top adaptor**]<**Insert items**> for mounting luminaire(s), metal lighting standard cap, and concealed raceway path connected to access handhole.
f. Mounting Provisions: [**Embedded**]<**Insert description of other mounting unless detailed on the Drawings**>.
g. Appearance Grade: Architectural appearance grade complying with AITC 110.
h. Preservative Treatment:

1) Exposure: Comply with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
2) Treatment after Dressing and End Cutting: Comply with AWPA M4 for surface cuts to a depth of more than **1/16 inch**.

i. Adhesive: Wet-use type complying with ASTM D2559.
j. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
k. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
l. Finish: [**Natural, unstained wood**][**Semitransparent stain applied after erection**][**Factory-applied semitransparent stain**], color as selected by Architect.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Pole & Timber**]
b. [**Baldwin Pole & Piling Co., Inc.**]
c. [**Bell Lumber and Pole Company**]
d. [**Cavawood Architectural Products**]
e. [**Cobb Lumber Company**]

f. [**Cox Utility Products Division**]
g. [**Guelph Utility Pole Co., Ltd.; a Stella-Jones company**]
h. [**Koppers Performance Chemicals**]
i. [**Langdale Forest Products Company**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**McFarland Cascade**]
l. [**Stella-Jones**]
m. [**T.R. Miller Mill Co., Inc.**]
n. [**Texas Electric Cooperatives, Inc.**]
o. [**Thomasson Company**]
p. [**TimberWood Products; J.H. Baxter & Co.**]
q. [**United Wood Treating Company**]
r. [**Wood Preservers, Inc.**]
s. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

   a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
   b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   c. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

   d. [**Douglas fir**][**Southern yellow pine**], [**machine trimmed by turning,**] for wood species used; and bored, roofed, and grained before treatment.

      1) Pole Brand: Brand the manufacturer's trademark and date of treatment, height and class of lighting standard, wood species, preservation code, and retention. Brand must be placed so that the bottom of the brand is minimum **10 ft** from lighting standard butt.
      2) Mounting Provisions: Embedded.

   e. Preservative Treatment: Treat in accordance with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
   f. Luminaire Brackets: Comply with NEMA/ANSI C136.13.

4. Other Available Features Required by the Project:

   a. Fasteners: [**Stainless steel**][**Galvanized steel**]**<Insert finish or grade>**, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

      1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
      2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after

fabrication unless otherwise indicated.

F. Prestressed Concrete Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Baldwin Pole & Piling Co., Inc.**]
   b. [**Holophane; an Acuity Brands company**]
   c. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   d. [**Lonestar Prestress Mfg., Inc.**]
   e. [**NOV Ameron**]
   f. [**Pre-Cast Specialties, Inc.**]
   g. [**Seminole Pole, Inc.**]
   h. [**StressCrete Group**]
   i. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

   a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
   b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   c. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

   d. Comply with ASTM C1089[**and manufactured by centrifugal spin-casting process**][**and manufactured by static-casting method**].

      1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
      2) Mounting Provisions: [**Steel butt flange for bolted mounting to foundation or breakaway support**][**Embedded**].
      3) Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
      4) Grounding: Continuous copper ground wire cast into lighting standard. Terminate at top of lighting standard[**and attach to 24 inch lighting rod**].
      5) Raceway: Smooth, internal, and not less than **3 inch** in diameter.

   e. Concrete: Minimum 28-day compressive strength of [**7000 psi**]**<Insert value>**.
   f. Cured with wet steam and aged for a minimum of 15 days prior to installation.
   g. Reinforcement: [**Reinforcing bars complying with ASTM A615/A615M**][**Cold-drawn spiral wire complying with ASTM A1064/A1064M**][**Prestressing strand, 270 K, complying with ASTM A416/A416M**].
   h. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and must have a maximum water-absorption rate of 3 percent.

i. Finish Texture: [**Standard form**][**Polished exposed aggregate**][**Etched exposed aggregate**].

1) Exposed aggregate must be of <**Insert aggregate type selected from manufacturers' lists**> type.

j. Nameplate: Aluminum cast into lighting standard wall at approximately **5 ft** above ground line, listing name of manufacturer, the Project identifier, overall height, and approximate weight.

k. Pole Brackets: Comply with NEMA/ANSI C136.31.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.

2.3 LIGHTING STANDARD ACCESSORIES

A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V(ac), 20 A in a weatherproof assembly.

1. [**Surface mounted**][**Recessed**][**12 inch**]<**Insert dimensions**> above finished grade.

a. UL 50E, [**Type 3R**][**Type 4X**], nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.

b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

B. Minimum 1800 W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept [**ballast(s)**][**indicated accessories**]. Include removable flanged access cover secured with bolts or screws.

E. Decorative accessories, supplied by decorative pole manufacturer, include the following:

1. Banner Arms: <**Insert material**>.
2. Flag Holders: <**Insert material**>.
3. Ladder Rests: <**Insert material**>.

F. Lowering System for Luminaires:

1. System Description: Capable of lowering luminaire [**assembly**]to a service position within **36 inch** of finished grade in winds up to **30 mile/h**. Provide manual plug connection to electrical power accessible in lowered position. Assembled system of pole, luminaire, and lowering device must be capable of loads specified in "Performance Requirements" Article.
2. Compatibility of Material: Materials for attachment and connection of luminaire-mounting assembly, lowering device, lowering cable, and portable winch must be compatible to avoid corrosion and electrolysis.
3. Structural and Mechanical Design Safety Factor: 5.0, minimum, for static and dynamic loads of

load-bearing components, including cable.

4. Luminaire-Mounting and Disconnect Arrangement: Multiple [**ring**][**carriage**]-mounted luminaires, arranged for lowering and rising as a group.

   a. Electrical cable for normal operating power to luminaires must manually disconnect inside pole base, using weatherproof multi-pin connector, and must be arranged to move within the pole during lowering and rising of luminaire assembly.
   b. Electrical cable for normal operating power to luminaires must automatically disconnect at weatherproof multi-pin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnect when luminaire or luminaire assembly is raised to the operating position.

5. Lowering Device: Weatherproof, cast-aluminum housing, and multiple mechanical latches. Moving parts of latching assembly must be located in the portion of the unit that is lowered to servicing position. Positive latching in the operating position must be indicated to the operator at the base of the pole by a clear visual signal or by other means acceptable to Owner or authorities having jurisdiction.
6. Lowering Cable: [**Zinc-electroplated-steel**][**or**][**stainless steel**] aircraft cable.
7. Portable Winch: [**Manual**][**120 V electric**] type. [**One**]<**Insert number**> required.

   a. Winch Power Connection: Cord and plug.
   b. Winch Raise-Lower Control: Remote-control station with [**15 ft**]<**Insert dimension**> of cable.

G. Mounting Hardware:

1. Anchor Bolts: Manufactured [**to ASTM F1554, Grade 55,**]with a minimum yield strength of **55,000 psi**.

   a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
   b. [**Bent**][**Headed**] rods <**Insert dimension**> in diameter by <**Insert dimension**> in length.
   c. Threading: [**Uniform National Coarse**][**Uniform National 8**], Class 2A.

2. Nuts: ASTM A563/A563M, Grade A, Heavy-Hex.

   a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
   b. [**Two**][**Four**]<**Insert number**> nuts provided per anchor bolt[**, shipped with nuts preassembled to the anchor bolts**].

3. Washers: ASTM F436/F436M, Type 1.

   a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
   b. [**One**][**Two**]<**Insert number**> washer(s) provided per anchor bolt.

2.4 UTILITY POLES

A. Wood Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Pole Company**]
b. [**Baxter, J. H. & Co**]
c. [**Bell Lumber and Pole Company**]
d. [**Brown Wood Preserving Co., Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Koppers Performance Chemicals**]
g. [**McFarland Cascade**]
h. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol**][**ammoniacal copper arsenate**][**ammoniacal copper zinc arsenate**][**and**][**chromated copper arsenate**].
b. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]**<Insert wood species selected from ATIS O5.1>**.
c. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.
2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high, with aluminum nails.

d. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

B. Concrete Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accord Industries**]
b. [**Bayshore Concrete Products Corporation**]
c. [**CPI Concrete Products**]
d. [**StressCrete Group**]
e. [**Valmont Industries, Inc.**]
f. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Spun-cast prestressed concrete, complying with requirements of ASTM C1089.

1) Comply with requirements of RUS Bulletin 1724E-216.

b. Design: Base design on calculation of strength required by IEEE C2 or indicated on the Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F**]**<Insert design**

temperature range at site location>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

c. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

d. Water Absorption: Not more than 3 percent.

e. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

f. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.

2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high.

2.5 UTILITY POLE ACCESSORIES

A. Crossarms:

1. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.

2. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch** thick by **1-1/4 inch** wide, minimum, with length to suit crossarm dimensions.

B. Guys and Anchors:

1. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

a. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb**]<**Insert value**>.

b. Cable Termination:

1) Thimble eye.

2) Hooks and guy strain plates, complying with IEEE C135.1.

3) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

2. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

a. Power-installed, screw-type anchors.

1) **15 inch** screw; with rod **8 ft** long by **1-1/2 inch** in diameter. Rated at **10,000 lb** when installed.

2) Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

b. <**Insert anchor size or type**>.

3. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Subparagraph in "Installation of Utility Poles" Article.

4. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft** long. Shatter resistant at temperatures below **0 deg F**.

PART 3 - EXECUTION

3.1 INSTALLATION OF FOUNDATIONS FOR POLES AND LIGHTING STANDARDS

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Precast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.

D. Direct-Buried Foundations: Install to depth indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. Add backfill [**in 6 to 9 inch layers, tamping each layer before adding the next**][**as indicated on the Drawings**]<**Insert requirement**>. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes **6 inch** in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of **3000 psi** at 28 days and finish in a dome above finished grade.
3. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied [**steel**][**plywood**] template, uniformly spaced.

3.2 INSTALLATION OF LIGHTING STANDARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Alignment: [**Align foundations and lighting standards for optimum directional alignment of luminaires and their mounting provisions on lighting standards**][**Align lighting standards as indicated**].
2. Clearances: Maintain the following minimum horizontal distances of lighting standards from surface and underground features unless otherwise indicated on the Drawings:

   a. Fire Hydrants and Water Piping: [**60 inch**]<**Insert dimension**>.
   b. Water, Gas, Electric, Communications, and Sewer Lines: [**10 ft**]<**Insert dimension**>.
   c. Trees: **15 ft** from tree trunk.
   d. <**Insert features and clearance dimensions**>.

3. Concrete Lighting Standard Foundations: Set anchor bolts in accordance with anchor-bolt templates furnished by manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
4. Foundation-Mounted Lighting Standards: Mount lighting standards with leveling nuts and tighten top nuts to torque level in accordance with manufacturer's published instructions.

   a. Use anchor bolts and nuts selected to resist seismic forces specified for the application and approved by manufacturer.
   b. Grout void between lighting standard base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   c. Install base covers unless otherwise indicated.
   d. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of lighting standard.

5. Lighting Standards and Foundations Set in Concrete-Paved Areas: Install lighting standards with a minimum **6 inch** wide, unpaved gap between the lighting standard or foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level **1 inch** below top of concrete slab.
6. Raise and set lighting standard using web fabric slings (not chain or cable) at locations indicated by manufacturer.
7. Corrosion Prevention:

   a. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
   b. Steel Conduits: Comply with requirements in Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with **0.010 inch** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

D. Interfaces with Other Work:

1. Grounding and Bonding: Bond metallic components of lighting standards and support structures as follows:

   a. Provide insulated equipment grounding conductors with supply feeders for bonding luminaires and other pole-mounted electrical or electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.
   b. Bond metallic components of luminaires, pole accessories, and foundation to insulated equipment grounding conductor.

2. Identification: Provide labels for lighting standards, components, wiring, cabling, terminals, and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3.3 INSTALLATION OF UTILITY POLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: [**IEEE C2**][**NFPA 70 and NECA NEIS 1**].
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: [**IEEE C2**][**NECA NEIS 331 and Article 250 of NFPA 70**].
5. Communications Work: BICSI N1.
6. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
2. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
3. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

   a. On level ground, set poles so tops of consecutive poles vary not more than **60 inch** in elevation.
   b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

4. Set poles in accordance with the following:

   a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
   b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

      1) Poles up to 35 ft (10.6 m) Long: **24 inch**.
      2) Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch**.
      3) Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch**.

   c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
   d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch** minimum, **2 inch** maximum, (after conductors are installed at required tension) for each **10 ft** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
   e. Backfill holes in **6 inch** maximum lifts, and thoroughly tamp each layer before starting the

next.

f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.

g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.

h. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch** below top of concrete slab.

5. Field treat factory-treated poles and crossarms as follows:

   a. Poles Treated More Than One Year before Installation: Treat portion from **24 inch** above ground line to butt.
   b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
   c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
   d. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

6. Installation of Crossarms: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

   a. Buck Arms: Install at corners and junction poles unless otherwise indicated.
   b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
   c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
   d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

7. Installation of Guys and Anchors:

   a. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch** or more. Comply with IEEE C2.

      1) Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
      2) At the anchor end, attach guy strand assembly with preformed grips.

   b. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
   c. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
   d. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch** from ground.
   e. Install strain insulators to provide a minimum of **12 inch** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

8. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

D. Interfaces with Other Work:

1. Grounding and Bonding:

   a. Comply with [**IEEE C2**][**NFPA 70**] grounding and bonding requirements.
   b. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft**][**5/8 inch by 8 ft**].

      1) Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
      2) Drive ground rods until tops are **12 inch** below finished grade in undisturbed earth.

   c. Grounding (Earthing) Conductors:

      1) 4 AWG minimum, soft-drawn copper.
      2) Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
      3) Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
      4) Lightning Arrester Grounding Conductors: Separate from other grounding conductors.

   d. Bonding Conductors: Provide equipment grounding conductors with supply feeders for bonding pole-mounted electrical and electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.

2. Identification: Provide labels for poles, components, wiring, cabling, terminals, and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

   1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
   2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
   3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
   4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

   1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.
3. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

   a. Acceptable Test Results: Denoted by movement of less than **3/8 inch** by the holding component of the anchor in the earth or other medium in which it is installed.
   b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

4. Pole Ground Resistance: Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

   a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
   b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch** below furnished grade.

5. <**Insert special inspections**>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 26 05 46 00

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Task	Specification	Specification Description
26 05 46 00	13 34 23 16	Fabricated Control Booths
26 05 46 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 53 00 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm"[**and Section 284614 "Single- and Multiple-Station Alarms"**] specifies fire detection and alarm devices referenced in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Champion America**]
   c. [**emedco**]
   d. [**Grafoplast Wire Markers**]
   e. [**HellermannTyton**]
   f. [**LEM Products Inc.**]
   g. [**Marking Services Inc.**]
   h. [**Panduit Corp**]
   i. [**Seton Identification Products; a Brady Corporation company**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Champion America**]
   c. [**emedco**]
   d. [**Grafoplast Wire Markers**]
   e. [**HellermannTyton**]
   f. [**LEM Products Inc.**]
   g. [**Marking Services Inc.**]
   h. [**Panduit Corp**]
   i. [**Seton Identification Products; a Brady Corporation company**]
   j. **<Insert manufacturer's name>**

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: [**Preprinted**][**Write-on**], **3 mil (0.08 mm)** thick, [**polyester**][**vinyl**] flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A'n D Cable Products**]
   b. [**Brady Corporation**]
   c. [**Brother International Corporation**]
   d. [**emedco**]
   e. [**Grafoplast Wire Markers**]
   f. [**Ideal Industries, Inc.**]
   g. [**LEM Products Inc.**]
   h. [**Marking Services Inc.**]
   i. [**Panduit Corp**]
   j. [**Seton Identification Products; a Brady Corporation company**]
   k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**Ideal Industries, Inc.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Panduit Corp**]
j. [**Seton Identification Products; a Brady Corporation company**]
k. <**Insert manufacturer's name**>

3. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
4. Marker for Labels:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: [**Polyester**][**Vinyl**], thermal, transfer-printed, **3 mil (0.08 mm)** thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]
i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]

i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

3. Minimum Nominal Size:

a. **1-1/2 by 6 inch (37 by 150 mm)** for raceway and conductors.
b. **3-1/2 by 5 inch (76 by 127 mm)** for equipment.
c. As required by authorities having jurisdiction.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of **200 deg F (93 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2.3 BANDS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]

b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, **2 inch (50 mm)** long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. **<Insert manufacturer's name>**

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]

e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]
e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. **<Insert manufacturer's name>**

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than **3 mil (0.08 mm)** thick by **1 to 2 inch (25 to 50 mm)** wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. **<Insert manufacturer's name>**

C. Tape and Stencil: **4 inch (100 mm)** wide black stripes on **10 inch (250 mm)** centers placed diagonally over orange background and are **12 inch (300 mm)** wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

D. Floor Marking Tape: **2 inch (50 mm)** wide, **5 mil (0.125 mm)** pressure-sensitive vinyl tape, with [**black and white**][**yellow and black**] stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. **<Insert manufacturer's name>**

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]

b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. **<Insert manufacturer's name>**

3. Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical [**and communications**]utility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Color and Printing:

a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
b. Inscriptions for Red Tapes: [**"CAUTION BURIED ELECTRIC LINE BELOW"**]**<Insert inscription>**.
c. Inscriptions for Orange Tapes: [**"CAUTION BURIED CATV LINE BELOW"**][**"CAUTION BURIED TELEPHONE LINE BELOW"**][**"CAUTION BURIED FIBER OPTIC LINE BELOW"**][**"CAUTION BURIED COMMUNICATION LINE BELOW"**]**<Insert inscription>**.

5. Nonconducting Line-Warning Tape :

a. Pigmented polyolefin, bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **4 mil (0.1 mm)**.
d. Weight: **18.5 lb/1000 sq. ft (9.0 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **30 lbf (133.4 N)** and **2500 psi (17.2 MPa)**.

6. Reinforced Nonconducting Line-Warning Tape :

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **12 mil (0.3 mm)**.
d. Weight: **36.1 lb/1000 sq. ft (17.6 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **400 lbf (1780 N)** and **11,500 psi (79.2 MPa)**.

7. Detectable Line-Warning Tape :

a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Overall Thickness: **5 mil (0.125 mm)**.
d. Foil Core Thickness: **0.35 mil (8.9 m)**.
e. Weight: **28 lb/1000 sq. ft (13.7 kg/100 sq. m)**.
f. Tensile in accordance with ASTM D882: **70 lbf (311.3 N)** and **4600 psi (31.7 MPa)**.

8. Reinforced Detectable Line-Warning Tape :

   a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
   b. Width: **3 inch (75 mm)**.
   c. Overall Thickness: **8 mil (0.2 mm)**.
   d. Foil Core Thickness: **0.35 mil (8.9 m)**.
   e. Weight: **34 lb/1000 sq. ft (16.6 kg/100 sq. m)**.
   f. Tensile in accordance with ASTM D882: **300 lbf (1334 N)** and **12,500 psi (86.1 MPa)**.

F. Concrete Cable Route Markers :

1. Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. Product Characteristics:

   a. Material: Precast reinforced concrete.
   b. Marker Type:

      1) Above-Ground Monument Post:

         a) Nominal Dimensions (Height, Width, Depth): **30 inch (760 mm)**, **6 inch (150 mm)**, **3 inch (75 mm)**.

      2) Above-Ground Monument Block:

         a) Nominal Dimensions (Height, Width, Depth): [**12 inch (300 mm)**, **12 inch (300 mm)**, **6 inch (150 mm)**][**24 inch (600 mm)**, **24 inch (600 mm)**, **4 inch (100 mm)**].

      3) In-Ground Protective Cover (Plank or Slab):

         a) Nominal Dimensions (Length, Width, Depth): [**36 inch (914 mm)**, **6 inch (150 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **9 inch (230 mm)**, **2 inch (50 mm)**][**12 inch (305 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**24 inch (610 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**].

   c. Legend: [**"DANGER - ELECTRICITY"**][**"ELECTRIC CABLES"**][**"ELECTRIC SPLICE"**].
   d. Lettering: Approximately **1/8 inch (3 mm)** deep, not less than [**1 inch (25 mm)**][**1.5 inch (38 mm)**] high, symmetrically spaced; marked on both sides to allow for reversal.

3. Required Product Options:

   a. Color: [**Red**]<**Insert color**> dye added to concrete during batching.
   b. Attach metal medallion or sign stamped with [**feeder number**]<**Insert required information**>.

G. Stenciled Legend: In nonfading, waterproof, [**black**]<**Insert color**> ink or paint. Minimum letter height must be [**1 inch (25 mm)**]<**Insert dimension**>.

2.5 TAGS

A. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**emedco**]
   d. [**Marking Services Inc.**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**emedco**]
   d. [**Marking Services Inc.**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. <**Insert manufacturer's name**>

B. Nonmetallic Preprinted Tags: Polyethylene tags, [**0.015 inch (0.38 mm)**][**0.023 inch (0.58 mm)**] thick, color-coded for phase and voltage level, with factory [**screened**][**printed**] permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**emedco**]
   d. [**Grafoplast Wire Markers**]
   e. [**LEM Products Inc.**]
   f. [**Marking Services Inc.**]
   g. [**Panduit Corp**]
   h. [**Seton Identification Products; a Brady Corporation company**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**emedco**]
   d. [**Grafoplast Wire Markers**]

e. [**LEM Products Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. [**Seton Identification Products; a Brady Corporation company**]
i. **<Insert manufacturer's name>**

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**LEM Products Inc.**]
   d. [**Pipemarker.com; Brimar Industries, Inc.**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**LEM Products Inc.**]
   d. [**Pipemarker.com; Brimar Industries, Inc.**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. **<Insert manufacturer's name>**

3. Polyester Tags: [**0.010 inch (0.25 mm)**][**0.015 inch (0.38 mm)**]**<Insert dimension>** thick, with corrosion-resistant grommet and cable tie for attachment.
4. Marker for Tags:

   a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
   b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**Champion America**]
   d. [**emedco**]
   e. [**Marking Services Inc.**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**Champion America**]
   d. [**emedco**]
   e. [**Marking Services Inc.**]
   f. <**Insert manufacturer's name**>

3. Preprinted aluminum signs, [**high-intensity reflective,**]punched or drilled for fasteners, with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **7 by 10 inch (180 by 250 mm)**.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Champion America**]
   c. [**emedco**]
   d. [**Marking Services Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brady Corporation**]
   b. [**Champion America**]
   c. [**emedco**]
   d. [**Marking Services Inc.**]
   e. <**Insert manufacturer's name**>

3. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with **0.0396 inch (1 mm)** galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **10 by 14 inch (250 by 360 mm)**.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brady Corporation**]
   b. [**Carlton Industries, LP**]
   c. [**emedco**]

d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. **<Insert manufacturer's name>**

3. Engraved legend.
4. Thickness:

a. For signs up to **20 sq. inch (129 sq. cm)**, minimum **1/16 inch (1.6 mm)** thick.
b. For signs larger than **20 sq. inch (129 sq. cm)**, **1/8 inch (3.2 mm)** thick.
c. Engraved legend with [**black letters on white face**][**white letters on dark gray background**]**<Insert colors>**.
d. [**Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting**][**Self-adhesive**].
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. **<Insert manufacturer's name>**

C. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

D. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and

Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black, except where used for color-coding.

E. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black.

F. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **7000 psi (48.2 MPa)**.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded [**service**][**feeder**][**and**][**branch-circuit**] conductors.

1. Color must be factory applied[**or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction**].
2. Colors for 208Y/120 V Circuits:

   a. Phase A: Black.

b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240 V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral (Grounded Conductor): [**White**][**or**][**gray**].
6. Color for Equipment Ground: [**Bare copper**][**Green**][**Green with yellow stripe**].
7. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."
4. <**Insert name**>.

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**write-on tags**][**nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation**].

J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with **3 inch (75 mm)** high, black letters on **20 inch (500 mm)** centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at [**10 ft (3 m)**][**30 ft (9 m)**] maximum intervals.
2. Identify system voltage[**and system or service type**] with black letters on orange field.
3. Apply floor marking tape to the following finished surfaces:

a. Floor surface directly above conduits running beneath and within **12 inch (300 mm)** of floor that is in contact with earth or is framed above unexcavated space.
b. Wall surfaces directly external to raceways concealed within wall.
c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: [**Vinyl wraparound labels**][**Snap-around labels**][**Self-adhesive labels**][**Snap-around color-coding bands for raceway and cables**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with black letters on orange field.

L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

M. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than [**30**]<**Insert number**> A and [**120**]<**Insert number**> V to Ground: Identify with self-adhesive [**raceway labels**][**vinyl tape applied in bands**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

N. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

P. Workspace Indication: Apply [**floor marking tape**][**or**][**tape and stencil**] to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

Q. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

   a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels[**containing equipment designation**].
   b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of [**self-adhesive,**

engraved,][**engraved,**] laminated acrylic or melamine label.

c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items.
e. Switchgear.
f. Switchboards.
g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
h. Substations.
i. Emergency system boxes and enclosures.
j. Motor-control centers.
k. Enclosed switches.
l. Enclosed circuit breakers.
m. Enclosed controllers.
n. Variable-speed controllers.
o. Push-button stations.
p. Power-transfer equipment.
q. Contactors.
r. Remote-controlled switches, dimmer modules, and control devices.
s. Uninterruptible power supplies.
t. Battery-inverter units.
u. Battery racks.
v. Power-generating units.
w. Monitoring and control equipment.
x. <**Insert equipment**>.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with [**NFPA 70E**][**and**][**Section 260573 "Power System Studies"**] requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:

   a. Black letters on orange field.
   b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

5. <**Insert names and wording of warning signs or labels (for example, multiple services and voltages, and others**>.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**].

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

   a. Power-transfer switches.
   b. Controls with external control power connections.
   c. <**Insert items**>.

E. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

F. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for [**power transfer**][**load shedding**]<**Insert emergency operations**>.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.5 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of **6 inch (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape not less than **12 inch (300 mm)** directly above cables or raceways buried **18 inch (450 mm)** or more below grade. Use multiple tapes where width of multiple lines installed in common trench [**or concrete envelope**]exceeds **16 inch (400 mm)** overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Concrete Cable Route Markers: [**As indicated on Drawings**]<**Insert Project-specific requirements**>.

W. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

X. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Y. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53 00

Task	Specification	Specification Description
26 05 53 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 83 00	26 05 13 00	Medium-Voltage Cables
26 05 83 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 83 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 09 00 00 - ADDRESSABLE LUMINAIRE LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bus power supply.
2. Controller/gateways.
3. User interface.
4. Lighting control system management software.
5. Luminaire switching and dimming modules.
6. Ballast switching and dimming modules.
7. Sensors.
8. Relays.
9. Manual switches and plates.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. DALI: Digital addressable lighting interface.

B. Data Bus: Two wires used to communicate with bus connected devices.

C. Device: A collective term for DALI-compliant bus connected devices, including fluorescent ballasts, incandescent luminaires, manual switches, switching relays, and similar. Sometimes also called "slave unit."

D. Group: A set of devices that respond at the same time to messages on the data bus.

E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. Scene: Digital light level associated with a preset; stored in the luminaire ballast.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches

and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
2. Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device, and device groups. The plans must be based on construction plans, using the same legend, symbols, and schedules.
3. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads connected to each data bus and total connected load for each data bus. Include percentage of rated connected load and device addresses.
4. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

   a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
   b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bus Power Supplies: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
2. Controller/Gateways: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
3. Incandescent Switching and Dimming Modules: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
4. Fluorescent Ballasts: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.

5. Lighting Control Relays: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Software: Failure of input and output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Ballast failure.
d. Damage of electronic components due to transient voltage surges.

2. Warranty Periods:

a. For DALI Ballasts: [**Three**]<**Insert number**> years from date of Substantial Completion.
b. For Control Components That Are Not Part of Ballasts: [**Three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. DALI:

1. Components: Individually addressable devices (such as ballasts, relays, dimmers, and switches) that are operated from digital signals received through a DALI-compliant bus, from data-entry and -retrieval devices (such as computers, Internet portals, hand-held IR programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs[**, and**]<**Insert digital communications device**>). Devices also report status to data-entry and -retrieval devices though the bus.
2. Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component must be automatically isolated and not affect global system functions.

B. Ethernet LAN:

1. Provide an Ethernet LAN to connect controller/gateways to a PC running a Microsoft Windows operating system. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."
2. Ethernet Protocols: Comply with and be compatible with 10/100 BaseT TCP/IP routers and networks.
3. TCP/IP Modem: Capable of maintaining a secure Internet connection using VPN or equivalent protocol.

C. Interface with HVAC DDC System: Hardware and software must interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.

b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**]<**Insert type of interface**>. Communication must interface with HVAC DDC system to remotely control and monitor lighting from HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel must be available through DDC system for HVAC. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge protective device complying with UL 1449, SPD Type 2.

E. Operation: Input signal from digital signal sources switches or dims DALI devices associated with ballasts or luminaires, or switches field-deployed, DALI-compliant, control relays.

1. Each device and relay is connected to a digital data bus.
2. Each DALI device and relay has a digital address and can be operated by a digital signal.
3. Each device or relay can be assigned to any or all of 16 available groups connected to a single data bus.
4. Each dimming ballast may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to ballasts and may be applied to groups.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

H. Comply with protocol described in IEC 60929, Annexes E and G, for DALI lighting control devices, wiring, and computer hardware and software.

I. Comply with UL 916.

2.2 BUS POWER SUPPLY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**nLight; Acuity Brands Lighting, Inc.**]
4. [**Philips; Signify North America; Signify Holding**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**nLight; Acuity Brands Lighting, Inc.**]
4. [**Philips; Signify North America; Signify Holding**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]

7. <**Insert manufacturer's name**>

C. Description: Supply power to data bus for 64 addressable devices, suitable for use with NFPA 70, Class 2 control circuit.

1. Primary Power: Field selectable, 120 and 277 V.
2. Power Supply: Regulated to maintain the operating voltage above 15 V(dc) under full load, and rated for full charging load of 250 mA and a minimum maintained connected load of 190 mA.
3. Pilot Lights: Indicate data bus ground-fault and data bus traffic.

2.3 CONTROLLER/GATEWAYS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**RAB Lighting**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**RAB Lighting**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

C. Description: DALI controller/gateways link the distributed data buses with an Ethernet network to provide computer configuration, control, analysis, and maintenance. Controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the LAN. Controller/gateways must provide local intelligence and features including the following:

1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
2. Integrated sunrise/sunset support based on the site location (latitude and longitude).
3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
4. Two digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.
5. Support [**one**][**two**] data bus(es).
6. Computer Monitoring and Configuration: The controller/gateway must allow configuration, monitoring, and analysis from PCs on the Ethernet LAN.

D. Each data bus must have the capacity to control 64 addressable devices, using NFPA 70, Class 2 control circuit.

1. Each data bus must have the capacity to control up to 16 groups and scenes.
2. 10 BaseT Ethernet port for DDC system for HVAC connection.

3. LED indicator lights for Ethernet status (link, send, and receive), power-on, and LAN failure.
4. Linking of switch and sensor inputs to relay and ballast outputs.
5. Viewing relay and ballast output status.
6. Controlling relay and ballast outputs.
7. Setting device addresses.
8. Assigning switch and sensor inputs and relay and ballast output modes.

E. Allow connection of the following DALI-compliant addressable devices:

1. Fluorescent luminaire switching and dimming, for linear and compact lamps.
2. Incandescent luminaire switching and dimming.
3. HID and HPS luminaire switching and dimming.
4. LED luminaire switching and dimming.
5. Occupancy and photoelectric sensors.
6. Emergency lighting interface complying with UL 924.

F. Stores system programming in nonvolatile memory.

1. Switch to enable or disable software programming.

2.4 USER INTERFACE

A. Workstations: A laptop PC, with Microsoft Windows operating system and lighting control system management software installed. With automatic backup.

1. Include documentation, storage media, and licensing for a minimum of five concurrent users.

B. Tablet Computer: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier. The software must provide for all DALI-protocol programming commands to be applied to the controller/gateway via a tethered connection.

C. Web Interface: Internet portal, with [**one**][**10**]<**Insert number**> unique username and password(s), and a custom graphical user interface, allowing DALI-protocol programming commands to be applied to the controller gateway via [**LAN**][**the Internet**].

D. IR Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.5 LIGHTING CONTROL SYSTEM MANAGEMENT SOFTWARE

A. The software must provide for programming, configuring, and monitoring all devices connected to all data buses of the lighting control system, using application-specific software with Microsoft Windows-based, user-friendly software with graphical user-interface designed screens.

1. The software must be object oriented with pop-up menus and built-in help screens. All specified features of the data-bus-connected devices and those associated with controller/gateways must be included in the software.

2.6 LUMINAIRE SWITCHING AND DIMMING MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Starfield Controls, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Starfield Controls, Inc.**]
5. <**Insert manufacturer's name**>

C. Description: Comply with DALI exponential dimming curve calibrated for the connected lamp type, group, and scene settings, and with DALI light-level and configuration commands. Dimmer rise time must be not less than 15 microseconds.

2.7 BALLAST SWITCHING AND DIMMING MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Lutron Electronics Co., Inc**]
2. [**OSRAM SYLVANIA**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Tridonic**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Lutron Electronics Co., Inc**]
2. [**OSRAM SYLVANIA**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Tridonic**]
5. <**Insert manufacturer's name**>

C. Each ballast or group must be addressable and must include on-off, fade, dimming, scene settings, and other standard DALI control functions and as required to meet the sequence of operation.

D. Ballasts: Comply with requirements in [**Section 265116 "Fluorescent Interior Lighting" for ballasts for linear fluorescent lamps**][**and**][**Section 265123 "HID Interior Lighting" for ballasts for HID lamps**]; electronic programmed-start; and the following:

1. Starting Method: Programmed rapid start with antiflash (turns on at previously set light level).
2. Dimming Range: 100 to 10 percent of rated lumens unless otherwise indicated.
3. Ballast Factor: 1.0 at full output; 0.01 at full dim.
4. Input Voltage Range: 108 to 305 V.

2.8 SENSORS

A. Comply with requirements in Section 260923 "Lighting Control Devices." All sensors must be DALI-protocol compliant.

B. Daylight Harvesting Switching and Dimming Controls:

1. Adjustments and Set Points: All adjustments with exception of sensor range must be made via the communication network.
2. Remote Monitoring and Reporting: Sensor value must be displayed when queried by lighting management software or must automatically report based on a change of value or change of time period setting.

C. Indoor Occupancy Sensors: May be powered directly from the lighting control network or with a standalone power supply. Units powered with a standalone power supply must interface with the lighting control system through an electrically isolated digital input.

2.9 RELAYS

A. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Pilot light indicates when relay is closed and latched. Control must be by DALI digital data bus. Relay status must be displayed when queried by lighting management software.

B. Relay Panel: A single enclosure with incoming lighting branch circuits, relays, and connection to the DALI digital control network.

1. Enclosure: NEMA 250, Type 1 unless otherwise indicated.
2. Barriers to separate control-voltage and low-voltage components.
3. Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.

C. Individually Mounted Relays:

1. Enclosure: Standard outlet box or NEMA 250, Type 1 unless otherwise indicated.
2. Directory: Cover mounted, identifying each relay with its device address.

2.10 MANUAL SWITCHES AND PLATES

A. Connection Type: RS-485 protocol, [**Category 5**][**Category 5e**] UTP cable, using 8PSJ connectors. Power must be from the control unit.

B. Push-Button Switches: Modular, operating over the DALI digital data bus.

1. Each switch must control the following functions, in coordination with programmed sequence of operation and related sensors:

a. On.
b. Off.
c. Dimming, increase light level.
d. Dimming, decrease light level.
e. Return to preset light level.

2. LED Pilot Lights: On to indicate that the control is active, or when the manual control is operated.
3. Match color and style specified in Section 262726 "Wiring Devices."
4. Integral IR receiver for programming.

C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.11 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

D. Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with [**Category 5e**][**Category 6**] for horizontal copper cable and with Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260523 "Control-Voltage Electrical Power Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
2. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Identify all ceiling-mounted controls with data bus number and device address.

D. Label each device cable within **6 inch (152 mm)** of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Test each bus controller using local and remote controls.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

D. Nonconforming Work:

1. Lighting controls will be considered defective if they do not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Field Test Reports:

1. Prepare test and inspection reports, including a certified report that identifies bus controllers included and describes query results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
2. Printed list of all points created from actual queries of all addressed control points to include lamps, ballasts, manual controls, and sensors.
3. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.

3.4 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Activate luminaires and verify that all lamps are operating at 100 percent.
3. Burn-in fluorescent lamps at 100 percent for 100 hours.
4. Confirm correct communications wiring, initiate communications between DALI devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
5. <**Insert startup steps if any**>.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION 26 09 00 00

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SECTION 26 09 00 00A - RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting control relay panels.
2. Networked lighting control panels.
3. Manual switches and cover plates.
4. Field-mounted signal sources.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.

6. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
7. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
9. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

    a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
    b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lighting Control Relays: Equal to <**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**>.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation in accordance with NECA 407.

1.7 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of standalone multipreset modular dimming controls perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-on Extended Warranty Period: [**Eight**]<**Insert number**> year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, must open or close one or more lighting control relays in the lighting control panels. Any combination of inputs must be programmable to any number of control relays.

B. Interface with HVAC DDC System: Hardware and software must interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.
b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert type of interface**>. The communication interface must enable the HVAC DDC system operator to remotely control and monitor lighting from a HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel must be available through the HVAC DDC system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

E. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

F. Comply with UL 916.

2.2 LIGHTING CONTROL RELAY PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
5. [**Lutron Electronics Co., Inc**]
6. [**Philips; Signify North America; Signify Holding**]
7. [**Siemens Industry, Inc., Energy Management Division**]
8. [**Touch-Plate Technologies**]
9. [**WattStopper; Legrand North America, LLC**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
5. [**Lutron Electronics Co., Inc**]
6. [**Philips; Signify North America; Signify Holding**]
7. [**Siemens Industry, Inc., Energy Management Division**]
8. [**Touch-Plate Technologies**]
9. [**WattStopper; Legrand North America, LLC**]
10. **<Insert manufacturer's name>**

C. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.

D. Lighting Control Panel:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

E. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

1. Timing Unit:

a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
c. [**Four**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
d. Schedule periods settable to the minute.
e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
f. [**10**]<**Insert number**> special date periods.

2. Sequencing Control with Override:

a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
d. Override control "blink warning" must warn occupants approximately [**five minutes**]<**Insert time**> before actuating the off sequence.

3. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation, including accurate time of day and date.

F. Relays:

1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be three-wire, 24 V(ac).
2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not

less than 14 kA. Control must be three-wire, 24 V(ac).

G. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and photo sensors.

H. Operator Interface:

1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
2. Log and display relay on-time.
3. Connect relays to one or more time and sequencing schemes.

2.3 NETWORKED LIGHTING CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
4. [**Lutron Electronics Co., Inc**]
5. [**Touch-Plate Technologies**]
6. [**WattStopper; Legrand North America, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
4. [**Lutron Electronics Co., Inc**]
5. [**Touch-Plate Technologies**]
6. [**WattStopper; Legrand North America, LLC**]
7. <**Insert manufacturer's name**>

C. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels must be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.

D. Lighting Control Panels:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

E. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.

1. Ethernet Communications: Comply with [**TCP/IP**]<**Insert network protocol**> protocol. The main control unit must provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.

2. Protocol: Controllers must support serial MS/TP and Ethernet IP communications in accordance with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**], and must be able to communicate directly via DDC system for HVAC TIA-485 serial networks and Ethernet 10Base-T networks as a native device.
3. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.

    a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    b. Panel summary showing the master and slave panels connected to the controller.
    c. Controller diagnostic information.
    d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.

4. Timing Unit:

    a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
    b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
    c. [**Four**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
    d. Schedule periods settable to the minute.
    e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    f. [**16**]<**Insert number**> special date periods.

5. Time Synchronization: The timing unit must be updated not less than every <**Insert number**> hour(s) with the network time server.
6. Sequencing Control with Override:

    a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
    b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
    c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
    d. Override control "blinking warning" must warn occupants approximately [**five minutes**]<**Insert time**> before actuating the off sequence.
    e. Activity log, storing previous relay operation, including the time and cause of the change of status.
    f. Download firmware to the latest version offered by manufacturer.

F. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.

1. Electronic control for operating and monitoring individual relays, and display relay on-time.
2. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation.
3. Integral keypad and digital-display front panel for local setup, including the following:

    a. Blink notice, time adjustable from software.
    b. Ability to log and display relay on-time.
    c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

G. Relays:

1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be [**three-wire, 24 V(ac)**][**digital control network**].
2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not less than 14 kA. Control must be [**three-wire, 24 V(ac)**][**digital control network**].

H. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and control-voltage photo sensors.

I. Operator Interface: At the main control unit, provide interface for a tethered connection of [**a portable PC running MS Windows**]<**Insert digital device and operating system**> for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device must remain the property of Owner.

J. Software:

1. Menu-driven data entry.
2. Online and offline programming and editing.
3. Provide for entry of the room or space designation for the load side of each relay.
4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
5. Size the software appropriate to the system.

2.4 MANUAL SWITCHES AND COVER PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Section 262726 "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Cover Plates: Single and multigang cover plates as specified in Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

B. Indoor Occupancy Sensors and Extreme-Temperature Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

D. Twisted-Pair Data Cable: [**Category 5e**][**Category 6**][**Category 6a**].

1. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels in accordance with NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

A. Wiring Methods:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.
2. Install cables in raceways and cable trays except within consoles, cabinets, desks, counters, accessible ceiling spaces, and gypsum board partitions where unenclosed wiring method may be used.
3. Install conductors and cables concealed in accessible ceilings, walls, and floors where possible.
4. Conceal raceway and cables except in unfinished spaces.
5. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.
6. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
7. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and

without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELS

A. Install panels and accessories in accordance with NECA 407.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mount top of trim [**90 inch (2286 mm)**]<**Insert dimension**> above finished floor unless otherwise indicated.

D. Mount panel cabinet plumb and rigid without distortion of box.

E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below[**and low-voltage surge arrestors**]. Certify compliance with manufacturer's test parameters.

a. Circuit-Breaker Tests:

1) Compare nameplate with Drawings and Specifications.
2) Inspect physical and mechanical conditions.
3) Inspect anchorage and alignment.
4) Verify that the units are clean.
5) Operate the circuit breaker to ensure smooth operation.
6) Inspect bolted electrical connections for high resistance using one or more of the following methods:

a) A low-resistance ohmmeter.
b) Verify tightness of bolted electrical connections by calibrated torque wrench.
c) Thermographic survey.

7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
8) Perform adjustments for final protective device settings in accordance with the overcurrent protective device coordination study. Comply with requirements in Section 260573.16 "Coordination Studies."
9) Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using manufacturer's published data.
10) Perform a contact/pole-resistance test.
11) Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be for one minute. Follow manufacturer's instructions for solid-state units.
12) Determine long-time pickup and delay by primary current injection.
13) Determine short-time pickup and delay by primary current injection.
14) Determine ground-fault pickup and time delay by primary current injection.
15) Determine instantaneous pickup by primary current injection.
16) Test functions of the trip unit by means of secondary injection.
17) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
18) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset trip logs and indicators.
19) Verify operation of charging mechanism.

b. Surge Arrestor Tests:

1) Compare nameplate with the Contract Documents.
2) Inspect physical and mechanical conditions.
3) Inspect anchorage, alignment, grounding, and clearances.
4) Verify that the units are clean.
5) Inspect bolted electrical connections for high resistance using one or more of the following methods:

a) Low-resistance ohmmeter.
b) Verify tightness of bolted electrical connections by calibrated torque wrench.

6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7) Perform an insulation-resistance test on each arrestor, phase terminal-to-ground using voltage in accordance with manufacturer instructions.
8) Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding tests.

C. Nonconforming Work:

1. Lighting control panel will be considered defective if it does not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and

observations made after remedial action.

E. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
3. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

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SECTION 26 09 23 00 - ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
4. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

1.2 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the RMS value of the voltage, and "I" is the RMS value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. L-G: Line to ground.

H. L-L: Line to line.

I. L-N: Line to neutral.

J. MODBUS TCP/IP: An open protocol for exchange of process data.

K. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

L. N-G: Neutral to ground.

M. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

B. Sustainable Design Submittals:

1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

C. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

1) Location of the meters and gateways, and routing of the connecting wiring.

2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

m. Owner training materials.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Addressable Relays: One for every [**10**]<**Insert number**> installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every [**10**]<**Insert number**> of each type installed. Furnish at least one of each type.
3. <**Insert material**>.

1.6 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1. Electrical meters that monitor, control, and connect to the data transmission network.
2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
3. Include [**PC-based workstation**][**multiple PC-based workstations**][**with web access**], with its operating system and application software, connected to data transmission network.

B. The electrical power monitoring and control system must be Internet based.

1. System software must be based on server thin-client architecture, designed around open standards of internet technology.
2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser must be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
3. Internet access must be password protected.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: [**SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.**][**Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."**]
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: Transmitters and receivers must communicate unique device identification and status reports to monitoring and control clients.

C. Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours)[**, power factor**]<**Insert monitoring point**>.
2. [**ASHRAE 135 (BACnet)**][**ISO/IEC 14908-1 (LonTalk)**][**MODBUS Application Protocol Specification**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC must enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC workstation. Control features and monitoring points displayed locally at metering panel must be available through the DDC system for HVAC.

D. Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls must have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. <**Insert manufacturer's name**>

C. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power Factor: 1.0 percent.
4. Frequency: 0.1 percent.
5. THD: 1.0 percent.
6. Waveform Sampling: 64 per cycle.

G. Data Link:

1. MODBUS TIA-485, RTU protocol, [**2**][**4**]-wire connection to host devices with a compatible port.
2. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:

a. One screen to show at least [**three**]<**Insert number**> user-selected values displayed at the same time. Selections available to display must include the following:

1) Meters.
2) Measurements.
3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

I. Sampling Rate: Continuously sample and record voltage and current at a rate not less than [**64**]<**Insert number**> samples per cycle, simultaneously on voltage and current channels of the meter.

J. Meters:

1. Instantaneous, RMS:

a. Current: Each phase, [**neutral**]and three-phase average.
b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): [**Each phase and**]three-phase total.
d. Reactive Power (kVAR): [**Each phase and**]three-phase total.

e. Apparent Power (kVA): [**Each phase and**]three-phase total.
f. Power Factor: [**Each phase and**]three-phase total.

2. Energy:

a. Active Energy (kWh): Three-phase total.

3. Demand, Derived from Instantaneous RMS Meters:

a. Current: Present and maximum.
b. Active: Present and maximum.
c. Reactive: Present and maximum.
d. Apparent: Present and maximum.

4. Power Quality Measurements:

a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

K. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics must be 150 mA at 200 V.

1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:

a. User-defined pulse output, associated with kWh.
b. User-defined pulse output, associated with kVARh.

2. <**Insert control function**>.

L. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

a. Voltage: Measurement autoranging, 60 to 400 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]

3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Energy Management Division**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Energy Management Division**]
6. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

G. Data Link:

1. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.

   a. Provide for firmware and software updates through the communications port.

2. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display must include the following:

a. Meters, including those listed under the following:

1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

I. Sampling Rate: Continuously sample and record voltage and current at a rate not less than [**32 samples per cycle**]<**Insert number**>, simultaneously on voltage and current channels of the meter.

J. Meters:

1. Measurements: Instantaneous, in real time, RMS to the 15th harmonic.

a. Voltage: L-L each phase, L-N each phase, and three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Unbalanced current, L-L V(ac) and L-N V(ac).
d. Active Power (+/- kW): Each phase and three-phase total.
e. Reactive Power (+/- kVAR): Each phase and three-phase total.
f. Apparent Power (+/- kVA): Each phase and three-phase total.
g. Displacement Power Factor: Each phase and three-phase total.
h. Distortion Power Factor: Each phase and three-phase total.
i. Frequency.

2. THD from measurements simultaneously from the same cycle, through [**15th**]<**Insert number**> harmonic.

a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
b. Current THD: Each phase and three-phase average.
c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

a. Three-phase average current.
b. Three-phase total active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Minimum and Maximum Values:

a. L-L and L-N voltages.
b. Current in each phase.
c. Power factor.
d. Active power total.
e. Reactive power total.
f. Apparent power total.
g. THD L-L and L-N voltages.

h. THD current in each phase.
i. Frequency.

K. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
   c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

   a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
   b. Signal is a communication signal. Calculation must be configurable as either a block or rolling block calculation.
   c. Provide for synchronizing the demand with the internal of this instrument.

L. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time RMS measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

M. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than [**15**]<**Insert number**> metered items. Each alarm must be user configured, by using the following options:

1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

N. Output Signals: Provide two mechanical relays, rated not less than 250 V(ac), 2 A resistive, and rated for 200,000 cycles or more. The relays must be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

O. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

P. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

a. Voltage: Measurements autoranging, 60 to 400 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 CIRCUIT METERS AND MONITORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.

1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. For Voltage and Current: 0.5 percent of reading.
3. For Active Power: 0.2 percent.
4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.
5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

G. Data Links:

1. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.
2. MODBUS TIA-232/TIA-485 RTU/ASCII protocol, [**2**][**4**]-wire connection.
3. MODBUS TCP:

   a. 10/100BaseTX balanced twisted pair cabling. 8PSJ connector, 100 m link.
   b. Optical fiber 100BaseFX, LC duplex connector, 1300 m link. Multimode 62.5/125 microsecond, 2000 m link.

4. Provide for firmware and software updates through the communications port.
5. Ethernet 10/100BaseTX balanced twisted pair cabling and MODBUS TIA-485 serial master port.
6. Ethernet 10/100BaseTX balanced twisted pair cabling and MODBUS TIA-485 serial master port, Ethernet to serial line gateway, and embedded web server.
7. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

I. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than [**128 samples per cycle**]<**Insert number**>, simultaneously on voltage and current channels of the meter.

J. Meters must measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, RMS to the [**31st**][**63rd**] harmonic:

   a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
   b. Current: Each phase, three-phase average, and neutral.
   c. Active Power (kW): Each phase and three-phase total.
   d. Reactive Power (kVAR): Each phase and three-phase total.
   e. Apparent Power (kVA): Each phase and three-phase total.
   f. Displacement Power Factor: Each phase and three-phase total.
   g. Distortion Power Factor: Each phase and three-phase total.
   h. Frequency.

2. THD from measurements simultaneously from the same cycle, through [**31st**][**63rd**]<**insert number**> harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.

3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Three-phase totals, present, predicted, peak.

a. Average current.
b. Active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Average, Minimum and Maximum Values:

a. Record, date and time stamp, and save the minimum and maximum values of RMS metered values since the last reset.
b. <**Insert values**>.

K. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
b. Synchronize demand with receipt of a communication signal. Calculation must be configurable as either a block or rolling block calculation.
c. Provide for synchronization to the clock in the instrument.

L. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.

d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

M. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated.

a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.
b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard must be user configurable.
c. Harmonic analysis performed on the captured waveforms must resolve harmonics through the 63rd.
d. Captured waveforms must be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures must be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

N. Disturbance Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating RMS magnitude of each half-cycle.
b. Event detection must be with user-defined parameters of threshold and delay. The threshold must be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument must automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
c. When detecting an alarm condition:

1) Initiate disturbance waveform capture.
2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
3) Alarm on must be visible on the display and be transmitted over the data link.
4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

O. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for phases must be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the RMS

values, as selected by the user.

P. Alarms: Alarm events must be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

   a. Date and time stamp.
   b. Enable-disable (default) or enable.
   c. Pickup magnitude.
   d. Pickup time delay.
   e. Dropout magnitude.
   f. Dropout time delay.
   g. Alarm type.
   h. Alarm label.

2. The following classes of events must be available to be programmed as alarm events:

   a. Over/under current.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kVA.
   h. Over kW or kVAR into/out of load.
   i. Over/under frequency.
   j. Under power factor, true or displacement.
   k. Over THD.
   l. Over demand, current or power.
   m. Reverse power.
   n. Phase reversal.
   o. Status input change.
   p. End of incremental energy interval.
   q. End of demand interval.
   r. Over/under analog inputs.
   s. Current sag/swell.
   t. Voltage sag/swell.

3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
4. The circuit meter and monitor alarms response time must be not less than one second.
5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.

Q. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

R. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.

1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:

   a. User-defined pulse output, associated with kWh.
   b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital Inputs: As follows:

   a. One input connection rated 24 to 125 V(ac) or V(dc), +/- 10 percent, less than 5 mA burden, 1350 V RMS isolation.
   b. Six input connections rated 19 to 30 V(dc), 5 mA maximum at 24 V(dc). Provide an onboard 24 V(dc) power supply.
   c. Two input connections rated 20 to 150 V(dc) or V(ac), 2 mA maximum.

3. Analog inputs, no fewer than two, adjustable from zero to 5 V(dc) or 4 to 20 mA.
4. Outputs to operate field-installed relays, no fewer than two, providing 6 to 240 V(ac) or 6 to 30 V(dc), 2 A RMS. 5 A maximum for 10 seconds per hour.
5. Analog outputs, no fewer than two, 4 to 20 mA(dc) into 600 ohms maximum.

S. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

   a. Each log entry must hold data of up to 96 parameters each.
   b. Each log must be user configurable to log data at a different user-defined schedule interval.
   c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
   d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.

2. Minimum/Maximum Logs:

   a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
   b. Minimum/Maximum log must include the time, date, and value for the minimum and maximum of each of the real-time metered values.

3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100 ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries must be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

T. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

   a. Voltage: Measurement autoranging, zero to 600 V(ac) L-L, zero to 347 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
   b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds

once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.

1. Provide for metering four-wire wye, three-wire wye, and three-wire delta power systems.
2. Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP52.

E. The circuit meter and monitor must meet UL 61010-1 overvoltage withstand rating of CAT IV.

F. Accuracy to the following plus/minus values:

1. Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
2. Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
3. Energy Meter: Comply with ANSI C12.20, Class 0.20.
4. Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
5. Power Factor: 0.002 from 0.5 leading to 0.5 lagging.

G. Data Links:

1. TIA-232 port.
2. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.
3. MODBUS Ethernet TCP/IP protocol:

a. 10/100BaseTX balanced twisted pair cabling. 8PSJ connector, 100 m link.
b. Optical fiber 100BaseFX, LC duplex connector, 1300 m link. Multimode 62.5/125 microsecond, 2000 m link.

c. HTML server, with standard home page and five customizable pages.

4. Firmware and software updates must be accessible through the communications port.
5. <**Insert protocol**>.

H. Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

I. Sampling Rate:

1. Sample current and voltage to provide RMS accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
2. Continuously sample and record voltage and current at a rate not less than [**512 samples per cycle**][**83,333 points per cycle**]<**Insert rate**>, simultaneously on voltage and current channels of the meter.

J. Measure, record with time stamp, and calculate; and, on request, display the following:

1. Measurements: Instantaneous, in real time, RMS to the 63rd harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
b. Current: Each phase, neutral, ground, three-phase average, apparent RMS, and percent unbalanced.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAR): Each phase and three-phase total.
e. Apparent Power (kVA): Each phase and three-phase total.
f. Displacement Power Factor: Each phase and three-phase total.
g. Distortion Power Factor: Each phase and three-phase total.
h. Frequency.
i. K-factor for each phase.

2. THD from measurements simultaneously from the same cycle, through [**255th**]<**Insert number**> harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Power: Active, reactive, and apparent power including power of up to [**41st**]<**Insert number**>.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand:

   a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.

      1) Present.
      2) Running average.
      3) Last completed interval.
      4) Peak.

   b. Current: Each phase, three-phase average, and neutral.

      1) Present.
      2) Last completed interval.
      3) Minimum.
      4) Peak.

   c. Active Power (kW): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kVA demand.
      5) Coincident with peal kVAR demand.

   d. Reactive Power (kVAR): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kW demand.
      5) Coincident with peal kVA demand.

   e. Apparent Power (kVA): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kW demand.
      5) Coincident with peak kVA demand.

   f. Distortion Power Factor: Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kVA demand.
      5) Coincident with peal kVAR demand.

K. Average, Minimum and Maximum Values:

   1. Record, date and time stamp, and save the minimum and maximum values of RMS metered values since the last reset.
   2. Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Voltage Unbalance: L-L each phase and L-N each phase.
c. Current:

1) RMS each phase, three-phase average, and calculated neutral current.
2) Apparent, RMS average.
3) Active Power (kW): Each phase and three-phase total.

d. Demand Current: RMS each phase and three-phase average.
e. Reactive Power (kVAR): Each phase and three-phase total.
f. Apparent Power (kVA): Each phase and three-phase total.
g. Demand Active Power: Each phase and three-phase total.
h. Demand Reactive Power: Each phase and three-phase total.
i. Demand Apparent Power: Each phase and three-phase total.
j. Accumulated Energy: MWh, MVAh, and MVARh.
k. Reactive energy (MVARh) by quadrant.
l. Power Factor: Three-phase displacement and distortion power factors.
m. K-factor for each phase.
n. THD L-L and L-N voltages.
o. THD current in each phase and neutral.
p. Frequency.

L. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting must be the 15-minute continuous sliding block.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
b. Synchronize demand with receipt of a communication signal. Calculation must be configurable as either a block or rolling block calculation.
c. Provide for synchronization to the clock in the instrument.

4. Record, date and time stamp, and save the following demand values of RMS metered values since the last reset, including the following:

a. Average demand current, per phase.
b. Peak demand current, per phase.
c. Average demand for active power, reactive power, and apparent power.
d. Predicted demand for active power, reactive power, and apparent power.

e. Peak demand for active power, reactive power, and apparent power.

M. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.
d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

N. Power Analysis Values:

1. THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
2. THD Current: Each phase, three-phase average, and neutral current.
3. Total demand distortion.
4. K-factor for each phase.
5. Crest factor, each phase.
6. Displacement power factor.
7. Fundamental voltage, magnitude and angle, each phase.
8. Fundamental currents, magnitude and angle, each phase.
9. Fundamental active power, each phase and three-phase total.
10. Fundamental reactive power, each phase and three-phase total.
11. Harmonic power, each phase and three-phase total.
12. Phase rotation.
13. Voltage and current unbalances.
14. Harmonic magnitudes and angles, each phase.
15. Distortion power.
16. Distortion power factor.

O. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated over the communications network.

a. Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.
b. Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard must be user configurable.
c. Harmonic analysis performed on the captured waveforms must resolve harmonics through the 255th for the following:

1) Voltage: L-N and L-G each phase.
2) Current: Of each phase and neutral current.

d. Captured waveforms must be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store digitally sampled data points for each cycle of

each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform must be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles must be adjustable.

3. Waveform samples must be available for transmission over the communications network, for display, archival, and analysis at computer workstations.

P. Transient Detection:

1. Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.

Q. Flicker Detection:

1. Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.
2. Display the flicker event as plots of magnitude versus time on semi-log graph background.

R. Sag and Swell Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

   a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating RMS magnitude of each half-cycle.
   b. Event detection must be with user-defined parameters of threshold and delay. The threshold must be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument must automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
   c. When detecting an alarm condition:

      1) Initiate disturbance waveform capture.
      2) Initiate 100 ms event recording.
      3) Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
      4) Causing an alarm on the display and transmit the alarm over the data link.
      5) The user must have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

S. 100 ms Event Recording: Capture, record with time stamp, and store.

1. Initiate recording by an alarm or external contact closure.
2. User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
3. Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
4. Operate an output relay in the I/O module of the instrument.

T. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.

2. The current and voltage information for phases must be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the RMS values, as selected by the user.

U. Alarms:

1. Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
2. The instrument must calculate the listed key electrical parameters at not less than 100 ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
3. The following classes of events must be available to be programmed as alarm events:

    a. Over/under current.
    b. Over/undervoltage.
    c. Current imbalance.
    d. Phase loss, current.
    e. Phase loss, voltage.
    f. Voltage imbalance.
    g. Wave shape alarm.
    h. Over kVA.
    i. Over kW or kVAR into/out of load.
    j. Over/under frequency.
    k. Under power factor, true or displacement.
    l. Over THD.
    m. Over K-factor.
    n. Over demand, current or power.
    o. Reverse power.
    p. Phase reversal.
    q. Status input change.
    r. End of incremental energy interval.
    s. End of demand interval.
    t. Over/under analog inputs.
    u. Current sag/swell.
    v. Voltage sag/swell.
    w. Transient events.

4. For each over/under metered alarm value, the user must define a pickup, dropout, and delay.
5. Waveform Alarms:

    a. The instrument must detect anomalous waveform events that are less than half-cycle in length.
    b. Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit must be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:

        1) Phase voltages.
        2) N-G voltages.
        3) Phase currents.
        4) Neutral currents.

    c. In response to a waveform alarm, the instrument must:

1) Log the event and record phase currents and voltages as defined in the 100 ms event recording.
2) Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.

6. Provide four alarm severity levels to allow the user to respond to the most important events first.
7. Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.
8. The circuit meter and monitor alarms response time must be not less than the following:

   a. Standard, one second.
   b. High speed, 100 ms.
   c. Disturbance, half-cycle.

9. Up to four alarms may be combined to give a single result using Boolean algebra operations.
10. Provide e-mail notification of alarm conditions.
11. Automatic Alarm Set-Point Adjustment:

    a. The instrument software must provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is connected to, and to select and adjust alarm set points based on that recognition.
    b. The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, must be set by the user by selection one of the following two modes:

       1) Fixed Learning: Initially configured user set points are used during the entire learning period.
       2) Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.

    c. The learning period must be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.

V. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

W. I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument must provide the following:

1. KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:

   a. User-defined pulse output, associated with kWh.
   b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital inputs, each having the following operating modes:

   a. Normal: Simple on/off digital inputs.
   b. Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
   c. Conditional Energy Control input to control conditional energy accumulation.

3. Output Relays and Control: Output relays must have normally open and normally closed contacts and must operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays must be user configured in one of the following listed modes:

    a. Normal contact closure where the contacts change state for as long as the signal exists.
    b. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
    c. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
    d. End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
    e. Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
    f. Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

X. Onboard Data Logs:

1. Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2. Onboard data logs must be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
3. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

    a. Each log entry must hold data of up to 96 parameters each.
    b. Each log must be user configurable to log data at a different user-defined schedule interval.
    c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    d. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

4. Minimum/Maximum Logs:

    a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
    b. Minimum/Maximum log must include the time, date, and value for the minimum and maximum of each of the active-time metered values.

5. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity must be not less than 1000 events. Record selected parameters at 100 ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
6. Waveform Logs: Capture and store waveforms as follows:

    a. One cycle, 512 samples, to the 255th harmonic. Manually triggered.
    b. Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
    c. Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.

Y. Programming: Programming of instrument functions must be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.

1. Programming language must include the following capabilities:

    a. Scheduled tasks.
    b. Event tasks.
    c. Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
    d. Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
    e. Loop commands.
    f. Compare statements.
    g. Counters and timers.

2. Manufacturer must provide custom programs to meet Project requirements that are described in "Capacities and Characteristics" Paragraph below.
3. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
4. Data reduction using smart data logging.
5. Automatic monthly logging/reset of kWh and peak demand.
6. Statistical profile analysis of metered quantities.
7. ITIC/SEMI power quality analysis.
8. Calculations for IEEE 519 verification.
9. Metering of combined utilities: gas, water, steam, and electric.
10. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.

Z. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

    a. Voltage: Measurements autoranging, zero to 600 V(ac) L-L, zero to 347 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater.
    b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
    c. Frequency: 45 to 67 Hz, and 350 to 450 Hz.
    d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

3. Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: [**8**]<**Insert number**> MB.
4. Number of Onboard Data Logs: [**14**]<**Insert number**>.
5. Number of Minimum/Maximum Log Files: [**Two**]<**Insert number**>.
6. Alarm Log Capacity: Not less than 1000 events.
7. Custom Programs: Provide the following programs with the instrument:

    a. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
    b. Data reduction using smart data logging.
    c. Automatic monthly logging/reset of kWh and peak demand.
    d. Statistical profile analysis of metered quantities.
    e. Calculations for IEEE 519 verification.
    f. Metering of combined utilities: gas, water, steam, and electric.
    g. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.
    h. <**Insert requirements**>.

2.7 PC OPERATING SYSTEM SOFTWARE

A. Description: System software must monitor, analyze, display, control, and save the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**][**or**][**64-**]bit operating system that allows execution of multiple real-time programs and custom program development.
2. Operating system must be capable of operating Microsoft Windows applications.
3. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.

2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

A. Description: System software must monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software must include interactive graphics client and must be web enabled.

C. System Software Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**][**or**][**64-**]bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system must be capable of operating Microsoft Windows applications.
3. Database management software must manage data on an integrated and non-redundant basis. Additions and deletions to database must be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.

D. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
3. Operator sign-off must be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period must be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:

a. Operator access to electrical monitoring and control system must be under password control.
b. An alphanumeric password must be user assignable to each operator.
c. Software must have at least five access levels.

1) View - View information. No change privileges allowed.
2) User - Same as View, but is able to initiate control functions.
3) Controller - Same as User, but is able to initiate communications.
4) Operator - Same as Controller, but is able to modify configurations.
5) Supervisor - Same as Operator, but is able to administer security privileges.

d. Each menu item must be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments must be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such must be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.9 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:

1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.

a. Support on-line changes while the data storage/retrieval application is running.
b. Suffer no interruption to its operation while changes are being made.
c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:

a. Locations and identification of monitored and controlled electrical equipment.
b. <**Insert requirements**>.

3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation[**, similar to that indicated on Drawings,**] with device

identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, [**gateways**][**and**][**other network devices**].

2.10 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:

a. Communication request/response and error rates, and timeouts.
b. Log acquisition services.

B. Database Maintenance Features:

1. Backup, archive, and trim data, event, and waveform logs.

a. Record start and end date for operation.
b. Allow copying data to another database.
c. Be capable of selecting logs specified for the meters that are Work of this Section.

1) Data logs.
2) Event logs.
3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:

a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
c. Distribution of reports via email.

2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100 ms PQ report.
6. Energy over Period Report:

a. User-defined rollup interval by day, week, month, or year.
b. Compare daily energy to the following:

1) Previous day.

2) Same day, previous week.
3) Same day, previous month.
4) User-defined specific day.

c. Compare weekly energy to the following:

1) Previous week.
2) Same week from previous month.
3) Same week from previous year.
4) User-defined specific week.

d. Compare monthly energy to the following:

1) Previous month.
2) Same month from previous year.
3) User-defined specific month.

e. Compare annual energy to the following:

1) Previous year.
2) User-defined specific year.

7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:

a. Show values for multiple measurements and measurements from multiple devices in the following graphical formats:

1) Line chart.
2) Pie graph.
3) Bar chart.
4) Column chart.
5) Smooth line chart.
6) Stacked column chart.
7) Stacked bar chart.

10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:

a. Device name.
b. Device type.
c. Device address.
d. Connection status.
e. Device protocol.
f. Device description.

12. Each default report must include the following:

a. Summary aggregation of data from the selected devices.
b. Individual device information.
c. Raw data.

13. The reporting tool must provide a graphical interface to create and manage multiple Time of Use schedules:

    a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
    b. Off-peak and on-peak times.

2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. A multipoint, MODBUS TIA-485 serial communications network must be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network must be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network must be included within the power distribution equipment.
3. Serial communications devices within the equipment must be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (8PSJ) Ethernet port, that is accessible from the front of the equipment. Initial setup must be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:

    a. User configurable, with secure password-protected login process.
    b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
    c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's TIA-485 port(s) through a standard web browser.
    d. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across different styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:

a. Circuit summary page to display circuit name, three-phase average RMS current, real power (kW), power factor, and breaker status (if applicable).
b. Load current summary page to display circuit name, and phase a, b, and c RMS current values.
c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above must be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
g. For motor-control centers, the circuit summary web page must be tailored specifically for this application, to display circuit name, three-phase average RMS current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.12 SYSTEM OPERATOR INTERFACES

A. Operator means of system access must be through the following:

1. Desktop workstation with hardwired connection through LAN port.
2. Portable terminal with hardwired connection through LAN port at each meter.
3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.13 DESKTOP WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running [**Microsoft Windows**]<**Insert operating system name**>.
3. ENERGY STAR compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>, [**Core i3**][**Core i5**][**Core i7**].
2. RAM:

    a. Capacity: [**2**][**4**][**8**]<**Insert value**>[**GB**].
    b. Speed and Type: [**1333**]<**Insert value**> MHz, <**Insert type**>.

3. Primary Hard Drive:

    a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
    b. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
    c. Capacity: <**Insert number and measurement unit**>.
    d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    e. Cache Buffer Size: <**Insert number and measurement unit**>.
    f. <**Insert requirements**>.

4. Second Hard Drive:

    a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
    b. Capacity: <**Insert number and measurement unit**>.
    c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    d. Cache Buffer Size: <**Insert number and measurement unit**>.
    e. <**Insert requirements**>.

5. Optical Drive:

    a. Type: <**Insert type**>.
    b. Minimum Average Access Time: <**Insert number**> ms.
    c. Data Transfer Speed: <**Insert number**>[**MB**][**TB**]/s.
    d. Reading Formats: Data, audio, recordable, <**Insert other**> and rewritable.

6. Optical Read and Write Drive:

    a. Include with at least 2 MB of data buffer.
    b. Type: <**Insert type**>.
    c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
    d. Minimum Average Access Time: <**Insert number**> ms.
    e. Nominal Data Transfer Rates:

        1) Reading: <**Insert number**>[**MB**][**TB**]/s.
        2) Writing: <**Insert number**>[**MB**][**TB**]/s.

    f. Average access time of 150 ms or less.
    g. MTBF of at least 100,000 power-on hours.

7. Expansion Slots: Minimum of 4, [**32**][**64**]<**Insert number**> bit.
8. Video Card:

    a. Capable of supporting [**one**][**two**][**three**][**four**] monitors.
    b. Resolution: [**1920 by 1200**]<**Insert values**> pixels minimum for each monitor.
    c. RAM: <**Insert number**>[**GB**][**TB**].
    d. Controller Speed: <**Insert number**>[**MHz**][**GHz**].
    e. On-Board Memory Speed: <**Insert number**>[**MHz**][**GHz**].
    f. On-Board Memory Data Width: <**Insert number**> bit.

9. Sound Card:

    a. At least 128 voice wavetable synthesis.
    b. Capable of delivering three-dimensional sound effects.
    c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

10. Network Interface Card: Include card with connection, as applicable.

    a. 10-100-1000 base TX Ethernet with 8PSJ connector port.
    b. 100 base FX Ethernet with SC or ST port.

11. Wireless Ethernet, 802.11 a/b/g/n.
12. Optical Modem: Full duplex link for connection to optical fiber cable provided.
13. I/O Ports:

    a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    b. One serial port.
    c. One parallel port.
    d. Two PS/2 ports.
    e. One 8PSJ.
    f. One stereo line-in and line-out on back panel.
    g. One microphone and headphone connector on front panel.
    h. One IEEE 1394 on front and back panel with PCI-e card.
    i. One ESATA port on back panel.

14. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

E. Keyboard:

1. 101-key enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to **72 inch (1800 mm)** in front of workstation.

F. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to **72 inch (1800 mm)** in front of workstation.

G. Flat Panel Display Monitor:

1. Number of Displays: [**One**][**Two**]<**Insert number**>.

    a. Display Support: [**Individual tilt adjustable base.**][**Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.**][**Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.**]<**Insert description.**>

2. Color display with <**Insert inch (mm)**> diagonal viewable area.
3. Aspect Ratio: [**16 to 9**]<**Insert value**>.
4. Resolution: [**1920 by 1080**]<**Insert value**> pixels at 60 Hz with pixel size of [**0.277**]<**Insert number**> mm or smaller.
5. [**Digital**][**or**][**analog**] input signal.

6. Response Time: <**Insert number**> ms.
7. Dynamic Contrast Ratio: [**50000 to 1**]<**Insert ratio**>.
8. Brightness: [**250 cd/sq. m**]<**Insert value**>.
9. ENERGY STAR compliant.
10. Antiglare display.

H. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

I. I/O Cabling: Include applicable cabling to connect I/O devices.

J. Software:

1. Factory-installed operating system.

2.14 PORTABLE WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. ENERGY STAR compliant.
3. Hardware and software must support local downloading to DDC controllers.
4. Data transfer rate to DDC controller must be at network speed.

D. Processor:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

   a. Capacity: <**Insert value**>[**GB**][**TB**].
   b. Speed and Type: <**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
b. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
c. Capacity: <**Insert number and measurement unit**>.
d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
e. Cache Buffer Size: <**Insert number and measurement unit**>.
f. <**Insert requirements**>.

4. Video Card: <**Insert number and measurement unit**> of RAM.

E. Input and Output Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 3.0 ports.
4. Ethernet port.
5. HDMI port.
6. IEEE 1394 port.

F. Battery:

1. Capable of supporting operation of portable workstation for a minimum of [**8**]<**Insert number**> hours.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Batteries: [**One**][**Two**].

G. Keyboard:

1. 85-key [**backlit**]keyboard.
2. Full upper- and lowercase ASCII keyset.

H. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.

I. Display:

1. <**Insert inch (mm)**> diagonal or larger high-definition WLED color display.
2. Antiglare screen.
3. [**1920 by 1080**]<**Insert value**> pixel resolution.
4. Brightness: 300 nits.

J. Network Interfaces:

1. Network Interface Card: Include card with connection, as application.

a. 10-100-1000 base TX Ethernet with 8PSJ connector port.
b. 100 base FX Ethernet with SC or ST port.

2. Wireless:

a. Internal with integrated antenna, capable of supporting 802.11 a/b/g/n.

K. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
2. Nominal Data Transfer Rates:

    a. Reading: <**Insert number**>[**MB**][**TB**]/s.
    b. Writing: <**Insert number**>[**MB**][**TB**]/s.

3. 160 ms access time.

L. Accessories:

1. Nylon carrying case.
2. Docking station.
3. Mobile broadband card.
4. Wireless optical mouse.
5. <**Insert value**>[**GB**][**TB**] portable hard drive.
6. Light-sensitive web cam and noise-cancelling digital array microphone.
7. Category 6a patch cable. Minimum cable length must be <**Insert length**>.
8. HDMI cable. Minimum cable length must be <**Insert length**>.

2.15 RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceways for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.16 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

1. Optical-Fiber Cable: Multimode, 50/125 micrometer OM3, six-fiber, [**nonconductive,**]tight-buffer, optical-fiber cable, with aqua jacket.
2. Balanced Twisted Pair Cable: 100 ohm, four-pair [**Category 5e**][**Category 6**].
3. Workstation Outlets: Four-port-connector assemblies mounted in single or multigang faceplate. Coordinate color and labels with Section 262726 "Wiring Devices."
4. TIA-485 Cable: Paired, [**one pair**][**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
5. Control-Voltage Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

    a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
    c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

C. TIA-232 Cable:

1. PVC-Jacketed, TIA-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper

conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

a. Type CM.
b. Flame Resistance: UL 1581, vertical tray.

2. Plenum-Type, TIA-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

a. Type CMP.
b. Flame Resistance: NFPA 262, flame test.

2.17 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**LEA International**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Mersen USA**]
9. [**PowerLogics, Inc./PQ Protection**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**LEA International**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Mersen USA**]
9. [**PowerLogics, Inc./PQ Protection**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. <**Insert manufacturer's name**>

C. SPDs: Comply with UL 1449, [**Type 1**][**Type 2**].

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor

components.

3. Include Form-C contacts rated at 5 A and 250 V(ac), one normally open and one normally closed, for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase must not be less than [**100 kA**]<**Insert value**>. The peak surge current rating must be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

E. Comply with UL 1283.

F. Protection modes and UL 1449 SPD for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

1. L-N: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
2. L-G: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
3. N-G: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
4. L-L: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

G. Protection modes and UL 1449 SPD for 240/120 V, single-phase, three-wire circuits must not exceed the following:

1. L-N: 700 V.
2. L-G: 700 V.
3. N-G: 700 V.
4. L-L: 1200 V.

H. SCCR: Equal or exceed [**100**][**200**]<**Insert value**> kA.

I. Nominal Rating: [**20**][**10**] kA.

J. Indoor Enclosures: NEMA 250, Type 1.

K. Outdoor Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and

without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Wiring and Cabling Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.

D. Raceways Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

E. Identification Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, TIA-485 cable, control-voltage cable, and TIA-232 cable.
3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

3.3 INSTALLATION OF WORKSTATIONS

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3. Install software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify that software functions properly.

C. Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of text for each graphic for Owner's[**and Architect's**] review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing must be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the

system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

A. For data communication wiring, comply with BICSI N1.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

   a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Optical-Fiber Cable Tests:

   a. Test instruments must meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
      2) Attenuation test results for links must be less than [**2.0 dB**][**that calculated according to equation in TIA-568-C.0**].

c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.

a. Test Analog Signals:

1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

b. Test Digital Signals:

1) Check digital signals using a jumper wire.
2) Check digital signals using an ohmmeter to test for contact making or breaking.

c. I/O Control Loop Tests:

1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2) Test every I/O point throughout its full operating range.
3) Test every control loop to verify that operation is stable and accurate.
4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.
7) Operate each analog point at the following:

a) Upper quarter of range.
b) Lower quarter of range.
c) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument must match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

C. Nonconforming Work:

1. Wiring and cabling will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 FINAL REVIEW

A. Submit written request to Architect [**and**][**Construction Manager**] when the power monitoring and control system is ready for final review. Written request must state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by [**Architect**][**and**][**Construction Manager**] will be made after receipt of written request. A field report must be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review must include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service must include [**three**][**six**][**nine**][**12**] months' full maintenance by manufacturer's authorized service representative. Include [**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 TRAINING

A. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of training materials and visual presentations.
2. Hard-copy materials must be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of hard-copy materials.

B. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system must be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

C. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

D. At Completion of Training: Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

E. Demonstration must include, but not be limited to, the following:

1. Accuracy and calibration of [**10**]<**Insert number**> I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:

    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

12. For Each Workstation:

    a. I/O point lists agree with naming conventions.
    b. Graphics are complete.

c. UPS unit, if applicable, operates.

END OF SECTION 26 09 23 00

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SECTION 26 09 23 00A - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Outdoor photoelectric switches.
3. Daylight-harvesting controls.
4. Business occupancy and vacancy sensors.
5. Storage occupancy sensors.
6. Outdoor motion sensors.
7. Industrial control switches.
8. Emergency lighting controls.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. [**Section 262726 "Wiring Devices"**][**Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches"**] for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

A. BCELTS: Branch circuit emergency lighting transfer switch.

B. DPDT: Double pole double throw.

C. DPST: Double pole single throw.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. PIR: Passive infrared.

G. SPDT: Single pole double throw.

H. SPST: Single pole single throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. ASHRAE/IES 90.1 LPD Compliance Documentation: Prepare plans and calculations demonstrating that as-constructed lighting power density complies with mandatory provisions of ASHRAE/IES 90.1 and that as-constructed lighting, including daylighting and controls, improves on baseline energy performance. If included with Project, indicate locations of energy meters for lighting loads.
2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Software and firmware service agreement.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multiteam projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed lighting control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that lighting control devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.
    c. <**Insert failure modes**>.

2. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
3. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Must comply with CCR Title 24.

2.2 TIME SWITCHES

A. UL WGZR - Electronic Time Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**Schneider Electric USA, Inc.**]
    g. [**TE Connectivity Ltd.**]
    h. [**Touché Lighting Control**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**Schneider Electric USA, Inc.**]

g. [**TE Connectivity Ltd.**]
h. [**Touché Lighting Control**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

   a. Contact Configuration: [**SPST**][**DPST**][**DPDT**]<**Insert configuration**>.
   b. Contact Rating: [**30 A inductive or resistive, 240 V(ac)**][**20 A driver load, 120/240 V(ac)**]<**Insert rating**>.
   c. Programs:

      1) Eight on-off set points on a 24-hour schedule[**and an annual holiday schedule that overrides the weekly operation on holidays**].
      2) Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week[**and an annual holiday schedule that overrides the weekly operation on holidays**].
      3) <**Insert number**> channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
      4) <**Insert number**> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
      5) <**Insert number**> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
      6) <**Insert number**> channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
      7) <**Insert number**> channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
      8) <**Insert configuration**>[**and an annual holiday schedule that overrides the weekly operation on holidays**].

   d. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[**on selected channels**].
   e. Astronomic Time: [**All**][**Selected**] channels.
   f. Automatic daylight savings time changeover.
   g. Battery Backup: Not less than seven days' reserve, to maintain schedules and time clock.

B. UL WGZR - Electromechanical-Dial Time Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**NSi Industries LLC**]

e. [**Schneider Electric USA, Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**NSi Industries LLC**]
e. [**Schneider Electric USA, Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

a. Contact Configuration: [**SPST**][**DPST**][**SPDT**][**DPDT**]<**Insert configuration**>.
b. Contact Rating: [**30 A inductive or resistive, 240 V(ac)**][**20 A driver load, 120/240 V(ac)**]<**Insert rating**>.
c. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
d. Astronomic time dial.
e. Eight-Day Program: Uniquely programmable for each weekday and holidays.
f. Skip-a-day mode.
g. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [**16**]<**Insert number**> hours.

C. UL WGZR - Digital Timer Light Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**nLight; Acuity Brands Lighting, Inc.**]
e. [**NSi Industries LLC**]
f. [**Schneider Electric USA, Inc.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**nLight; Acuity Brands Lighting, Inc.**]
e. [**NSi Industries LLC**]
f. [**Schneider Electric USA, Inc.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

   a. Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in [**10**][**20**]-minute increments.
   b. Rated 960 W at 120 V(ac) for tungsten lighting, 10 A at 120 V(ac) or 10 A at 277 V(ac) for fluorescent or LED lighting, and 1/4 hp at 120 V(ac).
   c. Standards: Comply with UL 20.
   d. Integral relay for connection to BAS.
   e. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage - 120 and 277 V**].
   f. Color: [**White**][**Black**]<**Insert color**>.
   g. Faceplate: Color matched to switch.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. UL WJFX - Solid-State Outdoor Photoelectric Switch, Flexible Mounting :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]

g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

   a. Solid state, with [**SPST**][**DPST**]<**Insert configuration**> dry contacts rated for [**1000 W incandescent**][**or**][**1800 VA inductive**]<**Insert value**>, to operate connected relay, contactor coils, or microprocessor input; and compatible with drivers and LED lamps.
   b. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   c. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range[**, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**].
   d. Time Delay: Fifteen-second minimum, to prevent false operation.
   e. Surge Protection: Metal-oxide varistor.
   f. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure[**from same source and manufacturer as switch**].
   g. Failure Mode: Luminaire stays ON.

B. UL WJFX - Solid-State Outdoor Photoelectric Switch, Luminaire-Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

   a. Solid state, with [**SPST**][**DPST**] dry contacts rated for [**1000 W incandescent**][**or**][**1800 VA inductive**], to operate connected load, and compatible with CFL and LED lamps.
   b. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range.
   c. Time Delay: Thirty-second minimum, to prevent false operation.
   d. Lightning Arrester: Air-gap type.
   e. Mounting: Twist lock complying with ANSI C136.10, with base[**from same source and manufacturer as switch**].
   f. Failure Mode: Luminaire stays ON.

C. UL WJFX - Solid-State, Low-Voltage, Outdoor Photoelectric Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

   a. Solid state; one set of N.O. dry contacts rated for [**24 V(dc) at 1 A**][**24 V(ac) at 1 A**], to operate connected load, and compatible with [**luminaire**][**power pack**][**lighting control**

panelboard].

b. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range.
c. Time Delay: Thirty-second minimum, to prevent false operation.
d. Mounting: **1/2 inch (13 mm)** threaded male conduit.
e. Failure Mode: Luminaire stays ON.
f. Power Pack:

1) Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

a) LED status lights to indicate load status.
b) Plenum rated.

2) Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] outputs rated for [**20 A**]<**Insert value**> incandescent[**or LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver**][**or**][**LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), Class 2 power source.

a) With integral current monitoring.
b) Compatible with digital addressable lighting interface.
c) Plenum rated.

2.4 DAYLIGHT-HARVESTING CONTROLS

A. UL WJCT - Daylight-Harvesting Control Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**nLight; Acuity Brands Lighting, Inc.**]
f. [**NSi Industries LLC**]
g. [**Sensor Switch, Inc**]
h. [**TE Connectivity Ltd.**]
i. [**WattStopper; Legrand North America, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]

d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**nLight; Acuity Brands Lighting, Inc.**]
f. [**NSi Industries LLC**]
g. [**Sensor Switch, Inc**]
h. [**TE Connectivity Ltd.**]
i. [**WattStopper; Legrand North America, LLC**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

   a. System operates indoor lighting.
   b. Ceiling-Mounted Switching Controls:

      1) Solid-state, light-level sensor unit, with [**integrated**]power pack, that detects changes in indoor lighting levels that are perceived by the eye.
      2) Solid-state, light-level sensor unit, with separate power pack[**mounted on luminaire**], that detects changes in indoor lighting levels that are perceived by the eye.

   c. Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
   d. Sensor Output:

      1) Contacts rated to operate the associated power pack, complying with UL 773A. Sensor must be powered by the power pack.
      2) Digital signal compatible with power pack.

   e. Sensor Type: [**Open loop**][**Closed loop**].
   f. Zone: [**Single**][**Multi**].
   g. Power Pack:

      1) Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

         a) LED status lights to indicate load status.
         b) Plenum rated.

      2) Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] outputs rated for [**20 A**]<**Insert value**> incandescent [**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver**][**or LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.

         a) With integral current monitoring
         b) Compatible with digital addressable lighting interface.
         c) Plenum rated.

   h. General Space Sensors Light-Level Monitoring Range: **10 to 200 fc (108 to 2152 lx)**, with an adjustment for turn-on and turn-off levels within that range.

i. Atrium Space Sensors Light-Level Monitoring Range: **100 to 1000 fc (1080 to 10 800 lx)**, with an adjustment for turn-on and turn-off levels within that range.
j. Skylight Sensors Light-Level Monitoring Range: **1000 to 10 000 fc (10 800 to 108 000 lx)**, with an adjustment for turn-on and turn-off levels within that range.
k. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
l. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
m. Test Mode: User selectable, overriding programmed time delay to allow settings check.
n. Control Load Status: User selectable to confirm that load wiring is correct.
o. Indicator: Two digital displays to indicate the beginning of on-off cycles.

6. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

a. Lighting control set point is based on two lighting conditions:

1) When no daylight is present.
2) When significant daylight is present (target level).

b. System programming is done with two handheld, remote-control tools.

B. UL WJCT - Daylight-Harvesting Analog Control Dimmer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**WattStopper; Legrand North America, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**WattStopper; Legrand North America, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

a. Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
b. System programming is done with two handheld, remote-control tools.

1) Initial setup tool.
2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

c. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [**integrated**][**separate**] power pack[**mounted on luminaire**], to detect changes in indoor lighting levels that are perceived by the eye.
d. Sensor Output: 0-10 V(dc) to operate luminaires. Sensor is powered by controller unit.
e. Light-Level Sensor Set-Point Adjustment Range: **20 to 60 fc (120 to 640 lx)**.
f. Power Pack: Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

1) LED status lights to indicate load status.
2) Plenum rated.

6. Sequence of Operation: Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).
b. When significant daylight is present.

C. UL WJCT - Daylight-Harvesting Digital Control Dimmer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**WattStopper; Legrand North America, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]

f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**WattStopper; Legrand North America, LLC**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

   a. Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   b. System programming is done with two handheld, remote-control tools.

      1) Initial setup tool.
      2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

   c. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [**integrated**][**separate**] power pack[**mounted on luminaire**], to detect changes in indoor lighting levels that are perceived by the eye.
   d. Sensor Output: 0-10 V(dc) to operate luminaires. Sensor is powered by controller unit.
   e. Light-Level Sensor Set-Point Adjustment Range: **20 to 60 fc (120 to 640 lx)**.
   f. Power Pack: Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] output(s) rated for [**20 A**]<**Insert value**> incandescent [**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver load**][**or**][**LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.

      1) With integral current monitoring.
      2) Compatible with digital addressable lighting interface.
      3) Plenum rated.

6. Sequence of Operation: Lighting control set point is based on the following two lighting conditions:

   a. When no daylight is present (target level).
   b. When significant daylight is present.

2.5 BUSINESS OCCUPANCY AND VACANCY SENSORS

A. Passive-Infrared (PIR) Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ademco; Honeywell**]
   b. [**ADT Security Services, Inc**]
   c. [**Cooper Lighting Solutions; Signify North America Corp.**]

d. [**Crestron Electronics, Inc.**]
e. [**Honeywell Security Group**]
f. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
i. [**Lutron Electronics Co., Inc**]
j. [**Napco Security Technologies, Inc.**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**RAB Lighting**]
m. [**WattStopper; Legrand North America, LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ademco; Honeywell**]
b. [**ADT Security Services, Inc**]
c. [**Cooper Lighting Solutions; Signify North America Corp.**]
d. [**Crestron Electronics, Inc.**]
e. [**Honeywell Security Group**]
f. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
i. [**Lutron Electronics Co., Inc**]
j. [**Napco Security Technologies, Inc.**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**RAB Lighting**]
m. [**WattStopper; Legrand North America, LLC**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.
c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Sensor Output: [**Contacts rated to operate the connected relay, complying with UL 773A**][**Sensor is powered from the power pack**][**Wireless**].
e. Power: [**Line voltage**][**Integral photovoltaic collector**].
f. Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
g. Mounting:

1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
2) Relay: Externally mounted through a **1/2 inch (13 mm)** knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

h. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
i. Bypass Switch: Override the "on" function in case of sensor failure.
j. Automatic Light-Level Sensor: Adjustable from **2 to 200 fc (21.5 to 2152 lx)**; turn lights off when selected lighting level is present.
k. Detector Sensitivity: Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**.

1) Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of **1000 sq. ft (93 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
2) Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within **90 ft (27.4 m)** when mounted on a **10 ft (3 m)** high ceiling.
3) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft (110 sq. m)**][**2000 sq. ft (220 sq. m)**][**3000 sq. ft (330 sq. m)**] when mounted **48 inch (1200 mm)** above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

B. Ultrasonic Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Lutron Electronics Co., Inc**]
e. [**WattStopper; Legrand North America, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Lutron Electronics Co., Inc**]
e. [**WattStopper; Legrand North America, LLC**]
f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.
c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Power: Line voltage.
e. Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
f. Mounting:

1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
2) Relay: Externally mounted through a **1/2 inch (13 mm)** knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

g. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
h. Bypass Switch: Override the "on" function in case of sensor failure.
i. Automatic Light-Level Sensor: Adjustable from **2 to 200 fc (21.5 to 2152 lx)**; turn lights off when selected lighting level is present.
j. Detector Sensitivity: Detect a person of average size and weight moving not less than **12 inch (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inch/s (305 mm/s)**.

1) Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of **600 sq. ft (56 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
2) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of **1000 sq. ft (93 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
3) Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of **2000 sq. ft (186 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
4) Detection Coverage (Corridor): Detect occupancy anywhere within **90 ft (27.4 m)** when mounted on a **10 ft (3 m)** high ceiling in a corridor not wider than **14 ft (4.3 m)**.
5) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft**

(110 sq. m)][2000 sq. ft (220 sq. m)][3000 sq. ft (330 sq. m)] when mounted 84 inch (2100 mm) above finished floor.

6. Operation:

   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

C. Dual-Technology, Passive-Infrared (PIR) and Ultrasonic, Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Lighting Solutions; Signify North America Corp.**]
   b. [**HLI Solutions; brand of GE Current, a Daintree Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Lighting Solutions; Signify North America Corp.**]
   b. [**HLI Solutions; brand of GE Current, a Daintree Company**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

   a. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
   b. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
   c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

   a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
   b. [**Integrated**][**Separate**] power pack.
   c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
   d. Sensitivity Adjustment: Separate for each sensing technology.
   e. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm), and detect a person of average size and weight moving not less than 12 inch (305 mm) in either a horizontal or a vertical manner at an approximate speed of

12 inch/s (305 mm/s).

1) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
2) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 sq. ft (110 sq. m)][2000 sq. ft (220 sq. m)][3000 sq. ft (330 sq. m)] when mounted 48 inch (1200 mm) above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

D. Dual-Technology, Passive-Infrared (PIR) and Passive-Acoustic, Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HLI Solutions; brand of GE Current, a Daintree Company**]
b. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
c. [**SensorWorx; brand of BLP Technologies, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HLI Solutions; brand of GE Current, a Daintree Company**]
b. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
c. [**SensorWorx; brand of BLP Technologies, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
b. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.

c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Sensitivity Adjustment: Separate for each sensing technology.
e. Detector Sensitivity: Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**, and detect a person of average size and weight moving not less than **12 inch (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inch/s (305 mm/s)**.

1) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of **1000 sq. ft (93 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
2) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft (110 sq. m)**][**2000 sq. ft (220 sq. m)**][**3000 sq. ft (330 sq. m)**] when mounted **48 inch (1200 mm)** above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

E. Wall-Switch Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Douglas Lighting Controls**]
c. [**Eaton**]
d. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Intermatic, Inc**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Lutron Electronics Co., Inc**]
i. [**nLight; Acuity Brands Lighting, Inc.**]
j. [**NSi Industries LLC**]
k. [**Philips; Signify North America; Signify Holding**]
l. [**RAB Lighting**]
m. [**Sensor Switch, Inc**]
n. [**Square D; Schneider Electric USA**]
o. [**WattStopper; Legrand North America, LLC**]
p. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Douglas Lighting Controls**]
c. [**Eaton**]
d. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Intermatic, Inc**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Lutron Electronics Co., Inc**]
i. [**nLight; Acuity Brands Lighting, Inc.**]
j. [**NSi Industries LLC**]
k. [**Philips; Signify North America; Signify Holding**]
l. [**RAB Lighting**]
m. [**Sensor Switch, Inc**]
n. [**Square D; Schneider Electric USA**]
o. [**WattStopper; Legrand North America, LLC**]
p. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in single gang switchbox[**, with provisions for connection to BAS**][**using hardwired connection**][**using wireless connection**].

1) Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2) Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
3) Switch Rating: Not less than 800 VA [**driver**][**or**][**LED**] load at 120 V, 1200 VA [**driver**][**or**][**LED**] load at 277 V, and 800 W incandescent.

b. Standard Range: [**180-degree field of view, field adjustable from 180 to 40 degrees**][**210-degree field of view**]; with a minimum coverage area of [**900 sq. ft (84 sq. m)**][**2100 sq. ft (196 sq. m)**].
c. Sensing Technology: [**PIR**][**Dual technology - PIR and ultrasonic**].
d. Switch Type: [**Single pole.**][**Single pole, dual circuit.**][**Single pole, manual "on," automatic "off."**][**Single pole, field-selectable automatic "on," or manual "on," automatic "off."**]
e. Capable of controlling load in three-way application.
f. Voltage: [**Match circuit voltage**][**120 V**][**277 V**][**Dual voltage - 120 and 277 V**].
g. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from **10 to 150 fc (108 to 1600 lx)**. Switch prevents lights from turning on when light level is higher than set point of sensor.

h. Time Delay:

1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
2) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

i. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
j. Color: [**White**][**Black**]<**Insert color**>.
k. Faceplate: Color matched to switch.

2.6 STORAGE OCCUPANCY SENSORS

A. High-Bay Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**nLight; Acuity Brands Lighting, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**nLight; Acuity Brands Lighting, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.

5. Standard Features:

a. Solid-State Unit: Designed to operate with the lamp and ballasts or drivers indicated.
b. Power: Line voltage.

1) Operating Ambient Conditions: **32 to 149 deg F (0 to 65 deg C)**.
2) Mounting: Threaded pipe.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4) Detector Technology: PIR.

c. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from **12 to 50 ft (3.7 to 15.2 m)**.

6. Other Available Features Required for the Project:

   a. HID Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
   b. HID Dimming Adapter: Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor[**and MyzerPORT option**].

7. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
8. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

B. Ceiling-Mounted, Solid-State, Extreme-Temperature Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**nLight; Acuity Brands Lighting, Inc.**]
   c. [**Sensor Switch, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**nLight; Acuity Brands Lighting, Inc.**]
   c. [**Sensor Switch, Inc**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Photoelectric Controls: UL CCN WJCT, including UL 773A.

5. Standard Features:

   a. Operating Ambient Conditions: From **minus 40 to plus 125 deg F (minus 40 to plus 52 deg C)**.
   b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
   c. Separate Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
   d. Mounting:

      1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
      2) Relay: Externally mounted through a **1/2 inch (13 mm)** knockout in a standard electrical enclosure.

3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.

e. Bypass Switch: Override the "on" function in case of sensor failure.
f. Automatic Light-Level Sensor: Adjustable from **2 to 10 fc (21.5 to 108 lx)**; keep lighting off when selected lighting level is present.
g. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

1) Detector Sensitivity: Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**.
2) Detection Coverage (Room): Detect occupancy anywhere in a circular area of **1500 sq. ft (139 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
3) Detection Coverage (High Bay): Detect occupancy within **25 ft (7.6 m)** when mounted on a **25 ft (7.6 m)** high ceiling.

6. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

2.7 OUTDOOR MOTION SENSORS

A. Solid-State Outdoor Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**NSi Industries LLC**]
h. [**RAB Lighting**]
i. [**Sensor Switch, Inc**]
j. [**WattStopper; Legrand North America, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**NSi Industries LLC**]
h. [**RAB Lighting**]

i. [**Sensor Switch, Inc**]
j. [**WattStopper; Legrand North America, LLC**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

   a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.
   b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
   c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

   a. [**PIR**][**Dual-technology (PIR and ultrasonic)**] type, weatherproof. Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**.
   b. Switch Rating:

      1) Luminaire-Mounted Sensor: [**1000 W incandescent, 500 VA fluorescent/LED**]<**Insert rating**>.
      2) Separately Mounted Sensor: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
      3) Switch Type: [**Single pole.**][**Single pole, dual circuit.**][**Single pole, manual "on," automatic "off."**][**Single pole, field-selectable automatic "on," or manual "on," automatic "off."**][**With bypass switch to override the "on" function in case of sensor failure.**]

   c. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage, 120 and 277 V**] type.
   d. Detector Coverage:

      1) Standard Range: 210-degree field of view, with a minimum coverage area of **900 sq. ft (84 sq. m)**.
      2) Long Range: 180-degree field of view and **110 ft (34 m)** detection range.
      3) <**Insert coverage area**>.

   e. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from **10 to 150 fc (108 to 1600 lx)**. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   f. Time Delay:

      1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
      2) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

   g. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
   h. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from **minus 40 to plus 130 deg F (minus 40 to plus 54 deg C)**, rated as "raintight" in accordance with UL 773A.

2.8 INDUSTRIAL CONTROL SWITCHES

A. Lighting Contactor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Allen-Bradley/Rockwell Automation**]
    c. [**ASCO Power Technologies**]
    d. [**Eaton**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Allen-Bradley/Rockwell Automation**]
    c. [**ASCO Power Technologies**]
    d. [**Eaton**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Industrial Control Switches: UL CCN NRNT, including UL 508.

5. Standard Features:

    a. Electrically operated and [**mechanically**][**electrically**] held, combination-type lighting contactors with [**fusible switch**][**nonfused disconnect**], complying with NEMA ICS 2.
    b. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush driver (driver with 15 percent or less THD of normal load current).
    c. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
    d. Enclosure Rating: Comply with UL 50E.
    e. Provide with control and pilot devices as [**indicated on the Drawings**][**scheduled**], matching the enclosure rating specified for the enclosure.
    f. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

        1) Monitoring: On-off status, <**Insert monitoring point**>.
        2) Control: On-off operation, <**Insert control point**>.

2.9 EMERGENCY LIGHTING CONTROLS

A. UL FTBR - Automatic Load Control Relay :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. [**Intelligent Lighting Controls Inc.**]
    e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    f. [**nLight; Acuity Brands Lighting, Inc.**]
    g. [**WattStopper; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. [**Intelligent Lighting Controls Inc.**]
    e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    f. [**nLight; Acuity Brands Lighting, Inc.**]
    g. [**WattStopper; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Emergency Lighting and Power Equipment: UL CCN FTBR, including UL 924.

5. Standard Features:

    a. N.C., electrically held relay.
    b. Coil Rating: [**120**][**277**] V.

B. UL WPWR - Branch Circuit Emergency Lighting Transfer Switch (BCELTS) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bodine; Signify North America; Signify Holding**]

b. [**Chloride; Signify North America; Signify Holding**]
c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Automatic Transfer Switches: UL CCN WPWR, including UL 1008.

5. Standard Features:

   a. Automatically transfers emergency lighting load from normal branch circuit to emergency branch circuit in accordance with Article 700 of NFPA 70.
   b. Rating: [**120**][**277**] V, not exceeding 20 A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**18 AWG**][**22 AWG**][**24 AWG**]. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**14 AWG**][**16 AWG**][**18 AWG**]. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 INSTALLATION OF LIGHTING CONTROL DEVICES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

   1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
   2. Electrical Maintenance: NFPA 70B.

3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.
3. Installation of Industrial Control Switches: Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.
4. Installation of Wiring:

   a. Conduit: Minimum conduit size is **1/2 inch (13 mm)**.
   b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.
   c. Size conductors in accordance with lighting control device manufacturer's published instructions unless otherwise indicated.
   d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Interfaces with Other Work:

1. Identification: Provide labels for lighting control devices and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Identify controlled circuits in lighting contactors.
   d. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
   e. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Lighting Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to the Project site during other-than-normal occupancy hours for this purpose. Some of the Work may be required during hours of darkness.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration:

1. [**With assistance from factory-authorized service representatives, demonstrate**][**Demonstrate**] to Owner's maintenance and clerical personnel[**and building occupants**] how to operate the following systems and equipment:

a. Lighting control devices.

B. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to adjust, operate, and maintain lighting control devices.

3.7 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

   a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 26 09 23 00A

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Task	Specification	Specification Description
26 09 23 00	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 09 23 00	26 09 00 00	Addressable Luminaire Lighting Controls
26 09 23 00	26 09 00 00a	Relay-Based Lighting Controls
26 09 23 00	26 24 19 00	Motor-Control Centers

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SECTION 26 11 16 00 - SECONDARY UNIT SUBSTATIONS WITH SWITCHBOARD SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Secondary unit substation equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for connecting wires.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**] control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
12. Section 260913 "Electrical Power Monitoring" specifies remote monitoring of metering instruments and for remote control of circuit breakers and switches.
13. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-mounted surge-suppression devices referenced in this Section.

1.2 DEFINITIONS

A. ICCB: Insulated-case circuit breaker.

B. MCCB: Molded-case circuit breaker.

C. PCB: Polychlorinated biphenyl.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

   a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
   b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
   c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.
4. Include product certificates for secondary unit substations, signed by manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

   a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. Design Data:

    a. Time-Current Characteristic Curves: For overcurrent protective devices.
    b. Primary Fuses: Submit recommendations and size calculations.
    c. Utility company's metering provisions with indication of approval by utility company.

C. Factory test reports.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by <**Insert name of electrical utility**> must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by electrical utility prior to submitting for action by Architect**][**Submit for action by Architect prior to submitting for approval by electrical utility**].

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

G. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage cable Installer must be approved by <**Insert name of electrical utility service provider**>.

H. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage duct Installer must be approved by <**Insert name of electrical utility service provider**>.

I. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment[**in accordance with electrical utility service provider requirements**].

1. Medium-voltage equipment Installer must be approved by <**Insert name of electrical utility service provider**>.

J. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.

K. Power Quality Specialist: Recognized experts possessing active NICET Electrical Power Testing (EPT) Technician IV certification and documented experience in power quality testing for installations similar in complexity to the Project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation will not form on or in units. Provide temporary heating in accordance with manufacturer's instructions.

D. Handle secondary unit substation components in accordance with manufacturer's instructions. Use factory-installed lifting provisions.

1.10 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Equipment Service Conditions," "Outdoor Equipment Service Conditions," and "Indoor Equipment Services Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.11 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substations performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchgear section; and including coordinated circuit breakers, fusible switches, and metering components.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. General Characteristics:

1. Referenced Standards: IEEE C2 and IEEE C37.121.
2. Indoor Unit Arrangement: Single assembly.
3. Outdoor Unit Arrangement: Single assembly.

   a. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
   b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.

4. Connections between the primary device and transformer must be [**cable**][**bus**], and between the transformer and secondary must be flexible bus braid unless noted otherwise.
5. Indoor Enclosure: Steel.
6. Outdoor Enclosure: Weatherproof, galvanized steel, listed for installation outdoors, complying with IEEE C37.20.1. Aisleless, full-height doors, with provisions for padlocking, in front of basic weatherproof equipment. Integral structural-steel base frame with factory-applied asphaltic undercoating.
7. Each compartment must have the following features:

   a. Structural design and anchorage adequate to resist loads imposed by [**125 mile/h (200 km/h)**]<**Insert wind speed**> wind.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
   c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
   d. Weatherproof ground-fault circuit interrupter duplex receptacle.
   e. Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated**].
   f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

8. Enclosure Finish:

   a. Outdoor Finish: Provide factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
   b. Indoor Finish: Provide factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
   c. Severe Environment Finish: Provide factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of **1/16 inch (1.6 mm)** from the test mark. The

scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with a rating of not less than 7 arrived at in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with a manufacturer's standard zinc-rich paint.

2.4 SECONDARY UNIT SUBSTATION EQUIPMENT

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation equipment.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation equipment, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with the following standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct transformer tests in accordance with IEEE C57.12.90.
2) Conduct primary switchgear tests in accordance with NEMA C37.51.
3) Conduct routine tests of completely assembled switchboard.
4) Resistance measurements of windings on rated voltage connection and on tap extreme connections.
5) Ratios on rated voltage connection and on tap extreme connections.
6) Polarity and phase relation on rated voltage connection.
7) No-load loss at rated voltage on rated voltage connection.
8) Exciting current at rated voltage on rated voltage connection.
9) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
10) Applied potential.
11) Induced potential.

2. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating.

a. Temperature test is not required if record of temperature test on essentially duplicate unit is available.
b. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

c. Factory Test Reports: Compile and submit factory test and inspection reports.

B. UL YEFV or DLAH or WVGN - Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.
b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]**<Insert other voltage>**.
d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. UL YEFV or DLAH or WVGN - Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
   c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

   a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

      1) Switchgear must be arc-resistant, complying with IEEE C37.20.7, [**Type 1A**][**Type 2A**][**Type 1C**][**Type 2C**].

   b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

      1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
      2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
      3) Main-Bus Rating: [**600**][**1200**][**2000**] A, continuous.

   c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

      1) Rating: [**600**][**1200**] A continuous duty and load break.
      2) Two-Time Duty-Cycle Fault Closing: [**25 000**][**40 000**] A, asymmetrical.
      3) Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
      4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
      5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
      6) Protective Shields: Cover live components and terminals.

a) Fuse Mounts: Single-frame mounted and de-energized when switch is open.

7) Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
8) Window: Permits viewing switch-blade positions when door is closed.
9) Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.

d. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with each fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

e. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of disconnecting device.

D. UL YEFV or DLAH or WVGN - Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three

wire; with three elements, [**15 min**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.

7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15 min**]<**Insert value**> interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

E. UL YEFV or XPLH - Liquid-Filled Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Liquid-Immersed Transformers: IEEE C57.12.00.

b. Liquid-Filled Distribution Transformers Over 600 V: UL CCN XPLH, including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

a. Insulating Liquid:

1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with ASTM D117.
2) Less flammable, edible-seed-oil based, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
3) Less flammable, dielectric, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than

300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.

4) Less flammable, silicone-based dielectric, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

b. Insulation Temperature Rise:

1) 55 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**. Insulation system must be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
2) 65 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**.

c. BIL: [**60**][**75**][**95**][**110**] kV.
d. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps[**, two above and two**] below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
e. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/ONAF/ONAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.
f. Impedance: <**Insert number**> percent.
g. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

1) Liquid-level gage.
2) Pressure-vacuum gage.
3) Liquid temperature indicator.
4) Drain and filter valves.
5) Pressure-relief device.

F. UL YEFV - Dry-Type Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Dry-Type Transformers: UL 1562.

4. Standard Features:

a. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for the transformer section.
b. Style:

1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.
2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.

c. Cooling System:

1) Class AA, air cooled, complying with IEEE C57.12.01.
2) Class AFA, air cooled with forced-air rating, complying with IEEE C57.12.01.

a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
b) Include mounting provision for fans.

3) Class AA/FA, air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include mounting provision for fans.

4) Class AFA, forced-air cooling, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include cooling fans.

d. Insulation Materials: IEEE C57.12.01, rated [**220**]<**Insert number**> deg C.

1) Insulation Temperature Rise: [**80**][**115**][**150**] deg C, maximum rise above **104 deg F**

(40 deg C).

e. BIL: [**60**][**75**][**95**][**110**] kV.
f. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps[**, two above and two**] below rated primary voltage.
g. Impedance: <**Insert number**> percent.
h. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

G. UL WEVC - Secondary Distribution Section Switchboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Dead-Front Switchboards: UL CCN WEVZ, including UL 891.

      1) Arc Resistance: Annex J of IEEE C37.20.7.

4. Standard Features:

   a. The secondary distribution section must be drawout, [**fused**][**fused where indicated**], low-voltage switchgear, complying with NEMA PB 2.
   b. Switchboard Structure: Front and rear accessible.

      1) Match and align the [**front**][**front and rear**] of the switchgear.
      2) Comply with UL requirements for service entrance equipment.

   c. Switchboard Bus:

      1) Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
      2) Main Phase Bus: Uniform capacity the entire length of section.
      3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.

Include braces for neutral-bus extensions for busway feeders.

4) Vertical Section Bus: Extend to spaces for future circuit breakers.
5) Phase- and Neutral-Bus Material:

   a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   b) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size **1/4-by-2 inch (6 by 50 mm)**.
7) Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
8) Neutral Disconnect Link: Bolted, uninsulated, **1/4-by-2 inch (6-by-50 mm)** copper bus, arranged to connect neutral bus to ground bus.

d. Switchboard Arrangement:

1) Main Disconnect Device(s): [**Power circuit breakers**][**Bolted pressure switches**][**ICCBs**][**MCCBs**][**Fusible switches**].
2) Feeder Protective Devices: [**Bolted pressure switches**][**ICCBs**][**MCCBs**][**Fusible switches**].

e. Power Circuit Breakers: [**Fixed**][**Drawout**] mounted, electrically operated air-circuit breakers, complying with UL 1066.

1) With "close" and "open" push buttons and red and green lighted breaker position indicators. Charging time of the motor operator must not exceed 8 seconds. Operator power must be from a control power transformer internal to the switchboard.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

   a) Adjustable long-delay pickup and time.
   b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
   c) Adjustable instantaneous pickup.
   d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test each trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator LED.

f. Bolted Pressure Switches: Fixed-mounted, manually operated, [**electrically tripped,**][**fusible,**]bolted pressure contact switch. Comply with UL 977.

1) Stored energy deadfront mechanism, compressed and released by the operating handle; switching action must be independent of the speed of the operating handle.
2) Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
3) With fuse clips and fuses for UL 248 Class L time-delay fuses.
4) Electrically tripped switches must include:

    a) Ground-fault protection, with adjustable time delay and test panel.
    b) Single-phase protection, tripping the switch on loss of a source phase.
    c) Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

g. ICCBs: [**Fixed**][**Drawout**]-mounted, [**manually**][**electrically**] operated air-circuit breakers. Comply with UL 1066.

1) With "close" and "open" push buttons and red and green lighted breaker position indicators. Charging time of the motor operator must not exceed 8 seconds. Operator power must be from a control power transformer internal to the switchboard.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-delay pickup and time.
    b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
    c) Adjustable instantaneous pickup.
    d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) With built-in connector to test the breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

h. MCCBs (to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) With trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs must not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-time delay.
    b) Adjustable short-time setting and delay to shape the time-current curve.

c) Adjustable instantaneous setting.
d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing installed circuit breakers with 225 A frame and higher.**]
7) With built-in digital ammeter display, showing load current and tripping cause.

i. MCCBs (1600 to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test each trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

j. Fusible Switches: Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch. Comply with UL 98.

1) Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2) With fuse clips and fuses.
3) Electrically tripped switches must include:

a) Shunt trip.
b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping the switch on loss of a source phase.
d) Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

H. UL YEFV or YEFR - Low-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Unit Substation Rated 600 V or Less: UL CCN YEFR, including UL 1062.

4. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh** **(MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
e. Surge Suppression: Factory installed as an integral part of the low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

1) Integral disconnect switch.
2) Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3) Indicator light display for protection status.
4) Form-C contacts rated at 5 A and 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5) Surge counter.

f. Control Power Supply: Control power transformer supplying 120 V control circuits through secondary disconnect devices.
g. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the**

following:]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

    a. Primary disconnect fuses.
    b. Potential transformer fuses.
    c. Control power fuses.
    d. Fuses and fusible devices for fused circuit breakers.
    e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.
3. Spare Mounting Gaskets: [**One**]<**Insert number**> set(s) for bushings, handholes, and the gasket between relief cover and flange of pressure-relief device.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Racking handle, to manually move circuit breaker between "connected" and "disconnected" positions.
2. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchboard.
3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
4. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
5. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
6. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.
2. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATION EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Hot Work: NFPA 51B.
7. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
8. Life Safety and Means of Egress Work: NFPA 101.
9. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
10. Work in Confined Spaces: NFPA 350.
11. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
12. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
13. Installation of Switchboards: NECA NEIS 400.
14. Installation of Liquid-Filled Transformers: NECA NEIS 410.
15. Installation of Medium-Voltage Switchgear: NECA NEIS 430.
16. AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install secondary unit substations on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices.

D. Interfaces with Other Work:

1. Identification: Provide labels for secondary unit substation equipment and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Install the number of signs required to be readable from each accessible side, but space the signs a maximum of **30 ft (9 m)** apart.
   e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with the maintenance materials.

2. Grounding and Bonding:

   a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not

smaller than 4/0 AWG. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.

b. At Exterior Locations:

c. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.

1) Fence and equipment connections must not be smaller than 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding **10 ft (3050 mm)**. Bond each gate section to the fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.

2) Make joints in grounding conductors and loops by exothermic weld or compression connector.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with the provisions of NFPA 70B Ch. 11, "Testing and Test Methods."
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation is tested at the specified value or less.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

a. Verify equipment nameplate data complies with the Contract Documents.

b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar

bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

E. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required area clearances.
c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
d. Verify that fuse and circuit-breaker sizes and types correspond to the Drawings and coordination study as well as the address of the circuit breaker that is used to identify it in microprocessor-communication software.
e. Verify that current and voltage-transformer ratios correspond to the Drawings.
f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-use or circuit-breaker ratings match the Drawings and comply with manufacturer's published instructions.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

c. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

d. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

e. Verify operation of space heaters.
f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

F. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify the arresters are clean.
d. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
e. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.

2. Electrical Test:

a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.
d. Verify the unit is clean.

e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate the applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform a ratio-verification test using the voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match the curve supplied by the manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. The measured burdens must match the instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages must comply with NETA ATS, Table 100.5. The insulation-resistance value must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
g. Perform dielectric-withstand-voltage tests on the primary winding with the secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application, the primary winding is considered to have passed the test.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply the test voltage for one minute in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS, Table 100.5. Insulation-resistance values of the transformers must not be less than values shown in NETA ATS, Table 100.5.
c. Perform a polarity test on each transformer to verify the polarity marks or H(1)- X(1) relationship. Polarity results must agree with transformer markings.
d. Perform a turns-ratio test on tap positions. Ratio errors must not exceed the tolerances specified in IEEE C57.13.

e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. The measured burdens must match the instrument transformer Accuracy Class rating.
f. Perform a dielectric-withstand-voltage test on the primary windings with the secondary windings connected to ground. The dielectric voltage must comply with NETA ATS, Table 100.9. The test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the primary windings are considered to have passed the test.
g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573 "Power System Studies."
h. Download settings from the relays. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme.

I. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect impact recorder prior to unloading.
c. Test dew point of tank gases if applicable.
d. Inspect anchorage, alignment, and grounding.
e. Verify the presence of PCB content labeling.
f. Verify removal of shipping bracing after placement.
g. Verify the bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.

k. Perform specific inspections and mechanical tests recommended by the manufacturer.
l. Verify presence of transformer surge arresters and that their ratings are as specified.
m. Verify that as-left tap connections are as specified.
n. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
c. Measure core insulation resistance at 500 V(dc) if the core is insulated and the core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
g. Measure the resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in the Operations and Maintenance Manual.
h. Perform an applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
j. Remove a sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove a sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

J. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify the unit is clean.

e. Perform specific inspections and mechanical tests recommended by the manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform turns-ratio tests at tap positions. The test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

K. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2.0 percent for power transformers.
2) 5.0 percent for distribution transformers.
3) Measure core insulation resistance at 500 V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).

c. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent must be investigated.
d. Perform turns-ratio tests at tap positions. The test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
e. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
f. Measure the resistance of each winding at each tap connection.

g. Perform an applied-voltage test on high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result must not exceed 100 percent of the AC RMS test voltage specified in IEEE C57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
h. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

L. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that maintenance devices are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.
b. Measure contact resistance across each power contact of the circuit breaker. Drop values for μΩ or mV(dc) must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed the value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's

published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.

g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils must conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.

i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

k. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

M. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage and alignment.

c. Verify the unit is clean.

d. Operate the circuit breaker to ensure smooth operation.

e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

f. Perform adjustments for final protective-device settings in accordance with the coordination study. Set the protective devices in accordance with coordination study report.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.

b. Perform a contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band, including adjustment factors.

d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils must conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.
j. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

N. Low-Voltage Ground-Fault Protection System Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect the components for damage and errors in polarity or conductor routing.

1) Verify that ground connection is made on the source side of the neutral disconnect link and on the source side of ground-fault sensor.
2) Verify that the neutral sensors are connected with correct polarity on both primary and secondary.
3) Verify that phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
4) Verify that grounding conductors do not pass through zero sequence sensors.
5) Verify that grounded conductor is solidly grounded.

b. Verify the unit is clean.
c. Operate the circuit breaker to ensure smooth operation.
d. Verify correct operation of functions of the self-test panel if provided.
e. Verify that the control power transformer has adequate capacity for the system.
f. Set pickup and time-delay settings. Record appropriate operation and test sequences in accordance with Section 230.95 "Ground-Fault Protection of Equipment" of NFPA 70.

2. Electrical Tests:

a. Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace the neutral disconnect link after testing. System neutral-to-ground insulation resistance must be a minimum of 1 MΩ. Correct wiring until the minimum is achieved.
b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test must be greater than 90 percent of the ground-fault protective-device pickup setting and less than 1200 A or 125 percent of the pickup setting, whichever is smaller. Adjust or replace the device until these parameters are achieved.
c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current-transformer pair. This test also applies to MCCBs utilizing an external neutral current transformer. The ground-fault protective device must operate when current direction is the same relative to polarity marks in the two current transformers. The ground-fault protective device must not operate when current direction is opposite relative to polarity marks in the two current transformers.

d. Measure time delay of the ground-fault protective device at a value equal to or greater than 150 percent of the pickup value. Relay timing must be in accordance with manufacturer's published data but must be no longer than one second at 3000 A in accordance with Section 230.95 "Ground-Fault Protection of Equipment" of NFPA 70.
e. Verify reduced control voltage tripping capability is 55 percent for AC systems and 80 percent for DC systems. Replace the ground-fault system if the reduced control voltage tripping requirement is not achieved, and retest.
f. Verify blocking capability of zone interlock systems. Results of zone-blocking tests must be in accordance with manufacturer's published data and design specifications.

O. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
c. Verify the unit is clean.
d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.

P. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

Q. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

R. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.7 PROTECTION

A. After installation, protect secondary unit substation equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Rebalance loads.
c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting:

    a. Prepare a written report covering monitoring performed and corrective action taken.
    b. For each relay and adjustable circuit breaker, tag the device with adjusting technician's initials and the date of the adjustment. Record the settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Scanning of Secondary Unit Substation Equipment: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the unit substation.
2. Follow-On Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between the area of concern and the reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of the deficient area.

5. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**one year**]<**Insert duration**> period for full maintenance by [**skilled employees of secondary unit substation equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper secondary unit substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

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SECTION 26 11 16 00A - SECONDARY UNIT SUBSTATIONS WITH MOTOR CONTROL CENTER SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Secondary unit substation equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
6. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.
7. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for connecting wires.
8. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
9. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
10. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
11. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
12. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
13. Section 260913 "Electrical Power Monitoring" specifies remote monitoring of metering instruments and for remote control of circuit breakers and switches.
14. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-mounted surge-suppression devices referenced in this Section.

1.2 DEFINITIONS

A. Combination Motor Controller: A combination motor-control unit that includes externally operable circuit-disconnecting means, branch-circuit overcurrent protection, and a motor controller with associated auxiliary devices when used.

B. CPT: Control power transformer.

C. ICCB: Insulated-case circuit breaker.

D. MCCB: Molded-case circuit breaker.

E. MCP: Motor-circuit protector.

F. PCB: Polychlorinated biphenyl.

G. SCR: Silicon controlled rectifier.

H. SPD: Surge protection device.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For unit substation. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.
4. Include product certificates for secondary unit substations, signed by manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

    a. Include plan view and cross section of equipment base, showing clearances, manufacturer's published instructions for minimum workspace clearances that account for breaker service and removal, and locations of penetrations for grounding and conduits.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. Material, size and number of bus bars, and current rating for buses, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. For motor-control secondary section, submit manufacturer's standard drawings complying with requirements of UL 845.

    a. Manufacturer's production drawings as defined in UL 845.
    b. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for installed controllers.
    c. Nameplate legends.
    d. Vertical and horizontal bus capacities.
    e. Features, characteristics, ratings, and factory settings of installed units.
    f. <**Insert required information**>.

11. Design Data:

    a. Time-Current Characteristic Curves: For overcurrent protective devices.
    b. Primary Fuses: Submit recommendations and size calculations.
    c. Utility company's metering provisions with indication of approval by utility company.

C. Factory test reports.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. For motor-control secondary section, submit the following:

1. Manufacturer's approval drawings as defined in UL 845.
2. Manufacturer's custom drawings as defined in UL 845.
3. Manufacturer's production drawings as defined in UL 845.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.8 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by <**Insert name of electrical utility**> must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by electrical utility prior to submitting for action by Architect**][**Submit for action by Architect prior to submitting for approval by electrical utility**].

1.9 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

G. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage cable Installer must be approved by <**Insert name of electrical utility service provider**>.

H. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage duct Installer must be approved by <**Insert name of electrical utility service provider**>.

I. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment[**in accordance with electrical utility service provider requirements**].

1. Medium-voltage equipment Installer must be approved by <**Insert name of electrical utility service provider**>.

J. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.

K. Power Quality Specialist: Recognized experts possessing active NICET Electrical Power Testing (EPT) Technician IV certification and documented experience in power quality testing for installations similar in complexity to the Project.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation will not form on or in units. Provide temporary heating in accordance with manufacturer's written instructions.

D. Handle secondary unit substation components in accordance with manufacturer's written instructions. Use factory-installed lifting provisions.

1. Handle MCCs in accordance with NEMA ICS 2.3 and NECA NEIS 402.

1.11 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility

Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Equipment Service Conditions," "Outdoor Equipment Service Conditions," and "Indoor Equipment Services Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.12 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage MCC section; and including coordinated circuit breakers, fusible switches, and metering components.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. General Characteristics:

1. Referenced Standards: IEEE C2 and IEEE C37.121.
2. Indoor Unit Arrangement: Single assembly, with secondary section MCC complying with [**UL 50E, Type 1**][**UL 50E, Type 1 (gasketed)**][**UL 50E, Type 12**] construction.
3. Outdoor Unit Arrangement: Single assembly.

   a. Weatherproof, listed for installation outdoors, with primary and transformer sections complying with IEEE C37.20.1, and MCC section complying with UL 50E, Type 3R.
   b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.

4. Connections between primary device and transformer must be [**cable**][**bus**], and between transformer and secondary must be flexible bus braid unless noted otherwise.
5. Indoor Enclosure: Steel.
6. Outdoor Enclosure: Weatherproof, galvanized steel, listed for installation outdoors, complying with IEEE C37.20.1. Aisleless, full-height doors, with provisions for padlocking, in front of basic weatherproof equipment. Integral structural-steel base frame with factory-applied asphaltic undercoating.

   a. Compartments must have the following features:

      1) Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
      2) Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of section above expected dew point.
      3) Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
      4) Weatherproof ground-fault circuit interrupter (GFCI) duplex receptacle.
      5) Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated on the Drawings**].
      6) Skid Mounted: Mount shipping group on integral base frame as complete weatherproof unit.

7. Unit Substation Enclosures Finish:

   a. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
   b. Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
   c. Factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120 h**][**480 h**] of exposure to salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654, with rating of not less than 7, in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized

sheet steel must be coated with manufacturer's standard zinc-rich paint.

2.4 SECONDARY UNIT SUBSTATION EQUIPMENT

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation equipment.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation equipment, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with the following standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct transformer tests in accordance with IEEE C57.12.90.
2) Conduct primary switchgear tests in accordance with NEMA C37.51.
3) Conduct routine tests of completely assembled MCC, including the following:

a) Dielectric Tests: Comply with NEMA ICS 1.
b) Verify correct operation of circuit breaker,[**motor circuit protector,**] magnetic contactor, and control devices, accessories and indicating lamps. Verification checks must be made at rated voltage with power supplies to main buses.
c) Verify correct operation of magnetic contactors with power at 90 percent of rated voltage.

4) Resistance measurements of windings on rated voltage connection and on tap extreme connections.
5) Ratios on rated voltage connection and on tap extreme connections.
6) Polarity and phase relation on rated voltage connection.
7) No-load loss at rated voltage on rated voltage connection.
8) Exciting current at rated voltage on rated voltage connection.
9) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
10) Applied potential.
11) Induced potential.

2. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating.

a. Temperature test is not required if record of temperature test on essentially duplicate unit is available.
b. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

c. Factory Test Reports: Compile and submit factory test and inspection reports.

B. UL YEFV or DLAH or WVGN - Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
   c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

   a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for transformer section.
   b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
   c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. UL YEFV or DLAH or WVGN - Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

1) Switchgear must be arc-resistant, complying with IEEE C37.20.7, [**Type 1A**][**Type 2A**][**Type 1C**][**Type 2C**].

b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
3) Main-Bus Rating: [**600 A**][**1200 A**][**2000 A**], continuous.

c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1) Rating: [**600 A**][**1200 A**] continuous duty and load break.
2) Two-Time Duty-Cycle Fault Closing: [**25 000 A(asym)**][**40 000 A(asym)**].
3) Switch Action: No external arc and no significant quantities of ionized gas released into enclosure.
4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6) Protective Shields: Cover live components and terminals.

   a) Fuse Mounts: Single-frame mounted and de-energized when switch is open.

7) Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
8) Window: Permits viewing switch-blade positions when door is closed.
9) Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.

d. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in switch.

e. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of disconnecting device.

D. UL YEFV or DLAH or WVGN - Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
   c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

   a. Instrument Transformers: Comply with IEEE C57.13.

      1) Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.

   b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

      1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
      2) Switch-selectable digital display with the following features:

         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand: Demand interval selectable from 5 to 60 min; plus or minus 2 percent.
         i) Accumulated Energy in MWh (MJ): Plus or minus 2 percent; stored values unaffected by power outages for up to 72 h.

      3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
      4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

   c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, [**15 min**]<**Insert duration**> indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15 min**]<**Insert duration**> interval.

d. Operation: Counts and records succession of pulses entering two channels.
e. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. UL YEFV or XPLH - Liquid-Filled Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Liquid-Immersed Transformers: IEEE C57.12.00.

b. Liquid-Filled Distribution Transformers over 600 V: UL CCN XPLH, including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

a. Insulating Liquid:

1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with

ASTM D117.

2) Less flammable, edible-seed-oil based, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
3) Less flammable, dielectric, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
4) Less flammable, silicone-based dielectric, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

b. Insulation Temperature Rise:

1) 55 deg C, based on average ambient temperature of 30 deg C over 24 h with maximum ambient temperature of 40 deg C. Insulation system must be rated to continuously allow additional 12 percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
2) 65 deg C, based on average ambient temperature of 30 deg C over 24 h with maximum ambient temperature of 40 deg C.

c. BIL: [**60 kV**][**75 kV**][**95 kV**][**110 kV**].
d. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
2) Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

e. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/ONAF/ONAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.
f. Impedance: <**Insert number**> percent.
g. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have steel base and frame allowing use of pipe rollers in any direction, and insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

1) Liquid-level gauge.
2) Pressure-vacuum gauge.
3) Liquid temperature indicator.
4) Drain and filter valves.
5) Pressure-relief device.

F. UL YEFV - Dry-Type Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Square D; Schneider Electric USA**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
      3) Dry-Type Transformers: UL 1562.

4. Standard Features:

   a. Primary Incoming Section: Transformer cover-mounted bushings. Bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
   b. Style:

      1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with 80 deg C average winding temperature rise above maximum ambient temperature of 40 deg C.
      2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with 80 deg C average winding temperature rise above maximum ambient temperature of 40 deg C.

   c. Cooling System:

      1) Class AA: air cooled, complying with IEEE C57.12.01.
      2) Class AFA: air cooled with forced-air rating, complying with IEEE C57.12.01.

         a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
         b) Include[**mounting provisions for**] cooling fans.

      3) Class AA/FA: air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

         a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
         b) Include mounting provisions for fans.

d. Insulation Materials: IEEE C57.12.01, rated [**220 deg C**]<**Insert deg C**>.

1) Insulation Temperature Rise: [**80 deg C**][**115 deg C**][**150 deg C**] maximum rise above 40 deg C.

e. BIL: [**60 kV**][**75 kV**][**95 kV**][**110 kV**].
f. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage.
2) Four nominal 2.5 percent taps below rated primary voltage.

g. Impedance: <**Insert number**> percent.

5. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

G. UL NJAV - Secondary Distribution Section MCC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Motor Control Center: UL CCN NJAV, including UL 845.

4. Standard Features:

a. MCC: Combination motor controllers, complying with NEMA ICS 18.

1) Wiring:

a) NEMA ICS 18, [**Class I**][**Class I-S**], [**Type A**][**Type B, for starters larger than Size 3**][**Type B-D, for starter Size 3 and smaller**][**Type B-T, for starter**

Size 3 and smaller][**Type C**].

b) NEMA ICS 18, [**Class II**][**Class II-S**], [**Type B, for starters larger than Size 3**][**Type B-D, for starter Size 3 and smaller**][**Type B-T, for starter Size 3 and smaller**][**Type C**].

2) Short-Circuit Current Rating for Each Unit: [**Combination series rated**][**Fully rated**]; [**22 kA**][**42 kA**][**65 kA**][**100 kA**]<**Insert kA**>.

3) Short-Circuit Current Rating of MCC: [**Combination series rated**][**Fully rated**] with its main overcurrent device; [**22 kA**][**42 kA**][**65 kA**][**100 kA**]<**Insert kA**>.

b. MCC Structure: Front and rear accessible.

1) Match and align front[**and rear**] of MCC.

2) Comply with UL requirements for service entrance equipment.

c. MCC Bus:

1) Use bus bars to connect compartments and vertical sections. Cable connections are prohibited.

2) Main Phase Bus: Uniform capacity entire length of section.

3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated on the Drawings. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.

4) Vertical Section Bus: Extend to spaces for future controllers.

5) Phase- and Neutral-Bus Material:

a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.

b) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.

7) Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.

d. Power Circuit Breaker: [**Fixed**][**Drawout**] mounted, electrically operated air-circuit breaker. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from supply internal to MCC.

2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.

3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.

4) LED indicators or display, with manual reset, to show cause of automatic trip.

5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.

6) Trip circuit breaker when closing on fault.

7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.

b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.

c) Adjustable instantaneous pickup.

d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator LED.

e. Bolted Pressure Switch: Fixed mounted, manually operated, [**electrically tripped,**][**fusible,**]bolted pressure contact switch. Comply with UL 977.

1) Stored energy deadfront mechanism, compressed and released by operating handle; switching action must be independent of speed of operating handle.
2) Indication whether switch is open or closed, and provisions for padlocking operating handle.
3) With fuse clips and fuses for UL 248 Class L time-delay fuses.
4) Electrically tripped switches must include:

a) Ground-fault protection, with adjustable time delay and test panel.
b) Single-phase protection, tripping switch on loss of source phase.
c) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.
d) Operator power must be from supply internal to MCC.

f. Insulated Case Circuit Breaker: [**Fixed**][**Drawout**] mounted, [**manually**][**electrically**] operated air-circuit breaker. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from supply internal to MCC.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) With built-in connector to test breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

g. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual

push-to-trip push-button.

2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) With trip-setting dials or interchangeable plugs to establish continuous trip of circuit breaker. Plugs must not be interchangeable between frames, and breaker may not be closed without plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-time delay.
    b) Adjustable short-time setting and delay to shape time-current curve.
    c) Adjustable instantaneous setting.
    d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test long-time delay, instantaneous, and ground-fault functions of breaker.[**Provide one test set for testing installed circuit breakers 225 A frame and higher.**]
7) With built-in digital ammeter display, showing load current and tripping cause.

h. MCCB (1600 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-delay pickup and time.
    b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
    c) Adjustable instantaneous pickup.
    d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

i. Fusible Switch: Fixed-mounted, manually operated, [**electrically tripped,**]quick-make, quick-break switch. Comply with UL 98.

1) Indication whether switch is open or closed, and provisions for padlocking operating handle.
2) With fuse clips and fuses.
3) Electrically tripped switches must include:

    a) Shunt trip.

b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping switch on loss of source phase.
d) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.
e) Operator power must be from supply internal to MCC.

j. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

1) Configurations: [**Nonreversing**][**and**][**reversing**]<**Insert configuration**>.

k. Reduced-Voltage Magnetic Controllers: Electrically held, NEMA ICS 2, general purpose, Class A; closed transition; adjustable time delay on transition.

1) Configurations: Reduced voltage, electrically held.

a) Wye-Delta Controller: Four contactors, with three-phase starting resistor/reactor bank.
b) Part-Winding Controller: Separate START and RUN contactors, field selectable for one-half or two-thirds winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
c) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; one RUN and two START contactors.

l. Reduced-Voltage, Solid-State Controllers: Comply with UL 508.

1) Description: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays.
2) Application: Suitable for use with NEMA MG 1 Design B, polyphase induction motors.
3) Configuration: [**Standard duty**][**Severe duty**]; [**nonreversible**][**reversible**].
4) Starting Mode: [**Voltage ramping**][**Current limit**][**Torque control**][**Torque control with voltage boost**][**; field selectable**].
5) Stopping Mode: [**Coast to stop**][**Adjustable torque deceleration**][**Adjustable braking**][**; field selectable**].
6) Surge Suppression: Factory installed as integral part of controller, SPD complying with UL 1449 as Type 2, or SPD complying with UL 1449, Type 4, suitable for use in Type 2 application.
7) Bypass Contactor: Operates automatically to bypass SCRs when motor has reached rated speed and full voltage is applied to motor. Solid-state controller protective features must remain active when bypass relay is in bypass mode.

a) Manufacturer's standard product.
b) NEMA ICS 2, general-purpose, Class A contactor, rated to start load across the line.

8) Bypass Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.[**Provide coil with SPD.**]
9) Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to [**400**]<**Insert number**> percent current limitation for 20 s.

10) SCR Bridge: At least two SCRs per phase, for stable and smooth acceleration [**with**][**without**] external feedback from motor or driven equipment.
11) Keypad: Front accessible; for programming controller parameters, functions, and features; must be manufacturer's standard and include not less than the following functions:

    a) Adjusting motor full-load amperes, as percentage of controller's rating.
    b) Adjusting current limitation on starting, as percentage of motor full-load current rating.
    c) Adjusting linear acceleration and deceleration ramps, in seconds.
    d) Setting initial torque, as percentage of nominal motor torque.
    e) Adjusting torque limit, as percentage of nominal motor torque.
    f) Adjusting maximum start time, in seconds.
    g) Adjusting voltage boost, as percentage of nominal supply voltage.
    h) Selecting stopping mode and adjusting parameters.
    i) Selecting motor thermal-overload protection class between 5 and 30.
    j) Activating and deactivating protection modes.
    k) Selecting or activating communications modes.
    l) <**Insert function**>.

12) Digital display, front accessible; for showing motor, controller, and fault status; must be manufacturer's standard and include not less than the following:

    a) Controller Condition: Ready, starting, running, stopping.
    b) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    c) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
    d) <**Insert items**>.

13) Controller Diagnostics and Protection:

    a) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via keypad.
    b) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    c) Input isolation contactor that opens when controller diagnostics detect faulted solid-state component, or when motor is stopped.
    d) Shunt trip that opens disconnecting means when controller diagnostics detect faulted solid-state component.
    e) <**Insert items**>.

14) Remote Output Features:

    a) All outputs prewired to terminal blocks.
    b) Form C status contacts that change state when controller is running.
    c) Form C alarm contacts that change state when fault condition occurs.
    d) <**Insert items**>.

15) Optional Features:

    a) Analog output for field-selectable assignment of motor operating characteristics; [**Zero to 10 V(dc)**][**4 to 20 mA(dc)**].

b) [**Two**]<**Insert number**> additional field-assignable Form C contacts for alarm outputs.
c) Full-voltage/BYPASS selector switch. Power contacts must be totally enclosed, double break, and made of silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.

m. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

1) Nonreversing Configuration: [**Consequent pole**][**Two winding**].

a) Two speed, with compelling relays to ensure that motor will start only at low speed.
b) Accelerating timer relays, for properly timed acceleration through speeds lower than that selected.
c) Decelerating timer relays, for automatically timed deceleration through each speed.

2) Reversing Configuration: [**Consequent pole**][**Two winding**].

a) Two speed, with compelling relay to ensure that motor will start only at low speed.
b) Compelling relays must ensure that motor starts only at low speed.
c) Accelerating timer relays, for properly timed acceleration through speeds lower than that selected.
d) Decelerating timer relays, for automatically timed deceleration through each speed.
e) Antiplugging timer relays, for time delay when transferring from FORWARD to REVERSE and back.

n. Controller Disconnect and OCPD:

1) Fusible Disconnecting Means:

a) NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**Class J**][**Class L**]<**Insert class**> fuses.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2) MCP Disconnecting Means:

a) UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d) [**N.C.**][**N.O.**] alarm contact that operates only when MCP has tripped.
e) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3) MCCB Disconnecting Means:

a) UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c) Lockable Handle: For three padlocks and interlocks with cover in closed position.
d) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e) [**N.C.**][**N.O.**] alarm contact that operates only when MCCB has tripped.

4) Molded-Case Switch Disconnecting Means:

a) UL 489, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
d) [**N.C.**][**N.O.**] alarm contact that operates only when molded-case switch has tripped.

o. Overload Relays:

1) Melting-Alloy Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2) Bimetallic Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

3) Solid-State Overload Relays:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
e) Analog communication module.

4) [**N.C.**][**N.O.**] isolated overload alarm contact.
5) External overload reset push-button.

p. Control Power:

1) Control Circuits: [**24 V(ac)**][**120 V(ac)**]<**Insert voltage**>; obtained from [**integral CPT, with primary and secondary fuses**]<**Insert source of control power**>, with [**CPT**][**control power source**] of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2) CPT Spare Capacity: [**50 VA**][**100 VA**][**200 VA**]<**Insert VA**>.

q. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

r. ICCB Feeder Tap Units: [**Fixed**][**Drawout**]-mounted, [**manually**][**electrically**] operated air-circuit breakers. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from control power transformer internal to switchboard.
2) Solid-state monitoring and tripping system must provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) Built-in connector tests breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

s. MCCB Feeder Tap Units (to 2500 A): Fixed-mounted, manually operated air-circuit breakers, complying with UL 489.

1) Include quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. Include manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) Include trip-setting dials or interchangeable plugs to establish continuous trip of circuit breaker. Plugs must not be interchangeable between frames, and circuit breaker may not be closed without plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-time delay.
b) Adjustable short-time setting and delay to shape time-current curve.
c) Adjustable instantaneous setting.
d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test long-time delay, instantaneous, and ground-fault functions of breaker.[**Provide one test set for testing installed circuit breakers 225 A frame and higher.**]
7) With built-in digital ammeter and digital display, showing tripping cause.

t. MCCB Feeder Tap Units (1600 to 2500 A): Fixed-mounted, manually operated air-circuit breakers, complying with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel indicates that status of system circuitry is fully operational or gives fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

u. Fusible Switch Feeder Tap Units: Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch. Comply with UL 98.

1) Indication whether switch is open or closed, and provisions for padlocking operating handle.
2) Include fuse clips and fuses.
3) Electrically tripped switches must include:

a) Shunt trip.
b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping switch on loss of source phase.
d) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.

v. Compartments: Modular; individual [**lift-off**]doors with concealed hinges and quick-captive screw fasteners. Interlocks on units require disconnecting means in off position before door can be opened or closed, except by operating permissive release device.
w. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other

units in MCC. Same-size compartments permit interchangeability and ready rearrangement of units, such as replacing three single units with unit requiring three spaces, without cutting or welding.

x. Wiring Spaces:

1) Vertical wireways in vertical section for vertical wiring to unit compartments; supports to hold wiring in place.
2) Horizontal wireways in [**bottom**][**and**][**top**] of vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

y. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1) Push-Buttons, Pilot Lights, and Selector Switches: [**Heavy**][**Standard**]-duty[**, oiltight**] type.

a) Push-Buttons: [**Covered**][**Lockable**][**Recessed**][**Shielded**][**Shrouded**][**Unguarded**] types; [**maintained**][**momentary**] contact unless otherwise indicated.
b) Pilot Lights: [**Incandescent**][**LED**][**Neon**][**Resistor**][**Transformer**] types; <**Insert color(s)**>[**; push to test**].
c) Selector Switches: [**Rotary**]<**Insert description**> type.

2) Elapsed-Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].

z. Meters: Panel type, **2 1/2 inch (64 mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having off position.
aa. [**N.C.**][**N.O.**][**Reversible N.C./N.O.**] contactor auxiliary contact(s).
bb. Control Relays: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.
cc. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.
dd. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
ee. Sun shields, installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
ff. Cover gaskets, for UL 50E, Type 1 enclosures.
gg. Terminals, for connecting power-factor correction capacitors to [**line**][**load**] side of overload relays.
hh. Spare control-wiring terminal blocks[**; unwired**][**; wired**].
ii. <**Insert auxiliary device**>.

H. UL YEFV or YEFR - Low-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]

d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Unit Substation Rated 600 V or Less: UL CCN YEFR, including UL 1062.

4. Standard Features:

   a. Instrument Transformers: Comply with IEEE C57.13.

      1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy Class 0.3 with burdens of W, X, and Y.
      2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

   b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

      1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
      2) Switch-selectable digital display with the following features:

         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand, with Demand Interval: Selectable from 5 to 60 min, plus or minus 2 percent.
         i) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 h.

      3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.

4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15 min indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15 min interval.

a) Operation: Counts and records succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Surge Suppression: Factory installed as integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

1) Integral disconnect switch.
2) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3) Indicator light display for protection status.
4) Form-C contacts rated at 5 A and 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5) Surge counter.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

a. Primary disconnect fuses.
b. Potential transformer fuses.
c. Control power fuses.
d. Fuses for secondary fusible devices.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[

Include the following:]

1. Racking handle, to manually move circuit breaker between "connected" and "disconnected" positions.
2. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
3. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.
2. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATION EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Hot Work: NFPA 51B.
7. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
8. Life Safety and Means of Egress Work: NFPA 101.

9. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
10. Work in Confined Spaces: NFPA 350.
11. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
12. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
13. Installation of Liquid-Filled Transformers: NECA NEIS 410.
14. Installation of Medium-Voltage Switchgear: NECA NEIS 430.
15. Installation of Motor Control Centers: NEMA ICS 2.3.
16. AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install secondary unit substations on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices.

D. Interfaces with Other Work:

1. Identification: Provide labels for secondary unit substation equipment and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Install number of signs required to be readable from accessible side, but space signs maximum of **30 ft (9 m)** apart.
   e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with maintenance materials.

2. Grounding and Bonding:

   a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   b. At Exterior Locations:

      1) For counterpoise use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **24 inch (610 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
      2) Fence and equipment connections must not be smaller than 4 AWG. Ground fence at gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
      3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
2. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system measurement at substation does not exceed specified value.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

    a. Verify equipment nameplate data complies with Contract Documents.
    b. Inspect bolted electrical connections for high resistance using one of the following two methods:

        1) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

E. Switchgear and MCC Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required area clearances.
    c. Verify unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as address of circuit breaker that is used to identify it in microprocessor-communication software.
    e. Verify that current and voltage-transformer ratios correspond to Drawings.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's published instructions.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform DC voltage insulation-resistance tests on bus section, phase-to-phase and phase-to-ground, for 1 min. If temperature of bus is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published recommendations or NETA ATS, Table 100.1.
2) Do not proceed to dielectric withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform dielectric withstand-voltage test on bus section, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no published recommendation for this test, it must be conducted to in accordance with NETA ATS, Table 100.2. Apply test voltage for 1 min.

1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand-voltage test, test specimen is considered to have passed test.

c. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

d. Perform current-injection tests on entire current circuit in section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that minimum current of 1.0 A flows in secondary circuit. Verify correct magnitude of current at device in circuit.
2) Perform current tests by primary injection with magnitudes such that minimum of 1.0 A flows in secondary circuit. Verify correct magnitude of current at device in circuit.

e. Verify operation of space heaters.

f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from every source.

F. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that arresters are clean.
d. Verify that ground lead on device is individually attached to ground bus or ground electrode.
e. Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

2. Electrical Test:

a. Perform insulation-resistance test on arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in table.
b. Perform watts loss test. Evaluate watts loss values by comparison with similar units and test equipment manufacturer's published data.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.
d. Verify that unit is clean.
e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of current transformer and its secondary wiring with respect to ground at 1000 V(dc) for 1 min. For units with solid-state components that cannot tolerate applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform polarity test of current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. Measured burdens must match instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test

voltages must comply with NETA ATS, Table 100.5. Insulation-resistance value must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.

g. Perform dielectric withstand-voltage tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by end of total time of voltage application, primary winding is considered to have passed test.

h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with test equipment manufacturer's published data.

i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply test voltage for 1 min in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.

b. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Test voltages must be applied for 1 min in accordance with NETA ATS, Table 100.5. Insulation-resistance values of transformers must not be less than values shown in NETA ATS, Table 100.5.

c. Perform polarity test on transformer to verify polarity marks or H(1) to X(1) relationship. Polarity results must agree with transformer markings.

d. Perform turns-ratio test on tap positions. Ratio errors must not exceed tolerances specified in IEEE C57.13.

e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. Measured burdens must match instrument transformer Accuracy Class rating.

f. Perform dielectric withstand-voltage test on primary windings with secondary windings connected to ground. Dielectric voltage must comply with NETA ATS, Table 100.9. Test voltage must be applied for 1 min. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand-voltage test, primary windings are considered to have passed test.

g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with test equipment manufacturer's published data.

h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect impact recorder prior to unloading.

c. Test dew point of tank gases if applicable.

d. Inspect anchorage, alignment, and grounding.
e. Verify presence of PCB content labeling.
f. Verify removal of shipping bracing after placement.
g. Verify that bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
k. Perform specific inspections and mechanical tests recommended by manufacturer.
l. Verify presence of transformer surge arresters and that their ratings are as specified.
m. Verify that as-left tap connections are as specified.
n. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with NETA ATS, Table 100.3.
c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
f. Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
g. Measure resistance of winding at tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
h. Perform applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
j. Remove sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

I. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify that unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform turns-ratio tests at tap positions. Test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

J. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify that unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2 percent for power transformers.
2) 5 percent for distribution transformers.

c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-

up test result exceeding 1 percent must be investigated.

e. Perform turns-ratio tests at tap positions. Test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

f. Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.

g. Measure resistance of winding at tap connection.

h. Perform applied-voltage test on high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for 1 min duration. DC dielectric-withstand-voltage test result must not exceed 100 percent of AC RMS test voltage specified in IEEE 57.12.91, Section 10.2, for 1 min duration. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

K. Low-Voltage Motor Controller Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect anchorage, alignment, grounding, and clearances.

b. Verify that unit is clean.

c. Inspect contactors:

1) Verify mechanical operation.

2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

d. Motor-Running Protection:

1) Verify that overload element rating is correct for its application.

2) If motor-running protection is provided by fuses, verify correct fuse rating.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests:

a. [**For contactor and circuit breaker, perform**][**Perform**]insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Insulation-resistance values must comply with manufacturer's published data or NETA ATS, Table 100.1. In absence of manufacturer's published data, comply with Table 100.5. Investigate and correct values of insulation resistance less than this table or manufacturer's published instructions.

b. Test circuit breakers as follows:

1) Operate circuit breaker to ensure smooth operation.

2) Perform contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Perform operational tests by initiating control devices. Control devices must perform in accordance with system design requirements.

L. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, and grounding.
   c. Verify that maintenance devices are available for servicing and operating breaker.
   d. Verify that unit is clean.
   e. Verify that arc chutes are intact.
   f. Inspect moving and stationary contacts for condition and alignment.
   g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
   h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
   i. Verify cell fit and element alignment.
   j. Verify racking mechanism operation.
   k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
   l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
   m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

   a. Perform insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published recommendations must be investigated.
   b. Measure contact resistance across power contact of circuit breaker. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
   c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed value shown in NETA ATS, Table 100.7.
   d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
   e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
   f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
   g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
   h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data,

comply with NETA ATS, Table 100.20.

i. Measure fuse resistance. Investigate fuse-resistance values that deviate from others by more than 15 percent.

j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

k. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

M. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage and alignment.

c. Verify that unit is clean.

d. Operate circuit breaker to ensure smooth operation.

e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

f. Perform adjustments for final protective-device settings in accordance with coordination study. Set protective devices in accordance with coordination study report.

2. Electrical Tests:

a. Perform insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published recommendations must be investigated.

b. Perform contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band, including adjustment factors.

d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.

g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.

i. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and

trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

j. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

N. Low-Voltage Ground-Fault Protection System Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect components for damage and errors in polarity or conductor routing.

1) Verify that ground connection is made on source side of neutral disconnect link and on source side of ground-fault sensor.
2) Verify that neutral sensors are connected with correct polarity on both primary and secondary.
3) Verify that phase conductors and neutral pass through sensor in same direction for zero sequence systems.
4) Verify that grounding conductors do not pass through zero sequence sensors.
5) Verify that grounded conductor is solidly grounded.

b. Verify that unit is clean.
c. Operate circuit breaker to ensure smooth operation.
d. Verify correct operation of functions of self-test panel if provided.
e. Verify that control power transformer has adequate capacity for system.
f. Set pickup and time-delay settings. Record appropriate operation and test sequences in accordance with Section 230.95 "Ground-Fault Protection Equipment" of NFPA 70.

2. Electrical Tests:

a. Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing. System neutral-to-ground insulation resistance must be minimum of 1 MΩ. Correct wiring until minimum is achieved.
b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test must be greater than 90 percent of ground-fault protective-device pickup setting and less than 1200 A or 125 percent of pickup setting, whichever is smaller. Adjust or replace device until these parameters are achieved.
c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to phase-neutral current-transformer pair. This test also applies to MCCBs utilizing external neutral current transformer. Ground-fault protective device must operate when current direction is same relative to polarity marks in two current transformers. Ground-fault protective device must not operate when current direction is opposite relative to polarity marks in two current transformers.
d. Measure time delay of ground-fault protective device at value equal to or greater than 150 percent of pickup value. Relay timing must be in accordance with manufacturer's published data but must be no longer than 1 s at 3000 A in accordance with Section 230.95 "Ground-Fault Protection Equipment" of NFPA 70.
e. Verify that reduced control voltage tripping capability is 55 percent for AC systems and 80 percent for DC systems. Replace ground-fault system if reduced control voltage tripping requirement is not achieved, and retest.
f. Verify blocking capability of zone interlock systems. Results of zone-blocking tests must be in accordance with manufacturer's published data and design specifications.

O. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
    c. Verify that unit is clean.
    d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

    a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
    b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
    c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
    d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

P. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

Q. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

R. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint

splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.7 PROTECTION

A. After installation, protect secondary unit substation equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of secondary unit substation. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch/h (25 mm/h)**. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Rebalance loads.
   c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting:

   a. Prepare written report covering monitoring performed and corrective action taken.
   b. For relay and adjustable circuit breaker, tag device with adjusting technician's initials and date of adjustment. Record settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Scanning of Secondary Unit Substation Equipment: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection. Take visible light photographs at same

locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of unit substation.
2. Follow-On Infrared Scanning: Perform additional follow-up infrared scan of switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

5. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**one year**]<**Insert duration**> period for full maintenance by [**skilled employees of substation equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

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SECTION 26 11 16 11 - SECONDARY UNIT SUBSTATIONS WITH SWITCHGEAR SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Articulated secondary unit substations with switchgear secondary.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in substation medium-voltage sections.
5. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for terminating cables in substation low-voltage sections.
6. Section 260523 "Control-Voltage Electrical Power Cables" for requirements for terminating cables in substation instrumentation sections.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
12. Section 262300 "Low-Voltage Switchgear" specifies low-voltage distribution sections referenced by this Section.

1.2 DEFINITIONS

A. NETA ATS: Acceptance testing specification.

B. PCB: Polychlorinated biphenyl.

C. RTD: Resistance temperature detector (IEEE C37.2 Device No. 26).

D. SCR: Silicon-controlled rectifier.

E. SPD: Surge protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

a. Include a plan view and cross section of equipment base, showing clearances, workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits in accordance with manufacturer's published instructions.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. Mimic-bus diagram.
11. Utility company's metering provisions with indication of approval by utility company.

D. Time-Current Characteristic Curves: For overcurrent protective devices.

E. Primary Fuses: Submit recommendations and size calculations.

F. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.
5. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by authorities having jurisdiction must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical

power system modeling and analysis of electrical safety in accordance with NFPA 70E.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation does not form on or in units. Provide temporary heating in accordance with manufacturer's published instructions.

D. Handle secondary unit substation components in accordance with manufacturer's published instructions. Use factory-installed lifting provisions.

1.10 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.11 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substation performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

1.12 WARRANTY FOR BATTERIES

A. Special DC Control System Manufacturer Extended Warranty: Manufacturer warrants that components

of DC control system perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended warranty period.

1. DC Control System Equipment (Excluding Batteries) Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Standard VRLA Batteries:

    a. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**Nine**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

3. Premium VRLA Batteries:

    a. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**19**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

4. Vented Ni-Cd Batteries:

    a. Initial Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**15**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

1. Unit Substations over 600 V: UL CCN YEFV, including IEEE C37.121 and the following:

    a. Metal-Clad Switchgear: IEEE C37.20.2 and NEMA C 37.55.
    b. Metal-Enclosed Switchgear: IEEE C37.20.3 and NEMA C 37.57.
    c. Liquid-Filled Transformer: IEEE C57.12.00.
    d. Dry-Type Transformer: UL 1562.

C. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap):

a. Batteries: [**1.0**]<**Insert value**>.
b. Transformers: [**1.0**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**2.5**]<**Insert value**>.
d. Cabling and Bus Ducts: [**2.5**]<**Insert value**>.

4. Component Response Modification Factor (Rp):

a. Batteries: [**2.5**]<**Insert value**>.
b. Transformers: [**2.5**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**6.0**]<**Insert value**>.
d. Cabling and Bus Ducts: [**6.0**]<**Insert value**>.

5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

a. Batteries: [**2.5**]<**Insert value**>.
b. Transformers: [**2.5**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**2.5**]<**Insert value**>.
d. Cabling and Bus Ducts: [**1.5**]<**Insert value**>.

2.2 ARTICULATED SECONDARY UNIT SUBSTATIONS WITH SWITCHGEAR SECONDARY

A. Description: [**Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchgear section; and including coordinated circuit breakers, fusible switches, and metering components**]<**Insert brief description of desired system, assembly, or equipment**>.

B. Indoor Unit Arrangement: [**Single assembly**][**Separate secondary distribution equipment connected with busway**].

C. Outdoor Unit Arrangement: [**Single assembly**][**Separate secondary distribution equipment connected with busway**].

1. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
2. Aisle-less Construction: Full-height doors in front of basic weatherproof equipment.

D. Selection of Components for Secondary Unit Substation:

1. Source Limitations: Obtain components for secondary unit substation from sources approved by [**manufacturer**][**fabricator**] warranting performance of entire [**system**][**assembly**].
2. Provide the following specified products with the secondary unit substation:

a. Secondary Unit Substation No. 1 :

1) Medium-voltage terminal compartment section .
2) Medium-voltage metal-clad switchgear section .
3) Medium-voltage metal-enclosed switchgear section .
4) Medium-voltage instruments section .
5) Liquid-filled medium-voltage transformer section .
6) Dry-type medium-voltage transformer section .
7) Secondary distribution terminal compartment section .
8) Secondary distribution network protectors section .
9) Secondary distribution low-voltage instrument section .
10) Secondary distribution switchgear section .
11) Secondary Distribution Low-Voltage Distribution Section : As specified in Section 262300 "Low-Voltage Switchgear."

E. General Criteria:

1. Connections between primary device and transformer must be [**cable**][**bus**], and between transformer and secondary must be flexible bus braid unless noted otherwise.
2. Indoor Enclosure: Steel.
3. Outdoor Enclosure: [**Weatherproof, aisle-less construction**][**Weatherproof, sheltered-aisle construction, with interior-lighted walk-in aisle**] for outdoor service. Galvanized-steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating.

   a. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
   b. Each compartment must have the following features:

      1) Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
      2) Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by [**thermostats to maintain temperature of each section above expected dew point**][**manual switching of branch-circuit protective device**].
      3) Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
      4) LED lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle
      5) Weatherproof ground-fault circuit interrupter (GFCI) duplex receptacle.
      6) Power for heaters, lights, and receptacles must be provided [**by control power transformer**][**as indicated**].

   c. Weatherproof internal-aisle construction must have the following features:

      1) Common internal aisle of sufficient width to permit protective device withdrawal, disassembly, and servicing in aisle.
      2) Doors: Personnel door at each end of aisle, minimum width of [**30 inch (762 mm)**]<**Insert dimension**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**].
      3) Aisle space heaters operating at one-half or less of rated voltage and thermostatically controlled.
      4) Vapor-proof fluorescent aisle lights with low-temperature ballasts and controlled by wall switch at each entrance.
      5) Emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors
      6) GFCI duplex receptacles, a minimum of two, located in aisle.
      7) Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**plus 10 deg F (minus 12 deg C)**]<**Insert temperature**> with outside design temperature of [**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**>.
      8) Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**85 deg F (29 deg C)**]<**Insert temperature**> with outside design temperature of [**104 deg F (40 deg C)**]<**Insert temperature**>.
      9) Ventilating openings[**complete with replaceable fiberglass air filters**].
      10) Thermostat: Single stage; wired to control heat and exhaust fan.

4. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.
5. Unit Substation Enclosures Finish:

a. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
b. Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
c. Factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. The scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with a rating of not less than 7 arrived at in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with a manufacturer's standard zinc-rich paint.

F. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation components.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation components, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Perform design and routine tests in accordance with standards specified for components. Conduct transformer tests in accordance with IEEE C57.12.90. Conduct switchgear and switchboard tests in accordance with NEMA C 37.51.
2) Perform the following factory-certified tests on each secondary unit substation:

a) Resistance measurements of all windings on rated voltage connection and on tap extreme connections.
b) Ratios on rated voltage connection and on tap extreme connections.
c) Polarity and phase relation on rated voltage connection.
d) No-load loss at rated voltage on rated voltage connection.
e) Exciting current at rated voltage on rated voltage connection.
f) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
g) Applied potential.
h) Induced potential.
i) Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

G. Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for transformer section.
   b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
   c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

H. Medium-Voltage Metal-Clad Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]

d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Metal-clad, circuit-breaker switchgear, complying with IEEE C37.20.2 and NEMA SG 4 and tested for compliance in accordance with NEMA C 37.55.

1) Arc Resistant: Comply with IEEE C37.20.7, [**Type 1**][**Type 2**][**Type 1C**][**Type 2C**].

b. Ratings must comply with IEEE C37.04, suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Nominal Interrupting-Capacity Class: [**250**][**350**][**500**][**750**][**1000**] MVA.
3) Main-Bus Rating: [**1200**][**2000**][**3000**] A, continuous.

c. Circuit Breakers: Electrically operated, drawout mounting; using three individual vacuum-sealed interrupter modules, and including the following features:

1) Designed to operate at rated voltage to interrupt fault current within its rating within [**three**][**five**] cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption must not exceed twice rated line-to-ground voltage of system.
2) Contact-Wear Indicator: Readily accessible to field maintenance personnel.
3) Minimum of six Type A and six Type B spare contacts.
4) Interchangeability: Interchangeable with vacuum circuit breakers of same current and interrupting ratings.
5) Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operation.

d. Control Power:

1) [**48**][**125**]<**Insert voltage**> V(dc) for closing and tripping.
2) [**120**][**240**]<**Insert voltage**> V(ac) for closing and tripping.

e. Low-DC-Voltage Alarm: Monitor DC control power voltage with a remote alarm. Alarm must sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full-charge voltage.
f. Remote-Tripping Device: Wall-mounting emergency control station to open circuit breakers; located in red cast-metal box with break-glass operation.
g. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

I. Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

1) Switchgear must be arc resistant, complying with IEEE C37.20.7, [**Type 1**][**Type 2**][**Type 1C**][**Type 2C**].

b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
3) Main-Bus Rating: [**600**][**1200**][**2000**] A, continuous.

c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1) Rating: [**600**][**1200**] A continuous duty and load break.
2) Two-Time Duty-Cycle Fault Closing: [**25 000**][**40 000**] A, asymmetrical.
3) Switch Action: No external arc and no significant quantities of ionized gas released into enclosure.
4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6) Protective Shields: Cover live components and terminals.
7) Fuse Mounts: Single-frame mounted and de-energized when switch is open.
8) Mechanical Interlock: Prevent opening of switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
9) Window: Permits viewing switchblade positions when door is closed.

4. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with

ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

J. Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. Instrument Transformers: Comply with IEEE C57.13.

      1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
      2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

   b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

      1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
      2) Switch-selectable digital display with the following features:

         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
         i) Accumulated energy, in **MWh** **(MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, [**15-minute**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15-minute**]<**Insert value**> interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Overcurrent and Ground-Fault Protective Relays: Multifunctional, solid-state microprocessor-based, medium-voltage relay, for operation from specified control power. Comply with IEEE C37.90.

1) Field-Selectable Relay Settings: Required by overcurrent protective device coordination study and arc-flash study.
2) Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.
3) Phase and Ground Protection: Field-selectable curves from IEEE moderately inverse, very inverse, or extremely inverse.
4) Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch, so that when phase instantaneous overcurrent has been programmed to "none," discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when breaker is being closed and must be deactivated after approximately eight cycles.
5) Contacts: Two Form A contacts, field selectable into contact pairs as follows and as required by overcurrent protective device coordination study and arc-flash study:

a) One contact assigned IEEE Device No. 51 phase and IEEE Device No. 51 ground, and other contact assigned IEEE Device No. 50 phase and IEEE Device No. 50 ground.
b) One contact assigned IEEE Device No. 51/50 phase, and other contact assigned 51/50 ground.

6) Alphameric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:

a) Individual phase currents.
b) Ground current.
c) Cause of trip.

d) Magnitude and phase of current causing trip.
e) Phase or ground indication.
f) Peak current demand for each phase and ground since last reset.
g) Current-transformer primary rating.
h) Programmed phase and ground set points.

7) Communications module to transmit the following data in accordance with Section 260913 "Electrical Power Monitoring."

a) Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.
b) Ability to close and open associated breaker with proper access code from remote location over communication network when relay is configured in remote open-close mode.

8) Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. Provide a "protection off" alarm, which must be normally energized when relay is powered and self-diagnostics indicates unit is functional. On loss of power or relay failure, this alarm relay must be de-energized providing a fail-safe protection off alarm.
9) The relay must operate reliably solely from breaker main current transformers during a fault condition, if normally connected auxiliary AC voltage is not available, even after an extended power outage.
10) Mount relay in a drawout case with a two-stage quick-release operation. The removal of relay from case must disconnect trip circuits and short current-transformer secondaries before unit control power is disconnected. When relay is inserted into case, control power connections must be made before trip circuits are activated. Include a self-shorting contact on case terminal block to provide alarm indication and tripping of circuit breaker upon removal of relay from case.

e. <**Insert other relay types**>.
f. Control Power Supply Transformer:

1) Control power transformer supplies 120 V control circuits through secondary disconnect devices.

a) Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
b) Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
c) Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
d) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
e) Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

g. Control Power Supply DC Battery System:

1) System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at **77 deg F (25 deg C)** with electrolyte at normal level and minimum ambient temperature of **55 deg F (13 deg C)**. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery

to operate ungrounded. Battery system capacity must be in accordance with switchgear manufacturer's published instructions to operate circuit breakers for intended duty.

2) Battery: [**Standard VRLA**][**Premium VRLA**][**Vented Ni-Cd**] batteries, with battery disconnect and overcurrent protective device.

3) Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]

   a) Thermometers with specific-gravity correction scales.
   b) Hydrometer syringes.
   c) Set of cell numerals.

4) Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with AC input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

   a) DC ammeter.
   b) DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
   c) Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by N.O. push-button contact.
   d) Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
   e) Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.
   f) AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of AC power supply for any interval.
   g) Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current, but must not disconnect charger from either battery or AC supply.
   h) Charger's Audible Noise: Less than 26 dB(A-weighted).

5) Control Wiring: Factory installed, complete with bundling, lacing, and protection.

   a) Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for 8 AWG and smaller.
   b) Conductors: Sized in accordance with NFPA 70 for duty required.

K. Liquid-Filled Medium-Voltage Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]

f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. IEEE C57.12.00 [**and UL 1062,**]liquid-filled, two-winding, secondary unit substation transformer.
   b. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
   c. Insulating Liquid:

      1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with ASTM D117.
      2) Less flammable, edible-seed-oil based, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
      3) Less flammable, dielectric, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
      4) Less flammable, silicone-based dielectric, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

   d. Insulation Temperature Rise:

      1) 55 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**. Insulation system must be rated to continuously allow an additional 12 percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
      2) 65 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**.

   e. BIL: [**60**][**75**][**95**][**110**][**150**][**200**] kV.
   f. Full-Capacity Voltage Taps:

      1) Four nominal 2.5 percent taps, two above and two below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
      2) Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

   g. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/OFAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.

h. Impedance: <**Insert number**> percent.

L. Dry-Type Medium-Voltage Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. IEEE C57.12.01 and IEEE C57.12.51, dry-type, two-winding, secondary unit substation transformer.
   b. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
   c. Style:

      1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.
      2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.

   d. Cooling System:

      1) Class AA, air cooled, complying with IEEE C57.12.01.
      2) Class AFA, air cooled with forced-air rating, complying with IEEE C57.12.01.

         a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
         b) Include mounting provision for fans.

      3) Class AA/AFA, air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include mounting provision for fans.

4) Class AFA, forced-air cooling, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include cooling fans.

e. Insulation Materials: IEEE C57.12.01, rated [**220**]<**Insert number**> deg C.

1) Insulation Temperature Rise: [**80**][**115**][**150**] deg C maximum rise above **104 deg F (40 deg C)**.

f. BIL: [**60**][**75**][**95**][**110**][**150**][**200**] kV.
g. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage.
2) Four nominal 2.5 percent taps below rated primary voltage.

h. Impedance: <**Insert number**> percent.
i. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

M. Secondary Distribution Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Low-Voltage Terminal Compartment: Bus [**bars mounted on standoff insulators**][**duct**

flange for close coupling with busway].

N. Secondary Distribution Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. The secondary distribution section must be drawout, [**fused**][**fused where indicated**], low-voltage switchgear, complying with IEEE C37.20.1 and UL 1558.

      1) Section barriers between main and tie circuit-breaker compartments must be extended to rear of section.

   b. Switchgear Structure:

      1) Match and align front and back of switchgear.
      2) Isolate line bus from load bus at each main and tie circuit breaker with bus isolation barriers.
      3) Allow the following circuit-breaker functions to be performed when compartment door is closed:

         a) Operate manual charging system.
         b) Open and close circuit breaker.
         c) Examine and adjust trip unit.
         d) Read breaker nameplate.

      4) Locate instrumentation transformers within breaker cell, and make front accessible and removable.

   c. Switchgear Bus:

      1) Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
      2) Main Phase Bus: Uniform capacity the entire length of section.

3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4) Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
5) Phase- and Neutral-Bus Material:

   a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   b) Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
   c) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
7) Use copper for connecting circuit-breaker line to copper bus.
8) Contact Surfaces of Buses: Silver plated.
9) Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
10) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.
11) Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
12) Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.
13) Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
14) Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
15) Sprayed Insulation Thickness: **3 mils (0.08 mm)**, minimum.
16) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

d. Circuit-Breaker Compartment:

1) Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in "connected," "test," and "disconnected" positions. Include the following features:

   a) Interlocks: Prevent movement of circuit breaker to or from "connected" position when it is closed, and prevent closure of circuit breaker unless it is in "connected," "test," or "disconnected" position.
   b) Primary Disconnect: Mount on stationary part of compartment. The disconnect must consist of a set of contacts extending to rear through an insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only "connected" position. The assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs must connect to bus extensions that terminate in solderless terminals in rear cable compartment.
   c) Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker. Disconnecting devices must be gold plated, and engagement must be maintained in

"connected" and "test" positions.

e. Circuit-Breaker Positioning: Permit racking of an open circuit breaker to or from "connected," "test," and "disconnected" positions only when compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:

1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

f. Circuit Breakers:

1) Comply with IEEE C37.13 and UL 1066.
2) Ratings: Continuous, interrupting, and short-time current ratings for each circuit breaker must match voltage and frequency ratings for switchgear.
3) Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

a) Normal Closing Speed: Independent of both control and operator.
b) Slow Closing Speed: Optional with operator for inspection and adjustment.
c) Stored-Energy Mechanism: [**Manually charged**][**Electrically charged**][**Electrically charged, and operator's choice of manual charging**].
d) Operating Handle: One for each circuit breaker capable of manual operation.
e) Electric Close Button: One for each electrically operated circuit breaker.
f) Operation counter.

4) Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

a) Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
b) Temperature compensation that ensures accuracy and calibration stability from **plus 23 to 104 deg F (minus 5 to plus 40 deg C)**.
c) Field-adjustable, time-current characteristics.
d) Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
e) Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."

5) Pickup Points:

a) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
b) Five minimum, for instantaneous-trip functions.

6) Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.

a) Arrange to provide protection for three-wire circuit or system.
b) Arrange to provide protection for four-wire circuit or system.
c) Arrange to provide protection for four-wire, double-ended substation.

7) Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
8) Auxiliary Contacts:

a) Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
b) Spare auxiliary switches, at least two, unless other quantity is indicated. Each switch must consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.

9) Arc Chutes: Readily removable from associated circuit breaker when it is in "disconnected" position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
10) Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

g. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
h. Key Interlocks: Arranged to prevent opening or closing interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.
i. Undervoltage Trip Devices:

1) Instantaneous, with adjustable pickup voltage.
2) Adjustable time-delay and pickup voltage.

j. Shunt-trip devices.
k. Fused Circuit Breakers: Circuit-breaker and fuse combinations complying with requirements for circuit breakers and trip devices.

1) Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
2) Circuit Breakers with Frame Size [**1600**]<**Insert number**> A and Smaller: Mount fuses on line side of associated circuit breaker[**, on a common drawout carriage**], arranged so fuses are accessible only when circuit breaker is in "disconnected" position.
3) Circuit Breakers with Frame Sizes More than [**1600**]<**Insert number**> A: Fuses and circuit breakers [**may**][**must**] be installed in separate compartments on separate drawout mountings. Interlock fuse drawout element with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in "open" position.
4) Open-Fuse Trip Device: Provide for a positive means of tripping and holding circuit breaker in "open" position when a fuse opens. Indicate open-fuse status [**at front of circuit breaker**][**or**][**fuse drawout element**].

l. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

O. Secondary Distribution Network Protectors Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. The secondary distribution section must be composed of drawout, fused, low-voltage network protectors, complying with IEEE C57.12.44 and IEEE C37.20.1. The switch must comply with UL 1066.

1) Rated for continuous service in an ambient temperature of up to **104 deg F (40 deg C)**, applied to three-phase, four-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.
2) Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Include mechanical interlocks to prevent racking in and racking out when protector is closed.
3) Locate relay and control panel on a separate drawout module.
4) Protector Operator: [**Spring-close**][**and**][**or**][**stored-energy**] mechanism, rated to close on a [**25 000**][**40 000**] A RMS symmetrical load.
5) Control Voltage: 125 V.
6) Program relay with factory default values. Provide one hand-held pendant to field adjust these values using relay calibration procedures. Include an anti-pumping program to lock protector open under abnormal conditions.
7) Include current-limiting fuses on network side of protector for protection against switchboard bus faults.

b. Coordinate and comply with requirements of low-voltage switchgear supplied by network.
c. Controls: Microprocessor-based, three-phase network relay, with features and functions as follows:

1) The protector control must use a positive and negative sequence-based algorithm for current and voltage.
2) Close protector if positive sequence power flows into network. Adjustable closing range must be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
3) Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors must be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
4) Trip protector if there is a flow of reverse magnetizing current to its associated transformer.
5) Relay parameters and watt or watt-var trip values must be field adjustable.
6) Protector must not open under any fault on network side of protector.

7) Include auxiliary contacts and control wiring for use with remote pilot devices that provide remote trip and lockout functions in low-voltage switchgear. Include [**two**]<**Insert number**> spare auxiliary contacts and an equal number of N.O. and N.C. types.

d. Network Communications: Data and digital data-transmission interface must be compatible with system specified in Section 260913 "Electrical Power Monitoring." Communicate the following network relay parameters:

1) Current in each phase.
2) Phase-to-phase and phase-to-neutral voltages.
3) Three-phase watts, VARs, and VA.
4) Frequency.
5) Power factor.
6) Network relay set points.

e. Enclosure:

1) With top-mounted transition to connect to low-voltage power network.
2) Network Switchgear-Mounted Disconnect Switch:

a) Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200 kA interrupting capacity and key interlocked with each associated protector.
b) Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by network transformers, less one. Use drawout type to provide a means of isolating load side of each protector from network bus.

P. Secondary Distribution Low-Voltage Instrument Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
e. Surge Suppression:

1) Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

a) Integral disconnect switch.
b) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
c) Indicator light display for protection status.
d) Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.**]
e) Surge counter.

2) Field-mounted surge suppressors complying with Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits." Include the following features and accessories:

a) Integral disconnect switch.
b) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
c) Indicator light display for protection status.
d) Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.**]
e) Surge counter.

f. Control Power Supply:

1) From medium-voltage instruments section.
2) Control power transformer supplying 120 V control circuits through secondary disconnect devices.

g. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

2.3 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing secondary unit substation, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses[**and fuses associated with network protector**]. Include spares for the following:

a. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will

operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.

2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with each fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

2. Spare Indicating Lights: Six of each type installed.
3. [**One**]<**Insert number**> set(s) of spare mounting gaskets for bushings, handholes, and gasket between relief cover and flange of pressure-relief device.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Control-power battery hoist.
2. Switchgear Circuit-Breaker Test Cabinet:

   a. Separately mounted.
   b. Containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately **108 inch (2740 mm)** long.
   c. Include secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet.
   d. Include provision for storage of test and maintenance accessories in cabinet.

3. Switchgear Maintenance Tools: Furnish tools and miscellaneous items required for switchgear test, inspection, maintenance, and operation.

   a. Fuse-handling tool.
   b. Relay and meter test plugs.
   c. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
   d. Racking handle to move circuit breaker manually between "connected" and "disconnected" positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.

4. Transformer Accessories Set: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

   a. Liquid-level gauge.
   b. Pressure-vacuum gauge.
   c. Liquid temperature indicator.
   d. Drain and filter valves.
   e. Pressure-relief device.

5. Low-Voltage Instruments Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

   a. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions.
   b. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without

removal from switchgear.

c. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

d. Circuit-Breaker Removal Apparatus:

1) Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.

2) Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

e. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

f. Storage for Manual: Include a rack or holder, near operating instructions, for a copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fuel tanks and fluid reservoirs.

2. Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

a. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.

b. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
12. Installation of Switchboards: NECA NEIS 400.
13. Installation of Liquid-Filled Transformers: NECA NEIS 410.
14. Installation of Medium-Voltage Metal-Clad Switchgear: NECA NEIS 430.
15. Installation and Maintenance of AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
16. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and NFPA 70.

D. Interfaces with Other Work:

1. Identification: Provide signs and labels for secondary unit substation and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Install number of signs required to be readable from each accessible side, but space signs a maximum of **30 ft (9 m)** apart.
   e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with maintenance materials.

2. Install secondary unit substations on concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.
4. Grounding and Bonding:

   a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   b. At Exterior Locations:

      1) For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as indicated. Keep lead lengths as short as practicable with no kinks or sharp bends.
      2) Fence and equipment connections must not be smaller than 4 AWG. Ground fence

at each gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond each gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.

3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

5. Connect feeder, branch-circuit, and instrumentation wiring.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. General Field Testing Requirements:

1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system at substation is tested at specified value or less.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

a. Verify equipment nameplate data complies with Contract Documents.
b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

6. Remove and replace malfunctioning units and retest.
7. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

D. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required area clearances.
c. Verify unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as to address of circuit breaker that is used to identify it in microprocessor-communication software.
e. Verify that current and voltage-transformer ratios correspond to Drawings.
f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

    1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
    2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise all active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

    1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
    2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's published instructions.
    3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform DC voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If temperature of bus is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

    1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
    2) Do not proceed to dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, conduct it in accordance with NETA ATS, Table 100.2. Apply test voltage for one minute.

    1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instructions.

1) Minimum insulation-resistance values of control wiring must not be less than 2 MΩ.

d. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

e. Perform current-injection tests on entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in secondary circuit. Verify correct magnitude of current at each device in circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in secondary circuit. Verify correct magnitude of current at each device in circuit.

f. Verify operation of space heaters.
g. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

E. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify arresters are clean.
d. Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
e. Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

2. Electrical Tests:

a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in table.
b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

F. Medium-Voltage Vacuum Circuit Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required clearances.
c. Verify that maintenance devices such as special tools and gauges specified by manufacturer are available for servicing and operating breaker.
d. Verify unit is clean.
e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
f. Measure critical distances on operating mechanism in accordance with manufacturer's published instructions. Critical distances of operating mechanism must be in accordance with manufacturer's published data.

g. Verify cell fit and element alignment.
h. Verify racking mechanism operation.
i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
j. Perform time-travel analysis. Travel and velocity values must be in accordance with manufacturer's published data.
k. Record as-found and as-left operation counter reading. Operation counter must advance one digit per close-open cycle.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's published instructions. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
b. Perform a contact/pole-resistance test. Compare bolted-connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of lowest value. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of trip and close coils must comply with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer' published data.
e. Trip circuit breaker by operation of each protective device. Reset all trip logs and indicators.
f. Perform power-factor or dissipation-factor tests on each pole with breaker open and each phase with breaker closed. Power-factor or dissipation-factor values must meet manufacturer's published data.
g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with contacts in "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by end of total time of voltage application during vacuum bottle integrity test, test specimen is considered to have passed test.
h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.
i. Verify operation of heaters.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.

d. Verify unit is clean.
e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform a ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. The measured burdens must match instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.5. The insulation-resistance value must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
g. Perform dielectric-withstand-voltage tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by end of total time of voltage application, primary winding is considered to have passed test.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with test equipment manufacturer's published data.
i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply test voltage for one minute in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS, Table 100.5. Insulation-resistance values of transformers must not be less than values shown in NETA ATS, Table 100.5.
c. Perform a polarity test on each transformer to verify polarity marks or H(1)-X(1) relationship. Polarity results must agree with transformer markings.
d. Perform a turns-ratio test on all tap positions. Ratio errors must not exceed tolerances specified in IEEE C57.13.

e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. The measured burdens must match instrument transformer Accuracy Class rating.
f. Perform a dielectric-withstand-voltage test on primary windings with secondary windings connected to ground. The dielectric voltage must comply with NETA ATS, Table 100.9. The test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, primary windings are considered to have passed test.
g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with test equipment manufacturer's published data.
h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean front panel and remove foreign material from case.
e. Check tightness of connections.
f. Verify that frame is grounded in accordance with manufacturer's published instructions.
g. Set relay in accordance with results in Section 260573 "Power System Studies."
h. Download settings from relay. Print a copy of settings for report and compare settings to those specified in coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of relay meter functions.
c. Functional Operation: Check functional operation of each element used in protection scheme as follows:

1) Timing Relay (IEEE C37.2 Device No. 2):

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) Volts Per Hertz Relay (IEEE C37.2 Device No. 24):

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at a second voltage level.
c) Determine time delay.

3) Sync Check Relay (IEEE C37.2 Device No. 25):

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine live line, live bus, dead line, and dead bus set points.
d) Determine time delay.

e) Verify dead bus/live line, dead line/live bus, and dead bus/dead line control functions.

4) Undervoltage Relay (IEEE C37.2 Device No. 27):

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at a second point on timing curve for inverse time relays.

5) Directional Power Relay (IEEE C37.2 Device No. 32):

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at a second point on timing curve for inverse time relays.
f) Plot operating characteristic.

6) Loss of Excitation/Field Relay (IEEE C37.2 Device No. 40):

a) Determine maximum reach.
b) Determine maximum torque angle.
c) Determine offset.
d) Plot impedance circle.

7) Phase Balance Current Relay (IEEE C37.2 Device No. 46):

a) Determine pickup of each unit.
b) Determine percent slope.
c) Determine time delay.

8) Negative Sequence Current Relay (IEEE C37.2 Device No. 46):

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on I-two-squared-t curve.

9) Phase Sequence or Phase Balance Voltage Relay (IEEE C37.2 Device No. 47):

a) Determine positive sequence voltage to close N.O. contact.
b) Determine positive sequence voltage to open N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close N.C. contact upon removal of voltage when previously set to rated system voltage.

10) Thermal Replica Relay (IEEE C37.2 Device No. 49):

a) Determine time delay at 300 percent of setting.
b) Determine a second point on operating curve.
c) Determine pickup.

11) RTD Biased Thermal Overload Relay (IEEE C37.2 Device No. 49RTD):

    a) Determine RTD resistance trip setting.
    b) Determine RTD resistance reset setting.

12) Instantaneous Overcurrent Relay (IEEE C37.2 Device No. 50):

    a) Determine pickup.
    b) Determine dropout.
    c) Determine time delay.

13) Time Overcurrent Relay (IEEE C37.2 Device No. 51):

    a) Determine minimum pickup.
    b) Determine time delay at two points on time current curve.

14) Power-Factor Relay (IEEE C37.2 Device No. 55):

    a) Determine tripping angle.
    b) Determine time delay.

15) Overvoltage Relay (IEEE C37.2 Device No. 59):

    a) Determine overvoltage pickup.
    b) Determine time delay to close contact with sudden application of 120 percent of pickup.

16) Voltage Balance Relay (IEEE C37.2 Device No. 60):

    a) Determine voltage difference to close contacts with one source at rated voltage.
    b) Plot operating curve for relay.

17) Sudden Pressure Relay (IEEE C37.2 Device No. 63):

    a) Determine rate-of-rise or pickup level of suddenly applied pressure in accordance with manufacturer's published data.
    b) Verify operation of auxiliary relay (IEEE C37.2 Device No. 63X) seal-in circuit.
    c) Verify trip circuit to remote operating device.

18) Ground Detector Relay (IEEE C37.2 Device No. 64):

    a) Determine maximum impedance to ground causing relay pickup.

19) Directional Overcurrent Relay (IEEE C37.2 Device No. 67):

    a) Determine directional unit minimum pickup at maximum torque angle.
    b) Determine closing zone.
    c) Determine maximum torque angle.
    d) Plot operating characteristics.
    e) Determine overcurrent unit pickup.
    f) Determine overcurrent unit time delay at two points on time current curve.

20) Reclosing Relay (IEEE C37.2 Device No. 79):

a) Determine time delay for each programmed reclosing interval.
b) Verify lockout for unsuccessful reclosing.
c) Determine reset time.
d) Determine close pulse duration.
e) Verify instantaneous overcurrent lockout.

21) Frequency Relay (IEEE C37.2 Device No. 81):

a) Verify frequency set points.
b) Determine time delay.
c) Determine undervoltage cutoff.

22) Pilot Wire Monitor (IEEE C37.2 Device No. 85):

a) Determine overcurrent pickup.
b) Determine undercurrent pickup.
c) Determine pilot wire ground pickup level.

23) Differential Protective Relay (IEEE C37.2 Device No. 87):

a) Determine operating unit pickup.
b) Determine operation of each restraint unit.
c) Determine slope.
d) Determine harmonic restraint.
e) Determine instantaneous pickup.
f) Plot operating characteristics for each restraint.

d. Control Verification:

1) Functional Tests:

a) Check operation of all active digital inputs.
b) Check output contacts or SCRs, preferably by operating controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) For pilot schemes, perform a loop-back test to check receive and transmit communication circuits.
e) For pilot schemes, perform satellite synchronized end-to-end tests.
f) For pilot schemes with direct transfer trip (DTT), perform transmit and received DTT at each terminal.
g) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

I. DC System VRLA Batteries Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.

f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify units are clean.
h. Inspect spill containment installation.
i. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust voltage in accordance with battery manufacturer's published instructions.
b. Verify charger functions and that alarms comply with system manufacturer's published instructions.
c. Measure negative post temperature. Negative post temperature must comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. Charger float and equalizing voltage levels must be in accordance with battery manufacturer's published data.
e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.
f. Measure intercell connection resistances.
g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
h. Perform a load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass test.
i. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

J. DC System Vented Ni-Cd Batteries Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify electrolyte level. Measure pilot-cell electrolyte temperature, and correct in accordance with manufacturer's maintenance procedures to bring temperature and electrolyte level to within normal limits.
h. Verify units are clean.
i. Inspect spill containment installation.
j. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust voltage in accordance with battery manufacturer's published instructions.
b. Verify charger functions and that alarms comply with system manufacturer's published instructions.
c. Measure each cell voltage and total battery voltage with charger energized and in float

mode of operation. Cell voltages must be within 0.05 volt of each other or in accordance with manufacturer's published data.

d. Measure intercell connection resistances.
e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
f. Perform a load test in accordance with manufacturer's published data or IEEE 1106. Replace units that fail to pass test.
g. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

K. DC System Charger Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect for physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify unit is clean.
d. Inspect filter and tank capacitors.
e. Verify operation of cooling fans and presence of filters.

2. Electrical Tests:

a. Verify float voltage, equalizing voltage, and overvoltage shutdown settings. Float and equalizing voltage settings must be in accordance with battery manufacturer's published data.
b. Verify current limit. Current limit must be set in accordance with manufacturer's published instructions.
c. Verify operation of alarms. Results of alarm operation must be in accordance with manufacturer's published data and system design.
d. Measure and record input and output voltage and current. Input and output voltage must be in accordance with manufacturer's published data.
e. Measure and record AC ripple current and voltage imposed on battery. AC ripple current and voltage imposed on battery must be in accordance with manufacturer's published data.
f. Perform full-load testing of charger. Charger must be capable of manufacturer's specified full load.

L. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect impact recorder prior to unloading.
c. Test dew point of tank gases if applicable.
d. Inspect anchorage, alignment, and grounding.
e. Verify presence of PCB content labeling.
f. Verify removal of any shipping bracing after placement.
g. Verify bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate in accordance with manufacturer's published instructions.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
k. Perform specific inspections and mechanical tests recommended by manufacturer's

published instructions.

l. Verify presence of transformer surge arresters and that their ratings are as specified.

m. Verify that as-left tap connections are as specified.

n. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.

b. Perform power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.

c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).

d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.

e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.

g. Measure resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.

h. Perform an applied-voltage test on primary and secondary windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.

i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

j. Remove a sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877/D877M or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove a sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

M. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, and grounding.

c. Verify that resilient mounts are free and that any shipping brackets have been removed.

d. Verify unit is clean.

e. Perform specific inspections and mechanical tests recommended by manufacturer's published instructions.

f. Verify that as-left tap connections are as specified.

g. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform turns-ratio tests at all tap positions. The test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

N. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate in accordance with manufacturer's published instructions.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by manufacturer's published instructions.
h. Verify that as-left tap connections are as specified.
i. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2.0 percent for power transformers.
2) 5.0 percent for distribution transformers.

c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent must be investigated.
e. Perform turns-ratio tests at all tap positions. The test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.
g. Measure resistance of each winding at each tap connection.
h. Perform an applied-voltage test on all primary and secondary windings-to-ground. See

IEEE C57.12.91, Sections 10.2 and 10.9. The AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The DC dielectric-withstand-voltage test result must not exceed 100 percent of AC RMS test voltage specified in IEEE C57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

O. Secondary Distribution Section Network Protector Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify unit is clean.
d. Verify arc chutes are intact.
e. Inspect moving and stationary contacts for condition and alignment.
f. Verify that maintenance devices are available for servicing and operating network protector.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of network protector are correct.
h. Perform mechanical operator and contact alignment tests on both network protector and its operating mechanism. Operations counter must advance one digit per close-open cycle.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify compliance with manufacturer's published instructions for lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Record as-found and as-left operation counter readings.
m. Perform a leak test on submersible enclosure in accordance with manufacturer's published data.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with network protector closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or Table 100.1.
2) Do not conduct insulation-resistance tests of control wiring until insulation-resistance levels of power circuits are raised above minimum values.

b. Perform a contact/pole-resistance test. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. In absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar protectors by more than 50 percent of lowest value.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instructions.

a. Minimum insulation-resistance values of control wiring must not be less than 2 MΩ.
b. Verify current-transformer ratios in accordance with IEEE C57.13.
c. Measure resistance of each network protector power fuse. Investigate and correct fuse-resistance values that deviate from each other by more than 15 percent.
d. Measure minimum pickup voltage of motor-control relay. Minimum pickup voltage of motor-control relay must be in accordance with manufacturer's published data, but not more than 75 percent of rated control circuit voltage.
e. Verify that motor can charge closing mechanism at minimum voltage specified by manufacturer. Minimum operating voltage of motor on closing mechanism must not exceed 75 percent of rated control circuit voltage.
f. Measure minimum pickup voltage of trip actuator. Trip actuator minimum pickup voltage must not exceed 7.5 percent of rated control circuit voltage. Verify that actuator resets correctly.
g. Calibrate network protector relays in accordance with "Medium-Voltage Instruments Section" Paragraph, "Overcurrent and Ground-Fault Protective Relays" Subparagraph, specifying microprocessor-based protective relays.
h. Perform the following operational tests:

1) Verify correct operation of all mechanical and electrical interlocks.
2) Verify trip-free operation.
3) Verify correct operation of auto-open-close control handle.
4) Verify protector will close with voltage on transformer side only.
5) Verify protector will open when source feeder breaker is opened.

i. Verify phase rotation, phasing, and synchronized operation.

P. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that all maintenance devices are available for servicing and operating breaker.
d. Verify unit is clean.
e. Verify that arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply

with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.

b. Measure contact resistance across each power contact of circuit breaker. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed value shown in NETA ATS, Table 100.7.

d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.

g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.

i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

k. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

Q. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.

c. Verify unit is clean.

d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.

b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.

c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.

d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

R. Nonconforming Work:

1. Equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

S. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

T. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Complete installation and startup checks required by electric utility provider.
3. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Rebalance loads.
   c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report:

a. Prepare a written report covering monitoring performed and corrective action taken.
b. For each relay and adjustable circuit breaker, tag device with adjusting technician's initials and date of adjustment. Record settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Inspection and Adjusting: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of unit substation.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of **1.8 deg F (1 deg C)** at **104 deg F (30 deg C)**.
4. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists the following results:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between area of concern and reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

5. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.6 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.7 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in coordination study report.
b. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three month**][**six month**][**nine month**][**one year**]<**Insert duration**> period for full

maintenance by [**skilled employees of secondary unit substation Installer**][**manufacturer's authorized service representative**]. Include periodic preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper secondary unit substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes secondary unit substation equipment software and firmware support for [**two years**]<**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 26 11 16 11

Task	Specification	Specification Description
26 11 16 11	26 11 16 00	Secondary Unit Substations with Switchboard Secondary
26 11 16 11	26 11 16 00a	Secondary Unit Substations with Motor Control Center Secondary

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SECTION 26 12 13 00 - LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-filled, medium-voltage substation transformers, with primary and secondary bushings within or without air-terminal enclosures.
2. Control network.
3. Warning labels and signs.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For liquid-filled, medium-voltage transformers. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, and furnished specialties and

accessories.

B. Shop Drawings:

1. For liquid-filled, medium-voltage transformers.

a. Include plans and elevations showing major components and features.

1) Include plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.

b. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
c. Include single-line diagram.
d. Include list of materials.
e. Include nameplate legends.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For transformers, signed by product manufacturer.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.5 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.6 PERFORMANCE REQUIREMENTS

A. Windings Material: [**Aluminum**][**Copper**].

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.

D. Efficiency: Comply with 10 CFR 431, Subpart K.

E. Insulation:

1. Transformer kVA Rating[**, when Indicated at 65 deg C Rise,**] Must Be as Follows: Average winding temperature rise above ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.
2. Transformer kVA Rating[**, when Indicated at 55/65 deg C Rise,**] Must Be as Follows: Average winding temperature rise above ambient temperature must not exceed 55 deg C, based on average ambient temperature of 30 deg C over 24 hours with maximum ambient temperature of 40 deg C. Insulation system must be rated to continuously allow additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life. Rating must conform to requirements of IEEE C57.12.90.

F. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.

G. Tap Changer: External, for de-energized operation.

H. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]

I. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

J. Insulating Liquids:

1. Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.
2. Less-Flammable Liquids:

a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
b. Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.
c. Silicone-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

K. Sound level must comply with NEMA TR 1 requirements.

L. Capacities and Characteristics:

1. Location: [**Indoors**][**Outdoors**].
2. Additional Standards: Comply with [**IEEE C57.12.10**][**IEEE C57.12.36**].

a. Comply with [**IEEE C57.12.10**][**IEEE C57.12.36**].
b. Comply with UL 1062 listing requirements.
c. Comply with FM Global Class No. 3990.
d. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

3. Connections:

a. Primary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Terminals for close connection to primary switch**][**Open wire**].
b. Secondary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Open wire**].

4. Transformer Ratings. Comply with IEEE C57.12.00 for cooling class.

a. Self-Cooled Rating, Class <**Insert letters**>: <**Insert number**> kVA.
b. Future Forced-Air-Cooled Rating, Class <**Insert letters**>:

1) Self-Cooled: <**Insert number**> kVA.
2) Forced-Air Cooled: <**Insert number**> kVA.
3) Make provision for future addition of forced-air-cooling equipment. Transformer bushings, leads, and related components must be sized for future equipment. Provide fan mounts, conduit supports, and terminal boxes.

c. Forced-Air-Cooled Rating, Class <**Insert letters**>:

1) Self-Cooled: <**Insert number**> kVA.
2) Forced-Air Cooled: <**Insert number**> kVA.
3) Equip with forced-air-cooling equipment, including fans, conduit, wiring, motor controllers, and top liquid thermometer for fan control.

d. Impedance: Not less than [**5.75**]<**Insert number**> percent.
e. Temperature Rise: [**65 deg C**][**55/65 deg C**].
f. Coils Connection:

1) Line-Side Winding: [**Delta**]<**Insert connection**>.
2) Load-Side Winding: [**Wye**]<**Insert connection**>.

g. Voltage and BIL Ratings:

1) Nominal primary phase-to-phase voltage and BIL: [**4160 V, 60 kV**][**13 800 V, 95 kV**][**34 500 V, 125 kV**]<**Insert requirements**>.
2) Nominal secondary voltage and BIL: [**208Y/120 V, 45 kV**][**480Y/277 V, 45 kV**]<**Insert requirements**>.

h. K-Factor: <**Insert number**>, complying with UL 1561.

5. Finish:

a. Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistance complying with IEEE C57.12.28.
b. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
c. Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer

coat to metal surface in excess of **1/16 inch (2 mm)** from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654 with rating of not less than 7, in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.

6. Taps: Two 2-1/2 percent, full-capacity taps above, and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.
7. Transformer Accessories:

   a. Drain and filter connection.
   b. Filling and top filter press connections.
   c. Pressure-vacuum gauge.
   d. Dial-type analog thermometer with alarm contacts.
   e. Magnetic liquid level indicator with high and low alarm contacts.
   f. Pressure-relief device set to operate at 10 psig, plus or minus 2 psig, and then automatically reseal when pressure drops to 6 psig minimum. Device flow must be as recommended by manufacturer. With alarm contacts and manual bleeder.
   g. At least four stainless steel ground connection pads.
   h. Provisions for jacking, lifting, and towing.
   i. Machine-engraved nameplate made of anodized aluminum or stainless steel.
   j. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

2.7 CONTROL NETWORK

A. Controllers: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as native device.

2.8 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

   1. Warning signs must be made of baked enamel.
   2. Equipment Identification Labels: [**Engraved, laminated-acrylic or -melamine label**][**Stenciled legend 4 inch (100 mm) high**].

2.9 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate liquid-filled, medium-voltage transformer.

C. Testing: Test and inspect liquid-filled, medium-voltage transformer in accordance with IEEE C57.12.90.

D. Factory Tests and Inspections: Perform the following tests and inspections on liquid-filled, medium-voltage transformer, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on

control units.

1. Resistance.
2. Turns ratio, polarity, and phase relation.
3. Transformer no-load losses and excitation current at 100 percent of ratings.
4. Transformer impedance voltage and load loss.
5. Operation of devices.
6. Control (auxiliary) and consumption losses.
7. Lightning impulse.
8. Low frequency.
9. Leak.
10. Transformer no-load losses and excitation current at 110 percent of ratings.
11. Insulation power factor.
12. Applied potential.
13. Induced potential.
14. Resistance measurements of windings on rated voltage connection and at tap extreme connections.
15. Ratios on rated voltage connection and at tap extreme connections.
16. Polarity and phase relation on rated voltage connection.
17. No-load loss at rated voltage on rated voltage connection.
18. Exciting current at rated voltage on rated voltage connection.
19. Impedance.

E. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign

material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

    a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.

b. Acid Neutralization Number: ASTM D974.
c. Specific Gravity: ASTM D1298.
d. Interfacial Tension: ASTM D971.
e. Color: ASTM D1500.
f. Visual Condition: ASTM D1524.
g. Water in Insulating Liquids: ASTM D1533.
h. Power Factor or Dissipation Factor: ASTM D924.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5Ω at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
2. At Exterior Locations:

   a. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
   b. Fence and equipment connections must not be smaller than 4 AWG. Ground fence at gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
   c. Make joints in grounding conductors and loops by exothermic weld or compression connector.

3. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.

4. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of substations in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspection and electrical test. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated

torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

   a. Visual and Mechanical Inspection:

      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, grounding, and clearances.
      3) Verify arresters are clean.
      4) Verify that ground lead on device is individually attached to ground bus or ground electrode.
      5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

   b. Electrical Test:

      1) Perform insulation-resistance test on arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
      2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

   a. Visual and Mechanical Inspection:

      1) Test dew point of tank gases if applicable.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify bushings are clean.
      4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
      5) Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
      6) Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
      7) Perform specific inspections and mechanical tests recommended by manufacturer.
      8) Verify presence of transformer surge arresters and that their ratings are as specified.
      9) Verify that as-left tap connections are as specified.
      10) Verify presence of surge arresters and that their ratings are as specified.

   b. Electrical Tests:

      1) Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
      2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.

3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 M Ω at 500 V(dc).
4) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
5) Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
6) Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
7) Measure resistance of winding at tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
8) Perform applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
9) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
10) Remove sample of insulating liquid in accordance with ASTM D923, and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

D. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

E. Assemble and submit test and inspection reports. Record as-left set points of adjustable devices.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

   a. Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 12 13 00

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Task	Specification	Specification Description
26 12 13 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 12 16 00 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-type, medium-voltage transformers.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 260513 "Medium-Voltage Cables" specifies installation of medium-voltage cables.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of low-voltage wiring.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. VPE: Vacuum Pressure Encapsulation.

B. VPI: Vacuum Pressure Impregnation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For dry-type, medium-voltage transformers. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Product Certificates: Include product certificate stating compliance with IEEE C57.16, signed by manufacturer or fabricator.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Include plans and elevations showing major components and features.

a. Include plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.

2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate legends.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

E. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload transformers carefully, observing packing label warnings and handling instructions.
6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.

4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Visually check for rust spots.

C. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of base plate of transformer case.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 MEDIUM-VOLTAGE TRANSFORMERS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.
c. Factory Tests and Inspections: Perform the following tests and inspections on transformer by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.16 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Tests for Transformers 500 kVA and Smaller:

a) Turns ratio, polarity, and phase relation on rated voltage connection.
b) Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
c) Applied voltage and induced voltage.
d) Partial discharge.
e) Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
f) Temperature rise at minimum and maximum ratings.
g) Impulse.
h) Insulation power factor.
i) Insulation resistance.
j) Audible sound level.
k) Short-circuit capability.
l) Operation of devices.
m) Control (auxiliary) and consumption loss data values.

2) Tests for Transformers 501 kVA and Larger:

a) Resistance measurements of windings on rated voltage tap and at tap extremes.
b) Turns ratio, polarity, and phase relation on rated voltage connection.
c) Transformer no-load losses and excitation current at 100 percent of ratings.
d) Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
e) Applied voltage and induced voltage.
f) Partial discharge.
g) Leak test.
h) Temperature rise at minimum and maximum ratings.
i) Impulse.
j) Insulation power factor.
k) Insulation resistance.
l) Audible sound level.
m) Short-circuit capability.
n) Operation of devices.
o) Control (auxiliary) and consumption loss data values.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Dry-Type, Medium-Voltage Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**GE Power; General Electric Company**]
d. [**Hammond Power Solutions Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**GE Power; General Electric Company**]
d. [**Hammond Power Solutions Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Transformers, Distribution, Dry Type, Over 600 V: UL CCN XPFS; including UL 1562 or IEEE C57.16.

4. Standard Features:

a. Referenced Standards: IEEE C2 and IEEE C57.16.
b. Windings Material: [**Aluminum**][**Copper**].
c. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.
d. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.

1) Self-Cooled Rating, Class <**Insert letters**>: <**Insert number**> kVA.
2) Future Forced-Air-Cooled Rating, Class <**Insert letters**>:

a) Self-Cooled: <**Insert number**> kVA.
b) Forced-Air Cooled: <**Insert number**> kVA.
c) Make provision for future addition of forced-air-cooling equipment. Transformer bushings, leads, and related components must be sized for future equipment. Provide fan mounts, conduit supports, and terminal boxes.

3) Forced-Air-Cooled Rating, Class <**Insert letters**>:

a) Self-Cooled: <**Insert number**> kVA.
b) Forced-Air Cooled: <**Insert number**> kVA.
c) Equip with forced-air-cooling equipment, including fans, conduit, wiring, motor controllers, and thermometer with alarm contacts for fan control.
d) Forced-air cooling must be regulated automatically by sensors placed in load-side winding's air ducts. Forced-air cooling must include three-phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicating lights, alarm, and alarm silencing switch.[**Connect to control network.**]

e. Coils Insulation Systems:

1) Primary and secondary coil assemblies must be manufactured using polyester VPI system.
2) Primary and secondary coil assemblies must be manufactured using silicone resin VPE system.
3) Primary coil assembly must be manufactured using <**Insert system description**>. Secondary coil assembly must be manufactured using <**Insert system description**>.

f. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
g. Efficiency: Comply with 10 CFR 431, Subpart K.
h. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
i. Tap Changer: External, for de-energized operation.

1) Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

j. Enclosure:

1) Provide with provisions for lifting and anchoring frame to concrete pad.
2) With integral skid-mounting frame, suitable to allow skidding or rolling of transformer

in any direction.

3) Enclosure Finish:

a) Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistant complying with IEEE C57.12.28.

b) Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.

c) Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654 with rating of not less than 7 in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.

k. Sound level must comply with requirements of NEMA TR 1.

l. Capacities and Characteristics:

1) Enclosure: [**Ventilated**][**Nonventilated**] power transformer, UL 50E [**Type 1**][**Type 2**][**Type 3R**] enclosure.

2) Additional IEEE Standards: Comply with IEEE C57.12.51.

3) Connections:

a) Primary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Terminals for close connection to primary switch**].

b) Secondary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**].

4) Transformer Ratings.

a) Impedance: Not less than [**5.75**]<**Insert number**> percent.

b) Temperature Rise: [**150 deg C**]<**Insert deg C**>.

5) Coils Connection:

a) Line-Side Winding: [**Delta**]<**Insert connection**>.

b) Load-Side Winding: [**Wye**]<**Insert connection**>.

6) Voltage and BIL Ratings:

a) Nominal primary phase-to-phase voltage and BIL: [**4160 V, 30 kV**][**13 800 V, 60 kV**][**34 500 V, 150 kV**]<**Insert requirements**>.

b) Nominal secondary voltage and BIL: [**208Y/120 V, 10 kV**][**480Y/277 V, 10 kV**]<**Insert requirements**>.

c) K-Factor: <**Insert number**>, complying with UL 1562.

7) Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.

8) Transformer Accessories:

a) Dial-type analog thermometer with alarm contacts.

b) At least four stainless steel ground connection pads.

c) Provisions for jacking, lifting, and towing.
d) Machine-engraved nameplate made of anodized aluminum or stainless steel.

9) Heaters: Where outdoor cast-coil transformers are indicated on Drawings, they must include thermostatically controlled space heaters powered from [**external source that remains energized when transformer is de-energized**][**a fused control power transformer connected to primary side of substation transformer**].

m. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders may cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

D. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

E. Verify that grounding and bonding connections are in place. Ground (earth) resistance at transformer location may not be greater than [**5 Ω**]<**Insert resistance in ohms**>.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFORMERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the

Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
2. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.
3. Grounding and Bonding:

   a. At Interior Locations: For grounding to grounding electrodes, provide bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   b. At Exterior Locations:

      1) For counterpoise, provide tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
      2) Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
      3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

   c. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
   d. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

4. Connect low-voltage wiring.

   a. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer's published instructions.
   b. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

5. Terminate medium-voltage cables in incoming section of substations.

D. Interfaces with Other Work:

1. Identification: Provide labels for transformers and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Install transformers on cast-in-place concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. General Field-Testing Requirements:

   a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
   b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
   c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
   e. Visual and Mechanical Inspection:

      1) Verify equipment nameplate data complies with Contract Documents.
      2) Inspect bolted electrical connections for high resistance using one of the following two methods:

         a) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
         b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or

NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

   a. Visual and Mechanical Inspection:

      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, grounding, and clearances.
      3) Verify arresters are clean.
      4) Verify that ground leads on devices are individually attached to ground bus or ground electrode.
      5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

   b. Electrical Test:

      1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in that table.
      2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Dry-Type Transformer Field Tests:

   a. Visual and Mechanical Inspection:

      1) Test dew point of tank gases if applicable.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify that resilient mounts are free and that shipping brackets have been removed.
      4) Verify bushings are clean.
      5) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
      6) Verify that cooling fans operate correctly and have appropriate overcurrent protection.
      7) Perform specific inspections and mechanical tests recommended by manufacturer.
      8) Verify that as-left tap connections are as specified.

   b. Electrical Tests:

      1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
      2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data.
      3) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
      4) Perform turns-ratio tests at tap positions. Turns-ratio test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
      5) Perform excitation-current test on each phase. The typical excitation-current test data pattern for three-legged core transformer is two similar current readings and

one lower current reading. Investigate and correct if test shows different pattern.

6) Measure resistance of windings at tap connections, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.

7) Perform applied-voltage test on high- and load-side windings-to-ground. Comply with IEEE C57.12.91 provisions for field-deployed dielectric tests. Measurements must be made only when voltage and current have reached stable value. Test must be discontinued immediately in the event current begins to increase without stabilizing. Record test values in Operations and Maintenance Manual.

8) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain transformer equipment.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.5 PROTECTION

A. After installation, protect transformer from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or

deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting: Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Scanning of Transformers: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies transformer equipment checked, testing technician, equipment used, and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action. List results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 12 16 00

Task	Specification	Specification Description
26 12 16 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 12 19 00 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-mounted, liquid-filled, medium-voltage transformers.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 260513 "Medium-Voltage Cables" specifies installation of medium-voltage cables.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of low-voltage wiring.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Elbow Connector: See "bushing elbow" above.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For {Insert system or product}. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Product Certificates: Include product certificate stating compliance with IEEE C57.12.00, signed by manufacturer or fabricator.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Plans and elevations showing major components and features.

a. Plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.

2. Details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
3. Single-line diagram.
4. List of materials.
5. Nameplate data.

6. Manufacturer's published time-current curves of transformer line-side fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

E. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Manufacturer's field reports for field quality-control support.

C. Field reports for voltage monitoring and adjusting.

D. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.

6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure that transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in the presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

C. Handling:

1. Handle transformers carefully, in accordance with manufacturer's recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116

"Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.
c. Factory Tests and Inspections: Perform the following tests and inspections on transformer, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.00 before delivering to site. Affix label

with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Resistance.
2) Turns ratio, polarity, and phase relation.
3) Transformer no-load losses and excitation current at 100 percent of ratings.
4) Transformer impedance voltage and load loss.
5) Operation of devices.
6) Lightning impulse.
7) Low frequency.
8) Leak.
9) Perform Optional Tests:

a) Transformer no-load losses and excitation current at 110 percent of ratings.
b) Insulation power factor.
c) Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
d) Induced potential.
e) Resistance measurements of windings on rated voltage connection and at tap extreme connections.
f) Ratios on rated voltage connection and at tap extreme connections.
g) Polarity and phase relation on rated voltage connection.
h) No-load loss at rated voltage on rated voltage connection.
i) Exciting current at rated voltage on rated voltage connection.
j) Impedance.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Single-Phase, Pad-Mounted Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**ERMCO-ECI**]
c. [**GE Power; General Electric Company**]
d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
e. [**Howard Industries, Inc**]
f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**ERMCO-ECI**]
c. [**GE Power; General Electric Company**]

d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
e. [**Howard Industries, Inc**]
f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
g. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Transformers, Distribution, Liquid-Filled Type, Over 600 V: UL CCN XPLH; including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

   a. [**Oil-filled**][**Less-flammable-liquid-filled**], two-winding, 60 Hz, 65 deg C rise above 30 deg C average ambient, self-cooled transformer.
   b. Reference Standards: IEEE C2 and IEEE C57.12.38.
   c. Windings Material: [**Aluminum**][**Copper**].
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.
   e. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
   f. Efficiency: Comply with 10 CFR 431, Subpart K.
   g. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.
   h. Tap Changer: External handle, for de-energized operation.
   i. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]
   j. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.
   k. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.
   l. Insulating Liquids:

      1) Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.
      2) Less-Flammable Liquids:

         a) Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
         b) Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.

   m. Sound level must comply with NEMA TR 1 requirements.

n. Corrosion Protection:

1) Transformer coating system must be factory applied, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.
2) Fabricate front sill, hood, and tank base of single-compartment transformers from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.
3) Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

o. Compartment Construction:

1) Single compartment for line- and load-side sections, clamshell style, with provision for padlocking hinged cover and single-point latching.
2) Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments. With hinged, lift-off doors, with stop in open position, three-point latching, and provision for padlocking.
3) Provide [**Type 1**][**Type 2**] terminal arrangement.

p. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1) 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.42.
2) Interrupting Rating: 50 000 A(rms sym) at system voltage.
3) Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperatures to provide transformer with thermal protection.
4) Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed.
5) Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

q. Line-Side Section: Dead-front design.

1) To connect primary cable, use separable insulated connectors. Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
2) Bushing inserts[**and feed-through inserts**]:

   a) Conform to requirements of IEEE 386.
   b) Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.[**Parking stands must be with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.**]
   c) Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts[**and insulated standoff bushings**].

3) Bushing wells configured for loop-feed application.

4) Access to liquid-immersed fuses.
5) Dead-front surge arrester(s).
6) Tap-changer operator.
7) Ground pad.

r. Load-Side Section:

1) Bushings with spade terminals drilled for terminating number of conductors indicated on the Drawings, and lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2) Metering: Coordinated with and complying with requirements of Section 262713 "Electricity Metering." [**Install**][**Make provision for installation by providing mounting space, brackets, and cable and conduit routing as well as**] the following:

a) Sensors.
b) BAS interface.
c) Kilowatt-hour meter.
d) Kilowatt-hour demand meter.

s. Capacities and Characteristics:

1) Power Rating: <**Insert number**> kVA.
2) Voltage Ratings: <**Insert primary voltage**> V - [**240/120**][**480/240**] V.
3) Taps: [**Four 2.5 percent, full-capacity taps below rated primary voltage**]<**Insert description**>.
4) Transformer BIL (kV): [**Comply with IEEE C57.12.38 requirements**]<**Insert number**>.
5) Minimum Tested Impedance (Percent) at 85 deg C: [**1.25**][**2.1**][**3.0**][**3.2**]<**Insert number**>.

t. Transformer Accessories:

1) Drain and filter connection.
2) Filling and top filter press connections.
3) Pressure-vacuum gauge.
4) Dial-type analog thermometer with alarm contacts.
5) Magnetic liquid level indicator with high and low alarm contacts.
6) Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer.[**With alarm contacts and manual bleeder.**]
7) Stainless steel ground connection pads.
8) Machine-engraved nameplate made of anodized aluminum or stainless steel.
9) Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

u. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].

c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

C. Three-Phase, Pad-Mounted Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**ERMCO-ECI**]
   c. [**GE Power; General Electric Company**]
   d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   e. [**Howard Industries, Inc**]
   f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**ERMCO-ECI**]
   c. [**GE Power; General Electric Company**]
   d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   e. [**Howard Industries, Inc**]
   f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Transformers, Distribution, Liquid-Filled Type, Over 600 V: UL CCN XPLH; including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

   a. [**Oil-filled**][**Less-flammable-liquid-filled**], two-winding, 60 Hz, 65 deg C rise above 30 deg C average ambient, self-cooled transformer.
   b. Reference Standards: IEEE C2 and IEEE C57.12.26.
   c. Windings Material: [**Aluminum**][**Copper**].
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.
   e. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
   f. Efficiency: Comply with 10 CFR 431, Subpart K.
   g. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using

combination of connections and taps that give highest average winding temperature rise.

h. Tap Changer: External handle, for de-energized operation.

i. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]

j. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.

k. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

l. Insulating Liquids:

1) Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.

2) Less-Flammable Liquids:

a) Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.

b) Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.

m. Sound level must comply with NEMA TR 1 requirements.

n. Corrosion Protection:

1) Transformer coating system must be factory applied, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

2) Fabricate front sill, hood, and tank base of single-compartment transformers from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.

3) Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

o. Compartment Construction:

1) Single-Compartment Construction: Clamshell style, with provision for padlocking, hinged cover, and single-point latching.

2) Double-Compartment Construction: Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with stop in open position and provision for padlocking.

p. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1) 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.42.

2) Interrupting Rating: 50 000 A(rms sym) at system voltage.
3) Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperature to provide thermal protection to transformer.[**Connect current-limiting fuses ahead of radial-feed load-break switch.**]
4) Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed and external drip shield is installed.
5) Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

q. Line-Side Section: Dead-front design.

1) To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
2) Bushing inserts[**and feed-through inserts**]:

a) Conform to requirements of IEEE 386.
b) Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.[**Parking stands must be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.**]
c) Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts[**and insulated standoff bushings**].

3) Bushing wells configured for loop-feed application.
4) Access to liquid-immersed fuses.
5) Dead-front surge arresters.
6) Tap-changer operator.
7) Ground pad.

r. Load-Break Switch:

1) Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with continuous current rating and load-break rating of [**200 A**][**300 A**]<**Insert amperage**>, and make-and-latch rating of 12 kA(rms sym).
2) Loop-feed sectionalizing switches, using three two-position, liquid-immersed-type switches for closed transition loop-feed and sectionalizing operation. Voltage class and BIL must match that of separable connectors, with continuous current rating and load-break rating of [**200 A**][**300 A**]<**Insert amperage**>, and make-and-latch rating of 12 kA(rms sym). Switch operation must be as follows:

a) Position I: Line A connected to line B and both lines connected to transformer.
b) Position II: Transformer connected to line A only.
c) Position III: Transformer connected to line B only.
d) Position IV: Transformer disconnected and line A not connected to line B.
e) Position V: Transformer disconnected and line A connected to line B.

s. Load-Side Section:

1) Bushings with spade terminals drilled for terminating number of conductors indicated on the Drawings, and lugs that comply with requirements of Section 260519 "Low-

Voltage Electrical Power Conductors and Cables."

2) Metering: Coordinated with and complying with requirements of Section 262713 "Electricity Metering." [**Install**][**Make provision for installation by providing mounting space, brackets, and cable and conduit routing as well as**] the following:

a) Sensors.
b) BAS interface.
c) Kilowatt-hour meter.
d) Kilowatt-hour demand meter.

t. Capacities and Characteristics:

1) Power Rating: <**Insert number**> kVA.
2) Voltage Ratings: <**Insert primary voltage**> V - [**208Y/120**][**480Y/277**] V.
3) Taps: [**Comply with IEEE C57.12.26 requirements**]<**Insert values**>.
4) Transformer BIL (kV): [**Comply with IEEE C57.12.26 requirements**]<**Insert number**>.
5) Minimum Tested Impedance (Percent) at 85 deg C: [**2.50**][**2.87**][**4.03**][**5.75**]<**Insert number**>.
6) K-factor: <**Insert number**>.
7) Comply with FM Global Class No. 3990.
8) Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

u. Transformer Accessories:

1) Drain and filter connection.
2) Filling and top filter press connections.
3) Pressure-vacuum gauge.
4) Dial-type analog thermometer with alarm contacts.
5) Magnetic liquid level indicator with high and low alarm contacts.
6) Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer.[**With alarm contacts and manual bleeder.**]
7) Stainless steel ground connection pads.
8) Machine-engraved nameplate, made of anodized aluminum or stainless steel.
9) Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

v. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

C. Examine concrete bases for suitable conditions for transformer installation.

D. Preinstallation Checks:

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
b. Acid Neutralization Number: ASTM D974.
c. Specific Gravity: ASTM D1298.
d. Interfacial Tension: ASTM D971.
e. Color: ASTM D1500.
f. Visual Condition: ASTM D1524.
g. Water in Insulating Liquids: Comply with ASTM D1533.
h. Power Factor or Dissipation Factor: ASTM D924.

E. Verify that grounding and bonding connections are in place. Ground (Earth) resistance may not exceed [**5 Ω**]<**Insert resistance in ohms**> at transformer location.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
2. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
3. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and IEEE C2.

D. Grounding and Bonding:

1. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
2. Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner posts and at intervals not exceeding **10 ft (3 m)**. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure.
5. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

E. Connect low-voltage wiring.

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

F. Terminate medium-voltage cables in incoming section of transformers.

G. Interfaces with Other Work:

1. Identification: Provide labels for transformers and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Install transformers on cast-in-place concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at transformer is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with the Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Verify arresters are clean.
3) Verify that ground leads on devices are individually attached to ground bus or ground electrode.

b. Electrical Test:

1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of

manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.

2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Test dew point of tank gases if applicable.
2) Inspect anchorage, alignment, and grounding.
3) Verify bushings are clean.
4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
5) Verify that liquid level in tanks is within manufacturer's published tolerances.
6) Perform specific inspections and mechanical tests recommended by manufacturer.
7) Verify presence of transformer surge arresters and that their ratings are as specified.
8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values may not be less than 1 MΩ at 500 V(dc).
4) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
5) Perform Optional Field Tests:

a) Perform turns-ratio tests at tap positions. Turns-ratio test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
b) Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
c) Measure resistance of windings at tap connections, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
d) Perform applied-voltage test on line- and load-side windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase wye-wye-connected transformers.

6) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
7) Remove sample of insulating liquid in accordance with ASTM D923, and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

E. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain transformer equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.5 PROTECTION

A. After installation, protect transformer from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are

obtained.

4. Field Reports for Voltage Monitoring and Adjusting: Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Scanning of Transformers: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies transformer equipment checked, testing technician, and equipment used, and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action. List results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

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SECTION 26 12 19 00A - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes:

1. Metal-enclosed, low-voltage switchgear, with drawout power circuit breakers and metering and control accessories.

   a. Switchgear structure.
   b. Additional requirements for indoor switchgear.
   c. Additional requirements for outdoor switchgear.
   d. Circuit breakers.
   e. Arc-flash limiting feeder circuit breakers.
   f. Zone-selective interlocking.
   g. Network protectors.
   h. Surge suppression.
   i. Control power supply, 120 V(ac).
   j. Control power supply, 24 V(dc).
   k. Instrumentation and control.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
4. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
5. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for submetering.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For switchgear. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for switchgear.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. For low-voltage switchgear.

a. System Power One-Line Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1) Frame size of circuit breakers.
2) Trip rating for circuit breakers.
3) Conduit and wire size for feeders.

b. Include plans, elevations, sections, shipping splits, and mounting details.
c. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
d. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
e. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
f. Indicate short-time and short-circuit current rating of switchgear assembly.
g. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
h. Include mimic-bus diagram.

C. Delegated Design Submittals: For low-voltage switchgear.

1. Comply with Section 260572 "Overcurrent Protective Device Short-Circuit Study" and Section 260573.16 "Coordination Studies."
2. For differential ground-fault protection scheme. Include wiring diagram of differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Submit evidence that switchgear is compatible with connected monitoring and control devices and systems specified in [**Section 260913 "Electrical Power Monitoring"**]<**Insert Section number and title for integrated controls**>.

1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of protocol.

B. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. For unloading and inspection, clearances, torque values, insulation-resistance testing, dielectric withstand-voltage testing, breaker testing, power factor testing, grounding, ground-fault protection testing, batteries and chargers testing, and system functional testing.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. System Power Riser Diagram: For switchgear, using non-fugitive ink on high-quality paper. Post on wall at switchgear location.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner the following spare parts for repairing switchgear that are packaged with protective covering for storage on-site and identified with labels describing contents:

1. Drawout Circuit Breakers: One of each type and rating used for circuit breaker in switchgear.
2. Fuses: [**One**]<**Insert number**> for every [**three**]<**Insert number**> of each type and rating, but no fewer than three of each for the following:

a. Potential transformers.
b. Control power circuits.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchgear, packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchgear.
2. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
3. Racking handle to move circuit breaker manually between connected and disconnected positions.
4. Circuit-Breaker Removal Apparatus:

a. Floor Type: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
b. Overhead Type: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

5. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
6. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fluid reservoirs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Indoor Switchgear Storage: Store in dry, clean location, placed on level surface to prevent strain and possible distortion. During construction period, provide protection against dust, dirt, falling objects, dripping water, water, excessive moisture, and other possible causes of damage to equipment. Temporary covering may not restrict ventilation and may not be removed until equipment is ready for installation.[**Store indoor equipment within heated building.**][**Take special precaution to keep equipment sufficiently warm with adequate ventilation to prevent condensation during storage period. Install temporary heating if necessary.**]

B. When provisions for temporary power connection are provided as part of switchgear assembly, provisions must be included to prevent energization of primary buses or connections by means of backfeed through fuses or control power transformers connected to primary buses or connections.

C. If outdoor switchgear cannot be installed and energized, temporary power must be provided for operation of space heaters provided so as to prevent condensation of moisture within housing.

D. Ventilation openings must be left open to permit proper air circulation.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 LOW-VOLTAGE SWITCHGEAR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.5 SYSTEM DESCRIPTION

A. Description: Metal-enclosed, low-voltage switchgear with drawout [**fused**][**fused, where indicated,**] power circuit breakers, with accessories and metering components.

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Comply with IEEE C37.20.1.
3. Listed and labeled as complying with UL 1558.
4. Listed and labeled for use as service entrance equipment.

2.6 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics:

1. Nominal System Voltage: [**480 V, three**][**480/277 V, four**][**240 V, three**][**208/120 V, four**] wire, 60 Hz.
2. Rated Maximum Voltage: [**254 V**][**508 V**][**635 V**].
3. Rated Power Frequency: 60 Hz.

4. Rated Insulation Level: Power frequency withstand must be not less than 2.2 kV(rms).
5. Rated Continuous Current:

    a. Main-Bus Continuous: [**1600 A**][**2000 A**][**3000 A**][**3200 A**][**4000 A**][**5000 A**].
    b. Vertical Section Bus Riser: Equal to frame size of low-voltage power circuit breaker connected to that riser.

6. Rated Short-Circuit Withstand Current: [**42 000 A(sym)**][**65 000 A(sym)**][**85 000 A(sym)**][**100 000 A(sym)**][**200 000 A(sym)**].
7. Short-Time and Short-Circuit Current: Match rating of integrated short-circuit current rating.

2.7 SWITCHGEAR STRUCTURE

A. Bus isolation barriers must be arranged to isolate line bus from load bus at main and tie circuit breaker. Extend section barriers between main and tie circuit breakers to rear of section.

B. Allow the following circuit-breaker functions to be performed when compartment door is closed:

1. Operate manual charging system.
2. Open and close circuit breaker.
3. Examine and adjust trip unit.
4. Read breaker nameplate.

C. Install instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires, and cables.

D. Switchgear Bus:

1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
2. Main Phase Bus: Uniform capacity entire length of assembly.
3. Neutral Bus: [**50**][**100**] percent of phase-bus ampacity unless otherwise indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4. Ground Bus: Uniform capacity entire length of assembly, with pressure connector terminations for feeder and branch-circuit ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.
5. Vertical Section Bus Size: [**Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers**][**Fully rated to system continuous current, equal to horizontal bus**].
6. Bus Material and Connections:

    a. Phase- and Neutral-Bus Material:

        1) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
        2) Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
        3) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

    b. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
    c. Use copper for connecting circuit-breaker line to copper bus.
    d. Contact Surfaces of Buses: Silver plated.

e. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.

7. Neutral Disconnect Link: Bolted, uninsulated, bus, arranged to connect neutral bus to ground bus.
8. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
9. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

   a. Sprayed Insulation Thickness: **3 mil (0.08 mm)**, minimum.
   b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

E. Circuit-Breaker Compartment:

1. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:

   a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
   b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   c. Circuit-Breaker Positioning: Permit racking of open circuit breaker to or from connected, test, and disconnected positions only when compartment door is closed unless live parts are covered by full dead-front shield. Permit manual withdrawal of open circuit breaker to position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:

      1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
      2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

   d. Primary Disconnect: Mount on stationary part of compartment. Disconnect must consist of set of contacts extending to rear through insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only connected position. Assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on fingers. Load studs must connect to bus extensions that terminate in solderless terminals in rear cable compartment.
   e. Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker.
   f. Provide verification of positive ground contact between circuit breaker and its compartment when accessory cover is removed while circuit breaker is in connected, test, disconnected, and withdrawn positions.
   g. Place 2400 A frame and larger circuit breakers at bottom of switchgear.

F. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility-company requirements.
2. Bus transition sections.
3. Incoming-line pull sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.

G. Pull Boxes: Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and

side covers and with ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

1. Set pull box back from front to clear circuit-breaker lifting mechanism.
2. Pull-Box Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
3. Cable Supports: Arranged to ease cabling and adequate to support cables, including those for future installation.

2.8 ADDITIONAL REQUIREMENTS FOR INDOOR SWITCHGEAR

A. Enclosure Rating: Indoor.

B. Enclosure Material: Steel.

C. Enclosure Finish: IEEE C37.20.1, manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Enclosure Rear Panels: Removable and hinged, to allow access to rear interior of switchgear.

2.9 ADDITIONAL REQUIREMENTS FOR OUTDOOR SWITCHGEAR

A. Outdoor Enclosure Rating: UL 1558.

B. Outdoor Enclosure Description: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating

C. Outdoor Enclosure Material: [**Steel**][**12 gage, ASTM A240, Type 304 or 304L stainless steel**].

D. Outdoor Enclosure Finish:

1. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
2. Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117, without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with rating of not less than 7 in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.
3. Front and rear doors must be provided with stainless steel padlockable vault handles with three-point catch. Bases, frames, and channels of enclosure must be corrosion resistant, fabricated of ASTM A240 Type 304 or 304L stainless steel. Base must include part of enclosure that is within **3 inch (75 mm)** of concrete pad. Coat enclosure, including bases, must be ASTM D1535 light gray No. 61 or No. 49. Coating system must comply with IEEE C57.12.29 for stainless steel.

E. Features:

1. Structural design and anchorage adequate to resist seismic and wind loads specified in Section 260011 "Facility Performance Requirements for Electrical."
2. Sloping, standing-seam type, insulated roof panels.
3. Mount shipping group on integral base frame as complete weatherproof unit.

4. Aisle-Less Construction: Vertical sections must have the following:

   a. Hinged front door with padlocking provisions.
   b. Interior light with switch.
   c. Weatherproof duplex receptacle.
   d. With draft-stop where busway exits vertical section.
   e. Vertical Section Space Conditioning: Provide outside-air openings with insect and rodent screens and filters; arranged to permit air circulation while excluding insects, rodents, and exterior dust. Provide thermostatically controlled space heaters operating at one-half or less of rated voltage.

5. Common Internal Aisle-Type Construction:

   a. With aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
   b. Aisle access doors with outside padlocking provisions and interior panic latches.
   c. Vaporproof [**LED aisle lights**][**fluorescent aisle lights with low-temperature ballasts**], controlled by wall switches at entrances.
   d. GFCI duplex receptacles, minimum of two, located in aisle.
   e. Interior Space Conditioning:

      1) Forced-air aisle ventilation with thermostatically controlled vent fans, interlocked with aisle space heaters operating at one-half or less of rated voltage. Provide outside-air openings with insect and rodent screens and filters; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
      2) Air conditioned.

2.10 CIRCUIT BREAKERS

A. Drawout type, unfused, power operated, with electromechanical or electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.

B. Ratings: For continuous, interrupting, and short-time current ratings for circuit breakers; voltage and frequency ratings same as switchgear. Comply with IEEE C37.16.

   1. Circuit breakers must have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85 000 A, whether or not equipped with instantaneous trip protection.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   3. Stored-Energy Mechanism: [**Manually charged**][**Electrically charged**][**Electrically charged, and operator's choice of manual charging**].

      a. Operating Handle: One for each circuit breaker capable of manual operation.
      b. Electric Close Button: One for each electrically operated circuit breaker.

   4. Provide interlock to discharge stored energy mechanism before circuit breaker can be withdrawn from its compartment.
   5. Operation counter.

D. Operator Display: Located on face of circuit breaker.

1. Electrical operation buttons to open and close circuit breaker.[**Provide clear lockable cover over buttons.**]
2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. Energized or hot condition must be indicated by red light. De-energized, open, and safe condition must be indicated by green light.
3. Indicator to show position of circuit-breaker contacts, status of closing springs, and circuit-breaker position in its compartment.
4. Provide "Charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.
5. Computer Display: One or more [**touchscreen**]computer displays with dedicated CPU, to display data that are generated for transmission via Ethernet connection. Display the following functions:

    a. Circuit-breaker status and circuit-breaker controls status.
    b. Onboard meters.
    c. User settings for overcurrent protection and undervoltage protection.
    d. <**Insert features**>.

E. Overcurrent Protective Tripping: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:

1. Programmable functions independent of each other in both action and adjustment.

    a. Long-time setting.
    b. Long-time-delay with selectable I2T or I4T curve shaping.
    c. Short-time setting.
    d. Short-time-delay with flat or selectable I2T curve shaping.
    e. Instantaneous trip.

2. Field-adjustable, time-current characteristics.
3. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or combination of these methods.
4. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
5. Pickup Points:

    a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2T operation.
    b. Five minimum, for instantaneous-trip functions.

F. Ground-Fault Protection:

1. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.
2. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
3. Test Form: Provide ground-fault relays with information sheets describing system-testing instructions, and with test form; comply with UL 1558.

G. Undervoltage Trip Devices:

1. Instantaneous, with adjustable pickup voltage.
2. Adjustable time-delay and pickup voltage.

H. Shunt-Trip Devices.

I. Metering:

1. Accuracy: [**0.5**][**1.0**] percent of reading, complying with ANSI C12.20.
2. Values must be RMS average over period of one second.

   a. Current: Each phase, [**neutral**]and three-phase average.
   b. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
   c. Active Power (kW): [**Each phase and**]three-phase total.
   d. Reactive Power (kVAR): [**Each phase and**]three-phase total.
   e. Apparent Power (kVA): [**Each phase and**]three-phase total.
   f. Power Factor: [**Each phase and**]three-phase total.
   g. Active Energy (kWh): Three-phase total.

J. Auxiliary Contacts:

1. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
2. Spare auxiliary switches, at least two, unless otherwise indicated. Switches must consist of two Type A and two Type B contacts wired through secondary disconnect devices to terminal block in stationary circuit-breaker compartment.

K. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

L. Padlocking Provisions: For installing at least three padlocks on circuit breakers to secure its enclosure and prevent movement of drawout mechanism.

M. Mechanical Interlocking of Circuit Breakers: Uses mechanical tripping lever or equivalent design and electrical interlocks.

N. Key Interlocks: Arranged to prevent opening or closing of interlocked circuit breakers, except in specified sequence. Include mountings and hardware for future installation of key interlocks.

2.11 ARC-FLASH LIMITING FEEDER CIRCUIT BREAKERS

A. Feeder circuit breakers must be without current-limiting fuses, listed as complying with UL 1066.

B. Short-circuit withstand current rating must be 200 kA.

C. Equip arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.

1. Provide manual switch on compartment door to switch circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce danger from potential arc-flash at downstream equipment.
2. Provide lock feature for switch so that it may be locked in either off or on maintenance-mode position.
3. Provide blue LED indicating light to indicate that switch is in maintenance mode.
4. Provide dry relay contacts on switches for annunciation of switch position.

2.12 ZONE-SELECTIVE INTERLOCKING

A. Trip units for indicated circuit breakers must include zone-interlocking capability for short-time delay and ground-fault delay trip functions for system coordination and arc energy reduction. Zone-interlocking system must restrain tripping of upstream circuit breaker and allow circuit breaker closest to fault to trip with no intentional time delay. In event that downstream breaker does not trip, upstream breaker must trip after preset time delay.[**Zone-interlock system must be factory wired and tested for circuit breakers within switchgear.**]

2.13 NETWORK PROTECTORS

A. Comply with IEEE 57.12.44 and IEEE C37.20.1. Switch must comply with UL 1066.

1. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Include mechanical interlocks to prevent racking in and racking out when protector is closed.
2. Locate relay and control panel on separate drawout module.
3. Protector Operator: [**Spring-close**][**and**][**or**][**stored-energy**] mechanism, rated to close on [**25 000 A(rms sym)**][**40 000 A(rms sym)**] load.
4. Program relay with factory-default values. Make provisions to field adjust these values using relay calibration procedures. Include antipumping program to lock protector open under abnormal conditions.
5. Include current-limiting fuses on network side of protector for protection against switchboard bus faults.

B. Controls must be via microprocessor-based, three-phase network relay, with the following features and functions:

1. Protector control must use positive and negative sequence-based algorithm for current and voltage.
2. Close protector if positive sequence power flows into network. Adjustable closing range must be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
3. Trip protector if there is net, three-phase, reverse power flow through protector. Trip protectors must be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
4. Trip protector if there is flow of reverse magnetizing current to its associated transformer.
5. Relay parameters and W or VAR trip values must be field adjustable.
6. Protector may not open under fault on network side of protector.
7. Include auxiliary contacts and control wiring for use with remote pilot devices that provide remote trip and lockout functions in low-voltage switchgear. Include [**two**]**<Insert number>** spare auxiliary contacts and equal number of N.O. and N.C. types.

C. Communicate the following network relay parameters:

1. Current in each phase.
2. Phase-to-phase and phase-to-neutral voltages.
3. Three-phase W, VAR, and VA.
4. Frequency.
5. Power factor.
6. Network relay set points.

2.14 SURGE SUPPRESSION

A. Factory Installed: Integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the

following features and accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

B. Field Mounted: Complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits." Include the following features and accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

2.15 CONTROL POWER SUPPLY, 120 V(ac)

A. Control Power Transformer: Supply 120 V control circuits through dry-type control power transformers, include secondary disconnect devices.

1. Place transformers larger than 3 kVA in separate compartments at bottom of vertical section, including related primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; transformers connected to line side of associated main circuit breaker.

   a. Secondary windings connected through relay(s) to control bus to affect automatic transfer scheme.
   b. Secondary windings connected through internal automatic transfer switch to switchgear control power bus.

3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

2.16 CONTROL POWER SUPPLY, 24 V(dc)

A. System Requirements: Battery must have number of cells and ampere-hour capacity based on initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate circuit breakers for intended duty.

B. Battery: [**Standard VRLA**][**Premium VRLA**][**Vented NiCd,**] batteries, with battery disconnect and overcurrent protective device.

C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]

D. Accessories:

1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with AC input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by N.O. push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell, and equalizing charge at 2.33 V per cell.
5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.
6. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of AC power supply for interval.
7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device must regulate charging current but may not disconnect charger from either battery or AC supply.
8. Charger's Audible Noise: Less than 26 dB(A-weighted).

2.17 INSTRUMENTATION AND CONTROL

A. Power Distribution Equipment must be web enabled, direct connected to Local Area Network (LAN) or Intranet.

B. Ethernet Connectivity:

1. Install multipoint, TIA-485 MODBUS serial communications network within switchgear to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network must be wired to Ethernet gateway in switchgear. Gateway must be web enabled, with integral network port and embedded web server with factory-configured firmware and HTML-formatted web pages for viewing of power monitoring and equipment status information from switchgear devices equipped with digital communication ports.
3. LAN must consist of multipoint, TIA-485 MODBUS serial communication network to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network must be connected to Ethernet server that functions as gateway and server, providing data access via [**10 Base-T**][**100 Base-T**][**100 Base-TX**][**100 Base FX**] LAN.
4. Server Configuration:

a. Initial network parameters set using standard web browser. Connect via local operator interface, or TIA-1096 Type 8P8C jack accessible from front of equipment.
b. Network server must be factory programmed with embedded HTML-formatted web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of TIA-485 network; with internal memory management information pages for viewing using standard web browser.
c. Password-protected login, with password administration accessible from LAN using standard web browser.
d. Operating Software: Suitable for local access; firewall protected.

5. All serial communications devices within equipment must be addressed at factory and tested.

C. Instrument Transformers: Comply with IEEE C57.13. Instrument transformers may not be used to power space conditioning equipment associated with outdoor switchgear, of for power to convenience receptacles and lighting.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and Accuracy class suitable for connected relays, meters, and instruments.

D. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1. Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3. Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a. Operation: Counts and records succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. Power Monitoring: Separately mounted, modular, permanently installed, solid-state, digital I/O multifunction metering instrument for power and energy metering and monitoring, complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue-related metering from unauthorized and accidental changes.
3. Comply with IEC 60529 degree of protection code of IP65 for front of meter, and code of IP30 for body.
4. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
5. Accuracy:

a. Comply with ANSI C12.20, Class 0.5.
b. Neutral Current Measurement: Not more than 0.65 percent.

c. Power Factor: 1.0 percent.
d. Frequency: 0.1 percent.
e. THD: 1.0 percent.
f. Waveform Sampling: 64 per cycle.

6. Data Link: Ethernet connectivity specified in this article.
7. Meter Physical Characteristics:

a. Display: Backlit LCD with antiglare and scratch-resistant lens.
b. Display of Metered Values: One screen to show at least [**three**]<**Insert number**> user-selected values displayed at same time. Selections available to display must include the following:

1) All meters.
2) Measurements.
3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

8. Sampling Rate: Continuously sample and record voltage and current at rate not less than [**64**]<**Insert number**> samples per cycle, simultaneously on voltage and current channels of meter.
9. Meters:

a. Instantaneous, RMS:

1) Current: Each phase, [**neutral**]and three-phase average.
2) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Power (kW): [**Each phase and**]three-phase total.
4) Reactive Power (kVAR): [**Each phase and**]three-phase total.
5) Apparent Power (kVA): [**Each phase and**]three-phase total.
6) Power Factor: [**Each phase and**]three-phase total.

b. Energy:

1) Active Energy (kWh): Three-phase total.

c. Demand, Derived from Instantaneous RMS Meters:

1) Current: Present and maximum.
2) Active: Present and maximum.
3) Reactive: Present and maximum.
4) Apparent: Present and maximum/

d. Power Quality Measurements:

1) THD: Current and voltage from measurements simultaneously from same cycle, as can be calculated from specified sampling rate.

10. I/O: Two optically isolated digital outputs for KYZ pulsing or control. Output signal characteristics must be 150 mA at 200 V.

a. KYZ Pulse: Generate standard KYZ pulses for user-defined increment of metered active energy as follows:

1) User-defined pulse output, associated with kWh.
2) User-defined pulse output, associated with kVARh.

b. <**Insert control function**>.

11. Capacities and Characteristics:

a. Circuit Connections:

1) Voltage: Measurement autoranging, 60 to 400 V(ac rms) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument-grade potential transformers secondary at 120 V.**] Meter impedance must be 2 MΩ L-L or greater.
2) Overload Tolerance: 1500 V(ac rms) continuously.
3) Current: Connect to instrument-grade current transformer with metering range of 5 mA to 6 A. Overcurrent tolerance of instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
4) Frequency: 45 to 65 Hz.
5) Time: Input from GPS receiver to synchronize internal clock of instrument and to time-synchronize this instrument with network to deviation of not greater than 1 ms.

2.18 POWER TRANSFER CONFIGURATIONS

A. Factory-installed and -tested controls of circuit breakers to accomplish automatic transfer controls for switchgear having two power sources.

B. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

C. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Install plugs in control wiring at shipping splits.

D. Two-Breaker Transfer Control:

1. Two-breaker transfer control must provide for switchgear assembly with common load bus and two normally energized medium-voltage power sources, designated "normal" and "standby," connected to load bus. Circuit breakers connecting two power sources to load bus must be controlled by microprocessor-based automatic transfer control. Power for transfer control must be from voltage sensing transformers.
2. In automatic mode, load bus is connected to normal power source. When normal source fails, control must automatically open normal power source and close standby source circuit breaker.
3. Sequence of Operation:

a. Default operation must be with normal source main breaker closed and standby main breaker open. On detection of undervoltage to line side of normal main breaker and after field-adjustable time delay, that main breaker must open and after additional field-adjustable time delay, standby breaker must close restoring power to facility.
b. On restoration of voltage to line side of normal main breaker and after field-adjustable time delay, standby main breaker must open and after field-adjustable time delay, normal main

breaker must close.

4. Field-Adjustable Transfer Parameters:

   a. Delay transfer from normal power source to standby power source and from standby power source to normal source. Time delay is to allow load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
   b. Delay initiation of transfer sequence. Time delay is recommended to override momentary power outage or voltage fluctuation. Delay range: zero seconds to 120 seconds.
   c. Delay transfer from standby power source to normal power source. Delay range: zero seconds to 30 minutes.
   d. A relay with contact that changes state when power is available on normal source and relay with contact that changes state when power is available on standby source.

5. Controls and Indicators: Besides delay setting controls, provide the following:

   a. Interlocks or relay control to prevent transfer when either of two controlled circuit breakers are tripped due to overcurrent or ground fault.
   b. Three-position selector switch to select normal source: Source 1, Source 2, or none.
   c. Transfer-control automatic and manual selector.

      1) Interlock must prevent paralleling of two power sources in manual mode.

   d. Open-close control switch for manual electrical operation of controlled circuit breakers.
   e. Selector to place control into programming mode.
   f. Circuit-breaker control switch for normal and standby source breakers, providing open and close operation.
   g. Push-button to initiate manual retransfer to normal source when transfer controller is in automatic mode.
   h. Meters and display to show the following:

      1) Voltage and frequency of both sources.
      2) A multiline display showing the following:

         a) Set points of timers, and voltage pickup and dropout set points.
         b) Date, time, and reason for at least last 10 transfers. Display may show information for one transfer at time using scrolling control, with others held in memory.
         c) When control system is in transferring process, display must show delay countdown in seconds.

   i. LED indicator lights to show the following:

      1) Normal source available.
      2) Standby source available.
      3) Normal source connected.
      4) Standby source connected.
      5) Load bus energized.

6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

E. Three-Breaker Transfer Control:

1. Switchgear assembly, with two normally energized, medium-voltage power sources designated "Main 1" and "Main 2" connected to load bus. N.O. bus tie circuit breaker can tie two load buses. Three circuit breakers must be controlled by microprocessor-based automatic-transfer control. Power for transfer control must be from voltage sensing transformers.
2. In automatic mode, on loss of voltage to line side of source, that main breaker must open and then bus tie must close. On restoration of power to previously failed main breaker, bus tie must open and open main must close.
3. Sequence of Operation:

    a. Default operation must be with main breakers closed and bus tie breaker open. On detection of undervoltage to line side of main breaker and after field-adjustable time delay, that main breaker must open and after additional field-adjustable time delay, bus tie breaker must close, restoring power to failed bus.
    b. On restoration of voltage to line side of previously failed main breaker and after field-adjustable time delay, tie breaker must open and after field-adjustable time delay, previously failed main breaker must close.

4. Field-Adjustable Transfer Parameters:

    a. Delay opening of failed main and closing of bus tie. Time delay is to allow load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
    b. Delay initiation of transfer sequence. Time delay is recommended to override momentary power outage or voltage fluctuation. Delay range: zero to 120 seconds.
    c. Delay opening of bus tie and closing of previously failed main. Time delay is to allow bus voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.

5. Controls and indicators must include the following in addition to delay setting controls:

    a. Interlocks or relay control to prevent transfer when any of three controlled circuit breakers trip due to overcurrent or ground fault.
    b. Transfer control automatic and manual selector.

        1) Interlock that prevents paralleling of two mains in manual or automatic mode.

    c. Open-close control switch for manual electrical operation of controlled circuit breakers.
    d. Selector must place control into programming mode.
    e. A relay with contact that changes state when power is available on both mains and relay with contact that changes state to indicate open main and when bus tie is closed.
    f. Push-button to initiate manual retransfer to previously failed source when transfer controller is in automatic mode.
    g. Meters and display must show the following:

        1) Voltage and frequency at line side of both mains.
        2) A multiline display must show following:

            a) Set points of timers, and voltage pickup and dropout set points.
            b) Date, time, and reason for at least last 10 transfers. Display may show information for one transfer at time using scrolling control, with others held in memory.
            c) When control system is in transferring process, display must show delay countdown in seconds.

    h. LED indicator lights must show the following:

1) Main source available.
2) Main source unavailable.
3) Main closed.
4) Main open.
5) Bus tie open or closed.

6. Voltage transformers must have primary and secondary protection and disconnecting means for sensing functions and control power.
7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative-sequence voltage protection.

2.19 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources must be devised by manufacturer to insure that proper main or tie breaker(s) operate properly in normal and emergency conditions. Switchgear must include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to main bus of switchgear. Ensure that the following occurs on main bus:

1. A ground fault at location in switchgear must trip system.
2. Combination of normal current flow and ground-fault current flow must trip system.
3. Circulating currents through neutral due to multiple grounds and sources external to immediate low-voltage power sources may not trip system.
4. System may not trip if there is no ground fault, during normal current flow.
5. System may not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Install plugs in control wiring at shipping splits.

2.20 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate low-voltage switchgear.

C. Factory Tests and Inspections: Test and inspect low-voltage switchgear, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C37.20.1 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units. Drawout circuit breakers need not be tested in assembly if they are tested separately.

1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate ability of insulation system to withstand voltages listed in IEEE C37.20.1. Voltage must be increased gradually from zero to required test value within 5 to 10 seconds and must be held at that value for one minute.
2. Perform mechanical operation tests to ensure proper functioning of operating mechanism,

mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
3. Test effectiveness of grounding of metal-case instrument transformer frame or case.
4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in intended sequence.
5. Perform control wiring insulation tests.
6. Verify correct polarity of connections between instrument transformers and meters and relays.

D. Serial communications devices within equipment must be addressed at factory and tested to verify reliable communications to equipment's Ethernet gateway.

E. Nonconforming Work:

1. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be [**5 Ω**]**<Insert Ω>** at switchgear location.

E. On delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's published instructions.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with bill of materials to verify that shipment is complete. Verify that switchgear and accessories comply with manufacturer's published instructions and Shop Drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

F. Handling:

1. Handle switchgear, in accordance with manufacturer's published instructions; avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against entrance of dust, rain, and snow.
3. Transport switchgear upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or lifting beam to obtain vertical lift and to protect switchgear from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Exterior Locations:

1. Install tinned bare copper conductors not smaller than 4/0 AWG, for ground conductors buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes.
2. Bond surge arrester and neutrals directly to switchgear enclosure and then to grounding electrode system with bare copper conductors, sized as indicated.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.
5. Fence and equipment connections may not be smaller than 4 AWG.
6. Ground fence at gate posts and corner posts and at intervals not exceeding **10 ft (3 m)**.
7. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned,**]flexible braided copper strap and clamps.

C. Terminate grounding and bonding conductors on common equipment grounding terminal on switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.

D. Complete switchgear grounding and surge-protector connections prior to making other electrical connections.

3.4 IDENTIFICATION

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

C. Compartment Nameplates: [**Engraved, laminated-acrylic**][**Engraved, melamine plastic**][**Preprinted aluminum signs**], as described in Section 260553 "Identification for Electrical Systems," for compartments, mounted with corrosion-resistant screws.

D. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

E. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce **3.5 by 5 inch (76 by 127 mm)** self-adhesive equipment label for work locations included in analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce **3.5 by 5 inch (76 by 127 mm)** self-adhesive equipment label for work locations included in analysis. Labels must be machine printed, with no field-applied markings.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

b. Labels must be machine printed, with no field-applied markings.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B and NETA ATS.
2. After installing switchgear and after electrical circuitry has been energized, test for compliance

with requirements.

3. Perform visual and mechanical inspections and electrical tests stated in NETA ATS. Certify compliance with test parameters.
4. Visual and Mechanical Inspection:

    a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study[**, as well as to circuit breaker's address in control network**].
    b. Verify that current and voltage transformer ratios correspond to Drawings.
    c. Inspect bolted electrical connections for high resistance using one of the following two methods:

        1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

    d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
        2) Make key exchange with devices operated in off-normal positions.

    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Inspect insulators for evidence of physical damage or contaminated surfaces.
    g. Verify correct barrier and shutter installation and operation.
    h. Exercise active components.
    i. Inspect mechanical indicating devices for correct operation.
    j. Verify that filters are in place and that vents are clear.
    k. Perform visual and mechanical inspection of instrument transformers in accordance with "Instrument Transformer Field Tests" Paragraph.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

5. Electrical Tests:

    a. Perform DC voltage insulation-resistance tests on bus sections, phase-to-phase and phase-to-ground, for one minute. If bus temperature is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

        1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
        2) Do not proceed to dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform dielectric withstand voltage test on bus sections, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand test, test specimen is considered to have passed test.

c. Perform insulation-resistance tests on control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instruction.

1) Minimum insulation-resistance values of control wiring may not be less than 2 MΩ.

d. Control Power Transformers:

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and windings-to-ground. Insulation-resistance values of winding insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to rated secondary voltage source. Verify correct potential at devices.
3) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
4) Verify correct function of control transfer relays located in switchgear with multiple control power sources.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

f. Perform current-injection tests on entire current circuit in switchgear sections.

1) Perform current tests by secondary injection with magnitudes such that minimum 1.0 A current flows in secondary circuit. Verify correct magnitude of current at devices in circuit.
2) Perform current tests by primary injection with magnitudes such that minimum 1.0 A current flows in secondary circuit. Verify correct magnitude of current at devices in circuit.

g. Perform system function tests in accordance with "System Function Tests" Paragraph.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from sources.

D. Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, and grounding.
c. Verify that maintenance devices are available for servicing and operating breaker.
d. Verify unit is clean.
e. Verify that arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by Owner.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across open poles. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's published instructions must be investigated.
b. Measure contact resistance across power contacts of circuit breakers. Drop values for μΩ or mV(dc) may not exceed high levels of normal range as indicated in manufacturer's published data. In absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times may not exceed value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current tolerance band.
e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must comply with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in

accordance with manufacturer's published data.

k. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

E. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data complies with Contract Documents.
b. Inspect physical and mechanical condition.
c. Verify correct connection of transformers with system requirements.
d. Verify that adequate clearances exist between primary and secondary circuit wiring.
e. Verify that unit is clean.
f. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

g. Verify that required grounding and shorting connections provide contact.
h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
i. Verify correct primary and secondary fuse sizes for voltage transformers.
j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of current transformers and secondary wiring for ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.5.
b. Perform polarity test on current transformers in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must be in accordance with IEEE C57.13.
d. Perform excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or be in accordance with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. Measured burdens must be compared to, and must match, instrument transformer ratings.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test voltages must be in accordance with NETA ATS, Table 100.5.
g. Perform dielectric withstand tests on primary winding with secondary grounded. Test voltages must be in accordance with NETA ATS, Table 100.9.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
i. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. That grounding point should be located

as specified by Engineer in Project Drawings.

3. Electrical Tests of Voltage Transformers:

   a. Perform insulation-resistance tests, winding-to-winding and windings-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.5.
   b. Perform polarity test on transformers to verify polarity marks or H1-X1 relationship as applicable. Polarity results must agree with transformer markings.
   c. Perform turns-ratio test on tap positions. Ratio errors must be in accordance with IEEE C57.13.
   d. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to, and must match, instrument transformer ratings.
   e. Perform dielectric withstand test on primary windings with secondary windings connected to ground. Dielectric voltage must be in accordance with NETA ATS, Table 100.9. Test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand test, primary windings are considered to have passed test.
   f. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use test equipment manufacturer's published data.
   g. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. Test results must indicate that circuits are grounded at only one point.

F. Ground-Resistance Test:

1. Visual and Mechanical Inspection:

   a. Verify that ground system complies with Contract Documents and with Article 250, "Grounding and Bonding," in NFPA 70.
   b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.
   c. Inspect bolted electrical connections for high resistance using one of the following two methods:

      1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

   d. Inspect anchorage.

2. Electrical Tests:

   a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on main grounding electrode or system. Resistance between main grounding electrode and ground must be no more than [**5 Ω**][**maximum ground-resistance value specified in "Examination"**

Article].

b. Perform point-to-point tests to determine resistance between main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 Ω. Compare equipment nameplate data with the Contract Documents.

c. Inspect physical and mechanical condition.

d. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

G. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.

d. Verify that unit is clean.

e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.

b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.

c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.

d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision,

and rated control voltage.

b. Verify operation of LEDs, display, and targets.
c. Record passwords for each access level.
d. Clean front panel and remove foreign material from case.
e. Check tightness of connections.
f. Verify that frame is grounded in accordance with manufacturer's published instructions.
g. Set relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from relay. Print copy of settings for report and compare settings to those specified in coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from circuits to grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of relay meter functions.
c. Check functional operation of elements used in protection scheme as follows:

1) ANSI No. 2/62, Timing Relay:

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) ANSI No. 24, Volts/Hertz Relay:

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at second voltage level.
c) Determine time delay.

3) ANSI No. 25, Sync Check Relay:

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine set points of live line, live bus, dead line, and dead bus.
d) Determine time delay.
e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.

4) ANSI No. 27, Undervoltage Relay:

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at second point on timing curve for inverse time relays.

5) ANSI No. 32, Directional Power Relay:

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at second point on timing curve for inverse time relays.
f) Plot operating characteristic.

6) ANSI No. 46, Current Balance Relay:

a) Determine pickup of unit.
b) Determine percent slope.
c) Determine time delay.

7) ANSI No. 46N, Negative Sequence Current Relay:

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on I2T curve.

8) ANSI No. 47, Phase Sequence or Phase Balance Voltage Relay:

a) Determine positive sequence voltage to close N.O. contact.
b) Determine positive sequence voltage to open N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close N.C. contact on removal of voltage when previously set to rated system voltage.

9) ANSI No. 50, Instantaneous Overcurrent Relay:

a) Determine pickup.
b) Determine dropout.
c) Determine time delay.

10) ANSI No. 51, Time Overcurrent:

a) Determine minimum pickup.
b) Determine time delay at two points on time current curve.

11) ANSI No. 64, Ground Detector Relay:

a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, Directional Overcurrent Relay:

a) Determine directional unit minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Plot operating characteristics.
e) Determine overcurrent unit pickup.
f) Determine overcurrent unit time delay at two points on time current curve.

13) ANSI No. 87, Differential Relay:

a) Determine operating unit pickup.
b) Determine operation of restraint unit.
c) Determine slope.
d) Determine harmonic restraint.
e) Determine instantaneous pickup.
f) Plot operating characteristics for restraint.

d. Control Verification:

1) Functional Tests:

a) Check operation of active digital inputs.
b) Check output contacts or SCRs, preferably by operating controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

I. Ground-Fault Protection Field Tests: Evaluate interconnected system in accordance with switchgear manufacturer's published instructions.

1. Determine proper location of sensors around bus of circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
2. Verify grounding points of system to determine that ground paths do not exist that would bypass sensors. Use high-voltage testers and resistance bridges.
3. Test installed system for correct response by application of full-scale current into equipment to duplicate ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:

a. A coil around sensors.
b. A separate test winding in sensors.

4. Record test results on test form provided with instructions provided by manufacturer.

J. DC System VRLA Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify that equipment nameplate data complies with the Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify that units are clean.
h. Inspect spill containment installation.
i. Verify application of oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and verify that alarms comply with system manufacturer's published instructions.
c. Measure negative post temperature. This temperature must comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. These levels must be in accordance with battery manufacturer's published data.
e. Measure monoblock/cell voltage and total battery voltage with charger energized and in

float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.

f. Measure intercell connection resistances.

g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical cells that are in fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical monoblocks/cells in fully charged state.

h. Perform load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass test.

i. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

K. DC System Vented NiCd Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.

b. Verify that battery area ventilation system is operable.

c. Verify existence of suitable eyewash equipment.

d. Verify that equipment nameplate data complies with the Contract Documents.

e. Inspect physical and mechanical condition.

f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.

g. Verify electrolyte level. Measure pilot-cell electrolyte temperature, and correct as recommended by manufacturer's maintenance procedures to bring temperature and electrolyte level to within normal limits.

h. Verify that units are clean.

i. Inspect spill containment installation.

j. Verify application of oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.

b. Verify charger functions and verify that alarms comply with system manufacturer's published instructions.

c. Measure cell voltage and total battery voltage with charger energized and in float mode of operation. Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published data.

d. Measure intercell connection resistances.

e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical cells that are in fully charged state.

f. Perform load test in accordance with manufacturer's published data or IEEE 1106. Replace units that fail to pass test.

g. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

L. System Function Tests: Perform system function tests after other field quality-control tests have been completed and components have passed specified tests. Verify correct interaction of sensing, processing, and action devices.

1. Develop test parameters and perform tests for purpose of evaluating performance of integral

components and their functioning as complete unit within design requirements and manufacturer's published data.
2. Verify correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify correct operation of sensing devices, alarms, and indicating devices.

M. Nonconforming Work:

1. Switchgear components will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

N. Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

O. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, and if requested by Owner, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at switchgear outgoing sections. Use voltmeters with calibration traceable to NIST standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust switchgear taps.
   b. Prepare published request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:

   a. Prepare published report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used and that lists results as follows:

   a. Description of equipment to be tested.
   b. Discrepancies.
   c. Temperature difference between area of concern and reference area.

d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
5. [**Follow-up Infrared Scanning: Perform additional follow-up infrared scan of switches 11 months after date of Substantial Completion.**]

C. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 26 12 19 00A

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Task	Specification	Specification Description
26 12 19 00	26 12 13 00	Liquid-Filled, Medium-Voltage Transformers
26 12 19 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 13 29 00 - MEDIUM-VOLTAGE COMPARTMENTALIZED SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes dead-front, remotely controlled insulated vacuum load and fault interrupting switchgear.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted switchgear and to provide a fully insulated connection. Also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Fault Interrupter: A self-controlled mechanical switching device capable of making, carrying, and automatically interrupting an alternating current. It includes an assembly of control elements to detect overcurrents and control the fault interrupter. A fault interrupter always consists of a switching device, a control unit, and sensors for current and/or voltage sensing.

F. Hotstick: An insulated stick, usually made of fiberglass, that is used to work energized overhead conductors and operate electrical equipment that is overhead, underground, and compartmentalized.

G. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

H. Way: A three-phase or single-phase circuit connection to the bus that may contain combinations of switches and protective devices or may be a solid bus.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For pad-mounted switchgear.

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations must show major components and features, and they will mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts[**and leveling channels**].
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Include list of materials.
6. Locate accessory and spare equipment storage.
7. Include single-line diagram.
8. Include control power wiring diagrams.
9. Include battery, charger, and transfer switch ratings.
10. Include copy of nameplate.
11. Switchgear Ratings:

    a. Voltage.
    b. Continuous current.
    c. Short-circuit rating.
    d. BIL.

12. Design Calculations: Signed and sealed by a qualified professional structural engineer. Calculate requirements for selecting seismic restraints.
13. Relay settings.
14. Interface data with monitoring or control network.
15. Wiring Diagrams: For each switchgear assembly, include the following:

    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits, showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices[**including SCADA remote terminal unit**].

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For pad-mounted switchgear.

1. Switch ratings as listed in IEEE C37.74.
2. Interrupter ratings as listed in IEEE C37.60.
3. Coating system compliance with the IEEE standard listed in "Switchgear Enclosure" Article.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace the switchgear control system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

2. Warranted Cycle Life for Premium VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 1.5 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

PART 2 - PRODUCTS

2.1 MEDIUM-VOLTAGE COMPARTMENTALIZED SWITCHGEAR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**S&C Electric Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**S&C Electric Company**]
4. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. Manufactured Unit: Pad-mounted switchgear, designed for application in [**solidly grounded neutral**][**ungrounded**][**impedance-grounded**] underground distribution systems.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

C. Comply with IEEE C2.

D. Comply with IEEE C37.74.

2.3 RATINGS

A. Switchgear is applied to a nominal [**4.16**][**13.2**][**13.8**][**23**][**24.94**][**34.5**]<**Insert voltage**> kV (L-L) medium-voltage electrical power system. Minimum ratings of the switchgear must be as follows:

1. Rated Maximum Voltage and Rated BIL: [**15.5 kV and 95 kV BIL**][**27 kV and 125 kV BIL**][**38 kV and 150 kV BIL**]<**Insert voltage**>.
2. Continuous and Load Interrupting Current: 600 A.
3. Short-Time and Short-Circuit Interrupting Current: [**12.5 kA SYM RMS**][**16 kA SYM RMS**][**20 kA SYM RMS**][**25 kA SYM RMS**].

2.4 SWITCHGEAR ENCLOSURE

A. Weatherproof enclosure with an integral skid mounting frame, designed for mounting on a concrete pad, suitable to allow skidding or rolling of the switchgear in any direction, and with provision for anchoring the frame to the pad.

B. Enclosure Integrity: Comply with IEEE C57.12.28 for compartmentalized enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

1. Each vertical section must have the following features:

a. Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
d. Weatherproof ground-fault circuit interrupter duplex receptacles.
e. Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated**].
f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

C. Corrosion Protection:

1. Enclosure coating system must be factory applied, meeting the requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.
2. Fabricate the support frame, enclosure base, and the enclosure from stainless steel, ASTM A167,

Type 304 or 304L. Enclosure coating system must be factory applied, meeting the requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.

2.5 SWITCHGEAR CONSTRUCTION

A. Dead-front, front and rear access switchgear.

B. Each disconnect switch in switched ways must be in a sealed, dielectric filled [**stainless**]steel tank, factory-filled with [**SF6 gas**][**mineral oil**][**or**][**less-flammable, high-firepoint fluid**].

1. SF6 Gas: Comply with ASTM D2472. Provide enclosure with pressure gauge and self-sealing fill valve.
2. Mineral Oil: Comply with ASTM D3487, Type II, and tested for compliance with ASTM D117. Provide enclosure with level gauge to monitor the dielectric level; automatic pressure relief valve; and fill, drain, and sampling valves.
3. Less-flammable, high-firepoint fluid must comply with ASTM D6871 and IEC 61099. The temperature rating of the fluid must be satisfactory for ambient air temperatures of **minus 22 and plus 104 deg F (minus 30 and plus 40 deg C)**. Provide enclosure with level gage to monitor the dielectric level; automatic pressure relief valve; and fill, drain, and sampling valves.

C. Construct switchgear assembly with switched ways that have front-accessible terminations for cables entering from below and with manual operating provisions with a lineman's hotstick.

D. Trapped Key Interlocks: Kirk key interlock system using a dowel pin design having no openings. Brass housing and 316 stainless steel key and lock bolts.

E. Viewing Windows: For each switch, located adjacent to manual operating devices, and positioned to show switch contact position.

F. Grounding: Provision to make grounding cable and wire connections at each way.

2.6 SWITCHED WAYS

A. Source Switch Ways: Non-fused, hotstick operated, ganged vacuum load interrupter switches[**, in series with a visible-break disconnect switch**].

1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Load Interrupter:

   a. With 24 V(dc) motor operators to open or close the load interrupter.
   b. Trip-free switch mechanism. Closing the switch must be independent of the speed of the operating handle.

3. Visible-Break Disconnect Switch: [**Three positions, with open, closed, and ground positions**][**Two positions, with open and closed positions**]. The switch must be mechanically interlocked so that the vacuum interrupter opens and closes first.

   a. Switch position indicator, clearly labeled.
   b. Padlocking and tagging provisions.

B. Fault Interrupting Switched Ways: Non-fused, hotstick-operated, ganged vacuum fault interrupter switches[**, in series with a visible-break disconnect**]. With internally mounted current transformers and electronic overcurrent sensing for [**single-phase or**]three-phase ganged tripping of the interrupter.

Comply with IEEE C37.60.

1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Fault Interrupter:

    a. Operated by a motor-charged stored energy mechanism, with provision to manually charge the mechanism. Charging motors must operate at 24 V(ac).
    b. Auxiliary Switches: Provide two auxiliary switches, each with field-selectable NC or NO switch position, for connection of remote indication of the position of the switched way. The switches must be rated at 15 A, 120 V(ac), and 1 A, 120 V(dc).
    c. Trip-free switch mechanism when manually operated. Closing the switch must be independent of the speed of the operating handle.
    d. Single operating handle and a clearly labeled switch position indicator; open, closed, tripped.
    e. Operations Counters: Mechanical type, linked to the operating handle of each switched way.
    f. Padlocking and tagging provisions.

3. Visible-Break Disconnect Switch: [**Three positions, with open, closed, and ground positions**][**Two positions, with open and closed positions**]. The switch must be mechanically interlocked so that the switch cannot be operated unless the vacuum fault interrupter is open.

    a. Switch position indicator, clearly labeled.
    b. Padlocking and tagging provisions.

C. Controls:

1. Motor Actuators: "Open," "close," and "stop" push buttons.
2. Switch Status LEDs: "Open" and "closed" lights. Show status of disconnect switch using its auxiliary contact.
3. Motor Actuator Process LEDs: "Opening" and "closing" lights indicating that the selected motor is operating the switch.
4. Power Switch: "On" and "off" toggle switch and circuit protector, to disconnect the dc supply to its motor and provide overload and short-circuit protection.
5. 120 V(ac) LED to display battery system power level.
6. Battery voltage meter to show battery condition.
7. Local and Remote Selector: In the "local" position remote operation of the switches is disabled and is possible only under the control of switchgear-mounted push buttons.

D. Overcurrent[**and Control**] Relays: Field-adjustable microprocessor electronic relays in each phase at indicated locations. Provide for current adjustment from 0 to 600 A.

1. Device Functions: [**51/50, 51N/50N, or 51G/50G in accordance with IEEE C37.2**]<**Insert values**>.

2.7 POWER SUPPLY

A. The power supply for instrumentation, communications, and switch operations must be for connection to two 120 V(ac) power sources, controlled by an automatic transfer switch to connect to the alternate supply when the primary supply has failed.

B. The power supply for instrumentation, communications, and switch operations must be from a potential transformer installed as part of the switchgear.

C. Control Power Supply: Dedicated [**48 V(dc)**][**120 V(dc)**][**240 V(dc)**] battery system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**C&D Technologies, Inc.**]
   b. [**EnerSys**]
   c. [**Trojan Battery Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**C&D Technologies, Inc.**]
   b. [**EnerSys**]
   c. [**Trojan Battery Company**]
   d. <**Insert manufacturer's name**>

3. System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at **77 deg F (25 deg C)** with electrolyte at normal level and minimum ambient temperature of **55 deg F (13 deg C)**. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.
4. Battery:

   a. [**Standard VRLA**][**Premium VRLA**]<**Insert type**> batteries, with system disconnect and overcurrent protective device.
   b. Rack: [**Two**]<**Insert number**>-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]
   c. Accessories:

      1) Set of cell numerals.
      2) Monitoring system.

   d. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

      1) DC ammeter.
      2) DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
      3) Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.
      4) Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
      5) Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.

6) AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.
7) Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.
8) Charger's Audible Noise: Less than 26 dB.

5. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
6. Control Wiring: Factory installed, complete with bundling, lacing, and protection.

   a. Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for No. 8 AWG and smaller.
   b. Conductors: Sized in accordance with NFPA 70 for duty required.

7. An automatic transfer switch to connect the alternate power supply when the primary power supply has failed.

2.8 AUTOMATIC SOURCE TRANSFER CONTROLS

A. An automatic switch control system must execute manual, automatic source-transfer, and SCADA operation of the source and fault interrupting switch ways. The source-transfer controls must open an incoming switch way where voltage is lost and close the other incoming switch way if voltage is present. The controls must include an overcurrent lockout that prevents the closing of a switch way into a system fault.

B. The automatic switch control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station using DNP3 communications protocol. Execution of remote commands must include enabling of the source-transfer controls and transfer of switch ways to "close," "open," and "ground" positions. Transmission of switchgear information must include switch way positions and DC supply system status. Additional switchgear information that must be transmitted follows:

   1. Voltage.
   2. Current in load ways.
   3. <**Insert text**>.

C. The control must have communication port provisions for connection to a multi-mode serial fiber link.

2.9 CONTROL NETWORK

A. Compliance with ASHRAE 135: Controllers must support serial MS/TP and Ethernet IP communications and must be able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

B. Support DNP3 protocol remote control commands received from the SCADA master stations that control switch operations. Comply with the requirements of IEEE 1815.

2.10 BUSHINGS

A. Separable insulated connectors must be used to connect primary cable. Comply with requirements in Section 260513 "Medium-Voltage Cables."

1. Bushings: One-piece, 600 A, BIL ratings the same as the connectors. Comply with IEEE 386.
2. Supply a standoff bracket or parking stand for each bushing, mounted horizontally adjacent to each bushing.

2.11 SURGE ARRESTERS

A. Distribution class; metal-oxide-varistor type, fully shielded, separable elbow type, suitable for plugging into the inserts. Comply with IEEE C62.11 and IEEE 386.

1. Nominal System Line-to-Line Voltage: <**Insert number**> kV RMS.
2. Maximum Continuous Operating Voltage: <**Insert number**> kV RMS.
3. Duty-Cycle Voltage: <**Insert number**> kV RMS.

2.12 WARNING LABELS AND SIGNS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labels and signs.

1. High-Voltage Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s). Legend must be "DANGER HIGH VOLTAGE" printed in two lines of minimum **2 inch (50 mm)** high letters. The word "DANGER" must be in white letters on a red background and the words "HIGH VOLTAGE" must be in black letters on a white background.
2. Arc-Flash Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s), warning of potential electrical arc-flash hazards and appropriate personal protective equipment required.

2.13 SOURCE QUALITY CONTROL

A. Factory Tests: Comply with requirements in IEEE C37.60 and IEEE C37.74 for testing procedures.

1. Circuit Resistance Test: Verify that switchgear contacts have been properly aligned and current transfer points have been properly assembled.
2. Power-frequency dry withstand voltage test.
3. Dielectric withstand test; one-minute dry power-frequency.
4. Calibrate overcurrent devices for conformance to published time-current characteristic curves.
5. Sealed Tank Leak Test:

a. Comply with IEC 62271-1 for test procedure for switchgear using SF6.
b. The test procedure for vacuum switchgear must be as follows:

1) Each vacuum tube must be identified by its serial number. Its vacuum pressure level must be tested by the manufacturer of the vacuum interrupter. Document the test results.
2) After assembly of the switchgear way, test the vacuum pressure level of the vacuum tubes by the routine dielectric test across the open contacts. The test voltage must be stated by the manufacturer. The dielectric test must be carried out after the mechanical routine test.

6. Operating tests must verify the following:

    a. Switch position indicators and contacts are in the correct position for both the open and closed positions.
    b. Insulating medium quantity indicator (if provided) is functioning properly.
    c. Circuit configuration is shown correctly.
    d. Mechanical interlocks are in place and operative.
    e. Position and polarity of current transformers meets requirements.
    f. Control, secondary wiring, and accessory devices are connected correctly.
    g. Devices and relays actually operate as intended. Circuits for which operation is not feasible must be checked for continuity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and Shop Drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear, in accordance with manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
3. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
4. Do not damage structure when handling switchgear.

C. Storage:

1. Switchgear may be stored outdoors. If possible, store switchgear at final installation locations on concrete pads. If dry concrete surfaces are not available, use pallets of adequate strength to protect switchgear from direct contact with the ground. Ensure switchgear is level.
2. Protect switchgear from physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
3. Store switchgear with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be [**5 ohms**]<**Insert value**> at switchgear location.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SWITCHGEAR INSTALLATION

A. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install level and plumb, tilting less than 1.5 degrees when energized.

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and NFPA 70.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
2. Fence and equipment connections must not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding **10 ft. (3 m)**. Bond each gate section to the fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure.
5. Complete the switchgear grounding and surge protector connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and

Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within the switchgear enclosure. Arrange conductors such that there is not excessive strain on the connections that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of switchgear in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" chapter.
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing switchgear but before primary is energized, verify that grounding system at the switchgear is tested at the specified value or less.
4. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

C. Medium-Voltage Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that current and voltage transformer ratios correspond to Drawings.
b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
c. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

d. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of

connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit breaker ratings match Drawings.

2. Electrical Tests:

a. Inspect bolted electrical connections using a low-resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring must not be less than 2 megohms.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests in accordance with "System Function Tests" Article.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Medium-Voltage Vacuum Interrupter Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required clearances.
    c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.
    d. Verify the unit is clean.
    e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
    f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism must be in accordance with manufacturer's published data.
    g. Verify cell fit and element alignment.
    h. Verify racking mechanism operation.
    i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    k. Perform time-travel analysis. Travel and velocity values must be in accordance with manufacturer's published data.
    l. Record as-found and as-left operation counter reading. Operation counter must advance one digit per close-open cycle.

2. Electrical Tests:

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
    b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range in accordance with manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
    d. Verify correct operation of auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer's published data.
    e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
    f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.
    g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time

of voltage application during the vacuum bottle integrity test, the specimen is considered to have passed the test.

h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the specimen is considered to have passed the test.

E. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme.
d. Control Verification:

1) Functional Tests:

a) Check operation of active digital inputs.
b) Check output contacts or silicone-controlled rectifiers, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

F. Ground Resistance Test:

1. Visual and Mechanical Inspection:

a. Verify ground system complies with the Contract Documents and NFPA 70 "Grounding and Bonding" Article.
b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.
c. Inspect bolted electrical connections using a calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of

manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect anchorage.

2. Electrical Tests:

a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than [**5 ohms**][**maximum ground resistance value specified in the "Examination" Article**].

b. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with Contract Documents.

c. Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect physical and mechanical condition.

e. Inspect anchorage.

G. Nonconforming Work:

1. Switchgear will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

H. Prepare test and inspection reports.

3.6 SYSTEM FUNCTION TESTS

A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after "Field Quality Control" tests have been completed and components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.7 MAINTENANCE

A. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove necessary covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at **86 deg F (30 deg C)**.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between the area of concern and the reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 13 29 00

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Task	Specification	Specification Description
26 13 29 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 18 36 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 19 18 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 19 80 60	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 21 13 00	26 05 13 00	Medium-Voltage Cables
26 21 13 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables

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SECTION 26 21 16 00 - PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multiple-generator paralleling monitoring and control system.
2. Single-generator paralleling monitoring and control system.
3. Metal-enclosed, circuit-breaker switchgear (600 V and less).

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
4. Section 260913 "Electrical Power Monitoring" for interfacing communication and metering requirements.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For {Insert system or product}. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of paralleling low-voltage switchgear.

a. Include technical data on features, performance, electrical characteristics, ratings, and

finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, [**SCADA interface devices,**][**Ethernet interface,**] and display components.

b. Include rated capacities, operating characteristics, furnished specialties, factory settings, and accessories for individual circuit breakers.

c. Include time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings:

1. For each type of paralleling low-voltage switchgear.

a. Include dimensioned plans, elevations, sections, details, shipping sections, weights of assembled sections, and required clearances and service space around equipment.

b. Include tabulation of installed devices with features and ratings.

c. Include enclosure types and details.

d. Detail locations for anchor bolts[**and leveling channels**].

e. Show bus configuration with current rating, size, and number of conductors in bus run, including phase, neutral, and ground conductors of main and branch buses.

f. Indicate short-time and short-circuit current rating of switchgear assembly.

g. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

h. Detail nameplate legends.

i. Include mimic-bus diagram.

j. Include three-line power wiring diagrams for paralleling low-voltage switchgear, generators, and related equipment showing device terminal numbers.

k. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.

l. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:

1) Engine generators.
2) Transfer switches.
3) Other load-control devices.
4) Elevator controller in elevator bank.
5) DDC system for HVAC controller.
6) SCADA remote terminal unit.

2. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and peak-shaving modes.

a. Include the following in description of automatic-mode sequence of operation:

1) Programmed sequence of initial generator starting and connection of generators to isolated paralleling bus, including description of how proposed design complies with requirements for redundancy.
2) Programmed sequence of transferring loads to isolated paralleling bus based on operator-adjustable preset priorities and preset loads. Include initial load settings.
3) Programmed sequence of starting and stopping generators based on actual real-time measured loads.
4) Programmed sequence of sending load-shed signal to transfer switches[**, and to other devices**] when generator frequency does not return to normal frequency within adjustable time period.
5) Programmed sequence of stopping generators based on no transfer switch or other device sending start signal.

b. Include the following in description of system testing mode sequence of operation:

1) Load.
2) No load.

c. Include in description, peak-shaving-mode sequence of operation.
d. Include in description, manual-mode sequence of operation showing that manual mode fulfills requirement to permit operator at paralleling low-voltage switchgear to accomplish automatic, system test, and peak-shaving functions.
e. Paralleling Low-Voltage Switchgear Redundancy: Identify single points of failure.

C. Samples:

1. Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

D. Delegated Design Submittal: For seismic restraints for switchgear and wind-loading for outdoor enclosures, include analysis data signed and sealed by qualified structural professional engineer responsible for their preparation.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Record Documentation: Include updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner the following spare parts for repairing paralleling switchgear that are packaged with protective covering for storage on-site and identified with labels describing contents:

1. Control Power Fuses: [**Six**]<**Insert number**> of each type and rating used. Include spares for the following:

a. Potential transformers.
b. Control power circuits.

2. Indicating Lights: [**Six**]<**Insert number**> of each type installed.
3. Draw-out Circuit Breakers: One of each type and rating used for circuit breaker in paralleling low-voltage switchgear.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchgear, packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Racking handle to move circuit breaker manually between connected and disconnected positions.
2. Tools for circuit-breaker and switchgear tests, inspections, maintenance, and operation.
3. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchgear.
4. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
5. Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
6. Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of draw-out circuit breaker installed.
7. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
8. Storage for Manual: Rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fluid reservoirs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver paralleling low-voltage switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store paralleling low-voltage switchgear indoors in clean dry space with uniform temperature to prevent condensation.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed paralleling switchgear perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of paralleling switchgear perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS[**TO BE MODIFIED**][**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Multiple-generator paralleling monitoring and control panel in paralleling low-voltage switchgear must monitor and control the following standby power system components:

1. Paralleling low-voltage switchgear.
2. Single-generator monitoring and control system.
3. Single-generator paralleling monitoring and control systems that are [**part of paralleling low-voltage switchgear**][**located at individual engine generator**].
4. Engine generators.
5. Transfer switches.
6. Circuit breakers downstream of transfer switches.
7. Other load-control devices.
8. Distribution circuit breakers in paralleling low-voltage switchgear.

C. Redundant Standby Power System:

1. Single generator with associated single-generator paralleling monitoring and control system.
2. Black-start controller with no single point of failure.
3. Black-start controller with backup control in multiple-generator paralleling monitoring and control system.
4. Multiple-generator paralleling monitoring and control system must automatically be performed by backup system without degradation in the event that primary system fails to function (such as component failure or off-line maintenance).
5. Multiple-generator paralleling monitoring and control system must automatically be performed by backup system without degradation in the event that primary system fails to function (such as component failure or off-line maintenance), except for the following manually operated functions:

   a. Load management.
   b. Peak shaving.
   c. <**Insert exceptions**>.

D. Sequence of Operation for Normal Conditions:

1. Paralleling low-voltage switchgear, including controlled generators[**, controlled circuit breakers,**][**, other controlled devices,**] and transfer switches, must be in automatic position and

ready to operate on loss of power or other designated initiation conditions.

2. Single-generator monitoring and control system has not received "start" signal from the following:

   a. Transfer switch.
   b. Multiple-generator paralleling monitoring and control system.
   c. <**Insert device**>.

E. Sequence of Operation for Loss of Normal Power Conditions:

1. Single-generator monitoring and control system must receive start signal from redundant system.

   a. Start signal may come from transfer switch[**or other device**] directly wired to start engine generator.
   b. Start signal may come from multiple-generator paralleling monitoring and control system that monitors loss of normal source availability from one or more transfer switches[**or other device**].

2. On receiving start signal, single-generator monitoring and control system must start engine generators and achieve rated voltage and frequency.
3. If engine generator fails to start, after expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
4. Transfer Inhibit Control: Multiple-generator paralleling monitoring and control system receives loss of normal source availability signal from transfer switch(es)[**or other device**] and sends transfer inhibit signals.

   a. Transfer switch(es) serving emergency loads may not be sent transfer-inhibit signal.
   b. Transfer switch(es) serving other than emergency loads that must transfer within required time must have transfer-inhibit signal end at such time as will permit transfer switch to operate within required time.
   c. Transfer switch(es) serving other than emergency loads that are not required to transfer within required time must be sent transfer-inhibit signal.
   d. Transfer switch(es) serving loads that are to be disconnected after detecting loss of normal source availability must signal associated circuit breakers and other load devices to de-energize these predetermined loads.
   e. Transfer switch(es) serving HVAC loads that need to operate at lower load by modifying HVAC sequence of operation after detecting loss of normal source availability must signal DDC system for HVAC to change to HVAC load-shed sequence of operation for associated equipment.
   f. Transfer switch(es) serving elevator loads after detecting loss of normal source availability must signal associated elevator controllers that elevators are connected to generator power and must initiate sequence of operation in elevator control system to protect elevators and to reduce elevator load demand.
   g. Distribution circuit breakers in paralleling low-voltage switchgear, which are indicated in priority-load schedule to transfer load by opening and closing circuit breaker, receive inhibit closing signal.

5. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.

   a. Comply with requirements in applicable engine generator Section for selection of first engine generator to connect to isolated paralleling bus.
   b. Redundant System: Multiple-generator paralleling monitoring and control system selects first engine generator to connect to isolated paralleling bus.

6. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
7. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.

F. Priority Controller Sequence of Operation:

1. Programming from Human-Machine Interface for Priority Controller:

   a. Set priority blocks of load that indicate priority number and scheduled size of load from Priority-Load Schedule. Set generator blocks of capacity that indicate individual engine generators and their capacity.
   b. Signal to transfer loads to engine generator source may be accomplished by one of the following:

      1) Signaling to transfer-inhibit enable transfer switch associated with priority load to transfer load.
      2) Signaling load-add relay at transfer switch to transfer priority load.
      3) Closing distribution-feeder circuit breaker associated with priority load.
      4) Enabling another device.

2. When generator has transferred Priority 1 emergency load, send signal to transfer loads that must be transferred within specific time in accordance with Priority-Load Schedule.
3. When generator capacity is adequate to support next priority load, send signal to transfer next priority load to generator source until priority loads have been transferred.

G. Overload Sequence of Operation:

1. Signal to shed loads from generator source may be accomplished by one of the following:

   a. Signaling load-shed relay in transfer switch associated with priority load.
   b. Opening distribution-feeder circuit breaker associated with priority load.
   c. Disabling another device.

2. Overload sequence of operation sends signal to shed lowest connected load priority when isolated paralleling bus frequency does not return to normal frequency within its adjustable time period.
3. If isolated paralleling bus does not return to normal frequency after shedding lowest connected priority load within adjustable time period, additional load continues to be shed by signaling to load shed in reverse priority until isolated paralleling bus returns to normal frequency.
4. Loads shed can be reconnected to isolated paralleling bus only by manual reset at human-machine interface.

H. Load-Demand Sequence of Operation:

1. With load-demand sequence of operation activated, controller continuously monitors total isolated paralleling bus load.
2. If isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
3. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.

I. Individual Transfer Switch Return to Normal Condition Sequence of Operation: Enable individual transfer switches to return to normal power when normal power is available at transfer switch.

J. Feeder Circuit Breakers in Paralleling Low-Voltage Switchgear Return to Normal Condition Sequence of Operation: When normal power is available at transfer switches served by feeder circuit breaker, open circuit breaker.

K. Individual Circuit Breaker or Other Load Device for Loads Controlled Downstream from Transfer Switch Sequence of Operation: Return circuit breaker or other load device to closed position when transfer switch serving circuit breaker has returned to normal power.

L. Return to Normal Condition Sequence of Operation:

1. Process starts on removal of start signals from system.
2. When no load remains on isolated paralleling bus, generator breakers open, go through cool-down period, and shut down.
3. If start signal is received during cool-down period, one engine generator is reconnected to isolated paralleling bus, and system operation follows that of "loss of normal power."

M. System Test Sequence of Operation:

1. Configure tests to comply with NFPA 110, Level 1 testing requirements for generator. Automatically generate NFPA 110, Level 1 reports.
2. Single-generator test.
3. Multiple-generator test.
4. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from [**DDC system for HVAC**][**SCADA system**].
5. Engine generator(s) start and achieve rated voltage and frequency.
6. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
7. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
8. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
9. Manually select or automatically preselect whether test is load or no-load test. If test is load test, manually select or automatically preselect loads to be transferred in accordance with schedule or by adjustable time delays at transfer switches. After generators are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices.[**If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.**]
10. After adjustable period of time system, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
11. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
12. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.

13. If there is outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal engine generator that is not currently operating to start, and cancel system test.

N. Peak-Shaving Sequence of Operation:

1. Start engine generators manually through human-machine interface or by remote contact initiated from peak-shaving command from [**DDC system for HVAC**][**SCADA system**].
2. Engine generator(s) start and achieve rated voltage and frequency.
3. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
4. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.
5. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
6. Failure of Engine Generator to Synchronize: If generator set fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
7. Through human-machine interface manually select or on closure of contact from peak-shaving command preselected loads to be automatically transferred to isolated paralleling bus. After engine generators are connected to isolated paralleling bus, transfer loads by sending signal to corresponding load-add relays that are connected to remote transfer to generator source control input at transfer switch or similar control devices. Add loads until contact closure from [**DDC system for HVAC**][**SCADA system**] opens.
8. After adjustable period of time, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
9. If isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
10. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
11. After peak shaving is completed, transfer loads back to normal power. Shut down system using sequence in automatic mode.
12. If there is outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send, send load-shed signals to lower-priority loads until load is below engine generator capacity, signal generators that are not currently operating to start, and cancel system peak-shaving operation.
13. Manual Sequence of Operation: Include functions indicated for automatic mode, except that operator must be able to monitor parameters and manually perform operations.

O. Comply with NFPA 110 for the following:

1. Legally Required Standby Systems: EPSS Level 1, Type 10.
2. Optional Standby Systems: EPSS [**Level 1**][**Level 2**], [**Type 10**][**Type 60**][**Type 120**][**Manual**].

P. Comply with NFPA 99 for healthcare applications.

2.4 MULTIPLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Components and Devices: Factory mounted in [**metal-enclosed, paralleling low-voltage switchgear**][**separate switchboard**].

1. Paralleling Low-Voltage Switchgear Door-Mounted Control Devices: Industrial, oil-type devices.
2. Indicator Lamps: High-intensity digital display.

E. Control Power for Multiple-Generator Monitoring and Control System: Supplied from 24 V(dc) starting batteries of engine generators.

1. Isolate battery bank to prevent failure of one battery from disabling entire system.
2. Include, if necessary, separate control power battery system rated 24 V(dc) for equipment unable to accept voltage drop that occurs during engine cranking.

F. Redundant Multiple-Generator Monitoring and Control System Controller:

1. Fully equip with hot swappable programmable logic controller, power supplies, and I/O points.
2. Black-start control equipment specified in applicable engine generator Section.

G. Multiple-generator monitoring and control system auto/manual selector switch.

H. Control switch for circuit breaker that serves load bank.

I. Full-Color, Touch-Screen, Human-Machine Interface Device:

1. Minimum viewing area of [**60 sq. inch (387 sq. cm)**][**100 sq. inch (645 sq. cm)**] must be configurable in either U.S. Standard or SI (metric) units.
2. Main Menu: Include date, time, and system status messages. Configure screens so that no

screen is more than three touches from other screen.

a. Individual engine generator data must be accessed at paralleling low-voltage switchgear from [**main menu**][**main menu and single-generator paralleling monitoring and control system**].

3. One-Line Diagram: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators.

   a. Conditions for Engine Generators, Buses, and Paralleling Circuit Breakers: Energized or de-energized.
   b. Engine Generator Modes:

      1) Auto.
      2) Lockout.
      3) Reset.
      4) Off.
      5) Cool down.
      6) Test off line.
      7) Test on load.

   c. Engine Generator Status: Normal, warning, shutdown, or load-demand stop.
   d. Paralleling Circuit-Breaker Status: Open, closed, or tripped.
   e. Bus Conditions: Energized or de-energized.
   f. Percent load.

4. AC metering screen for isolated paralleling bus must display the following:

   a. Phase, volts, and amperes.
   b. Kilowatts.
   c. Kilovolt amperes.
   d. Kilovolt-ampere rating.
   e. Power factor.
   f. Frequency.
   g. Kilowatt hour.
   h. Kilowatt demand.
   i. Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
   j. A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and minimum duration of four hours.
   k. Percent of available capacity of engine generators that are operating in parallel on bus.

5. Engine Generator Monitoring and Control Screen:

   a. Control:

      1) Engine generator manual start/stop control (functional only when paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) Engine generator alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit controls.
      4) Engine function and timer settings.
      5) System function, testing, and timer settings.
      6) Engine generator optimization settings: automatically determine priority of engine generators based on engine run time and number of engine starts or manually assign engine priorities.

b. Status and Alarms:

1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
2) Engine run hours.
3) Engine status.
4) Number of generator circuit-breaker operations.
5) Replicate status and alarms from single-generator paralleling monitoring and control panel.

6. Dual, Three-Phase, Metering Screen: Graphical analog (270 electrical degree) metering representation with digital display. Display two generators at same time or one generator and isolated paralleling bus at same time. Display graphical synchroscope when one generator and isolated paralleling bus are selected.

a. True RMS, three-phase voltage, amperes, kilowatts, kilovolt amperes, kilovolt-ampere reactive, power factor, and frequency parameters.
b. Engine battery voltage display.

7. Password-Protected System Control Screen:

a. System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
b. Test with Load: Starts and synchronizes engine generators on isolated paralleling bus; loads are transferred to isolated paralleling bus.
c. Test without Load: Starts and synchronizes engine generators on isolated paralleling bus but does not transfer loads to isolated paralleling bus.
d. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

8. Password-Protected, Peak-Shaving Control Screen:

a. Peak-Shaving Modes: Manual start and transfer of loads; automatic start and transfer of loads by DDC system for HVAC peak-shaving relay closure.
b. For automatic mode, set load priorities for peak-shaving function.
c. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

9. Load-Demand Control Screen: Monitors total load on isolated paralleling bus and controls number of engine generators running so that capacity tracks load demand.

a. Load-Demand Control: Enable/disable.
b. Set engine generator shutdown sequence.
c. Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
d. Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.

10. Manual Load Control Screen: Allows operator to manually add or delete engine generators from paralleled system in response to system load parameters.

a. Indication of system available in kilowatts and amperes.
b. Control functions allow manual addition/removal of engine generators on system, and activation of load-shed/load-restore functions.

11. Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:

a. Display sequence.
b. Assigns "load-add sequence priority" to load-control relay with designation for relay operation after set number of engine generators are online.
c. Assigns "load-shed sequence priority" to load-control relay with designation for relay operation depending on number of engine generators online.

12. Alarm Summary and Run Report Screen:

a. Lists most recent alarm conditions and status changes.
b. Lists minimum of most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
c. For start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual engine generators.
d. Lists generator circuit position and status.
e. Access to trend monitored automatic transfer switches.
f. [**16-gigabyte**]<**Insert value**> hard-disk space for storing database file for multiple-generator paralleling monitoring and control panel trending and event logging. Trend and log data at resolution of one second. If hard drive is full, overwrite in first-in-first-out procedure.

1) Trend up to eight monitored points simultaneously.

13. Load Status and Control Screen: Displays status of automatic transfer switches connected to system for [**32**][**64**] transfer switches, and other controlled devices.

a. Automatic transfer switch connected to normal.
b. Automatic transfer switch connected to emergency.
c. Controlled circuit breakers downstream from automatic transfer switch device enabled or disabled.
d. Engine start indication.
e. Load-shed indication.
f. Load-add indication.
g. Inhibit to emergency source.
h. Inhibit to normal source.
i. Transfer Switch Power Metering Function: Total kilowatt, three-phase current, and three-phase voltage.
j. Automatic Transfer Switch Load Priority: Ability to change priorities of automatic transfer switches (password protected).
k. Display name, status, and priority of load block (whether on or off) and total load of that block.
l. Allow for manually adding or shedding loads.

14. Automated email messages must be transmitted when shutdowns occur and must include time and date of alarm.
15. Based on either number operations or time since last maintenance, suggest maintenance period for generator (run hours), controlled circuit breaker (number of operations), and transfer switches (number of transfers).
16. Status and Alarm Screen:

a. Visual alarm status indicator and alarm horn with silence and acknowledge push-button.
b. Status, Light Only:

1) "SYSTEM NOT IN AUTO" (red).
2) Running Status: Display engine generator number and running-status light (green).
3) Load-demand mode (green).

4) Priority Load Status: Display load number with "LOAD ADD" (green) and "LOAD SHED" (red).
5) System test (green).
6) Remote system start (red).
7) Monitoring of Transfer Switch:

a) Normal source available (green).
b) Connected to normal (green).
c) Generator source available (green).
d) Connected to generator source (green).

c. Status Light and Alarm:

1) Isolated paralleling bus under frequency (red).
2) Isolated paralleling bus over frequency (red).
3) Auxiliary power failure (red).
4) Emergency start signal power failure (red).
5) Load-Shed Level Status: Displays load number and red load-shed, status light.
6) Generator Alarm Status: Displays generator number and red "Check Generator" status light.
7) Controller malfunction (red).
8) Check station battery (red).
9) Isolated paralleling bus overload (red).
10) System not in auto (red).
11) Main tank, low fuel (amber)
12) Main tank, high fuel (amber).
13) Main tank, fuel leak (red).

J. Remote Monitoring: Replicate human-machine interface monitoring functions [**at SCADA**][**at remote computer terminal**][**via communication bus**].

K. Remote Monitoring of Status and Alarms: Replicate human-machine interface status and alarms at DDC system for HVAC via isolated contacts.

2.5 SINGLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]

5. [**Russelectric, Inc**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Components and Devices: Factory mount in single-generator section of metal-enclosed, paralleling low-voltage switchgear.

1. Paralleling low-voltage switchgear door-mounted control devices must be industrial oil-type devices. Indicator lamps must be high-intensity digital display.

E. Control Power: Supply control power from 24 V(dc) starting batteries from controlled generator. Include separate control power battery system rated 24 V(dc) for equipment unable to accept voltage drop that occurs during engine cranking.

F. Programmable Logic Controller: Factory-mounted controller, separate from multiple-generator paralleling monitoring and control system in single-generator paralleling monitoring and control module of metal-enclosed, paralleling low-voltage switchgear.

G. Single-Generator Paralleling Low-Voltage Switchgear Circuit Breaker:

1. Factory mount circuit-breaker control switch.
2. Paralleling Circuit-Breaker Monitor and Control:

a. Monitors circuit-breaker auxiliary contacts.
b. Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
c. Trips open and locks out paralleling circuit breaker on paralleling circuit breaker failure to close, until manually reset.

H. Generator Mode Selector Switch: Factory mounted in single-generator paralleling monitoring and control system module of metal-enclosed, paralleling low-voltage switchgear.

1. "Lockout/Reset" mode prevents generator from starting or immediately shuts down generator if running.
2. "Off/Cool-Down" mode stops engine after cool-down period.
3. "Auto" mode allows generator to start on receipt of remote start signal. If generator is already running and there is not start signal, then "Auto" mode allows engine to run for predetermined cool-down period before stopping.
4. "Test Off-Line" allows engine to start and run as if start signal were received, except it does not allow generator to connect to isolated paralleling bus unless start signal is received.
5. "Test Online" allows engine to start, run, and connect to isolated paralleling bus as if start signal were received.

I. Engine Generator Controller: Woodward compatible.

1. Factory mount governor (speed control and load sharing) supplied in applicable engine generator Section in single-generator monitoring and control module.
2. Loading control interface to governor system.
3. Automatic synchronizer.

J. Automatic Synchronizer:

1. Include sync mode selector switch with RUN-OFF-CHECK-PERMISSIVE positions. In RUN mode, enable active synchronization and sync-check function. In CHECK mode, perform sync-

check function. In PERMISSIVE mode, annunciate when generator and bus are synchronized but do not allow breaker closure.

a. Include discrete inputs in synchronizer to switch to each mode.

2. Bias generator speed and voltage to match paralleling isolated bus.
3. If automatic synchronizer receives permissive signal to allow closure to paralleling isolated bus and generator is within synchronizing limits, send close signal to single-generator paralleling circuit breaker.

K. Sync-switch, removable, keyed T-handle.

L. "Engine Generator Synchronized" Indication: Indicator lamp or digital-display indication of synchronization.

M. Voltage and Frequency Raise and Lower Switches: Allow plus or minus 5 percent adjustment when engine generator is operating but is not connected to isolated paralleling bus.

N. Control and Reset Push-Button: Have flashing lamp to indicate generator is locked out due to fault condition.

O. Lamp Test Push-Button: Simultaneously tests lamps on panel.

P. Control Panel Illumination: DC lamps illuminate panel when lighting from surrounding environment is unavailable.

Q. Emergency Stop Push-Button: Red mushroom-head switch maintains its position until manually reset.

R. Alarm and Status Indicating Display:

1. Status and Alarm Indications:

a. Status, Light Only (Nonlatching):

1) Generator mode selector switch not in auto (red).
2) Generator mode selector switch in auto (green).
3) Start signal received (green).
4) Emergency stop activated (red).
5) Demand mode standby (green).
6) Timing for start (green).
7) Timing for shutdown (green).
8) Generator circuit breaker closed (red).
9) Generator circuit breaker open (green).

a) Generator circuit breaker locked out (white).
b) Generator circuit breaker racked out (white)

10) Remote generator breaker is open (red).
11) Engine stopped (green).
12) Time-delay start (green).
13) Engine running (red).
14) Engine cool-down (green).

b. Pre-Alarm, Light and Horn (Nonlatching):

1) Pre-high coolant temperature (amber).
2) Pre-low oil pressure (amber).
3) Low coolant temperature (amber).
4) Engine low battery (amber).
5) Battery charger failure (amber).
6) Auxiliary power failure (amber).
7) Low fuel-day tank (amber).
8) Paralleling low-voltage switchgear generator breaker failed to close (amber).
9) Paralleling low-voltage switchgear generator breaker failed to open (amber).
10) Overcurrent alarm (amber).
11) Day tank low-fuel alarm (amber).
12) Ground-fault alarm (amber).

c. Shutdown Alarm, Light and Horn (Latching):

1) Engine overcrank (red).
2) Engine overspeed (red).
3) Engine low oil pressure (red).
4) Engine high coolant temperature (red).
5) Engine low coolant level (red).
6) Engine remote emergency shutdown (red).
7) Generator fail to synchronize shutdown (red).
8) Generator circuit breaker tripped (red).
9) Generator circuit breaker failure (red).
10) Generator not in auto (red).
11) Generator loss of field (red).
12) Generator reverse power (red).
13) Generator undervoltage (red).
14) Generator overvoltage (red).
15) Generator underfrequency (red).
16) Generator overfrequency (red).
17) Phase rotation (red).
18) Generator short circuit (red)
19) Day tank low-fuel shutdown (red).
20) Air damper activated, shutdown (red).

S. Paralleling Controls and Protection:

1. Engine Generator Governor (Speed Control and Load Sharing): Comply with requirements in applicable engine generator Section. Components must be Woodward compatible.
2. Kilowatt Load Sharing Control and Interface:

a. Operates engine generator governors during synchronizing and provides isochronous load sharing when paralleled.
b. Allows engine generator to ramp up to kilowatt load level[**signaled by multiple-generator monitoring and control controller**].

3. Load-Demand Governing Control:

a. Causes engine generator to ramp down at operator-adjustable rate to zero load when signaled to shut down in load-demand mode.
b. Causes engine generator to ramp up at operator-adjustable rate to proportional share of total isolated paralleling bus load when signaled to restart.

4. Kilovolt-Ampere-Reactive Load Sharing Control:

a. Operates alternator excitation system while engine generator is paralleled.
b. Causes sharing of reactive load among engine generators to within 1 percent of equal levels without voltage drop.

5. Paralleling Monitor and Control:

a. Monitors and verifies that engine generator has reached 90 percent of nominal voltage and frequency before closing to isolated paralleling bus.
b. Prevents accidental closure of breaker with engine generator out of phase with bus.
c. Prevents out-of-phase closure to isolated paralleling bus due to errant manual or automatic operation of synchronizer.
d. System of diagnostic digital displays to assist in analyzing synchronization.

6. Synchronizer Control:

a. Adjusts engine governor to match voltage, frequency, and phase angle of isolated paralleling bus.
b. Maintains engine generator voltage within 1 percent of isolated paralleling bus voltage, and phase angle within 20 electrical degrees of isolated paralleling bus for 0.5 seconds before circuit-breaker closing.
c. Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down engine generator on failure condition.

7. Reverse Power Monitor and Control:

a. Prevents sustained reverse power flow in engine generator.
b. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse power condition exceeds 10 percent of engine generator kilowatt for three seconds.
c. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse kilovolt-ampere conditions exceeds 20 percent of generator kilovolt-ampere rating.

8. Phase Rotation Monitor and Control: Verifies engine generator and isolated paralleling bus phase rotation match prior to closing paralleling circuit breaker.
9. Electronic Alternator Overcurrent Alarm and Shutdown Control:

a. Monitors current flow at engine generator output terminals.
b. Initiates alarm when load current on engine generator is more than 110 percent of rated current for more than 60 seconds.
c. Overcurrent shutdown function matched to thermal damage curve of alternator.

10. Electronic Alternator Short-Circuit Protection: Shuts down generator, without instantaneous-trip function, when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator.
11. Loss of Excitation Monitor: Displays alarm on single-generator paralleling monitoring and control panel when generator controls sense loss of excitation to alternator while paralleled to isolated paralleling bus.
12. Cool-Down, Time-Delay Control: Adjustable, zero to 600 seconds.
13. Start Time-Delay Control: Adjustable, zero to 300 seconds.
14. Frequency Control: Initiate alarm condition when engine generator is below 90 percent of rated frequency for more than 20 seconds or is over frequency.
15. Under- and Overvoltage Control: Initiate alarm condition when engine generator is at 90 percent voltage for more than 20 seconds or is over voltage.

2.6 METAL-ENCLOSED, CIRCUIT-BREAKER SWITCHGEAR (600 V AND LESS)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and UL 1558.

E. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded neutral system.

F. Nominal System Voltage: [**480 V, three**][**480/277 V, four**][**240 V, three**][**208/120 V, four**] wire, 60 Hz.

G. Isolated Paralleling Bus: [**5000 A**][**4000 A**][**3200 A**][**2000 A**][**1600 A**]<**Insert amperes**>.

1. Phase-, Neutral-, and Ground-Bus Materials:

a. Phase[**and Neutral**] Bus: [**Copper, silver plated at connection points**][**Copper, tin plated**][**Aluminum, tin plated**].
b. Ground Bus: Copper[**, silver**][**, tin**] plated; minimum size **1/4 by 2 inch (6 by 50 mm)**.

2. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

a. Uniform capacity for horizontal and vertical bus.
b. Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. [**Equip bus with pressure-connector terminations for outgoing neutral conductors**][**Include braces for neutral-bus extensions for busway feeders**].
c. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.

H. Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

I. Switchgear Fabrication:

1. Bus isolation barriers must be arranged to isolate line bus from load bus at main and tie circuit breaker.
2. Circuit-breaker compartments must be equipped to house drawout-type circuit breakers and must be fitted with hinged outer doors.
3. Auxiliary Compartments: Match and align with basic switchgear assembly.

a. Bus transition sections.
b. Pull sections.
c. Hinged front panels for access to accessory and blank compartments.
d. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers; and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

1) Set pull box back from front to clear circuit-breaker lifting mechanism.
2) Bottom: Insulating, fire-resistive material with separate holes for cable drops into switchgear.
3) Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

e. Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.
f. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
g. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

1) Sprayed Insulation Thickness: **3 mil (0.08 mm)**, minimum.
2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

4. Circuit-Breaker Terminals for Cable Connections: Silver-plated copper bus extensions equipped with pressure connectors for conductors.

J. Circuit Breakers: Comply with IEEE C37.13, IEEE C37.16, and IEEE C37.17.

1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

a. Normal Closing Speed: Independent of both control and operator.
b. Slow Closing Speed: Optional with operator for inspection and adjustment.

3. Stored-Energy Mechanism: Electrically charged, with optional manual charging[**and operation counter**].
4. Trip Devices:

a. Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, and release mechanism.
b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
c. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
d. Time-Current Characteristics: Field adjustable.
e. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or combination of these methods.
f. Long-Time- and Short-Time-Delay Functions: Three bands, minimum; marked "minimum," "intermediate," and "maximum."
g. Pickup Points:

1) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip

function for switchable I-squared-t operation.
2) Five minimum, for instantaneous-trip functions.

h. Ground-fault protection[**alarm**] with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:

1) Three-wire circuit or system.
2) Four-wire circuit or system.
3) Four-wire, double-ended substation.

i. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated, consisting of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to terminal block in stationary housing.
6. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions.

a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed.
b. Circuit-Breaker Positioning:

1) An open circuit breaker may be racked to or from connected, test, and disconnected positions only with associated compartment door closed, unless live parts are covered by full dead-front shield.
2) An open circuit breaker may be manually withdrawn to position for removal from structure with door open.
3) Status for connection devices for different positions includes the following:

a) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
b) Disconnected Position: Primary and secondary devices and ground contact disengaged.

7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position; arranged to permit inspection of contacts without removing circuit breaker from switchgear.
8. Padlocking Provisions: For installing at least three padlocks on circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
9. Operating Handle: One for each circuit breaker capable of manual operation.

a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with isolated paralleling bus.

10. Electric Close Button: One for each electrically operated circuit breaker.

a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with isolated paralleling bus.

11. Mechanical Interlocking of Circuit Breakers: Uses mechanical tripping lever or equivalent design and electrical interlocks.
12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are

included where future installation of key-interlock devices is indicated.

13. Undervoltage Trip Devices:

    a. Instantaneous, with adjustable pickup voltage.
    b. Adjustable time-delay and pickup voltage.

14. Shunt-Trip Devices:

    a. 24 V(dc) for generator paralleling circuit breakers and for distribution paralleling switchgear circuit breakers.
    b. Where indicated.

15. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

K. Metering:

1. Type and Locations:

    a. Isolated Paralleling Bus: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on door of separate metering compartment.
    b. Generator Circuit Breakers: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on circuit-breaker door.
    c. Distribution Circuit Breakers: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on circuit-breaker door.

2. Instrument Transformers:

    a. Comply with IEEE C57.13.
    b. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    c. Current Transformers:

        1) Burden and accuracy class suitable for connected relays, meters, and instruments.
        2) Size for maximum momentary current amperage based on calculation or momentary rating of circuit breaker protecting conductor.
        3) Include shorting-type terminal blocks.

3. Multifunction Digital-Metering Monitor:

    a. Microprocessor-based unit suitable for three- or four-wire systems.
    b. Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
    c. Switch-selectable digital display with the following features:

        1) Phase Currents, Each Phase: Plus or minus 1 percent.
        2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
        3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
        4) Three-Phase Real Power: Plus or minus 2 percent.
        5) Three-Phase Reactive Power: Plus or minus 2 percent.
        6) Power Factor: Plus or minus 2 percent.
        7) Frequency: Plus or minus 0.5 percent.

8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
9) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

d. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
e. Mounting: Display and control unit that is flush or semirecessed mounted in instrument compartment door.

4. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, accurate within 1 percent of full scale range; semirecessed mounting, with antiparallax 250-degree scale and external adjustment.

a. Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
b. Voltmeter Selector Switch: Rotary type with off position; provides readings of phase-to-phase[**and phase-to-neutral**] voltages.
c. Ammeters: Cover expanded scale range of bus rating plus 10 percent.
d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
e. Watt-Hour Meters: Flush- or semirecessed-mounting type, [**5 A, 120 V, three phase, three wire; with three elements**]<**Insert characteristics**>, [**15-minute**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.
f. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15-minute**]<**Insert value**> interval.

1) Operation: Counts and records succession of pulses entering two channels.
2) Housing: Drawout type, back-connected case arranged for semirecessed mounting.

L. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.

1. Functions: <**Insert functions**>.
2. Characteristics: <**Insert characteristics**>.

M. Door-Mounted Control Components: Industrial-type oiltight devices and digital-display indicator lamps.

N. Control Power Supply:

1. Control power transformer must supply 120 V(ac) control circuits from generator source through secondary disconnect devices.
2. Include control power transformer for generator paralleling switchgear circuit breaker connected to generator side of circuit breaker.
3. Include control power transformer for distribution paralleling switchgear circuit breaker.
4. Dry-type transformers must be in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
5. Two control power transformers in separate compartments with necessary interlocking relays; transformer must be connected to line side of associated main circuit breaker.

a. Secondary windings must be connected through relay(s) to control bus to effect automatic transfer scheme.
b. Secondary windings must be connected through internal automatic transfer switch to paralleling switchgear control power bus.

6. Control Power Fuses: Primary and secondary fuses must provide current-limiting and overload protection.

O. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Conductors must be sized in accordance with NFPA 70 for duty required.

P. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

Q. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems" for electrical identification devices and installation.

1. Identify units, devices, controls, and wiring.
2. Mimic Bus: Continuous mimic bus, applied to front of paralleling low-voltage switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

   a. Mimic-bus segments coordinated with devices in paralleling low-voltage switchgear sections to which applied, to produce concise visual presentation of principal paralleling switchgear components and connections.
   b. Medium: Painted graphics, as selected by Architect.
   c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

R. Indoor Enclosure Material: Steel.

S. Outdoor Enclosure Fabrication Requirements: Galvanized steel, weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating.

1. Features for Compartment or Group of Compartments:

   a. Thermostatically controlled air-conditioning units sized to prevent temperatures exceeding [**80 deg F (27 deg C)**]<**Insert temperature**>.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
   c. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
   d. Hinged front door with locking provisions.
   e. Interior light with switch.
   f. Weatherproof ground-fault circuit-interrupter duplex receptacle.
   g. Power for air conditioning, heaters, lights, and receptacles to be provided from control power transformer.

2. Features for Weatherproof Internal Aisle Construction:

   a. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
   b. Aisle access doors with exterior padlocking provisions and interior panic latches.
   c. Thermostatically controlled aisle space heaters operating at one-half or less of rated voltage.
   d. Thermostatically controlled, aisle air-conditioning units sized to prevent temperatures exceeding **104 deg F (40 deg C)**.
   e. Vaporproof, fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at entrance.
   f. At least two duplex, ground-fault circuit-interrupter receptacles, located in aisle.

g. Aisle ventilation louvers arranged with makeup air near floor level and exhaust air near roof level.

1) Louvers must have insect and rodent screen and filter, arranged to permit air circulation while excluding insects, rodents, and exterior dust.
2) Exhaust fans.

T. Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of paralleling low-voltage switchgear.

U. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

2.7 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

1. Perform successfully tests prior to witness test.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate paralleling switchgear.

C. [**Factory**]Tests and Inspections: Test and inspect paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with {Insert standards} before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units.

1. Paralleling Low-Voltage Switchgear:

a. NETA ATS, 7.6.1.2, "Circuit Breaker, Air, Low-Voltage Power Switchgear."
b. Factory test with simulated inputs. Test control and relay functions for proper operation.

2. Engine Generator:

a. NETA ATS, 7.22.1, "Emergency Systems, Engine Generator."
b. NETA ATS, 7.15.1, "Rotating Machinery, AC Motors & Generator."

3. Automatic Transfer Switches:

a. NETA ATS, 7.22.3, "Emergency System, Automatic Transfer Switches."

D. Verification of Performance: Rate paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], in accordance with operation of functions and features specified.

E. Nonconforming Work:

1. Paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling low-voltage switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF SWITCHGEAR COMPONENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for paralleling low-voltage switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

3.3 INSTALLATION

A. Comply with applicable portions in NECA 400.

B. Equipment Mounting:

1. Install paralleling low-voltage switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
2. Comply with requirements for seismic control devices specified in [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from paralleling low-voltage switchgear units and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:

1. Frame and mount under clear acrylic plastic on front of paralleling low-voltage switchgear.

   a. Operating Instructions: Printed basic instructions for paralleling low-voltage switchgear, including control and key-interlock sequences and emergency procedures.
   b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Compartment Nameplates: [**Engraved, laminated acrylic**][**Engraved, melamine plastic**][**Preprinted**

aluminum], as described in Section 260553 "Identification for Electrical Systems," for compartment, mounted with corrosion-resistant screws.

D. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

E. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in analysis. Labels must be machine printed, with no field-applied markings.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

b. Labels must be machine printed, with no field-applied markings.

3.5 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with wire and cable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation: Prepare for acceptance tests as follows:

1. Test insulation resistance for switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of circuit.
3. Inspect paralleling switchgear installation, including wiring, components, connections, and equipment.[**Test and adjust components and equipment.**]
4. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
5. Complete installation and startup checks in accordance with manufacturer's written instructions.

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform visual and mechanical inspections and electrical tests stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for the following NETA categories:

   a. AC generators and emergency systems.
   b. Switchgear.
   c. Circuit breakers.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.

2. Perform NFPA 110 tests for Type 1 essential power systems.
3. Test sequence of operation step by step for each mode.

D. Nonconforming Work:

1. Paralleling low-voltage switchgear will be considered defective if it does not pass tests and inspections.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.7 ADJUSTING

A. Set field-adjustable, electronic circuit-breaker trip characteristics in accordance with results specified in Section 260573.16 "Coordination Studies."

B. Set field-adjustable, electronic circuit-breaker trip characteristics.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling low-voltage switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling low-voltage switchgear, in accordance with manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.10 MAINTENANCE

A. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of switchgear 11 months after date of Substantial Completion.
2. Instrument: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 21 16 00

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Task	Specification	Specification Description
26 21 16 00	26 05 13 00	Medium-Voltage Cables
26 21 16 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 22 00 00	26 12 19 00a	Low-Voltage Switchgear

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SECTION 26 22 13 00 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS[**TO BE MODIFIED**][**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
3. [**Dongan Electric Manufacturing Company**]
4. [**Eaton**]
5. [**Federal Pacific**]
6. [**Hammond Power Solutions Inc.**]
7. [**Jefferson Electric, Inc.**]
8. [**Lincoln Electric Products Co., Inc.**]
9. [**Mag-Tran; a division of Quality Transformer & Electronics**]
10. [**Marcus Transformer LTD**]
11. [**MGM Transformer Company**]
12. [**Micron Industries Corporation**]
13. [**Mirus International Inc.**]
14. [**Powersmiths International Corp.; Socomec Group**]
15. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
16. [**Rex Power Magnetics**]
17. [**Siemens Industry, Inc., Energy Management Division**]
18. [**SolaHD; Emerson Electric Co., Automation Solutions**]
19. [**Square D; Schneider Electric USA**]
20. [**TEMCo Transformers**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
3. [**Dongan Electric Manufacturing Company**]
4. [**Eaton**]
5. [**Federal Pacific**]
6. [**Hammond Power Solutions Inc.**]
7. [**Jefferson Electric, Inc.**]
8. [**Lincoln Electric Products Co., Inc.**]
9. [**Mag-Tran; a division of Quality Transformer & Electronics**]
10. [**Marcus Transformer LTD**]
11. [**MGM Transformer Company**]
12. [**Micron Industries Corporation**]
13. [**Mirus International Inc.**]
14. [**Powersmiths International Corp.; Socomec Group**]
15. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
16. [**Rex Power Magnetics**]
17. [**Siemens Industry, Inc., Energy Management Division**]
18. [**SolaHD; Emerson Electric Co., Automation Solutions**]
19. [**Square D; Schneider Electric USA**]
20. [**TEMCo Transformers**]
21. <**Insert manufacturer's name**>

C. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.4 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.5 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70[**, and list and label as complying with UL 1561**].

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
3. Grounded to enclosure.

C. Coils: Continuous windings[**without splices**] except for taps.

1. Coil Material: [**Aluminum**][**Copper**].
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: [**Welded**][**Bolted**].

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: [**Ventilated**][**Totally enclosed, nonventilated**].

1. Core and coil must be encapsulated within resin compound[**using vacuum-pressure impregnation process**] to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

a. Indoor: UL 50E, [**Type 2**][**Type 3R**][**Type 4X, Stainless Steel**].
b. Outdoor: UL 50E, [**Type 3R**][**Type 4X**][**Type 4X, Stainless Steel**].

5. Finish Color: [**Gray**][**ANSI 49 gray**][**ANSI 61 gray**] weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: [**None**][**One 5 percent tap above normal full capacity**].

G. Taps for Transformers 7.5 to 24 kVA: [**One 5 percent tap above and one 5 percent tap below normal**

full capacity][**Two 5 percent taps below rated voltage**].

H. Taps for Transformers 25 kVA and Larger: [**Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity**][**Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity**].

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of [**150 deg C**][**115 deg C**][**80 deg C**] rise above 40 deg C ambient temperature.

K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

L. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.

1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.

M. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding shield.

N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

O. Wall Brackets: [**Manufacturer's standard brackets**][**Wall brackets fabricated from design drawings signed and sealed by qualified structural professional engineer**].

P. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: [**40 dB(A-weighted)**]<**Insert dB(A-weighted)**>.
2. 9.01 to 30.00 kVA: [**45 dB(A-weighted)**]<**Insert dB(A-weighted)**>.
3. 30.01 to 50.00 kVA: [**45 dB(A-weighted) for K-factors of 1, 4, and 9**][**48 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
4. 50.01 to 150.00 kVA: [**50 dB(A-weighted) for K-factors of 1, 4, and 9**][**53 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
5. 150.01 to 300.00 kVA: [**55 dB(A-weighted) for K-factors of 1, 4, and 9**][**58 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
6. 300.01 to 500.00 kVA: [**60 dB(A-weighted) for K-factors of 1, 4, and 9**][**63 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
7. 500.01 to 700.00 kVA: [**62 dB(A-weighted) for K-factors of 1, 4, and 9**][**65 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
8. 700.01 to 1000.00 kVA: [**64 dB(A-weighted) for K-factors of 1, 4, and 9**][**67 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
9. 1000.01 to 1500.00 kVA: <**Insert dB(A-weighted)**>.

2.6 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.

B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

   a. Line-side to ground.
   b. Load-side to ground.
   c. Line-side to load-side.

9. Temperature tests.
10. Factory Sound-Level Tests: [**Conduct sound-level tests on equipment for this Project**][**Conduct prototype sound-level tests on production-line products**].

C. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated [**by transformer manufacturer**][**from design drawings signed and sealed by qualified structural professional engineer**].

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions[**, seismic requirements applicable to Project,**] and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base in accordance with manufacturer's published instructions.

E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-

tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

2. Large (Larger Than 167 kVA Single Phase or 500 kVA Three Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform power-factor or dissipation-factor tests on windings.
4) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
5) Perform excitation-current test on each phase.
6) Perform applied voltage test on line- and load-side windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

E. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Assemble and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 22 13 00

Task	Specification	Specification Description
26 22 13 00	26 12 19 00a	Low-Voltage Switchgear

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SECTION 26 24 13 00 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

B. Related Requirements

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Groud-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and

service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

a. Test procedures used.
b. Test results that comply with requirements.
c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
3. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
4. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.
5. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [**install temporary electric heating (250 W per section)**][**connect factory-installed space heaters to temporary electrical service**] to prevent condensation.

C. Handle and prepare switchboards for installation in accordance with [**NECA 400**][**NEMA PB 2.1**].

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial

Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

I. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: [**Panel**][**Fixed, individually**] mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

J. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel mounted.
3. Section Alignment: [**Front**][**and**][**Rear**] aligned.

K. Front- and Rear-Accessible Switchboards:

1. Main Devices: [**Fixed, individually**][**Drawout**] mounted.
2. Branch Devices: [**Panel**][**Fixed, individually**][**Panel and fixed, individually**][**Fixed and individually compartmented**][**Individually compartmented and drawout**] mounted.
3. Sections [**front and rear**][**rear**] aligned.

L. Nominal System Voltage: [**480Y/277 V**][**208Y/120 V**]<**Insert system voltage**>.

M. Main-Bus Continuous: [**5000**][**4000**][**3000**][**2500**][**2000**][**1600**][**1200**]<**Insert ampere rating**> A.

N. Indoor Enclosures: Steel, UL 50E, [**Type 1**][**Type 2**].

O. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**][**custom color**] finish over rust-inhibiting primer on treated metal surface.

P. Outdoor Enclosures: [**Type 3R**][**Type 3R, with interior-lighted walk-in aisle**].

1. Finish: Factory-applied finish in manufacturer's [**standard**][**custom**] color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of [**30 inch (762 mm)**]<**Insert value**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**]. At least one door must be sized to permit largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: LED luminaires, ceiling mounted; wired to three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:

   a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**40 deg F (5 deg C)**]<**Insert temperature**> with outside design temperature of [**0 deg F (minus 18 deg C)**]<**Insert temperature**>.
   b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**100 deg F (38 deg C)**]<**Insert temperature**> with outside design temperature of [**90 deg F (32 deg C)**]<**Insert temperature**>.
   c. Ventilating openings[**complete with replaceable fiberglass air filters**].
   d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include control-power transformer, with spare capacity of 25 percent, within switchboard. Supply voltage must be [**120 V(ac)**][**120/240 V(ac)**][**120/208 V(ac)**].
7. Power for space heaters, ventilation, lighting, and receptacle provided by remote source.

Q. Barriers: Between adjacent switchboard sections.

R. Insulation and isolation for[**main bus of main section and**] main and vertical buses of feeder sections.

S. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: [**Thermostats to maintain temperature of each section above expected dew point**][**Manual switching of branch-circuit protective device**].
2. Space-Heater Power Source: [**Transformer, factory installed in switchboard**][**120 V external branch circuit**].

T. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.

U. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

V. Customer Metering Compartment: Separate customer metering compartment[**and section with front hinged door,**] and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring must be terminated on shorting-type terminal blocks.[**Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

X. Removable, Hinged Rear Doors and Compartment Covers: Secured by [**captive thumb screws**][**standard bolts**], for access to rear interior of switchboard.

Y. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Z. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
4. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

AA. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
2. Phase- and Neutral-Bus Material:

   a. Hard-drawn copper of 98 percent conductivity[**, silver-plated**].
   b. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

3. Copper feeder circuit-breaker line connections.
4. Tin-plated aluminum feeder circuit-breaker line connections.
5. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with [**mechanical**][**compression**] connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

6. Ground Bus: [**1/4 by 2 inch (6 by 50 mm-)**][**1/4 by 1 inch (6 by 25 mm-)**][**Minimum-size required by UL 891,**] hard-drawn copper of 98 percent conductivity, equipped with [**mechanical**][**compression**] connectors for feeder and branch-circuit ground conductors.
7. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
8. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

9. Neutral Buses: [**50**][**100**] percent of ampacity of phase buses unless otherwise indicated, equipped with [**mechanical**][**compression**] connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
10. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

BB. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

CC. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

DD. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**Eaton**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**Eaton**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

C. SPDs: Listed and labeled in accordance with UL 1449, [**Type 1**][**Type 2**].

D. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.

3. Indicator light display for protection status.
4. Form-C contacts rated at [**5 A and 250 V(ac)**][**2 A and 24 V(ac)**]<**Insert values**>, one normally open and one normally closed, for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

E. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**200 kA**][**250 kA**][**300 kA**]<**Insert amperes**>. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits may not exceed the following:

1. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
2. Line to Ground: [**1200 V for 480Y/277 V**][**1200 V for 208Y/120 V**].
3. Line to Line: [**2000 V for 480Y/277 V**][**1000 V for 208Y/120 V**].

G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: [**700 V**][**1000 V**].
3. Line to Line: 1000 V.

H. SCCR: Equal or exceed [**100 kA**][**200 kA**]<**Insert amperes**>.

I. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with [**series-connected rating**][**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long and short time adjustments.
   d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: [**Mechanical**][**Compression**] style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at [**55**][**75**] percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Auxiliary Contacts: [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): [**80**][**100**] percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. [**Fixed**][**Drawout**] circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. [**Standard**][**Full**]-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Time adjustments for long- and short-time pickup.
    c. Ground-fault pickup level, time delay, and I squared t response.
    d. <**Insert settings**>.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
8. Control Voltage: [**40 V(dc)**][**125 V(dc)**][**250 V(dc)**][**120 V(ac)**].

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on switch blade after it engages stationary contacts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Boltswitch, Inc.**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Boltswitch, Inc.**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
4. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

5. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
6. Service-Rated Switches: Labeled for use as service equipment.
7. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

a. Configuration: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

8. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

3. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
4. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

5. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
6. Service-Rated Switches: Labeled for use as service equipment.
7. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

   a. Configuration: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
   c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
   d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

8. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, [**single**][**tapped**][**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; [**wound**][**bushing**][**bar or window**] type; [**single**][**double**] secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

    a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    d. Megawatts: Plus or minus 1 percent.
    e. Megavars: Plus or minus 1 percent.
    f. Power Factor: Plus or minus 1 percent.
    g. Frequency: Plus or minus 0.1 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Analog Meters:

1. Meters: **4 inch (100 mm)** diameter or **6 inch (150 mm)** square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.

D. Voltmeters: Cover expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of phase-to-phase voltages and, where neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in closed-circuit condition at all times.

F. Ammeters: **2-1/2 inch (64 mm)** minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.

3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**five**][**15**][**30**]<**Insert time period**>-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits:

1. 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
2. 120 V(ac), supplied from remote branch circuit.
3. <**Insert control voltage**> V(dc).

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with [**NECA 400**][**NEMA PB 2.1**].

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and

other conditions affecting performance of the Work or that affect performance of equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 400**][**NEMA PB 2.1**].
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, **4 inch (100 mm)** nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

   a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend **2 inch (50 mm)** above concrete base after switchboard is anchored in place.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch (450 mm)** centers around full perimeter of concrete base.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to switchboards.
   f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.

   a. Set field-adjustable switches and circuit-breaker trip ranges.

7. Install spare-fuse cabinet.

3.4 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

D. Support and secure conductors within switchboard in accordance with NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Mimic Bus:

1. Entire single-line switchboard bus work, as depicted on factory record drawing, on minimum **0.032 inch (0.813 mm)** thick anodized aluminum photoengraved nameplate, located at eye level on front cover of switchboard incoming service section.
2. Entire single-line switchboard bus work, as depicted on factory record drawing, on engraved minimum **0.0625 inch (1.588 mm)** thick laminated-plastic (Gravoply) nameplate, located at eye level on front cover of switchboard incoming service section.
3. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove [**front**][**front and rear**] panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as indicated.**][**as specified in Section 260573.16**

"Coordination Studies."]

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13 00

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Task	Specification	Specification Description
26 24 13 00	26 27 13 00	Electricity Metering
26 24 13 00	26 28 16 00	Enclosed Switches And Circuit Breakers

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SECTION 26 24 16 00 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Disconnecting and overcurrent protective devices.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**> .

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
8. Section 260913 "Electrical Power Monitoring" specifies power monitoring and control systems installed by this Section.
9. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
10. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
4. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment.

1. Include plans, elevations, sections, details, and attachments to other Work.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality Control Reports: For specified tests and inspections.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with [**NECA 407**][**NEMA PB 1**] .

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials [**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 1.

E. Enclosures: [**Flush**][**and**][**Surface**] -mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: UL 50E, [**Type 1**]<**Insert type**> .
b. Outdoor Locations: UL 50E, [**Type 3R**]<**Insert type**> .
c. Kitchen and Wash-Down Areas: UL 50E, [**Type 4X**]<**Insert type**> , [**stainless steel**]<**Insert material**> .
d. Other Wet or Damp Indoor Locations: UL 50E, [**Type 4**]<**Insert type**> .
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, [**Type 5**][**Type 12**] .

2. Height: **7 ft (2.13 m)** maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: [**Steel**][**and**][**galvanized steel**] , factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: [**Galvanized steel**][**Same finish as panels and trim**] .
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Phase, Neutral, and Ground Buses:

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .

    a. Plating must run entire length of bus.
    b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: [**Compression**][**Mechanical**] type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: [**5**][**10**][**20**]<**Insert number**> percent.

J. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

    a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as

shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

   a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
   b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.4 PANELBOARDS

A. UL QEUY - Distribution Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]
   c. [**ESL Power Systems, Inc.**]
   d. [**Mersen USA**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]
   c. [**ESL Power Systems, Inc.**]
   d. [**Mersen USA**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Distribution Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

   a. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

      1) For doors more than [**36 inch (914 mm)**]<**Insert dimension**> high, provide two latches, keyed alike.

b. Mains: [**Circuit breaker**][**Fused switch**][**Lugs only**] .

1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

c. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in circuit breakers**][**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
d. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: [**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
e. Branch Overcurrent Protective Devices: Fused switches.

6. Other Available Features Required by Project:

a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
e. Do not mount neutral bus in gutter.
f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

B. UL QEUY - Lighting and Appliance Branch-Circuit Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]

b. [**Bender Inc.; Bender GmbH & Co. KG**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**Bender Inc.; Bender GmbH & Co. KG**]
   c. [**Eaton**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

   a. Mains: [**Circuit breaker**][**or**][**lugs only**] .

      1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
      2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

   b. Branch Overcurrent Protective Devices: [**Plug-in**][**Bolt-on**] circuit breakers, replaceable without disturbing adjacent units.

6. Other Available Features Required by Project:

   a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
   b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
   d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
   e. Do not mount neutral bus in gutter.
   f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor

material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

k. Doors: Door-in-door construction with concealed hinges; secured with [**flush**][**or**][**multipoint**] latch with tumbler lock; keyed alike. [**Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.**]

l. Column-Type Panelboards: Single row of overcurrent devices [**with narrow gutter extension**][**and**][**overhead junction box equipped with ground and neutral terminal buses**] .

1) Column-Type Panelboard Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

C. UL QEUY - Electronic-Grade Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

   a. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
   b. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
   c. Factory-Installed, Integral SPD:

      1) Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**100 kA**]<**Insert value**> . Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
      2) Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits may not exceed the following:

         a) Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
         b) Line to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
         c) Neutral to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
         d) Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**] .

      3) Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

         a) Line to Neutral: 700 V.
         b) Line to Ground: 700 V.
         c) Neutral to Ground: 700 V.
         d) Line to Line: 1200 V.

      4) SCCR: Equal to [**SCCR of panelboard in which installed**][**or exceed 100 kA**][**or exceed 200 kA**][**or exceed**]<**Insert value**> .
      5) Inominal Rating: [**20 kA**][**10 kA**] .

   d. Buses:

      1) Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
      2) Copper equipment and isolated ground buses.

   e. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. UL QEUY - Load Center :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]

c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67.

5. Standard Features:

   a. Mains: [**Circuit breaker**][**or**][**lugs only**] .
   b. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
   c. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
   d. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. MCCB: Comply with UL 489, with [**series-connected rating**][**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.

c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long- and short-time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFPE Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: [**Compression**][**Mechanical**] style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system.
h. Shunt Trip: [**120 V**][**24 V**]<**Insert voltage**> trip coil energized from separate circuit, set to trip at [**55**][**75**] percent of rated voltage.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**][**off**][**on or off**] position.
j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
k. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**][**with field-adjustable 0.1- to 0.6-second**] time delay.
l. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**]<**Insert value**> A must have interchangeable rating plugs or electronic adjustable trip units.
m. Auxiliary Contacts: [**One, SPDT switch**][**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
n. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
o. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
p. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
q. Multipole units enclosed in [**single housing with single handle**][**or**][**factory assembled to operate as single unit**] .

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Provide fuses and spare fuse cabinet.
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: [**One**][**Two**] normally open and normally closed contact(s) that operate with switch handle operation.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Keys: [**Two**]<**Insert number**> spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFPE Types: [**Two**]<**Insert number**> spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with [**NECA 407**][**NEMA PB 1.1**] .

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PANELBOARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 407**][**NEMA PB 1.1**] .
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).
b. Attach panelboard to vertical finished or structural surface behind panelboard.
c. Mount surface-mounted panelboards to steel slotted supports [**5/8 inch (16 mm)**][**1-1/4 inch (32 mm)**] in depth. Orient steel slotted supports vertically.
d. Provide seismic control devices.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Mount top of trim [**7.5 ft (2.3 m)**]<**Insert height**> above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

a. Set field-adjustable, circuit-breaker trip ranges.
b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub four **1 inch (25 mm)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four **1 inch (25 mm)** empty conduits into raised floor space or below slab not on grade.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties [**after completing load balancing**] .
12. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in [**transparent card holder**][**metal frame with transparent protective cover**] .

   a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

   a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads [**after balancing panelboard loads**] ; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers [**and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers [**and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**] . [**Do not perform**][**Perform**] optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 26 24 16 00

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SECTION 26 24 16 00A - ELECTRONICALLY OPERATED CIRCUIT-BREAKER PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Circuit breakers.
3. Main controllers.
4. Slave panel controllers.
5. Control network.
6. Manual switches and cover plates.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each electronically operated, circuit-breaker panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for

each type of overcurrent protective device.

7. Include diagrams for power, signal, and control wiring.
8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
9. Submit evidence that electronic controls are compatible with connected monitoring and control devices and systems specified in other Sections.

    a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
    b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of network protocol.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Electrically Operated, Molded-Case Circuit Breakers: Equal to <**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**>.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to [**NECA 407**][**NEMA PB 1.1**].

1.6 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-on Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 ELECTRICALLY OPERATED CIRCUIT-BREAKER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain electrically operated circuit breakers and power distribution components from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Input signal from field-mounted or on-board signal source must open or close one or more electrically operated circuit breakers in electronically operated, circuit-breaker panelboards. Any combination of inputs must be programmable to any combination outputs.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by the authorities having jurisdiction, and marked for intended location and application.

C. Comply with 47 CFR Part 15, Subpart A and Subpart B, for Class A digital devices.

2.3 PERFORMANCE REQUIREMENTS

A. Expansion Requirements: Capacity for future expansion of number of control functions by 25 percent of current capacity; to include equipment ratings, housing capacities, spare spaces for circuit breakers, terminals, number of conductors in control cables, and control software.

B. Interface with DDC System for HVAC: Provide hardware and software to enable DDC system for HVAC to monitor, control, display, and record data for use in processing reports.

1. Hardwired Points:

   a. Monitoring: On-off status, <**Insert monitoring point**>.
   b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert type of interface**> communication interface with DDC system for HVAC must enable DDC system for HVAC operator to remotely control and monitor electronically operated circuit breakers from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at panelboard controller must be available through DDC system for HVAC.

2.4 PANELBOARDS

A. Electronically operated, circuit-breaker panelboards may contain remotely operated circuit breakers and standard branch circuit breakers specified in Section 262416 "Panelboards."

B. Assemblies: Comply with UL 67 and NEMA PB 1.

C. Surge Protective Device:

1. Field mounted, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Integrally mounted, complying with UL 1449 Type 1.

a. Comply with IEEE C62.41, Category C, 200 kA short-circuit current rating.
b. Non-modular type with the following features and accessories:

1) Digital-display indicator lights for power and protection status.
2) <**Insert features and accessories**>.

D. Enclosures: Comply with UL 50.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by a qualified electrical testing laboratory. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected, short-circuit rating by a qualified electrical testing laboratory.
2. Fully rated to interrupt [**10 kA**]symmetrical short-circuit current available at terminals.

2.5 CIRCUIT BREAKERS

A. Remotely operated branch circuit breakers must provide branch circuit overcurrent protection.

B. Labeled with SWD and HID Ratings: Comply with UL 489 for 15 and 20 A, single-pole branch devices.[**15 and 20 A circuit breakers, if scheduled, must be a product of same manufacturer, and be of same class as rated circuit breakers.**]

C. Switching Endurance Rating: Not less than [**50,000**][**200,000**]<**Insert number**> full-load open/close/open remote operations.

D. Remotely Operated Circuit Breakers: Manual override switch or handle position must enable or disable remote operation of device and allow breaker handle to manually control breaker's on-off status.

2.6 MAIN CONTROLLERS

A. Description: Controllers must contain power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.

1. Comply with UL 916 (CSA C22.2, No. 205); with a microprocessor-based, solid-state, 365-day

timing and control unit.

2. Power Supply: Powered from panelboard, sized to provide control power for operation of remotely operated circuit breakers, controller, bus system, control-voltage inputs, and field-installed sensors.
3. Integral keypad and digital-display front panel for local setup, including the following:

    a. Log and display remotely operated breaker on-time.
    b. Provision to accept downloadable firmware so that latest features may be added in future without replacing module.

4. Nonvolatile memory must retain all setup configurations. After a power failure, controller must automatically reboot and return to normal system operation.
5. Ethernet Communications: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert network protocol**> protocols.

    a. Each input connected to controller must control any remotely operated breaker in any other networked electronically operated, circuit-breaker panelboard.
    b. A schedule programmed at one controller must be able to control any remotely operated breaker in any other networked panelboard.

6. Time Synchronization: Timing unit must be updated not less than every <**Insert number**> hour(s) with network time server.
7. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard Web browser.

    a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    b. Separate Web page, showing status of each main and slave electronically operated, circuit-breaker panelboards with arrangement of breakers on page matching physical appearance of panel. Status must include breaker nametags, pole configuration, location in panel, actual contact state (on-off/tripped/manual), and breaker on-time.
    c. Panel summary showing master and slave panels connected to controller.
    d. Controller diagnostic information.
    e. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.

8. Alarm and E-mail Notification: Automatically initiate alarms based on preconfigured conditions listed below and routing alarm alerts as set at control panel.

    a. General Alarms: Power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of DDC system for HVAC commands.
    b. Specific Alarms: Input status, zone status, breaker status on-time (zero to 99999 hours).
    c. E-mail Notification: Automatically route e-mail messages to five individual e-mail addresses. Within body text of e-mail, include a link that will automatically redirect user to associated panels' status Web page.

B. Timing Unit:

1. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
2. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
3. [**16**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
4. Schedule periods settable to the minute.
5. Day of week, day of month, day of year with one-time or repeating capability.

6. [**32**]<**Insert number**> special date periods.

C. With [**eight**][**16**]<**Insert number**> inputs, each configurable to the following parameters:

1. Normally open, normally closed, two-wire maintained toggle, two-wire momentary toggle, two-wire momentary on, two-wire momentary off, or three-wire momentary operation.
2. On and off-delay timers for local override operation, adjustable from five minutes to 12 hours. Local override must be by field-installed, two-wire momentary toggle switch.

2.7 SLAVE PANEL CONTROLLERS

A. Slave panels must contain necessary busses and network hardware to allow connection of sub-net wiring between panels, with programming at main panel controller. Programmable timing unit, Web server, alarm and e-mail notification, and Ethernet connection to control network is not required provided all of these functions are available for slave panel from main panel controller.

B. Sub-net wiring connections must allow connection of wiring to a terminal that can be removed from panel without interrupting communications to other panels.

C. Slave panels must contain a nameplate label attached to deadfront trim indicating panel designation, panel network address, and panel designation of associated master panel.

2.8 CONTROL NETWORK

A. Panel Controllers: Networked with other [**electronically operated, circuit-breaker panel controllers**][**DDC system for HVAC controllers**] in a peer-to-peer configuration using Ethernet [**10Base-T**][**100Base-T**] network.

B. Protocol: Controllers must support serial MS/TP and Ethernet IP communications, and must be able to communicate directly via DDC system for HVAC TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

2.9 MANUAL SWITCHES AND COVER PLATES

A. Keypads: Programmable, designed to control functions associated with equipment of this Section. Units must be able to control any system output device.

B. Push-Button Switches: Modular, momentary-contact, control-voltage type.

1. Match color specified in Section 262726 "Wiring Devices."
2. Integral green [**digital-display**][**neon**] pilot light to indicate when circuit is on.
3. Internal white [**digital-display**][**neon**] locator light to illuminate when circuit is off.

C. Manual, Maintained Contact, Line-Voltage or Control-Voltage Switch: Comply with Section 262726 "Wiring Devices."

D. Cover Plates: Single and multigang cover plates as specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 and Class 3 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

D. Twisted-Pair Data Cable:

1. [**Category 5e**][**Category 6**][**Category 6a**]. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."
2. [**Category 5e**][**Category 6**][**Category 6a**]. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to [**NECA 407**][**NEMA PB 1.1**].

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

A. Wiring Method:

1. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   c. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELBOARDS

A. Install panelboards and accessories according to [**NECA 407**][**NEMA PB 1.1**].

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mounting Height: [**90 inch (2286 mm)**]<**Insert dimension**> to top of trim above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.

D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's instructions.
2. Confirm correct communication wiring, initiate communications between panels, and program control system according to approved time-of-day schedules and input override assignments.
3. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and

access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 26 24 16 00A

SECTION 26 24 19 00 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:

1. Automatic power transfer.
2. Feeder-tap units.
3. Measurement and control.
4. Auxiliary devices.
5. Panelboards.
6. Transformers.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor-control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Sustainable Design Submittals:

1. Product Data: For continuous metering equipment for energy consumption.
2. Product Data: For continuous metering equipment for energy consumption.
3. Product Data: For continuous metering equipment for energy consumption.
4. Product Data: For continuous metering equipment for energy consumption.
5. Product Data: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each MCC, manufacturer's [**approval**][**custom**][**and**][**production**] drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
g. Specified optional features and accessories.
h. <**Insert required information**>.

2. Schematic[**and Connection**] Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.
6. <**Insert required information**>.

1.4 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Seismic Qualification Data: Certificates, for MCCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their

installation requirements.

F. Product Certificates: For each MCC.

G. Source quality-control reports.

H. Field quality-control reports.

I. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

K. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications [**and field-assigned wiring identification**]incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; [**install temporary electric heating, with at least 250 W per vertical section**][**connect factory-installed space heaters to temporary electrical service**].

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace [**MCC**][**and**][**SPD**]<**Insert devices**> that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MOTOR-CONTROL CENTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Rockwell Automation, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Rockwell Automation, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than **0 deg F (minus 18 deg C)** and not exceeding **104 deg F (40 deg C)**, with an average value not exceeding **95 deg F (35 deg C)** over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than **minus 4 deg F (minus 20 deg C)** and not exceeding **140 deg F (60 deg C)**
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding **6600 feet (2000 m)**, or **3300 feet (1000 m)** if MCC includes solid-state devices.
5. <**Insert unusual service condition**>.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

a. Nominal System Voltage: [**277**][**277/480**][**600**]<**Insert number(s)**>-V ac.
b. Service Equipment Rated: [**Yes**][**No**].
c. Enclosure: NEMA 250, Type <**Insert number or number and a letter**>.

2. Integrated Short-Circuit Rating for MCC:

a. Combination series rated; <**Insert number**> kA.
b. Fully rated; <**Insert number**> kA.

3. Integrated Short-Circuit Rating for Each Unit:

a. Combination series rated; <**Insert number**> kA.
b. Fully rated; <**Insert number**> kA.

4. Wiring Class: <**Insert numbers and letters**>.
5. Bus:

a. Horizontal Bus: <**Insert number**> kA.
b. Neutral Bus: [**None**][**50 percent**][**Full size**][**150 percent**]<**Insert percentage**>.

6. Main Disconnect Device:

a. Main Disconnect: [**MCCB, UL 489,**][**Fusible switch, UL 98,**] three pole, <**Insert number**> A.[**Manually operated, electrically tripped.**]
b. SPD: UL 1449, [**Type 1**][**Type 2**].
c. Optional Features: <**Insert items**>.

7. Automatic Power Transfer: Electrically operated MCCBs, three pole, <**Insert number**> A.
8. Magnetic Controllers:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Classification by Starting Method: <**Insert text**>.
2) Controller Size: <**Insert number or numbers and letters**> complying with NEMA ICS 2.
3) Optional Features: <**Insert items**>.

9. Reduced-Voltage Solid-State Controllers:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Starting Configuration: <**Insert text**>.
2) Starting Mode: <**Insert text**>.
3) Stopping Mode: <**Insert text**>.
4) Controller Size: <**Insert number or numbers and letters**> complying with NEMA ICS 2.
5) Bypass Contactor: Comply with NEMA ICS 2.
6) Acceleration Control: <**Insert number**>.
7) Overload Relays: [**Melting alloy**][**Bimetallic**][**Solid state**]. Class [**10**][**20**][**30**].
8) Isolated Overload Alarm Contact: [**NC**][**NO**].
9) Optional Features: <**Insert items**>.

10. VFCs:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Bypass Mode: [**Manual**][**Field selectable, manual or automatic**].
2) Bypass Style: [**Two**][**Three**] contactor style.

3) Bypass Contactor Classification: [**Full-voltage (across-the-line)**][**Reduced-voltage autotransformer, open transition**][**Reduced-voltage autotransformer, closed transition**]<**Insert type**>.
4) Overload Relays: [**Melting alloy**][**Bimetallic**][**Solid state**]. Class [**10**][**20**][**30**].
5) Isolated Overload Alarm Contact: [**NC**][**NO**].
6) Optional Features: <**Insert items**>.

11. Controller-Mounted Auxiliary Devices:

    a. Push Buttons and Selector Switches: [**Heavy**][**Standard**]-duty, [**oiltight**] type.
    b. <**Insert devices**>.
    c. Feeder Tap Units: Main Disconnect: [**MCCB, UL 489,**][**Fusible switch, UL 98,**] three pole, <**Insert number**> A.[**Manually operated, electrically tripped.**]

12. Panelboards: Tag Number <**Insert designation**>.

    a. Mains: [**MCCB**][**Main lugs only**], <**Insert number**> phase, <**Insert number**> V, <**Insert number**> A.
    b. [**Plug-in**][**Bolt-on**] circuit breakers.

13. Transformer(s): Tag Number <**Insert designation**>, <**Insert number**> kVA, <**Insert number**> V primary, <**Insert number**> V secondary.

    a. Primary Circuit Breaker: MCCB, <**Insert number**> A.

14. Transfer Switch: Tag Number <**Insert designation**>, <**Insert number**> pole, <**Insert number**> A.

2.4 MOTOR-CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, [**Type 1**][**Type 1A**][**Type 2**][**Type 12**] unless otherwise indicated to comply with environmental conditions at installed location.

B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

    1. Space-Heater Control: [**Thermostats to maintain temperature of each section above expected dew point**][**Manual switching of branch-circuit protective device**].
    2. Space-Heater Power Source: [**Transformer, factory installed in MCC**][**120-V external branch circuit**].

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**][**custom color**] finish over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures: Type 3R, [**non-walk-in aisle**][**with interior-lighted walk-in aisle**].

    1. Finish: Factory-applied finish in manufacturer's [**standard**][**custom**] color; undersurfaces treated with corrosion-resistant undercoating.
    2. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
    3. Doors: Personnel door at each end of aisle, minimum width of [**30 inches (762 mm)**]<**Insert dimension**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**].
    4. Accessories: Fluorescent luminaires, ceiling mounted; wired to a three-way light switch at each

end of aisle; GFCI duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.

5. Walk-in Aisle Heating and Ventilating:

   a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**40 deg F (5 deg C)**]<**Insert temperature**> with outside design temperature of [**plus 23 deg F (minus 5 deg C)**]<**Insert temperature**>.
   b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**100 deg F (38 deg C)**]<**Insert temperature**> with outside design temperature of [**104 deg F (40 deg C)**]<**Insert temperature**>.
   c. Ventilating openings[**complete with replaceable fiberglass air filters**].
   d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be [**120**][**120/240**][**120/208**]-V ac.
7. Power for space heaters, ventilation, lighting, and receptacle supplied from a remote source.

2.5 ASSEMBLY

A. Structure:

   1. Comply with UL requirements for service entrance equipment.
   2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
   4. Pull Boxes:

      a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
      b. Set the box back from front to clear circuit-breaker removal mechanism.
      c. Covers: Removable covers forming top, front, and sides.
      d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
      e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
      f. When equipped with barriers, supply with access to check bus bolt tightness.

B. Compartments: Modular; individual [**lift-off**]doors with concealed hinges and quick-captive screw fasteners.

   1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
   2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
   3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

D. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and PTs or potential taps as required by utility company. If separate vertical section is

required for utility metering, match and align with basic MCC. Install service entrance label and applicable service entrance features. Comply with requirements in Section 262713 "Electricity Metering."

E. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.[**Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]

F. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

G. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in [**bottom**][**and**][**top**] of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

H. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

I. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: [**Combination series rated**][**Fully rated**]; [**22**][**42**][**65**][**100**]<**Insert number**> kA.
2. Short-Circuit Current Rating of MCC: [**Combination series rated**][**Fully rated**] with its main overcurrent device; [**22**][**42**][**65**][**100**]<**Insert number**> kA.

J. Control Power:

1. 120-V ac, supplied centrally [**from a CPT**][**from a remote branch circuit**].
2. [**24**][**120**]<**Insert number**>-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
3. Control Circuits: 24-V dc, supplied centrally from two redundant, automatically switched power supplies.
4. CPT Spare Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

K. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class:

a. NEMA ICS 18, [**Class I**][**Class I-S**], [**Type A**][**Type B, for starters larger than Size 3**][**Type B-D, for starters Size 3 and smaller**][**Type B-T, for starters Size 3 and smaller**][**Type C**].
b. NEMA ICS 18, [**Class II**][**Class II-S**], [**Type B, for starters larger than Size 3**][**Type B-D, for starters Size 3 and smaller**][**Type B-T, for starters Size 3 and smaller**][**Type C**].

2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

L. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions[**from both ends**].
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material:

   a. Hard-drawn copper of 98 percent minimum conductivity or [**silver**][**tin**]-plated alloy, with [**mechanical**][**compression**] connectors for outgoing conductors.
   b. Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy, with [**mechanical**][**compression**] connectors for outgoing conductors.

4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size **1/4-by-2 inches (6 by 50 mm)**. Equip with [**mechanical**][**compression**] connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, **1/4-by-2-inch (6-by-50-mm)** copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

   a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
   b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
   c. Time-current adjustments to achieve protective-device coordination as follows:

      1) Adjustable long-time delay.
      2) Adjustable short-time setting and delay to shape the time-current curve.
      3) Adjustable instantaneous setting.
      4) Individually adjustable ground-fault setting and time delay.

   d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing the installed circuit breakers 225-A frame and higher.**]
   e. Built-in digital ammeter display, showing load current and tripping cause.

3. Switch operator power shall be from control power specified in "Assembly" Article.

B. MCCB (1600 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
b. LED indicators or display, with manual reset, to show reasons of automatic trip.
c. Display panel to indicate the status of the system circuitry, or give fault location based on automatic diagnosis.
d. Trip the circuit breaker when closing on a fault.
e. Time-current adjustments to achieve protective-device coordination as follows:

1) Adjustable long-delay pickup and time.
2) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
3) Adjustable instantaneous pickup.
4) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

f. One test kit to test each trip function.
g. Battery backup for informational displays after automatic trip, with battery status indicator.

3. Switch operator power shall be from control power specified in "Assembly" Article.

C. MCC Main Disconnect Device: Fusible switch; fixed-mounted, manually operated, [**electrically tripped,**]quick-make, quick-break switch. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Fuse clips and fuses.
3. Electrically tripped switches shall include the following:

a. Shunt trip.
b. Ground-fault protection, with adjustable time delay and test panel.
c. Single-phase protection, tripping the switch on loss of a source phase.
d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.
e. Switch operator power shall be from control power specified in "Assembly" Article.

D. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD [**Type 1**][**Type 2**].

2.7 AUTOMATIC POWER TRANSFER

A. Two-Breaker Transfer Control:

1. Transfer control, using electrically operated MCCBs, for an MCC supplied from two normally energized low-voltage power sources, designated "normal" and "standby." The circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage-sensing transformers.

2. MCCBs (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

    a. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
    b. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

        1) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
        2) Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
        3) Time-current adjustments to achieve protective-device coordination as follows:

            a) Adjustable long-time delay.
            b) Adjustable short-time setting and delay to shape the time-current curve.
            c) Adjustable instantaneous setting.
            d) Individually adjustable ground-fault setting and time delay.

        4) Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing the installed circuit breakers 225-A frame and higher.**]
        5) Built-in digital ammeter display, showing load current and tripping cause.

3. In the automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
4. Sequence of Operation:

    a. The default operation shall be with the normal source main breaker closed and standby main breaker open. On detection of an undervoltage to the line side of the normal main breaker and after a field-adjustable time delay, the main breaker shall open and, after an additional field-adjustable time delay, the standby breaker shall close and restore power to the facility.
    b. On restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker shall open and, after a field-adjustable time delay, the normal main breaker shall close.

5. Field-Adjustable Transfer Parameters:

    a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range is zero seconds to 30 minutes.
    b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range is zero to 120 seconds.
    c. Delay the transfer from the standby power source to the normal power source. Delay range is zero seconds to 30 minutes.
    d. A relay with contact that changes state when the power is available on the normal source, and a relay with contact that changes state when the power is available on the standby source.

6. Controls and Indicators: In addition to the delay setting controls, include the following:

a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers trip due to overcurrent or ground-fault.
b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
c. Transfer-control automatic and manual selector.

1) Interlock shall prevent paralleling of the two power sources in manual mode.

d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
e. Selector to place control into programming mode.
f. Circuit breaker control switch for each of the normal and standby source breakers, providing open and close operation.
g. Push button to initiate manual retransfer to the normal source when the transfer controller is in the automatic mode.
h. Meters and display to show the following:

1) Voltage and frequency of both sources.
2) A multiline display showing the following:

a) Set points of timers, and voltage pickup and dropout set points.
b) Date, time, and reason for minimum of the last 10 transfers. The display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
c) When the control system is in the transferring process, the display shall show delay countdown in seconds.

i. LED indicators to show the following:

1) Normal source available.
2) Standby source available.
3) Normal source connected.
4) Standby source connected.
5) Load bus energized.

7. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
8. Voltage Sensing Relays: Microprocessor-based, IEEE device number 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.8 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:

1. Fusible Switch:

a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with

motor locked-rotor amperes.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

C. Controllers: Comply with UL 508.

1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification: [**Nonreversing**][**and**][**reversing**]<**Insert classification**>.

2. Reduced-Voltage Magnetic Controllers: Electrically held, NEMA ICS 2, general purpose, Class A; [**closed**][**open**] transition; adjustable time delay on transition. [**Electrically**][**Mechanically**] held.

a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
b. Part-Winding Controller: Separate START and RUN contactors, with separate overload relays for starting and running sequences.
c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; one RUN and two START contactors.

3. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification, Nonreversing: [**Consequent pole**][**Two winding**].

1) Two speed, with compelling relays to ensure that motor will start only at low speed.
2) Timer Relays:

a) Accelerating, for properly timed acceleration through speeds lower than that selected.
b) Decelerating, for automatically timed deceleration through each speed.

b. Classification, Reversing: [**Consequent pole**][**Two winding**].

1) Two speed, with compelling relay to ensure that motor will start only at low speed.
2) Timer Relays:

a) Accelerating, for properly timed acceleration through speeds lower than that selected.
b) Decelerating, for automatically timed deceleration through each speed.

c. Antiplugging Relays: Time delay when transferring from FORWARD to REVERSE and back.

D. Overload Relays:

1. Melting-Alloy Overload Relays:

a. Inverse-time-current characteristic.
b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

a. Inverse-time-current characteristic.
b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

3. Solid-State Overload Relays:

a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
e. Analog communication module.

4. [**NC**][**NO**] isolated overload alarm contact.
5. External overload reset push button.

2.9 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

A. Controller Units: An integrated unit with disconnects, power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays. Comply with UL 508.

1. Suitable for use with NEMA MG 1 Design B, polyphase induction motors.
2. <**Insert special applications**>.

B. Disconnects:

1. Fusible Switch:

   a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

   a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
   e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

   a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

   a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
   d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

C. Configuration: [**Standard**][**Severe**] duty; [**nonreversible**][**reversible**].

D. Starting Mode: [**Voltage ramping**][**Current limit**][**Torque control**][**Torque control with voltage boost**][**; field selectable**].

E. Stopping Mode: [**Coast to stop**][**Adjustable torque deceleration**][**Adjustable braking**][**; field selectable**].

F. Bypass Controller: Operates automatically to bypass the SCRs when the motor has reached rated speed and full voltage is applied to motor. Solid-state controller protective features shall remain active when the bypass relay is in the bypass mode.

   1. Bypass Contactor: [**Manufacturer's standard product**][**or**][**NEMA ICS 2, general-purpose, Class A contactor, rated to start the load across the line**][**, as indicated on Drawings**].
   2. Bypass Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.

G. Acceleration Control: Adjustable, using voltage or current ramp, and adjustable starting torque control with up to [**400**]<**Insert number**> percent current limitation for 20 seconds.

H. SCR Bridge: At least two SCRs per phase, for stable and smooth acceleration [**with**][**without**] external feedback from the motor or driven equipment.

I. Keypad: Front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:

1. Adjusting motor full-load amperes, as a percentage of the controller's rating.
2. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
3. Adjusting linear acceleration and deceleration ramps, in seconds.
4. Setting initial torque, as a percentage of the nominal motor torque.
5. Adjusting torque limit, as a percentage of the nominal motor torque.
6. Adjusting maximum start time, in seconds.
7. Adjusting voltage boost, as a percentage of the nominal supply voltage.
8. Selecting stopping mode and adjusting parameters.
9. Selecting motor thermal-overload protection class between 5 and 30.
10. Activating and deactivating protection modes.
11. Selecting or activating communications modes.
12. <**Insert function**>.

J. Digital Display: Front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:

1. Controller Condition: Ready, starting, running, stopping.
2. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
3. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
4. <**Insert items**>.

K. Controller Diagnostics and Protection:

1. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency excursions to over- or under-normal. Accomplish protection by the following:

   a. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
   b. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
   c. <**Insert items**>.

L. Remote Output Features:

1. All outputs prewired to terminal blocks.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.
4. <**Insert items**>.

M. Overload Relays:

1. Melting-Alloy Overload Relays:

    a. Inverse-time-current characteristic.
    b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    d. Ambient compensated.
    e. Automatic resetting.

3. Solid-State Overload Relays:

    a. Switch or dial selectable for motor-running overload protection.
    b. Sensors in each phase.
    c. [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    d. UL 1053, Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    e. Analog communication module.

N. Optional Features:

1. Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10-V dc**][**4- to 20-mA dc**].
2. [**Two**]<**Insert number**> additional field-assignable Form C contacts for alarm outputs.
3. Full-voltage/BYPASS selector switch. Power contacts shall be totally enclosed, double break, made of silver-cadmium oxide, and assembled to allow inspection and replacement without disturbing line or load wiring.

2.10 VFC

A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and [**UL 508E**]<**Insert standard**>.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.

B. Disconnects:

1. Fusible Switch:

   a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

   a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
   e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

   a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

   a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
   b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
   d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

5. Disconnect Rating:

   a. Not less than 115 percent of VFC input current rating.
   b. Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

6. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.
7. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
8. [**NC**][**NO**] alarm contact that operates only when circuit breaker has tripped.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus [**10**][**15**] percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding [**3**][**5**] percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: [**96**][**97**]<**Insert number**> percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: [**96**][**98**]<**Insert number**> percent under any load or speed condition.

6. Overload Capability:

    a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
8. Speed Regulation: Plus or minus [**5**][**10**] percent.
9. Output Carrier Frequency: Field selectable.
10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
11. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
    d. Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
    e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
    f. <**Insert adjustment and parameters**>.

12. Self-Protection and Reliability Features:

    a. Input transient protection by means of SPDs for three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
    b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    c. Under- and overvoltage trips.
    d. Inverter overcurrent trips.
    e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
    f. Critical frequency rejection, with [**three**]<**Insert number**> selectable, adjustable deadbands.
    g. Instantaneous line-to-line and line-to-ground overcurrent trips.
    h. Loss-of-phase protection.
    i. Reverse-phase protection.
    j. Short-circuit protection.
    k. Motor overtemperature fault.
    l. <**Insert additional protection or reliability feature**>.

13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
14. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:

1. Inverter Logic: Microprocessor based, [**16**][**32**] bit, isolated from all power circuits.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:

1. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last [**four**]<**Insert number**> faults with time and date stamp for each.
e. <**Insert information or display**>.

2. Indicating Devices: Digital display[**and additional readout devices as required,**] mounted flush in VFC door and connected to display VFC parameters including the following:

a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percentage).
f. Fault or alarming status (code).
g. PID feedback signal (percentage).
h. DC-link voltage (V dc).
i. Set-point frequency (Hz).
j. Motor output voltage (V ac).
k. <**Insert parameter**>.

F. Bypass Systems:

1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Manual Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
3. Field-Selectable Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
4. Two-Contactor Bypass Controller: Allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode**].

a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
b. Output Isolating Contactor: Non-load-break, [**IEC**][**NEMA**]-rated contactor.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

5. Three-Contactor Bypass Controller: Allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier**] arranged to isolate the power converter

input and output and permit safe testing[**and troubleshooting**] of the power converter, both energized and de-energized, while motor is operating in bypass mode.

a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
b. Input and Output Isolating Contactors: Non-load-break, [**IEC**][**NEMA**]-rated contactors.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

6. Bypass Contactor Classification: [**Full-voltage (across-the-line)**][**Reduced-voltage autotransformer, open transition**][**Reduced-voltage autotransformer, closed transition**]<**Insert type**> type.
7. NORMAL/BYPASS selector switch.

a. HAND/OFF/AUTO selector switch.
b. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

8. Overload Relays: NEMA ICS 2.

a. Melting-Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

b. Bimetallic Overload Relays:

1) Inverse-time-current characteristic.
2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.

c. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

d. [**NC**][**NO**] isolated overload alarm contact.
e. External overload reset push button.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from [**the firefighter's control station**][**smoke-control fan controller**]<**Insert location**>, the following password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal [**automatically**][**manually**].

K. Communication Port: [**Ethernet**][**RS-232 port**][**USB 2.0 port**] or equivalent connection Capable of connecting a printer[**and a notebook computer**].

L. <**Insert feature**>.

2.11 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.

1. Push Buttons, Pilot Lights, and Selector Switches: [**Heavy**][**Standard**]-duty, [**oiltight**] type.

a. Push Buttons: [**Covered**][**Lockable**][**Recessed**][**Shielded**][**Shrouded**][**Unguarded**] types; [**maintained**][**momentary**] contact unless otherwise indicated.
b. Pilot Lights: [**LED**][**Resistor**][**Transformer**] types; <**Insert color(s)**>[**; push to test**].
c. Selector Switches: [**Rotary**]<**Insert description**> type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].

C. Meters: Panel type, **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.

D. Auxiliary Dry Contacts: [**NC**][**NO**][**Reversible NC/NO**].

E. Control Relays:

1. Time Delay: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.
2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.
3. <**Insert control device**>.

2.12 MEASUREMENT AND CONTROL DEVICES

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. PTs: IEEE C57.13; 120 V, 60 Hz, [**single**][**tapped**][**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; [**wound**][**bushing**][**bar or window**] type; [**single**][**double**] secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, for selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker and ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Listed or recognized by a nationally recognized testing laboratory.
2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
3. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:

   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
   e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
   i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
   j. Contact devices to operate remote impulse-totalizing demand meter.

4. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1. **4-inch (100-mm)** diameter or **6 inches (150 mm)** square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.

1. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
2. Feeder Ammeters: **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for feeder circuits, unless otherwise indicated.

D. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

E. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

F. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with MCC watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**five**][**15**][**30**]<**Insert time**>-minute integrated demand of totalized system.

G. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

2.13 FEEDER TAP UNITS

A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.

3. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
4. With built-in digital ammeter and a digital display, showing tripping cause.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker

contacts.
8. Alarm Switch: One [**NC**][**NO**] contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Remote control for on, off, and reset operations.

B. Fusible Switches (to 600 A): Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch with 200-kA interrupting and short-circuit current rating when fitted with UL 248-8 Class J fuses. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Include fuse clips and fuses.
3. Electrically tripped switches shall include the following:

a. Shunt trip.
b. Ground-fault protection, with adjustable time delay and test panel.
c. Single-phase protection, tripping the switch on loss of a source phase.
d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

2.14 PANELBOARDS

A. Comply with NEMA PB 1.

B. Branch OCPDs for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in**][**Bolt-on**] circuit breakers.

C. Branch OCPDs for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

D. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

E. Accessory Control Power Voltage: Integrally mounted, self-powered, <**Insert number**> [**Remote mounted and powered**].

2.15 TRANSFORMERS

A. Factory-assembled and -tested, air-cooled, two-winding, low-voltage dry-type transformers; with primary circuit breaker. Comply with NEMA ST 20.

B. Taps for Transformers Smaller Than 3 kVA: [**None**][**One 5 percent tap above normal full capacity**].

C. Taps for Transformers 7.5 to 24 kVA: [**One 5 percent tap above and one 5 percent tap below normal full capacity**][**Two 5 percent taps below rated voltage**].

D. Taps for Transformers 25 kVA and Larger: [**Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity**][**Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity**].

E. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of

[**150**][**115**][**80**] deg C rise above 40 deg C ambient temperature.

F. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

2.16 TRANSFER SWITCHES

A. Factory-assembled and -tested, open-transition transfer switches. The transfer switch shall comply with UL 1008[**and be listed and labeled by a qualified testing agency**].

B. Comply with NEMA ST 20.

C. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

D. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

E. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

F. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41.1. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

G. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

I. Neutral Switching. Where four-pole switches are indicated, equip with [**neutral pole switched simultaneously with phase poles**][**overlapping neutral contacts**].

J. Neutral Terminal: Solid and rated the same as the neutral bus.

K. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall

have communication capability matched with remote device.

2.17 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in [**NEMA ICS 18**]<**Insert standard**>.

B. VFC Testing: Test and inspect VFCs according to requirements in [**NEMA ICS 61800-2**]<**Insert standard**>.

1. Test each VFC while connected to [**its specified motor**][**a motor that is comparable to that for which the VFC is rated**].
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

C. MCCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, <**Insert Project-specific conditions,**> and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on **4-inch (100-mm)** nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Install power factor correction capacitors. Connect to the [**line**][**load**] side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 INSTALLATION OF CONTROL WIRING

A. Install wiring between [**enclosed controllers**][**master terminal boards**] and remote devices [**and facility's BAS**][**and facility's central-control system**]. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533.13 "Conduits for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

2. <**Insert startup steps if any**>.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify [**Architect**][**Construction Manager**][**Owner**] before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at [**50**][**65**][**80**] percent.

E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

F. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

G. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 260573.16 "Coordination Studies."**]

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers[**, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers**].

END OF SECTION 26 24 19 00

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Task	Specification	Specification Description
26 24 19 00	26 09 23 00	Electrical Power Monitoring
26 24 19 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 24 19 00	26 27 33 00	Power Distribution Units

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SECTION 26 25 00 00 - LOW-VOLTAGE ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Enclosed bus assemblies.
2. Plug-in devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Shop Drawings: For each type of product.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
2. Show fittings, materials, fabrication, and installation methods for [**listed firestop barriers**][**and**][**weather barriers**].
3. Indicate required clearances, method of field assembly, and location and size of each field connection.
4. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Cable and conductor terminal sizes for bus and plug-in device terminations.
6. Wiring Diagrams: Power[**and signal**][**and control**][**, signal, and control**] wiring.

B. Delegated Design Submittal: For seismic-restraint details, signed and sealed by a qualified structural professional engineer.

1. Include design calculations for selecting seismic restraints.
2. Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plug-in Units: [**10**]<**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**> unit(s).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Source Limitations: Obtain enclosed bus assemblies[**and plug-in devices**] from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 857.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified electrical professional engineer to design enclosed bus assemblies, plug-in devices, and components.

2.3 ENCLOSED BUS ASSEMBLIES

A. Feeder-Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**EAE USA**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**EAE USA**]
c. [**Eaton**]

d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure.
4. Electrical Characteristics:

   a. Voltage: [**120/208**][**240**][**480**][**277/480**] V.
   b. Phase: Three; [**3 wire**][**4 wire**].
   c. Percent of Neutral Capacity: [**50**][**100**][**200**]<**Insert value**>.

5. Short-Circuit Interrupting Rating:

   a. For Bus Amperage of 800: 85 symmetrical kAIC.
   b. For Bus Amperage of 1200: 100 symmetrical kAIC.
   c. For Bus Amperage of 1600: 125 symmetrical kAIC.
   d. For Bus Amperage of 2500: 150 symmetrical kAIC.
   e. For Bus Amperage of 5000: 200 symmetrical kAIC.

6. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
7. Bus Materials: Current-carrying [**copper**][**aluminum**] conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
8. Voltage Drop:

   a. Measure voltage drop at 30 deg C ambient with bus thermally stabilized at full rated load.
   b. Three-phase, line-to-line voltage drop less than 3.1 V per **100 ft. (30.5 m)** at 40 percent power factor.

9. Ground: 50 percent capacity, [**integral with housing**][**internal bus bar of material matching bus material**][**isolated, internal bus bar of material matching bus material**].
10. Enclosure: [**Steel**][**Aluminum**], with manufacturer's standard finish.[**Weatherproof, sealed seams, drains, and removable closures.**]
11. Fittings and Accessories: Manufacturer's standard.
12. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
13. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to **10 ft. (3 m)** for horizontally mounted runs and up to **16 ft. (5 m)** for vertically mounted runs.
14. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

B. Plug-in Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Electrical Characteristics:

   a. Voltage: [**120/208**][**240**][**480**][**277/480**] V.
   b. Phase: Three; [**3 wire**][**4 wire**].
   c. Percent of Neutral Capacity: [**100**][**200**]<**Insert value**>.

4. Short-Circuit Interrupting Rating:

   a. For Bus Amperage of 800: 85 symmetrical kAIC.
   b. For Bus Amperage of 1200: 100 symmetrical kAIC.
   c. For Bus Amperage of 1600: 125 symmetrical kAIC.
   d. For Bus Amperage of 2500: 150 symmetrical kAIC.
   e. For Bus Amperage of 5000: 200 symmetrical kAIC.

5. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
6. Bus Materials: Current-carrying [**copper**][**aluminum**] conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
7. Ground: 50 percent capacity, [**integral with housing**][**internal bus bar of material matching bus material**][**isolated, internal bus bar of material matching bus material**].
8. Enclosure: [**Steel**][**Aluminum**], with manufacturer's standard finish.
9. Plug-in Openings: **24 inch (600 mm)** on center on each side of bus, and hinged covers over unused openings. Plug-in openings must be finger-safe with covers open or closed.
10. Fittings and Accessories: Manufacturer's standard.
11. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
12. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to **10 ft. (3 m)** for horizontally mounted runs and up to **16 ft. (5 m)** for vertically mounted runs.
13. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

C. Joints:

1. Busway joints must use one high-strength steel bolt with Belleville washers.
2. Bolts must be torque indicating type and at ground potential.
3. Bolts must be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
4. Access must be required to only one side of the busway for tightening joint bolts.
5. Joint connection assemblies must be removable without disturbing adjacent busway lengths.
6. Joint connection assemblies that rely on the joint cover to provide ground continuity are unacceptable.

2.4 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with [**R-type rejection**][**J-type**][**L-type**] fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position. See Section 262813 "Fuses" for fuses and fuse installation requirements.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. [**Square D; Schneider Electric USA**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. [**Square D; Schneider Electric USA**]
d. <**Insert manufacturer's name**>

B. Molded-Case Circuit Breakers: UL 489; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**NOARK Electric North America**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**NOARK Electric North America**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

C. SPD: NEMA 250, Type 1 enclosure with NEMA KS 1, fusible, disconnect switch and external handle to isolate SPD from busway. SPD product and installation requirements are specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Advanced Protection Technologies Inc. (APT)**]
   c. [**ALLTEC LLC**]
   d. [**Eaton**]
   e. [**Emerson Electric Co., Automation Solutions**]
   f. [**LEA International**]
   g. [**Leviton Manufacturing Co., Inc.**]
   h. [**Mersen USA**]
   i. [**PowerLogics, Inc./PQ Protection**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Energy Management Division**]
   l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Advanced Protection Technologies Inc. (APT)**]
   c. [**ALLTEC LLC**]
   d. [**Eaton**]
   e. [**Emerson Electric Co., Automation Solutions**]
   f. [**LEA International**]
   g. [**Leviton Manufacturing Co., Inc.**]
   h. [**Mersen USA**]
   i. [**PowerLogics, Inc./PQ Protection**]
   j. [**Schneider Electric USA, Inc.**]
   k. [**Siemens Industry, Inc., Energy Management Division**]
   l. **<Insert manufacturer's name>**

D. Motor Controllers: NEMA ICS 2, Class A, full voltage, nonreversing, across the line unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ABB, Motion Business**]
   c. [**Cerus Industrial, Inc.**]
   d. [**Eaton**]
   e. [**Rockwell Automation, Inc.**]
   f. [**Siemens Industry, Inc., Energy Management Division**]
   g. [**Square D; Schneider Electric USA**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**ABB, Motion Business**]
c. [**Cerus Industrial, Inc.**]
d. [**Eaton**]
e. [**Rockwell Automation, Inc.**]
f. [**Siemens Industry, Inc., Energy Management Division**]
g. [**Square D; Schneider Electric USA**]
h. <**Insert manufacturer's name**>

3. Control Circuit: 120 V; obtained from [**integral control power transformer**]<**Insert source of control power**> with a control power [**transformer**][**source**] of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
4. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

   a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with [**R-type rejection**][**J-type**] fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1, as certified by an NRTL acceptable to authorities having jurisdiction. See Section 262813 "Fuses" for fuses and fuse installation requirements.
   b. Circuit-Breaker Disconnecting Means: UL 489, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

5. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, [**Class 10**][**Class 20**][**Class 30**] tripping characteristic. Overload relays must have heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
6. Adjustable Overload Relay: Dipswitch selected for motor running overload protection with NEMA ICS 2, [**Class 10**][**Class 20**][**Class 30**] tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Adjustable overload relays must have Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.

E. Multispeed Magnetic Controllers: Match controller to motor type, application, and number of speeds.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]

f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Compelling relay ensures motor starts only at low speed.
4. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
5. Decelerating relay ensures automatically timed deceleration through each speed.

F. Accessories: Hookstick operator, adjustable to maximum extension of [**14 ft. (4.3 m)**]<**Insert dimension**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including luminaires, HVAC equipment, fire-suppression system, and partition assemblies.

B. Equipment Mounting:

1. Install enclosed bus assemblies on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.

1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."
2. Design each fastener and support to carry **200 lb (90 kg)** or 4 times the weight of bus assembly, whichever is greater.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Support bus assembly with not less than [**3/8 inch (10 mm)**]<**Insert dimension**> steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
5. Fasten supports securely to building structure according to Section 260529 "Hangers and Supports for Electrical Systems."
6. Bolts and nuts that are loosened for any reason after tightening to manufacturer's recommended torque setting must be discarded and replaced with new bolts and nuts.

D. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.

E. Construct rated firestop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Section 078413 "Penetration Firestopping."

F. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 079200 "Joint Sealants" for materials and application.

G. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.

H. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

I. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Terminate to transformer enclosures with matching bus assemblies according to Section 262200 "Low-Voltage Transformers."

D. Terminate to switchgear enclosures with matching bus assemblies according to Section 262300 "Low-Voltage Switchgear."

E. Terminate to switchboard enclosures with matching bus assemblies according to Section 262413 "Switchboards."

F. Terminate to panelboard enclosures with matching bus assemblies according to Section 262416 "Panelboards."

G. Terminate to motor-control centers enclosures with matching bus assemblies according to Section 262419 "Motor-Control Centers."

3.3 FIELD QUALITY CONTROL

A. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

   a. Compare equipment nameplate data with Drawings and Specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, and grounding.
   d. Verify correct connection according to single-line diagram.
   e. Inspect bolted electrical connections for high resistance using one or more of the following methods:

      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
      3) Perform thermographic survey.

3. Electrical Tests:

a. Perform insulation resistance measurements through bolted connections and bus joints with low-resistance ohmmeter.
b. Perform insulation resistance tests of each busway, phase to phase, and phase to ground.
c. Perform a dielectric withstand voltage test on each busway, phase to ground with phases not under test grounded for one minute.
d. Measure resistance of assembled busway sections on insulated busway and compare values with adjacent phases.
e. Perform phasing test on each busway tie section energized by separate sources.
f. Verify operation of busway space heaters.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

E. Nonconforming Work:

1. Enclosed bus assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Set field-adjustable, circuit-breaker trip ranges[**and overload relay trip settings**] as indicated.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 25 00 00

Task	Specification	Specification Description
26 25 13 00	26 25 00 00	Low-Voltage Enclosed Bus Assemblies
26 25 16 00	26 25 00 00	Low-Voltage Enclosed Bus Assemblies

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SECTION 26 27 13 00 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electricity meters.
2. Work to accommodate utility company revenue meters, and Owner's electricity meters used to manage electrical power system.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by metering industry to describe method of measuring consumption of electricity (kWh) that is based on relay opening and closing in response to rotation of disk in meter. Electronic meters generate pulses electronically.

1.3 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control

wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

4. Include series-combination rating data for modular meter centers with main disconnect device.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in [**Section 260913 "Electrical Power Monitoring and Control."**]<**Insert Section number and title.**>

    a. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
    b. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation of metering equipment.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed metering equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that metering equipment performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by Utility.

1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Steady-state and short-circuit current ratings must meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of main service [**terminal box with lugs only**][**disconnect device**], wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Comply with requirements of utility company for meter center.

   a. Comply with UL 67.

4. Housing: UL 50E, [**Type 1**][**Type 3R**][**Type 4X**] enclosure.
5. Meter Socket Rating: Coordinated with connected feeder circuit rating.
6. Minimum Short-Circuit Rating: [**22 000 A**][**42 000 A**][**65 000 A**][**100 000 A**]<**Insert amperes**> symmetrical at rated voltage.
7. Steady-state and short-circuit current ratings must have ratings that match connected circuit ratings.
8. Main Disconnect Device:

   a. Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers must be operable from outside enclosure to disconnect unit. Configure cover so it can be opened only when disconnect switch is open.
   b. Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch must be operable from outside enclosure to disconnect unit. Configure cover so that it can be opened only when disconnect switch is open.

9. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have [**10 000 A**]<**Insert amperes**> interrupting capacity.

   a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
   b. Physical Protection: Tamper resistant, with hasp for padlock.

10. Surge Protection:

    a. Factory-installed in main disconnect, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    b. Field-mounted external to main disconnect, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    c. Factory-installed in main terminal box, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    d. Field-mounted external to main terminal box, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels:

1. Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply **3-1/2-by-5 inch (76-by-127 mm)** thermal transfer label of high-adhesion

polyester for each work location included in the analysis.

2. Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply **3-1/2-by-5 inch (76-by-127 mm)** thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels must be machine printed, with no field-applied markings.

   a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

      1) Location designation.
      2) Nominal voltage.
      3) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**ABB, Electrification Business**]
   2. [**Davidge Controls**]
   3. [**E-Mon**]
   4. [**Eaton**]
   5. [**GE Power; General Electric Company**]
   6. [**Leviton Manufacturing Co., Inc.**]
   7. [**National Meter Industries**]
   8. [**Sensus Metering Systems**]
   9. [**Siemens Industry, Inc., Energy Management Division**]
   10. [**Square D; Schneider Electric USA**]
   11. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   1. [**ABB, Electrification Business**]
   2. [**Davidge Controls**]
   3. [**E-Mon**]
   4. [**Eaton**]
   5. [**GE Power; General Electric Company**]
   6. [**Leviton Manufacturing Co., Inc.**]
   7. [**National Meter Industries**]
   8. [**Sensus Metering Systems**]
   9. [**Siemens Industry, Inc., Energy Management Division**]
   10. [**Square D; Schneider Electric USA**]
   11. **<Insert manufacturer's name>**

D. General Requirements for Meters:

1. Comply with NEMA ANSI C12.1 and NEMA ANSI C12.20, [**0.1**][**0.2**][**0.5**] accuracy class.
2. Ambient Temperature: **Minus 22 deg F to plus 158 deg F (Minus 30 deg C to plus 70 deg C)**.
3. Humidity: Zero to 95 percent, noncondensing.
4. Capacities and Characteristics:

    a. Circuit: 120/240 V(ac), 100 A.
    b. Measure: kWh, onboard LED display.
    c. Remote-Reading Options: None.

5. Billing Meters Accuracy: [**0.2**][**0.5**][**1.0**] percent of reading, complying with NEMA ANSI C12.20.
6. Meter Certification: Certified by [**California Type Evaluation Program**]<**Insert agency**> as complying with [**4 CCR 4027, Article 2.2**]<**Insert state or Federal regulatory requirement**>.
7. Certify that meters comply with NEMA ANSI C12.20 requirements by laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). Laboratory must use test equipment that is certified annually and is traceable to NIST standards.
8. Enclosure: Supplied by meter manufacturer, UL 50E, [**Type 1**][**Type 3R**][**Type 4X**] minimum, with provisions for locking or sealing.
9. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
10. Onboard Nonvolatile Data Storage: kWh, until reset.
11. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: [**Split**][**and**][**solid**] core, complying with recommendation of meter manufacturer.

E. kWh Meter: Electronic [**single-phase**][**and**][**three-phase**] meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display:

    a. LCD with characters not less than **0.25 inch (6 mm)** high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in nonvolatile memory, until reset.
    b. Digital electromechanical counter, indicating accumulative kWh.

F. kWhd Meter: Electronic [**single-phase**][**and**][**three-phase**] meters, measuring electricity use and demand. Demand must be integrated over [**15-minute**]<**Insert time**> interval.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than **0.25 inch (6 mm)** high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in nonvolatile memory, until reset.

G. KY and KYZ Pulse Totalizer:

1. Pulse Totalizer: Instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. Instrument must totalize kWh accumulated over user-selected period and must log maximum and minimum kWhd for that period. Record each period

with date/time stamp. Time period must be user selected from one to 60 minutes.

a. Pulse Input: [**One**]<**Insert number**>, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width must be field adjustable, set for pulse stream provided by utility revenue meter.
b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
c. Instrument Power: User selectable, 120 V(ac) and 277 V(ac).
d. Clock: Line frequency.

H. Remote Reading Options:

1. Pulse Output: [**KY**][**KYZ**], complete with optical sensor and interface devices.
2. TIA-232 serial interface.
3. TIA-485 serial interface, with [**Modbus RTU protocol**]<**Insert protocol name**>.
4. USB interface.
5. TCP/IP adapter.

I. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

J. Uninterruptible Power Supply: Single phase, 120 V(ac), sized and rated to provide continuous power to meter for operations of [**48**]<**Insert number**> hours after interruption of normal power.

1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
2. Battery: Maintenance free, sealed, lead acid, and leakproof.
3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

K. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

L. Software: PC-based product [**of**][**recommended by**] meter manufacturer, suitable for calculating utility cost allocation.

1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:

a. At least [**15**]<**Insert number**> departments.
b. At least [**30**]<**Insert number**> tenants or activities.
c. At least [**five**]<**Insert number**> processes.
d. At least [**five**]<**Insert number**> buildings.
e. <**Insert entity**>.

2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements[**and invoices**] based on electricity use[**and peak demand**]. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Install modular meter center according to switchboard installation requirements in NECA 400.
2. Install arc-flash labels as required by NFPA 70.

C. Special Techniques:

1. Install meters furnished by utility company. Install raceways and equipment according to utility company's published instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
2. Wiring Methods:

   a. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems."
   b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
   c. Minimum conduit size is metric designator 16 (trade size 1/2).

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide additional card holder suitable for [**printed, weather-resistant card**][**typewritten card**] with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Equipment and Software Setup:

   a. Set meter date and time clock.
   b. Test, calibrate, and connect pulse metering system.
   c. Set and verify billing demand interval for demand meters.
   d. Report settings and calibration results.
   e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect load of known power rating, [**1.5 kW**]<**Insert kilowatts**> minimum, to circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain measurable meter

indication. Use test-load placement and setting that ensures continuous, safe operation.

5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from meter reading tests.

D. Nonconforming Work:

1. Electricity metering will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.4 PROTECTION

A. After installation, protect metering equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 26 27 13 00

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SECTION 26 27 16 00 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4. Rack or frame systems.
5. Enclosure-mounted power distribution.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding for RBBs referenced by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. RBB: Rack bonding busbar, located in equipment cabinets and racks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Custom Enclosures and Cabinets: Include plans, elevations, sections, and attachment details.
2. Shop Drawings for Racks or Frames:

    a. Include plans, elevations, sections, details, and attachments to other work.
    b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Include workspace requirements and access for cable connections.
    d. Grounding: Indicate location of RBB and its mounting detail showing standoff insulators and wall-mounting brackets.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 CABINETS AND CUTOUT BOXES

A. UL CYIV - Indoor Sheet Metal Cabinets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL CYIV - Indoor Sheet Metal Cutout Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Adalet; division of Scott Fetzer Co.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Erickson Electrical Equipment Company**]
   f. [**FSR Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Milbank Manufacturing Company**]
   j. [**N J Sullivan Company**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Robroy Enclosures; Robroy Industries**]
   m. [**Siemens Industry, Inc., Building Technologies Division**]
   n. [**Square D; Schneider Electric USA**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Adalet; division of Scott Fetzer Co.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Erickson Electrical Equipment Company**]
   f. [**FSR Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Milbank Manufacturing Company**]
   j. [**N J Sullivan Company**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Robroy Enclosures; Robroy Industries**]
   m. [**Siemens Industry, Inc., Building Technologies Division**]
   n. [**Square D; Schneider Electric USA**]
   o. **<Insert manufacturer's name>**

3. Listing Criteria:

   a. UL CCN CYIV.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

   a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
   b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL CYIV - Outdoor Sheet Metal Cabinets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]

o. **<Insert manufacturer's name>**

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL CYIV - Outdoor Sheet Metal Cutout Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. **<Insert manufacturer's name>**

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. UL XCKT - Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**Erickson Electrical Equipment Company**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Milbank Manufacturing Company**]
    h. [**N J Sullivan Company**]
    i. [**Square D; Schneider Electric USA**]
    j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**Erickson Electrical Equipment Company**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Milbank Manufacturing Company**]
    h. [**N J Sullivan Company**]
    i. [**Square D; Schneider Electric USA**]
    j. **<Insert manufacturer's name>**

3. Listing Criteria:

    a. UL CCN XCKT; including UL 1773.
    b. Non-Environmental Characteristics: UL 50.
    c. Environmental Characteristics: UL 50E.

4. Standard Features:

    a. Listed and labeled for installation on line side of service equipment.
    b. Indoor Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].
    c. Outdoor Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL XCKT - Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. UL CCN XCKT; including UL 1773.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

   a. Listed and labeled for installation on load side of service equipment.
   b. Indoor Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].
   c. Outdoor Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 MISCELLANEOUS ENCLOSURES

A. UL XCKT or NWIN - Indoor Sheet Metal Miscellaneous Enclosures :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. **<Insert manufacturer's name>**

3. Listing Criteria:

   a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL XCKT or NWIN - Outdoor Sheet Metal Miscellaneous Enclosures :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Erickson Electrical Equipment Company**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Milbank Manufacturing Company**]
h. [**N J Sullivan Company**]
i. [**Square D; Schneider Electric USA**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Erickson Electrical Equipment Company**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Milbank Manufacturing Company**]
h. [**N J Sullivan Company**]
i. [**Square D; Schneider Electric USA**]
j. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
b. Non-Environmental Characteristics: UL 50.

c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.7 RACK OR FRAME SYSTEMS

A. Description: This category covers rack or frame systems that are not complete but include components and assemblies that are intended to power, protect, heat, cool, or otherwise support electrical or electronic equipment that will be installed at a later time.

B. UL NWIN - 19 Inch Open Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**Bud Industries, Inc.**]
d. [**CommScope, Inc**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Dell Technologies Inc.**]
g. [**Hammond Mfg. Co. Inc**]
h. [**Hoffman; brand of nVent Electrical plc**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Kendall Howard**]
k. [**Leviton Manufacturing Co., Inc.**]
l. [**Liebert; Vertiv Holdings Co.**]
m. [**Middle Atlantic Products; Legrand North America, LLC**]
n. [**Ortronics, Inc.**]
o. [**Panduit Corp**]
p. [**Siemon Co. (The)**]
q. [**Tripp-Lite**]
r. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Black Box Corporation**]
    c. [**Bud Industries, Inc.**]
    d. [**CommScope, Inc**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**Dell Technologies Inc.**]
    g. [**Hammond Mfg. Co. Inc**]
    h. [**Hoffman; brand of nVent Electrical plc**]
    i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    j. [**Kendall Howard**]
    k. [**Leviton Manufacturing Co., Inc.**]
    l. [**Liebert; Vertiv Holdings Co.**]
    m. [**Middle Atlantic Products; Legrand North America, LLC**]
    n. [**Ortronics, Inc.**]
    o. [**Panduit Corp**]
    p. [**Siemon Co. (The)**]
    q. [**Tripp-Lite**]
    r. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. UL CCN NWIN; including UL 2416.
    b. Non-Environmental Characteristics: UL 50.
    c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

    a. Threaded rails designed for mounting telecommunications equipment.
    b. Width: Compatible with EIA/ECIA 310-E, **19 inch (482.6 mm)** equipment mounting with an opening of **17.72 inch (450 mm)** between rails.
    c. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
    d. Finish: Manufacturer's standard, baked-polyester powder coat.
    e. Cable Management:

        1) Metal, with integral wire retaining fingers.
        2) Baked-polyester powder coat finish.
        3) Vertical cable management panels have front and rear channels with covers.
        4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

    f. Configuration: [**Two post**][**and**][**four post**].
    g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted,

manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.

b. Floor-Mounted Racks:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.

2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.

3) Rail Depth: [**3 inch (76.2 mm)**][**6 inch (152.4 mm)**]<**Insert value**>

4) Two-Post Load Rating: [**200 lb (91 kg)**][**400 lb (181 kg)**]<**Insert value**>.

5) Four-Post Load Rating: [**1000 lb (454 kg)**][**2000 lb (907 kg)**]<**Insert value**>.

6) Number of Rack Units per Rack: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

7) Threads: [**10-32**][**12-24**][**Universal square**].

8) Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug[**, and a power strip**].

9) Base must have minimum four mounting holes for permanent attachment to floor.

10) Top must have provisions for attaching to cable tray or ceiling.

11) Self-leveling.

c. Wall-Mounted Racks:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.

2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.

3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.

4) Number of Rack Units per Rack: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.

5) Threads: [**10-32**][**12-24**][**Universal square**].

6) Wall Attachment: Four pre-punched mounting holes.

7) Equipment Access: Integral swing.

C. UL NWIN - 19 Inch Enclosed Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]

b. [**Black Box Corporation**]

c. [**Bud Industries, Inc.**]

d. [**Chatsworth Products, Inc.**]

e. [**CommScope, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kendall Howard**]
j. [**Leviton Manufacturing Co., Inc.**]
k. [**Liebert; Vertiv Holdings Co.**]
l. [**Middle Atlantic Products; Legrand North America, LLC**]
m. [**Ortronics, Inc.**]
n. [**Panduit Corp**]
o. [**Siemon Co. (The)**]
p. [**Tripp-Lite**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**Bud Industries, Inc.**]
d. [**Chatsworth Products, Inc.**]
e. [**CommScope, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kendall Howard**]
j. [**Leviton Manufacturing Co., Inc.**]
k. [**Liebert; Vertiv Holdings Co.**]
l. [**Middle Atlantic Products; Legrand North America, LLC**]
m. [**Ortronics, Inc.**]
n. [**Panduit Corp**]
o. [**Siemon Co. (The)**]
p. [**Tripp-Lite**]
q. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

a. Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment.
b. Threaded rails designed for mounting telecommunications equipment.
c. Width: Compatible with EIA/ECIA 310-E, **19 inch (482.6 mm)** equipment mounting with an opening of **17.72 inch (450 mm)** between rails.
d. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
e. Finish: Manufacturer's standard, baked-polyester powder coat.
f. Cable Management:

1) Metal, with integral wire retaining fingers.
2) Baked-polyester powder coat finish.
3) Vertical cable management panels have front and rear channels with covers.
4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.
b. Modular Freestanding Cabinets:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**3000 lb (1362 kg)**]<**Insert value**>.
4) Number of Rack Units: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Removable and lockable side and top panels.
7) Hinged and lockable front and rear doors.
8) Adjustable feet for leveling.
9) Screened ventilation openings in roof and rear door.
10) Cable access provisions in roof and base.
11) RBB.
12) [**Rack**][**Roof**]-mounted, **550 cfm (260 L/s)** fan with filter.
13) Power strip.
14) All cabinets keyed alike.

c. Modular Wall Cabinets:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Lockable front[**and rear**] doors.
7) Louvered side panels.
8) Cable access provisions top and bottom.
9) Grounding lug.
10) [**Rack**][**Roof**]-mounted, **250 cfm (118 L/s)** fan.
11) Power strip.
12) All cabinets keyed alike.

D. UL NWIN - 23 Inch Open Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Black Box Corporation**]
   c. [**CommScope, Inc**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Kendall Howard**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Liebert; Vertiv Holdings Co.**]
   j. [**Middle Atlantic Products; Legrand North America, LLC**]
   k. [**Ortronics, Inc.**]
   l. [**Panduit Corp**]
   m. [**Siemon Co. (The)**]
   n. [**Tripp-Lite**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Black Box Corporation**]
   c. [**CommScope, Inc**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Kendall Howard**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Liebert; Vertiv Holdings Co.**]
   j. [**Middle Atlantic Products; Legrand North America, LLC**]
   k. [**Ortronics, Inc.**]
   l. [**Panduit Corp**]
   m. [**Siemon Co. (The)**]
   n. [**Tripp-Lite**]
   o. **<Insert manufacturer's name>**

3. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

a. Threaded rails designed for mounting telecommunications equipment.
b. Width: Compatible with **23 inch (584.2 mm)** equipment mounting.
c. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
d. Finish: Manufacturer's standard, baked-polyester powder coat.
e. Cable Management:

1) Metal, with integral wire retaining fingers.
2) Baked-polyester powder coat finish.
3) Vertical cable management panels have front and rear channels with covers.
4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

f. Configuration: [**Two post**][**and**][**four post**].
g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.
b. Floor-Mounted Racks:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Rail Depth: [**3 inch (76.2 mm)**][**6 inch (152.4 mm)**]<**Insert value**>
4) Two-Post Load Rating: [**200 lb (91 kg)**][**400 lb (181 kg)**]<**Insert value**>.
5) Four-Post Load Rating: [**1000 lb (454 kg)**][**2000 lb (907 kg)**]<**Insert value**>.
6) Number of Rack Units per Rack: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

7) Threads: [**10-32**][**12-24**][**Universal square**].
8) Vertical and horizontal cable management channels, top and bottom cable troughs,

grounding lug[**, and a power strip**].
9) Base must have minimum four mounting holes for permanent attachment to floor.
10) Top must have provisions for attaching to cable tray or ceiling.
11) Self-leveling.

c. Wall-Mounted Racks:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units per Rack: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.
5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Wall Attachment: Four pre-punched mounting holes.
7) Equipment Access: Integral swing.

E. UL NWIN - 23 Inch Enclosed Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Dell Technologies Inc.**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Kendall Howard**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**Liebert; Vertiv Holdings Co.**]
k. [**Middle Atlantic Products; Legrand North America, LLC**]
l. [**Ortronics, Inc.**]
m. [**Panduit Corp**]
n. [**Siemon Co. (The)**]
o. [**Tripp-Lite**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Dell Technologies Inc.**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Kendall Howard**]

i. [**Leviton Manufacturing Co., Inc.**]
j. [**Liebert; Vertiv Holdings Co.**]
k. [**Middle Atlantic Products; Legrand North America, LLC**]
l. [**Ortronics, Inc.**]
m. [**Panduit Corp**]
n. [**Siemon Co. (The)**]
o. [**Tripp-Lite**]
p. **<Insert manufacturer's name>**

3. Listing Criteria:

   a. UL CCN NWIN; including UL 2416.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

   a. Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment.
   b. Threaded rails designed for mounting telecommunications equipment.
   c. Width: Compatible with **23 inch (584.2 mm)** equipment mounting.
   d. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   e. Finish: Manufacturer's standard, baked-polyester powder coat.
   f. Cable Management:

      1) Metal, with integral wire retaining fingers.
      2) Baked-polyester powder coat finish.
      3) Vertical cable management panels have front and rear channels with covers.
      4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

   g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Color: [**Black**]**<Insert color>**.
   b. Modular Freestanding Cabinets:

      1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on**

Drawings]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**3000 lb (1362 kg)**]<**Insert value**>.
4) Number of Rack Units: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Removable and lockable side and top panels.
7) Hinged and lockable front and rear doors.
8) Adjustable feet for leveling.
9) Screened ventilation openings in roof and rear door.
10) Cable access provisions in roof and base.
11) RBB.
12) [**Rack**][**Roof**]-mounted, **550 cfm (260 L/s)** fan with filter.
13) Power strip.
14) All cabinets keyed alike.

c. Modular Wall Cabinets:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.
5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Lockable front[**and rear**] doors.
7) Louvered side panels.
8) Cable access provisions top and bottom.
9) Grounding lug.
10) [**Rack**][**Roof**]-mounted, **250 cfm (118 L/s)** fan.
11) Power strip.
12) All cabinets keyed alike.

2.8 ENCLOSURE-MOUNTED POWER DISTRIBUTION

A. Description: This category covers relocatable power taps and power distribution units.

B. UL XBYS - Enclosure-Mounted Relocatable Power Tap :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: UL CCN XBYS; including UL 1363.
4. Standard Features:

    a. Rocker-type on-off switch, illuminated when in on position.
    b. LED indicator lights for power and protection status.
    c. LED indicator lights for reverse polarity and open outlet ground.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Wiring Devices: [**Six**]<**Insert quantity**>[**5-15R**][**5-20R**]<**Insert type**> receptacles.
    b. Circuit Breaker and Thermal Fusing: [**When protection is lost, circuit opens and cannot be reset**][**Unit continues to supply power if protection is lost**].
    c. Cord Length: [**Close-coupled, direct plug-in**][**15 ft (4.5 m)**].
    d. Surge Protection: Type 3 SPDs.

        1) Peak Single-Impulse Surge Current Rating: [**33**][**26**][**13**] kA per phase.
        2) Protection modes must be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes may not be more than [**330 V**]<**Insert value**>.

C. UL QPQY - Rack-Mounted Power Distribution Center :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Fujitsu Network Communications**]
    c. [**Vertiv Co.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Fujitsu Network Communications**]
    c. [**Vertiv Co.**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: UL CCN QPQY; including UL 62368-1 or UL 60950-1, in addition to UL Subject 1801.
4. Standard Features:

    a. Input Voltage: [**120 V**][**208 V**][**120/208 V**][**208Y/120 V**][**208 V Delta**].
    b. Input Current: [**15 A**][**20 A**][**30 A**].
    c. Output Receptacle Types and Quantities:

        1) 5-15R: [**6**][**8**][**10**][**12**][**14**][**20**].
        2) 5-20R: [**6**][**10**][**12**][**20**].
        3) L5-20R: [**6**][**12**][**24**].
        4) L5-30R: 6.
        5) L6-20R: [**1**][**12**][**20**][**24**].
        6) L6-30R: [**1**][**6**].
        7) L21-30R: 1.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Rack transfer switch.
    b. Switched receptacles.
    c. Monitoring: [**Unit level**][**Outlet level**].
    d. Sensors:

        1) Temperature: [**1**][**3**].
        2) Humidity.
        3) Dew point.
        4) Airflow.
        5) Plug-and-play dry contact.
        6) Door position.
        7) Water.
        8) Power failure.

PART 3 - EXECUTION

3.1 SELECTION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written

instructions, comply with NFPA 70 for selection of electrical cabinets and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. [**Type 3R**][**Type 4**][**Type 3**] unless otherwise indicated.
b. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
e. Locations in-Ground or Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**][**Type 3RX**].
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: [**Type 12**][**Type 2**][**Type 4**][**Type 5**].
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: [**Type 12**][**Type 12K**].
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: [**Type 4**][**Type 6**].
f. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
g. Locations Exposed to Brief Submersion: [**Type 6**][**Type 6P**].
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**].
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

3.2 INSTALLATION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in ITE Rooms: NFPA 75.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Cabinets and Cutout Boxes: Article 312 of NFPA 70.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Mount cabinets and enclosures at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [**center**][**top**][**bottom**] of box unless otherwise indicated.
2. Do not install cabinets, enclosures, or fittings in contact with concrete or earth.
3. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
4. Identification: Provide labels for cabinets, enclosures, racks and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.
c. Label each cabinet, enclosure, and rack with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Firestop penetrations of rated walls and partitions.
2. Ground and bond RBBs in cabinets, enclosures, and racks.
3. Apply arc-flash hazard warning labels cabinets, enclosures, and racks.
4. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

5. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF ELECTRICAL CABINETS AND ENCLOSURES

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Cabinet, enclosure, or rack will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from cabinets, enclosures, and racks.

3.5 PROTECTION

A. Protect coatings and finishes of cabinets, enclosures, and racks from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 27 16 00

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Task	Specification	Specification Description
26 27 16 00	26 09 23 00	Electrical Power Monitoring
26 27 16 00	26 24 19 00	Motor-Control Centers

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SECTION 26 27 19 00 - MULTI-OUTLET ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Indoor service poles.
5. Floor-mounted, enclosure multi-outlet assemblies.
6. Fire-rated, poke-through assemblies.
7. Above-floor service fittings.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for raceways.
4. Section 260533.16 "Boxes and Covers for Electrical Systems" for floor boxes and covers.
5. Section 262726 "Wiring Devices" for receptacles and switches.
6. Section 271513 "Communications Copper Horizontal Cabling" for control-voltage communications outlet devices.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Indoor service poles.
5. Floor-mounted, enclosure multi-outlet assemblies.
6. Fire-rated, poke-through assemblies.
7. Above-floor service fittings.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED, SURFACE METAL RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings. Multi-outlet assemblies used for communications or data must also comply with UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.

E. Wall-Mounted, Surface Metal Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

3. Options:

   a. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
   b. Color: <**Indicate color**>.
   c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
   d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
   e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Wall-Mounted, Surface Metal Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell**

Incorporated]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.2 WALL-MOUNTED, SURFACE NONMETALLIC RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface nonmetallic raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5A for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.

E. Wall-Mounted, Surface Nonmetallic Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**PVC**]<**Indicate material**>.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Wall-Mounted, Surface Nonmetallic Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**PVC**]<**Indicate material**>.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].

e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.3 FLOOR-MOUNTED, RECESSED METAL RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece flush-mounted, in-floor, metal raceway, with factory-wired multi-outlet harness, for installation flush in floor or under floor finish.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Floor-Mounted, Recessed Metal Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Load-Bearing Capacity: [**1000 lb (450 kg)**]<**Indicate capacity**>.
b. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
c. Color: <**Indicate color**>.
d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting

anywhere along length of recessed raceway.

e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Floor-Mounted, Recessed Metal Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

3. Options:

   a. Load-Bearing Capacity: [**1000 lb (450 kg)**]<**Indicate capacity**>.
   b. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
   c. Color: <**Indicate color**>.
   d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting anywhere along length of recessed raceway.
   e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
   g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.4 INDOOR SERVICE POLES

A. Description: Factory-assembled and -wired, exposed raceway and fittings to route electrical wiring from connections above ceiling to outlets below ceiling.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings, and UL 2024 for communications raceway and fittings.

2. Listed and labeled in accordance with NFPA 90A for installation in air-handling plenum spaces.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to above ceiling structural supports; with pole foot and carpet pad attachment.
4. Provide barrier to separate channel for power wiring from channel for voice and data communication cabling.

D. Indoor Service Pole :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Panduit Corp**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Panduit Corp**]
   c. <**Insert manufacturer's name**>

3. Options:

   a. Material: [**Aluminum**][**Steel**].
   b. Height: <**Insert height**> below ceiling, and <**Insert height**> above ceiling.
   c. Finish: [**Manufacturer's standard painted finish and trim combination**][**Satin-anodized aluminum**].

      1) Color: [**Clear anodized**][**White**][**Ivory**][**Gray**][**Black**]<**Insert color**>.

   d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
   e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
   g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.5 FLOOR-MOUNTED ENCLOSURE MULTI-OUTLET ASSEMBLIES

A. Description: Floor-mounted box with cover enclosing multiple power[**and communications**] outlets in a single assembly.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
3. Compartments: Barrier separates power from voice and data communication cabling.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Floor-Mounted Enclosure Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

3. Options:

   a. Floor Box and Cover:

      1) [**Provide floor boxes classified for use in 1-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      2) [**Provide floor boxes classified for use in 1-1/2-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      3) [**Provide floor boxes classified for use in 2-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      4) [**Provide floor boxes classified for use in 3-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      5) [**Provide floor boxes for installation in raised floors.**]
      6) [**Provide floor boxes for installation in wood floors.**]
      7) Floor boxes for concrete floors must provide a minimum of **4 inch (100 mm)** of adjustment prior to concrete pour and a minimum of **1/2 inch (12.5 mm)** after concrete is set.
      8) Provide [**cast-metal**][**sheet metal**][**nonmetallic**] floor boxes with [**four**][**six**][**eight**][**10**] gangs.
      9) Provide brass or aluminum flanges approved for use on carpet, tile, or wood floor applications. Flanges and cover plates must have a buffed appearance and a

protective finish. Covers must match appearance of floor flanges and provide access to included devices.

10) Covers must lay flat on floor surface when open. Provide for cable egress when cover is closed. Provide ADA-compliant covers.

11) Provide flanges, mounting brackets, keystones, and accessories for mounting devices and connections indicated on Drawings.

b. Outlets:

1) Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."

2) Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3) Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."

4) A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.6 FIRE-RATED, POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables.
3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Fire-Rated, Poke-Through Assembly : [**Recessed**][**Flush**][**Pedestal**] type.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Square D; Schneider Electric USA**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Square D; Schneider Electric USA**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Options:

a. Modular, [**recessed**][**flush**][**pedestal**]-type, dual-service units suitable for wiring method used[**, with cover flush with finished floor**].
b. Service Plate, Flaps, and Cover: [**Rectangular**][**Round**], [**die-cast aluminum**][**solid brass**] with satin finish.
c. Core Size: Selected to fit nominal [**4 inch (100 mm)**][**6 inch (150 mm)**][**8 inch (200 mm)**][**10 inch (250 mm)**] cored holes in floor and matched to floor thickness.
d. Closure Plug: Close unused cored opening and reestablish fire rating of floor.
e. Feed Conduits: Provide connection points for conduits as indicated on Drawings or required for conductors shown. Provide minimum [**1 inch (25 mm)**]<**Insert nominal size**> conduits for communications cables.
f. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> gray finish, unless otherwise indicated, in accordance with Section 262726 "Wiring Devices."
g. Telephone and Data Outlets: <**Indicate quantity**>[**blank cover with bushed cable opening.**][**modular, keyed, color-coded, 8PSJ jacks in accordance with Section 271513 "Communications Copper Horizontal Cabling."**]
h. Audio and Video Outlets: [**Blank cover with bushed cable opening**]<**Indicate quantity and type**>.

2.7 ABOVE-FLOOR SERVICE FITTINGS

A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables in compliance with NFPA 76.
3. See Section 260533.16 "Boxes and Covers for Electrical Systems" for more details and requirements for floor boxes.
4. Compartments: Barrier separates power from voice and data communication cabling.

C. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

D. Pedestal-Type, Above-Floor Service Fitting :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]

c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Options:

a. Service Plate and Housing: [**die-cast aluminum**][**solid brass**] with satin finish.
b. Wiring, Raceways, and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of [**two**][**four**] four-pair cables in accordance with Section 260533.23 "Surface Raceways for Electrical Systems" and Section 271513 "Communications Copper Horizontal Cabling."
c. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> gray finish, unless otherwise indicated, in accordance with Section 262726 "Wiring Devices."
d. Communications Outlets: <**Indicate quantity**>[**blank cover with bushed cable opening.**][**modular, keyed, color-coded, 8PSJ jacks in accordance with Section 271513 "Communications Copper Horizontal Cabling."**]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 for device mounting heights, except where requirements on Drawings or in this Section are stricter.

B. Comply with NECA 101 for installation requirements for steel raceways, except where requirements on Drawings or in this Section are stricter.

C. Comply with NECA 102 for installation requirements for aluminum raceways, except where requirements on Drawings or in this Section are stricter.

D. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies.

E. Provide terminations, adapters, boxes, and other fittings required for installation.

F. Install surface raceway with a minimum **2 inch (50 mm)** radius control at bend points.

G. Secure metallic surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inch (1200 mm)** and with no fewer than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.

H. Do not install aluminum raceways or fittings in contact with concrete.

I. Secure nonmetallic surface raceway with screws or other anchor-type devices in each wiring channel at intervals not exceeding **18 inch (460 mm)** and with no fewer than two supports per straight raceway section in each wiring channel. Support nonmetallic surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.

J. Do not install PVC raceways where ambient temperature exceeds [**122 deg F (50 deg C)**]<**Insert temperature**>. Conductors with insulation rated higher than 75 deg C installed in PVC raceways may not be operated at a temperature greater than 75 deg C.

K. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

L. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and support.

M. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for installation of raceways.

N. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for additional requirements for floor boxes.

O. Coordination with Other Work:

1. Adjust locations of multi-outlet assemblies to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
2. Provide outlets with special requirements, such as GFCI, AFCI, or special environmental requirements, where required by Drawings or to meet codes.
3. Adjust locations of poke-through assembly penetrations to coordinate with locations of structural members, concealed piping, and concealed conduit. Obtain written approval from Architect prior to drilling penetrations in floors other than where dimensioned on architectural Drawings. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 27 19 00

Task	Specification	Specification Description
26 27 19 00	26 05 39 00	Underfloor Raceways For Electrical Systems
26 27 23 00	26 27 26 00	Wiring Devices

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SECTION 26 27 26 00 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Cord reels and fittings.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
8. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
9. Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.
10. Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.
11. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
12. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.
13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
14. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.
15. Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.
16. Section 262726.39 "Locking Receptacles" for additional wiring device products.
17. Section 262726.41 "Pin-and-Sleeve Receptacles" for additional wiring device products.

18. Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.
19. Section 262726.51 "Connectors, Cords, and Plugs" for additional wiring device products.
20. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

C. GFCI: Ground-Fault Circuit Interrupter.

D. SPD: Surge Protective Device.

E. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting [**as videoconference**][**at Project site**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

2. Include manufacturer's sample extended warranty language.

B. Samples: One for each type of product specified, in each finish and color specified for [**public spaces**] .

C. Shop Drawings: Prepare and submit wiring diagrams for duplex straight-blade receptacles with integral switching means.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

3. Record floor plan Drawings indicating as-installed locations of switches and dimmers, indicating lighting zone's each device control, to verify extent of ability of the installed Work to provide occupant control for customizing environment.
4. Record floor plan Drawings indicating as-installed locations of uncontrolled and marked controlled receptacles superimposed on office furniture layout, to verify extent of ability of the installed Work to provide each occupant ability to select at least one uncontrolled receptacle and at least one controlled receptacle for powering workspace equipment. Indicate locations of UL-approved relocatable power taps and power strips, indicating means of securing protection from damage and accessibility for inspection. Indicate locations of temporary extension cords, indicating plan for replacing them with permanent wiring within 90 days.

5. Product Data for Automated Demand Response Controls: For automated demand response controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

E. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For wiring devices.

B. Field Reports: Manufacturer's field reports for field QC support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Special manufacturer extended warranty for devices and cord reels and fittings.
2. Special installer extended warranty for devices and cord reels and fittings.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish straight-blade receptacles and connectors, cords, and plugs.

B. Special Tools: Furnish straight-blade receptacles and connectors, cords, and plugs.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able

to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.9 WARRANTY FOR DEVICES

A. Special Installer Extended Warranty: Installer warrants that installed devices perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to the Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

1.10 WARRANTY FOR CORD REELS AND FITTINGS

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .

b. Configuration:

1) General-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) General-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) Extra-heavy-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
4) Extra-heavy-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
5) Extra-heavy-duty, 120-277 V, 30 A, [**single pole**][**double pole**][**three way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Black**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) 120-277 V, 30 A, [**single pole**][**double pole**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. Rocker Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) 120-277 V, 15 A, [**single pole**][**three way**][**four way**] .
      2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

   c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Rocker Switch with Nightlight :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration: 120-277 V, 20 A, [**single pole**][**three way**][**four way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Type I Dimmer Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**GE Lighting; a Savant Company**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lutron Electronics Co., Inc**]
f. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. General-Use Switch Dimmers: UL CCN EOYX and UL 1472.

4. Standard Features:

a. UL 1472 Type I dimmer.

b. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
c. Switch Style: [**Toggle**][**Rocker**][**Push button**] .
d. Dimming Control Style: [**Slide**][**Rotary**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Air-Gap Fan-Speed Controller Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Fan-Speed Controls: UL CCN GQHG and UL 1917.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**][**NEMA 5-30R**][**NEMA 5-50R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**][**NEMA 6-30R**][**NEMA 6-50R**] .
4) General-duty, smooth face, NEMA 6-20R.
5) General-duty, [**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**] .
6) Heavy-duty, [**NEMA 5-30R**][**NEMA 5-50R**] .
7) Heavy-duty, [**NEMA 6-30R**][**NEMA 6-50R**] .
8) Heavy-duty, [**NEMA 7-20R**][**NEMA 7-30R**][**NEMA 7-50R**] .
9) Heavy-duty, [**NEMA 14-20R**][**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**][**NEMA 14-60R**] .
10) Heavy-duty, [**NEMA 15-20R**][**NEMA 15-30R**][**NEMA 15-50R**][**NEMA 15-60R**] .
11) Heavy-duty, [**NEMA 18-20R**][**NEMA 18-30R**][**NEMA 18-50R**][**NEMA 18-60R**] .
12) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
13) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**White nylon**][**Ivory nylon**][**Brass**][**Stainless steel**][**Brushed brass**][**Nickel plated**] .
   b. Configuration: Recessed, smooth wallplate; [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**Brushed brass**][**Nickel plated**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

2.6 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
4) General-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .
5) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
6) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
7) Heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
8) Heavy-duty, smooth face, NEMA 6-15R.
9) Heavy-duty, NEMA 7-15R.
10) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
11) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
12) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
13) Extra-heavy-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Leviton Manufacturing Co., Inc.**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      6) Extra heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Isolated Ground Duplex Straight-Blade Receptacle with Type 3 Surge Protective Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
2) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
3) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.
4) General-duty, smooth face, two USB-A ports.
5) General-duty, smooth face, four USB-A ports.

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Wired Full-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. Wired Half-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.7 HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

A. Hospital-Grade, Non-Ferrous Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration:

        1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
        3) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        4) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Hospital-Grade, Tamper-Resistant, Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Leviton Manufacturing Co., Inc.**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Pass & Seymour; Legrand North America, LLC**]
   d. >

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration:

      1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
      2) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.8 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]

b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Outlet Branch-Circuit Type GFCIs and AFCIs: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch** **(1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.9 LOCKING RECEPTACLES

A. UL RTRT - NEMA, 125 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton, Wiring Devices; Arrow Hart**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

   a. Device Color: Black with yellow voltage indication on face.
   b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

B. UL RTRT - NEMA, 125 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

   a. Device Color: Black with yellow voltage indication on face.
   b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

C. UL RTRT - NEMA, 250 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

   a. Device Color: Black with blue voltage indication on face.
   b. Configuration:

      1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
      2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
      3) 4 pole, 4 wire, non-grounding, [**NEMA L18-20R**][**NEMA L18-30R**] .
      4) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

D. UL RTRT - NEMA, 250 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

a. Device Color: Black with blue voltage indication on face.
b. Configuration:

1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
3) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

2.10 PIN-AND-SLEEVE RECEPTACLES

A. UL QLIW - C2 Series, 125/250 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
b. Voltage Rating: 125/250 V.
c. Configuration:

1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

B. UL QLIW - C2 Series, 480 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

   a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
   b. Voltage Rating: 480 V.
   c. Configuration:

      1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
      2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
      3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

2.11 CORD REELS AND FITTINGS

A. Power Outlet Cord Management Assembly :

1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
2. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:

   a. Cord Management System:

      1) Spring-driven commercial/industrial-use cord reel .
      2) Cord reel for use in Class I Group D hazardous location .

   b. Termination Fitting:

      1) the Owner-furnished fitting.

      2) Outdoor-use, watertight, sealed cord connector;

3. Accessories:

   a. Mounting: [**Ceiling**][**Wall**][**Floor**] mounted.

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**] .

B. Spring-Driven Commercial/Industrial-Use Cord Reel, 14 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton**]
   b. [**Ericson Manufacturing Company**]
   c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**18 A**][**15 A**][**12 A**][**10.5 A**][**7.5 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .

2) 14 AWG, three wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][35 ft (10.7 m)][40 ft (12.2 m)][50 ft (15.2 m)][60 ft (18.3 m)][70 ft (21.3 m)] .
3) 14 AWG, five wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][40 ft (12.2 m)][50 ft (15.2 m)][60 ft (18.3 m)] .
4) 14 AWG, seven wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)][40 ft (12.2 m)][50 ft (15.2 m)] .
5) 14 AWG, nine wires and equipment ground, [20 ft (6 m)][30 ft (9.1 m)] .
6) 14 AWG, eleven wires and equipment ground, [20 ft (6 m)][60 ft (18.3 m)] .

7) 14 AWG, two wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)][90 ft (27.4 m)][100 ft (30.5 m)][125 ft (38.1 m)][150 ft (45.7 m)] .
8) 14 AWG, three wires and equipment ground, [25 ft (7.6 m)][45 ft (13.7 m)][65 ft (19.8 m)][80 ft (24.4 m)][90 ft (27.4 m)][100 ft (30.5 m)][125 ft (38.1 m)][150 ft (45.7 m)] .
9) 14 AWG, five wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)] .
10) 14 AWG, seven wires and equipment ground, [25 ft (7.6 m)][35 ft (10.7 m)][45 ft (13.7 m)] .
11) 14 AWG, nine wires and equipment ground, [25 ft (7.6 m)][50 ft (15.2 m)] .
12) 14 AWG, eleven wires and equipment ground, [25 ft (7.6 m)][30 ft (9.1 m)] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

c. Component Amplification Factor (ap): [**1.0**][**2.5**].

d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Spring-Driven Commercial/Industrial-Use Cord Reel, 12 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Appleton; Emerson Electric Co., Automation Solutions**]
b. [**Ericson Manufacturing Company**]
c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Reelcraft Industries Inc**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**25 A**][**20 A**][**16 A**][**14 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**] .
      2) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**45 ft (13.7 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**100 ft (30.5 m)**] .
      3) 12 AWG, five wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      4) 12 AWG, seven wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**] .

      5) 12 AWG, two wires and equipment ground, [**35 ft (10.7 m)**][**45 ft (13.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**100 ft (30.5 m)**][**125 ft (38.1 m)**][**150 ft (45.7 m)**] .
      6) 12 AWG, three wires and equipment ground, [**35 ft (10.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**125 ft (38.1 m)**] .
      7) 12 AWG, four wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      8) 12 AWG, five wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**] .
      9) 12 AWG, seven wires and equipment ground, [**25 ft (7.6 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

D. Spring-Driven Cord Reel for Use in Class I Group D Hazardous Locations :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton; Emerson Electric Co., Automation Solutions**]
   b. [**Conductix-Wampfler USA; Delachaux Group**]
   c. [**KH Industries, Inc.**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord Reels for Use in Hazardous Locations: UL CCN SAOX and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**35 A**][**25 A**][**20 A**][**18 A**][**15 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
      2) 14 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
      3) 12 AWG, two wires and equipment ground, [**30 ft (9.1 m)**][**50 ft (15.2 m)**] .

      4) 14 AWG, two wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .
      5) 14 AWG, three wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
      6) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
      7) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**] .
      8) No. 10 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      9) No. 10 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

2.12 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Ericson Manufacturing Company**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Fuseless Attachment Plugs: UL CCN AXUT and UL 498.

3. Standard Features:

   a. Configuration:

      1) NEMA 5-15 [**with diagnostic LED indicator**] .
      2) NEMA 5-20 [**with diagnostic LED indicator**] .
      3) NEMA 6-15.
      4) NEMA 6-20.
      5) NEMA L5-15.
      6) NEMA L5-20 [**with diagnostic LED indicator**] .
      7) NEMA L5-30.
      8) NEMA L6-15.
      9) NEMA L6-20.
      10) NEMA L6-30.
      11) NEMA L7-15.
      12) NEMA L7-20.
      13) NEMA L7-30.
      14) NEMA L14-20.
      15) NEMA L14-30.
      16) NEMA L15-20.
      17) NEMA L15-30.
      18) NEMA L16-20.
      19) NEMA L16-30.
      20) NEMA L17-30.
      21) NEMA L18-30.

2.13 MAINTENANCE MATERIAL ITEMS FOR STRAIGHT-BLADE RECEPTACLES

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. SPD Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.
2. Controlled Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to controlled receptacles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

2.14 MAINTENANCE MATERIAL ITEMS FOR CONNECTORS, CORDS, AND PLUGS

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. Cord Connectors: [**One**] of each kind.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cord connectors, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for the Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels and Fittings:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

A. Private and Open Office Spaces:

1. Uncontrolled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one uncontrolled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
2. Controlled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one controlled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
3. Contact Architect for resolution of discrepancies between these requirements and Drawings, as directed by the Owner.

3.3 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Life Safety and Means of Egress Work: NFPA 101.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Wiring Devices: NECA NEIS 130.
6. Mounting Heights: NECA NEIS 1.
7. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification:

a. Identify cover or cover plate for device with panelboard identification and circuit number.

b. Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.

      1) Identify cover or cover plate for device with panelboard identification and circuit number.

      2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

   d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.6 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.

      1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.7 INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in UL 1686.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.8 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Hot Work: NFPA 51B.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

3.9 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

3.10 FIELD QUALITY CONTROL OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections in accordance with manufacturers' published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.11 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.12 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.13 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]

as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Measure line voltage.
3. Measure percent voltage drop.
4. Measure ground impedance, which must be not greater than 2 ohms.
5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.14 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.15 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.16 SYSTEM STARTUP FOR GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.17 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within [**12**] months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to the Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.18 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

B. Cord Reels and Fittings: After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

C. Connectors, Cords, and Plugs: After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

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SECTION 26 27 26 00A - RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles with AFCI devices.
2. Receptacles with both AFCI and GFCI devices.
3. Receptacles with GFCI devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
8. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
9. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
10. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.
11. Section 262726.41 "Pin-and-Sleeve Receptacles" for pin-and-sleeve receptacles.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. GFCI: Ground-Fault Circuit Interrupter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

   a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and

fitness for purpose.

b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.

c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Samples:

1. One for each kind of receptacles with AFCI devices[**and cover plate accessory**] specified, in each finish and color specified.
2. One for each kind of receptacles with AFCI and GFCI devices[**and cover plate accessory**] specified, in each finish and color specified.
3. One for each kind of receptacles with GFCI devices[**and cover plate accessory**] specified, in each finish and color specified.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 RECEPTACLES WITH AFCI DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH BOTH AFCI AND GFCI DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Outlet Branch-Circuit Type GFCIs and AFCIs: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 RECEPTACLES WITH GFCI DEVICES

A. General-Grade Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]

b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. General-Grade, Weather-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on**

architectural Drawings].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth

finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

H. General-Grade, Isolated Ground, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

I. General-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade

Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

J. Hospital-Grade Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

K. Hospital-Grade, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

L. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

M. Hospital-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]

d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

N. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

O. Hospital-Grade, Isolated Ground, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

P. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.3 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.

      1) Identify cover or cover plate for device with panelboard identification and circuit number.
      2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
3. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.

2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
8. <**Insert tests and inspections**>.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 26 00A

SECTION 26 27 26 00B - CONNECTORS, CORDS, AND PLUGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuseless attachment cord connectors.
2. Extra-hard-usage, jacketed, flexible cord.
3. Antimicrobial, extra-hard-usage, jacketed, flexible cord.
4. Hard-usage, jacketed, flexible cord.
5. Strain-relief cord grips.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262726.43 "Special-Purpose Power Outlet Assemblies" specifies fabricated power-outlet cord management assemblies containing connectors and cords specified by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: One for each kind of cord connector specified, in each finish and color specified.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSELESS ATTACHMENT CORD CONNECTORS

A. Description: Connectors for attachment to cord that do not incorporate switches or overcurrent protection.

B. Indoor-Use, Dry Location Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration: NEMA 5-15[**with lighted blade**].

C. Indoor-Use, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

D. Hospital-Grade, Indoor-Use, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ericson Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

   a. Configuration: [**NEMA 5-15**][**NEMA 5-20**].

E. Indoor-Use, Compression-Grip, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ericson Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.

F. Outdoor-Use, Watertight, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. **<Insert manufacturer's name>**

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.

18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

G. Antimicrobial, Watertight, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. **<Insert manufacturer's name>**

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Options:

a. Antimicrobial additive embedded in connector grip polymer.
b. Configuration:

1) NEMA 5-15.
2) NEMA 5-20.
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20.
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

2.3 EXTRA-HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Indoor Damp Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**STO**][**STOO**][**SEO**][**SEOO**][**SO**][**SOO**].

B. Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**STOW**][**STOOW**][**SEOW**][**SEOOW**][**SOW**][**SOOW**].

2.4 ANTIMICROBIAL, EXTRA-HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Antimicrobial, Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket for pendant or portable extra-hard usage in damp or wet locations.
b. Antimicrobial additive embedded in jacket polymer.
c. Flexible Cord Type: [**STOW**][**SEOW**].
d. Configuration:

1) No. 14 AWG, two wires and equipment ground.
2) No. 12 AWG, two wires and equipment ground.
3) No. 12 AWG, three wires and equipment ground.
4) No. 10 AWG, two wires and equipment ground.
5) No. 10 AWG, three wires and equipment ground.

2.5 HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Oil-Resistant, Hard-Usage, Jacketed, Flexible Cord for Indoor Damp Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 300 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**SJTO**][**SJTOO**][**SJEO**][**SJEOO**][**SJO**][**SJOO**].

B. Oil-Resistant, Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Ericson Manufacturing Company**]
   c. [**Southwire Company, LLC**]
   d. [**U.S. Wire & Cable Corp.**]
   e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

   a. 300 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
   b. Flexible Cord Type: [**SJTOW**][**SJTOOW**][**SJEOW**][**SJEOOW**][**SJOW**][**SJOOW**].

2.6 STRAIN-RELIEF CORD GRIPS

A. Strain-Relief Cord Grip:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ericson Manufacturing Company**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Pass & Seymour; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Reference Standards: UL CCN QCRV and UL 514B.

3. Standard Features:

   a. Strain-relief grip for bus drop cable.
   b. Noninsulated strain-relief grip for flexible cord.
   c. Insulated strain-relief grip for flexible cord.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' instructions**>.

D. Interfaces with Other Work:

1. Coordinate with Section 262726.43 "Special-Purpose Power Outlet Assemblies" for installation of connectors and cords on fabricated power-outlet cord management assemblies.
2. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.
2. <**Insert Project-specific test or inspection**>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 26 27 26 00B

Task	Specification	Specification Description
26 27 26 00	26 09 23 00	Electrical Power Monitoring

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SECTION 26 27 33 00 - POWER DISTRIBUTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured power distribution units.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. EPO: Emergency power-off.

B. SPD: Surge protective device.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For power distribution units. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives of Owner, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.
2. Coordinate layout and installation of power distribution units with Owner's equipment.

3. Record agreements reached in meetings and distribute record to other participants.
4. Adjust arrangements and locations of power distribution units to accommodate and optimize arrangement and space requirements of equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Factory test reports.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Manufacturer's field reports for field quality-control support.

C. Manufacturer's field reports for system startup support.

D. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able

to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 MANUFACTURED POWER DISTRIBUTION UNITS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate power distribution units.
c. Factory Tests and Inspections: Test and inspect power distribution units, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct factory sound-level tests.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Power Distribution Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Liebert; Vertiv Holdings Co.**]
d. [**Myers Power Products, Inc**]
e. [**Power Distribution, Inc.; Eaton, Electrical Sector**]
f. [**Powersmiths International Corp.; Socomec Group**]
g. [**Square D; Schneider Electric USA**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Liebert; Vertiv Holdings Co.**]
d. [**Myers Power Products, Inc**]

e. [**Power Distribution, Inc.; Eaton, Electrical Sector**]
f. [**Powersmiths International Corp.; Socomec Group**]
g. [**Square D; Schneider Electric USA**]
h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Standard Features:

a. Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in single cabinet or modular assembly of cabinets[**each with full-swivel casters mounted to bottom frame**]. Include the following components:

1) Input-power, circuit-breaker section.
2) Isolation transformer.
3) SPD system.
4) Output panelboard(s).
5) Alarm, monitoring, and control system.

b. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
c. Wiring Access: [**Top**][**and**][**bottom**] wiring access.
d. Unit Capacity Rating: Carry indicated RMS kilovolt-ampere load continuously without affecting normal operation of circuit breakers, monitoring system, or unit controls and without exceeding rated insulation temperature for the following input voltage and load current:

1) Input Voltage: Within rated input-voltage tolerance band of unit.
2) Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.

e. Input-Power, Circuit-Breaker Section: Three-pole, [**shunt-tripped,**]thermal-magnetic-type circuit breaker, rated for indicated interrupting capacity and 125 percent of input current of unit at 100 percent rated load at unit capacity rating.

1) Dual-Input Units:

a) Two input circuit breakers arranged to provide transfer between two input-power sources.
b) Controls and interfaces to allow selecting either open- or closed-transition transfer between two input-power sources.
c) Use 120 V permissive signal from both upstream voltage sources to indicate acceptable conditions for closed-transition transfer.
d) Open second circuit breaker automatically after closed-transition transfer is completed.

2) Static Transfer Switch: Three-pole, double-throw; solid-state, automatic transfer switch.

f. Isolation Transformer Section: Dry-type, electrostatically shielded, three-phase, common-core, convection-air-cooled isolation transformer.

1) Comply with UL 1561[**including requirements for nonsinusoidal load-current-handling capability defined by designated K-factor**].
2) Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses, one leg per phase.
3) Coil Material and Insulation: [**Aluminum**][**Copper**] windings, 220 deg C insulation

class.

4) Temperature Rise: Designed for [**80**][**115**][**150**] deg C rise above 40 deg C ambient.
5) Output Impedance: 3.5 plus or minus 0.5 percent.
6) Regulation: 2 to 4 percent maximum, at full-resistive load; 5 percent maximum, at rated nonlinear load.
7) Taps: Six full-capacity compensation taps at 2.5 percent increments; two above and four below nominal voltage.
8) Full-Load Efficiency: Minimum 96 percent at rated[**nonlinear**] load.
9) Magnetic-Field Strength External to Transformer Enclosure: Less than 0.1 G at **18 inch (450 mm)**.
10) K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

    a) Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
    b) Indicate value of K-factor on transformer nameplate.

11) Electrostatic Shielding: Independently shield each winding with full-width, [**single**][**double**], copper, electrostatic shield arranged to minimize interwinding capacitance.

    a) Coil leads and terminal trips must be arranged to minimize capacitive coupling between input and output connections.
    b) Shield Terminal: Separate, and marked "Shield" for grounding connection. Shield must be connected to reference ground point for distribution panels.
    c) Capacitance: Limit capacitance between primary and secondary windings to maximum of 33 pF over frequency range of 20 Hz to 1 MHz.
    d) Common-Mode Noise Attenuation: 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
    e) Normal-Mode Noise Attenuation: 52 dB minimum, 1.5 to 10 kHz.

12) Neutral Rating: [**1.732 times**][**200 percent of**] system full-load ampere rating.
13) Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

g. SPD System: Integrated SPD system, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," to protect unit panelboard, and having the following features:

1) Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize SPD system while permitting power distribution units to continue operation. Fuses must be rated for 200 kA interrupting capacity.
2) Nonlinear Loading: System must accommodate rated-load current with minimum 3.0 crest factor and 85 percent total harmonic distortion.

h. Output Panelboards: Panelboards complying with Section 262416 "Panelboards" except for mounting provisions. Mount [**single**][**double**] panelboards on power distribution unit behind flush doors. Include the following features:

1) Construction: [**30**][**42**] pole, [**208 V**][**240 V**], three phase; capable of accepting branch circuit breakers rated up to 100 A.
2) Panelboard Rating: [**225 A**]<**Insert value**>, with main circuit breaker.
3) Panelboard Phase, Neutral, and Ground Buses: Copper, with neutral bus at least

[**1.732**][**two**] times nominal phase bus rating.

4) Isolated Ground Bus: Copper, adequate for branch-circuit equipment ground conductors; insulated from supports.
5) Branch Circuit Breakers: [**Bolt**][**Plug**] on.
6) Cable Racks: Removable and arranged for supporting and routing cables for panelboard entrance.
7) Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in future.

i. Power Distribution Unit Controls: Include the following control features:

1) EPO switch integral with power distribution unit.
2) Power-off input terminals for connection to remote EPO switch.
3) Shutdown with automatic unit disconnection for the following alarm conditions:

a) High temperature in transformer coil.
b) High or low input or output voltage.
c) Phase loss.
d) Ground fault.
e) Reverse-phase rotation.

4) Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact set must change state if monitored function goes into alarm mode.
5) Auxiliary Control Outputs: <**Insert control function outputs**>.

j. Monitoring, Status, and Alarm Annunciation: Microprocessor-based monitoring, status, and alarm annunciation panel mounted flush in front of power distribution unit to provide status display and failure-indicating interface for the following:

1) Power Monitoring:

a) Input Voltage: Line-to-line, RMS.
b) Output Voltage: Line-to-line and line-to-neutral, RMS.
c) Output current.

2) Status Indication: Unit on.
3) Alarm Annunciation:

a) High temperature in transformer coil.
b) High and low input voltage.
c) High and low output voltage.
d) Phase loss.
e) Ground fault.
f) Frequency.
g) Phase rotation.
h) SPD module failure.

4) Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch must silence audible alarm but leave visual indication active until alarm condition is corrected.

k. Sound Level:

1) Fully assembled products must have average audible sound levels[**more than 3 dB**] below the following maximum sound levels, without fans running, when factory

tested in accordance with IEEE C57.12.91:

a) 9 kVA and Smaller: [**40**]<**Insert number**> dB(A-weighted).
b) 9.01 to 30 kVA: [**45**]<**Insert number**> dB(A-weighted).
c) 30.01 to 50 kVA: [**45**][**48**]<**Insert number**> dB(A-weighted).
d) 50.01 to 150 kVA: [**50**][**53**]<**Insert number**> dB(A-weighted).
e) 150.01 to 300 kVA: [**55**][**58**]<**Insert number**> dB(A-weighted).
f) 300.01 to 500 kVA: [**60**][**63**]<**Insert number**> dB(A-weighted).
g) 500.01 to 700 kVA: [**62**][**65**]<**Insert number**> dB(A-weighted).
h) 700.01 to 1000 kVA: [**64**][**67**]<**Insert number**> dB(A-weighted).

2) Mount transformer on rubber isolation pads.

l. Enclosure:

1) Single, freestanding, galvanized steel, UL 50E Type 1 enclosure. Opening of exterior door may not provide access to live parts. Panels and covers that expose hazardous voltages must require tools to remove.
2) Access from front, top, and side only for installation, operations, and normal maintenance, including infrared scanning of bus and breakers. Normal operating controls and instrumentation must be located on front of enclosure.
3) Arrange enclosure to allow lifting and moving via forklift.

m. Finish: Manufacturer's standard finish over corrosion-resistant pretreatment and primer.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**6.0**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.

9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Connections to Connectors and Terminals: Comply with torque-tightening values in UL 486A-486B.
11. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Arrange power distribution units to provide adequate access to equipment and circulation of cooling air. Locate transformers away from corners and not parallel to adjacent wall surface.

D. Interfaces with Other Work:

1. Identification: Provide labels for power distribution units and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Coordinate size and location of [**concrete bases**][**access flooring support**] with actual power distribution unit provided.
3. Equipment Mounting:

   a. Provide cast-in-place concrete equipment base(s) for equipment.
   b. Provide vibration isolation and seismic control devices for equipment.
   c. Supports must penetrate and be independent of access flooring.

4. Ground and bond power distribution unit.
5. Install flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.2 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for circuit

breakers, molded case; and for transformers, dry type, air cooled, low voltage. Certify compliance with test parameters.

3. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.
4. Test Labeling: On completion of satisfactory testing of each unit, attach dated and signed "Satisfactory Test" label to tested component.

E. Nonconforming Work:

1. Power distribution unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Verify that power distribution units are installed and connected in accordance with the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal and with published installation requirements in other electrical Sections.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Adjust power distribution units to provide optimal voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain power distribution units.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.7 PROTECTION

A. After installation, protect power distribution units from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Power Distribution Units: Two months after Substantial Completion, perform infrared scan of conductor and bus joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of power distribution units, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies joints and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 27 33 00

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Task	Specification	Specification Description
26 27 73 00	26 27 26 00	Wiring Devices

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SECTION 26 28 13 00 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonrenewable cartridge fuses.
2. Spare-fuse cabinets.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 260573 "Power System Studies" specifies coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit [**in electronic format suitable for use in coordination software**][**and**][**in PDF format**].
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

1.4 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than [**40 deg F (5 deg C)**]<**Insert temperature**> or more than [**100 deg F (38 deg C)**]<**Insert temperature**>, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 NONRENEWABLE CARTRIDGE FUSES

A. Class CC Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-4 (Class CC).

5. Standard Features:

a. NEMA FU 1, Class CC, 200 kA(sym) interrupt rating, current limiting, sizes up to 30 A, 600 V(ac), [**12 s minimum time-delay at 200 percent**][**non-time-delay**], with rejection feature.

B. Class CD Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Littelfuse, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Littelfuse, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-18 (Class CD).

5. Standard Features:

   a. UL 248-18, Class CD, 200 kA(sym) interrupt rating, current limiting, sizes 31 to 60 A, 600 V(ac), [**12 s minimum time-delay at 200 percent**][**non-time-delay**], with rejection feature.

C. Class J Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-8 (Class J).

5. Standard Features:

    a. NEMA FU 1, Class J, [**200 kA(sym)**][**300 kA(sym)**] interrupt rating, current limiting, sizes up to 600 A, 600 V(ac), [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

D. Class L Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-10 (Class L).

5. Standard Features:

    a. NEMA FU 1, Class L, 300 kA(sym) interrupt rating, current limiting, sizes 100 to 6000 A, 600 V(ac), [**4 s minimum time-delay (nonstandard) at 500 percent**][**10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature, with bolt-on terminals.

E. Class RK1 Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

5. Standard Features:

a. NEMA FU 1, Class RK1, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, [**250 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

F. Class RK5 Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]

d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

5. Standard Features:

   a. NEMA FU 1, Class RK5, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, [**250 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

      1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

G. Class T Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-15 (Class T).

5. Standard Features:

a. NEMA FU 1, Class T, 200 kA(sym) interrupt rating, current limiting, sizes up to 1200 A, [**300 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with [**15**]<**Insert number**> percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

2.4 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FUSES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Work in Confined Spaces: NFPA 350.
5. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
6. Fuse Applications: NECA NEIS 420.
7. Work with Fuses in Motor Control Centers: NECA NEIS 402.

C. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

D. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

E. Install spare-fuse cabinet(s) in location indicated on the Drawings or as indicated in the field by [**Architect**][**Construction Manager**][**Owner**].

F. Interfaces with Other Work:

1. Identification: Provide labels for spare fuse cabinet.

   a. Legend: "SPARE FUSES" in **1-1/2 inch (38 mm)** high letters on exterior of door.

2. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with results of coordination study and arc-flash hazard analysis.

END OF SECTION 26 28 13 00

Task	Specification	Specification Description
26 28 13 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary

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SECTION 26 28 16 00 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Enclosed Switches:

a. UL WIAX or NITW - Single- or double-throw enclosed switch.
b. UL WIAX or NITW - Fused electrically-tripped enclosed switch.
c. UL WIAX or NITW - Electrically-tripped ground-fault protection enclosed switch.

2. Dead-Front Switches:

a. UL WHXS - Switch for mounting in separate dead-front enclosure.

3. Enclosed Switches for Use in Hazardous (Classified) Locations:

a. UL WRPR - Enclosed switch for use in hazardous location.

4. Fused Power-Circuit Devices:

a. UL IYSR - Enclosed fused bolted-pressure contact switch.
b. UL IYSR - Enclosed fused high-pressure butt-type contact switch.

5. Molded-Case Circuit Breakers and Enclosures:

a. UL DIVQ - Enclosed molded-case circuit breaker.

6. Molded-Case Switches and Enclosures:

a. UL WJAZ - Enclosed molded-case switch.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding electrical equipment including raceways, electrical power cabling, and communications cabling referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic- [**and wind-**] control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and

warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies short-circuit current analysis, coordination study, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. GFCI: Ground-fault circuit interrupter.

C. MCCB: Molded-case circuit breaker.

D. N.C.: Normally closed.

E. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

F. N.O.: Normally open.

G. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
2. Include manufacturer's sample extended warranty language.
3. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
4. Enclosure types and details for types other than UL 50E, Type 1.
5. Current and voltage ratings.
6. Short-circuit current ratings (interrupting and withstand, as appropriate).
7. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
9. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in [**PDF**][**and**]<**Insert calculation program format**> electronic format.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Enclosed Switches and Circuit Breakers:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Include wiring diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.7 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for electrical Work specified in this Section must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria" unless otherwise specified in this Section or on the Drawings.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Enclosures:

1. Enclosed Switches and Circuit Breakers: UL 489, NEMA BS 31047, UL 50E, and UL 50, to comply with environmental conditions at installed location.
2. Enclosure Finish: Enclosure must be [**finished with**][**gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1)**][**gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12)**][**a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel)**][**copper-free cast aluminum alloy (UL 50E Types 7, 9)**] .
3. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
4. Operating Mechanism: Circuit-breaker operating handle must be [**externally operable with operating mechanism being integral part of box, not cover**][**directly operable through front cover of enclosure (UL 50E Type 1)**][**directly operable through dead front trim of enclosure (UL 50E Type 3R)**][**externally operable with operating mechanism being integral part of cover (UL 50E Types 7, 9)**] . Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
5. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
6. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

D. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**, and unit must be fully operational after seismic events**] .
2. Component Importance Factor (Ip): [**1.0**][**1.5**] .
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**> .
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**> .
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**> .

2.2 ENCLOSED SWITCHES

A. UL WIAX or NITW - Single- or Double-Throw Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**ABB Industrial Connections and Solutions LLC (Tradename Midwest)**]
   c. [**Appleton; Emerson Electric Co., Automation Solutions**]
   d. [**Bussmann; Eaton, Electrical Sector**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Eaton**]
   g. [**Hubbell Inc Wiring Device Div**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Siemens**]
   j. [**Square D; Schneider Electric USA**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**ABB Industrial Connections and Solutions LLC (Tradename Midwest)**]
   c. [**Appleton; Emerson Electric Co., Automation Solutions**]
   d. [**Bussmann; Eaton, Electrical Sector**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Eaton**]
   g. [**Hubbell Inc Wiring Device Div**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Siemens**]
   j. [**Square D; Schneider Electric USA**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.

b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
h. Poles: [**Two**][**Three**][**Four**] .
i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
l. Fusing: [**Fused**][**Nonfused**] .
m. Load Class: [**General**][**Isolating**] Use.
n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

1) Interlocking Linkage: Provide interlock between receptacle and switch mechanism to prevent inserting or removing plug while switch is in on position, while inserting plug other than specified, and while turning switch on if incorrect plug is inserted or correct plug has not been fully inserted into receptacle.

b. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
c. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
d. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
e. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
f. Service-Rated Switches: Labeled for use as service equipment.
g. Hookstick Handle: Allows use of hookstick to operate handle.
h. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
i. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

B. UL WIAX or NITW - Fused Electrically-Tripped Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Eaton**]
b. [**Mersen USA**]
c. [**Siemens**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Mersen USA**]
c. [**Siemens**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.
b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Shunt Trip: Comply with [**ASME A17.1,**] UL 50E, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.
h. Shunt Trip Control Circuit: 120 V(ac); obtained from [**integral control power transformer, with primary and secondary fuses,**]<**Insert source of control power**> with control power [**transformer**][**source**] of enough capacity to operate shunt trip, pilot, indicating and control devices.
i. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
j. Poles: [**Two**][**Three**][**Four**] .
k. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
l. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
m. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
n. Fusing: [**Fused**][**Nonfused**] .
o. Load Class: [**General**][**Isolating**] Use.
p. Throw: [**Single**][**Double**] .

6. Accessories:

   a. Elevator Disconnect Accessories:

      1) Oiltight key switch for key-to-test function.
      2) Oiltight Pilot Light: [**Red**][**Green**][**White**][**Yellow**] ON.
      3) Isolated Neutral Lug: [**100**][**200**] percent rating.
      4) Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
      5) Three-pole, double-throw, fire-safety and alarm relay: [**120 V(ac)**][**24 V(dc)**] coil voltage.
      6) Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

   b. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   c. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   d. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   e. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   f. Service-Rated Switches: Labeled for use as service equipment.
   g. Hookstick Handle: Allows use of hookstick to operate handle.
   h. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
   i. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

C. UL WIAX or NITW - Electrically-Tripped Ground-Fault Protection Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton**]
   b. [**Mersen USA**]
   c. [**Siemens**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Mersen USA**]
   c. [**Siemens**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.
b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Shunt Trip: Comply with UL 50E, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.
h. Shunt Trip Control Circuit: 120 V(ac); obtained from [**integral control power transformer, with primary and secondary fuses,**]<**Insert source of control power**> with control power [**transformer**][**source**] of enough capacity to operate shunt trip, pilot, indicating and control devices.
i. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
j. Poles: [**Two**][**Three**][**Four**] .
k. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
l. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
m. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
n. Fusing: [**Fused**][**Nonfused**] .
o. Load Class: [**General**][**Isolating**] Use.
p. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.3 DEAD-FRONT SWITCHES

A. UL WHXS - Switch for Mounting in Separate Dead-Front Enclosure :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton**]
b. [**Erickson Electrical Equipment Company**]
c. [**Siemens**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Erickson Electrical Equipment Company**]
c. [**Siemens**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Dead-Front Switches: UL CCN WHXS, including UL 98.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
h. Poles: [**Two**][**Three**][**Four**] .
i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
l. Fusing: [**Fused**][**Nonfused**] .
m. Load Class: [**General**][**Isolating**] Use.
n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground

conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.4 ENCLOSED SWITCHES FOR USE IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. UL WRPR - Enclosed Switch for Use in Hazardous Location :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Appleton Group (tradename NEER)**]
b. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Rockwell Automation, Inc.**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Appleton Group (tradename NEER)**]
b. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Rockwell Automation, Inc.**]
d. [**Square D; Schneider Electric USA**]
e. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Enclosed Switches: UL CCN WRPR, including UL 98.
b. Listed Equipment for Use in and Relating to Classes I, II, and III, Divisions 1 and 2 Hazardous Locations: UL CCN AAIZ, including one or more of the following combinations of applicable standards:

1) Class I, Division 1: UL 1203, UL 913, NFPA 496, UL 60079-28, and UL 60079-33.
2) Class I, Division 2: UL 121201, NFPA 496, UL 60079-28, and UL 60079-33.
3) Class II, Division 1: UL 1203, UL 913, NFPA 496, UL 60079-28, and UL 60079-33.
4) Class II, Division 2: UL 121201, NFPA 496, UL 60079-28, and UL 60079-33.
5) Class III, Divisions 1 and 2: UL 913, UL 121201, and UL 60079-33.

5. Standard Features:

   a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
   b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
   c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
   d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
   e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
   f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
   g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
   h. Poles: [**Two**][**Three**][**Four**] .
   i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
   j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
   k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
   l. Fusing: [**Fused**][**Nonfused**] .
   m. Load Class: [**General**][**Isolating**] Use.
   n. Throw: [**Single**][**Double**] .

6. Accessories:

   a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   e. Service-Rated Switches: Labeled for use as service equipment.
   f. Hookstick Handle: Allows use of hookstick to operate handle.
   g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
   h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.5 FUSED POWER-CIRCUIT DEVICES

A. UL IYSR - Enclosed Fused Bolted-Pressure Contact Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton**]
   b. [**Schneider Electric USA, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Eaton**]
b. [**Schneider Electric USA, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

   a. Listed Fused Power-Circuit Devices: UL CCN IYSR, including UL 977.

5. Standard Features:

   a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047 providing additional pressure or clamping action at both ends of the switch blades when the blades are in a fully closed position.
   b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
   c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
   d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
   e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
   f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
   g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
   h. Poles: [**Two**][**Three**][**Four**] .
   i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
   j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
   k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
   l. Fusing: [**Fused**][**Nonfused**] .
   m. Load Class: [**General**][**Isolating**] Use.
   n. Throw: [**Single**][**Double**] .

6. Accessories:

   a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   e. Service-Rated Switches: Labeled for use as service equipment.
   f. Hookstick Handle: Allows use of hookstick to operate handle.
   g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
   h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

B. UL IYSR - Enclosed Fused High-Pressure Butt-Type Contact Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB**]
   b. [**Eaton**]
   c. [**Siemens**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB**]
   b. [**Eaton**]
   c. [**Siemens**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

   a. Listed Fused Power-Circuit Devices: UL CCN IYSR, including UL 977.

5. Standard Features:

   a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047 and having butt-type contacts and a spring-charged mechanism.
   b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
   c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
   d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
   e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
   f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
   g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
   h. Poles: [**Two**][**Three**][**Four**] .
   i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
   j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
   k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
   l. Fusing: [**Fused**][**Nonfused**] .
   m. Load Class: [**General**][**Isolating**] Use.
   n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.6 MOLDED-CASE CIRCUIT BREAKERS AND ENCLOSURES

A. UL DIVQ - Enclosed Molded-Case Circuit Breaker :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB**]
b. [**ABB Industrial Connections and Solutions LLC (GE ED&C)**]
c. [**Eaton**]
d. [**Hubbell Inc Wiring Device Div**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Littelfuse, Inc.**]
g. [**NOARK Electric North America**]
h. [**Siemens Industry, Inc.**]
i. [**Square D; Schneider Electric USA**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ABB**]
b. [**ABB Industrial Connections and Solutions LLC (GE ED&C)**]
c. [**Eaton**]
d. [**Hubbell Inc Wiring Device Div**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Littelfuse, Inc.**]
g. [**NOARK Electric North America**]
h. [**Siemens Industry, Inc.**]
i. [**Square D; Schneider Electric USA**]
j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Fused Power-Circuit Devices: UL CCN DIVQ, including UL 489.

5. Standard Features:

a. Product Reference Standard: NEMA AB 3.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Short-Circuit Current Rating: As determined by results of Power System Studies.
d. System Frequency: [**50/60 Hz**][**DC**][**400 Hz**]<**Insert frequency**> .
e. Voltage Rating: [**120 V(ac)**][**125 V(ac)**][**120/240 V(ac)**][**208 V(ac)**][**208Y/120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480Y/277 V(ac)**][**480 V(ac)**][**347 V(ac)**][**600Y/347 V(ac)**][**600 V(ac)**][**24 V(dc)**][**48 V(dc)**][**60 V(dc)**][**65 V(dc)**][**80 V(dc)**][**125 V(dc)**][**125/250 V(dc)**][**160 V(dc)**][**250 V(dc)**][**500 V(dc)**][**600 V(dc)**] .
f. Poles: [**One**][**Two**][**Three**][**(corner-grounded delta)**] .
g. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
h. Current Rating: [**15 A**][**20 A**][**25 A**][**30 A**][**34 A**][**40 A**][**45 A**][**50 A**][**60 A**][**70 A**][**80 A**][**90 A**][**100 A**][**110 A**][**125 A**][**150 A**][**175 A**][**200 A**][**225 A**][**250 A**][**300 A**][**350 A**][**400 A**][**450 A**][**500 A**][**600 A**][**700 A**][**800 A**][**1000 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**][**5000 A**][**6000 A**] .
i. Tripping Means: [**Thermal-Magnetic**][**Hydraulic-Magnetic**][**Electronic (Solid-State)**] .
j. Intended Use: [**Main**][**Feeder**][**Branch circuit**] protection.
k. Specific Purpose Categories:

1) Remotely operated.
2) Integrally-fused.
3) Current-limiting.
4) Switching Duty (SWD).
5) Instantaneous trip only (motor circuit protector or circuit interrupter).
6) Heating, air conditioning, and refrigeration (HACR).
7) Marine.
8) Naval.
9) Mining.
10) High intensity discharge lighting (HID).
11) Ground-fault circuit interrupter (GFCI).
12) Arc-fault circuit interrupter (AFCI).
13) Equipment ground-fault protective device.
14) Classified (alternates).
15) Secondary surge arrester.
16) Transient voltage surge suppressor (TVSS).
17) For use with uninterruptible power supplies (UPS).
18) 100 percent rated.
19) Photovoltaic (PV).

l. Fusing: [**Fused**][**Nonfused**] .
m. Conductor Connections: [**Front-connected**][**Rear-connected**] .
n. Mounting Arrangement: [**Stationary**][**Plug-in**][**Drawout**] .
o. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material. Suitable for [**60 deg C rated wire on 125 A circuit breakers and below**][**75 deg C rated wire**][**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**] .
p. Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
q. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features

compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring."

6. Accessories:

   a. Interchangeable Trip Unit: Field-installable assembly that controls tripping functions.
   b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   c. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   d. Auxiliary Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   e. Alarm Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . One [**N.O.**][**N.C.**] contact operates only when circuit breaker has tripped.
   f. Electrical Operator: Provide remote control for on, off, and reset operations.
   g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
   h. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
   i. Handle Locking Device: Capable of locking circuit breaker in isolated position.
   j. Accessory Control Power: [**Integrally mounted, self-powered**][**Remote mounted and powered**] ; [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**12 V(dc)**][**24 V(dc)**][**120 V(dc)**] .

2.7 MOLDED-CASE SWITCHES AND ENCLOSURES

A. UL WJAZ - Enclosed Molded-Case Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**Bussmann; Eaton, Electrical Sector**]
   c. [**Eaton**]
   d. [**NOARK Electric North America**]
   e. [**Schneider Electric USA, Inc.**]
   f. [**Siemens Industry, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**Bussmann; Eaton, Electrical Sector**]
   c. [**Eaton**]
   d. [**NOARK Electric North America**]
   e. [**Schneider Electric USA, Inc.**]
   f. [**Siemens Industry, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with the following guide information and corresponding standards:

a. Listed Fused Power-Circuit Devices: UL CCN WJAZ, including UL 489.

5. Standard Features:

a. Product Reference Standard: NEMA AB 3 and is designed to open and close a circuit by nonautomatic means.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Short-Circuit Current Rating: As determined by results of Power System Studies.
d. System Frequency: [**50/60 Hz**][**DC**][**400 Hz**]<**Insert frequency**> .
e. Voltage Rating: [**120 V(ac)**][**125 V(ac)**][**120/240 V(ac)**][**208 V(ac)**][**208Y/120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480Y/277 V(ac)**][**480 V(ac)**][**347 V(ac)**][**600Y/347 V(ac)**][**600 V(ac)**][**24 V(dc)**][**48 V(dc)**][**60 V(dc)**][**65 V(dc)**][**80 V(dc)**][**125 V(dc)**][**125/250 V(dc)**][**160 V(dc)**][**250 V(dc)**][**500 V(dc)**][**600 V(dc)**] .
f. Poles: [**One**][**Two**][**Three**][**(corner-grounded delta)**] .
g. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
h. Current Rating: [**15 A**][**20 A**][**25 A**][**30 A**][**34 A**][**40 A**][**45 A**][**50 A**][**60 A**][**70 A**][**80 A**][**90 A**][**100 A**][**110 A**][**125 A**][**150 A**][**175 A**][**200 A**][**225 A**][**250 A**][**300 A**][**350 A**][**400 A**][**450 A**][**500 A**][**600 A**][**700 A**][**800 A**][**1000 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**][**5000 A**][**6000 A**] .
i. Tripping Means: [**Thermal-Magnetic**][**Hydraulic-Magnetic**][**Electronic (Solid-State)**] .
j. Intended Use: [**Main**][**Feeder**][**Branch circuit**] protection.
k. Specific Purpose Categories:

1) Remotely operated.
2) Integrally-fused.
3) Current-limiting.
4) Switching Duty (SWD).
5) Instantaneous trip only (motor circuit protector or circuit interrupter).
6) Heating, air conditioning, and refrigeration (HACR).
7) Marine.
8) Naval.
9) Mining.
10) High intensity discharge lighting (HID).
11) Ground fault circuit interrupter (GFCI).
12) Arc fault circuit interrupter (AFCI).
13) Equipment ground fault protection.
14) Classified (alternates).
15) Secondary surge arrester.
16) Transient voltage surge suppressor (TVSS).
17) For use with uninterruptible power supplies (UPS).
18) 100 percent rated.
19) Photovoltaic (PV).

l. Fusing: [**Fused**][**Nonfused**] .
m. Conductor Connections: [**Front-connected**][**Rear-connected**] .
n. Mounting Arrangement: [**Stationary**][**Plug-in**][**Drawout**] .
o. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material. Suitable for [**60 deg C rated wire on 125 A switches and below**][**75 deg C rated wire**][**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**] .
p. Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator;

relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

q. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**DIN-rail-mounted**] communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring."

6. Accessories:

a. Interchangeable Trip Unit: Field-installable assembly that controls tripping functions.
b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
c. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
d. Auxiliary Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
e. Alarm Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . One [**N.O.**][**N.C.**] contact operates only when switch has tripped.
f. Electrical Operator: Provide remote control for on, off, and reset operations.
g. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.
h. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
i. Handle Locking Device: Capable of locking switch in isolated position.
j. Accessory Control Power: [**Integrally mounted, self-powered**][**Remote mounted and powered**] ; [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**12 V(dc)**][**24 V(dc)**][**120 V(dc)**] .

2.8 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Fuse Pullers: [**Two**]<**Insert number**> for each size and type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, [**Type 1**]<**Insert type**> .

B. Outdoor Locations: UL 50E, [**Type 3R**][**Type 4X**]<**Insert type**> .

C. Kitchen and Wash-Down Areas: UL 50E, [**Type 4X**]<**Insert type**> , [**stainless steel**]<**Insert material**> .

D. Other Wet or Damp, Indoor Locations: UL 50E, [**Type 4**]<**Insert type**> .

E. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

F. Hazardous Areas Indicated on the Drawings: UL 50E, [**Type 7**][**Type 9**]<**Insert type**>[**with cover attached by Type 316 stainless steel bolts**] .

3.3 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
6. Hot Work: NFPA 51B.
7. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
8. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
9. Communications Work: BICSI N1.
10. Work in ITE Rooms: NFPA 75.
11. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
12. Life Safety and Means of Egress Work: NFPA 101.
13. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
14. Work in Confined Spaces: NFPA 350.
15. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
16. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
17. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification: Provide labels for enclosed switches, circuit breakers, and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Grounding and Bonding:

   a. Equipment Grounding Conductors: Provide and route insulated equipment grounding conductors with other feeder or branch circuit conductors. Bond equipment grounding conductor to enclosure using provided hardware in accordance with manufacturer's published instructions.
   b. Equipment Bonding Conductors: Provide equipment bonding straps or jumpers where additional bonding is indicated on the Drawings between enclosed switches or circuit breakers and adjacent metallic equipment, enclosures, piping, or building structure. Route

bonding conductors along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access panels or placing conductors where they may be subjected to strain, impact, or damage.

3.4 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Special Techniques:

1. Layout Coordination: Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Mounting Heights: Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Seismic Controls: Provide equipment mounts and anchors complying with seismic requirements for the Project.
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Fusing: Install fuses in fusible devices.

3.5 FIELD QUALITY CONTROL OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Acceptance Testing Preparation: <**Insert requirements**> .

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

D. Tests and Inspections for Enclosed Switches, Dead-Front Switches, Enclosed Switches for Use in Hazardous (Classified) Locations, and Fused Power-Circuit Devices:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and the Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the methods as follows:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar

connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded-Case Circuit Breakers and Enclosures and for Molded-Case Switches and Enclosures:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that unit is clean.
e. Operate circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the methods as follows:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 MΩ.
e. Determine the primary current injection by the following:

1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Test and adjust controls, remote monitoring, and safeties.

F. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate in accordance with manufacturer's published instructions.

B. Set field-adjustable circuit-breaker trip ranges [**in accordance with results of power system studies.**][**to values indicated on the Drawings.**][**to values indicated in attached schedule.**]

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Circuit Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 28 16 00

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Task	Specification	Specification Description
26 28 16 13	26 24 16 00	Panelboards
26 28 16 13	26 28 16 00	Enclosed Switches And Circuit Breakers
26 28 16 16	26 28 16 00	Enclosed Switches And Circuit Breakers

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SECTION 26 29 13 00 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Magnetic motor controllers.
3. Combination motor controllers.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SCPD: Short-circuit protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. Laboratory and file number for listing by qualified electrical testing laboratory.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Field quality-control reports.

E. System startup testing reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for infrared scanning.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; [**install temporary electric heating, with at least**][**50 W**]<**Insert number**>[**per controller**][**connect factory-installed space heaters to temporary electrical service**].

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than **23 deg F (minus 5 deg C)** and not exceeding **104 deg F (40 deg C)**.
2. Altitude: Not exceeding **6600 ft (2010 m)** for electromagnetic and manual devices.
3. The effect of solar radiation is insignificant.

4. <**Insert unusual service condition**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Enclosures:

1. Environmental Ratings: Comply with UL 50E, type designations as indicated on the Drawings.
2. Construction: Comply with NEMA IA 10030.
3. Controllers in Hazardous (Classified) Locations: Comply with UL 1203.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Motion Business**]
b. [**Eaton**]
c. [**Rockwell Automation, Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Motion Business**]
b. [**Eaton**]
c. [**Rockwell Automation, Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]

e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**][**Reversing**][**Two speed**].
   c. Mounting: [**Flush**][**Surface**].
   d. Pilot Light Color: [**Red**][**Green**].
   e. Additional Nameplates: [**FORWARD and REVERSE for reversing switches**][**HIGH and LOW for two-speed switches**]<**Insert special markings**>.

B. Fractional Horsepower Manual Controllers (FHPMC) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

   a. Referenced Standards: Comply with NEMA ICS 2.

      1) Overload Relays:

         a) Inverse-time-current characteristics; [**Class 10**]<**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**][**; melting alloy type**].
         b) Bimetallic class as scheduled on the Drawings.

   b. Configuration: [**Nonreversing**][**Two speed**].
   c. Pilot Light: [**Red**]<**Insert color**>.

C. Integral Horsepower Manual Controllers (IHPMC) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

   a. Referenced Standards: Comply with NEMA ICS 2.

1) Overload Relays:

a) Inverse-time-current characteristics; [**Class 10**]<**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**][**; melting alloy type**].
b) Bimetallic class as scheduled on the Drawings.

b. Configuration: [**Nonreversing**][**Two speed**].

2.3 MAGNETIC MOTOR CONTROLLERS

A. Enclosed Full-Voltage Magnetic Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Across-the-line start, electrically held, for nominal system voltage of 600 V(ac) and less.

a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.
b. Configuration: [**Nonreversing**]<**Insert configuration**>.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity as Indicated on the Drawings: [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

1) Thermal Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters: In each phase; coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

g. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

B. Enclosed Reduced-Voltage Magnetic Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]

f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Electrically held; closed transition; adjustable time delay on transition, 600 V(ac) or less.

   a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.
   b. Configuration:

      1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
      2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half- or two-thirds-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
      3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

   c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

      1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

   d. Control Power: [**24**][**120**] V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

      1) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

   e. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual

protected motor and with appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
g. Digital Communication Module: [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

C. Multispeed Magnetic Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Two speed, full voltage, across the line, electrically held.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: Nonreversing[**, multispeed**].

      1) Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

         a) Operating Voltage: Manufacturer's standard unless otherwise indicated.

      2) Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

         a) Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
         b) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

      3) Compelling Relays: Ensure that motor will start only at low speed.
      4) Accelerating Timer Relays: Ensure properly timed acceleration through speeds lower than that selected.
      5) Decelerating Timer Relays: Ensure automatically timed deceleration through each speed.
      6) Antiplugging Timer Relays: Ensure a time delay when transferring from FORWARD to REVERSE and back.

   c. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         d) Ambient compensated.
         e) Automatic resetting.

      2) Solid-State Overload Relay:

         a) Switch or dial selectable for motor-running overload protection.
         b) Sensors in each phase.
         c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

   d. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
   e. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire**

connection to host devices with a compatible port]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

2.4 COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Combination Full-Voltage Magnetic Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**]<**Insert configuration**>.

c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity as Indicated on the Drawings: [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

1) Thermal Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters: In each phase coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

g. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

h. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

k. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

B. Combination Reduced-Voltage Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL

60947-4-1.

5. Standard Features: Factory-assembled, combination reduced-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

   a. Configuration:

      1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
      2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half- or two-thirds-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
      3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

   b. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

      1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

   c. Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

      1) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

   d. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         d) Ambient compensated.
         e) Automatic resetting.

      2) Solid-State Overload Relay:

         a) Switch or dial selectable for motor-running overload protection.
         b) Sensors in each phase.
         c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

   e. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

   f. Digital Communication Module: [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

      1) Instantaneous rms current each phase, and 3-phase average.

2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

g. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

h. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

C. Combination Multispeed Magnetic Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination of multispeed magnetic motor controller, consisting of the controller, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**][**Reversing**]; [**consequent pole**][**two-winding**].

      1) Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

         a) Operating Voltage: Manufacturer's standard unless otherwise indicated.

      2) Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
      3) Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

         a) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

      4) Compelling Relays: Ensure that motor will start only at low speed.
      5) Accelerating Timer Relays: Ensure properly timed acceleration through speeds lower than that selected.
      6) Decelerating Timer Relays: Ensure automatically timed deceleration through each speed.
      7) Antiplugging Timer Relays: Ensure a time delay when transferring from FORWARD to REVERSE and back.

   c. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         d) Ambient compensated.
         e) Automatic resetting.

      2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

d. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

e. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

f. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

g. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

h. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push-Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy duty or oiltight where indicated in the controller schedule.

a. Push-Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].
3. Meters: Panel type, **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. Motor Protection Relays: Provide solid-state sensing circuit and isolated output contacts for hardwired connections.

1. Phase-failure.
2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
4. <**Insert description**>.

C. Breather Assemblies: Maintain interior pressure and release condensation in [**Type 4**][**Type 4X**][**Type 7**][**Type 9**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space Heaters: Provide N.C. auxiliary contacts, to mitigate condensation in [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun Shields: Install on fronts, sides, and tops of enclosures that are installed outdoors and subject to direct and extended sun exposure.

F. <**Insert accessories**>.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing motor controllers, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses for Fused Switches: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NECA NEIS 1, NFPA 1, and NFPA 70.
2. Electrical Maintenance: NECA NEIS 91 and NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Work in Confined Spaces: NFPA 350.
8. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
9. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks for support unless otherwise indicated.
2. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).
3. Provide seismic control devices.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

D. Interfaces with Other Work:

1. Identification: Provide labels for motor controllers and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure and each compartment with [**baked-enamel signs**][**metal-backed butyrate signs**][**laminated acrylic or melamine plastic signs**], mounted with corrosion-resistant screws.
   c. Provide warning signs for electrical equipment.

2. Arc-Flash Warning Labels:

   a. Provide self-adhesive equipment label for each work location[**included in the arc-flash**

hazard analysis].

b. Labels must be machine printed, with no field-applied markings.

c. Labels must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

3.3 FIELD QUALITY CONTROL OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with NFPA 70B.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Inspect contactors:

1) Verify mechanical operation.
2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

f. Motor-Running Protection:

1) Verify overload element rating is correct for its application.
2) If motor-running protection is provided by fuses, verify correct fuse rating.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. [**For the contactor and circuit breaker, perform**][**Perform**] insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole.

1) Insulation Resistance: In accordance with manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5.
2) Investigate and correct insulation resistance values less than those of this table or manufacturer's published instructions.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices in accordance with manufacturer's published data.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings in accordance with the coordination study. Comply with coordination study recommendations.

e. Perform operational tests by initiating control devices.

E. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service in accordance with manufacturer's published instructions.

B. System Startup Testing: Verify the correct interaction of sensing, processing, and action devices. Perform system startup testing after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass system startup testing.

D. System Startup Testing Report: Compile, prepare, and submit system startup testing reports.

E. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.6 MAINTENANCE

A. Infrared Scanning of Motor Controllers: Perform infrared scanning during periods of maximum possible loading. Comply with NFPA 70B requirements. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment must detect emitted radiation and convert detected radiation to a visual signal.
2. Act on inspection results and recommended action, and considering the recommendations of NETA ATS Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
4. Follow-On Infrared Scanning: Perform follow-up infrared scans of motor controller at 11 months after Substantial Completion.
5. Field Reports for Infrared Scanning: Prepare a certified report including the following information:

   a. Identities of personnel performing infrared scanning.

b. Description of test equipment used and record of their calibration.
c. Description of motor controllers and associated equipment tested.
d. Deficiencies found, remedial actions taken, and observations found when scans were repeated after the remedial actions.
e. Temperature difference between the area of concern and the reference area.
f. Probable cause of temperature difference.
g. Areas inspected. Identify inaccessible and unobservable areas and equipment.
h. Load conditions at time of inspection.
i. Photographs and thermograms of the deficient area.
j. Recommended action.

END OF SECTION 26 29 13 00

SECTION 26 29 13 00A - SOFT-START MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soft-start motor controllers.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
9. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-installed surge protection referenced by this Section.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. FLA: Full-load amperes.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor circuit protector.

E. N.C.: Normally closed.

F. N.O.: Normally open.

G. OCPD: Overcurrent protective device.

H. SCCR: Short-circuit current rating.

I. SCPD: Short-circuit protective device.

J. SCR: Silicon-controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Product Schedule: For each enclosed controller.

1. Each installed soft-start controller type.
2. Laboratory and file number for listing by qualified electrical testing laboratory..
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.

a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

1) Listing document proving Type 2 coordination.

b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by qualified electrical testing laboratory acceptable to authorities having jurisdiction.

D. Field quality-control reports.

E. System startup testing reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

2. Manufacturer's field reports for system startup support.
3. Field reports for infrared scanning.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover soft-start controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; [**install temporary electric heating, with at least**][**50 W**]<**Insert number**>[**per controller**][**connect factory-installed space heaters to temporary electrical service**].

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than **32 deg F (0 deg C)** and not exceeding **104 deg F (40 deg C)**, humidity noncondensing.
2. Altitude: Not exceeding **3300 ft (1000 m)**.
3. The effect of solar radiation is insignificant.
4. <**Insert unusual service condition**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Enclosures:

1. Environmental Ratings: Comply with UL 50E, type designations as indicated on Drawings.
2. Construction: Comply with NEMA ICS IA 10030.
3. Controllers in Hazardous (Classified) Locations: Comply with UL 1203.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 SOFT-START MOTOR CONTROLLERS

A. Enclosed Soft-Start Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop.

   a. Construction: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   b. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
   c. Referenced Standards: NEMA ICS 2, general purpose, Class A.
   d. Configuration: [**Standard duty**]<**Insert configurations**>.

      1) Motor Starting and Stopping: Provide at least two SCRs per phase.
      2) Microprocessor Control: Continuously monitor current and proper operation of the SCRs.

   e. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls must remain active when this contactor is in the bypass mode.

      1) Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and opens automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
      2) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
      3) Surge Protection: Provide [**NEMA ICS 2 compliant factory-installed**][**field-installed**] surge suppression.

   f. Control Power:

      1) For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      2) Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

   g. Controller Diagnostics and Protection:

      1) Microprocessor-based thermal-protection system for monitoring SCR and motor

thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3) Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4) <**Insert items**>.

h. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1) Starter Status: "Ready," "Starting," "Stopping," or "Run."
2) Motor current in amperes.
3) Faults:

a) Motor overcurrent trip.
b) Motor thermal overload.
c) Starter thermal fault.
d) Low line voltage.
e) Loss of a phase.
f) Phases reversed.
g) Maximum stating time exceeded.
h) Serial communications error.

i. Interface Panel: [**Mounted on controller door**][**Mounted remotely within 50 ft (15 m)**].[**With plug-in connector and removable.**]

1) Guarded adjustable set points, not readily accessible.

a) Motor FLA, adjustable from [**40 to 110**]<**Insert numbers**> percent of the controller's rating.
b) Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
c) NEMA ICS 2 Overload Class: Include the following selections: Class 5, Class 10, Class 15, Class 20, and Class 30.

2) Adjustable set points, readily accessible[**, password protected**].

a) Linear acceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.
b) Maximum start time, adjustable from [**1 to 250 s**]<**Insert range in seconds**>.
c) Selector switch; select coast to stop or soft stop.
d) Linear deceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.

j. Remote Output Features. All outputs prewired to terminal blocks.

1) Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10 V(dc)**][**4- to 20 mA(dc)**].
2) Form C status contacts that change state when controller is running.
3) Form C alarm contacts that change state when a fault condition occurs.
4) <**Insert items**>.

k. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous root mean square (RMS) current each phase, and three-phase average.
2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Energy (kilowatt-hour): Three-phase total.
4) Power Factor:[**Each phase and**] three-phase total.
5) <**Insert value**>.

B. Combination Soft-Start Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure.

   a. Construction: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   b. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
   c. Referenced Standards: NEMA ICS 2, general purpose, Class A.
   d. Configuration: [**Standard duty**]<**Insert configurations**>.

1) At least two SCRs per phase to control the starting and stopping of the motor.
2) Continuously monitor current and proper operation of the SCRs.
3) Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls remain active when this contactor is in the bypass mode.
4) Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and opens automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
5) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
6) Surge Protection: Provide [**NEMA ICS 2 compliant factory-installed**][**field-installed**] surge suppression.

e. Control Power:

1) For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2) Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

f. Controller Diagnostics and Protection:

1) Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3) Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4) <**Insert items**>.

g. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1) Starter Status: "Ready," "Starting," "Stopping," or "Run."
2) Motor current in amperes.
3) Faults:

a) Motor overcurrent trip.
b) Motor thermal overload.
c) Starter thermal fault.
d) Low line voltage.
e) Loss of a phase.
f) Phases reversed.
g) Maximum stating time exceeded.
h) Serial communications error.

h. Interface Panel: [**Mounted on controller door**][**Mounted remotely within 50 ft (15 m)**].[**With plug-in connector and removable.**]

1) Guarded adjustable set points, not readily accessible.

a) Motor FLA, adjustable from [**40 to 110**]<**Insert numbers**> percent of the controller's rating.

b) Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
c) NEMA ICS 2 Overload Class: Include the following selections: Class 5, Class 10, Class 15, Class 20, and Class 30.

2) Adjustable set points, readily accessible[**, password protected**].

a) Linear acceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.
b) Maximum start time, adjustable from [**1 to 250 s**]<**Insert range in seconds**>.
c) Selector switch; select coast to stop or soft stop.
d) Linear deceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.

i. Remote Output Features: All outputs prewired to terminal blocks.

1) Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10 V(dc)**][**4- to 20 mA(dc)**].
2) Form C status contacts that change state when controller is running.
3) Form C alarm contacts that change state when a fault condition occurs.
4) <**Insert items**>.

j. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous RMS current each phase, and three-phase average.
2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Energy (kilowatt-hour): Three-phase total.
4) Power Factor:[**Each phase and**] three-phase total.
5) <**Insert value**>.

k. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate [**Class J**][**Class L**][**indicated**] fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O. or N.C., arranged to activate before switch blades open.

l. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4) [**N.C.**][**N.O.**] alarm contact that operates only when MCP has tripped.
5) Current-limiting module to increase controller SCCR (withstand) to 100 kA.

m. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
5) [**N.C.**][**N.O.**] alarm contact that operates only when MCCB has tripped.

n. Molded-Case Switch Disconnecting Means:

1) UL 489 and NEMA AB 3, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
4) [**N.C.**][**N.O.**] alarm contact that operates only when molded-case switch has tripped.

C. Bypass Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination, full-voltage electromagnetic motor controller with a disconnecting means, SCPD and OCPD, in a single enclosure. Connected as a

bypass controller, operating manually, with NORMAL/BYPASS selector switch.

a. Referenced Standards: NEMA ICS 2, general purpose, Class A.
b. Configuration: Across-the-line start, electrically held.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

    1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, and with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    1) Spare CPT Capacity: As indicated on Drawings, [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

    1) Thermal-Overload Relays:

        a) Inverse-time-current characteristic.
        b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
        c) Heaters: In each phase; coordinate with nameplate FLA of actual protected motor; include appropriate adjustment for duty cycle.
        d) Ambient compensated.
        e) Automatic resetting.

    2) Solid-State Overload Relays:

        a) Switch or dial selectable for motor running overload protection.
        b) Sensors in each phase.
        c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
g. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

    1) Instantaneous RMS current each phase, and three-phase average.
    2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    3) Active Energy (kilowatt-hour): Three-phase total.
    4) Power Factor:[**Each phase and**] three-phase total.
    5) <**Insert value**>.

h. Fusible Disconnecting Means:

    1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
    2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

k. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push-Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy duty or oiltight where indicated in the controller schedule.

a. Push-Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].
3. Meters: Panel type, **2-1/2 inch (64 mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.

B. Breather Assemblies: Maintain interior pressure and release condensation in [**Type 4**][**Type 4X**][**Type 7**][**Type 9**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

C. Space Heaters: Provide N.C. auxiliary contacts, to mitigate condensation in [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Sun Shields: Install on fronts, sides, and tops of enclosures that are installed outdoors and subject to direct and extended sun exposure.

E. <**Insert accessories**>.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing motor controllers, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses for Fused Switches: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF SOFT-START MOTOR CONTROLLERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Work in Confined Spaces: NFPA 350.
8. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
9. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems and bolted to wall.
2. Freestanding Controllers: Provide slotted support systems.
3. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).
4. Provide seismic control devices.
5. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and

distribution spools.

7. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and similar motors.

D. Interfaces with Other Work:

1. Identification: Provide labels for motor controllers and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure and each compartment with [**baked enamel signs**][**metal backed butyrate signs**][**laminated acrylic or melamine plastic signs**], mounted with corrosion-resistant screws
   c. Provide warning signs for electrical equipment.

2. Arc-Flash Warning Labels:

   a. Provide self-adhesive equipment label for each work location [**included in the arc-flash hazard analysis**].
   b. Labels must be machine printed, with no field-applied markings.
   c. Labels must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from the arc-flash hazard analysis:

      1) Location designation.
      2) Nominal voltage.
      3) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

3.3 FIELD QUALITY CONTROL OF SOFT-START MOTOR CONTROLLERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Tests and Inspections:

1. Comply with NFPA 70B.
2. Visual and Mechanical Inspection:

   a. Compare equipment nameplate data with Drawings and the Specifications.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify that the unit is clean.
e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Inspect Contactors:

1) Verify mechanical operation.
2) Verify that contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

h. Motor-Running Protection:

1) Verify that motor FLA is at, or under, the controller current rating.
2) Verify that overload element setting is correct for its application.
3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
4) If motor-running protection is provided by fuses, verify correct fuse rating.

i. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. [**For the contactor and circuit breaker, perform**][**Perform**] insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole.

1) Insulation Resistance: In accordance with manufacturer's published instructions or NETA ATS, Table 100.1. In the absence of manufacturer's published instructions, use Table 100.5.
2) Investigate and correct insulation resistance values less than those of this table or manufacturer's published instructions.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices according to manufacturer's published instructions.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings in accordance with the coordination study. Comply with coordination study recommendations.

e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

f. Test the following parameters in accordance with NETA relay calibration procedures, or as recommended by manufacturer:

1) ANSI No. 49R, Overtemperature Protection:

a) Determine time delay at 300 percent of setting.
b) Determine a second point on the operating curve.
c) Determine pickup.

2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:

a) Determine positive sequence voltage to close the N.O. contact.
b) Determine positive sequence voltage to open the N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close the N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the N.C. contact on removal of voltage when previously set to rated system voltage.

3) ANSI No. 81, Overfrequency Protection:

a) Verify frequency set points.
b) Determine time delay.
c) Determine undervoltage cutoff.

4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.

g. Perform operational tests by initiating control devices.

D. Nonconforming Work:

1. Motor controllers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service in accordance with manufacturer's published instructions.

B. System Startup Testing: Verify the correct interaction of sensing, processing, and action devices. Perform system startup testing after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Motor controllers will be considered defective if they do not pass system startup testing.

D. System Startup Testing Report: Compile, prepare, and submit test and inspection reports.

E. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.6 MAINTENANCE

A. Infrared Scanning of Motor Controllers: Perform infrared scanning during periods of maximum possible loading. Comply with NFPA 70B requirements. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment detects emitted radiation and convert detected radiation to a visual signal.
2. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
4. Follow-On Infrared Scanning: Perform follow-up infrared scans of motor controller at 11 months after Substantial Completion.
5. Field Reports for Infrared Scanning: Prepare a certified report including the following information:

a. Identities of personnel performing infrared scanning.
b. Description of test equipment used and record of their calibration.
c. Description of motor controllers and associated equipment tested.

d. Deficiencies found, remedial actions taken, and observations found when scans were repeated after the remedial actions.
e. Temperature difference between the area of concern and the reference area.
f. Probable cause of temperature difference.
g. Areas inspected. Identify inaccessible and unobservable areas and equipment.
h. Load conditions at time of inspection.
i. Photographs and thermograms of the deficient area.
j. Recommended action.

END OF SECTION 26 29 13 00A

Task	Specification	Specification Description
26 29 13 13	26 29 13 00	Manual and Magnetic Motor Controllers
26 29 13 13	26 29 13 00a	Soft-Start Motor Controllers

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SECTION 26 29 23 00 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field

connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed,

and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and [**install temporary electric heating, with at least 250 W per controller**][**connect factory-installed space heaters to temporary electrical service**].

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ABB, Motion Business**]
3. [**Cerus Industrial, Inc.**]
4. [**Danfoss, Inc.**]
5. [**Eaton**]
6. [**Nidec Motor Corporation; Nidec Corporation**]
7. [**Rockwell Automation, Inc.**]
8. [**Schneider Electric USA, Inc.**]
9. [**Siemens Industry, Inc., Building Technologies Division**]
10. [**Yaskawa Electric America, Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ABB, Motion Business**]
3. [**Cerus Industrial, Inc.**]
4. [**Danfoss, Inc.**]
5. [**Eaton**]
6. [**Nidec Motor Corporation; Nidec Corporation**]
7. [**Rockwell Automation, Inc.**]
8. [**Schneider Electric USA, Inc.**]
9. [**Siemens Industry, Inc., Building Technologies Division**]
10. [**Yaskawa Electric America, Inc.**]
11. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and [**UL 508A**][**UL 508C**]<**Insert standard**>.

B. Application: [**Constant torque**][**and**][**variable torque**]<**Insert application**>.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus [**10**][**15**] percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding [**3**][**5**] percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: [**96**][**97**]<**Insert number**> percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: [**96**][**98**]<**Insert number**> percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: [**10**][**22**][**65**][**100**]<**Insert value**> kA.
7. Ambient Temperature Rating: Not less than **32 deg F (0 deg C)** and not exceeding **104 deg F (40 deg C)**.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding **3300 feet (1000 m)**.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: [**1.1**][**1.5**] times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus [**5**][**10**] percent.
14. Output Carrier Frequency: Selectable; 0.5 to [**15**]<**insert number**> kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, [**16**][**32**] bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: [**Electrical**][**Pneumatic**].

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
4. Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.
6. <**Insert adjustment and parameters**>.

J. Self-Protection and Reliability Features:

1. Surge Suppression: [**Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2**][**Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2**].
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC

overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with [**three**]<**Insert number**> selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.
12. <**Insert protection or reliability feature**>.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: [**UL 489, instantaneous-trip circuit breaker**][**UL 489, molded-case switch, with power fuse block and current-limiting fuses**][**UL 489, thermal-magnetic circuit breaker**][**NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses**][**NEMA KS 1, fusible switch**] with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: [**Not less than 115 percent of VFC input current rating**][**Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger**].
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. [**NC**][**NO**] alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.

3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. <**Insert condition**>.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

   a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last [**four**]<**Insert number**> faults with time and date stamp for each.
5. <**Insert information or display**>.

D. Indicating Devices: Digital display[**and additional readout devices as required,**] mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).
11. <**Insert parameter**>.

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of [**two**]<**Insert number**> programmable analog inputs: [**0- to 10-V dc**][**4- to 20-mA dc**][**Operator-selectable "x"- to "y"-mA dc**]<**Insert signal parameters**>.
   b. A minimum of [**six**]<**Insert number**> multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: **3 to 15 psig (20 to 104 kPa)**.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.

c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.
e. <**Insert signal input**>.

4. Output Signal Interface: A minimum of [**one**]<**Insert number**> programmable analog output signal(s) ([**0- to 10-V dc**][**4- to 20-mA dc**][**operator-selectable "x"- to "y"-mA dc**]<**Insert signal parameters**>), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).
g. <**Insert indication**>.

5. Remote Indication Interface: A minimum of [**two**]<**Insert number**> programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.
e. <**Insert indication**>.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: [**One**][**Two**]<**Insert number**>.

G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.
b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**]<**Insert type of interface**>. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. Output Filtering: <**Insert requirements**>.

C. EMI/RFI Filtering:

1. CE marked; certify compliance with IEC 61800-3 for [**Category C2**]<**Insert category**>.
2. <**Insert requirements**>.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode:

1. Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller:

1. Two-Contactor-Style Bypass: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode**].

   a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
   b. Output Isolating Contactor: Non-load-break, [**IEC**][**NEMA**]-rated contactor.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2. Three-Contactor-Style Bypass: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier**] arranged to isolate the power converter input and output and permit safe testing[**and troubleshooting**] of the power converter, both energized and de-energized, while motor is operating in bypass mode.

   a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, [**IEC**][**NEMA**]-rated contactors.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: [**Full-voltage (across-the-line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to

allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: [**120**]<**Insert number**>-V ac; obtained from [**integral CPT, with primary and secondary fuses**]<**Insert source of control power**>, with [**CPT**][**control power source**] of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

   a. CPT Spare Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

6. Overload Relays: NEMA ICS 2.

   a. Melting-Alloy Overload Relays:

      1) Inverse-time-current characteristic.
      2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

   b. Bimetallic Overload Relays:

      1) Inverse-time-current characteristic.
      2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
      3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
      4) Ambient compensated.
      5) Automatic resetting.

   c. Solid-State Overload Relays:

      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      5) Analog communication module.

   d. [**NC**][**NO**] isolated overload alarm contact.
   e. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.

   1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
   2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
   3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from [**the firefighter's control station**][**smoke-control fan controller**]<**Insert location**>, this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal [**automatically**][**manually**].

F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

G. Remote digital operator kit.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer[**and a notebook computer**].

I. <**Insert feature**>.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: [**Type 1**]<**Insert type**>.
2. Outdoor Locations: [**Type 3R**][**Type 4X**]<**Insert type**>.
3. [**Kitchen**][**Wash-Down**] Areas: [**Type 4X**]<**Insert type**>, [**stainless steel**]<**Insert material**>.
4. Other Wet or Damp Indoor Locations: [**Type 4**]<**Insert type**>.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
6. <**Insert enclosure requirements**>.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: [**Covered**][**Lockable**][**Shielded**][**Unguarded**].
2. Pilot Lights: Push to test.
3. Selector Switches: [**Rotary**]<**Insert description**> type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. [**NC**][**NO**][**Reversible NC/NO**] bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, [**Type 4**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, [**Type 1**][**Type 12**]<**Insert enclosure type**>; UL 508 component recognized: Supply fan, with [**composite**][**stainless steel**]<**Insert material**> intake and exhaust grills [**and filters**]; [**120**]<**Insert number**>-V ac; obtained from [**integral CPT**]<**Insert source of control power**>.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

J. Spare control-wiring terminal blocks[**; unwired**][**; wired**].

K. <**Insert accessory**>.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in [**NEMA ICS 61800-2**]<**Insert standard**>.

1. Test each VFC while connected to [**its specified motor**][**a motor that is comparable to that for which the VFC is rated**].
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, **<insert Project-specific conditions,>** and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on **4-inch (100-mm)** nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices[**and facility's central-control system**]. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and

control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation.[**Test and adjust controllers, components, and equipment.**]
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify [**Architect**][**Construction Manager**][**Owner**] before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify [**Architect**][**Construction Manager**][**Owner**] before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 260573.16 "Coordination Studies."**]

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 26 29 23 00

Task	Specification	Specification Description
26 29 33 13	21 31 16 00	Diesel-Drive, Centrifugal Fire Pumps
26 29 33 13	21 31 13 00a	Pressure-Maintenance Pumps

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SECTION 26 31 00 00 - PHOTOVOLTAIC COLLECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured PV units.
2. PV module framing.
3. PV array construction.
4. Inverters.
5. System overcurrent protection.
6. Mounting structures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."

G. PV: Photovoltaic.

H. PVUSA: Photovoltaics for Utility Systems Applications.

I. STC: Standard Test Conditions defined in IEC 61215.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manufactured PV units.
2. PV module framing.

3. PV array construction.
4. Inverters.
5. System overcurrent protection.
6. Mounting structures.

B. Shop Drawings: For PV modules.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.

1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:

a. Faulty operation of PV modules.
b. <**Insert failure modes**>.

2. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.

1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:

a. Specified minimum power output to [**80**]<**Insert number**> percent or more, for a period of [**25**]<**Insert number**> years.

b. **<Insert additional minimum power output special warranty>**.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aleo Solar**]
2. [**BP Solar USA**]
3. [**Canadian Solar**]
4. [**ET Solar**]
5. [**Evergreen Solar, Inc.**]
6. [**GE Solar; General Electric Company**]
7. [**Kaneka Corporation**]
8. [**Kyocera International, Inc.**]
9. [**Lumos Solar, LLC**]
10. [**Mitsubishi Electric US, Inc.**]
11. [**REC Solar US LLC**]
12. [**SANYO North America Corporation**]
13. [**Schott Solar**]
14. [**Sharp Electronics Corp.**]
15. [**Suniva**]
16. [**SunPower Corporation**]
17. [**Suntech Power**]
18. [**Trina Solar Limited**]
19. [**United Solar Ovonic LLC**]
20. [**Yingli Green Energy Holding Co., Ltd.**]
21. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Aleo Solar**]
2. [**BP Solar USA**]
3. [**Canadian Solar**]
4. [**ET Solar**]
5. [**Evergreen Solar, Inc.**]
6. [**GE Solar; General Electric Company**]
7. [**Kaneka Corporation**]
8. [**Kyocera International, Inc.**]
9. [**Lumos Solar, LLC**]
10. [**Mitsubishi Electric US, Inc.**]
11. [**REC Solar US LLC**]
12. [**SANYO North America Corporation**]
13. [**Schott Solar**]
14. [**Sharp Electronics Corp.**]
15. [**Suniva**]
16. [**SunPower Corporation**]
17. [**Suntech Power**]
18. [**Trina Solar Limited**]
19. [**United Solar Ovonic LLC**]

20. [**Yingli Green Energy Holding Co., Ltd.**]
21. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Hazardous Locations: FM Global approved for NFPA 70, Class 1, Division 2, Group C and Group D.

2.3 PV CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics:

1. Rated Open-Circuit Voltage: <**Insert V(dc)**>.
2. Maximum System Voltage: <**Insert V(dc)**>.
3. Maximum Power at Voltage (Vpm): <**Insert V(dc)**>.
4. Short-Circuit Temperature Coefficient: <**Insert mA/deg C**>.
5. Rated Short-Circuit Current (Isc): <**Insert amperes**>.
6. Maximum System: <**Insert V(dc)**>.
7. Rated Operation Current (Imp): <**Insert amperes**>.
8. Maximum Power at STC (Pmax): <**Insert watts**>.

B. Additional Electrical Characteristics:

1. PTC Rating: <**Insert watts**>.
2. Peak Power per Unit Area: <**Insert watts**>.
3. Tolerance of Pmax: <**Insert number**> percent.
4. Minimum Peak Power: <**Insert watts**>.
5. Series Fuse Rating: <**Insert amperes**>.
6. Module Efficiency: <**Insert number**> percent.
7. Temperature Cycling Range: <**Insert deg C**>.
8. Humidity, Freeze, Damp Heat Condition: <**Insert number**> percent RH.
9. Wind Loading or Surface Pressure: <**Insert lb/ft2 (N/m2)**>.
10. Maximum Distortion Angle: <**Insert degrees**>.
11. Hailstone Impact Withstand: <**Insert inch (mm)**> diameter at <**Insert mile/h (km/h)**> wind velocity.

C. Normal Operating Temperature Characteristics (NOTC):

1. Temperature at Nominal Operating Cell Temperature: <**Insert deg C**>.
2. Temperature Coefficient (NOTC Nominal Power): <**Insert deg C**>.
3. Temperature Coefficient (NOTC Open-Circuit Voltage): <**Insert deg C**>.
4. Temperature Coefficient (NOTC Short Circuit Current): <**Insert deg C**>.
5. Temperature Coefficient (NOTC Maximum Power Voltage): <**Insert deg C**>.
6. Temperature Coefficient (NOTC Maximum Power Current): <**Insert deg C**>.

2.4 PV SYSTEMS DESCRIPTION

A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Utility-interactive inverter.
    d. Overcurrent protection, disconnect, and rapid shutdown devices.
    e. Mounting structure.
    f. Utility meter.
    g. <**Insert component**>.

B. Hybrid PV System: Collectors connected to provide power to DC and AC loads, connected to utility through interactive inverters or meters, and connected to energy storage.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Charge controller.
    d. Energy storage.
    e. System control.
    f. [**Inverter**][**Utility-interactive inverter**].
    g. Overcurrent protection, disconnect, and rapid shutdown devices.
    h. Mounting structure.
    i. [**Meter**][**Utility-interactive meter**].
    j. <**Insert component**>.

C. Stand-Alone PV System: Collectors connected to provide power to Project DC and AC loads through an energy storage system.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Charge controller.
    d. Energy storage.
    e. Inverter.
    f. Overcurrent protection, disconnect, and rapid shutdown devices.
    g. Mounting structure.

2.5 MANUFACTURED PV UNITS

A. Cell Materials, Thin Film:

1. Amorphous silicon (a-Si).
2. Micromorphous silicon (a-Si+uc-Si).
3. Copper indium (di)selenide (CIS).
4. Copper indium gallium (di)selenide (CIGS).
5. Cadmium telluride (CdTe).
6. Cadmium sulfide.

B. Cell Materials, Wafer: [**Polycrystalline**][**Monocrystalline**].

1. c-Si.
2. Gallium arsenide (GaAs).

C. Module Construction:

1. Nominal Size: **32 inch (800 mm)** wide by **64 inch (1600 mm)** long.
2. Weight: **42.8 lb (19.4 kg)**.

D. Insulating Substrate Film: [**Flexible**][**Rigid**], [**polyester**][**polyimide**].

E. Conducting Substrate Film: [**Flexible**][**Rigid**][**Fluoropolymer**], [**ETFE**][**FEP**].

F. Encapsulant: Ethyl vinyl acetate.

G. Front Panel: [**Fully tempered glass**][**0.125 inch (3.2 mm) thick glass**][**Low iron glass**][**Antireflective coating glass**][**Laminating film**][**Laminating material**].

H. Backing Material: [**Tempered glass**][**0.125 inch (3.2 mm) thick glass**][**Polyester film**][**PVC film**].

1. Layers: <**Insert number**>.
2. Color: [**White**]<**Insert color**>.

I. Bypass Diode Protection: Internal.

J. Junction Box:

1. Size: **1.56-by-3.96-by-0.52 inch (39.6-by-100.6-by-13.2 mm)**.
2. Fully potted, vandal resistant.
3. IP Code: [**IP65**][**IP66**][**IP67**]<**Insert IP code designation**>.
4. Flammability Test: UL 1703.

K. Output Cabling:

1. [**0.158 inch (4 mm)**]<**Insert dimension**>.
2. Quick, multiconnect, polarized connectors.
3. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

L. Series Fuse Rating: <**Insert amperes**>.

2.6 PV MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.

1. Entire assembly UL listed for electrical and fire safety, [**Class A**][**Class C**], according to UL 1703, and complying with IEC 61215.
2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
3. Anodized Aluminum Finish: Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
4. High-performance Organic Finish: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not

less than 70 percent PVC resin by weight.
5. Baked-enamel finish.
6. Color: As indicated by manufacturer's designations.

2.7 PV ARRAY CONSTRUCTION

A. Framing:

1. Material: [**Extruded aluminum**][**Galvanized steel**][**Coated steel**].
2. Maximum System Weight: Less than **4 lb/ft2 (19.53 kg/m2)**.
3. Minimum Distance to Connectors: <**Insert inch (mm)**>.
4. Raceway Cover Plates: [**Plastic**][**Aluminum**][**Galvanized steel**].

B. Flat-Roof Mounting:

1. No roof penetrations.
2. Self-ballasting.
3. Wind-tunnel tested to **110 mile/h (160 km/h)** wind.
4. Service Life: [**25**]<**Insert number**> years.
5. Freestanding system.

2.8 INVERTER

A. Inverter Type: [**Central**][**Microgrid**].

B. Control Type: [**Pulse-width-modulation control**][**Maximum power point tracker control**].

C. Inverter Electrical Characteristics:

1. Maximum Recommended PV Input Power: <**Insert kilowatts**>.
2. Maximum Open-Circuit Voltage: <**Insert V(dc)**>.
3. PV Start Voltage: <**Insert V(dc)**>.
4. MPPT Voltage Range: <**Insert V(dc)**>.
5. Maximum Input Current: <**Insert amperes**>.
6. Number of String Inputs: <**Insert number**>.
7. Number of Independent MPPT Circuits: <**Insert value**>.
8. Nominal Output Voltage: <**Insert V(dc)**>.
9. CEC Rated Power: <**Insert kilowatts**>.
10. Maximum Output Current: <**Insert amperes**>.
11. Peak Efficiency: <**Insert number**> percent.
12. CEC Weighted Efficiency: <**Insert number**> percent.
13. CEC Night Tare Loss: <**Insert watts**>.
14. DC/AC Terminal Range (AWG): <**Insert range of AWG values**>.
15. Communications Interface: [**TIA-485**][**TIA-232**][**Ethernet**][**Zigbee**]<**Insert type**>.
16. Utility Interface: Utility-interactive inverter.

D. Operating Conditions:

1. Operating Ambient Temperatures: **Minus 4 to plus 122 deg F (20 to plus 50 deg C)**.
2. Storage Temperature: **Minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)**.
3. Relative Humidity: Zero to 95 percent, noncondensing.

E. Charge controllers must have the following:

1. Overcurrent protection.
2. Generator input breaker box.
3. Automatic transfer relay.
4. Digital display.
5. Transformer.
6. Disconnect switch.
7. Shunt controller.
8. Shunt regulator.
9. Surge overload protection.

F. Enclosure:

1. UL 50E[**, Type 3R**][**, Type 4X**].
2. Enclosure Material: [**Galvanized steel**][**Steel**].
3. Cooling Methods:

   a. Fan convection cooling.
   b. Passive cooling.

4. Protective Functions:

   a. AC over/undervoltage.
   b. AC over/underfrequency.
   c. Ground overcurrent.
   d. Overtemperature.
   e. AC and DC overcurrent.
   f. DC overvoltage.

5. Standard LCD, four lines, 20 characters, with user display and on/off toggle switch.

G. Disconnects: Rated for system voltage and conductor.

H. Regulatory Approvals:

1. IEEE 1547.1.
2. IEEE 1547.3.
3. UL 1741.

I. Characteristics:

1. Inverter Dimensions: <**Insert inch (mm)**>.
2. Inverter Weight: <**Insert lb (kg)**>.

2.9 SYSTEM OVERCURRENT PROTECTION

A. Fuses: <**Insert amperes**>.

B. Circuit Breakers: <**Insert amperes**>.

2.10 MOUNTING STRUCTURES

A. Roof Mount: Extruded aluminum, [**two**][**four**] rails, tilt legs, and roof standoffs.

B. Pole Mount: [**Top**][**Panel tops**][**Side**].

C. Tracking Mounts: [**One**][**Two**] axis.

2.11 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of PV panels with [**roof**][**support**] assembly and other construction.

B. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.

C. Install PV [**inverters,**][**energy storage,**][**charge controller,**][**rapid shutdown,**][**and**][**system control**] in locations indicated on Drawings.

D. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 079200 "Joint Sealants" for materials and application.

E. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electric Systems."

F. Wiring Method: Install cables in raceways.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.

B. Coordinate installation of utility-interactive meter with utility.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].

END OF SECTION 26 31 00 00

Task	Specification	Specification Description
26 32 13 00	26 32 13 19	Bi-Fuel-Engine-Driven Generator Sets

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SECTION 26 32 13 13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel-engine-driven generator sets.
2. Diesel engine.
3. Diesel fuel-oil system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Generator, exciter, and voltage regulator.
7. Load bank.
8. Outdoor engine generator enclosure.
9. Remote radiator motors.
10. Vibration isolation devices.

B. Related Requirements:

1. Section 262313 "Paralleling Low-Voltage Switchgear" for controls and paralleling equipment for large or multiple parallel engine generators.
2. Section 263343 "Battery Chargers" for remote engine battery chargers.
3. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in **gallons per hour (liters per hour)** at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in **cubic feet per minute (cubic meters per minute)** at 0.8 power factor, with air-supply temperature of **95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C)**. Provide Drawings indicating requirements and limitations for location

of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight[**, including full fuel tank**], [**supplied enclosure,**][**external silencer,**][**subbase-mounted fuel tank,**][**skid-mounted load bank,**] and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIESEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]

4. [**Hipower Systems**]
5. [**Kohler Power Systems**]
6. [**Rolls-Royce Solutions America Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Hipower Systems**]
5. [**Kohler Power Systems**]
6. [**Rolls-Royce Solutions America Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, [**subbase fuel tank,**][**day tank,**] engine generator, batteries, battery racks, silencers, [**load banks,**] sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.[**Water shall be substituted for diesel fuel in fuel tank during test.**]
3. Component Importance Factor: [**1.5**][**1.0**].

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level [**1**][**2**] EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier [**2**][**3**][**4**] requirements and applicable state and local government requirements.

F. Noise Emission: Comply with [**applicable state and local government requirements**]<**Insert Project criteria**> for maximum noise level at [**adjacent property boundaries**]<**Insert critical locations**> due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: [**41 to 104 deg F (5 to 40 deg C)**][**5 to 104 deg F (Minus 15 to plus 40 deg C)**].
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to [**1000 feet (300 m)**]<**Insert altitude**>.

H. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. [**High salt-dust content in the air due to sea-spray evaporation**]<**Insert unusual condition**>.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: [**Prime**][**Industrial**][**Standby**].

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. EPSS Class: Engine generator shall be classified as a [**Class 2**][**Class 6**][**Class 48**][**Class 96**]<**Insert classification**> according to NFPA 110.

F. Service Load: <**Insert number**> kVA.

G. Power Factor: [**0.8**]<**Insert number**>, lagging.

H. Frequency: 60 Hz.

I. Voltage: [**208**][**240**][**480**][**600**][**4160**]-V ac.

J. Phase: Three-phase, [**three**][**four**] wire, [**wye**][**delta**].

K. Induction Method: [**Naturally aspirated**][**Turbocharged**].

L. Governor: Adjustable isochronous, with speed sensing.

M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

N. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries[**, with capacity as required to operate as a unit as evidenced by records of prototype testing**].
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

O. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

P. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
b. [**10**]<**Insert number**> seconds.

Q. Parallel Engine Generators:

1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
3. Protective relays required for equipment and personnel safety.
4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

1. <**Insert specific fuel grade requirements**>.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499[**and with NFPA 110 requirements for Level 1 equipment for heater capacity**].

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

a. Rating: **50-psig (345-kPa)** maximum working pressure with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Remote Cooling System: Closed loop, liquid cooled, with remote radiator and [**integral engine driven**][**auxiliary**] coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: [**Vertical**][**Horizontal**] air discharge.
2. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer:

1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 25 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**78**]<**Insert number**> dBA or less.

2. Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 18 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**85**]<**Insert number**> dBA or less.

3. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 12 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**90**]<**Insert number**> dBA or less.

H. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: [**12**][**24**]-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: [**As required by NFPA 110 for system level specified**][**60 seconds**].
4. Battery: [**Lead acid**][**Nickel cadmium**], with capacity within ambient temperature range specified

in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above **50 deg F (10 deg C)** regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for [**lead-acid**][**nickel-cadmium**] batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from **minus 40 to 140 deg F (minus 40 to plus 60 deg C)** to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in [**Section 231313 "Facility Underground Fuel-Oil Storage Tanks."**][**Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."**]

1. Fuel Tank Capacity: [**Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills plus fuel for the hours of continuous operation required for the indicated EPSS Class.**][**As recommended by engine manufacturer for an uninterrupted period of 8 hours' operation at 100 percent of rated power output of engine generator**

system without being refilled]<**Insert gallons (liters)**>.

2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

   a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

H. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for [**15**][**30**]<**Insert number**> minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:

    a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.
    b. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards." Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
    c. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

F. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, [**for each phase**][**connected to a phase selector switch**].
    f. AC ammeter, [**for each phase**][**connected to a phase selector switch**].
    g. AC frequency meter.
    h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low-water temperature alarm.
    g. High engine temperature prealarm.
    h. High engine temperature.

i. High engine temperature shutdown device.
j. Overspeed alarm.
k. Overspeed shutdown device.
l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required [**for the indicated EPSS class**][**in "Fuel Tank Capacity" Subparagraph in "Diesel Fuel-Oil System" Article**].

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS load indicator.
t. Battery high-voltage alarm.
u. Low cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.
y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual stop shutdown device.
cc. Air shutdown damper alarm when used.
dd. Air shutdown damper shutdown device when used.
ee. Generator overcurrent-protective-device not-closed alarm.
ff. Hours of operation.
gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. Engine Generator Metering: Comply with [**Section 260913 "Electrical Power Monitoring and Control."**][**Section 262713 "Electricity Metering."**][**Section 260913 "Electrical Power Monitoring and Control" and Section 262713 "Electricity Metering."**]

H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via [**ModBus**][**LonWorks**][**Ethernet**]<**Insert data protocol**>. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

J. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.

3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

   a. Tripping Characteristic: Designed specifically for generator protection.
   b. Trip Rating: Matched to generator output rating.
   c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
   d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

   a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
   b. Trip Settings: Selected to coordinate with generator thermal damage curve.
   c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
   d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

3. Insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

4. Molded-case type disconnect switch; 100 percent rated:

a. Trip Rating: Matched to generator output rating.
b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: [**Class H**][**or**][**Class F**].

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide [**six**][**12**]-lead alternator.

E. Range: Provide [**limited**][**broad**][**extended**] range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified[**and as required by NFPA 110**].

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within [**15**][**20**][**30**] percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within [**5**][**10**][**15**] percent and stabilize at rated frequency within [**2**][**5**] seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: [**12**]<**Insert number**> percent, maximum.

2.9 LOAD BANK

A. Description:

1. Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, [**resistive**][**resistive and reactive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**100**]<**Insert number**> percent rated-system capacity, at [**80**]<**Insert number**> percent power factor, lagging.[**Unit may contain separate resistive and reactive load banks controlled by a common control panel.**] Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Permanent, radiator-mounted[**, resistive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**50**][**70**]<**Insert number**> percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps of load-bank rating and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and stainless-steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases. Galvanized steel is prohibited. Element's maximum resistance shall be between 100 and 105 percent of rated resistance.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load-Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, aluminized steel complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with **1/2-inch- (13-mm-)** square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge. Components other than resistive elements shall

receive exterior epoxy coating with compatible primer. Comply with requirements in Section 099600 "High-Performance Coatings."

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

I. Load-Bank Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.10 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to **100 mph (160 km/h)**. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

a. Sound Attenuation Level: <**Insert level**>.

2. Prefabricated or pre-engineered, galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure; erected on concrete foundation.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to **100 mph (160 km/h)**.

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Fire Protection: Provide fire protection according to Section 211000 "Water-Based Fire-Suppression Systems." Provide smoke detector in enclosure; mounted according to NFPA 72.

E. Hinged Doors: With padlocking provisions.

F. Space Heater: Thermostatically controlled and sized to prevent condensation.

G. Lighting: Provide weather-resistant [**fluorescent**][**LED**] lighting with [**30 fc (330 lx)**][**50 fc (550 lx)**] average maintained.

H. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

I. Muffler Location: [**Within**][**External to**] enclosure.

J. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature

at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

K. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

L. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.11 REMOTE RADIATOR MOTORS

A. Description: NEMA MG 1, Design B, medium-induction, random-wound, squirrel-cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:

1. Motors [**15**]<**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than [**15**]<**Insert number**> HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.12 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: [**Standard neoprene**][**Natural rubber**][**Bridge-bearing neoprene, complying with AASHTO M 251**] separated by steel shims.
2. Shore A Scale Durometer Rating: [**30**][**40**][**45**][**50**][**60**][**65**][**70**]<**Insert number**>.

3. Number of Layers: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
4. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.13 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115[**and with NFPA 110, Level 1 Energy Converters**].

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions[**and with NFPA 110**].

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators[**and remote radiators mounted on grade**]. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install [**packaged engine generator**][**engine generator in a walk-in enclosure**] with [**elastomeric isolator pads**][**restrained spring isolators**] having a minimum deflection of [**1 inch (25 mm)**]<**Insert static deflection**> on **4-inch- (100-mm-)** high concrete base. Secure [**sets**][**enclosure**] to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Remote Radiators:

   a. Install remote radiator with [**elastomeric isolator pads**][**restrained spring isolators**] on [**concrete base on grade**][**roof equipment supports on roof**].
   b. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and [**heat exchanger**][**remote radiator**]. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of **9 inches (225 mm)** of clearance from combustibles.
2. Insulate cooling-system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
4. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of **9 inches (225 mm)** of clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

H. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
2. Copper and galvanized steel shall not be used in the fuel-oil piping system.

I. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect cooling-system water piping to engine generator and [**remote radiator**][**heat exchanger**] with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.
3. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
4. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.

a) Machines Larger Than **200 hp (150 kW)**: Test duration shall be 10 minutes. Calculate polarization index.
b) Machines **200 hp (150 kW)** or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration test for each main bearing cap.
6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding **40-inch wg (120 kPa)**. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at [**four**]<**Insert number**> locations [**25 feet (8 m)** **from edge of the generator enclosure**][**on the property line**]<**Insert location for measurement**>, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and [**retest**][**reinspect**] as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**12**]<**Insert number**> months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

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Task	Specification	Specification Description
26 32 13 13	26 32 13 19	Bi-Fuel-Engine-Driven Generator Sets

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SECTION 26 32 13 19 - BI-FUEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bi-fuel-engine-driven generator sets.
2. Bi-fuel engine.
3. Diesel fuel-oil system.
4. Gas fuel system.
5. Control and monitoring.
6. Generator overcurrent and fault protection.
7. Generator, exciter, and voltage regulator.
8. Load bank.
9. Outdoor engine generator enclosure.
10. Remote radiator motors.
11. Vibration isolation devices.

B. Related Requirements:

1. Section 262313 "Paralleling Low-Voltage Switchgear" for controls and paralleling equipment for large or multiple parallel engine generators.
2. Section 263343 "Battery Chargers" for remote engine battery chargers.
3. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

A. Bi-Fuel: An engine generator that starts using diesel fuel, and upon assumption of the electrical load, transitions to a diesel fuel and natural gas mix.

B. EPS: Emergency power supply.

C. EPSS: Emergency power supply system.

D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in [**gallons per hour (liters per hour)**][**and**][**cubic feet per hour (cubic meters per hour)**] at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

a. Include fuel consumption at power factor and loads above at 3:1, 2:1, and 1:1 natural gas to diesel ratio.

5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in **cubic feet per minute (cubic meters per minute)** at 0.8 power factor, with air-supply temperature of **95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C)**. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight[**including full fuel tank**], [**supplied enclosure,**][**external silencer,**][**subbase-mounted fuel tank,**][**skid-mounted load bank,**] and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BI-FUEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Rolls-Royce Solutions America Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Rolls-Royce Solutions America Inc.**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, [**subbase fuel tank,**][**day tank,**] engine generator, batteries, battery racks, silencers, [**load banks,**]and sound-attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst case normal levels.[**Water shall be substituted for diesel fuel in fuel tank during test.**]
3. Component Importance Factor: [**1.5**][**1.0**].

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level [**1**][**2**] EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier [**2**][**3**][**4**] requirements and applicable state and local

government requirements.

F. Noise Emission: Comply with [**applicable state and local government requirements**]<**Insert Project criteria**> for maximum noise level at [**adjacent property boundaries**]<**Insert critical locations**> due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: [**41 to 104 deg F (5 to 40 deg C)**][**5 to 104 deg F (Minus 15 to plus 40 deg C)**].
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to [**1000 feet (300 m)**]<**Insert altitude**>.

H. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. [**High salt-dust content in the air due to sea-spray evaporation**]<**Insert unusual condition**>.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.

C. Power Rating: [**Prime**][**Industrial**][**Standby**].

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. EPSS Class: Engine generator shall be classified as a [**Class 2**][**Class 6**][**Class 48**][**Class 96**]<**Insert classification**> according to NFPA 110.

F. Service Load: <**Insert number**> kVA.

G. Power Factor: [**0.8**]<**Insert number**>, lagging.

H. Frequency: 60 Hz.

I. Voltage: [**208**][**240**][**480**][**600**][**4160**]-V ac.

J. Phase: Three-phase, [**three**][**four**]-wire, [**wye**][**delta**].

K. Induction Method: [**Naturally aspirated**][**Turbocharged**].

L. Governor: Adjustable isochronous, with speed sensing.

M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

N. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries[**, with capacity as required to operate as a unit as evidenced by records of prototype testing**].
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

O. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

P. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three

seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

Q. Parallel Engine Generators:

1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
3. Protective relays required for equipment and personnel safety.
4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

2.4 BI-FUEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15 and natural gas.

1. <**Insert specific fuel grade requirements**>.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skidmounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499[**and with NFPA 110 requirements for Level 1 equipment for heater capacity**].

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110

percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: **50-psig (345-kPa)** maximum working pressure with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Remote Cooling System: Closed loop, liquid cooled, with remote radiator and [**integral engine-driven**][**auxiliary**] coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: [**Vertical**][**Horizontal**] air discharge.
2. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer:

1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 25 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**78**]<**Insert number**>dBA or less.

2. Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 18 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**85**]<**Insert number**>dBA or less.

3. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 12 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**90**]<**Insert number**>dBA or less.

H. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: [**12**][**24**]-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: [**As required by NFPA 110 for system level specified**][**60 seconds**].
4. Battery: [**Lead acid**][**Nickel cadmium**], with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above **50 deg F (10 deg C)** regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for [**lead-acid**][**nickel-cadmium**] batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from **minus 40 to 140 deg F (minus 40 to plus 60 deg C)** to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in [**Section 231313 "Facility Underground Fuel-Oil Storage Tanks."**][**Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."**]

1. Fuel Tank Capacity: [**Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills plus fuel for the hours of continuous operation required for the indicated EPSS Class.**][**As recommended by engine manufacturer for an uninterrupted period of 8 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

   a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

H. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation for indicated EPSS class.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 GAS FUEL SYSTEM

A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."

B. Gas Train: Comply with NFPA 37.

C. Engine Fuel System:

1. Natural Gas, Vapor-Withdrawal System:

a. Carburetor.
b. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
c. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
d. Fuel Filters: One for each fuel type.
e. Manual Fuel Shutoff Valves: One for each fuel type.
f. Flexible Fuel Connectors: Minimum one for each fuel connection.

2.7 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run-time control set for [**15**][**30**]<**Insert number**> minutes with override only by operating a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:

a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.

b. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards." Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
c. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

F. Control and Monitoring Panel:

1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

a. Engine lubricating-oil pressure gage.
b. Engine-coolant temperature gage.
c. DC voltmeter (alternator battery charging).
d. Running-time meter.
e. AC voltmeter, [**for each phase**][**connected to a phase selector switch**].
f. AC ammeter, [**for each phase**][**connected to a phase selector switch**].
g. AC frequency meter.
h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices and common visual alarm indication including the following:

a. Cranking control equipment.
b. Run-Off-Auto switch.
c. Control switch not in automatic position alarm.
d. Overcrank alarm.
e. Overcrank shutdown device.
f. Low water temperature alarm.
g. High engine temperature pre-alarm.
h. High engine temperature.
i. High engine temperature shutdown device.
j. Overspeed alarm.
k. Overspeed shutdown device.
l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required [**for the indicated EPSS class**][**in "Fuel Tank Capacity" Subparagraph in "Diesel Fuel-Oil System" Article**].

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS supplying load indicator.
t. Battery high-voltage alarm.
u. Low cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.

y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual stop shutdown device.
cc. Air shutdown damper alarm when used.
dd. Air shutdown damper shutdown device when used.
ee. Generator overcurrent-protective-device not-closed alarm.
ff. Hours of operation.
gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. Engine Generator Metering: Comply with [**Section 260913 "Electrical Power Monitoring and Control."**][**Section 262713 "Electricity Metering."**][**Section 260913 "Electrical Power Monitoring and Control" and Section 262713 "Electricity Metering."**]

H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via [**ModBus**][**LonWorks**][**Ethernet**]<**Insert data protocol**>. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

J. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature pre-alarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

a. Tripping Characteristic: Designed specifically for generator protection.
b. Trip Rating: Matched to generator output rating.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to or integrated with control and monitoring panel.

3. Insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

4. Molded-case type disconnect switch; 100 percent rated:

a. Trip Rating: Matched to generator output rating.
b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.

2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: [**Class H**][**or**][**Class F**].

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide [**six**][**12**]-lead alternator.

E. Range: Provide [**limited**][**broad**][**extended**] range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified[**and as required by NFPA 110**].

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within [**15**][**20**][**30**] percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within [**5**][**10**][**15**] percent and stabilize at rated frequency within [**2**][**5**] seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: [**12**]<**Insert number**> percent, maximum.

2.10 LOAD BANK

A. Description:

1. Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, [**resistive**][**resistive and reactive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**100**]<**Insert number**> percent rated-system capacity, at [**80**]<**Insert number**> percent power factor, lagging.[**Unit may contain separate resistive and reactive load banks controlled by a common control panel.**] Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Permanent, radiator-mounted[**, resistive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**50**][**70**]<**Insert number**> percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps of load-bank rating and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and stainless-steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases. Galvanized steel is prohibited. Element's maximum resistance shall be between 100 and 105 percent of rated resistance.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load-Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, aluminized steel complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with **1/2-inch- (13-mm-)** square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge. Components other than resistive elements shall receive exterior epoxy coating with compatible primer. Comply with requirements in Section 099600 "High-Performance Coatings."

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

I. Load-Bank Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.11 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to **100 mph**

(160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

2. Prefabricated or preengineered, galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure; erected on concrete foundation.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Fire Protection: Provide fire protection according to Section 211000 "Water-Based Fire-Suppression Systems." Provide smoke detector in enclosure; mounted according to NFPA 72.

E. Hinged Doors: With padlocking provisions.

F. Space Heater: [**Gaseous**][**Electric**]. Thermostatically controlled and sized to prevent condensation.

G. Lighting: Provide weather-resistant [**fluorescent**][**LED**] lighting with [30 fc (330 lx)][50 fc (550 lx)] average maintained.

H. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

I. Muffler Location: [**Within**][**External to**] enclosure.

J. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

K. Interior Lights with Switch: Factory-wired, vaporproof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

L. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.12 REMOTE RADIATOR MOTORS

A. Description: NEMA MG 1, Design B, medium-induction, random-wound, squirrel-cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:

1. Motors [**15**]<**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than [**15**]<**Insert number**> HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.13 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: [**Standard neoprene**][**Natural rubber**][**Bridge-bearing neoprene, complying with AASHTO M 251**] separated by steel shims.
2. Shore A Scale Durometer Rating: [**30**][**40**][**45**][**50**][**60**][**65**][**70**]<**Insert number**>.
3. Number of Layers: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
4. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connectors materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.14 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.15 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115[**and with NFPA 110, Level 1 Energy Converters**].

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections to verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions[**and with NFPA 110**].

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators[**and remote radiators mounted on grade**]. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install [**packaged engine generator**][**engine generator in a walk-in enclosure**] with [**elastomeric isolator pads**][**restrained spring isolators**] having a minimum deflection of [**1 inch (25 mm)**]<**Insert static deflection**> on **4-inch- (100-mm-)** high concrete base. Secure [**sets**][**enclosure**] to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Remote Radiators:

   a. Install remote radiator with [**elastomeric isolator pads**][**restrained spring isolators**] on [**concrete base on grade**][**roof equipment supports on roof**].
   b. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and [**heat exchanger**][**remote radiator**]. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of **9 inches (225 mm)** of clearance from combustibles.
2. Insulate cooling system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of **9 inches (225 mm)** of clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

H. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are

specified in Section 231113 "Facility Fuel-Oil Piping."
2. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."
3. Copper and galvanized steel shall not be used in the diesel fuel-oil piping system.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine generator and [**remote radiator**][**heat exchanger**] with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Fuel Connections:

1. Connect fuel piping to engines with a gate valve and union and flexible connector.
2. Install manual shutoff valve in a remote location to isolate gas supply to the generator.
3. Vent gas pressure regulators outside building a minimum of **60 inches (1500 mm)** from building openings.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the generator set from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.
3. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

4. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs, as specified in NETA ATS. Certify compliance with test parameters.

   a. Visual and Mechanical Inspection:

      1) Compare equipment nameplate data with Drawings and the Specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment, and grounding.
      4) Verify that the unit is clean.

   b. Electrical and Mechanical Tests:

      1) Perform insulation-resistance tests according to IEEE 43.

         a) Machines Larger Than **200 hp (150 kW)**: Test duration shall be 10 minutes. Calculate polarization index.
         b) Machines **200 hp (150 kW)** or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

      2) Test protective relay devices.
      3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Perform vibration test for each main bearing cap.
      6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding **40-inch wg (120 kPa)**. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at [**four**]<**Insert number**> locations [**25 feet (8 m) from edge of the generator enclosure**][**on the property line**]<**Insert location for measurement**>, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and [**retest**][**reinspect**] as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**12**]<**Insert number**> months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13 19

SECTION 26 33 43 00 - BATTERY CHARGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes battery chargers for emergency engine generators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of battery charger.

1. Include system overview, construction details, material descriptions, and dimensions of battery charging and monitoring systems.
2. Include rated capacities, operating characteristics, electrical characteristics, performance specifications, and furnished accessories.

B. Shop Drawings: For battery chargers.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include instructions for Installer.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Seismic Qualification Data: Certificates, for battery changers, accessories, and components, from manufacturer.

1. Basis for Certification: Include Certificate of Compliance for nonstructural components and systems. Withstand certification is for below-grade, grade, and roof-level installations, installations in essential facilities, and for life-safety applications, based on actual shake-testing. Certified installation locations shall include mounting directly to structural wall and directly to nonstructural wall.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For battery chargers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's operating specifications and user's guides.
b. Data sheet for each battery charger with nameplate information and performance

specifications.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide certification that manufacturer complies with requirements of ISO 9001.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of battery chargers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 1236 for Category BBHH. OEM-supplied, open-frame chargers may be UL recognized to Category BBHH provided they are housed in a listed enclosure.

C. NFPA Compliance: Comply with NFPA 110.

D. Environmental Conditions: Battery charger shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: **Minus 40 to plus 158 deg F (minus 40 to plus 70 deg C)** with full charger output available up to **104 deg F (40 deg C)**.
2. Relative Humidity: 5 to 95 percent.
3. Altitude: Meets full performance from sea level to **5000 feet (1600 m)**. Chargers installed at higher altitudes may automatically derate output power to prevent overheating of internal components, but shall remain operable.
4. Electromagnetic Immunity: Charger power terminals shall be immune to conducted and radiated electromagnetic energy to IEC 61000-4-12.
5. Vibration Resistance: Charger enclosure rated to IEC 60068-2-6 vibration test; 4-g force from 18 to 500 Hz on 3 axes; and 0.01 power spectral density value from 20 to 500 Hz.

E. Seismic Performance: Battery chargers shall withstand the effects of earthquake motions determined according to [**IBC 2006**][**IBC 2009**][**IBC 2012**][**IBC 2015**][**the latest edition of the IBC**][**ASCE/SEI 7**]<**Insert requirement**>.

1. Shake-Table Testing: Comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
3. Component Importance Factor: [**1.5**][**1.0**].
4. Equipment seismic application, spectral response acceleration, short period (Sds) for Project is

[**indicated on Drawings**]<**Insert requirements**>.

F. Battery-Charger Power Conversion Energy Efficiency:

1. Certified to California Code of Regulations, Title 20, "Appliance Efficiency Regulations"; https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx.
2. Comply with Oregon Department of Energy standards for appliance energy efficiency.

2.2 BATTERY CHARGERS FOR EMERGENCY ENGINE GENERATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cummins Power Generation**]
2. [**GE Power; General Electric Company**]
3. [**Stored Energy Systems LLC**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cummins Power Generation**]
2. [**GE Power; General Electric Company**]
3. [**Stored Energy Systems LLC**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain battery chargers from single source from single manufacturer.

D. Battery-Charger Operation: Current-limited, constant-voltage, automatic-boost type charger designed for [**lead-acid**][**nickel-cadmium**] batteries, with the following features:

1. Automatic Boost Mode: Operates in boost charging mode after battery discharge. Boost duration automatically adjusted depending on the following:

   a. Differing depths of battery discharge.
   b. Differing relationships of battery amp-hour capacity to charger ampere output.
   c. Differing parasitic direct current loads.

2. Output Voltage Regulation: Charger regulates output to within plus or minus 0.5 percent of manufacturer-provided voltage settings despite variations of input voltage, input frequency, and output current.
3. Battery Thermal Compensation: Battery temperature compensation with adjustable slope, factory set at minus 0.18 percent per degree C, and equipped for sensing battery temperature.[**Include battery temperature sensor mounted on battery negative terminal.**]
4. Automatic Dead Battery Recharge: Charger automatically recharges a battery discharged to 0 V at full-rated output current, without the need for user intervention.
5. AC Input: Charger operates from any 47- to 63-Hz ac source with voltage ranging from 90- to 265-V rms.
6. Lead-Acid Battery Longevity and Safety Mode: Charger emulates vehicle duty for which starting batteries are designed to maximize battery life, minimize battery explosion risk, and minimize electrolyte loss in lead-acid batteries:

   a. Boost Mode Recharge: After recharge is complete in boost mode, charger reverts to a voltage just above battery open-circuit voltage, for the majority of battery-charger operating

hours, when fully charged. The charger remains in operation to prevent battery discharge.

b. Float Mode: Charger periodically elevates output voltage to ensure a fully charged battery, charger then returns to just above battery nominal voltage. Charger repeats this this cycle until the next battery discharge, when the battery shall be recharged in the boost mode.

7. Charger Enclosure: NEMA 250, [**Type 1 (IP20)**][**Type 3R (IP22)**], wall mounted and rated for generator duty with charger enclosure vibration resistance. Housing materials: aluminum or stainless steel.

E. Battery-Charger Status Indication and Alarms:

1. Output Voltage and Current: Digital or analog meters on front panel, or by conveying performance data to generator control panel via J-1939 datalink. Accuracy: Plus 2 percent for voltage and plus 5 percent for current.
2. Alarm Outputs: [**Individual Form C contacts**][**Single summary Form C contact**], or by conveying alarms to generator control panel via J-1939 datalink.

a. AC voltage failure.
b. Low dc voltage.
c. High dc voltage.
d. Low cranking voltage.

2.3 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate battery-charger fabricator's quality-control and testing methods.

B. Testing: Test and inspect battery chargers according to UL 1236 for Category BBHH recharge performance.

C. Factory Tests: Test and inspect assembled battery chargers to manufacturer's written instructions. Verify NFPA 110 recharge performance by validating that battery charger is listed to UL 1236 Category BBHH on the UL certification database.

D. Battery charger will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, mounting locations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting battery-charger performance.

B. Examine roughing-in for conduit systems and electrical connections to verify actual locations of connections before battery-charger installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BATTERY-CHARGER INSTALLATION

A. Follow manufacturer's written instructions to prevent damage from static electricity. Provide clearances for service and ventilation.

B. Battery chargers are configured at the factory. If settings need to be field-configured, follow manufacturer's setup written instructions.

C. Coordinate jumper datalinks with emergency generator control panel capabilities.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide branch-circuit overcurrent protection.

C. Comply with requirements for branch-circuit protection and service disconnects in Section 262816 "Enclosed Switches and Circuit Breakers."

3.4 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with authorities having jurisdiction**][**with the assistance of a factory-authorized service representative**]:

1. Verify that certification labels are properly installed. Verify NFPA 110 compliance by validating that battery charger is listed to UL 1236 Category BBHH on the UL certification database.
2. Verify that connections are secure and in the proper locations. Ensure wiring is correctly connected between charger and battery.
3. Operational Test: After electrical circuitry has been energized, apply input voltage to confirm proper unit operation.
4. Test and adjust alarms, display indicators, controls, and safeties.

D. Battery charger will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain battery chargers and related equipment.

B. Coordinate this training with that for emergency engine generator equipment.

END OF SECTION 26 33 43 00

SECTION 26 33 43 00A - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public address systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding equipment referenced by this Section.
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
7. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
9. Section 262716 "Electrical Cabinets and Enclosures" specifies rack or frame system enclosures referenced by this Section.
10. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
11. Section 284600 "Fire Detection and Alarm" specifies fire-alarm system interfaces referenced by this Section.
12. Section 284700 "Mass Notification" specifies mass notification system interfaces referenced by this Section.

1.2 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. FAS: Fire alarm system.

C. I&TFAS: Inspection and testing of fire alarm system.

D. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.

E. SPDT: Single pole, double throw.

F. VU: Volume unit.

G. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: For power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Console layouts.
4. Control panels.
5. Rack arrangements.
6. Calculations: For sizing backup battery.
7. Wiring Diagrams: For power, signal, and control wiring.

a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

1.6 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, to supervise Level I and Level II technicians, to provide submittal packages, and to interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, to interpret codes and standards, to conduct training, and to serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and to prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke-control interfaces, air-sampling systems, multi-zone voice evacuation systems, or high-rise applications) and to prepare related records and reports.

G. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS [**Senior**]Engineering Technician certification.

H. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician **[I][II]** certification.

I. Communications Design Professional: Design professional possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Expertise in design of communications infrastructure and distribution equipment.
2. BICSI Registered Communications Distribution Designer (RCDD)[**or Outside Plant Designer (OSP)**] certification.

J. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000

"Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**]<**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

K. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Functional Description:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature must connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter must allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation, including standby mode with inputs off, and output free of nonuniform coverage of amplified sound.
7. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
8. Equipment must be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
9. Equipment Mounting: Where rack or cabinet mounting is indicated, equipment must be designed to mount in a **19 inch (483 mm)** housing complying with Section 262716 "Electrical Cabinets and Enclosures."

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.

4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 PUBLIC ADDRESS SYSTEMS

A. UL AZOT - Public Address System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altec Lansing Technologies, Inc**]
   b. [**Atlas Sound LP**]
   c. [**Bogen Communications, Inc**]
   d. [**Bosch Security Systems, Inc.**]
   e. [**Edwards; Carrier Global Corporation**]
   f. [**Federal Signal Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altec Lansing Technologies, Inc**]
   b. [**Atlas Sound LP**]
   c. [**Bogen Communications, Inc**]
   d. [**Bosch Security Systems, Inc.**]
   e. [**Edwards; Carrier Global Corporation**]
   f. [**Federal Signal Corporation**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain public address system from single source from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Audio Equipment: UL CCN AZOT, including UL 62368-1[**; or UL CCN AZJX, including UL 813**][**; or UL CCN AZSQ, including UL 60065**].
   b. Weather-Resistant Equipment: Marked for use in wet or damp locations.

B. Preamplifiers:

1. Separately mounted.
2. Integral to power amplifier.
3. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
4. Total Harmonic Distortion: Less than 1 percent.
5. Frequency Response: Within plus or minus 2 dB from 20 to 20 000 Hz.
6. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.
7. Minimum Noise Level: Minus 55 dB below rated output.
8. Controls: On-off, input levels, and master gain.

C. Power Amplifiers:

1. Mounting: [**Console**][**Rack**].
2. Output Power: 70 V balanced line. [**80 percent of the sum of wattage settings of connected**]<**Insert wattage**> for each station and speaker connected in all-call mode of operation, plus a [**10 percent**][**15 percent**][**25 percent**] allowance for future stations.
3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12 000 Hz.
4. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.
5. Frequency Response: Within plus or minus 3 dB from 20 to 12 000 Hz.
6. Output Regulation: Less than 2 dB from full to no load.
7. Controls: On-off, input levels, and low-cut filter.
8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

D. Transfer to Standby Amplifier:

1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

E. Paging Microphone:

1. Type: Dynamic, with [**cardioid**][**omnidirectional**] polar characteristic.
2. Impedance: [**500 Ω**][**250 Ω**].
3. Frequency Response: Uniform, 50 to 15 000 Hz.
4. Sensitivity: Minus 70 dB.
5. Output Level: Minus 58 dB, minimum.
6. Cable: Braided shield cable with [**Amphenol**][**Neutrik**] XLR connectors. Coordinate impedance with microphone impedance.
7. Mounting: Desk stand with integral-locking, press-to-talk switch.

F. <**Insert requirements for other microphone types**>.

G. Volume Limiter/Compressor Minimum Performance Requirements:

1. Frequency Response: 45 to 15 000 Hz, plus or minus 1 dB minimum.
2. Reduction Ratio: Automatically vary compression ratio, and attack and release times for voice and music inputs.

   a. Compression Ratio Range: 3:1 to 10:1 minimum.
   b. Averaging Compressor Attack Time: Up to 500 ms.
   c. Signal Fast Compression Attack Time: Less than 10 ms.
   d. Release time: Up to 500 ms.

3. Distortion: 0.5 percent, maximum.
4. Rated Output: Minimum of plus 14 dB.
5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
6. Rack mounted.

H. Control Console Enclosure:

1. Cabinet: Modular, [**desktop**][**desk style**]; complying with EIA/ECA-310-E.
2. Housing: Steel, **0.0478 inch (1.2 mm)** minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
3. Panel for Equipment and Controls: Rack mounted.
4. Controls:

a. Switching devices to select signal sources for distribution channels.
b. Program selector switch to select source for each program channel.
c. Switching devices to select zones for paging.
d. All-call selector switch.

5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
8. Microphone jack.

I. Equipment Cabinet Enclosure:

1. Comply with requirements in Section 262716 "Electrical Cabinets and Enclosures."
2. House amplifiers and auxiliary equipment at each location.
3. Cabinet Housing:

a. Front- and rear-locking doors.
b. Arranged for floor or wall mounting as indicated.
c. Sized to house all equipment indicated, plus spare capacity.
d. Include [**20**]<**Insert number**> percent minimum spare capacity for future equipment in addition to space required for[**future**] DVD or CD player.

4. Power Provisions: A single switch in cabinet disconnects cabinet power distribution system and electrical outlets, which must be uniformly spaced to accommodate AC power cords for each item of equipment.
5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan must be equipped with a filtered input vent and must be connected to operate from 105 to 130 V(ac), 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

J. Equipment Rack Enclosure:

1. Racks: **19 inch (483 mm)** standard, complying with requirements in Section 262716 "Electrical Cabinets and Enclosures."
2. Power-Supply Connections: Compatible plugs and receptacles.
3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.
6. Service Light: At top rear of rack with an adjacent control switch.
7. Vertical Plug Strip: Grounded receptacles, **12 inch (300 mm)** on center; the full height of rack for public address system equipment use only.
8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
9. Spare Capacity: [**20**]<**Insert number**> percent in rack for future equipment.

K. Telephone Paging Adapter:

1. Adapters must accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

a. Minimum Frequency Response: Flat, 200 to 2500 Hz.
b. Impedance Matching: Adapter matches telephone line to public address equipment input.
c. [**Rack**][**Cabinet**] mounted.

L. Tone Generator:

1. Provide clock and program interface with public address system.
2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
3. Pitch Control: Chimes and tone.
4. Volume Control: All outputs.
5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
6. Mounting: [**Rack**][**Cabinet**].

M. Monitor Panel:

1. Monitor power amplifiers.
2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
4. Mounting: [**Rack**][**Cabinet**].

N. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1 W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15 000 Hz.
3. Size: [**6 inch (150 mm)**][**8 inch (200 mm)**] with **1 inch (25 mm)** voice coil and minimum **5 oz (140 g)** ceramic magnet.
4. Rated Output Level: [**8**][**10**] W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least **0.0478 inch (1.2 mm)** steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with [**white**]<**Insert color**> baked enamel.

O. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12 000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

P. Noise-Operated Gain Controller:

1. Gain controller must be designed to continuously sense space noise level and automatically adjust signal level to local speakers.
2. Frequency Response: 20 to 20 000 Hz, plus or minus 1 dB.
3. Level Adjustment Range: 30 dB minimum.
4. Maximum Distortion: 0.5 percent.

5. Control: Permits adjustment of sensing level of device.

Q. Outlets:

1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

   a. Wattage Rating: 10 W unless otherwise indicated.
   b. Attenuation per Step: 3 dB, with positive off position.
   c. Insertion Loss: 0.4 dB maximum.
   d. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
   e. Label: "PA Volume."

2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

R. Battery Backup Power Unit:

1. Rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
2. Supplies public address equipment with 12 to 15 V(dc) power automatically during an outage of normal 120 V(ac) power.
3. Float charge batteries when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
4. Automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

S. Conductors and Cables:

1. Jacketed, twisted pair and twisted multipair, untinned solid copper.

   a. Insulation for Wire in Conduit: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
   b. Microphone Cables: Neoprene jacketed, not less than **2/64 inch (0.8 mm)** thick, over shield with filled interstices. Shield 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   c. Plenum Cable: Listed and labeled for plenum installation.

T. Conduits and Boxes:

1. Flexible metal conduit is not permitted.
2. Outlet Boxes: Not less than **2 inch (50 mm)** wide, **3 inch (75 mm)** high, and **2-1/2 inch (64 mm)** deep.

2.3 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Microphone: [**One**]<**Insert number**>.
2. Microphone Desk Stand(s): [**One**]<**Insert number**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF COMMUNICATIONS CABLE PATHWAYS

A. Comply with NECA NEIS 1.

B. Special Installation Techniques:

1. Install manufactured conduit sweeps and long-radius elbows whenever possible.
2. Wiring Method:

   a. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters[**, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal pathway and cables except in unfinished spaces.

      1) Install plenum cable in environmental air spaces, including plenum ceilings.
      2) Install pathways and boxes for communications cabling.

   b. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
4. Terminate conductors; no cable may contain unterminated elements. Make terminations only at outlets and terminals.
5. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
6. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used.
10. Open-Cable Installation:

    a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
    b. Suspend speaker cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceiling by cable supports not more than [**60 inch (1524 mm)**]<**Insert dimension**> apart.
    c. Do not run cables through structural members or in contact with pipes, ducts, or other potentially damaging items.

11. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least **12 inch (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by

equipment manufacturer.

3.2 INSTALLATION OF PUBLIC ADDRESS SYSTEM

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, and NECA NEIS 305.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
3. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
4. Equipment Cabinets and Racks:

   a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
   b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

5. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
6. Wall-Mounted Outlets: Flush mounted.
7. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.
8. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than 18 AWG and conductors from microphone receptacles to amplifiers not smaller than 22 AWG.
9. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
10. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.

D. Interfaces with Other Work:

1. Seal penetrations of rated walls and partitions.
2. Identification: Provide labels for public address system equipment and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3. Grounding and Bonding:

a. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
b. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
c. Install grounding electrodes.

3.3 FIELD QUALITY CONTROL OF PUBLIC ADDRESS SYSTEM

A. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a

signal generator using a 1000 Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

b. Repeat test for each separately controlled zone of loudspeakers.

c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12 000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12 000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground.
9. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Nonconforming Work:

1. Public address system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to the Project during other-than-normal occupancy hours for this purpose.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

3.7 PROTECTION

A. After installation, protect public address system equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 33 43 00A

Task	Specification	Specification Description
26 33 43 00	27 52 23 00	Nurse Call Code Blue Systems

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SECTION 26 33 53 00 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.
2. Manufacturer's field reports for field quality-control support.

1.4 CLOSEOUT SUBMITTALS

A. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

1.5 WARRANTY FOR UPS SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed UPS system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that UPS system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.6 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**],

freight prepaid.

2. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]**<Insert number>** years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Additional Warranted Cycle Life Criteria for Standard Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F**:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
    b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

4. Additional Warranted Cycle Life Criteria for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F**:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
    b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

5. Additional Warranted Cycle Life Criteria for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F** and preventive maintenance performed in accordance with manufacturer's published instructions:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
    b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL Compliance: Listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with UL 1778.

B. NFPA Compliance: UPS components must be listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for installation in computer rooms in accordance with NFPA 75.

C. The UPS must perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state AC input voltage deviates up to plus or minus [**10**][**15**] percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is [**30**][**50**][**100**] percent unbalanced continuously.

D. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is [**five**][**10**][**15**]<**Insert duration**> minutes.

E. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state AC input voltage varies plus 10 percent and minus [**15**][**20**][**30**] percent from nominal voltage.

F. Overall UPS Efficiency: Equal to or greater than [**94**][**95**]<**Insert number**> percent at 100 percent load, [**94**][**95**]<**Insert number**> percent at 75 percent load, and [**93**][**94**]<**Insert number**> percent at 25 percent load.

G. Maximum Acoustical Noise: <**Insert value**>, "A" weighting, emanating from any UPS component under any condition of normal operation, measured <**Insert distance**> from nearest surface of component enclosure.

H. Maximum Energizing Inrush Current: [**Six times the full-load current**][**Eight times the full-load current**][**Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds**].

I. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

J. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

K. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

L. Limitation of harmonic distortion of input current to the UPS must be as follows:

1. Rectifier-charger circuits must limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
2. THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

M. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for [**100 percent rated nonlinear load current**][**rated full load with THD up to 50 percent**], with a load crest factor of 3.0.

N. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

O. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage must remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

P. Input Power Factor: A minimum of [**0.90**][**0.95**] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

Q. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging must not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

R. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.2 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]
6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with UL 50E, Type 1, unless otherwise indicated.

E. Configuration: [**Single-cabinet**][**Multicabinet**][**Field-assembled, multicabinet**] modular style units.

F. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

G. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

H. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

I. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future [**25**]**<Insert number>** percent increase in UPS capacity.

J. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

K. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

L. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.3 OUTPUT ISOLATION TRANSFORMER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Eaton**]
3. **<Insert manufacturer's name>**

B. Description: [**Shielded unit**][**Unit**] with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately [**4**][**9**][**13**][**20**].
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
6. Coil Leads: Physically arranged for minimum interlead capacitance.
7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 pF, maximum, over a frequency range of 20 Hz to 1 MHz.

2.4 BATTERY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. **<Insert manufacturer's name>**

B. General Characteristics:

1. Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

   a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2. Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, complete with battery disconnect switch and intercell connectors.

   a. Factory assembled in an isolated compartment of UPS cabinet.
   b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
   c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

3. Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
4. Flooded cell, heavy-duty, industrial, Ni-Cd units in polypropylene containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks, complete with battery disconnect switch and intercell connectors.
5. Valve-regulated, heavy-duty, industrial, recombinant, pocket plate design, Ni-Cd units in polypropylene containers, complete with battery disconnect switch and intercell connectors.

   a. Factory assembled in an isolated compartment of UPS cabinet.
   b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
   c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

C. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

2.5 BASIC BATTERY MONITORING

A. Basic Battery Monitoring: Continuous, real-time capture of battery performance data.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 Ω.

D. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater

than **167 deg F** occurs within the compartment.

E. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F** occurs within the compartment.

F. Annunciation of Alarms: At UPS control panel and remotely.

2.6 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Product Certificates: For each product, from manufacturer.
4. Sample Warranties: For manufacturer's special warranties.

B. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
2. Factory Tests and Inspections: Test and inspect UPS system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with NETA ATS before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

   a. Factory test complete UPS system before shipment. Use [**actual batteries that are part of final installation**][**the same type of batteries that are part of final installation**][**simulated battery testing**]. Include the following:

      1) Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
      2) Full-load test.
      3) Transient-load response test.
      4) Overload test.
      5) Power failure test.

3. Nonconforming Work:

   a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports. Include the following data:

   a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   c. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
4. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch** centers around the full perimeter of concrete base **6 inch** from the outer edge of the base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

E. Connections: Interconnect system components. Make connections to supply and load circuits in accordance with manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:

a. Inspect anchorage, alignment, grounding, and required clearances.
b. Component type and labeling verification.
c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.
3. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter in accordance with Section 7.22.2.2 of NETA ATS.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published instructions or Table 100.12 of NETA ATS.
    c. Perform thermographic survey in accordance with Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.
5. Test DC undervoltage trip level on inverter input breaker. Set in accordance with manufacturer's published instructions.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Test insulated-case and molded-case breakers.

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published instructions. In the absence of manufacturer's published instructions, use Table 100.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components, follow manufacturer's recommendation.
    c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
    d. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published instructions.
    e. Verify operation of charging mechanism.
    f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.

    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.22.3.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
    c. Perform a contact/pole-resistance test.
    d. Verify settings and operation of control devices.
    e. Calibrate and set all relays and timers in accordance with Section 7.9 of NETA ATS.
    f. Verify phase rotation, phasing, and synchronized operation as required by the application.
    g. Perform automatic transfer tests.

        1) Simulate loss of normal power.
        2) Return to normal power.
        3) Simulate loss of emergency power.
        4) Simulate all forms of single-phase conditions.

    h. Verify correct operation and timing of the following functions:

        1) Normal source voltage-sensing and frequency-sensing relays.

2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
b. [**Verify electrolyte level. Measure electrolyte level, specific gravity, and temperature.**]
c. Inspect spill containment installation. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
d. Verify all charger functions and alarms.
e. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
f. Perform a load test in accordance with manufacturer's published instructions or IEEE 450.
g. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
h. Test values.

1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels must be in accordance with battery manufacturer's published instructions.
3) The results of charger functions and alarms must be in accordance with manufacturer's published instructions.
4) Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published instructions.
5) Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
6) Results of load tests must be in accordance with manufacturer's published instructions or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**]<**Insert time**> in accordance with NIST standards.

a. Simulate malfunctions to verify protective device operation.
b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

D. Seismic-restraint tests and inspections must include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices in accordance with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Nonconforming Work:

1. The UPS system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Include references to manufacturers' published instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

END OF SECTION 26 33 53 00

SECTION 26 35 33 00 - POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GTO: Gate turn-off thyristor.

B. IGBT: Isolated gate bipolar transistor.

C. PF: Power factor.

D. pF: Picofarads.

E. THD: Total harmonic distortion.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

1. UPS systems.
2. Surge suppression.

3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.
2. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Spare Parts: Furnish to Owner spare parts, for repairing UPS system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type and rating, but no fewer than [**one**][**one set**]<**Insert number**> of each.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters.
2. Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

   a. Cabinet Ventilation Filters: [**One**]<**Insert number**> complete set(s).

1.7 WARRANTY FOR UPS SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed UPS system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that UPS system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.8 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Additional Warranted Cycle Life Criteria for Standard Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

   a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
   b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
   c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

4. Additional Warranted Cycle Life Criteria for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

5. Additional Warranted Cycle Life Criteria for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)** and preventive maintenance performed in accordance with manufacturer's published instructions:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Double Conversion, Standard Efficiency:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
c. Power Failure: If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.

2. Double Conversion, Line Interactive:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, with the rectifier-charger and inverter turned off and the battery disconnected.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the rectifier-charger and inverter turn on and the battery supplies energy to provide constant, regulated inverter power output to the load with minimum of 98 percent UPS system efficiency.
c. Power Failure: If normal power fails, there is a maximum 4 μs delay while the rectifier-charger and inverter turn on and the battery supplies energy to re-establish constant, regulated power output to the load.

3. Double Conversion, IGBT:

   a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in both rectifier-charger and inverter circuits, provides a minimum of 97 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.
   b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.
   c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls must automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger must supply power to the load through the inverter and simultaneously recharge the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger must charge the battery. The rectifier-charger must automatically shift to float-charge mode on reaching full charge.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch must switch the load to the normal AC supply circuit without disturbance or interruption.
7. The output power converters must produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter must sustain steady-state overload conditions of up to 200 percent of rated full-load current for 60 seconds in normal operation.
8. The inverter must be capable of sustaining 150 percent of system capacity for 30 seconds while powered from the battery.
9. Should overloads persist past the time limitations, the automatic static transfer switch must switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch must return the load to the UPS system.
10. If the battery is disconnected, the UPS must supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

   1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal AC supply circuit without disturbance or interruption.
   2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:

   1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS AC input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
   2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS AC supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
   3. Normal: Normal UPS AC supply terminals are energized and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.2 PERFORMANCE REQUIREMENTS

A. UL Compliance: Listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with UL 1778.

B. NFPA Compliance: UPS components must be listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for installation in computer rooms in accordance with NFPA 75.

C. The UPS must perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state AC input voltage deviates up to plus or minus [**10**][**15**] percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is [**30**][**50**][**100**] percent unbalanced continuously.

D. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is [**five**][**10**][**15**]<**Insert duration**> minutes.

E. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state AC input voltage varies plus 10 percent and minus [**15**][**20**][**30**] percent from nominal voltage.

F. Overall UPS Efficiency: Equal to or greater than [**94**][**95**]<**Insert number**> percent at 100 percent load, [**94**][**95**]<**Insert number**> percent at 75 percent load, and [**93**][**94**]<**Insert number**> percent at 25 percent load.

G. Maximum Acoustical Noise: <**Insert value**>, "A" weighting, emanating from any UPS component under any condition of normal operation, measured <**Insert distance**> from nearest surface of component enclosure.

H. Maximum Energizing Inrush Current: [**Six times the full-load current**][**Eight times the full-load current**][**Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds**].

I. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

J. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

K. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

L. Limitation of harmonic distortion of input current to the UPS must be as follows:

1. Rectifier-charger circuits must limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
2. THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

M. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for [**100 percent rated nonlinear load current**][**rated full load with THD up to 50 percent**], with a load crest factor of 3.0.

N. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

O. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage must remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

P. Input Power Factor: A minimum of [**0.90**][**0.95**] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

Q. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging must not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

R. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]
6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]

6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

D. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

E. Enclosures: Comply with UL 50E, Type 1, unless otherwise indicated.

F. Configuration: [**Single-cabinet**][**Multicabinet**][**Field-assembled, multicabinet**] modular style units.

G. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

H. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

I. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

J. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future [**25**]<**Insert number**> percent increase in UPS capacity.

K. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

L. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

M. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each AC power input connection including main disconnect switch, static bypass transfer switch[**, and maintenance bypass/isolation switch**]. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested in accordance with IEEE C62.41.1 and IEEE C62.41.2, [**Category B**][**Category C**].
2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 400 Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

2.5 RECTIFIER-CHARGER

A. Description: Voltage source converter, [**six**][**12**]-pulse [**IGBT**][**GTO**] rectifier.

B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

C. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

D. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

E. Battery Float-Charging Conditions: Comply with battery manufacturer's published instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger must be matched to the battery type supplied.

F. Ni-Cd Battery Charger: Sense full charge by measuring the rate of temperature increase. Battery charging must be terminated when the rate of temperature rise reaches **1.8 deg F (1 deg C)** per minute. If the battery reaches **140 deg F (60 deg C)** prior to reaching this rate of temperature rise, charging must terminate. Chargers that determine full charge by voltage measurement to sense a 10 mV drop per cell when reaching full charge are also acceptable.

2.6 INVERTER

A. Description:

1. Pulse-width modulated, [**carrier stored trench IGBT**][**IGBT**] with sinusoidal output.
2. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: [**Labeled LED**][**Plain-language messages on a digital LCD**].

1. Quantitative indications must include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications must include the following:

    a. Normal operation.
    b. Load-on bypass.
    c. Load-on battery.
    d. Inverter off.
    e. Alarm condition.

3. Alarm indications must include the following:

    a. Bypass AC input overvoltage or undervoltage.
    b. Bypass AC input overfrequency or underfrequency.
    c. Bypass AC input and inverter out of synchronization.
    d. Bypass AC input wrong-phase rotation.
    e. Bypass AC input single-phase condition.
    f. Bypass AC input filter fuse blown.
    g. Internal frequency standard in use.
    h. Battery system alarm.
    i. Control power failure.
    j. Fan failure.
    k. UPS overload.
    l. Battery-charging control faulty.
    m. Input overvoltage or undervoltage.
    n. Input transformer overtemperature.
    o. Input circuit breaker tripped.
    p. Input wrong-phase rotation.
    q. Input single-phase condition.
    r. Approaching end of battery operation.
    s. Battery undervoltage shutdown.
    t. Maximum battery voltage.
    u. Inverter fuse blown.
    v. Inverter transformer overtemperature.
    w. Inverter overtemperature.
    x. Static bypass transfer switch overtemperature.
    y. Inverter power supply fault.
    z. Inverter transistors out of saturation.
    aa. Identification of faulty inverter section/leg.
    bb. Inverter output overvoltage or undervoltage.
    cc. UPS overload shutdown.
    dd. Inverter current sensor fault.
    ee. Inverter output contactor open.
    ff. Inverter current limit.

4. Controls must include the following:

    a. Inverter on-off.
    b. UPS start.
    c. Battery test.
    d. Alarm silence/reset.
    e. Output-voltage adjustment.

D. Dry-form "C" contacts must be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.

3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

E. Emergency Power off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

C. Input SPD: [**80**][**160**] kA.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch must be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch must electrically isolate other UPS components to permit safe servicing.
3. Switch must electrically isolate the rectifier-charger, inverter, and static bypass transfer switch from the load, but must allow primary power to the UPS for testing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load UPS current.

D. Mounting Provisions: [**Internal to system cabinet**][**Separate wall- or floor-mounted unit**].

E. Key interlock with key that is released only when the rectifier-charger and inverter are bypassed by the static bypass transfer switch. Key must be required to unlock maintenance bypass/isolation switch before switching from open (normal) position to closed position. Lock must be designed specifically for mechanical and electrical component interlocking.

2.10 OUTPUT DISTRIBUTION SECTION

A. Panelboards: Comply with Section 262416 "Panelboards," except provide assembly integral to UPS cabinet.

2.11 OUTPUT ISOLATION TRANSFORMER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]

2. [**Eaton**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Eaton**]
3. <**Insert manufacturer's name**>

C. Description: [**Shielded unit**][**Unit**] with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately [**4**][**9**][**13**][**20**].
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
6. Coil Leads: Physically arranged for minimum interlead capacitance.
7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 pF, maximum, over a frequency range of 20 Hz to 1 MHz.

2.12 REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicating [**five**]<**Insert quantity**> basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 REMOTE MONITORING

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

1. Connectors and network interface units for data transmission via TIA-485, Ethernet, or web-based link.
2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
3. Software and Hardware: Compatible with that specified in Section 260913 "Electrical Power Monitoring and Control."

2.14 BATTERY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. <**Insert manufacturer's name**>

C. General Characteristics:

1. Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

    a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2. Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

3. Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
4. Flooded cell, heavy-duty, industrial, Ni-Cd units in polypropylene containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks, complete with battery disconnect switch and intercell connectors.
5. Valve-regulated, heavy-duty, industrial, recombinant, pocket plate design, Ni-Cd units in polypropylene containers, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

D. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

2.15 BASIC BATTERY MONITORING

A. Basic Battery Monitoring: Continuous, real-time capture of battery performance data.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

D. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 Ω.

E. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F (75 deg C)** occurs within the compartment.

F. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F (75 deg C)** occurs within the compartment.

G. Annunciation of Alarms: At UPS control panel and remotely.

2.16 ADDITIONAL BATTERY MONITORING

A. Monitoring features and components must include the following:

1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
2. Connections for data transmission via TIA-485 link, [**and**][**network interface and**] external signal wiring to [**computer**][**electrical power monitoring and control equipment**]. External signal wiring and computer are not specified in this Section.
3. USB ports for printer and accessories.
4. PC-based software designed to store and analyze battery data, compile reports on individual-cell parameters and total battery performance trends, and provide data for scheduling and prioritizing battery maintenance.

B. Operation: Automatically measure and electronically record the following parameters on a routine

schedule and during battery discharge events. During discharge events, record measurements timed to nearest second; including measurements of the following parameters:

1. Total battery voltage and ambient temperature.
2. Individual-cell voltage, impedance, and temperature, and string current. During battery-discharging events such as utility outages, measures battery and cell voltages, battery string current and records values versus time to nearest second.
3. Individual-cell electrolyte levels.

2.17 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.

B. Operation: Automatically measure and record each discharge event, classify it according to duration category and total discharges in accordance with warranty criteria, and display remaining warranted battery life on front panel display.

C. Additional monitoring functions and features must include the following:

1. Measuring and Recording: Total voltage at battery terminal. Initiate an alarm for excursions outside the proper float-voltage level.
2. Monitoring: Ambient temperature at battery; initiate an alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provide access to monitored data using front panel display.
4. Alarm Contacts: Arrange to initiate [**local**][**remote**] alarm for [**battery discharge events**][**abnormal temperature**][**abnormal battery voltage or temperature**].
5. Memory: Store recorded data in nonvolatile electronic memory.
6. Ethernet Port: Permits downloading of data to a PC.

2.18 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Product Certificates: For each product, from manufacturer.
4. Sample Warranties: For manufacturer's special warranties.

B. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
2. Factory Tests and Inspections: Test and inspect UPS system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with NETA ATS before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

   a. Factory test complete UPS system before shipment. Use [**actual batteries that are part of final installation**][**the same type of batteries that are part of final installation**][**simulated battery testing**]. Include the following:

1) Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2) Full-load test.
3) Transient-load response test.
4) Overload test.
5) Power failure test.

3. Nonconforming Work:

   a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports. Include the following data:

   a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   c. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify installation conditions are representative of the conditions used in the coordination studies for the electrical system. Provide fuse protection in accordance with Section 262813 "Fuses" if required for coordination with UPS overcurrent protective device requirements.

3.2 INSTALLATION

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
   4. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch (450 mm)** centers around the full perimeter of concrete base **6 inch (150 mm)** from the outer edge of the base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

E. Connections: Interconnect system components. Make connections to supply and load circuits in accordance with manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.3 GROUNDING

A. Separately Derived Systems:

1. If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
2. If part of a listed power supply for a data-processing room, comply with manufacturer's published instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells in accordance with manufacturer's published instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:

    a. Inspect anchorage, alignment, grounding, and required clearances.
    b. Component type and labeling verification.
    c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.
3. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter in accordance with Section 7.22.2.2 of NETA ATS.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published instructions or Table 100.12 of NETA ATS.
    c. Perform thermographic survey in accordance with Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.
5. Test DC undervoltage trip level on inverter input breaker. Set in accordance with manufacturer's published instructions.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Test insulated-case and molded-case breakers.

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published instructions. In the absence of manufacturer's published instructions, use Table 100.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components, follow manufacturer's recommendation.
    c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
    d. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published instructions.
    e. Verify operation of charging mechanism.
    f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.

    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.22.3.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
    c. Perform a contact/pole-resistance test.
    d. Verify settings and operation of control devices.
    e. Calibrate and set all relays and timers in accordance with Section 7.9 of NETA ATS.
    f. Verify phase rotation, phasing, and synchronized operation as required by the application.
    g. Perform automatic transfer tests.

        1) Simulate loss of normal power.
        2) Return to normal power.

3) Simulate loss of emergency power.
4) Simulate all forms of single-phase conditions.

h. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
b. [**Verify electrolyte level. Measure electrolyte level, specific gravity, and temperature.**]
c. Inspect spill containment installation. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
d. Verify all charger functions and alarms.
e. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
f. Perform a load test in accordance with manufacturer's published instructions or IEEE 450.
g. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
h. Test values.

1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels must be in accordance with battery manufacturer's published instructions.
3) The results of charger functions and alarms must be in accordance with manufacturer's published instructions.
4) Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published instructions.
5) Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
6) Results of load tests must be in accordance with manufacturer's published instructions or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**]<**Insert time**> in accordance with NIST standards.

a. Simulate malfunctions to verify protective device operation.
b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

D. Seismic-restraint tests and inspections must include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices in accordance with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Nonconforming Work:

1. The UPS system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Include references to manufacturers' published instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.7 PERFORMANCE TESTING

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated[**for each UPS system**].

B. Monitoring and Testing Schedule: Perform monitoring and testing in [**a single 10-day period**][**four 10-day periods, each in a different season of the year**]<**Insert period**>.

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments must provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments must monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments must be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.
2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.
10. Battery cell temperature during charging.
11. Ambient temperature.

D. Monitoring and Testing Procedures[**for Each Test Period**]:

1. Exploratory Period: For the first [**two**]<**Insert number**> days[**of the first scheduled monitoring and testing period**], make recordings at various circuit locations and with various parameter-

threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.

2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.

    a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
    b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period in accordance with directions of Owner's power quality specialist.
    c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
    d. Using loads and devices available as part of the facility's installed systems and equipment[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
    e. Using temporarily connected resistive/inductive load banks[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
    f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing; repeat appropriate monitoring and testing to verify success of corrective action.

E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.

1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
2. Coordinate printouts with recordings for monitoring performed in accordance with this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

F. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist must design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load

conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in [**each**]report:

1. Descriptions of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendations for alterations to the UPS installation.
7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

END OF SECTION 26 35 33 00

Task	Specification	Specification Description
26 35 33 16	26 09 23 00	Electrical Power Monitoring
26 35 33 16	26 35 33 00	Power Factor Correction Equipment

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SECTION 26 36 00 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Molded-case-type automatic transfer switches.
3. Nonautomatic transfer switches.
4. Transfer switch accessories.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Contactor-type automatic transfer switches.
2. Molded-case-type automatic transfer switches.
3. Nonautomatic transfer switches.
4. Transfer switch accessories.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, [**bypass/isolation switch,**]power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer-authorized service representative**][**testing agency**].

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**12 months**][**18 months**][**Two years**]<**Insert time**> from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for [**three**][**30**]<**Insert number**> cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. In systems with a neutral, the bonding connection shall be on the neutral bus.
4. Provide removable link for temporary separation of the service and load grounded conductors.
5. Surge Protective Device: Service rated.
6. Ground-Fault Protection: Comply with UL 1008 for [**normal bus**][**normal and alternative buses**].
7. Service Disconnecting Means: Externally operated, manual [**mechanically**][**electrically**] actuated.

L. Neutral Switching: Where four-pole switches are indicated, provide [**neutral pole switched simultaneously with phase poles**][**overlapping neutral contacts**].

M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

N. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

O. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

P. Battery Charger: For generator starting batteries.

1. Float type, rated [**2**][**10**] A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

Q. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

R. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable [**with printed**][**tape**][**shrinkable sleeve**] markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via [**rear**][**front**] access.

S. Enclosures: General-purpose NEMA 250, [**Type 1**][**Type 3R**][**Type 4X**][**Type 12**], complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Eaton**]
6. [**Generac**]
7. [**Hubbell Utility Solutions; Hubbell Incorporated**]
8. [**Kohler Power Systems**]
9. [**Rolls-Royce Solutions America Inc.**]
10. [**Russelectric, Inc**]
11. [**Vertiv; Vertiv Holdings Co.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Eaton**]
6. [**Generac**]
7. [**Hubbell Utility Solutions; Hubbell Incorporated**]
8. [**Kohler Power Systems**]
9. [**Rolls-Royce Solutions America Inc.**]
10. [**Russelectric, Inc**]
11. [**Vertiv; Vertiv Holdings Co.**]
12. <**Insert manufacturer's name**>

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].
6. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
7. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.
10. <**Insert features**>.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

G. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

I. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

J. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

K. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

L. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

M. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal [**and Alternate**]Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

N. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Caterpillar, Inc.; Electric Power Division**]

3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**Generac**]
7. [**Kohler Power Systems**]
8. [**Lake Shore Electric Corporation**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**Generac**]
7. [**Kohler Power Systems**]
8. [**Lake Shore Electric Corporation**]
9. <**Insert manufacturer's name**>

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using contactor-based components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].
6. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
7. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.
10. <**Insert features**>.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero

phase difference.

G. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

I. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

J. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

K. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

L. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

M. Transfer Switches Based on Molded-Case-Switch Components: Comply with UL 489 and UL 869A.

N. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal [**and Alternative**]Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

O. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.4 NONAUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASCO Power Technologies**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**ESL Power Systems, Inc.**]
6. [**Russelectric, Inc**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASCO Power Technologies**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**ESL Power Systems, Inc.**]
6. [**Russelectric, Inc**]
7. <**Insert manufacturer's name**>

C. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

D. Manual and Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

E. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

F. Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."

H. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

I. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].

5. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
6. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.
9. <**Insert features**>.

2.5 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

   a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
   b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
   c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
   d. Transition:

      1) Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
      2) Provide [**open**][**closed**]-transition operation when transferring between power sources.

   e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
   f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
   g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
   h. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
   i. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
   j. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.

2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.
    f. Control of switch-test initiation.
    g. Control of switch operation in either direction.
    h. Control of time-delay bypass for transfer to normal source.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

    a. Controls and indicating lights grouped together for each transfer switch.
    b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
    c. Digital Communication Capability: Matched to that of transfer switches supervised.
    d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for [**emergency**][**legally required**] systems. Include results of test for the following conditions:

    a. Overvoltage.
    b. Undervoltage.
    c. Loss of supply voltage.
    d. Reduction of supply voltage.
    e. Alternative supply voltage or frequency is at minimum acceptable values.
    f. Temperature rise.
    g. Dielectric voltage-withstand; before and after short-circuit test.
    h. Overload.
    i. Contact opening.
    j. Endurance.
    k. Short circuit.
    l. Short-time current capability.
    m. Receptacle withstand capability.
    n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, [**motor controls,**]control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions[.][**and Section 260529 "Hangers and Supports for Electrical Systems."**] Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than **18 inches (457 mm)** in length.

3.3 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Owner will engage qualified testing agency to administer and perform tests and inspections.
2. Engage qualified testing agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.

l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery

from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

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Task	Specification	Specification Description
26 36 13 00	26 28 16 00	Enclosed Switches And Circuit Breakers
26 36 13 00	26 36 00 00	Transfer Switches
26 36 23 00	26 28 16 00	Enclosed Switches And Circuit Breakers
26 36 23 00	26 36 00 00	Transfer Switches

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SECTION 26 43 13 00 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).
3. Type 3, Type 4, and Type 5 surge protective devices (SPDs).
4. Enclosures.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
4. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
5. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 DEFINITIONS

A. In: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) In ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [**10**]<**Insert number**> year(s) from date of Substantial Completion, for materials only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**DITEK Surge Protection**]
6. [**Eaton**]
7. [**Intermatic, Inc**]
8. [**Leviton Manufacturing Co., Inc.**]
9. [**Liebert; Vertiv Holdings Co.**]
10. [**Mersen USA**]
11. [**Schneider Electric USA, Inc.**]
12. [**Siemens Industry, Inc., Energy Management Division**]
13. [**SSI, an ILSCO Company**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**DITEK Surge Protection**]
6. [**Eaton**]
7. [**Intermatic, Inc**]
8. [**Leviton Manufacturing Co., Inc.**]
9. [**Liebert; Vertiv Holdings Co.**]
10. [**Mersen USA**]
11. [**Schneider Electric USA, Inc.**]
12. [**Siemens Industry, Inc., Energy Management Division**]
13. [**SSI, an ILSCO Company**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain devices from single source from single manufacturer.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than [**160**][**200**][**240**][**320**]<**Insert value**> kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

a. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
b. Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

   a. Line to Neutral: 700 V.
   b. Line to Line: 1200 V.

6. SCCR: Not less than [**100**][**200**]<**Insert value**> kA.
7. In Rating: 20 kA.

E. Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at [**2 A and 24 V(ac)**]<**Insert values**> for remote monitoring of protection status.
6. Include surge counter.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**Eaton**]
6. [**Intermatic, Inc**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Liebert; Vertiv Holdings Co.**]
9. [**Mersen USA**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. [**SSI, an ILSCO Company**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**Eaton**]
6. [**Intermatic, Inc**]
7. [**Leviton Manufacturing Co., Inc.**]

8. [**Liebert; Vertiv Holdings Co.**]
9. [**Mersen USA**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. [**SSI, an ILSCO Company**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain devices from single source from single manufacturer.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 2[**; UL 1283**].
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than [**100**][**150**]<**Insert value**> kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

   a. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
   b. Line to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
   c. Neutral to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
   d. Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.

6. SCCR: Equal or exceed [**100**][**200**]<**Insert value**> kA.
7. In Rating: [**20**][**10**] kA.

E. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at [**2 A and 24 V(ac)**]<**Insert values**> for remote monitoring of protection status.
4. Include surge counter.

2.3 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)

A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.[**See "Related Requirements" Paragraph in "Summary" Article for products with manufacturer-installed Type 3, Type 4, and Type 5 SPDs.**]

2.4 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: [**Type 3R**][**Type 4X**].

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and

inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13 00

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SECTION 26 50 00 00 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables"**][**and**][**Section 260523 "Control-Voltage Electrical Power Cables"**] specifies wiring connections installed by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
6. Section 260546 "Poles for Electrical Systems" specifies lighting standards, utility poles, and accessories referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
8. Section 260923 "Lighting Control Devices" specifies automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors installed by this Section.
9. Section 260936 "Modular Dimming Controls" specifies architectural dimming systems with dimming installed by this Section.
10. Section 260943.16 "Addressable Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" specify manual or programmable control systems with low-voltage control wiring or data communication circuits installed by this Section.

1.2 DEFINITIONS

A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.

B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.

C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

D. IDA: International Dark-Sky Association.

E. IES: Illuminating Engineering Society.

F. LPD: Lighting power density.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Luminaires: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.

1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on the Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.
3) Air and Thermal Performance Data: For air-handling luminaires, include data required in [**Section 233713.13 "Air Diffusers."**][**Section 233713.23 "Registers and Grilles."**][**Section 233713.43 "Security Registers and Grilles."**]
4) Sound Performance Data: For air-handling luminaires, indicate sound power level and sound transmission class in test reports certified in accordance with standards specified in [**Section 233713.13 "Air Diffusers."**][**Section 233713.23 "Registers and Grilles."**][**Section 233713.43 "Security Registers and Grilles."**]

c. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
d. Include operating characteristics, electrical characteristics, and furnished accessories.
e. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
f. Include battery and charger data for emergency lighting units.
g. Include ballast factor.
h. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
i. Include photometric data and adjustment factors obtained from qualified laboratory tests.
j. Include manufacturer's sample warranty language.
k. <**Insert requirements**>.

2. Luminaire Fittings: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
c. Include operating characteristics, electrical characteristics, and furnished accessories.
d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
e. Include manufacturer's sample warranty language.
f. <**Insert requirements**>.

B. Samples:

1. Luminaires: One for each kind of luminaire with specified rating, size, finish, color, and texture.
2. Luminaire Fittings: One for each kind of luminaire fitting with specified rating, size, finish, color, and texture.

C. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.
2. ASHRAE/IES 90.1 LPD Compliance Documentation: Prepare plans and calculations demonstrating that as-constructed lighting power density complies with mandatory provisions of ASHRAE/IES 90.1 and that as-constructed lighting, including daylighting and controls, improves on baseline energy performance. If included with Project, indicate locations of energy meters for lighting loads.

E. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Extra stock material.

1.7 MOCKUPS

A. Provide mockups as indicated on the Drawings to verify selections made under Sample submittals and to set quality standards for materials and execution.

1. Build mockup of luminaires in room or space, complete with power and control connections.
2. Obtain Architect's approval of mockups before starting installation of related Work on the Project.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Maintain mockups during construction in undisturbed condition as standard for judging the completed Work.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under NIST HB 150-1, and complying with applicable IES testing standards.

E. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

1.10 WARRANTY FOR LUMINAIRES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed luminaires perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that luminaires perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.11 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**10**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
4. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 LUMINAIRES

A. Surface-Mounted Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   c. [**Amerlux**]
   d. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   e. [**Atlas Lighting Products**]
   f. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   g. [**Cooper Lighting Solutions; Signify North America Corp.**]
   h. [**Deco Lighting**]
   i. [**Digital Lumens**]
   j. [**E-conolight**]
   k. [**Edison Price Lighting**]
   l. [**Elite Lighting Corporation**]
   m. [**Focal Point; Legrand North America, LLC**]
   n. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
   o. [**GE Lighting; a Savant Company**]
   p. [**H.E. Williams**]
   q. [**Howard Lighting Products**]
   r. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   s. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   t. [**Lighting Services, Inc.**]
   u. [**Lightolier; brand of Signify North America Corp.**]
   v. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   w. [**LMPG Inc.**]
   x. [**Luraline Lighting**]
   y. [**OSRAM SYLVANIA**]
   z. [**Philips; Signify North America; Signify Holding**]
   aa. [**Pure Lighting Manufacturing Ltd.**]
   bb. [**PureEdge Lighting**]
   cc. [**RAB Lighting**]
   dd. [**Selux Corporation**]
   ee. [**Specialty Lighting Industries, Inc.**]
   ff. [**Visa Lighting**]
   gg. [**West Durable Lighting**]
   hh. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
   ii. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners**

(AIP)]
b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Amerlux**]
d. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
e. [**Atlas Lighting Products**]
f. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
g. [**Cooper Lighting Solutions; Signify North America Corp.**]
h. [**Deco Lighting**]
i. [**Digital Lumens**]
j. [**E-conolight**]
k. [**Edison Price Lighting**]
l. [**Elite Lighting Corporation**]
m. [**Focal Point; Legrand North America, LLC**]
n. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
o. [**GE Lighting; a Savant Company**]
p. [**H.E. Williams**]
q. [**Howard Lighting Products**]
r. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
s. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
t. [**Lighting Services, Inc.**]
u. [**Lightolier; brand of Signify North America Corp.**]
v. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
w. [**LMPG Inc.**]
x. [**Luraline Lighting**]
y. [**OSRAM SYLVANIA**]
z. [**Philips; Signify North America; Signify Holding**]
aa. [**Pure Lighting Manufacturing Ltd.**]
bb. [**PureEdge Lighting**]
cc. [**RAB Lighting**]
dd. [**Selux Corporation**]
ee. [**Specialty Lighting Industries, Inc.**]
ff. [**Visa Lighting**]
gg. [**West Durable Lighting**]
hh. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
ii. **<Insert manufacturer's name>**

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

   a. Incandescent Luminaires: UL CCN IEZR; including UL 1598.
   b. LED Luminaires: UL CCN IFAM; including UL 1598.
   c. Outdoor Canopy Luminaires: UL CCN IFAW; including UL 1598.
   d. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Luminaire Description: **<Insert description of desired shape and dimensional limitations>**.
6. Standard Features:

   a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from

enclosure.

b. Nominal Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480 V(ac)**][**120/60 V(ac)**][**12 V(dc)**][**24 V(dc)**].

c. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**][**70 to 150 W**][**150 to 300 W**][**Greater than 300 W**]<**Insert basis-of-design product's rated wattage**>.

d. CRI: [**80+**][**90+**].

e. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].

f. Materials:

1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.

2) Enclosure Ingress Protection Rating: [**UL 50E Type 1 or IEC 60529 IP20**][**UL 50E Type 3R or IEC 60529 IP24**][**UL 50E Type 4X or IEC 60529 IP65**][**UL 50E Type 12 or IEC 60529 IP54**].

3) Lenses, Diffusers, and Globes:

a) [**Fixed**][**Adjustable**] lens.

b) [**Spot**][**Medium**][**Wide**] light distribution.

c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.

d) Lens Thickness: Not less than **0.125 inch (3 mm)** unless otherwise indicated.

e) Distribution: [**Type I**][**Type II**][**Type III**][**Type IV**][**Type V**].

4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

g. Incandescent Luminaires (UL CCN IEZR):

1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**][**Mogul (E39)**].

2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

h. LED Luminaires (UL CCN IFAM):

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.

2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.

3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.

4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.

b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and**

Design Lights Consortium].

c. Backlight, Uplight, and Glare (BUG) Ratings: Exterior luminaire complies with IES LP-11-recommended BUG ratings at luminaire's intended location.

d. IDA/IES Five Principles Ready:

1) Exterior luminaire is adjustable to illuminate only to extent necessary for its intended purpose.
2) Exterior luminaire is aimable.
3) Exterior luminaire is dimmable.
4) Exterior luminaire is controllable to turn on only when needed.
5) Exterior luminaire has warm color temperature.

e. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

f. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

g. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

h. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

i. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Hardware: [**Ceiling-mounted**][**Pendant-mounted**][**Wall-mounted**][**Building-mounted**][**Pole-mounted**]<**Insert desired mounting hardware**>; with [**integral mounting provisions**][**extruded-aluminum**][**stainless steel**]<**Insert material**>[**rectangular arm,**][**round arm,**][**11 inch (280 mm) in length**][**13 inch (330 mm) in length**].

b. Mounting Height: <**Insert height of luminaire from finished grade or floor**>.

c. Bollard:

1) Shape: [**Round**][**Square**][**Hexagonal**][**Fluted**]<**Insert shape or feature**>.
2) Height from Finished Grade: [**24 inch (610 mm)**][**30 inch (762 mm)**][**36 inch (900 mm)**]<**Insert value**>.
3) Overall Height: [**30 inch (762 mm)**][**36 inch (900 mm)**]<**Insert value**>.
4) Diameter: [**6 inch (150 mm)**]<**Insert value**>.
5) Bollard Mounting: [**Three-point cast-aluminum base**]<**Insert mounting provisions**>.

d. Decorative Post Top: [**Arm mounted**][**Tenon mounted**][**Ring mounted**].

e. Roadway Pole: [**Arm mounted**][**Tenon mounted**][**Ring mounted**].

f. Finishes:

1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
2) Reflector: [**Aluminum**]<**Insert material finish**>.
3) Reflecting surfaces must have minimum reflectance as follows, unless otherwise indicated:

a) White Surfaces: 85 percent.
b) Specular Surfaces: 83 percent.
c) Diffusing Specular Surfaces: 75 percent.

g. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

1) Finish designations prefixed by AA comply with system established by Aluminum Association for designating aluminum finishes.
2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3) Class I, Clear-Anodic Finish: AA-M32C22A41, complying with AAMA 611.

a) Mechanical Finish: Medium satin.
b) Chemical Finish: Etched, medium matte.
c) Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker.

4) Class I, Color-Anodic Finish: AA-M32C22A42/A44, complying with AAMA 611.

a) Mechanical Finish: Medium satin.
b) Chemical Finish: Etched, medium matte.
c) Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker).

5) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**]<**Insert color**>.

h. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
3) Color: [**As selected from manufacturer's standard catalog of colors**][**As selected by Architect from manufacturer's full range**][**Match color sample provided by Architect**].

i. Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.
j. Dimmable from 100 percent to zero percent of maximum light output.
k. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast or driver requiring filter.
l. Stainless steel latches.
m. Integral pressure equalizer.
n. Photoelectric Switch: Factory-mounted integral to luminaire; listed and labeled in accordance with UL CCN WJFX, including UL 773, or in accordance with UL CCN WJCT, including UL 773A.

1) Contact Relays: Factory mounted, single throw, designed to fail in on position, and factory set to turn light unit on at **1.5 to 3 fc (15 to 30 lx)** and off at **4.5 to 10 fc (45 to 100 lx)** with 15 s minimum time delay.[**Relay must have directional lens in front of photocell to prevent artificial light sources from causing false turn-off.**]

a) Relay with locking-type receptacle must comply with NEMA C136.10.
b) Adjustable window slide for adjusting on-off set points.

9. Installation Markings:

   a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
   b. All Luminaires (UL CCN HYXT):

      1) "DRY LOCATIONS ONLY."
      2) "SUITABLE FOR DAMP LOCATIONS."
      3) "SUITABLE FOR WET LOCATIONS."
      4) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
      5) "SUITABLE FOR GROUND-MOUNTED RECESSED."
      6) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
      7) "COVERED CEILING MOUNT ONLY."
      8) "WALL MOUNT ONLY"
      9) "FOR CEILING MOUNTING ONLY."
      10) Marked with mounting orientation, such as "THIS END UP."
      11) "SUITABLE FOR AIR-HANDLING USE."
      12) "VENTILATING OR COOLING AIR ONLY."
      13) "ONLY FOR USE IN CEILING PLENUM OF NONCOMBUSTIBLE CONSTRUCTION OR WITH AIR-HANDLING PARTS THAT COVER VENT OPENINGS."
      14) "INSTALL ONLY IN ENVIRONMENTAL AIR-HANDLING SPACES WHERE A COMPLETE METAL ENCLOSED WIRING SYSTEM IS PROVIDED."
      15) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
      16) "NOT FOR USE IN DWELLING."
      17) "SUITABLE FOR USE AS RACEWAY."
      18) "60 Hz" or "AC ONLY."
      19) Marked to identify voltage supply or type of branch circuit or both.

   c. Incandescent Luminaires (UL CCN IEZR):

      1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
      2) "PUSH CONDUCTORS INTO JUNCTION BOX."
      3) "SUITABLE FOR UNDER-CABINET MOUNT."
      4) "SUITABLE FOR CONTINUOUS ROW MOUNTING."
      5) "THIS LUMINAIRE MUST BE MOUNTED OR SUPPORTED INDEPENDENTLY OF AN OUTLET BOX."

   d. LED Luminaires (UL CCN IFAM):

      1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
      2) "PUSH CONDUCTORS INTO JUNCTION BOX."
      3) "WALL MOUNT ONLY."
      4) "NONCOMBUSTIBLE SURFACE ONLY."
      5) "SUITABLE FOR UNDER-CABINET MOUNT."
      6) "SUITABLE FOR CONTINUOUS ROW MOUNTING."
      7) "THIS LUMINAIRE MUST BE MOUNTED OR SUPPORTED INDEPENDENTLY OF AN OUTLET BOX."

   e. Outdoor Canopy Luminaires (UL CCN IFAW):

      1) "CANOPY LUMINAIRE - NOT THERMALLY PROTECTED."
      2) "FOR COVERED CEILING MOUNT ONLY."

3) "OPEN CEILING MOUNT ONLY."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

    a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
    b. Component Importance Factor (Ip): [**1.0**][**1.5**].
    c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
    d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
    e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

B. Recessed Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    c. [**Amerlux**]
    d. [**Axis Lighting, Inc.**]
    e. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    f. [**Cooper Lighting Solutions; Signify North America Corp.**]
    g. [**Digital Lumens**]
    h. [**Edison Price Lighting**]
    i. [**Elite Lighting Corporation**]
    j. [**Focal Point; Legrand North America, LLC**]
    k. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
    l. [**GE Lighting; a Savant Company**]
    m. [**Lighting Services, Inc.**]
    n. [**Lightolier; brand of Signify North America Corp.**]
    o. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    p. [**LMPG Inc.**]
    q. [**OSRAM SYLVANIA**]
    r. [**PureEdge Lighting**]
    s. [**RAB Lighting**]
    t. [**Selux Corporation**]
    u. [**Specialty Lighting Industries, Inc.**]
    v. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    c. [**Amerlux**]

d. [**Axis Lighting, Inc.**]
e. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Cooper Lighting Solutions; Signify North America Corp.**]
g. [**Digital Lumens**]
h. [**Edison Price Lighting**]
i. [**Elite Lighting Corporation**]
j. [**Focal Point; Legrand North America, LLC**]
k. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
l. [**GE Lighting; a Savant Company**]
m. [**Lighting Services, Inc.**]
n. [**Lightolier; brand of Signify North America Corp.**]
o. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
p. [**LMPG Inc.**]
q. [**OSRAM SYLVANIA**]
r. [**PureEdge Lighting**]
s. [**RAB Lighting**]
t. [**Selux Corporation**]
u. [**Specialty Lighting Industries, Inc.**]
v. <**Insert manufacturer's name**>

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

a. Incandescent Luminaires: UL CCN IEZX; including UL 1598[**.**][**, and "Chicago Electrical Code."**]
b. LED Luminaires: UL CCN IFAO; including UL 1598[**, and "Chicago Electrical Code."**]
c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Luminaire Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Ceiling Compatibility: NEMA LE 4.
b. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
c. Nominal Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**12 V(dc)**][**24 V(dc)**].
d. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**]<**Insert basis-of-design product's rated wattage**>.
e. CRI: [**80+**][**90+**].
f. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].
g. Materials:

1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.
2) Enclosure Ingress Protection Rating: [**UL 50E Type 1 or IEC 60529 IP20**][**UL 50E Type 3R or IEC 60529 IP24**][**UL 50E Type 4X or IEC 60529 IP65**][**UL 50E Type 12 or IEC 60529 IP54**].
3) Lenses, Diffusers, and Globes:

a) [**Fixed**][**Adjustable**] lens.

b) [**Spot**][**Medium**][**Wide**] light distribution.
c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.
d) Lens Thickness: Not less than **0.125 inch (3 mm)** unless otherwise indicated.

4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

h. Incandescent Luminaires (UL CCN IEZX):

1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**][**Mogul (E39)**].
2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

i. LED Luminaires (UL CCN IFAO):

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.
2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.
3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.
4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Backlight, Uplight, and Glare (BUG) Ratings: Exterior luminaire complies with IES LP-11-recommended BUG ratings at luminaire's intended location.
d. IDA/IES Five Principles Ready:

1) Exterior luminaire is adjustable to illuminate only to extent necessary for its intended purpose.
2) Exterior luminaire is aimable.
3) Exterior luminaire is dimmable.
4) Exterior luminaire is controllable to turn on only when needed.
5) Exterior luminaire has warm color temperature.

e. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
f. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
g. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
h. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

i. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Hardware: [**Ceiling-mounted**][**Wall-mounted**]<**Insert desired mounting hardware**>; include universal mounting bracket and integral junction box with conduit fittings.

b. Finishes:

1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
2) Reflector: [**Aluminum**]<**Insert material finish**>.
3) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

c. Dimmable from 100 percent to zero percent of maximum light output.

d. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast or driver requiring filter.

e. Stainless steel latches.

f. Integral pressure equalizer.

9. Installation Markings:

a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.

b. All Luminaires (UL CCN HYXT):

1) "DRY LOCATIONS ONLY."
2) "SUITABLE FOR DAMP LOCATIONS."
3) "SUITABLE FOR WET LOCATIONS."
4) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
5) "SUITABLE FOR GROUND-MOUNTED RECESSED."
6) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
7) "COVERED CEILING MOUNT ONLY."
8) "WALL MOUNT ONLY"
9) "FOR CEILING MOUNTING ONLY."
10) Marked with mounting orientation, such as "THIS END UP."
11) "SUITABLE FOR AIR-HANDLING USE."
12) "VENTILATING OR COOLING AIR ONLY."
13) "ONLY FOR USE IN CEILING PLENUM OF NONCOMBUSTIBLE CONSTRUCTION OR WITH AIR-HANDLING PARTS THAT COVER VENT OPENINGS."
14) "INSTALL ONLY IN ENVIRONMENTAL AIR-HANDLING SPACES WHERE A COMPLETE METAL ENCLOSED WIRING SYSTEM IS PROVIDED."
15) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
16) "NOT FOR USE IN DWELLING."
17) "SUITABLE FOR USE AS RACEWAY."
18) "60 Hz" or "AC ONLY."
19) Marked to identify voltage supply or type of branch circuit, or both.

c. Incandescent Luminaires (UL CCN IEZX):

1) "TYPE IC LUMINAIRE."

2) "TYPE NON-IC LUMINAIRE."
3) "INHERENTLY PROTECTED LUMINAIRE."
4) "INSTALL IN BUILDINGS OF FIRE-RESISTANT CONSTRUCTION."
5) "INSTALL WITH MINIMUM SPACINGS BETWEEN A) CENTER-TO-CENTER OF ADJACENT LUMINAIRES: <**Insert distance**> INCHES; B) TOP OF LUMINAIRE AND AN OVERHEAD BUILDING MEMBER: <**Insert distance**> INCHES; AND C) LUMINAIRE CENTER-TO-SIDE OF BUILDING MEMBER: <**Insert distance**> INCHES."
6) "FOR USE IN CONCRETE ONLY."
7) "SUITABLE FOR USE IN POURED CONCRETE."
8) "SUITABLE FOR SUSPENDED CEILING."
9) "SUITABLE FOR GROUND-MOUNTED RECESSED."
10) "BLINKING LIGHT OF THIS THERMALLY PROTECTED LUMINAIRE MAY INDICATE OVERHEATING."
11) "MAXIMUM OF <**Insert size**> AWG BRANCH CIRCUIT CONDUCTOR SUITABLE FOR <**Insert temperature**>□ PERMITTED IN BOX."
12) "FOR USE IN ONE- AND TWO-FAMILY DWELLINGS ONLY."
13) "FOR USE IN NON-FIRE-RATED INSTALLATIONS."
14) Provide correlating markings identifying matching housing, trim, rough-in section, and finishing section.
15) "Chicago Electrical Code" or "CCEA."

d. LED Luminaires (UL CCN IFAO):

1) "TYPE IC LUMINAIRE."
2) "TYPE NON-IC LUMINAIRE."
3) "INHERENTLY PROTECTED LUMINAIRE."
4) "INSTALL IN BUILDINGS OF FIRE-RESISTANT CONSTRUCTION."
5) "INSTALL WITH MINIMUM SPACINGS BETWEEN A) CENTER-TO-CENTER OF ADJACENT LUMINAIRES: <**Insert distance**> INCHES; B) TOP OF LUMINAIRE AND AN OVERHEAD BUILDING MEMBER: <**Insert distance**> INCHES; AND C) LUMINAIRE CENTER-TO-SIDE OF BUILDING MEMBER: <**Insert distance**> INCHES."
6) "FOR USE IN CONCRETE ONLY."
7) "SUITABLE FOR USE IN POURED CONCRETE."
8) "SUITABLE FOR SUSPENDED CEILING."
9) "SUITABLE FOR GROUND-MOUNTED RECESSED ONLY."
10) "SUITABLE FOR GROUND-MOUNTED RECESSED."
11) "BLINKING LIGHT OF THIS THERMALLY PROTECTED LUMINAIRE MAY INDICATE OVERHEATING."
12) "MAXIMUM OF <**Insert size**> AWG BRANCH CIRCUIT CONDUCTOR SUITABLE FOR <**Insert temperature**>□ PERMITTED IN BOX."
13) "ACCESS ABOVE CEILING REQUIRED."
14) "ACCESS BEHIND WALL REQUIRED."
15) "FOR USE IN ONE- AND TWO-FAMILY DWELLINGS ONLY."
16) "FOR USE IN NON-FIRE-RATED INSTALLATIONS."
17) Provide correlating markings identifying matching housing, trim, rough-in section, and finishing section.
18) "Chicago Electrical Code" or "CCEA."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational**

after seismic events]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

C. UL IFFR - Track-Lighting Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   b. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   c. [**Axis Lighting, Inc.**]
   d. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   e. [**Cooper Lighting Solutions; Signify North America Corp.**]
   f. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   g. [**Edison Price Lighting**]
   h. [**Elite Lighting Corporation**]
   i. [**GE Lighting; a Savant Company**]
   j. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   k. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   l. [**Lighting Services, Inc.**]
   m. [**Lightolier; brand of Signify North America Corp.**]
   n. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   o. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
   p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   b. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   c. [**Axis Lighting, Inc.**]
   d. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   e. [**Cooper Lighting Solutions; Signify North America Corp.**]
   f. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   g. [**Edison Price Lighting**]
   h. [**Elite Lighting Corporation**]
   i. [**GE Lighting; a Savant Company**]
   j. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   k. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   l. [**Lighting Services, Inc.**]

m. [**Lightolier; brand of Signify North America Corp.**]
n. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
o. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
p. <**Insert manufacturer's name**>

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

   a. Track Lighting: UL CCN IFFR; including UL 1574.
   b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

   a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
   b. Nominal Luminaire Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**12 V(dc)**][**24 V(dc)**].
   c. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**][**70 to 150 W**][**150 to 300 W**][**Greater than 300 W**]<**Insert basis-of-design product's rated wattage**>.
   d. CRI: [**80+**][**90+**].
   e. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].
   f. Materials:

      1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.
      2) Enclosure Ingress Protection Rating: UL 50E Type 1 or IEC 60529 IP20.
      3) Lenses, Diffusers, and Globes:

         a) [**Fixed**][**Adjustable**] lens.
         b) [**Spot**][**Medium**][**Wide**] light distribution.
         c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.
         d) Lens Thickness: Not less than **0.125 inch (3 mm)** unless otherwise indicated.

      4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

   g. Incandescent Lamp Track-Lighting Luminaire:

      1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**].
      2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

h. LED Track-Lighting Luminaires:

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.
2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.
3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.
4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Hardware: [**Ceiling-mounted**][**Pendant-mounted**][**Wall-mounted**]<**Insert desired mounting hardware**>; with integral mounting provisions.
b. Mounting Height: <**Insert height of luminaire from finished grade or floor**>.
c. Finishes:

1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
2) Reflector: [**Aluminum**]<**Insert material finish**>.
3) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

d. Dimmable from 100 percent to zero percent of maximum light output.

9. Installation Markings:

a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
b. All Luminaires (UL CCN HYXT):

1) "DRY LOCATIONS ONLY."
2) "SUITABLE FOR DAMP LOCATIONS."
3) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
4) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
5) "60 Hz" or "AC ONLY."
6) Marked to identify voltage supply or type of branch circuit, or both.

c. Track Systems (UL CCN IFFR):

1) "FOR CLIP MOUNTING ONLY."
2) "DO NOT PENDANT MOUNT THIS TRACK SUCH AS BY STEMS OR WIRES."
3) "FOR USE IN <**Insert ceiling grid manufacturer and product**>."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. UL FTBR or FTBV - Emergency Lighting and Power Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
d. [**Evenlite, Inc.**]
e. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Philips; Signify North America; Signify Holding**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
d. [**Evenlite, Inc.**]
e. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Philips; Signify North America; Signify Holding**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

a. Emergency Lighting and Power: UL CCN FTBR or UL CCN FTBV; including UL 924, NFPA 101, and ICC IBC.

b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
b. Status and Test Indication: Visible and accessible without opening luminaire or entering ceiling space.

1) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
2) Test Push-Button: Push-to-test button in unit housing simulates loss of normal power and demonstrates unit operability.

c. Nominal Operating Voltage: [**120 V(ac)**][**277 V(ac)**][**6 V(dc)**][**9.6 V(dc)**][**12 V(dc)**][**24 V(dc)**].
d. Mounting: [**Ceiling**][**Wall**] with universal junction box adaptor.
e. Enclosure: UV stable thermoplastic housing rated for [**damp**][**wet**] locations.
f. Flame Rating: UL 94 [**5VA**][**5VB**][**V-0**][**V-1**][**V-2**][**HB**].
g. Light Source: [**One**][**Two**][**halogen lamp(s)**][**krypton lamp(s)**][**LED head(s)**].

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (lgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Height: <**Insert height of luminaire from finished floor**>.
b. Internal-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body[**and compatible with ballast or driver**].

1) Emergency Connection: Operate [**one**]<**Insert number**> lamp(s) continuously at an output of [**1100**]<**Insert value**> lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast or driver.
2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically

recharged and floated on charger.

3) Nightlight Connection: Operate lamp continuously at [**40**]<**Insert number**> percent of rated light output.
4) Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

   a) Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5) Battery Type: [**Ni-Cd**][**Li-ion**].
6) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
7) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

c. External-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1) Emergency Connection: Operate [**one**]<**Insert number**>[**incandescent**][**LED**] lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire[**ballast or driver**].
2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3) Nightlight Connection: Operate lamp in a remote luminaire continuously.
4) Battery Type: [**Ni-Cd**][**Li-ion**].
5) Charger: Fully automatic, solid-state, constant-current type.
6) Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by [**ballast or driver**][**emergency power unit**] manufacturer, whichever is less.
7) Test Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

9. Installation Markings:

a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and

coating on factory-applied label that is visible when luminaire is open for relamping.

b. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
4) Marked to identify voltage supply or type of branch circuit or both.

c. Emergency Lighting and Power Equipment (UL CCN FTBR):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
2) "HAS CLASS 2 OUTPUTS."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

E. UL FWBO - Exit Fixture :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Evenlite, Inc.**]
d. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**Philips; Signify North America; Signify Holding**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Evenlite, Inc.**]
d. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**Philips; Signify North America; Signify Holding**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

a. Exit Fixtures: UL CCN FWBO; including UL 924, NFPA 101[**, NFPA 5000**], and ICC IBC.
b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Nominal Operating Voltage: [**120 V(ac)**][**277 V(ac)**][**6 V(dc)**][**9.6 V(dc)**][**12 V(dc)**][**24 V(dc)**].
b. Light Source: LED; 50,000 hours minimum rated life.
c. Legend Color: [**Red**][**Green**].
d. Internal emergency power unit.
e. Battery Type: [**Ni-Cd**][**Li-ion**].
f. Master/Remote Sign Configurations:

1) Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in [**LED power supply**][**battery**] for power connection to remote unit.
2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Height: <**Insert height of luminaire from finished floor**>.

9. Installation Markings:

a. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
4) Marked to identify voltage supply or type of branch circuit or both.

b. Exit Fixtures (UL CCN FWBO):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

F. UL FWBX - Self-Luminous or Photoluminescent Exit Sign :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Evenlite, Inc.**]
d. [**Isolite Corporation**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Evenlite, Inc.**]
d. [**Isolite Corporation**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: UL CCN FWBX; including UL 924, NFPA 101[**, NFPA 5000**], and ICC IBC.
5. Exit Sign Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs must be guaranteed by manufacturer to maintain minimum brightness requirements in UL 924 for [**10**][**15**][**20**] years.
b. Use strontium oxide aluminate compound to store ambient light and release stored energy when light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

7. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Installation Markings:

a. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."

b. Self-Luminous and Photoluminescent Exit Signs (UL CCN FWBX):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
2) Mark with minimum illumination level of necessary lighting type to achieve required visibility.

9. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.3 LUMINAIRE FITTINGS

A. Luminaire Support Accessories:

1. Standard Features:

a. Sized and rated for luminaire weight.
b. Capable of maintaining luminaire position after cleaning and relamping.
c. Capable of supporting luminaire without causing deflection of ceiling or wall.
d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

2. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

3. Other Available Features Required by the Project:

a. Hook Hangers: Integrated assembly matched to luminaire, supply voltage, and equipment with threaded attachment, cord, and locking-type plug.
b. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, [**12 gage (2.68 mm)**]<**Insert size**> wire supports [**adjustable to**][**10 ft (3 m)**]<**Insert value**> in length.
c. Aircraft Cables: [**5/32 inch (4 mm)**]<**Insert value**> diameter aircraft cable supports [**adjustable to**][**10 ft (3 m)**]<**Insert value**> in length.
d. Single-Stem Hangers: **1/2 inch (13 mm)** nominal diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
e. Rod Hangers: **3/16 inch (5 mm)** nominal diameter, cadmium-plated, threaded steel rod.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing lighting equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Diffusers and Lenses: [**One for every 100**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: [**One for every 20**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.

B. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Incandescent Lamps: [**10 for every 100**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.
2. Luminaire-Mounted Emergency Battery Packs: [**One for every 20**][**One for every 50**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Lighting: If approved by Architect, specified luminaires for the Project may be installed for temporary lighting. Install and energize minimum quantity of luminaires necessary to meet needs of construction activities. When construction is sufficiently complete, remove, disassemble, clean, and relamp luminaires used for temporary lighting before reinstalling for the Project's delivery.

3.3 SELECTION OF LUMINAIRES

A. Finished Spaces:

1. Location: <**Insert list of product types**>.

B. Unfinished Spaces:

1. Location: <**Insert list of product types**>.

3.4 INSTALLATION OF LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
3. Work in Confined Spaces: NFPA 350.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Installation of Indoor Lighting Systems: NECA NEIS 500.
6. Installation of Exterior Lighting Systems: NECA NEIS 501.
7. Installation of Industrial Lighting Systems: NECA NEIS 502.
8. Installation of Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
9. Installation of Extra-Low-Voltage Lighting: Article 411 of NFPA 70.
10. Installation of Lighting for Sensitive Electronic Equipment: Article 647 of NFPA 70.
11. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
12. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
2. Install luminaires at height and aiming angle as indicated on the Drawings.
3. Coordinate layout and installation of luminaires with other construction.
4. Adjust luminaires that require field adjustment or aiming.[**Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.**]

5. Exterior Bollard Luminaires:

   a. Align units for optimum directional alignment of light distribution.
   b. Install on concrete base with top [**4 inch (100 mm)**]<**Insert dimension**> above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

6. Exterior In-Ground Luminaires:

   a. Install on concrete base with top [**4 inch (100 mm)**]<**Insert dimension**> above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

7. Exterior Corrosion Prevention:

   a. Do not use aluminum in contact with earth or concrete. When in direct contact with dissimilar metals, protect aluminum with insulating fittings or treatment.
   b. When embedding steel conduits in concrete, wrap conduit with **10 mil (0.254 mm)** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

8. Flush-Mounted Luminaire Support:

   a. Secured to outlet box.
   b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   c. Trim ring flush with finished surface.

9. Wall-Mounted Luminaire Support: [**Attached to structural members in walls**][**Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members**][**Attached using through bolts and backing plates on either side of wall**]<**Insert means of attachment**>.

   a. Do not attach luminaires directly to gypsum board.

10. Suspended Luminaire Support:

    a. Ceiling Mount:

       1) Hook hangers.
       2) [**Two**]<**Insert number**> wires.
       3) [**Two**][**Four**]<**Insert number**> aircraft cables.

    b. Pendants and Rods: Where longer than **48 inch (1220 mm)**, brace to limit swinging.
    c. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
    d. Continuous Rows of Luminaires: Provide tubing or stem for wiring at one point and [**tubing or rod**][**wire support**] for suspension for each unit length of luminaire chassis, including one at each end.
    e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

11. Ceiling-Grid-Mounted Luminaire Support:

a. Install ceiling support system rods or wires[**, independent of the ceiling suspension devices,**] for each luminaire. Locate not more than **6 inch (150 mm)** from luminaire corners.
b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.
c. Luminaires of Sizes Smaller than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with no fewer than two **3/4 inch (20 mm)** metal channels spanning and secured to ceiling tees.
d. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.0.

12. Remote Mounting of Ballasts or Drivers: Do not exceed distance between ballast or driver and luminaire recommended by ballast or driver manufacturer.
13. Emergency Power Units: Secure with approved fasteners in four or more locations, spaced near corners of unit.
14. Install wiring connections for luminaires.
15. Identification: Provide labels for luminaires and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each enclosure with engraved metal or laminated-plastic nameplate.

16. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

3.5 FIELD QUALITY CONTROL OF LIGHTING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Field Tests and Inspections of Lighting Installations:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Verify operation of photoelectric controls.
5. Exterior Illumination Tests:

   a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.

F. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project's site.

3.6 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Burn-in lamps that require specific aging period to operate properly, prior to occupancy by Owner.
3. Charge [**emergency power units**][**and**][**batteries**] minimum of one hour and depress switch to conduct short-duration test.
4. Charge [**emergency power units**][**and**][**batteries**] minimum of 24 hours and conduct one-hour

discharge test.

5. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project's site.

3.7 ADJUSTING

A. Luminaire Aiming Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to [**two**]<**Insert number**> visits to the Project's site during other-than-normal hours for this purpose. Some of the Work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
3. Adjust aim of luminaires in presence of Architect.

3.8 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain luminaires[**and photoelectric controls**].

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.9 PROTECTION

A. After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 50 00 00

Task	Specification	Specification Description
26 51 00 00	26 50 00 00	Lighting
26 51 13 00	26 50 00 00	Lighting
26 51 16 00	26 50 00 00	Lighting
26 51 19 00	26 50 00 00	Lighting
26 51 23 00	26 50 00 00	Lighting
26 51 33 00	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 51 33 00	26 50 00 00	Lighting
26 52 00 00	26 50 00 00	Lighting
26 52 13 00	26 50 00 00	Lighting
26 52 13 13	26 50 00 00	Lighting
26 52 13 16	26 50 00 00	Lighting
26 54 00 00	26 50 00 00	Lighting
26 54 13 00	26 50 00 00	Lighting
26 54 16 00	26 50 00 00	Lighting
26 54 19 00	26 50 00 00	Lighting
26 54 23 00	26 50 00 00	Lighting
26 55 00 00	26 50 00 00	Lighting
26 55 13 00	26 50 00 00	Lighting
26 55 16 00	26 50 00 00	Lighting
26 55 29 00	26 50 00 00	Lighting
26 55 53 00	26 50 00 00	Lighting
26 55 53 11	26 50 00 00	Lighting
26 55 53 12	26 50 00 00	Lighting
26 55 53 13	26 50 00 00	Lighting

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SECTION 26 55 61 00 - THEATRICAL LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires and accessories.
2. Distribution components.
3. Lighting control system.
4. Desktop operator workstation.
5. Rigging components.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm" specifies fire-alarm control panels and cabling referenced by this Section.

1.2 DEFINITIONS

A. Channel: An individual control output on a control console, accessed and regulated by a slider, switch, or button; or in some cases, accessed by a discretely assigned address and regulated by a data input apparatus.

B. Control Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For theatrical lighting.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Detail fabrication and installation for dimmer racks and arrangements, characteristics, and circuit assignments of various modules and rack-mounted accessories.
3. Elevation views of front, rear, and side panels indicating devices and controls, including

illustrations and dimensioned outline drawings.
4. Include diagrams for power, signal, and control wiring. Show connections, circuits, and channel assignments.
5. Equipment legend showing a unified system of designations for lighting instruments, panels, dimmers, circuits, and equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plan(s), and other details drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances for operation, maintenance, and environmental conditions.
2. Areas above and around dimming equipment where piping and ducts are prohibited.
3. Rack layout and relationships between components and adjacent structural and mechanical elements.

B. Qualification Data: For Installer.

C. Seismic Qualification Data: Certificates, for lighting equipment, distribution equipment, and rigging components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires, distribution components, software operating manuals, and controls to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructional DVD: Professionally produced informational presentation to provide comprehensive instructions for equipment installation, connectivity, programing, and functional use. Information provided shall be specific to equipment provided for Project and shall include ancillary equipment and its integration into the theatrical lighting control system.
b. Control-Console Introduction:

1) Descriptions of controls and features.
2) Software instruction manuals.
3) Setup requirements for unit and related equipment.
4) Default settings.
5) Maintenance procedures and schedules.

c. Control-Console Operation:

1) Elementary on-off operation.
2) How to set cues manually.
3) How to patch dimmer to channels electronically.
4) How to operate presets manually.
5) How to operate fundamental memory.
6) How to set and record simple cues.
7) How to recall, play back, and revise cues and scenes.
8) How to use submasters, groups, focus points, fader channels; and how to split cues, store and recall programs, set up special effects, and print out cues.
9) How to set up and run system for a typical event or performance.
10) How to get help.

d. Dimming Racks:

1) Descriptions of features, functions, and safety and security precautions.
2) Descriptions of dimming module features, software-driven functions, non-dim functions, and associated racking systems.
3) How to compare connected loads against dimmer capacity ratings.
4) How to terminate basic power-in and power-out connections.
5) Basic maintenance requirements, including need for qualified electrician for internal maintenance; basic maintenance schedule; techniques for keeping terminals properly tightened, filter screens clean, and overheat sensors checked; and techniques for performing other required servicing.
6) How to adjust dimmer-control module.
7) How to get help.
8) Description of warranty.

e. System Troubleshooting: Procedures for handling problems with common software, programming, control console, dimmer rack, and distribution system; include information on how to get help.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive or compact disk, complete with data files.
3. Device address list if applicable.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Dimmer Modules: [**One**]<**Insert number**> of each type and rating installed.
2. Fuses: Three of each kind.
3. Lamps: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type and rating installed. Furnish at least one of each type.
4. Glass Roundels: [**One**]<**Insert number**> for every [**three**]<**Insert number**> of each type and color installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of the complete dimming control system and luminaires that fail in materials or workmanship within specified warranty period.

1. Lamps are not included as part of the special warranty.
2. Warranty Period: Cost to repair or replace parts for [**two**]<**Insert number**> years from date of Substantial Completion.
3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for [**eight**]<**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Dimmer racks shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 PLUG CONNECTORS

A. Pin Type: ANSI E1.24, two pole, three wire, 20 A.

B. Twist-Locking Type: NEMA WD 6, two pole, three wire, 20 A.

2.3 LUMINAIRES AND ACCESSORIES

A. General:

1. Comply with UL 1573 and listed and labeled by an NRTL.
2. Luminaires: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
3. Metal Parts: Free of burrs, sharp corners, and edges.
4. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
5. Luminaire Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.
6. Pigtail: Factory wired, **36-inch- (900-mm-)** long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
7. Lamp Sockets: Relampable without disturbing alignment or focus adjustment.

8. Luminaire Ventilation Openings: Baffled against light leaks.
9. Luminaire Operating Controls and Handles: Thermally insulated.
10. Lenses: Borosilicate glass in silicone mountings.
11. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades adjust plus or minus 30 degrees of rotation in gate for 120-degree-minimum total angular rotation between adjacent blades.
12. Color Filter Frame Holder: Attached to front of luminaire.
13. Luminaire Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

B. Ellipsoidal Spotlights: Luminaires with an elliptical reflector mounted in a fixed relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

3. Tag ES-1 :

   a. Lamp: [**1000 W Q1000/4CL, ANSI FEL**][**750 W ANSI HPL**]<**Insert description**>.
   b. Pattern Holders: Three for each luminaire, with framing shutters.
   c. Color Frame: Black, metal.
   d. Minimum Cosine Illumination Performance Ratings When Operated with ANSI 1.9, FEL Lamp:

      1) 171,000-beam candlepower at 20-degree field angle.
      2) 48,000-beam candlepower at 40-degree field angle.

   e. Minimum Cosine Illumination Performance Ratings When Operated with ANSI 1.9 Series, HPL Lamp:

      1) 124,300-beam candlepower at 20-degree field angle.
      2) 51,500-beam candlepower at 40-degree field angle.

C. Zoom Ellipsoidal Spotlights: Luminaires with an elliptical reflector mounted in an adjustable relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a

gobo, or an iris. The shaped beam shall then be focused by a system of lenses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

3. Tag ZES-1 :

   a. Lamp: [**1000 W Q1000/4CL, ANSI FEL**][**750 W ANSI HPL**]<**Insert description**>.
   b. Pattern Holders: Three for each luminaire, with framing shutters.
   c. Operator adjustable from [**15- to 35**][**25- to 50**]-degree field angle.
   d. Field-angle adjustment scale label on instrument housing for field reference.
   e. Minimum Cosine Illumination Performance Rating When Operated with ANSI 1.9, FEL Lamp: 82,000-beam candlepower at 35-degree field angle.
   f. Minimum Cosine Illumination Performance Rating When Operated with ANSI 1.9, HPL Lamp: 95,330-beam candlepower at 35-degree field angle.

D. Fresnel Lens Spotlights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Lighting & Electronics, Inc.**]
   d. [**Philips; Signify North America; Signify Holding**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]

c. [**Lighting & Electronics, Inc.**]
d. [**Philips; Signify North America; Signify Holding**]
e. <**Insert manufacturer's name**>

3. Die-cast extruded-aluminum housing, with hinged front for relamping.
4. Tag FLS-1 :

a. Lamp: [**1000 W Q1000T7/4CL, ANSI EGT**][**750 W ANSI HPL**]<**Insert description**>.
b. Lens: **6 inches (152 mm)**.
c. Illumination Performance Rating When Operated with ANSI 1.9, EGT Lamp:

1) 175,000-beam candlepower at 12.5-degree field angle in spot focus.
2) 12,000-beam candlepower at 74.6-degree field angle in flood focus.

d. Illumination Performance Rating When Operated with ANSI 1.9, HPL Lamp:

1) 124,300-beam candlepower at 20-degree field angle in spot focus.
2) 17,600-beam candlepower at 65-degree field angle in flood focus.

e. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.

E. Follow Spotlights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Altman Lighting Co. Inc.**]
b. [**Lycian Stage Lighting**]
c. [**Strong International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Altman Lighting Co. Inc.**]
b. [**Lycian Stage Lighting**]
c. [**Strong International**]
d. <**Insert manufacturer's name**>

3. Tag FS-1 :

a. Lamp:

1) [**Metal halide; G22 medium bi-post; CRI: 90; color: 6000 K; life: 750 hours; HMI 575 W/GS 95 V**]<**Insert description**>.
2) Quartz-projector type, <**Insert number**> W, for <**Insert number**>-V supply.

b. Adjustable lenses in metal housing.
c. Adjustable, underslung base stand mounted on **3-inch (75-mm)**, locking-type, rubber-tired, ball-bearing casters.
d. Adjustable lamp holder and socket assembly with precision tuning adjustment; allows user to replace lamp without tools.
e. Three-leaf, full-range mechanical dimmer.

f. Adjustable iris and framing shutters.
g. Automatic color boom.
h. Removable power cable, **25 feet (8 m)** long.
i. Iris-Open, Spot-Focus Performance: [**800,000**]<**Insert value**> -beam candlepower at [**7.2**]<**Insert number**>-degree field angle.
j. Iris-Open, Flood-Focus Performance: [**330,000**]<**Insert value**> -beam candlepower at [**12.2**]<**Insert number**>-degree field angle.

F. PAR Lamp Holders:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Lighting & Electronics, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Lighting & Electronics, Inc.**]
   d. <**Insert manufacturer's name**>

3. Tag PLH-1 :

   a. Lamp: [**300 W PAR 38**]<**Insert description**>.
   b. Housing: Steel or aluminum,[**flat black color,**] with porcelain-plated shell socket.
   c. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.

4. Tag PLH-2 :

   a. Lamp: [**575 W tungsten halogen; 90 GLA 575 W; 120 V; color: 3050 K, ANSI GKV**]<**Insert description**>.
   b. Housing: Steel or aluminum, with porcelain-plated shell socket[**and color frame**].
   c. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.
   d. With Lens Holder and Replaceable Lenses:

      1) - Very narrow spot.
      2) - Narrow spot.
      3) - Medium flood.
      4) - Wide flood.
      5) - Very wide flood.

   e. [**Motorized**][**Manual**] color wheel.

G. Borderlight Units: Compartmented, three-circuit striplight with nine [**120-W, PAR 38/SP**][**120-W, PAR 38/FL**][**250-W, PAR 38/SP**] lamps in porcelain sockets and steel sheet housing, **90 inches (2286 mm)** long. Compartments shall be in line and wired on [**two**][**three**][**four**] alternate circuits, each producing a different color.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Lighting & Electronics, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Lighting & Electronics, Inc.**]
   c. <**Insert manufacturer's name**>

3. Front Door: Spring loaded; designed to hold either filter frames or color roundels.
4. Color Roundels: One for each lamp; [**alternating red, blue, and clear**]<**Insert colors**>.

   a. Additional Roundels: <**Insert number**> amber and <**Insert number**> green.

5. Hanger: Adjustable, steel-strap type equipped at each end with pipe clamp and safety cable for suspension from a batten.
6. Housing shall be constructed of **0.036-inch (0.9-mm)** steel with louvers for heat dissipation and baffles for control of light leaks within luminaire.

H. Cyclorama Lights: Suitable for lighting cycloramas from above.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. <**Insert manufacturer's name**>

3. Tag CL-1 :

   a. Lamp: [**1000 W Q1000T3/1CL, ANSI FFT**]<**Insert description**>.
   b. Housing: Aluminum[**or steel**][**, flat black color**][**, with color frame**].

I. Black Lights: Portable, producing a wash of UV light for special effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Lighting & Electronics, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Lighting & Electronics, Inc.**]
   c. <**Insert manufacturer's name**>

3. Tag BL-1 :

   a. Lamp: [**250-W blacklight flood, H37KB-250, with integral filter to eliminate far-UV effect while maximizing the near-UV effect**]<**Insert description**>.
   b. Housing: Steel[**or aluminum**][**, flat black color**], with carry handle.
   c. C-clamp for using on light pipe.

J. Moving Lights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**High End Systems, Inc**]
   b. [**Martin Professional, Inc**]
   c. [**Vari-Lite; Signify North America; Signify Holding**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**High End Systems, Inc**]
   b. [**Martin Professional, Inc**]
   c. [**Vari-Lite; Signify North America; Signify Holding**]
   d. <**Insert manufacturer's name**>

3. Tag ML-1 :

   a. General: 700-W, 120-V, metal halide, motorized remote-controlled lighting instrument; NRTL listed.
   b. Lamp: Short-arc metal halide, 14,500 lumens; color temperature of 5600 K, CRI of 80.
   c. Color System: Three-filter CYM (cyan, yellow, magenta) cross-fading mechanism, and 11 standard colors on a fixed wheel.
   d. Optics: Zoom optics with continuously variable field angle from 18.5 to 42 degrees, programmable over a timed range of 2 seconds to 20 minutes; with a mechanical iris for beam-size control. Variable beam focus to soften the edges of gobos and light beams.

Zoom combined with iris can project a beam with a field angle of 8 degrees.
e. Dimming: Coated glass dimmer wheel, with controls to provide smooth timed fades.
f. Strobe for strobe lighting effects.
g. Gobo: One rotating wheel with five rotatable wheel positions and one open position. One fixed gobo wheel with 11 pattern positions and one open position.
h. Beam Orientation Control: Smooth pan and tilt using a three-phase stepper motor system. Pan, 540 degrees; tilt, 270 degrees at 0.3-degree repeatability on either axis.
i. Control: ANSI E1.11 (USITT DMX512-A) protocol using five pin connectors.

2.4 DISTRIBUTION COMPONENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Electronic Theatre Controls, Inc**]
2. [**ESL Power Systems, Inc.**]
3. [**Performance Electric**]
4. [**SSRC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Electronic Theatre Controls, Inc**]
2. [**ESL Power Systems, Inc.**]
3. [**Performance Electric**]
4. [**SSRC**]
5. <**Insert manufacturer's name**>

C. Connector Strip: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly.

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of **3 by 4-1/2 inches (75 by 115 mm)**.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles:

a. Pigtail mounted, **18 inches (450 mm)** long, with strain relief at wireway wall penetration.
b. Flush mounted in wireway cover.

4. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
5. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
6. Mounting Hardware: Furnished with each unit; permits surface, single-pipe-bracket, or double-pipe-bracket mounting.
7. Finish: Semigloss or matte black.

D. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, **24 inches (600 mm)** long unless otherwise indicated; with the following features:

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of **3 by 4-1/2 inches (75 by 115 mm)**.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles:

a. Pigtail mounted, **18 inches (450 mm)** long, with strain relief at wireway wall penetration.
b. Flush mounted in wireway cover.

4. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
5. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
6. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
7. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.
8. Finish: Semigloss or matte black.

E. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.

1. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable; and brackets for surface or pipe mounting.
3. Finish: Semigloss or matte black.

F. Floor Pockets: Listed and labeled by an NRTL; flush-mounted, receptacle outlet assembly.

1. Box: **0.0598-inch (1.5-mm)** steel sheet, **10 inches (250 mm)** deep.
2. Cover Plate: Steel, cast iron, or cast aluminum with nonskid safety tread surface and self-closing, hinged door with cable notches.
3. Barrier for allowing installation of control-voltage control receptacle for console input or handheld remotes.

G. Company Switch: Listed and labeled by an NRTL as complying with UL 891.

1. Enclosure: NEMA 250 [**Type 3R**][**Type 4X**] with interlocked, full-height doors.
2. Breakers:

a. General Requirements: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
b. Features and Accessories:

1) Main molded case circuit breaker with safety interlock to doors.
2) Standard frame sizes, trip ratings, and number of poles.
3) Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material.
4) Application Listing: Appropriate for application; Type HID for feeding lighting circuits.
5) Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

3. Receptacles:

a. [**Locking**][**Locking, cam style**] color coded, wired to main circuit breaker.
b. Cable entry at [**side**][**bottom**] of enclosure.
c. Rated for [**200**][**400**] amps at 600-V ac.
d. Integral safety interlock allowing access only if main circuit breaker is in "OFF" position.

4. Integral ground lug for facility ground conductor.

2.5 WIRE AND CABLE

A. Building Wire in Raceways: Comply with requirements specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.

C. Ethernet Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. For 10/100BaseT, comply with provisions for UTP cable and hardware.
2. For 10Base-FL, comply with provisions for [**50/125**][**62.5/125**]-micrometer, multimode, optical-fiber cable and hardware.

D. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. Standard Cable, NFPA 70 [**Type CM**][**or**][**Type CMG**]:

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, [**No. 22 AWG**][**No. 24 AWG**], stranded, tinned-copper conductors.
b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
c. Outer Shield: 90 percent coverage, tinned-copper braid.
d. Outer Shield Drain Wire: Stranded, tinned copper.
e. Listed and labeled in accordance with UL 444.

2. Plenum-Rated Cable, NFPA 70 Type CMP:

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, [**No. 22 AWG**][**No. 24 AWG**], stranded, tinned-copper conductors.
b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
c. Outer Shield: 90 percent coverage, tinned-copper braid.
d. Outer Shield Drain Wire: Stranded, tinned copper.
e. Listed and labeled in accordance with UL 444.
f. Investigate insulation and jacket materials in accordance with UL 2257.

E. Control-Voltage Control Cabling:

1. Control-Cable Conductors:

a. Class 1 Control Circuits:

1) Conductor: Stranded copper, [**Type THHN-THWN, single-conductor wire complying with UL 83**][**Type XHHW, single-conductor wire complying with UL 44**][**Type XHHW, multi-conductor cable complying with UL 44**].
2) Method: [**In raceway**][**Concealed in building finishes**][**In cable tray**].

b. Class 2 Control Circuits:

1) Conductor: Stranded copper, [**Type THHN-THWN, single-conductor wire complying with UL 83**][**Type XHHW, single-conductor wire complying with UL 44**][**Type XHHW, multi-conductor cable complying with UL 44**].
2) Method: [**In raceway**][**Concealed in building finishes**][**In cable tray**].

c. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW complying with UL

83.

2. Standard Cable, NFPA 70 Type CMG:

   a. One pair, twisted, [**No. 16 AWG, stranded**][**or**][**No. 18 AWG, stranded (19x30)**], tinned-copper conductors.
   b. Unshielded.
   c. Listed and labeled in accordance with UL 444.

3. Plenum-Rated Cable, NFPA 70 Type CMP:

   a. One pair, twisted, [**No. 16 AWG, stranded (19x29)**][**or**][**No. 18 AWG, stranded (19x30)**], tinned-copper conductors.
   b. Unshielded.
   c. Listed and labeled in accordance with UL 444.
   d. Investigate insulation and jacket materials in accordance with UL 2257.

2.6 LIGHTING CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Electronic Theatre Controls, Inc**]
   2. [**Entertainment Technology**]
   3. [**Leviton Manufacturing Co., Inc.**]
   4. [**Philips; Signify North America; Signify Holding**]
   5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**Electronic Theatre Controls, Inc**]
   2. [**Entertainment Technology**]
   3. [**Leviton Manufacturing Co., Inc.**]
   4. [**Philips; Signify North America; Signify Holding**]
   5. <**Insert manufacturer's name**>

C. Description: Microprocessor-based modular system consisting of dimmer and control modules operated from remote-control stations and a control console.

   1. Comply with UL 508.
   2. Comply with ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] for data transmission.

D. Dimmer Racks: Listed and labeled by an NRTL; dead-front, front-access, [**wall-mounted**][**freestanding**] rack for mounting modular dimmers; formed-steel or extruded-aluminum structural members; completely enclosed with steel or aluminum panels. Painted with manufacturer's standard corrosion-resistant primer and finish coats, and having the following features:

   1. Primary Circuit Breaker: Fault-current withstand rating of the rack; not less than [**10,000 A**][**50,000 A**]<**Insert number**>, symmetrical.
   2. Hinged, locking front door, with openings to allow air intake across the face of all dimmer modules.
   3. Individual rack sections shall not exceed **84 inches high by 25 inches deep by 30 inches wide**

(2134 mm high by 635 mm deep by 762 mm wide). Multisection racks shall be interconnected with busbars.

4. For each module position, provide support rails and control-pin configurations, constructed for precise alignment of dimmer modules into power and signal connector sockets, with keyed connections for power capacity restrictions.
5. Forced-air cooling of each rack for maintaining operating temperature at each dimmer, assuming full load, in ambient temperature not to exceed 40 deg C. Exhaust rates shall be variable, using temperature sensors and fan-speed control electronics. Individual control of multiple fans is acceptable in lieu of fan-speed control. Fan(s) shall start and stop automatically. Fan noise at full load shall be less than 3.1 sones.
6. Each rack shall have an automatic air-temperature sensor to shut off all dimmers in the rack, should the internal temperature rise above maximum safe operating limits. In an overheat condition, the fan shall continue operating. When a safe operating temperature is restored, the system shall automatically reset to allow normal user control.
7. Fabricate and test dimmer racks to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Dimmers: Modular solid-state units that operate smoothly over their operating ranges without audible lamp noise or radio-frequency interference at any setting. Modules shall be dead-front, draw-out type with floating line, load, and control sockets for smooth insertion and withdrawal; with load-side thermal-magnetic circuit breaker, speed-controlled cooling fan, and overtemperature sensor.

1. Non-Dim Units: On-off relay control only. Capable of serving inductive loads, such as motors or HID luminaires.
2. Surge Protection: Modules shall withstand power-line surges of 6000 V/3000 A according to IEEE C62.41.1 and IEEE C62.41.2.
3. Filter each dimmed circuit to provide a minimum 350-mic.sec., current-rise time at a 90-degree conduction angle at 50 percent of rated dimmer capacity. At any load within rating, rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load current waveform.

F. Control System: Microprocessor-based control system, ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] protocol, with a nonvolatile system memory to adjust dimmer channel settings for different scenes, to patch dimmers to channels, and to manually or automatically change dimmer settings from one preset scene to another.

1. Control shall support Ethernet-based LAN at devices.
2. Provide means to create and monitor show data on a PC using software by console manufacturer. Software shall be capable of the following:

   a. Creating show and providing for use of show files.
   b. Playing back show in a console-simulation mode.
   c. Accessing all remote-control stations associated with the console and control system.
   d. Providing standard Ethernet connection between the console control system and the lighting system components.

3. Display the following system status information on a color, [**17-inch (430-mm) LCD**]<**Insert size and type**> monitor associated with the control console:

   a. Current channel intensities.
   b. Cue information.
   c. Monitor.

4. Moving Lights: Include a standard control library, a program patch specific to luminaire(s) provided, and selective programming with ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] addressing of fade, focus points, beam, image, color, <**Insert attributes**> and position.

G. Control Console: Tabletop unit with manual and computer-based programming controls, memory units, indicating devices, and the following features:

1. Grand-master level control.
2. Blackout switch.
3. Multiple submaster level controls with overlapping pile-on performance.
4. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
5. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
6. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
7. Multibutton keypad for programming in multiscene memory mode.
8. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
9. Digital display, for operating menus and memory readout.
10. Controls for setting levels into memory.
11. Cord and connector for connecting console to outlets for console power and control.

H. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using USB drive port. Operational capability includes the following:

1. Live and blind programming.
2. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
3. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
4. Inserting cues between designated cues without renumbering.
5. Out-of-sequence playback of cues.
6. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
7. Retaining programmed cues in memory for minimum of one year after power outage.
8. Automatic sequential execution of programmed cues.
9. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.

I. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.

J. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:

1. System controls designated houselights, stage lights, and other lights.
2. Stage lighting controls compatible with dimming and control system.
3. Flush mounting.
4. [**Four**][**Eight**][**Sixteen**] channels, each with slider potentiometer control.
5. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
6. Fully on switch that turns all channels on at full brightness regardless of slider position.
7. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.

8. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to maximum.
9. Illuminated push buttons for activating preset scenes of house lighting and labeled [**"Entry."**][**"Panic."**][**"Entry" and "Panic."**]
10. Flush wall mounted unless otherwise indicated.

K. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.

1. LED indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

L. Key-Entry Station: Key-operated switch controls station to activate or deactivate indicating light and presets scene of lighting control system.

1. LED indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

M. Emergency Lighting Control Station: [**Key-operated**]push button activates indicating light and brings selected dimmers to fully bright condition (i.e., the "Panic" preset). Operating push button a second time returns dimmers to previous setting.

1. Emergency mode indicating light.
2. Labeled "Emergency Lights."

N. Flush wall mounted unless otherwise indicated.

2.7 DESKTOP OPERATOR WORKSTATION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running [**Microsoft Windows**]<**Insert operating system name**>.
3. ENERGY STAR compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

   a. Capacity: [**2**][**4**][**8**]<**Insert value**>[**GB**].
   b. Speed and Type: [**1333**]<**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

   a. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
   b. Capacity: <**Insert number and measurement unit**>.
   c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
   d. Cache Buffer Size: <**Insert number and measurement unit**>.
   e. <**Insert requirements**>.

4. Second Hard Drive:

   a. Capacity: <**Insert number and measurement unit**>.
   b. Minimum Average Seek Time: <**Insert number and measurement unit**>.
   c. Cache Buffer Size: <**Insert number and measurement unit**>.
   d. <**Insert requirements**>.

5. Optical Drive:

   a. Type: <**Insert type**>.
   b. Minimum Average Access Time: <**Insert number**> ms.
   c. Data Transfer Speed: <**Insert number**>[**MB**][**TB**]/s.
   d. Reading Formats: Data, audio, recordable, <**Insert other**> and rewritable.

6. Optical Read and Write Drive:

   a. Include with at least 2 MB of data buffer.
   b. Type: <**Insert type**>.
   c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
   d. Minimum Average Access Time: <**Insert number**> ms.
   e. Nominal Data Transfer Rates:

      1) Reading: <**Insert number**>[**MB**][**TB**]/s.
      2) Writing: <**Insert number**>[**MB**][**TB**]/s.

   f. Average access time of 150 ms or less.
   g. MTBF of at least 100,000 power-on hours.

7. Expansion Slots: Minimum of 4, [**32**][**64**]<**Insert number**> bit.
8. Video Card:

   a. Capable of supporting [**one**][**two**][**three**][**four**] monitor(s.)
   b. Resolution: [**1920 by 1200**]<**Insert values**> pixels minimum for each monitor.
   c. RAM: <**Insert number**>[**MB**][**GB**][**TB**].
   d. Controller Speed: <**Insert number**>[**MHz**][**GHz**].
   e. On-Board Memory Speed: <**Insert number**>[**MHz**][**GHz**].
   f. On-Board Memory Data Width: <**Insert number**> bit.

9. Sound Card:

a. At least 128 voice wavetable synthesis.
b. Capable of delivering three-dimensional sound effects.
c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

10. Network Interface Card: Include card with connection, as applicable.

a. 10-100-1000 base TX Ethernet with RJ45 connector port.
b. 100 base FX Ethernet with SC or ST port.

11. Wireless Ethernet, 802.11 a/b/g/n.
12. Optical Modem: Full duplex link for connection to fiber-optic cable provided.
13. I/O Ports:

a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
b. One serial port.
c. One parallel port.
d. Two PS/2 ports.
e. One RJ-45.
f. One stereo line-in and line-out on back panel.
g. One microphone and headphone connector on front panel.
h. One IEEE 1394 on front and back panel with PCI-e card.
i. One ESATA port on back panel.

14. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

E. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.

F. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.

G. Flat Panel Display Monitor:

1. Number of Displays: [**One**][**Two**]<**Insert number**>.

a. Display Support: [**Individual tilt adjustable base**][**Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization**][**Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization**]<**Insert description**>.

2. Color display with <**Insert inches (mm)**> diagonal viewable area.
3. Aspect Ratio: [**16 to 9**]<**Insert value**>.
4. Resolution: [**1920 by 1080**]<**Insert value**> pixels at 60 Hz with pixel size of [**0.277**]<**Insert number**> mm or smaller.
5. [**Digital**][**or**][**analog**] input signal.
6. Response Time: <**Insert number**> ms.
7. Dynamic Contrast Ratio: [**50000 to 1**]<**Insert ratio**>.
8. Brightness: [**250 cd/sq. m**]<**Insert value**>.

9. ENERGY STAR compliant.
10. Antiglare display.

H. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

I. I/O Cabling: Include applicable cabling to connect I/O devices.

J. Software:

1. Factory-installed operating system.

K. Uninterruptable power supply (UPS) unit for the workstation.

1. Provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.

   a. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads, but excluding the printer. UPS shall provide [**15**]<**Insert number**> minutes of battery power.

2. Performance:

   a. Input Voltage: Single phase, 120-V ac, compatible with field power source.
   b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
   c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89- and 152-V ac.
   d. On-Battery Output Voltage: Sine wave.
   e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
   f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
   g. Transfer Time: 6 ms.

3. UPS shall be automatic during fault or overload conditions.
4. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
5. Include front panel with power switch and visual indication of power, battery, fault, and temperature.
6. Unit shall include an audible alarm of faults and front panel silence feature.
7. Unit with four 120-V, 15-A receptacles.
8. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[**and connect the points to the monitoring and control system**].
9. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
10. Include tower models installed in ventilated cabinets at the particular installation location.

2.8 RIGGING COMPONENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Altman Lighting Co. Inc.**]
2. [**James Thomas Engineering, Inc.**]
3. [**SSRC**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Altman Lighting Co. Inc.**]
2. [**James Thomas Engineering, Inc.**]
3. [**SSRC**]
4. <**Insert manufacturer's name**>

C. Pipe Clamps: Malleable iron, suitable for clamping luminaires or items to pipe from **3/4 to 2 inches (20 to 51 mm)** in OD. Arranged for horizontal rotation of yoke for aiming; equipped with T-bolt to lock alignment.

D. Safety Cables: Heavy-duty, flexible steel; **30-inch (762-mm)** nominal length, with spring clip at one end and steel ring at the other end.

E. Cable Grips: [**Stainless**][**Galvanized**] steel; basket-weave type for supporting stage cables.

F. <**Insert accessories**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA NEIS 1.

B. Set permanently mounted items level, plumb, and square with ceilings and walls.

C. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.

D. Mount and connect luminaires, and install and connect distribution devices.

1. If arrangement is not indicated, install so each luminaire, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.
2. Install safety cables secured to stage rigging or gridiron for all pipe-mounted electrical luminaires and equipment.

E. Dimmer Rack Mounting: Install and anchor dimmer racks level on **4-inch- (100-mm-)** high concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around full perimeter of base.
2. For dimmer racks, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to dimmer racks.

F. Comply with mounting and anchoring requirements specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548 "Vibration and Seismic Controls for Electrical Systems."

3.2 WIRING

A. Power Wiring:

1. Install wiring as specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for hardwired connections. Install wiring in raceways except cable and plug connections. Install cable strain relief device on power and control cable drops.
2. Install power wiring with a separate neutral for each output circuit from main dimmer and for each house and stage lighting circuit.

B. Signaling, Remote-Control, and Power-Limited Circuits:

1. Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables" for installation of wiring. [**Install wiring in raceways except cable and plug connections**]<**Insert wiring method**>.
2. Comply with the following unless otherwise indicated:

a. Size conductors according to lighting control device manufacturer's written instructions.
b. Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
c. Install circuits to eliminate RFI and electromagnetic interference.

3. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 circuit standards in NFPA 70.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.

E. Remove wall plates and protect devices and assemblies during painting.

F. Support luminaires, distribution components, and accessories as specified in Section 260529 "Hangers and Supports for Electrical Systems." Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

B. Label each luminaire, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
2. Visual and Mechanical Tests and Inspections:

   a. Inspect each luminaire, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
   b. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
   c. Check tightness of electrical connections with torque wrench.
   d. Verify proper protective device settings, fuse types, and ratings.
   e. Record results of tests and inspections.

3. Electrical Tests: Perform tests according to manufacturer's written instructions.

   a. Continuity tests of circuits.
   b. Operational Tests: Connect each outlet to a luminaire and a dimmer output circuit, so each dimmer module, dimmer-control and output circuit, outlet, and luminaire in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate luminaires, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station, including optional plug-in, control-console outlet locations. Record luminaire and outlet assignments, control settings, operations, cues, and observations of performance.

C. Stage lighting will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

1. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected luminaires, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

B. Modify the software programming as required to comply with the Contract Documents.

3.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's staff to adjust, operate, and maintain stage lighting equipment.

1. Training shall be [**one**][**two**] four-hour [**session**][**sessions**].
2. Include costs associated with the training with the equipment installation.
3. Provide a 14-day notice to Owner prior to scheduling training period.

END OF SECTION 26 55 61 00

Task	Specification	Specification Description
26 55 61 00	26 50 00 00	Lighting
26 55 63 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
26 55 63 00	26 50 00 00	Lighting

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SECTION 26 55 68 00 - ATHLETIC FIELD LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Athletic field luminaires and lamps.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 055000 "Metal Fabrications" specifies pipe bollards installed by this Section.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies cables installed by this Section.
7. Section 260533.13 "Conduits for Electrical Systems" specifies raceways installed by this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies boxes and covers installed by this Section.
9. Section 260553 "Identification for Electrical Systems" specifies identification products installed by this Section.
10. [**Section 260923 "Lighting Control Devices"**][**Section 260943.16 "Addressable Luminaire Lighting Controls"**][**Section 260943.23 "Relay-Based Lighting Controls"**][**and**][**Section 265561 "Theatrical Lighting"**] specifies lighting control equipment and cabling connections to luminaires installed by this Section.
11. Section 262716 "Electrical Cabinets and Enclosures" specifies enclosures installed by this Section.
12. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies surge protective devices installed by this Section.
13. Section 260546 "Poles for Electrical Systems" specifies poles installed by this Section.

1.2 DEFINITIONS

A. ACN: Architecture for Control Networks.

B. CCT: Correlated color temperature; a measure of the chromaticity (yellowness or blueness) of a white light source, expressed as the absolute temperature in kelvins of a blackbody radiator having similar chromaticity.

C. CRI: Color rendering index; a unitless estimation of how accurately a white light source displays the colors of reflected surfaces.

D. CV: Coefficient of variation.

E. DMX512: Digital multiplex with 512 pieces of information.

F. LLF: Light-loss factor.

G. RGBA: Red, green, blue, and amber.

H. RGBW: Red, green, blue, and white.

I. SPD: Surge protective device.

J. UG: Uniformity gradient.

K. UGR: Unified glare rating.

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals:

1. Engage qualified lighting design professional to design athletic field lighting equipment.
2. Engage qualified electrical professional engineer to design power distribution for athletic field lighting equipment.
3. Engage qualified structural professional engineer to design poles, hangers, and supports for athletic field lighting equipment.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For athletic field lighting. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Complete ordering information for luminaire, lamps, and accessories.
3. Data on features, accessories, and finishes.
4. Physical description and dimensions of luminaires.
5. Ballast, including UL listing and recognition, ANSI certification, and Energy Independence and Security Act of 2007 compliance.
6. Lamps, including life, output (lumens, CCT, and CRI), and energy-efficiency data.
7. Photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each lighting luminaire type. Adjustment factors must be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
8. Photoelectric relays.

9. Means of attaching luminaires to supports and indication that attachment is suitable for components involved.
10. Include sample warranty language.
11. Product Certificates:

    a. For each type of bilevel and dimmer-controlled luminaire ballast, signed by product manufacturer.
    b. For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, signed by product manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Nonstandard or Custom Luminaire:

    a. Include plans, elevations, sections, and mounting and attachment details.
    b. Details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Diagrams for power, signal, and control wiring.
    d. <**Insert additional requirements for drawing content or format**>.

C. Delegated Design Submittals: Include analysis data signed by delegated design professional(s) responsible for their preparation.

1. Drawings and specifications for construction of lighting system.
2. Manufacturer's determination of LLF used in design calculations.
3. Lighting system design calculations for the following:

    a. Target illuminance.
    b. Point calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
    c. Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
    d. Calculations of source intensity of luminaires observed at eye level from indicated properties near the playing fields.

4. Luminaire layout and aiming diagrams.
5. Electrical system design calculations for the following:

    a. Short-circuit current calculations for rating of panelboards.
    b. Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
    c. Capacity of [**feeder**][**service**] required to supply lighting system.

6. Electrical wiring diagrams, including required conductors, cables, and wiring methods.
7. Electrical riser diagrams.
8. Structural analysis data and calculations used for the following:

    a. Pole selection.
    b. Luminaire mounting arrangement.

D. Field quality-control reports.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.7 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Consumable items.

1.9 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

E. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic-load and wind-load controls, utility poles, equipment hangers and supports, and concrete foundations.

F. Lighting Design Professional: Design professional possessing active qualifications in accordance with Section 014000 "Quality Requirements" and the following:

1. Expertise in lighting design.
2. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).

G. Exterior Athletic Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by exterior athletic lighting manufacturer prior to starting installation.

H. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.

I. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY FOR ATHLETIC FIELD LIGHTING

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed athletic field lighting and associated electrical equipment perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**][**20**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.
2. Alignment Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

   a. Accuracy of alignment of luminaires must remain within specified illuminance uniformity ratios.
   b. Realign luminaires that become misaligned during the warranty period.
   c. Replace alignment products that fail within the warranty period.
   d. Verify successful realignment of luminaires by retesting as specified in "Field Quality Control of Athletic Field Lighting" Article.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that athletic field lighting and associated electrical equipment perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Luminaire Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only free on board [**origin**][**destination**], freight prepaid.
2. Lamps and Fuses Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Description: <**Insert brief description of desired athletic field lighting system**>.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. General Characteristics:

a. Facility Type: [**Professional**][**College**][**Semiprofessional**][**Sports club**][**Amateur league**][**High school**][**Training facility**][**Elementary school**][**Recreational or social facility**].
b. Glare Control: Design illumination for each playing area to minimize direct glare in adjacent and nearby areas.

1) Design source intensity of luminaires that may be observed at an elevation of **60 inch (1524 mm)** above finished grade from nearby properties to be less than [**12 000 cd**][**20 000 cd**][**30 000 cd**]<**Insert candela**> when so observed.
2) Design source intensity of luminaires that may be observed at an elevation of **60 inch (1524 mm)** above finished grade from designated "spill-light critical" areas to be less than [**12 000 cd**][**20 000 cd**][**30 000 cd**]<**Insert candela**> when so observed.

c. Egress Lighting: In case of power failure, provide not less than [**1.0 fc (10.8 lx)**]<**Indicate value**> average illumination, within 30 seconds, measured at grade in spectator and spectator egress areas.

1) Duration of emergency illumination must be not less than [**15 min**]<**Insert time**>.
2) Momentary Power Interruptions: Provide emergency illumination immediately following restoration of power to the lighting circuits. Emergency illumination must automatically extinguish after [**15 min**]<**Insert time**>.

d. Lighting Control: Manual, low voltage, or digital; providing the following functions, integrated into a single control station, with multiple subcontrol stations as indicated:

1) Control Station: Key-operated master switch, manual push-button controls, and system status indicator lights.[**Test switch of egress lighting system.**]
2) Light Levels: Two levels of control - [**100/50 percent**]<**Insert two percentages**> of minimum target illumination.
3) <**Insert Project-specific control requirements**>.

e. Electric Power Distribution Requirements:

1) Electric Power: [**208 V**][**240 V**][**480 V**]; three phase.

a) Include roughing-in of service indicated for nonsports improvements on the Project site.
b) Balance load between phases. Install wiring to balance three phases at each support structure.
c) Include required overcurrent protective devices and individual lighting control for each sports field or venue.
d) Include indicated feeder capacity and panelboard provisions for future lighted sports field construction.

2) Maximum Total Load: <**Insert number**> A.
3) Maximum Total Voltage Drop from Source to Load: [**5 percent**]<**Insert percentage**>, including voltage drops in branch circuit, subfeeder, and feeder.

3. Illumination Criteria: Calculate by computer-analyzed point method complying with IES RP-6 to optimize selection, location, and aiming of luminaires.

a. Minimum average target illuminance level for each lighted area for each sports venue and for the indicated class of play in accordance with IES RP-6.
b. CV and maximum-to-minimum uniformity ratios for each lighted area equal to or less than those listed in IES RP-6 for the indicated class of play.
c. UG levels within each lighted area equal to or less than those listed in IES RP-6 for the indicated speed of sport.
d. Minimum Average Target Illumination: <**Insert fc or lx**>.
e. CV: <**Insert value**>.
f. Maximum-to-Minimum Uniformity Ratio: <**Insert value**>.
g. UG Level: <**Insert value**>.
h. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas. Each grid point represents the center of the grid area defined by the length and width of the grid spacing.
i. Spill-Light Control: Minimize spill light for each playing area on adjacent and nearby areas.

1) Prevent light trespass on properties near the Project as defined by <**Insert name(s) of authorities having jurisdiction**>.
2) For areas indicated on the Drawings as "spill-light critical," limit the level of illuminance directed into the area from any luminaire or group of luminaires, and measured **36 inch (914 mm)** above grade to the following:

a) Maximum Horizontal Illuminance: [**0.25 fc (2.7 lx)**][**0.5 fc (5.4 lx)**][**0.75 fc (8.1 lx)**].
b) Maximum Vertical Illuminance from the Direction of the Greatest Contribution of Light: [**1.0 fc (10.8 lx)**][**2.0 fc (21.5 lx)**][**3.0 fc (32.3 lx)**].

3) Calculate the horizontal and vertical illuminance due to spill light for points spaced [**20 ft (6 m)**]<**Insert dimension**> apart in areas indicated on the Drawings as "spill-light critical," to ensure that design complies with the above limits.

j. Determine LLF in accordance with IES RP-6 and manufacturer's test data.

1) Use LLF at [**100 percent**]<**Insert percentage**> of rated lamp life. LLF must be applied to initial illumination to ensure that target illumination is achieved at 100 percent of lamp life and must include consideration of field factor.
2) LLF must not be higher than 70 percent and may be lower when determined by manufacturer after application of the ballast output and optical system output, in accordance with IES RP-6.

k. Luminaire-Mounting Height: Comply with IES RP-6[**, with consideration for requirements to minimize spill light and glare**].

l. Luminaire Placement: Luminaire clusters must be outside the glare zones defined by IES RP-6.

m. Baseball Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

n. Softball Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **20 by 20 ft (6 by 6 m)**.

o. Football Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

p. Soccer Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

q. Outdoor Tennis Courts:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **10 by 10 ft (3 by 3 m)**.

r. Insert Sport:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: <**Insert dimensions**>.

4. Life-Cycle Cost Criteria:

a. Estimated life-cycle cost of lighting system for period of <**Insert number**> years based on the parameters below:

1) Energy Cost: <**Insert dollars**>.
2) Lamp Replacement Cost: <**Insert dollars**>.
3) General Maintenance Cost: <**Insert dollars**>.

b. <**Insert life-cycle cost criteria**>.

2.2 ATHLETIC FIELD LUMINAIRES AND LAMPS

A. UL IFAM - LED Surface-Mounted Athletic Field Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CHM Lighting**]
   b. [**Ephesus Sports Lighting; a brand of Cooper Lighting Solutions; Signify N.V.**]
   c. [**Musco Lighting**]
   d. [**Sportsbeams**]
   e. [**Sportsliter Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CHM Lighting**]
   b. [**Ephesus Sports Lighting; a brand of Cooper Lighting Solutions; Signify N.V.**]
   c. [**Musco Lighting**]
   d. [**Sportsbeams**]
   e. [**Sportsliter Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

   a. LED Surface-Mounted Luminaires: UL CCN IFAM; including UL 1598.
   b. LED Drivers: UL CCN FKSZ or UL CCN FKSZ2; including UL 8750.

5. Standard Features:

   a. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit servicing without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during servicing and when secured in operating position. Doors must be removable for cleaning or replacing lens. Designed to disconnect driver when door opens.
   b. Finishes:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and can be and are assembled or installed to minimize contrast.

   c. Exposed Hardware: Corrosion-resistant metal latches, fasteners, and hinges.
   d. Markings: "Suitable for Wet Locations."
   e. Luminaire Mounting: Bracket mounted.
   f. Driver Mounting: [**Remote; grouped in cabinets**][**Bracket mounted**][**Integral to luminaire; field changeable**].
   g. Driver Performance:

1) Nominal Input Voltage: [**120 V**][**208 V**][**240 V**][**277 V**][**480 V**], 60 Hz.
2) Nominal Input Power: [**80 W**][**100 W**][**150 W**][**300 W**][**500 W**][**1000 W**][**1200 W**][**1500 W**]<**Insert wattage**>.
3) Power Factor: Not less than [**0.90**]<**Insert power factor requirement**> lagging.
4) Total Harmonic Distortion: Not greater than [**16 percent**][**20 percent**]<**Insert percentage**>.

h. Beam Spread Pattern: [**NEMA Type 1 (very narrow)**][**NEMA Type 2 (narrow)**][**NEMA Type 3 (medium narrow)**][**NEMA Type 4 (medium)**][**NEMA Type 5 (medium wide)**][**NEMA Type 6 (wide)**][**NEMA Type 7 (very wide)**][**Narrow spot (2 deg H by 2 deg V)**][**Narrow flood (4 deg H by 4 deg V)**][**Horizontal flood (5 deg H by 3 deg V)**][**Vertical flood (3 deg H by 5 deg V)**][**Medium flood (5 deg H by 5 deg V)**][**Wide flood (6 deg H by 6 deg V)**]<**Insert _ deg H by _ deg V beam angles**>.

i. Light Color: [**White only**][**Tunable RGBW**][**Tunable RGBA**]<**Insert color requirement**>[**; designed for 4K/HDTV broadcasting**].

1) White Correlated Color Temperature: [**2700 to 3000 K**][**4000 K**][**5000 K**][**5700 to 6000 K**][**3000/4000/5000 K selectable**]<**Insert CCT kelvins**>.
2) White Color Rendering Index: [**70+**][**80+**][**90+**]<**Insert CRI**>.

j. Energy Efficiency: [**Premium**][**DLC listed**][**and**][**ENERGY STAR listed**].

6. Other Available Features Required by the Project:

a. Spill-Light Control Devices: Internal louvers and external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
b. Dimming: [**0-10 V dimmable**]<**Insert dimming requirement**>.
c. Dimming Range (Light Output): [**0-100 percent**][**10-100 percent or better**][**20-100 percent or better**]<**Insert dimming range requirement**>.
d. Dim to off.
e. Surge Protection: Provide integral Type 2 SPDs; nonmodular, with digital indicator lights[**and one set of dry contacts**].

1) Maximum SPD Discharge Current Rating: [**10 kA**][**20 kA**]<**Insert kA**> per phase.

f. Unified Glare Rating: [**Less than 22**][**Less than 19**]<**Insert UGR requirement**>.
g. Field-changeable lenses.
h. Luminaire Lighting Control Interface: [**TIA-485 jack for ESTA E1.11 DMX512 cable**][**Termination box for ESTA E1.11 DMX512 cable**][**8P8C jack for ESTA E1.31 ACN Ethernet cable**][**DALI driver**][**Wireless**] Open Lighting Alliance compliant interface.
i. Pre-terminated wiring pigtail.
j. 12 V secondary output power for external sensors, controls, or accessories.

2.3 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing sports lighting, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: [**One percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.
2. Ballasts: [**One percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.
3. Fuses: [**10 percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of

each type.

B. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Lamps: [**10 percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical and communications conduit to verify actual locations of connections before pole or luminaire installation.

C. Examine foundations for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ATHLETIC FIELD LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Life Safety and Means of Egress Work: NFPA 101.
5. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
6. Luminaires and Supports: Article 410 of NFPA 70.
7. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Athletic Field Luminaires, Lamps, and Ballasts:

a. Install luminaires at height and aiming angle as indicated on Drawings.
b. Install controls and ballast housings in cabinets mounted on support structure at least **10 ft (3 m)** above finished grade.

2. Structural Supports:

a. Provide [**steel**][**aluminum**][**concrete**] poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations for athletic field lighting.
b. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
c. Install poles and other structural units level, plumb, and square.

d. Except for embedded structural members, grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of **1/2 inch (13 mm)** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole. Nonshrink grout is specified in Section 055000 "Metal Fabrications."
e. Extend cast-in-place bolted base foundations **36 inch (914 mm)** above grade, minimum.
f. Install protective pipe bollards on [**two**][**three**]<**Insert number**> sides of each embedded pole installed in paved areas.

3. Surge Protection: Install Type 2 surge protective devices; nonmodular, with digital indicator lights[**and one set of dry contacts**].

   a. Peak Single-Impulse Surge Current Rating: <**Insert number**> kA per phase.

4. Wiring Methods:

   a. Install cables in raceways, except when cables are installed within boxes and poles. Conceal raceways and cables.
   b. Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; 10 AWG minimum conductor size for power wiring.
   c. Overhead-, pole-, or structure-supported wiring and transformers are[**not**] permitted.
   d. Electrical Enclosures Exposed to Weather: UL 50E, Type 3R enclosure constructed from [**stainless steel**][**corrosion-resistant material**], with hinged doors fitted with padlock hasps or lockable latches.
   e. Install lighting control equipment and cabling connections to luminaires.

5. Identification: Provide labels for athletic field lighting and associated electrical equipment.

   a. Identify system components and terminals.
   b. Identify field-installed conductors, interconnecting wiring, and components.
   c. Provide warning signs.
   d. Label each enclosure with engraved metal or laminated-plastic nameplate.

6. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 260573 "Power System Studies" for mitigating available fault current and arc-flash hazard in electrical equipment installed for athletic field lighting.
3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration: Integrate athletic field lighting controls with facility lighting controls.

3.3 FIELD QUALITY CONTROL OF ATHLETIC FIELD LIGHTING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Field Tests and Inspections of Lighting Installations:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
2. Playing and Other Designated Areas: Make field measurements at intersections of grids, dimensioned and located as specified in "Performance Requirements" Article and as described below:

   a. Baseball Fields: Measure at least [**25**]<**Insert number**> points of the infield and [**87**]<**Insert number**> points of the outfield. Extend the grid **15 ft (5 m)** outside the foul lines, extending to outfield boundary or fence.
   b. Softball Fields: Measure at least [**16**]<**Insert number**> points of the infield and [**48**]<**Insert number**> points of the outfield. Extend the grid **15 ft (5 m)** outside the foul lines, extending to outfield boundary.
   c. Football Fields: Lighted area is [**180 by 360 ft (55 by 110 m)**]<**Insert dimensions**>. Measure at least [**91**]<**Insert number**> points.
   d. Soccer Fields: Lighted area is [**210 by 370 ft (64 by 113 m)**]<**Insert dimensions**>. Measure at least [**91**]<**Insert number**> points.
   e. Outdoor Tennis Courts: Measure at least [**30**]<**Insert number**> points for a double court.
   f. <**Insert sports venue**>: Measure at least <**Insert number**> points.

3. Make field measurements at established test points in areas of concern for spill light and glare.
4. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated

values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
5. Report results in writing.

F. Nonconforming Work:

1. Sports lighting will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.
3. Correction of Illumination Deficiencies for Playing Areas: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent.

   a. Add or replace luminaires; change mounting height and aiming; or install louvers, shields, or baffles.
   b. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
   c. Do not replace luminaires with units of higher or lower wattage without Architect's approval.
   d. Retest as specified above after repairs, adjustments, or replacements are made.
   e. Report results in writing.

G. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.

1. Replace luminaires; change mounting heights and revise aiming; or install louvers, shields, or baffles.
2. Obtain Architect's approval to replace luminaires with units of higher or lower wattage.
3. If mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
4. Retest as specified above after repairs, adjustments, or replacements are made.

H. Assemble and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.5 ADJUSTING

A. Adjust luminaires and supports to maintain orientation and aiming as recommended by manufacturer.

B. Luminaire Aiming Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to [**two**]<**Insert number**> visits to the Project site during other-than-normal hours for this purpose. Some of the Work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
3. Adjust aim of luminaires in presence of Architect.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain luminaires[**and lighting controls**].

3.7 PROTECTION

A. After installation, protect athletic field lighting and associated electrical equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of athletic field lighting Installer**][**manufacturer's authorized service representative**]. Include [**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper athletic field lighting operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 55 68 00

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Task	Specification	Specification Description
26 55 68 00	26 50 00 00	Lighting
26 56 00 00	26 50 00 00	Lighting
26 56 13 00	02 41 19 00	Selective Demolition
26 56 13 00	26 50 00 00	Lighting
26 56 18 00	26 50 00 00	Lighting
26 56 19 00	26 50 00 00	Lighting
26 56 21 00	26 50 00 00	Lighting
26 00 00 00MOD000	01 00 00 00MOD000	Supplemental Requirements for Electrical

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SECTION 27 11 00 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications-circuit accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 061000 "Rough Carpentry" furnishes equipment backing panels installed by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies the following installed by this Section:

    a. Grounding and bonding conductors.
    b. Grounding and bonding clamps.
    c. Grounding and bonding bushings.
    d. Grounding and bonding hubs.
    e. Grounding and bonding connectors.
    f. Intersystem bonding bridge grounding connector.
    g. Grounding and bonding busbars.
    h. Signal reference grids.

7. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases for communications equipment installed by this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" furnishes the following installed by this Section:

    a. Metallic outlet boxes, device boxes, rings, and covers.
    b. Junction boxes and pull boxes.
    c. Cover plates for device boxes.

9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies labels and warning signs for communications pathways installed by this Section.
11. Section 262716 "Electrical Cabinets and Enclosures" specifies the following installed by this Section:

    a. Cabinets and cutout boxes.
    b. Termination boxes.
    c. Miscellaneous enclosures.

d. Rack or frame systems.
e. Enclosure-mounted relocatable power taps.

12. Section 262719 "Multi-Outlet Assemblies" specifies the following installed by this Section:

    a. Wall-mounted, surface metal raceway multi-outlet assemblies.
    b. Indoor service poles.

13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" specifies duplex receptacles installed by this Section.
14. Section 262726.39 "Locking Receptacles" specifies locking receptacles installed by this Section.
15. Section 262726.51 "Connectors, Cords, and Plugs" specifies pendant flexible cords and connectors installed by this Section.
16. Section 270528 "Pathways for Communications Systems" specifies cable pathways serving communications equipment room fittings installed under this Section.

1.2 DEFINITIONS

A. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

B. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

C. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For communications equipment room planning. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Representative of Owner's information and communications technology staff[**that will be installing electronic equipment**][**and cables**], installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Communications Equipment Room Drawings, Diagrams, and Supporting Documents:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Equipment Racks and Cabinets: Indicate workspace requirements and access for cable connections.
d. Switchboards, Panelboards, and Safety Switches: Indicate workspace requirements and access for cable connections.
e. Grounding and Bonding: Indicate location of busbars and their mounting details showing standoff insulators and wall mounting brackets.
f. Cable Trays, Large Raceways, Ducts, and Piping: Indicate elevation and route of vertical and horizontal cable trays, raceways or ducts larger than **2 inch (50 mm)** wide, and fire-suppression piping located inside communications equipment room.
g. Luminaires: Indicate elevation, orientation, and size of luminaires inside the communications equipment room for coordination with cable trays, equipment racks, cabinets, and other equipment.
h. Access Panels: Indicate locations, dimensions, and clearances required to open access panels in ducts, walls, or ceilings inside communications equipment room.
i. Controls: Indicate locations of sensors, switches, and push-buttons for HVAC, fire suppression, fire alarm, and standby power.
j. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
k. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
l. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 COMMUNICATIONS-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for connecting communications circuits in accordance with Article 800 of NFPA 70.

B. UL DUXR - 66-Style or 110-Style Cross-Connect Frame :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features: This product type includes the frame only. Block inserts and related termination equipment are specified in communications cabling Sections.

C. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]

b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
   b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features:

   a. Mounting: [**Equipment rack**][**Wall**].
   b. Style: [**Modular**][**Prepopulated 110 punch down**].
   c. EMI Compatibility: [**Shielded**][**Unshielded**].
   d. Configuration: [**Standard**][**High density**]; [**flat**][**angled**].
   e. Include provisions for labeling ports.
   f. Distribution Port Quantity: [**12**][**24**][**48**][**72**][**144**]<**Insert quantity**>.
   g. Cable Type: [**Cat. 5e**][**Cat. 6**][**Cat. 6a**][**Optical fiber**]<**Insert cable type**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Grounding and Bonding Conductors:

1. Communications Busbar Connections:

   a. TBC: Not smaller than [**1/0 AWG**][**3/0 AWG**]<**Insert wire size**> and no smaller than largest TBB.
   b. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
   c. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
   d. TEBC: Not smaller than [**2 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted connectors.
   e. UBC: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on

Drawings. Provide bolted connectors.

f. Bonding Conductors to Structural Steel: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted clamp connectors.

2. Cable Tray Connections:

a. Cable Tray Equipment Grounding Conductor: [**8 AWG**][**6 AWG**][**4 AWG**].

b. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than [**10 AWG**][**6 AWG**] and not longer than **12 inch (300 mm)**. If jumper is wire, it must be terminated with lug having [**one hole and standard barrel for one crimp**][**two holes and long barrel for two crimps**]. If jumper is flexible braid, it must be terminated with [**one- or two-hole ferrule**][**one-hole ferrule**]. Attach with bonding screw or connector provided by cable tray manufacturer.

3. Underground Connections: Not smaller than [**2 AWG**]<**Insert wire size**>. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

B. Grounding and Bonding Busbars:

1. PBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.

b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

2. SBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.

b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

C. Access Floor Signal Reference Grid:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing [**6 AWG**]<**Insert wire size**> bonding conductors in a grid pattern under the floor.

a. Install grid bonding conductors on **4 ft (1200 mm)** centers, so as to permit bonding of one structural pedestal for each access floor tile. Connect grid conductors together where they cross each other.

b. Bond SBBs in room to two or more bonding conductors of reference grid with TEBCs.

c. Bond equipment to nearest SBB and to reference grid with TEBCs.

d. Bond conduits and piping entering equipment room with TEBCs to nearest SBB and to grid conductor nearest entry into room.

D. Signal Reference Grid Wire Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing wire mesh [**in concrete floor slab**][**above ceiling**] with the following features:

a. Wire mesh, 10 AWG solid copper, **2 inch (50 mm)** spacing.

b. Wire mesh, 10 AWG solid copper, **3 inch (75 mm)** spacing.

c. Wire mesh, 10 AWG solid copper, **4 inch (100 mm)** spacing.

d. Wire mesh, 10 AWG solid copper, **6 inch (150 mm)** spacing.

e. Wire mesh, 10 AWG solid copper, **12 inch (300 mm)** spacing.
f. Wire mesh, 8 AWG solid copper, **4 inch (100 mm)** spacing.
g. Wire mesh, 8 AWG solid copper, **6 inch (150 mm)** spacing.
h. Wire mesh, 8 AWG solid copper, **8 inch (200 mm)** spacing.
i. Wire mesh, 8 AWG solid copper, **12 inch (300 mm)** spacing.
j. Wire mesh, 6 AWG solid copper, **4 inch (100 mm)** spacing.
k. Wire mesh, 6 AWG solid copper, **6 inch (150 mm)** spacing.
l. Wire mesh, 6 AWG solid copper, **8 inch (200 mm)** spacing.
m. Wire mesh, 6 AWG solid copper, **12 inch (300 mm)** spacing.
n. Wire mesh, 6 AWG solid copper, **24 inch (610 mm)** spacing.
o. Wire mesh, 4 AWG solid copper, **4 inch (100 mm)** spacing.
p. Wire mesh, 4 AWG solid copper, **6 inch (150 mm)** spacing.
q. Wire mesh, 4 AWG solid copper, **12 inch (300 mm)** spacing.
r. Wire mesh, 2 AWG solid copper, **4 inch (100 mm)** spacing.
s. Wire mesh, 2 AWG solid copper, **6 inch (150 mm)** spacing.
t. Wire mesh, 2 AWG solid copper, **12 inch (300 mm)** spacing.
u. Wire mesh, 2 AWG solid copper, **24 inch (610 mm)** spacing.

E. Signal Reference Grid Tape Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing tape mesh under floor finish with the following features:

a. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **12 inch (300 mm)** spacing.
b. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **24 inch (610 mm)** spacing.

3.3 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color Coding Scheme for Communications Cable and Terminations: Comply with BICSI N1 and TIA-598.

D. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "COMMUNICATIONS."
2. "FIRE ALARM."
3. "SECURITY."
4. <**Insert name**>.

E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

F. Locations of Underground Lines: Underground-line warning tape for communication, control wiring, and optical-fiber cable.

G. Communications Vaults, Manholes, Handholes, and Pull and Junction Boxes: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use [**write-on tags**][**self-adhesive labels**] with conductor or cable designation, origin, and destination.

I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide [**heat-shrink preprinted tubes**][**self-adhesive labels**] with conductor designation.

J. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

K. Auxiliary Electrical Systems Conductor Identification: [**Marker tape**][**Self-adhesive vinyl tape**] that is uniform and consistent with system used by manufacturer for factory-installed connections.

L. Equipment and Cabling Identification for Administrative Records and Labeling: Comply with TIA-606 requirements for [**Class 1**][**Class 2**][**Class 3**][**Class 4**] network administration.

M. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

   a. Racks, Frames, and Enclosures: Identify front and rear of each enclosure with self-adhesive labels[**containing equipment designation**].
   b. Patch Panels: [**Label individual rows in each rack, starting at top and working down, with self-adhesive labels.**][**Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.**]
   c. Communications cabinets.
   d. Access doors and panels for concealed communications items.
   e. Emergency system boxes and enclosures.
   f. Contactors.
   g. Remote-controlled switches, dimmer modules, and control devices.
   h. Monitoring and control equipment.
   i. Fire-alarm equipment.
   j. Security equipment.
   k. Life-safety communications equipment.
   l. <**Insert equipment**>.

N. Backbone Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**] indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

O. Horizontal Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**].

P. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Identify cover plate in accordance with TIA-606.

Q. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.4 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT/RACK HAS MULTIPLE POWER SOURCES."
2. <**Insert names and wording of warning signs or labels**>.

D. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

E. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for <**Insert emergency operations**>.

F. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.5 INSTALLATION OF FITTINGS FOR ENTRANCE FACILITY

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is

fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 66-style or 110-style cross-connect frame .
10. Patch panel .

3.6 INSTALLATION OF FITTINGS FOR EQUIPMENT ROOM

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

   a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.7 INSTALLATION OF FITTINGS FOR TELECOMMUNICATIONS ROOMS

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.

3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in intermediate distribution frame room or space as indicated on Drawings:

1. Equipment backing panel .

   a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. SBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.8 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Grounding of Communications: Bond PBB and SBBs to grounding electrode conductors at electrical power service entrance, and at electrical power derived systems serving communications equipment, using intersystem bonding termination device.

1. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.

B. Comply with manufacturer's published instructions.

C. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

D. Special Techniques:

1. Bonding of Busbars:

   a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers **12 inch (300 mm)** above finished floor unless otherwise indicated.
   b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

2. Bonding Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
d. Install without splices.
e. Support conductors at not more than **36 inch (900 mm)** intervals.
f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing and bond both ends of raceway to SBB.

3. Provide TBC and terminate ends to PBB and intersystem bonding [**termination device**][**busbar**] at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together with BBCs where required by TIA-607.
5. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
6. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide [**top-mounted**][**vertically mounted**] RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.
7. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
8. Primary Protector: Bond to PBB with insulated bonding conductor.
9. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
10. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
11. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
12. Access Floors: Bond metal parts of access floors to SBB.
13. <**Insert connections for other equipment**>.

3.9 FIELD QUALITY CONTROL FOR BONDING OF COMMUNICATIONS

A. Administrant for Grounding and Bonding Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections

on components, assemblies, and equipment installations, including connections.

4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

   a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

      1) If measured resistance from electrical service equipment to ground exceeds [**5 Ω**]<**Insert resistance**>, notify Architect and include recommendations to reduce resistance to ground.

   b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

   a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB[**and to SBBs**]. Maximum acceptable AC current level is 1 A.

E. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

3.10 PROTECTION

A. After installation, protect communications equipment room fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 11 00 00

Task	Specification	Specification Description
27 11 16 00	27 11 00 00	Communications Equipment Room Fittings
27 11 19 00	27 11 00 00	Communications Equipment Room Fittings
27 11 19 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 11 23 00	27 11 00 00	Communications Equipment Room Fittings

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SECTION 27 13 13 00 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backbone communications cables.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. See Section 270553 "Identification for Communications Systems" for communications equipment labels.
2. See Section 271513 "Communications Copper Horizontal Cabling" for Type CM, CMG, and CMX cabling.

D. Related Requirements:

1. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 270010 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.3 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.4 DEFINITIONS

A. Cable Types:

1. FTP: Foil shielded twisted pair.
2. F/FTP: Bundle of FTP cables with overall foil shield.
3. F/UTP: Bundle of UTP cables with overall foil shield.
4. S/FTP: Bundle of FTP cables with overall braided shield.
5. S/UTP: Bundle of UTP cables with overall braided shield.
6. UTP: Unshielded twisted pair.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

1.5 SEQUENCING

A. Wet-work in spaces must be completely dry, and HVAC system must be operating and maintaining ambient temperature and humidity conditions within manufacturer's recommended limits, before delivering and installing cables and connecting materials.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Shop Drawings:

1. Cable labeling schedules.
2. Cabling administration diagrams.
3. Wiring diagrams.
4. Cross-connect and patch panel details.
5. Twisted-pair cable testing plan.

C. Field quality-control reports.

D. Sustainable design submittals.

1. Backbone communications cable.

1.7 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Field Reports:

1. Factory Test Reports:

a. Backbone communications cable.

1.8 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: For communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Special Tools: For communications-, audio/video-, data-, and other signaling-circuit accessories.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted-pair cable for open and short circuits.

1.11 WARRANTY FOR COMMUNICATIONS COPPER BACKBONE CABLE ASSEMBLIES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed communications copper backbone cable assemblies perform in accordance with specified requirements and agrees to repair or replace cable assemblies that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Certified Cable: UL CCN DUZX; including UL 444.
b. Verified Cable: UL CCN DVBI; including TIA-568.2.
c. Type CMP: NFPA 262.
d. Type CMR: UL 1666.
e. Limited Smoke: Marked "-LS" in accordance with UL 1685.
f. Halogen-Free: Marked "-HF" in accordance with UL Subject 2885.
g. Low Smoke and Halogen-Free: Marked "-LSHF" in accordance with IEC 61034-2.
h. Cable Heating Test: Marked "-LP" with current rating and temperature rating.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Sustainable Design Submittals: Prepare and submit documentation for the following:

    a. Product Data: For each conductor and cable indicating lead content of less than 300 parts per million.
    b. Environmental Product Declaration: For each product.
    c. Health Product Declaration: For each product.
    d. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
    e. Third-Party Certifications: For each product.
    f. Third-Party Certified Life Cycle Assessment: For each product.

3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Factory Tests:

    a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
    b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate cable reels.
    c. Factory Tests and Inspections: Test and inspect cable on reels, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-568.2 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.
    d. Nonconforming Work:

        1) Cable reels that do not pass tests and inspections will be considered defective.

    e. Factory Test Reports: Prepare and submit factory test and inspection reports.

D. UL DUZX and DVBI - Type CMP, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Molex Premise Networks**]
    f. [**Panduit Corp**]
    g. [**Prysmian Cables and Systems; Prysmian Group North America**]
    h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    i. [**West Penn Wire; brand of Belden, Inc.**]
    j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell**

Incorporated]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

E. UL DUZX and DVBI - Type CMP, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

F. UL DUZX and DVBI - Type CMP, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. **<Insert manufacturer's name>**

3. Product Marking: Type CMP; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]**<Insert number>**.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]**<Insert color>** thermoplastic.

G. UL DUZX and DVBI - Type CMP, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

H. UL DUZX and DVBI - Type CMR, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]

k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

I. UL DUZX and DVBI - Type CMR, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 5e.
4. Options:

a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

J. UL DUZX and DVBI - Type CMR, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**Leviton Manufacturing Co., Inc.**]
   f. [**Mohawk; a division of Belden Networking, Inc.**]
   g. [**Molex Premise Networks**]
   h. [**Panduit Corp**]
   i. [**Prysmian Cables and Systems; Prysmian Group North America**]
   j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   k. [**TE Connectivity Ltd.**]
   l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**Leviton Manufacturing Co., Inc.**]
   f. [**Mohawk; a division of Belden Networking, Inc.**]
   g. [**Molex Premise Networks**]
   h. [**Panduit Corp**]
   i. [**Prysmian Cables and Systems; Prysmian Group North America**]
   j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   k. [**TE Connectivity Ltd.**]
   l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6.
4. Options:

   a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

K. UL DUZX and DVBI - Type CMR, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]

d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

L. UL DUZX and DVBI - Type CMR, Category 8 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 8.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**F/FTP**][**S/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

M. UL DUZX and DVBI - Type CMR-LS, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 3.
4. Options:

   a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

N. UL DUZX and DVBI - Type CMR-LS, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 5e.
4. Options:

   a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].

c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

O. UL DUZX and DVBI - Type CMR-LS, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 6.
4. Options:

   a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

P. UL DUZX and DVBI - Type CMR-LSHF, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 3.
4. Options:

   a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.

b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

Q. UL DUZX and DVBI - Type CMR-LSHF, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CommScope, Inc**]
   b. [**Hitachi Cable America Inc.**]
   c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CommScope, Inc**]
   b. [**Hitachi Cable America Inc.**]
   c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 5e.
4. Options:

   a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

R. UL DUZX and DVBI - Type CMR-LSHF, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**CommScope, Inc**]
   b. [**Hitachi Cable America Inc.**]
   c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CommScope, Inc**]

b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.2 COMMUNICATIONS-, AUDIO/VIDEO-, DATA-, AND OTHER SIGNALING-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for use in residential or commercial communications-station applications for connections to communications circuit as defined in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. Listing Criteria:

a. Communications-Circuit Accessories: UL CCN DUXR; including UL 1863.
b. Audio/Video-, Data-, and Other Signaling-Circuit Accessories: UL CCN DUXR; including UL 1977.
c. For Use in Air-Handling Spaces: UL 2043.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL DUXR - Connecting Block :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]

e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]
e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

3. Options:

a. Configuration: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**].
b. Quantity of Terminations: Number of cables terminated on block, plus [**25**]<**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. UL DUXR - Cross-Connect :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

3. Options:

a. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

F. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

3. General Characteristics:

    a. Universal T568A and T568B wiring labels.
    b. Labeling areas adjacent to conductors.
    c. Replaceable connectors.
    d. 24 or 48 ports.
    e. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

4. Options:

    a. Number of Jacks per Field: One for each four-pair [**twisted-pair cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].
    b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

G. UL DUXR - 8P8C Plugs and Plug Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

3. General Characteristics:

a. Male; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

H. UL DUXR - 8P8C Jacks and Jack Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]

c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. **<Insert manufacturer's name>**

3. General Characteristics:

a. Female; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Designed to snap into patch panel or cover plate.
c. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

I. UL DUXR - Patch Cords :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. **<Insert manufacturer's name>**

3. General Characteristics:

a. Factory-made, four-pair cables; terminated with an 8P8C plug at each end.
b. Bend-relief-compliant boots and color-coded icons to ensure Category 6 performance.

c. Latch guards to protect against snagging.
d. Color-coded boots for circuit identification.

4. Options:

a. Length: [3 ft (0.9 m)][4 ft (1.2 m)]<**Insert length**>.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

J. Accessories:

1. Spare Parts: Furnish to Owner spare parts, for repairing cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. Connecting Blocks: [**One**]<**Insert number**> of each type.
b. Patch Panels: [**One**]<**Insert number**> of each type.
c. Plugs: [**Ten**]<**Insert number**> of each type.
d. Jacks: [**Ten**]<**Insert number**> of each type.

2. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. <**Insert name of special tool**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Cable Labeling Schedules: Submit electronic files[**using software and format requested by Owner**].
2. Cabling Administration Diagrams: Submit diagrams and supporting electronic files[**using software and format requested by Owner**].

a. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

3. Wiring Diagrams:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch Panel Details: Include mounting assemblies, elevations, and physical relationship between installed components.
5. Twisted-Pair Cable Testing Plan: Include list of cables to be tested, identification of tests to be

performed, pass/fail criteria, and copy of testing procedures (may be separate volume). Indicate Installer's required tests for warranty compliance.

3.2 SELECTION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Air-Handling Spaces:

1. Type CMP[**in listed plenum communications raceway**][**in listed cable routing assembly**].
2. Type CMR or Type CMP[**, Type CM, Type CMG, or Type CMX**] in metallic conduit installed in accordance with Rule 300.22 of NFPA 70.

B. Vertical Chases:

1. Type CMR.
2. Type CMP or Type CMR[**in listed plenum or riser communications raceway**][**in metallic conduit installed in accordance with Rule 300.22 of NFPA 70**].

3.3 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:

1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

   a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
   b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

2. Drawings indicate general arrangement of pathways and fittings.
3. Wiring Methods:

   a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

      1) Install plenum cable in environmental air spaces, including plenum ceilings.
      2) Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

   b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.

c. Within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

4. General Requirements for Cabling:

   a. Install 110-style IDC termination hardware unless otherwise indicated.
   b. Do not untwist twisted-pair cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
   c. Terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   d. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
   g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
   h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
   i. In the communications equipment room, install **10 ft (3 m)** long service loop on each end of cable.
   j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:

   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**5 ft (1.5 m)**]<**Insert dimension**> apart.
   c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

6. Installation of Cable Routed Exposed under Raised Floors:

   a. Install plenum-rated cable only.
   b. Install cabling after the flooring system has been installed in raised floor areas.
   c. Coil cable [**6 ft (1.8 m)**]<**Insert dimension**> long not less than [**12 inch (300 mm)**]<**Insert dimension**> in diameter below each feed point.

7. Group connecting hardware for cables into separate logical fields.
8. Separation from EMI Sources:

   a. Comply with BICSI N1 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
   b. Separate open communications cables or cables in nonmetallic raceways from unshielded power conductors and electrical equipment as follows:

      1) Power Rating Less Than 2 kVA: Minimum **5 inch (127 mm)**.
      2) Power Rating between 2 and 5 kVA: Minimum **12 inch (300 mm)**.
      3) Power Rating More Than 5 kVA: Minimum **24 inch (600 mm)**.

c. Separate communications cables in grounded metallic raceways from unshielded power lines or electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum **2-1/2 inch (64 mm)**.
2) Power Rating between 2 and 5 kVA: Minimum **6 inch (150 mm)**.
3) Power Rating More Than 5 kVA: Minimum **12 inch (300 mm)**.

d. Separate communications cables in grounded metallic raceways from power lines and electrical equipment located in grounded metallic conduits or enclosures as follows:

1) Power Rating Less Than 2 kVA: No minimum distance.
2) Power Rating between 2 and 5 kVA: Minimum **3 inch (76 mm)**.
3) Power Rating More Than 5 kVA: Minimum **6 inch (150 mm)**.

e. Separate communications cables from electrical motors and transformers rated 5 kVA or 5 HP and larger minimum **48 inch (1200 mm)**.
f. Separate communications cables from fluorescent luminaires minimum **5 inch (127 mm)**.

9. Identify system components, wiring, and cabling in accordance with TIA-606.

a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
b. Paint and label colors for equipment identification must comply with TIA-606 for [**Class 2**][**Class 3**][**Class 4**] level of administration[**, including optional identification requirements of this standard**].

10. Cable and Wire Identification:

a. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
2) Label each unit and field within distribution racks and frames.

e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

11. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
12. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets,[**backbone pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways,

and equipment grounding conductors.

13. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Entrance Facilities: Coordinate backbone cabling with Section 271100 "Communications Equipment Room Fittings" for cabinets, racks, and protectors and demarcation point provided by communications service provider.
2. Coordinate with Section 078413 "Penetration Firestopping" for sealing fire-rated penetrations.
3. Coordinate with Section 260533.16 "Boxes and Covers for Electrical Systems" for installation of outlet boxes and cover plates.
4. Coordinate with Section 270526 "Grounding and Bonding for Communications Systems" for grounding communications cabling and connectors.
5. Coordinate with Section 270528 "Pathways for Communications Systems" for installation of provisions for routing and terminating cable assemblies.
6. Coordinate with Section 270529 "Hangers and Supports for Communications Systems" for installation of cable supports.
7. Coordinate with Section 270536 "Cable Trays for Communications Systems" for installation of cable trays.
8. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

9. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Visually inspect jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test

equipment manufacturer for channel or link test configuration.

D. Nonconforming Work:

1. Cable assemblies will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective cable assemblies and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 13 13 00

Task	Specification	Specification Description
27 13 13 13	26 05 13 00	Medium-Voltage Cables
27 13 13 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 13 13 13	27 13 13 00	Communications Copper Backbone Cabling

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SECTION 27 13 23 00 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type OFNR optical fiber cable.
2. Type OFCR optical fiber cable.
3. Type OFNP optical fiber cable.
4. Type OFCP optical fiber cable.
5. Types OFN and OFNG optical fiber cable.
6. Types OFC and OFCG optical fiber cable.
7. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.

D. Type OFCR: Conductive cable for use as riser in vertical shafts or from floor to floor.

E. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

F. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.

G. Types OFC and OFCG: Conductive cable for general purpose use.

H. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Type OFNR optical fiber cable.
2. Type OFCR optical fiber cable.
3. Type OFNP optical fiber cable.

4. Type OFCP optical fiber cable.
5. Types OFN and OFNG optical fiber cable.
6. Types OFC and OFCG optical fiber cable.
7. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:

   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:

   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Cross-connects.
   f. Patch panels.
   g. Patch cords.

4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

E. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Patch-Panel Units: [**One**]<**Insert number**> of each type.
2. Plugs: [**10**]<**Insert number**> of each type.
3. Jacks: [**10**]<**Insert number**> of each type.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use [**optical fiber flashlight**][**or**][**optical loss test set**]<**Insert test instrument**>.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNR OPTICAL FIBER CABLE

A. Type OFNR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFNR, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**Prysmian Cables and Systems; Prysmian Group North America**]
   i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**Prysmian Cables and Systems; Prysmian Group North America**]
   i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Orange**]<**Insert color**>.

D. Type OFNR, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]

b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

E. Type OFNR, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.

F. Type OFNR, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Additional Characteristics:

   a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
   c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.

G. Type OFNR, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5**

dB/km]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

H. Type OFNR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

I. Type OFNR, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

J. Type OFNR, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]**<Insert dB/km>** at 1310 nm wavelength; [**0.5 dB/km**]**<Insert dB/km>** at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]**<Insert color>**.

2.2 TYPE OFCR OPTICAL FIBER CABLE

A. Type OFCR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

   a. Performance: TIA-568.3.
   b. Inside Plant Mechanical Properties: ICEA S-83-596.
   c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
   d. Jacket:

      1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
      2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFCR, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Type OFCR, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]

e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Orange**]<**Insert color**>.
   d. Armor: [**Steel**][**Aluminum**].

E. Type OFCR, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
   c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.
   d. Armor: [**Steel**][**Aluminum**].

F. Type OFCR, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
   c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

G. Type OFCR, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]<**Insert color**>.
   d. Armor: [**Steel**][**Aluminum**].

H. Type OFCR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

I. Type OFCR, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

J. Type OFCR, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low

water peak.

b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.3 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFNP, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**Prysmian Cables and Systems; Prysmian Group North America**]
   i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Orange**]<**Insert color**>.

D. Type OFNP, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**Berk-Tek, a Leviton Company**]
   d. [**CommScope, Inc**]
   e. [**Corning Optical Communications; Corning Incorporated**]
   f. [**General Cable; Prysmian Group North America**]
   g. [**Hitachi Cable America Inc.**]
   h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**Berk-Tek, a Leviton Company**]

d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

E. Type OFNP, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm

wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.

F. Type OFNP, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**TE Connectivity Ltd.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**TE Connectivity Ltd.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
   c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.

G. Type OFNP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]<**Insert color**>.

H. Type OFNP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Berk-Tek, a Leviton Company**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Mohawk; a division of Belden Networking, Inc.**]
   e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
    c. Jacket Color: [**Yellow**]<**Insert color**>.

I. Type OFNP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CommScope, Inc**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. [**General Cable; Prysmian Group North America**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CommScope, Inc**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. [**General Cable; Prysmian Group North America**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]

g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
   b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]<**Insert color**>.

J. Type OFNP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**CommScope, Inc**]
   d. [**General Cable; Prysmian Group North America**]
   e. [**Hitachi Cable America Inc.**]
   f. [**Mohawk; a division of Belden Networking, Inc.**]
   g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
   b. [**Belden Inc.**]
   c. [**CommScope, Inc**]
   d. [**General Cable; Prysmian Group North America**]
   e. [**Hitachi Cable America Inc.**]
   f. [**Mohawk; a division of Belden Networking, Inc.**]
   g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

2.4 TYPE OFCP OPTICAL FIBER CABLE

A. Type OFCP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFCP, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]

d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Type OFCP, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Orange**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

E. Type OFCP, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Aqua**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

F. Type OFCP, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]

b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

G. Type OFCP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
    c. Jacket Color: [**Yellow**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

H. Type OFCP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

I. Type OFCP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

J. Type OFCP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]

b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.5 TYPES OFN AND OFNG OPTICAL FIBER CABLE

A. Types OFN and OFNG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.

d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Types OFN and OFNG, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

D. Types OFN and OFNG, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corning Optical Communications; Corning Incorporated**]
b. [**General Cable; Prysmian Group North America**]
c. [**Mohawk; a division of Belden Networking, Inc.**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corning Optical Communications; Corning Incorporated**]
b. [**General Cable; Prysmian Group North America**]
c. [**Mohawk; a division of Belden Networking, Inc.**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

E. Types OFN and OFNG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Berk-Tek, a Leviton Company**]

b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]**<Insert dB/km>** at 1310 nm wavelength; [**0.5 dB/km**]**<Insert dB/km>** at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]**<Insert color>**.

F. Types OFN and OFNG, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.

b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

2.6 TYPES OFC AND OFCG OPTICAL FIBER CABLE

A. Types OFC and OFCG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Types OFC and OFCG, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**General Cable; Prysmian Group North America**]

d. [**Hitachi Cable America Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Types OFC and OFCG, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.

c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

E. Types OFC and OFCG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Berk-Tek, a Leviton Company**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Mohawk; a division of Belden Networking, Inc.**]
   e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Berk-Tek, a Leviton Company**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Mohawk; a division of Belden Networking, Inc.**]
   e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]<**Insert color**>.
   d. Armor: [**Steel**][**Aluminum**].

F. Types OFC and OFCG, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.7 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

C. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: [**One**]<**Insert number**> for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, dual-fiber cables in **36 inch (900 mm)** lengths.

F. Connector Type: [**Type SC complying with TIA-604-3,**][**Type ST complying with TIA-604-2,**][**Type LC complying with TIA-604-10,**][**Type MT-RJ complying with TIA-604-12,**][**Type MPO complying with TIA-604-5,**]<**Insert type**> connectors.

G. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.8 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate cables.

C. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

D. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. [**Type OFNR**][**or**][**Type OFNP**][**in listed plenum communications raceway**].
b. [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.

2. Conductive:

a. [**Type OFCR**][**or**][**Type OFCP**][**in listed plenum communications raceway**].
b. [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNP[**in listed plenum communications raceway**].
b. [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.

2. Conductive:

a. Type OFCP[**in listed plenum communications raceway**].
b. [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.
2. Conductive: [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

   a. Install plenum cable in environmental airspaces, including plenum ceilings.
   b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide **10 ft (3 m)** long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Installation of Cable Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable [**6 ft (1.8 m)**]<**Insert size**> long not less than [**12 inch (300 mm)**]<**Insert size**> in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607 and NECA/BICSI-607.

C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least **2 inch (50 mm)** clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification must comply with TIA-606 for [**Class 2**][**Class 3**][**Class 4**] level of administration[**including optional identification requirements of this standard**].

C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**backbone pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

G. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.

2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 27 13 23 00

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Task	Specification	Specification Description
27 13 23 13	27 13 23 00	Communications Optical Fiber Backbone Cabling

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SECTION 27 15 13 00 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 3 twisted pair cable.
2. Category 5e twisted pair cable.
3. Category 6 twisted pair cable.
4. Category 6a twisted pair cable.
5. Category 7 twisted pair cable.
6. Twisted pair cable hardware.
7. Multiuser telecommunications outlet assembly (MUTOA).
8. Cable management system.
9. Identification products.

B. Related Requirements:

1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately **100 sq. ft. (9.3 sq. m)**, and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is **295 feet (90 m)**. This maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Category 3 twisted pair cable.
2. Category 5e twisted pair cable.
3. Category 6 twisted pair cable.
4. Category 6a twisted pair cable.
5. Category 7 twisted pair cable.
6. Twisted pair cable hardware.
7. Multiuser telecommunications outlet assembly (MUTOA).
8. Cable management system.
9. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.

c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.
g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

E. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and cover plates for color selection and evaluation of technical features**].

F. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Cover Plates: [**One**]<**Insert number**> of each type.
3. Jacks: [**Ten**]<**Insert number**> of each type.

4. Multiuser Telecommunications Outlet Assemblies: [**One**]<**Insert number**> of each type.
5. Patch-Panel Units: [**One**]<**Insert number**> of each type.
6. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of [**Technician**][**Level 2 Installer**], who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685[**or Type CMP in listed plenum communications raceway**][**or Type CMP in listed cable routing assembly**].
b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. Type CMR complying with UL 1666[**and ICEA S-103-701**].
b. Type CMP or Type CMR in listed plenum or riser communications raceway.
c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**]<**Insert value**> or less.
2. Smoke-Developed Index: [**50**][**450**]<**Insert value**> or less.

C. RoHS compliant.

2.3 CATEGORY 3 TWISTED PAIR CABLE

A. Category 3 Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hitachi Cable America Inc.**]
2. [**Mohawk; a division of Belden Networking, Inc.**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hitachi Cable America Inc.**]
2. [**Mohawk; a division of Belden Networking, Inc.**]
3. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

2.4 CATEGORY 5e TWISTED PAIR CABLE

A. Category 5e Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

2.5 CATEGORY 6 TWISTED PAIR CABLE

A. Category 6 Twisted Pair Cable: Four-pair, balanced -twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

E. Conductors: 100-ohm, 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.6 CATEGORY 6a TWISTED PAIR CABLE

A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with TIA-568-C.2 for Category 6a cables.

E. Conductors: 100-ohm, 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.7 CATEGORY 7 TWISTED PAIR CABLE

A. Category 7 Twisted Pair Cable: Four-pair, balanced twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 7 cable at frequencies up to 600 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hitachi Cable America Inc.**]
2. [**Siemon Co. (The)**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hitachi Cable America Inc.**]
2. [**Siemon Co. (The)**]
3. <**Insert manufacturer's name**>

D. Standard: Comply with ISO 11801, Category F.

E. Conductors: 100-ohm, 22 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: Overall [**foil shield with foil shielded twisted pairs (F/FTP)**][**braided shield with foil shielded twisted pairs (S/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.8 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. **<Insert manufacturer's name>**

D. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**][**Category 6**][**Category 6a**][**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

E. Source Limitations: [**Obtain twisted pair cable hardware from single source from single manufacturer.**][**Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.**]

F. Connecting Blocks:

1. 110-style IDC for Category 5e.
2. 66-style IDC for Category 5e.
3. 110-style IDC for Category 6.
4. 110-style IDC for Category 6a.
5. Provide blocks for the number of cables terminated on the block, plus [**25**]**<Insert number>** percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**]**<Insert number>** for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on **19-inch (483 mm)** equipment racks.

3. Number of Jacks per Field: One for each four-pair [**cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in [**36-inch (900-mm)**][**48-inch (1200-mm)**]<**Insert length**> lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

L. Cover Plate:

1. [**Two**][**Four**][**Six**] port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. [**Eight**][**Ten**][**Twelve**] port, vertical double gang cover plates designed to mount to double gang wall boxes.
3. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
4. Metal Cover Plate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.9 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]
2. [**Chatsworth Products, Inc.**]
3. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

4. [**Molex Premise Networks**]
5. [**Ortronics, Inc.**]
6. [**Panduit Corp**]
7. [**Siemon Co. (The)**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**Chatsworth Products, Inc.**]
3. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Molex Premise Networks**]
5. [**Ortronics, Inc.**]
6. [**Panduit Corp**]
7. [**Siemon Co. (The)**]
8. <**Insert manufacturer's name**>

C. Description: MUTOAs shall meet the requirements of "Twisted Pair Cable Hardware" Article.

1. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.
2. Number of Connectors per Field:

   a. [**One**]<**Insert number**> for each four-pair unshielded or shielded twisted pair cable indicated.
   b. [**One**]<**Insert number**> for each four-pair unshielded or shielded twisted pair group of indicated cables, plus [**25**]<**Insert number**> percent spare positions.

3. Mounting: [**Recessed in ceiling**][**Wall**][**Desk**][**Furniture**].
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA-568-C.1.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.10 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database[**and graphic**] capabilities.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**iTRACS Corporation**]
2. [**Telsoft Solutions**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**iTRACS Corporation**]
2. [**Telsoft Solutions**]
3. <**Insert manufacturer's name**>

D. Document physical characteristics by recording the network, TIA details, and connections between

equipment and cable.

E. Information shall be presented in database view[**, schematic plans, or technical drawings**].

1. [**Microsoft Visio Professional**][**or**][**AutoCAD**] drawing software shall be used as drawing and schematic plans software.

F. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

D. Comply with Section 260536 "Cable Trays for Electrical Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted pair cables at least **49 feet (15 m)** from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (600 mm)**.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for [**Class 2**][**Class 3**][**Class 4**] level of administration[**, including optional identification requirements of this standard**].

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable

or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 27 15 13 00

Task	Specification	Specification Description
27 15 13 00	26 05 13 00	Medium-Voltage Cables
27 15 13 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 15 13 00	26 05 23 00	Control-Voltage Electrical Power Cables

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SECTION 27 15 23 00 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.3 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling is to contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
3. Bridged taps and splices are not to be installed in the horizontal cabling.

B. A work area is approximately **100 sq. ft. (9.3 sq. m)**, and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is **295 feet (90 m)**. This maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.
g. Mechanical, electrical, and plumbing systems.

C. Fiber optic cable testing plan.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.

E. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and faceplates for color selection and evaluation of technical features**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Jacks: [**Ten**]<**Insert number**> of each type.
3. Patch-Panel Units: [**One**]<**Insert number**> of each type.
4. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by an [**RCDD**][**Technician**].
2. Installation Supervision: Installation is to be under the direct supervision of [**Technician**][**Level 2 Installer**], who is to be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an [**RCDD**][**Technician**].

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use [**optical fiber flashlight**][**or**][**optical loss test set**]<**Insert test instrument**>.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each.

Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

1.12 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for [**two**]<**Insert number**> years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software is to include operating system. Upgrade is to include new or revised licenses for use of software.

1. Provide [**30**]<**Insert number**> days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]

2. [**Berk-Tek, a Leviton Company**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**Prysmian Cables and Systems; Prysmian Group North America**]
9. [**Superior Essex Inc.; subsidiary of LS Corp.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**Berk-Tek, a Leviton Company**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**Prysmian Cables and Systems; Prysmian Group North America**]
9. [**Superior Essex Inc.; subsidiary of LS Corp.**]
10. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Jacket:

1. Jacket Color: [**Orange**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color is to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**General Cable; Prysmian Group North America**]
7. [**Hitachi Cable America Inc.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**General Cable; Prysmian Group North America**]
7. [**Hitachi Cable America Inc.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Jacket:

1. Jacket Color: [**Orange**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

   a. Type OFCP[**or Type OFNP**], complying with NFPA 262.
   b. Type OFCP or Type OFNP in listed plenum communications raceway.
   c. Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.4 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**Hitachi Cable America Inc.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**Hitachi Cable America Inc.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.

3. Comply with TIA-492AAAC for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

I. Jacket:

1. Jacket Color: [**Aqua**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

J. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP[**or Type OFNP**], complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.5 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive,**]tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]
2. [**CommScope, Inc**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**Hitachi Cable America Inc.**]
5. [**Mohawk; a division of Belden Networking, Inc.**]

6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**CommScope, Inc**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**Hitachi Cable America Inc.**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

I. Jacket:

1. Jacket Color: [**Aqua**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

J. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

   a. Type OFCP, complying with NFPA 262.
   b. Type OFCP or Type OFNP in listed plenum communications raceway.
   c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.6 9/125 MICROMETER SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS1)

A. Description: Single mode, 9/125-micrometer, [**1**][**2**]<**Insert number**> fibers, tight buffered, [**nonconductive**][**conductive**] optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**General Cable; Prysmian Group North America**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**General Cable; Prysmian Group North America**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

D. Conductive cable is to be [**steel**][**aluminum**] armored type.

E. Maximum Attenuation: [**0.5**]<**Insert number**> dB/km at 1310 nm; [**0.5**]<**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [**Yellow**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

G. Standards:

1. Comply with TIA-492CAAA for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.

c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP, complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.7 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, [**1**][**2**]<**Insert number**> fibers, tight buffered, [**nonconductive**][**conductive**] optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Hitachi Cable America Inc.**]
6. [**Mohawk; a division of Belden Networking, Inc.**]
7. [**Superior Essex Inc.; subsidiary of LS Corp.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Hitachi Cable America Inc.**]
6. [**Mohawk; a division of Belden Networking, Inc.**]
7. [**Superior Essex Inc.; subsidiary of LS Corp.**]
8. <**Insert manufacturer's name**>

D. Conductive cable is to be [**steel**][**aluminum**] armored type.

E. Maximum Attenuation: [**0.5**]<**Insert number**> dB/km at 1310 nm; [**0.5**]<**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [**Yellow**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

G. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

   a. Type OFCP, complying with NFPA 262.
   b. Type OFCP or Type OFNP in listed plenum communications raceway.
   c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]

11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

C. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: [**One**]<**Insert number**> for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, single-fiber cables in **36-inch (900-mm)** lengths.

F. Connector Type: [**Type SC complying with TIA-604-3-B,**][**Type ST complying with TIA-604-2-B,**][**Type LC complying with TIA-604-10-B,**][**Type MT-RJ complying with TIA-604-12,**][**Type MPO complying with TIA-604-5-D,**]<**Insert type**> connectors.

G. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

I. Faceplate:

1. [**Two**][**Four**][**Six**] -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**][**Ten**][**Twelve**] -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.9 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
9. In the communications equipment room, provide a **10-foot- (3-m-)** long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment

grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification are to comply with TIA-606-B for [**Class 2**][**Class 3**][**Class 4**] level of administration[**including optional identification requirements of this standard**].

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**horizontal pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments are to meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for horizontal links are to be less than 2.0 dB. Attenuation test results are to be less than those calculated according to equation in TIA-568-C.1.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 27 15 23 00

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SECTION 27 15 33 00 - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

1.3 COAXIAL HORIZONTAL CABLING DESCRIPTION

A. Coaxial horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

B. Product Data Submittals: For each product.

1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

C. Shop Drawings:

1. System Labeling Schedule:

   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration drawings and printouts.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and faceplates for color selection and evaluation of technical features**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Jacks: [**Ten**]<**Insert number**> of each type.
3. Patch-Panel Units: [**One**]<**Insert number**> of each type.
4. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by an [**RCDD**][**Technician**].
2. Installation Supervision: Installation is to be under the direct supervision of [**Technician**][**Level 2 Installer**], who is to be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each coaxial cable [**on the reel**] for continuity.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated, Type CMP: Complying with UL 1685[**or Type CMP in listed plenum communications raceway**][**or Type CMP in listed cable routing assembly**].
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed in accordance with NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. CATV Plenum Rated: Type CATVP [**installed in riser raceways or cable routing assemblies**], complying with NFPA 262.
2. CATV Cable: Type CATV[**, or CATVP or CATVR**][**installed in general purpose, riser, or plenum communications raceways or cable routing assemblies**] in fireproof riser shafts with firestops at each penetration.

2.3 COMMUNICATIONS COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:

1. RG-6/U: UL Type [**CMP**][**and**][**CL2P**].

   a. No. [**16**][**18**]<**Insert size**> AWG, solid, copper-covered steel conductor.
   b. Plenum rated.
   c. Gas-injected, foam-PE insulation.
   d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
   e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
   f. Jacketed with [**black**][**white**] PVC or PE.
   g. Suitable for indoor installations.

2. RG-11/U: UL Type [**CMP**][**and**][**CL2P**].

   a. No. [**14**]<**Insert size**> AWG, solid, copper-covered steel conductor.
   b. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from

minus 40 to plus 85 deg F (minus 40 to plus 30 deg C).

c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with sunlight-resistant, [**black**][**white**] PVC or PE.

3. RG-59/U: UL Type [**CMP**][**and**][**CL2P**].

a. No. [**20**]<**Insert size**> AWG, solid copper conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Single shielded with 100 percent aluminum shield and 40 percent aluminum braid.
e. PVC jacket.

2.4 CATV COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. RG-6/U: UL Type CATVP.

a. No. 18 AWG, solid, copper-covered steel conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with [**black**][**white**] PVC or PE.
g. Suitable for indoor installations.

2.5 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

D. Coaxial-Cable Connectors: Type BNC, 75 ohms.

E. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

F. Patch Cords: Factory-made cables in [**36-inch (900-mm)**][**48-inch (1200-mm)**]<**Insert length**>lengths; terminated with a male Type BNC connector at each end.

G. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.

   a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.

4. Legend:

   a. Factory labeled by silk-screening or engraving [**for**][**stainless steel**][**brass**]<**Insert description**>[**faceplates**].
   b. Machine printed, in the field, using adhesive-tape label.
   c. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Comply with Section 271100 "Communications Equipment Room Fittings." Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.

B. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits [**3 inches (76 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF COAXIAL HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
2. Terminate all conductors; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
8. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend coaxial cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (610 mm)**.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260529 "Hangers and Supports for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**horizontal pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communications cabling, use a different color for jacks and plugs of each service.

E. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 27 15 33 00

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Task	Specification	Specification Description
27 15 33 00	26 05 13 00	Medium-Voltage Cables
27 15 33 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 15 33 00	26 05 23 00	Control-Voltage Electrical Power Cables
27 15 53 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 16 16 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 16 19 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 16 19 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 21 16 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 32 13 00	26 27 26 00	Wiring Devices

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SECTION 27 41 33 00 - MASTER ANTENNA TELEVISION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. MATV equipment.
2. Off-air antennas.
3. MATV headend components.
4. Distribution components.

B. Related Sections:

1. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
2. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
3. Section 271333 "Communications Coaxial Backbone Cabling" for riser-rated coaxial data cabling associated with system panels and devices.
4. Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted-pair optical-fiber cables and connectors.
5. Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical-fiber cables and connectors.
6. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial cables and connectors.
7. Section 282000 "Video Surveillance" for cameras, monitors, computers, and cabling for video surveillance systems.

1.2 DEFINITIONS

A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.

B. A/V: Audio/visual.

C. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.

D. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.

E. CATV: Community antenna television. A communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.

F. CCTV: Closed-circuit television.

G. CEA: Consumer Electronics Association.

H. db mV: Decibels relative to 1 mV across 75 ohms. db mV = 20 log 10(V(1)/V(2), where V(1) is the

measurement of voltage at a point having identical impedance to V(2) (0.001 V across 75 ohms).

I. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."

J. I/O: Input/output.

K. MATV: Master antenna television. A small television antenna distribution system usually restricted to one or two buildings.

L. RF: Radio frequency.

M. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the [**terminal blocks to which the end user may connect coaxial cabling**][**75-ohm terminals on device plates**]<**Define user-interface points**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. MATV equipment.
2. Off-air antennas.
3. MATV headend components.
4. Distribution components.

B. Shop Drawings: For headend and distribution system. Include plans, elevations, sections, details, and attachments to other work.

1. Detail fabrication and installation details for television equipment.
2. Functional Block Diagram: Show single-line interconnections between components for headend and distribution system to user-interface points. Show cable types and sizes.
3. Dimensioned Plan and Elevations of Headend Equipment: Show access and workspace requirements.
4. Wiring Diagrams: For power, signal, and control wiring. Balanced twisted-pair or optical-fiber cable include cross connects, patch panels, and patch cords.

C. Samples: Full size for each outlet device plate in required colors and textures.

D. Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to headend input points for each antenna, satellite dish, and CATV grouping. Allowable losses between components and user interface shall be used to determine size and type of coaxial cable.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements.

B. Equipment List: Include each piece of equipment and include model number, manufacturer, serial number, location, and date of original installation. Insert testing record of each piece of adjustable

equipment, listing name of person testing, date of test, and description of as-left set points.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For headend and distribution system to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide no fewer than one of each item listed below. Deliver extra materials to Owner.

1. Fuses: One for every [**10**]<**Insert number**> of each type and rating.
2. Splitters: One for every [**10**]<**Insert number**> installed.
3. MATV Distribution Power Amplifiers: One for every [**10**]<**Insert number**> of each type installed.
4. MATV Signal Traps: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type used.
5. MATV Attenuators: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type used.
6. Cable: **100 feet (30 m)** of each type used.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: System components shall be equipped and rated for the environments in which they are installed.

B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components, except central-station control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments shall be rated for continuous operation in ambient conditions of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Interior, Uncontrolled Environment: System components installed in non-[**air-conditioned**][**temperature-controlled**] interior environments shall be rated for continuous operation in ambient conditions of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to [**85 mph (137 km/h)**]<**Insert wind speed**>[**and snow cover up to 24 inches (610 mm) thick**].

1.8 COORDINATION

A. Coordinate size and location of raceway system and provisions for electrical power to equipment specified in this Section.

B. Coordinate Work of this Section with requirements of [**cable television service**][**direct broadcast**

satellite service][**an off-air antenna system**][**CCTV cameras and video recorders**] service provider.

C. Coordinate sizes and locations of concrete bases with actual equipment provided.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. System shall consist of [**cable television service**][**direct broadcast satellite service**][**an off-air antenna system**][**CCTV cameras and video recorders**] and a coaxial cable distribution system.

1. Headend equipment shall consist of receiving antennas, satellites, and associated signal distribution amplification and equalization.
2. Distribution of direct broadcast satellite-service signals, which includes coordinating with Owner's selected service provider for installation of its dish-type antennas and processing the signals as needed to provide specified services combined into a single-feed point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
3. Distribution of cable television service signals, which includes coordinating with Owner's selected service provider for installation of cable to the service point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
4. Cable distribution system consisting of coaxial cables, user interfaces, signal taps and splitters, RF amplifiers, signal equalizers, power supplies, and required hardware, complying with EIA/ECA 310-E and CTA-2032-B and resulting in performance parameters specified in this Section. System shall be capable of distributing television channels according to CTA-542-D.

B. Hardware Requirements: Use plug-in, modular, solid-state electronic components. Mount amplifiers and other powered equipment in standard **19-inch (483-mm)** cabinet complying with EIA/ECA 310-E.

C. Off-Air Stations: Install antennas for the reception and distribution of selected stations.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum acceptable performance of distribution system at all user-interface points shall be as follows:

1. RF Video-Carrier Level: Between 3 and 12 db mV.
2. Relative Video-Carrier Level: Within 3 db to adjacent channel.
3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 db during a 60-minute period.
4. Carrier Level Stability, Long Term: Level shall not change more than 2 db during a 24-hour period.
5. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz frequency range, referenced to video; signal amplitude shall be plus or minus 1 db, maximum.
6. Carrier-to-Noise Ratio: 45 db or more.
7. RF Visual Signal-to-Noise Ratio: 43 db or more.
8. Antenna Combiner Insertion Loss: 40 db maximum.
9. Signal Power Splitter and Isolation Tap Return Loss: 17 db maximum.
10. Cable Connectors Attenuation: Less than 0.1 db.

11. Cross Modulation: Less than minus 50 db.
12. Carrier-to-Echo Ratio: More than 40 db.
13. Composite Triple Beat: Less than minus 53 db.
14. Second Order Beat: Less than minus 60 db.
15. Terminal Isolation from Television to Television: 25 db, minimum.
16. Terminal Isolation between Television and FM: 35 db, minimum.
17. Hum Modulation: 2 percent, maximum.
18. RF FM Carrier Level: 13 to 17 db below video-carrier level.
19. FM Frequency Response: More than in the 88- to 108-MHz frequency range; signal amplitude is plus or minus 0.75 db, maximum.
20. FM Carrier-to-Noise Ratio: More than 24 db.

2.3 SYSTEM REQUIREMENTS

A. Components: Plug-in, modular, heavy-duty, industrial- or commercial-grade units.

B. Equipment: Silicon-based, solid-state, integrated circuit devices.

C. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.

D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

E. Provide ac-powered equipment with integral surge protection devices complying with UL 1449.

F. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 MATV EQUIPMENT

A. Description: Signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring. System shall receive, amplify, process, and distribute signals to outlets for receiving sets. Equipment shall translate UHF channels to VHF channels before distribution to outlets.

B. Identification of Signal Sources Distributed:

1. <**Insert signal sources and basic service selection**>.

C. MATV System Qualitative and Quantitative Performance Requirements: Reception quality of color-television program transmissions at each system outlet from each service and source shall be equal to or superior than that obtained with performance checks specified in "Field Quality Control" Article, using standard, commercial, cable-ready, multiple A/V input color-television receivers.

2.5 OFF-AIR ANTENNAS

A. Antennas shall be tested, marked, and packaged, according to CTA-774-A, CEA-2028-B, and CEA-2032-B. Antennas shall be labeled according to CEA antenna mapping program.

B. Off-Air, Mast-Mounted Antennas: Weatherproof single-channel or broadband type, constructed of high-strength anodized aluminum and rated to survive in a [**100-mph (160-km/h)**]<**Insert speed**> wind, minimum.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Channel Master**]
   b. [**Winegard Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Channel Master**]
   b. [**Winegard Company**]
   c. <**Insert manufacturer's name**>

3. Elements: Internally dampened against mechanical vibration that may occur in service.
4. Ends of Crossarms and Elements: Sealed.
5. Mounting and Connecting Hardware: Corrosion proof.
6. Frequency Range: Matched to source frequencies.
7. CEA Reception Patterns: <**Insert reception pattern and number of antennas**>.
8. FM Antenna: Separate from the broadband antenna and the [**omnidirectional**][**directional**] antenna, with 2-db minimum gain.

C. Antenna-Supporting Structures: Prefabricated, hot-dip galvanized-steel units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Channel Master**]
   b. [**Winegard Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Channel Master**]
   b. [**Winegard Company**]
   c. <**Insert manufacturer's name**>

3. Strength of Structure and Attachments: Adequate to withstand [**100-mph (160-km/h)**]<**Insert speed**> winds while supporting installed antennas.

4. Comply with 47 CFR 17 and TIA 222-G.
5. Comply with FAA AC 70/7460-1L.

2.6 MATV HEADEND COMPONENTS

A. Headend Equipment:

1. Components:

a. Channel mixers.
b. Processors.
c. Broadband amplifier.
d. Single-channel amplifiers.
e. FM module.
f. Combining networks.

2. Description: For receiving off-air television and FM signals and outputting the signals to cable distribution system. Equip coaxial down-leads of the off-air antennas with preamplifiers to send signals at strength required by headend. Headend component performance specified in this article is minimum acceptable; better performance may be required to comply with minimum acceptable system performance standard in "Performance Requirements" Article.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Cisco Systems, Inc.**]
e. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Cisco Systems, Inc.**]
e. <**Insert manufacturer's name**>

5. House units in standard **19-inch (483-mm)** electronic equipment cabinet complying with EIA/ECA 310-E.

B. Antenna Combiner: Directional coupler design network, combining up to eight antenna signals into a single output. Frequency response of the device shall be 5 to 400 MHz, and the insertion loss between input ports shall be not less than 40 db.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATX Networks Inc.**]

b. [**Blonder Tongue Laboratories, Inc**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. **<Insert manufacturer's name>**

C. Down-Lead Preamplifiers: Antenna mast-mounted preamplifier, designed to boost antenna signal and contained in weatherproof housing; single-channel or broadband type. Install power supplies indoors at headend equipment, connected through power inserters to provide power to preamplifiers through the coaxial down-lead cable.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Channel Master**]
e. [**Leviton Manufacturing Co., Inc.**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Channel Master**]
e. [**Leviton Manufacturing Co., Inc.**]
f. **<Insert manufacturer's name>**

3. Frequency Response: Plus or minus 0.75 db.
4. Minimum Input: Minus 20 db mV.
5. Return Loss: 14 db.
6. I/O Impedance: 75 ohms.

D. Channel Mixers: Use for nonadjacent channels only.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ATX Networks Inc.**]
   b. [**Blonder Tongue Laboratories, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. <**Insert manufacturer's name**>

3. Insertion Loss (Maximum 54 to 216 MHz): 2.5 db.
4. Return Loss: 14 db.
5. Out-of-Band Rejection: 12 db.
6. I/O Impedance: 75 ohms.

E. Processors: One for each channel to be translated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Blonder Tongue Laboratories, Inc**]
   d. [**Cisco Systems, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Blonder Tongue Laboratories, Inc**]
   d. [**Cisco Systems, Inc.**]
   e. <**Insert manufacturer's name**>

3. Bandwidth: 6 MHz.
4. Return Loss: 16 db, within the 6-MHz bandwidth.
5. Noise: Not more than 10 db at maximum gain.
6. Input Level Range, VHF: Minus 20 to plus 30 db mV.
7. Input Level Range, UHF: Minus 20 to plus 25 db mV.
8. Output Level Range: 50 to 60 db mV.
9. Carrier-to-Noise Ratio: Minus 57 db at plus 10-db mV input.
10. Automatic Gain Control: Plus or minus 1-db output variation for rated input level range variation.
11. Frequency Stability: Plus or minus 10 kHz over the operational temperature range.
12. Spurious Output: 60 db below the video carrier with video-carrier output level at plus 60 db mV and audio-carrier level at plus 45 db mV.
13. Adjacent Channel Rejection: Not less than 60 db.
14. I/O Impedance: 75 ohms.

F. Broadband Amplifier:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. <**Insert manufacturer's name**>

3. Frequency Range: [**54 to 108, 174 to 220**][**54 to 220**] MHz.
4. Frequency Response: Plus or minus 1.0 db across passband.
5. Maximum Noise: 10 db.
6. Minimum Return Loss: 16 db.
7. I/O Impedance: 75 ohms.

G. Single-Channel Amplifiers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Cisco Systems, Inc.**]
d. [**Leviton Manufacturing Co., Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Cisco Systems, Inc.**]
d. [**Leviton Manufacturing Co., Inc.**]
e. <**Insert manufacturer's name**>

3. Frequency: 6 MHz for specified channel.
4. Frequency Response: Plus or minus 0.5 db.
5. Maximum Noise: 10 db.
6. Minimum Return Loss: 14 db.
7. Automatic Gain Control: Plus or minus 1-db output variation for rated input level range variation.
8. Skirt Rejection: Minus 26 db at plus or minus 5 MHz from channel center.
9. Sound Trap: Adjustable to 10 Vdb of attenuation of the sound carrier.
10. I/O Impedance: 75 ohms.

H. FM Module: One RF processor module for each station listed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ATX Networks Inc.**]
    b. [**Blonder Tongue Laboratories, Inc**]
    c. [**Cisco Systems, Inc.**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ATX Networks Inc.**]
    b. [**Blonder Tongue Laboratories, Inc**]
    c. [**Cisco Systems, Inc.**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. <**Insert manufacturer's name**>

3. Frequency Range: Between 88 and 108 MHz.
4. Output Level: 52 db mV.
5. Output Level Control: Plus or minus 10 db.
6. Stability: 0.005 percent, crystal controlled.
7. Sensitivity: 3 mV for 30-db quieting.
8. Input Level: 60 mV, stereo.
9. Image Rejection: 901 db.
10. Passband: 200 kHz.
11. Selectivity: Plus or minus 150 kHz or less, at 30 db down. Plus or minus 250 kHz or less, at 50 db down.

I. Combining Network (Mixer): Combines the off-air television [**FM**][**CCTV**][**and**][**CATV**] signals into a single-broadband output. An output test point, a 75-ohm television jack, a mixer output step attenuator dual-pilot insertion network, and a removable mixer-to-trunk jumper are included.

1. Passband: As required by system performance.
2. Distortion:

    a. Not more than plus or minus 0.1 db over any 6-MHz segment.
    b. Not more than plus or minus 0.5 db over the 54- to 216-MHz frequency range.

3. Nominal Insertion Loss:

    a. 15 db maximum, channel input to single-system output.
    b. 13 db maximum, channel input to mixer output.
    c. 20 db maximum at test point (e.g., loss from trunk output).

4. Isolation between Any Two Inputs: 30 db.
5. I/O Impedance: 70 ohms.

2.7 DISTRIBUTION COMPONENTS

A. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughput

capacity shall exceed load by at least 25 percent.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATX Networks Inc.**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ATX Networks Inc.**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. <**Insert manufacturer's name**>

3. Return Loss: 17 db.
4. RFI Shielding: 100 db.
5. Isolation: 25 db.
6. I/O Impedance: 75 ohms.

B. Distribution System Amplifiers: Powered by coaxial cable system and equipped with surge protection device and external test points to allow convenient signal monitoring.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. <**Insert manufacturer's name**>

C. Cable System Power Supplies: Plug-in, modular construction, with surge, short-circuit, and overload protection.

D. Signal Traps: Packaged filters tuned to interference frequencies encountered in Project.

E. Attenuators: Passive, of fixed value, and used to balance signal levels.

F. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

G. Jack: Flush, female-type outlets, designed to mimic power duplex outlet; for mounting in standard outlet box; with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semirecessed, so its protrusion is flush with the plane of device plate.[**Feed-through-type cable connection shall not be used**][**, except in area housing a single tenant**][**, except within a single-dwelling unit**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Canare Corporation of America**]
   d. [**Cisco Systems, Inc.**]
   e. [**Leviton Manufacturing Co., Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Canare Corporation of America**]
   d. [**Cisco Systems, Inc.**]
   e. [**Leviton Manufacturing Co., Inc.**]
   f. <**Insert manufacturer's name**>

3. Cable Connector: Female, Type F.
4. Wall Plates: Match materials and finish of power outlets in same space.
5. Attenuation: Less than 0.1 db.
6. Voltage Standing-Wave Ratio: Less than 1.15 to 1.

2.8 ENCLOSURES

A. Enclosures for Interior, Controlled Environments: NEMA 250, Type 1.

B. Enclosures for Interior, Uncontrolled Environments: NEMA 250, [**Type 3R**][**Type 4**][**Type 12**][**Type 12K**].

C. Enclosures for Exterior Environments: NEMA 250, [**Type 3**][**Type 3R**][**Type 3S**][**Type 4**][**Type 4X**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for antenna to verify actual locations of cable connections before antenna installation.

B. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install signal line surge suppressors on coaxial cables entering headend equipment space and at antenna-mounted amplifiers. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

B. Install antenna towers, masts, and mountings on concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 INSTALLATION OF ANTENNA AND HEADEND COMPONENTS

A. Mount headend equipment in electronic equipment cabinets recommended by manufacturer. Group related items in methodical sequence.

B. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space. Parts that require periodic service or maintenance shall be readily accessible. Headend components that require tuning adjustments shall be accessible from the front of equipment cabinets.

C. Align antenna elements to achieve maximum signal level and quality.

D. Antenna-Supporting Structure: Increase antenna height as required to obtain signal strength needed for specified system performance.

1. Attachment to Building:

a. Use **0.375-inch- (10-mm-)** minimum expansion anchors for masonry, and place anchors clear of grout or mortar joints.
b. Use **0.375-inch- (10-mm-)** minimum lag bolts for attachment to wood.

2. Lightning Protection: Comply with requirements in Section 264113 "Lightning Protection for Structures."

E. Antenna Cable Entrance: Use weatherproof entrance fittings, and seal at penetrations of the building envelope.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
2. Replace malfunctioning or damaged items.
3. Retest until satisfactory performance and conditions are achieved.
4. Prepare television equipment for acceptance and operational testing.
5. Use an agile receiver and signal strength meter or spectrum analyzer for testing.
6. Off-Air, Mast-Mounted Antenna Sources: Connect receiver to the down-lead of a 10-element, single-channel antenna, tuned and oriented to optimize reception for the channel and placed at system antenna's location. Alternatively, connect receiver to a single-channel video amplifier connected to the down-lead of the above single-channel antenna.
7. CATV Sources: Connect receiver to an agile demodulator or CATV set-top converter at CATV service entrance to the facility.
8. Satellite Earth-Station System Sources: Adapt receiver to the output of satellite-television receiver.
9. CCTV Sources: Connect receiver to the output of each CCTV signal source or the distribution amplifier associated with it.
10. Test Schedule: Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
11. Operational Tests: Perform tests of operational system to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
12. Distribution System Acceptance Tests:

    a. Field-Strength Instrument: Rated for minus 40-db mV measuring sensitivity and a frequency range of 54 to 812 MHz, minimum. Provide documentation of recent calibration against recognized standards.
    b. Signal Level and Picture Quality: Use a field-strength meter or spectrum analyzer, and a standard television receiver to measure signal levels and check picture quality at [**all**][**25 percent of**]<**Insert number or percentage**> user-interface outlets.

        1) Test the signal strength in db mV at 55[**, 151, 547,**] and 750 MHz.
        2) Minimum acceptable signal level is 0 db mV (1000 mV).
        3) Maximum acceptable signal level over the entire bandwidth is 15 db mV.
        4) Television receiver shall show no evidence of cross-channel intermodulation, ghost images, or beat interference.

13. Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn, and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 db.
14. Qualitative and Quantitative Performance Tests: Demonstrate reception quality of color-television program transmissions at each user interface from each designated channel and source. Quality shall be equal to or superior than that obtained with performance checks specified below, using a standard, commercial, cable-ready, color-television receiver. Level and quality of signal at each outlet and from each service and source shall comply with the following Specifications when tested according to 47 CFR 76:

    a. RF video-carrier level.
    b. Relative video-carrier level.
    c. Carrier level stability, during 60-minute and 24-hour periods.

d. Broadband frequency response.
e. Channel frequency response.
f. Carrier-to-noise ratio.
g. RF visual signal-to-noise ratio.
h. Antenna combiner insertion loss.
i. Signal power splitter loss.
j. Cable connector attenuation.
k. Cross modulation.
l. Carrier-to-echo ratio.
m. Composite triple beat.
n. Second order beat.
o. Terminal isolation.
p. Terminal isolation between television and FM.
q. Hum modulation.
r. RF FM carrier level.
s. FM frequency response.
t. FM carrier-to-noise ratio.

C. Headend and distribution system will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Cap all unused connectors and seal weathertight.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain MATV equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Demonstrate programming and tuning of satellite receivers.

END OF SECTION 27 41 33 00

Task	Specification	Specification Description
27 51 43 00	26 33 43 00a	Public Address Systems

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SECTION 27 52 23 00 - NURSE CALL CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Visual/tone nurse-call system.
2. Audiovisual/voice nurse-call system.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Visual/tone nurse-call system.
2. Audiovisual/voice nurse-call system.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
3. Station Installation Details: For built-in equipment, dimensioned and to scale.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: All colors for corridor dome lights and zone lights equal to [**20**]<**Insert number**> percent of amount installed.
2. Fuses: One for every 10 of each type and rating, but no fewer than <**Insert quantity**> of each.
3. Printed Circuit Boards: Each kind, equal to [**10**]<**Insert number**> percent of amount installed, but

no fewer than one unit.
4. Master-Station Privacy Handset: [**One**]<**Insert number**>.
5. System program backup software.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.

C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Nickel-Cadmium Batteries, Lithium Batteries, and Wet-Cell Batteries:

1) Full Warranty: [**Five**]<**Insert number**> years.
2) Pro Rata: [**15**]<**Insert number**> years.

1.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for [**two**]<**Insert number**> years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide [**30**]<**Insert number**> days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 NURSE-CALL SYSTEM GENERAL REQUIREMENTS

A. Station Zones: Able to program [**256**]<**Insert number**> station zones for each master station in the network with [**eight**]<**Insert number**> priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.

B. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.

C. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by [**25**]<**Insert number**> percent above those indicated without adding internal or external components or main trunk cable conductors.

D. Existing System Compatibility: Functionally and electrically compatible with existing system so components and wiring operate as an extension or upgrade of the existing system and existing or upgraded functional performance of the existing system applies to the entire final system. Colors, tones, types, and durations of signal manifestation shall be common among new and existing systems.

E. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

F. Equipment: Microprocessor, electronic, modular.

G. Master Nurse-Call Station: Programmed via a PC.

H. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

I. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.

J. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

2.2 VISUAL/TONE NURSE-CALL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**Cornell Communications, Inc**]
5. [**Intego Systems, Inc.**]
6. [**Intercall Systems, Inc**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Rauland-Borg Corporation**]
9. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
10. [**TekTone Sound & Signal Mfg., Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**Cornell Communications, Inc**]

5. [**Intego Systems, Inc.**]
6. [**Intercall Systems, Inc**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Rauland-Borg Corporation**]
9. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
10. [**TekTone Sound & Signal Mfg., Inc.**]
11. **<Insert manufacturer's name>**

C. Operational Requirements:

1. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
2. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
3. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be extinguished and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
4. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
5. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
6. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
7. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master station; and sounds programmed tone on master station display equipped phones and pocket pagers.
8. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.
9. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.

D. Central Annunciator:

1. Lamp type.
2. Lamp Legends: Machine lettered and legible from a distance of at least **48 inches (1200 mm)** when a call is present. Legend shall identify initiating station and priority of call.
3. Power-on Indicator: Digital, or push-to-test switch.
4. Audible Signal: Electronic tone.

E. Central Equipment Cabinet:

1. Lockable metal.
2. Houses power supplies, controls, terminal strips, and other components.
3. Power-on indicator lamp.
4. Battery Backup Unit: Sealed [**nickel-cadmium, wet-cell**]<**Insert type**> battery supplies power through an automatic switch when normal power fails, for a period of not less than [**six**]<**Insert number**> minutes at rated output. System shall lose no unanswered calls or calls in progress during the transfer operation.

    a. Automatic retransfer to normal power, after a [**15**]<**Insert number**>-minute time delay.
    b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

F. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.

G. Dual-Patient Station: Single call-placed lamp, single reset push button, and two polarized receptacles matching cord-set plug; mounted in a single faceplate.

H. Ambulatory-Patient Station: Call push-button switch, call-placed lamp, and reset push button; mounted in a single faceplate.

I. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.

2.3 AUDIOVISUAL/VOICE NURSE-CALL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**BEST HEALTHCARE COMMUNICATIONS**]
5. [**Cornell Communications, Inc**]
6. [**Intego Systems, Inc.**]
7. [**Intercall Systems, Inc**]
8. [**Jeron Electronic Systems, Inc**]
9. [**Rauland-Borg Corporation**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**TekTone Sound & Signal Mfg., Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**BEST HEALTHCARE COMMUNICATIONS**]
5. [**Cornell Communications, Inc**]
6. [**Intego Systems, Inc.**]
7. [**Intercall Systems, Inc**]
8. [**Jeron Electronic Systems, Inc**]
9. [**Rauland-Borg Corporation**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]

11. [**TekTone Sound & Signal Mfg., Inc.**]
12. **<Insert manufacturer's name>**

C. Operational Requirements:

1. Station Selection from Master Station: Capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click, or manual switch; and capable of programming up to [**256**]**<Insert number>** stations for each master station in the network.
2. Master Station Privacy: Capable of conversing with individual stations in complete privacy.
3. Called Station:

    a. Capable of hands-free and two-way conversation.
    b. Pressing "talk/listen" key shall cause the annunciation tone to cease.
    c. Pressing "cancel" key terminates normal calls and conversations.
    d. Terminating of high-priority level [**1**][**2**][**3**][**or**][**4**] shall not be allowed except at calling station location and shall send "remind" message if the call is not acknowledged at point of origin in programmed time frame.

4. Annunciation:

    a. At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.
    b. Call type indications include alarm assist, bath, bed, code, communication fault, cord out, door, emergency, and fire.
    c. Memory lamps or lighted displays identify stations selected for outgoing calls.

5. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.
6. Patient Station Calls:

    a. Lights the call-placed lamp at patient station, zone, and corridor dome lights.
    b. Sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station.
    c. When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice.
    d. During voice communications, entertainment audio at the calling station is automatically muted.

7. Pull-Cord-Call Station Calls and Emergency-Call Station Calls:

    a. Lights call-placed lamp and corridor dome light and flashes zone light.
    b. Master station tone pulses and annunciator light for that room flashes.
    c. When master station acknowledges the call by touch screen or switch, the tone stops but lights continue to flash until the call is canceled at the initiating point.

8. Code Blue and Staff/Duty Station Calls:

    a. Lights the call-placed lamp at the station and actuates annunciation at the master station.
    b. When the called station is selected at the master station, the caller and the master station operator can converse.
    c. Code Blue: Unique sound and light pattern indicating the highest priority emergency.
    d. Staff Station: Unique sound and light pattern indicating an emergency.
    e. Duty Station: Sound and light pattern indicating a call to the nurse station.

9. Handset Operation: Lifting the handset on master station disconnects speaker/microphone and transfers conversation to the handset.
10. Station Privacy: No patient or staff/duty station can be remotely monitored without lighting a warning lamp at the monitored station.
11. Patient Station Cord-Set Removal:

    a. A patient station call is initiated as described above when a patient station cord-set plug is removed from the jack in the station faceplate.
    b. Tone stops but lights continue to flash until the call is canceled at the initiating point or the plug is reinserted or replaced with a dummy plug when the master station call button for the station is pressed.

12. Patient Control Unit:

    a. Controls entertainment volume and channel selection.
    b. Speaker is used for both nurse communication and entertainment sound.
    c. Entertainment sound is automatically muted when station is communicating with master station.
    d. Nurse button on the unit initiates a patient station call.

13. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.
14. Staff Reminder:

    a. Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station.
    b. This reminder will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights.
    c. Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.

15. Call Priority Indication:

    a. Capable of [**eight**]<**Insert number**> call priority levels in addition to normal.
    b. Call priority switch near each patient station, or integral with the master station, shall control priority status of the call transmitted by individual stations.
    c. Switch selects one of the following status levels:

        1) Normal: No change to the normal call initiation and canceling sequence.
        2) Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.
        3) Priority: System response is the same for emergency status except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.

16. Additional Call:

    a. Waiting display window on the master station similar to current call window displays incoming calls.
    b. Master station shall have a call-overflow indicator when incoming calls exceed <**Insert number**> calls.
    c. System shall store unlimited number of incoming calls.
    d. System shall be capable of automatically answering incoming calls in order of priority.

17. Calling Intercom Stations:

a. Master station shall be capable of calling any intercom station using the handset or the hands-free speaker/microphone.
b. Receipt of a call at the intercom station shall be preceded by an optional pre-announce tone.
c. If there is a call in process, system shall place the active call on automatic hold while the new call is placed, then reestablish the previous call when the new call has ended.

18. Privacy Override:

a. Temporarily deactivates the "Privacy" mode of a called station by calling the station and instructing the called party to press the call-cord button.
b. On completion of the conversation, the called station shall automatically return to the "Privacy" mode.
c. When in "Privacy" mode, a called station shall be capable of hearing the master station; however, the master station shall not be capable of hearing the called station; a privacy message shall be indicated on the master station display.

19. Master-Station-to-Master-Station Calls:

a. Master stations shall be capable of calling other master stations using the handset.
b. Calls from master stations shall be answered using the handset only.
c. Busy master stations shall be indicated by a master station intercom busy tone.

20. Voice Paging:

a. Capable of voice paging to all stations using a single "All Call" key.[**The page shall be preceded by an optional pre-announce tone.**]
b. Capable of voice paging to eight user-defined groups of stations by selecting the group and then the "All Call" key.[**The page shall be proceeded by a pre-announce tone.**]
c. Capable of voice paging to all staff/duty stations and all patient stations where staff has registered presence using a single "Public Address (PA)/Staff" key.[**The page shall be proceeded by a pre-announce tone.**]
d. Capable of voice paging through a third-party PA system.
e. Capable of including or excluding any station from the voice paging function(s).
f. Automatically places an active station call on hold during any page and reestablishes the connection at the end of the page.
g. Automatically cancels a page if the talk mode is inactive for more than 15 seconds.

21. Station Monitor:

a. An audio monitor feature shall allow a user to sequentially or simultaneously listen to one or all stations that are included in the user-created list.
b. Master station display shall indicate which station is being monitored when in sequential mode.
c. The dwell time each station is monitored shall be user programmable.
d. The user shall be able to stop the monitoring sequence by activating a "pause" key.
e. The user shall be able to manually sequence through stations using a "next" key.

22. Night Service:

a. Functions shall be adaptable for nighttime staffing levels, patient traffic, and day/night operations.
b. Staff Follow:

1) Capable of locating roving staff; forwarding visual and audible annunciation of

incoming calls to station(s) where personnel have registered presence.
2) Master station shall display locations where staff have registered presence.
3) Incorporates a programmable timer that automatically cancels a forgotten staff presence registration.

c. Tones:

1) Deactivates audio signals from a duty station and mini-master display telephones.
2) Capable of changing the tone volume at the master and duty stations.
3) Satellite function shall permit the user to deactivate audio signals from duty stations and other remote annunciator devices.

d. Day/Night Transfer:

1) Permits one nurse station to take control of all or individually selected bed call cords from another nurse station. It shall be possible to view transfer status of a nurse station.
2) Transfer Modes: As a minimum, include the following three transfer modes to allow one nurse station to take control or share calls and operations from another nurse station:

a) Parallel Transfer Mode: Permits both nurse stations to share all calls and operations.
b) Supervised Transfer Mode: Permits the transferred nurse station to share all calls and operations with the controlling nurse station; however, the controlling nurse station calls are not shared with the transferring station.
c) Capture Transfer Mode: Transfers all calls and operations from the transferred nurse station to the controlling nurse station.
d) Transferred station shall have no control over calls, and its display shall indicate calls have been transferred to another station.

3) Patient Swing Modes: As a minimum, include the following two patient swing modes to allow one nurse station to take control or share calls from one or many calls from another nurse station:

a) Supervised Transfer Mode: Permits the transferred calls to be shared with the controlling nurse station.
b) Capture Transfer Mode: Transfers all calls from the call cord from the transferred nurse station to the controlling nurse station.
c) Transferred station has no control over those transferred calls.

23. Service Request:

a. Permits users to assign a service request to a substation, at programmable priority level.
b. Displays service request on the nurse station display and light the green flashing corridor lamp at the respective substation and automatically generate a service reminder request.
c. Cancels service requests only at the initiating point.
d. Recall calls shall sound and be displayed at the master station if the service request has not been cancelled at the initiating point within the programmed period of time.

24. Call Reminder Function:

a. Automatically generates a reminder call for a patient- or staff-initiated, high-priority [**2**][**3**][**or**][**4**] request that has had the call tones silenced, allowing time to physically attend to the request and cancel the call at the initiating point.
b. Regenerated calls shall display the same tones and visual indications and priority as the

original call and shall also display a "regenerated call" message.
c. Capable of manually adding low-priority calls to the reminder list.
d. "Call Reminder" function and reminder timer shall be programmable by call priority.

25. Hide Function: Prevents a selected station from displaying calls or generating tones on the nurse station.
26. Door Control Function: Capable of being programmed to enable the user to remotely activate electric door locks.
27. Test and Diagnostics Feature:

    a. Able to automatically diagnose system faults and categorize them as warnings, communication errors, or fatal errors.
    b. Warnings shall indicate possible system problems.
    c. Communication errors shall indicate the inability of the master station to communicate with a substation or another nurse-call station.
    d. Fatal errors shall indicate a major hardware or software failure.

28. User-Configured System Programming - Access Code Not Required:

    a. Patient call-cord priority levels.
    b. Monitor list.
    c. "All Call" list.
    d. Master station communication parameters (volume, filtering, talk/listen, sensitivity).
    e. Master and duty station call annunciation tone volume.
    f. Date/time.
    g. Staff-follow operating mode.
    h. Transfer type.
    i. Pocket pager list assignment.
    j. Presence mode.

29. User-Configured System Programming - Access Code Required:

    a. Master station number.
    b. Room device type.
    c. Room number.
    d. Bed number.
    e. Bed alpha or numeric.
    f. Reminder duration.
    g. Staff presence registration cancel duration.
    h. Display language.
    i. Paging group assignment(s).
    j. Zone group assignments.
    k. Monitoring duration.
    l. Pocket pager number.
    m. Call tone assignment by priority.
    n. Pretone activation.
    o. Call tones minimum volume.
    p. Clock mode (12 h/24 h).

D. Master Station:

1. Speaker/microphone unit with operating controls.
2. Indicator lamps with legends or by digital display designate identification and priority of calling stations and called stations.
3. Pulse rate of incoming-call lights denotes priority of calls awaiting response.

4. Station Selection Controls: Touchpad select stations for two-way voice communications.
5. Signal Tones: Programmable to announce incoming calls.
6. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.
7. Volume Control: Regulates incoming-call volume.
8. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch attached to each station unless otherwise indicated.
9. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.
10. Call Priority Selection: Controls associated with patient-station selection switches determine the priority displayed when a call is initiated at a patient station.

E. Central Equipment Cabinet:

1. Lockable metal.
2. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.
3. Amplifier: With fidelity and overall gain necessary to achieve the sound-transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.

    a. Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.
    b. Hum and Noise: 60 dB below full output with normal input open.
    c. Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.
    d. Protection: Circuit to prevent damage to the amplifier in case of shorted or open circuit.

4. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet, rated 15 W.
5. System Power Supply:

    a. 24-V dc for operation of the call system.
    b. Equipment Rating: Suitable for continuous operation between **32 and 120 deg F (0 and 49 deg C)**, from a primary line voltage between 105- to 125-V ac, 60 Hz.
    c. Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10-mV, rms level.
    d. Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.

6. Power-on indicator lamp.
7. Surge Protector Device: Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors, with [**digital indicator lights for power and protection status**]<**Insert accessories**>.
8. Battery Backup Unit: Sealed [**nickel-cadmium, wet-cell**]<**Insert type**> battery supplies power through an automatic switch when normal power fails, for a period of not less than [**six**]<**Insert number**> minutes at rated output.

    a. Automatic retransfer to normal power, after a [**15**]<**Insert number**>-minute time delay.
    b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

F. Speaker/Microphones:

1. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
2. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of **48 inches (1220 mm)** on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.

3. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
4. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.

G. Single-Patient Station: Speaker/microphone with **2-inch (50-mm)** dynamic cone, a polarized receptacle to match the cord-set plug, monitor lamp, reset switch, and call-placed lamp; assembled under a single faceplate.

H. Dual-Patient Station:

1. Speaker/microphone with **2-inch (50-mm)** dynamic cone, two polarized receptacles to match cord-set plugs, monitor lamp, and reset switch; assembled under a single faceplate.
2. Single call-placed lamp serves both beds.
3. Dual call-placed lamps, one for each bed.

I. Staff/Duty Stations: Audible call-tone signal device, speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.

J. Code Blue Station: Audible call-tone signal device, speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.

K. Ambulatory-Patient Station: Speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, call-placed lamp, and call push button; assembled under a single faceplate.

L. Selective Paging Speakers: **8-inch (200-mm)** cone type with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet, multitap matching transformer, flush-mounted steel back-box, and white enamel-finished metal ceiling grille.

M. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."

N. Staff Reminder Cancel Switch Station: Momentary contact.

2.4 SYSTEM COMPONENTS

A. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.

B. Emergency-Bath Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.

6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

C. Code Blue Station:

1. Consists of a sliding, chemical-resistant, ABS blue fascia marked with the word "CODE" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.
6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

D. Staff, Emergency Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Mounts on a single-gang electrical box wire to the input controller.

E. Pull-Cord-Call Station:

1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
2. Reset trigger.
3. Call-placed lamp.
4. Water-resistant construction.

F. Patient Control Unit:

1. Equipped with plug and **96-inch- (2400-mm-)** long white cord.
2. Ethylene oxide, sterilizable.
3. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
4. Integral Speaker: **2 inches (50 mm)**, with **0.35-oz. (9.9-g)** magnet, rated 0.2 W.
5. Controls: Speaker volume, TV control, and nurse call.
6. Housing: High-impact white plastic.
7. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
8. Quantity: 12 units for every 10 patient beds.

G. Call-Button Cord Set:

1. Plug and **72-inch (1800-mm)** white cord; cord set shall be resistant to medical gas environment equipped with momentary-action, call-button switch.
2. Ethylene oxide, sterilizable.
3. Washable cord.
4. Palladium switch contacts in high-impact white housing with cord-set strain relief.
5. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
6. Quantity: Three cord sets for every 10 patient beds.

H. Geriatric Call-Button Cord Set:

1. Plug and **72-inch (1800-mm)** white cord.
2. Resistant to medical gas environment equipped with momentary-action, light-pressure switch in soft outer jacket.
3. Ethylene oxide, sterilizable.

4. Washable cord.
5. Palladium switch contacts in high-impact white housing with cord-set strain relief.
6. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
7. Quantity: Two cord sets for every 10 patient beds.

I. Squeeze-Bulb Switch Cord Set:

1. Plug and **72-inch (1800-mm)** washable tube with white cord set.
2. Resistant to medical gas environment; washable; equipped with neoprene squeeze-bulb activator, and plug-mounted, momentary contact switch.
3. Ethylene oxide, sterilizable.
4. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
5. Quantity: Two cord sets for every 10 patient beds.

J. Breath Call Cord:

1. Flexible PVC jacketed cable and a momentary contact air-pressure sensitive switch.
2. Cord: **108 inches (2700 mm)** long.
3. Include an adjustable arm for clamping and suitable for use in oxygen atmospheres.
4. Include 12 replacement straws.

K. Pillow Speakers:

1. Eight-conductor, DIN, flexible PVC jacketed cable.
2. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
3. Cord: **96 inches (2400 mm)** long with sheet clip.

L. Call-Button Plug:

1. Designed to plug into patient station cord-set receptacle.
2. Button switches call circuit.
3. Two plugs for every 10 patient beds.

M. Dummy Plugs:

1. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
2. Three plugs for every 10 patient beds.

N. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

O. Station Faceplates, Stainless Steel:

1. Minimum of **0.0375 inch (0.95 mm)** thick.
2. Finish: Brushed.
3. Machine-engraved labeling identifies indicator lamps and controls.

P. Station Faceplates, High-Impact Plastic:

1. Color: [**Beige**]<**Insert color**>.
2. Molded or machine-engraved labeling identifies indicator lamps and controls.

Q. Corridor Dome Lights and Zone Lights:

1. Three-lamp signal lights.
2. Lamps: [**LED.**]Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
3. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
4. Filters: Two per unit, amber and red.

R. Cable:

1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
2. Sizes and Types: As recommended by equipment manufacturer.
3. Cable for Use in Plenums: Listed and labeled for plenum installation.

S. Grounding Components: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

2.5 SOFTWARE REQUIREMENTS

A. Telephone System Interface:

1. Permits use of wired and/or wireless telephones to execute nurse-call master station.
2. Two-way communication with patient and staff stations.
3. Two-way communication with the master nurse station.
4. "All Call," group call, and staff call paging.
5. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
6. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
7. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
8. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
9. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.

B. Display Telephones:

1. Digital telephones for use as mini-master nurse-call stations.
2. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
3. Ring patterns shall be identical to those generated at the master station.
4. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
5. Capable of placing or answering outside calls when interfaced with the facility telephone system.
6. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.

C. Third-Party Pocket Pager Interface:

1. Equipped with a standalone pocket pager interface.
2. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.

D. Statistical Software:

1. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
2. Windows based and operated on a PC that is connected to the nurse-call system network.
3. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
4. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
5. Capable of assigning a patient name to bed number.
6. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

E. Data Analysis Software:

1. Capable of analyzing the stored information and generating computed analysis.
2. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
3. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

F. Statistical Software Package:

1. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
2. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:

   a. Choice of color by type of call.
   b. Choice of display size (character size).
   c. Choice of priority levels, type of events, points of origin.
   d. Identification of facility.
   e. Identification of ward.
   f. Identification of patient with specific patient information.

2.6 CONDUCTORS AND CABLES

A. Audio Cables:

1. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
3. Shielding: For speaker/microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
4. Minimum Shielding Coverage on Conductors: 60 percent.
5. Plenum Cable: Listed and labeled for plenum installation.

B. Data Cable and Hardware: [**Category 5e**][**Category 6**] balanced twisted-pair cabling and hardware. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

C. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables."**][**Section 260523 "Control**

Voltage Electrical Power Conductors and Cables."]

D. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables."**][**Section 260523 "Control Voltage Electrical Power Conductors and Cables."**]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**].

   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Conceal raceway and cables except in unfinished spaces.

2. Cable Trays: Comply with requirements in Section 260536 "Cable Trays for Electrical Systems."
3. Conduit and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."[**Flexible metal conduit shall not be used.**]

   a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

B. Install cables without damaging conductors, shield, or jacket.

C. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, or fittings.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide **12-inch (300-mm)** minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in

junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

J. Identification of Conductors and Cables: Comply with requirements in Section 260553 "Identification for Electrical Systems" for cable administration, cable schedule, and cable and wire identification.

K. Equipment Identification:

1. Comply with requirements in Section 260553 "Identification for Electrical Systems" for equipment labels and signs and labeling installation requirements.
2. Label stations, controls, and indications using approved consistent nomenclature.

3.2 EXISTING SYSTEMS

A. Examine existing systems for proper operation, compatibility with new equipment, and deficiencies. If discrepancies or impairments to successful connection and operation of interconnected equipment are found, report them and do not proceed with installation until directed. Schedule existing systems' examination so there is reasonable time to resolve problems without delaying construction.

3.3 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Schedule tests a minimum of seven days in advance.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume

levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:

a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:

a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.

D. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to [**three**]<**Insert number**> visits to Project during other-than-normal operating hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

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SECTION 27 53 13 00 - CLOCK SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Master and secondary clock system.
2. Master clock.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power booster.
6. Back boxes for secondary indicating clocks and program devices.
7. Guards.
8. Rack-mounting provision for master clock.
9. Conductors and cables.
10. Pathways.

1.2 DEFINITIONS

A. NIST: The National Institute of Science and Technology.

B. PC: Personal computer.

C. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Master and secondary clock system.
2. Master clock.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power booster.
6. Back boxes for secondary indicating clocks and program devices.
7. Guards.
8. Rack-mounting provision for master clock.
9. Conductors and cables.
10. Pathways.

B. Product Data Submittals: For each product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:

1. Master unit.
2. Indicating clocks.

3. Signal equipment.
4. Equipment enclosures and back boxes.
5. Accessory components.

C. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring and correction circuits.

a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.

2. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:

a. Surface-mounted and semirecessed secondary indicating clocks.
b. Master clock [**enclosures**][**mounting racks**].
c. Clock circuit power boosters.

3. Details of seismic strengthening of master clock [**enclosures**][**mounting racks**].
4. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

D. Samples for Initial Selection:

1. Manufacturer's color photographs or color chips showing the full range of colors available for clocks, signal equipment, and control panels.
2. Representative operating models of clock type <**Insert designations of clocks for which Samples are required**>.

E. Delegated Design Submittals: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of the master clock and housing.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for the master clock, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.2 MASTER AND SECONDARY CLOCK SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Time & Signal Co**]
2. [**Dukane Communication Systems**]
3. [**Faraday**]
4. [**Lathem Time**]
5. [**Midwest Time Control, Inc.**]
6. [**National Time & Signal Corporation**]
7. [**Primex, Inc.**]
8. [**Rauland-Borg Corporation**]
9. [**Sapling, Inc.**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Telecor Inc**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Time & Signal Co**]
2. [**Dukane Communication Systems**]
3. [**Faraday**]
4. [**Lathem Time**]
5. [**Midwest Time Control, Inc.**]
6. [**National Time & Signal Corporation**]

7. [**Primex, Inc.**]
8. [**Rauland-Borg Corporation**]
9. [**Sapling, Inc.**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Telecor Inc**]
12. **<Insert manufacturer's name>**

C. System Functions and Features:

1. Supply power to remote indicating clocks[**except those indicated to have correction signals applied through a data circuit**].
2. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any [**one**][**two**]**<Insert number>** type(s) of secondary indicating clocks, including the following:

    a. Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.
    b. Digital Clocks: Test clocks automatically for synchronization with master time control at least once every hour and automatically correct those not synchronized with the time reference unit.[**Automatically correct clocks immediately when power is restored after an outage of power to the master clock.**]

3. Initiate and execute programs for scheduled automatic operation of remote devices. Include [**audible signal devices**][**and**][**visual signal devices**][**and on and off switching of equipment and circuits**].
4. Provide for manual control of programmed signal and equipment-switching circuits.
5. Communicate with remote PC [**for access to UTC time base**][**and**][**to permit programming from remote location**].
6. Maintain system access security with a minimum of [**one level**][**two levels**][**three levels**] of user-access control to restrict use of system controls to authorized personnel.[**Levels of access apply to both local access and access from a remote computer.**] Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:

    a. Access to review existing programs only.
    b. Access to normal system operating controls.
    c. Access to all user-programming and control functions.

7. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
8. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator, and automated periodic reference to NIST or UTC time signals via [**internal telephone modem and automatic dialup connection**][**internal modem and network or microcomputer Internet access**][**dedicated internal radio receiver tuned to NIST time signal broadcasts**]. Reference time signals shall be automatically accessed at programmable intervals.
9. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.

    a. Quantity of Programmable Schedules: [**Three**][**Four**][**Eight**][**18**][**250**], minimum.
    b. Number of Weekly Events That Can Be Programmed for Each Schedule: [**64**][**128**][**300**][**600**][**2500**], minimum.
    c. Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
    d. Advance Programming for Automatic Holiday Schedule Changes: Number of schedule

changes that can be programmed to suit holidays and vacations shall be [**10**][**16**][**50**][**100**], and each change may be programmed up to a year in advance to occur on any day of the calendar year.

10. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel[**or a remote computer with the proper access code**] shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.
11. Provide [**manually initiated**][**programming for automatic**] daylight savings time correction.
12. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

2.3 MASTER CLOCK

A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.

1. Programming and control switches.
2. Informational Display: LED or backlit LCD type.

   a. Normally shows current time[**, date, and day of week**] display.
   b. Provides programming cues when system is being programmed.

3. Output Circuits for Power and Correction of Secondary Indicating Clocks:

   a. Wired Synchronous Clock Power-and-Correction Circuits: For [**analog**][**and**][**digital**] clocks; a minimum of [**one**][**two**]<**Insert number**> required. Relay controlled.
   b. Wired Synchronous Digital Clock Power-and-Correction Circuits: [**One**]<**Insert number**> required.
   c. Existing Clock Power-and-Correction Circuit: An output circuit suitable for <**Insert description of type of existing power-and-correction circuit and number of clocks to be connected**>.

4. Data Output Port for Secondary Clock Correction Circuit: [**Digital,**]RS485 or similar circuit for scheduled periodic correction signals.
5. Modem and PC interface software suitable for [**remote programming**][**and**][**automatic NIST or UTC synchronization**].
6. Circuits for Audible Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**five**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
7. Circuits for Visual Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**five**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
8. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**5**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
9. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.
10. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semirecessed, or flush mounting as indicated.
11. Housing: Rack-mounting metal enclosure with display indication visible on front panel face.

a. Reinforce mounting and attachment capable of resisting seismic forces described in Section 260548.16 "Seismic Controls for Electrical Systems."

12. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.
13. Electrostatic Discharge Resistance: Master clock[**and secondary indicating clocks**] shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

2.4 SECONDARY INDICATING CLOCKS

A. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.

B. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours [**and minutes**][**, minutes, and seconds**].

1. Display Height, 2-1/2-Inch (64-mm) Clock: Hour and minute numerals readable at **50 feet (15 m)**.
2. Display Height, 4-Inch (102-mm) Clock: Hour and minute numerals readable at **100 feet (30 m)**.
3. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.
4. Connections for Power and Correction:

a. Wired synchronous connection to the master clock for both operating power and correction.

1) Time-Base Backup, Internal Alkaline Battery: Backs up internal time base to maintain timekeeping during power outages of up to six days' duration.
2) Time-Base Backup, Internal Capacitor: Back up internal time base to maintain timekeeping during power outages of up to 12 hours' duration.

b. Correction by RS485, Ethernet, or similar data line with operating power supplied over a separate connection.
c. Power Connection for Secondary Indicating Clocks: [**Plug connector**][**Wire pigtail or compression splice**].

C. Interval-Timer Clock: Digital microprocessor-controlled, **4-inch (102-mm)** unit with **2-1/2-inch (64-mm)**, red LED digital display for hours and minutes and **1-5/16-inch (33-mm)** display for seconds; a separately mounted, mode-control switch; and the following features:

1. Display Visibility: Hour and minute numerals readable at [**30 feet (10 m)**]<**Insert dimension**> in normal ambient light.
2. Operating Modes:

a. Normal: Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
b. Count-Down or Count-Up Timer: Selected by mode-control switch count-up and count-down positions, and capable of being preset at the mode-control station.
c. Code Blue: Automatically selected by a signal through a wiring connection from [**the code-blue system**]<**Insert source for the initiating signal**>. This signal captures control of the clock regardless of current mode or correction status and instantly initiates count-up operation, starting at time 00:00:00. While in this mode, other clock functions, including correction, shall run in the background. Clock shall revert to normal operating mode when

the initiating-signal system is reset.

3. Mode-Selector Switch: Push-button or rotary, multiposition type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
4. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.

D. Provision for Modular Panel Installation: Equip designated clock for panel mounting. Mount flush or semirecessed with arrangement and trim as indicated. Coordinate wiring with other modular panel components, including [**room lighting switches**][**intercom devices**][**convenience outlets**][**data outlets**][**speaker**] and other similar devices.

E. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Section 275116 "Public Address and Mass Notification Systems."

F. Secondary Indicating Clock Characteristics:

1. Clock Type: [**Analog**][**Digital**].
2. Face Configuration: [**Single**][**Double**].
3. Mounting: [**Recessed**][**Semirecessed**][**Pendant**][**Surface**][**Suspended**][**Within time-tone unit**][**Within modular panel**]<**Insert mounting height of pendant, wall, and suspended clocks**>.
4. Nominal Dimensions: <**Insert depth and nominal diameter or height and width in inches (mm)**>.
5. Casing Finish: <**Insert description, including types and colors**>.
6. Special Environmental Conditions: <**Describe conditions such as corrosive, damp, or wet locations**>.
7. Dial Face Color: <**Insert color**>.
8. Analog Clock Crystal: Clear [**glass**][**acrylic**][**polycarbonate**].
9. Face Color: <**Insert color**>.
10. Display Height: <**Insert inches (mm)**>.
11. Seconds Display: [**Yes**][**No**].
12. Digital Clock Lens: Antiglare acrylic material.
13. Battery Backup: [**Yes**][**No**].
14. Interval-Timer Display: [**Yes**][**No**].

2.5 PROGRAM SIGNAL DEVICES

A. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at **10 feet (3 m)**:

1. 4-Inch (100-mm) Bell: 90 dB.
2. 6-Inch (150-mm) Bell: 95 dB.
3. 10-Inch (250-mm) Bell: 104 dB.

B. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at **10 feet (3 m)** shall be 75 dB.

C. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.

1. Sound-Output Rating Measured at 3 Feet (1 m): 75 dB.
2. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.

D. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at **10 feet (3 m)**.

E. Projector Horns: Adjustable-output, vibrating type with [**single**][**double**] projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at **10 feet (3 m)**.

F. Loudspeakers for Audible Tones: See Section 275116 "Public Address and Mass Notification Systems."

G. Visible Signal Devices: Strobe lights with [**blue**][**yellow**] polycarbonate lens and xenon flash tube, with lens mounted on an aluminum faceplate and the word "Program" engraved in letters at least **1 inch (25 mm)** high on lens. Lamp unit shall have a minimum rated light output of 75 candela.

H. Combination Audible and Visible Signal Devices: Factory-integrated horn and strobe light in a single mounting assembly.

I. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.

J. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.

K. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.

L. Connection Provision for Signal-Indicating Devices: [**Plug connector**][**Wire pigtail or compression splice**].

2.6 CLOCK CIRCUIT POWER BOOSTER

A. Description: Transformer power supply, mounted in steel cabinet with hinged door, and having fuse-protected input and output circuits.

2.7 BACK BOXES FOR SECONDARY INDICATING CLOCKS AND PROGRAM DEVICES

A. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.

2.8 GUARDS

A. Description: Formed-steel wire, shaped to fit around guarded device, with **1-inch (25-mm)** maximum clearance.

1. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
2. Finish for Indoor Devices: [**Clear**]<**Insert finish color**> epoxy lacquer over zinc plating.
3. Finish for Outdoor Devices: [**Black**]<**Insert finish color**> powder coat over zinc plating and primer.

2.9 RACK-MOUNTING PROVISION FOR MASTER CLOCK

A. Equipment Cabinet: [**Floor**][**Wall**]-mounted, rack type. Comply with EIA-310-D and the following:

1. Cabinet Housing: Constructed of steel, with front[**and rear**] doors; with manufacturer's standard tumbler locks, keyed alike.

   a. Front door shall have a clear panel in front of the master clock display.
   b. Housing shall enclose master clock and auxiliary clock system components, plus a minimum of [**20**]<**Insert number**> percent spare capacity for future equipment.

2. Forced Ventilation: Internal low-noise fan with a filtered intake vent, connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable and arranged to be powered when main cabinet power switch is on.
3. Natural Ventilation: Ventilated rear and sides with louvers and solid top.
4. Arrange inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
5. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by equipment or panels.
6. Finish: Uniform, baked-enamel, [**manufacturer's standard color**]<**Insert color**> finish over rust-inhibiting primer.
7. Power-Control Panel: On front of equipment housing; with master power on-off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
8. Vertical Plug Strip: Grounded receptacles, **12 inches (300 mm)** o.c. the full height of rack, to supply rack-mounting equipment.
9. Maintenance Receptacles: Duplex convenience outlet with supply terminals separate from equipment plug strip and located in front of rack.

2.10 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG. Voltage drop for signal, control, and clock correction circuits shall not exceed 10 percent under peak load conditions.

B. 120-V AC and Class 1 Signal and Control Circuits: Stranded, single conductors of size and type recommended by system manufacturer. Materials and installation requirements are specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 2 and Class 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable. Materials and installation requirements are specified in Section 260523 "Control-Voltage Electrical Power Conductors and Cables."

D. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.

E. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.

F. Plenum Cable: Listed and labeled for plenum installation.

G. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.

H. Shielding: For speaker-microphone leads and at other locations recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.

1. Minimum Shielding Coverage on Conductors: 60 percent.

2.11 PATHWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."

1. Raceway Type: [**Optical fiber/communications raceway and fittings**][**Metal wireways**][**Nonmetal wireways**][**Surface metal raceways**][**Surface nonmetal raceways**].

B. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

C. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Section 260548.16 "Seismic Controls for Electrical Systems."

3.2 WIRING METHODS

A. Wiring in Raceways and Trays: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring in Ceilings, Walls, and Floors: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA-568-C.

3.3 ELECTRICAL CONNECTIONS

A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Use [**plug connectors**][**splices**] for connections to clocks and signal devices.

C. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.4 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

D. Clock system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Program system according to Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

B. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION 27 53 13 00

Task	Specification	Specification Description
27 53 13 13	27 53 13 00	Clock Systems
27 53 13 16	27 53 13 00	Clock Systems

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SECTION 28 10 00 00 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Access control system.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.
5. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] specifies the following:

   a. Electric strike(s).
   b. Electromagnetic lock(s).
   c. Delayed-egress electromagnetic lock(s).
   d. Electromechanical lock(s).
   e. Self-contained electronic lock(s).
   f. Exit lock(s) and alarm(s).
   g. Auxiliary electrified door hardware.

6. Section 087113 "Power Door Operators" specifies the following:

   a. Door operator controls.
   b. Panic exit device(s).
   c. Electric strike(s).
   d. Auxiliary electrified door hardware.

7. Section 281300 "Access Control Software and Database Management" specifies the following:

   a. Access control system unit operating system software.
   b. Access control system unit antivirus and security protection software.
   c. Visitor management database software.
   d. Mobile credential validation database software.
   e. Access control system supplementary computer equipment operating system software.
   f. Access control system supplementary computer equipment antivirus and security protection software.
   g. Credential card personalization software.
   h. Credential card printer and encoder software.

8. Section 281400 "Access Control System Hardware" specifies the following:

a. Access control system server(s).
b. Access control system DGP(s).
c. Access control system door controller(s).
d. Access control system input/output interface(s).
e. Access control system power supply and battery charger(s).
f. Access control system [**terminal(s)**][**workstation(s)**].
g. Access control system printer(s) and encoder(s).

9. Section 281500 "Integrated Access Control Hardware Devices" specifies the following:

a. Swipe card reader(s).
b. Proximity reader(s) for card, fob, or smartphone.
c. Door lock keypad(s).
d. Scramble keypad(s).
e. Combination card reader(s) and keypad(s).
f. Access control cards.
g. Electrically controlled single-point latch(es).
h. Electrically controlled three-point latch(es).
i. Type 1 high-security electronic lock(s).
j. Type 1F high-security combination lock(s).
k. REX motion sensor(s).
l. REX push-button(s).
m. Magnetic lock hardware with special locking arrangement for fire-rated door(s).
n. Panic hardware with special locking arrangement for fire-rated door(s).
o. NFC access control device(s).
p. Electronic key management system unit(s).

10. Section 281511 "Integrated Credential Readers and Entry Management" specifies the following:

a. Swipe card reader(s).
b. Chip card reader(s).
c. Proximity reader(s) for card, fob, or smartphone.
d. Proximity card reader(s) for hazardous (classified) location.
e. Door lock keypad(s).
f. LCD alarm keypad(s).
g. Scramble keypad(s).
h. Single finger scanner(s).
i. Palm scanner(s).
j. Iris scanner(s).
k. Facial scanner(s).
l. Combination card reader(s) and keypad(s).
m. Combination card reader(s)/keypad(s) and biometrics scanner(s).

11. Section 281513 "Access Control Credentials" specifies the following:

a. Access control cards.
b. Wireless key fobs.

12. Section 281515 "Electrified Locking Devices and Accessories" specifies the following:

a. Electrically controlled single-point latch(es).
b. Electrically controlled two-point latch(es).
c. Electrically controlled three-point latch(es).
d. Type 1 high-security electronic lock(s).
e. Type 1F high-security combination lock(s).

f. Type 2 high-security combination lock(s).
g. REX motion sensor(s).
h. REX push-button(s).

13. Section 281517 "Egress Management Devices" specifies the following:

a. Magnetic lock hardware with special locking arrangement.
b. Panic hardware with special locking arrangement.

14. Section 281519 "Access Control Remote Devices" specifies the following:

a. NFC access control device(s).
b. Bluetooth communications access control device(s).
c. Wireless communications access control device(s).

15. Section 281521 "Telephone Entry Systems" specifies the following:

a. Analog audio telephone entry system(s).
b. Digital audio-video telephone entry system(s).

16. Section 281523 "Intercom Entry Systems" specifies the following:

a. Digital audio intercom entry system(s).
b. Digital audio-video intercom entry system(s).

17. Section 281525 "Electronic Key Management Systems" specifies the following:

a. Electronic key management system unit(s).
b. Mechanical key management system unit(s).

18. Section 281527 "Access Control Electronic Turnstiles and Mobility Systems" specifies turnstile operator(s) with access control devices.

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. NFC: Near field communications.

C. REX: Request-to-exit.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For access control. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.
4. End-to-end system communications details.
5. Secondary power calculations
6. <**Insert requirements**>.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable software add-ons.
2. Installation and programming instructions for antivirus and security protection software.
3. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
4. Troubleshooting instructions for operating system software and applicable software add-ons.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.
7. Installation instructions for access control system servers.
8. Installation instructions for access control system DGPs.
9. Installation instructions for access control system input/output interface.
10. Installation instructions for access control system door controllers.
11. Installation instructions for access control system workstation.
12. Installation instructions for access control system power supplies and battery chargers.
13. Installation instructions for access control system printers.
14. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
15. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
16. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.
17. Installation instructions for integrated credential readers and entry management devices.
18. Printing, programming, and handling instructions for access control credentials.
19. Installation instructions for electrified locking devices and accessories.
20. Installation instructions for egress management devices.
21. Installation instructions for access control remote devices.
22. Installation instructions for telephone entry systems.
23. Installation instructions for intercom entry systems.
24. Installation instructions for electronic key management systems.
25. Installation instructions for access control electronic turnstiles and mobility systems.

26. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
27. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
28. Manufacturer's recommended tests and inspections for egress management devices.
29. Manufacturer's recommended tests and inspections for access control remote devices.
30. Manufacturer's recommended tests and inspections for telephone entry systems.
31. Manufacturer's recommended tests and inspections for intercom entry systems.
32. Manufacturer's recommended tests and inspections for electronic key management systems.
33. Manufacturer's recommended tests and inspections for access control electronic turnstiles and mobility systems.
34. Manufacturer's recommended testing and inspection procedure for end-to-end operation of access control system software, hardware, and integrated hardware devices.

B. Warranty documentation.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for access control system requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for access control system require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.9 WARRANTY FOR ACCESS CONTROL SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system performs in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of access control system perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of

Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for components[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

1.10 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within warranted cycle life.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**Ten**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. Certification: Provide certificate, authorized under UL Certification Service, that access control system installation complies with installation requirements of UL CCN ALOV.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

C. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by [**manufacturer**][**fabricator**][**Installer**] warranting performance of entire system.
2. Provide the following specified products with the access control system:

a. Access Control Software and Database Management:

1) Access control system unit operating system software.
2) Access control system unit antivirus and security protection software.
3) Visitor management database software.
4) Mobile credential validation database software.
5) Access control system supplementary computer equipment operating system software.
6) Access control system supplementary computer equipment antivirus and security protection software.
7) Credential card personalization software.
8) Credential card printer and encoder software.

b. Access Control System Hardware:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system server(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system DGP(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system door controller(s) <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system input/output interface(s) <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system power supply and battery charger(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system [**terminal(s)**][**workstation(s)**]<**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system printer(s) and encoder(s) <**Insert drawing designation**>.

c. Security Door Hardware:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electric strike(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electromagnetic lock(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> delayed-egress electromagnetic lock(s) <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electromechanical lock(s) <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> self-contained electronic lock(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> exit lock(s) and alarm(s) <**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> auxiliary electrified door hardware <**Insert drawing designation**>.
8) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> door operator controls <**Insert drawing designation**>.
9) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> panic exit device(s) with electric strike <**Insert drawing designation**>.

d. Integrated Credential Readers and Entry Management:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> swipe card reader(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> chip card reader(s)

<Insert drawing designation>.

3) [Quantity as indicated on Drawings of][One]<Insert quantity> proximity reader(s) for card, fob, or smartphone <Insert drawing designation>.
4) [Quantity as indicated on Drawings of][One]<Insert quantity> proximity card reader(s) for hazardous (classified) location <Insert drawing designation>.
5) [Quantity as indicated on Drawings of][One]<Insert quantity> door lock keypad(s) <Insert drawing designation>.
6) [Quantity as indicated on Drawings of][One]<Insert quantity> LCD alarm keypad(s) <Insert drawing designation>.
7) [Quantity as indicated on Drawings of][One]<Insert quantity> scramble keypad(s) <Insert drawing designation>.
8) [Quantity as indicated on Drawings of][One]<Insert quantity> single finger scanner(s) <Insert drawing designation>.
9) [Quantity as indicated on Drawings of][One]<Insert quantity> palm scanner(s) <Insert drawing designation>.
10) [Quantity as indicated on Drawings of][One]<Insert quantity> iris scanner(s) <Insert drawing designation>.
11) [Quantity as indicated on Drawings of][One]<Insert quantity> facial scanner(s) <Insert drawing designation>.
12) [Quantity as indicated on Drawings of][One]<Insert quantity> combination card reader(s) and keypad(s) <Insert drawing designation>.
13) [Quantity as indicated on Drawings of][One]<Insert quantity> combination card reader(s)/keypad(s) and biometrics scanner(s) <Insert drawing designation>.

e. Access Control Credentials:

1) [Quantity as indicated on Drawings of][25][50][100]<Insert quantity> access control cards <Insert drawing designation>.
2) [Quantity as indicated on Drawings of][25][50][100]<Insert quantity> wireless key fobs <Insert drawing designation>.

f. Electrified Locking Devices and Accessories:

1) [Quantity as indicated on Drawings of][One]<Insert quantity> electrically controlled single-point latch(es) <Insert drawing designation>.
2) [Quantity as indicated on Drawings of][One]<Insert quantity> electrically controlled two-point latch(es) <Insert drawing designation>.
3) [Quantity as indicated on Drawings of][One]<Insert quantity> electrically controlled three-point latch(es) <Insert drawing designation>.
4) [Quantity as indicated on Drawings of][One]<Insert quantity> Type 1 high-security electronic lock(s) <Insert drawing designation>.
5) [Quantity as indicated on Drawings of][One]<Insert quantity> Type 1F high-security combination lock(s) <Insert drawing designation>.
6) [Quantity as indicated on Drawings of][One]<Insert quantity> Type 2 high-security combination lock(s) <Insert drawing designation>.
7) [Quantity as indicated on Drawings of][One]<Insert quantity> REX motion sensor(s) <Insert drawing designation>.
8) [Quantity as indicated on Drawings of][One]<Insert quantity> REX push-button(s) <Insert drawing designation>.

g. Egress Management Devices:

1) [Quantity as indicated on Drawings of][One]<Insert quantity> magnetic lock hardware with special locking arrangement <Insert drawing designation>.
2) [Quantity as indicated on Drawings of][One]<Insert quantity> panic hardware

with special locking arrangement <**Insert drawing designation**>.

h. Access Control Remote Devices:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> NFC access control device(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> Bluetooth communications access control device(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> wireless communications access control device(s) <**Insert drawing designation**>.

i. Telephone Entry Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> analog audio telephone entry system(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio-video telephone entry system(s) <**Insert drawing designation**>.

j. Intercom Entry Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio intercom entry system(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio-video intercom entry system(s) <**Insert drawing designation**>.

k. Electronic Key Management Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electronic key management system unit(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> mechanical key management system unit(s) <**Insert drawing designation**>.

l. Access Control Electronic Turnstiles and Mobility Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> turnstile operator(s) with access control devices <**Insert drawing designation**>.

3. Operation:

a. Exchange database information directly with DGPs.
b. <**Insert specific requirements for sending and receiving access control data to and from external database or storage array**>.

D. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.
3. Wiring Methods:

a. Backbone Cable Type: [**Single-mode fiber**][**and**][**or**][**multi-mode fiber**][**or**][**copper**]<**Insert cable type**>.
b. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
c. Analog Maximum Cable Length: [**1000 ft**]<**Insert cable length**>.
d. Digital Maximum Cable Length: [**300 ft**][**500 ft**]<**Insert cable length**>.

E. Interfaces with Other Work:

1. Coordinate installation of new access control system components with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**][**applicable Division 08 Sections**] for interfacing access control system devices with door hardware.
3. Coordinate with [**Section 142100 "Electric Traction Elevators"**][**Section 142400 "Hydraulic Elevators"**] for interfacing access control system with elevator controls.
4. Coordinate with [**Section 230923 "Direct Digital Control (DDC) System for HVAC"**][**Section 230993.11 "Sequence of Operations for HVAC DDC"**] for interfacing access control system with temperature controls to turn HVAC system on and off.
5. Coordinate with [**Section 260923 "Lighting Control Devices"**][**Section 260943.16 "Addressable Luminaire Lighting Controls"**][**Section 260943.23 "Relay-Based Lighting Controls"**] for interfacing access control system with lighting controls.
6. Coordinate with Section 284600 "Fire Detection and Alarm" for unlocking secured doors that are in exit ways, with or without delay.
7. Coordinate with Section 284700 "Mass Notification" for unlocking secured doors that are in exit ways, with or without delay.
8. Coordinate with Section 285213 "Detention Monitoring and Control System and Interfaces" for interfacing access control system with detention monitoring and controls.
9. Coordinate with Section 323113 "Chain Link Fences and Gates" for interfacing access control system with fence and gate controls.

F. Systems Integration:

1. Coordinate with [**Section 283100 "Intrusion Detection"**][**Section 283121 "Area and Perimeter Intrusion Detection"**] for integrating access control system with intrusion detection system.
2. Coordinate with Section 282000 "Video Surveillance" for integrating access control system with video surveillance controls.
3. <**Insert requirements for integrating access control system with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM COMPONENTS

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for access control system components.
2. Perform [**industry standard**]<**Insert test**> tests and inspections for power supplies, batteries, and other standby power provisions.
3. Engage factory-authorized service representative to test end-to-end system connection and functionality.
4. Verify monitoring of access control system status and diagnostics information.

E. Nonconforming Work:

1. Access control equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 ADJUSTING

A. Control Sensor Adjustments: Adjust control devices to suit actual occupied conditions.

1. For proximity motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.5 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Control Sensor Readjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in readjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 28 10 00 00

SECTION 28 10 00 00A - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Software for access control system units.
2. Software for access control system supplementary computer equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281400 "Access Control System Hardware" for hardware required to run software specified in this Section.
5. Section 281500 "Integrated Access Control Hardware Devices" for access control field devices controlled by software specified in this Section.

1.2 DEFINITIONS

A. RAM: Random-access memory.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Certificates:

1. <**Insert certificate requirement**>.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and**][**testing**][**and**][**troubleshooting**] instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable

software add-ons.
2. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
3. Troubleshooting instructions for operating system software and applicable software add-ons.
4. Installation and programming instructions for antivirus and security protection software.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 SOFTWARE FOR ACCESS CONTROL SYSTEM UNITS

A. Description: This category covers software products intended for installation on access control system units.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. <**Insert requirements**>.

2. Listing Criteria:

a. Cybersecurity: UL CCN CYBR; including UL 2900-1 and UL 2900-2-3.
b. Access Control System Functionality: UL CCN ALVY; including UL 294.
c. Hardware that Interfaces with Fire Alarm or Mass Notification: UL CCN UOJK; including UL

864.

C. Access Control System Unit Operating System Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   d. [**LenelS2; Carrier Global Corporation**]
   e. [**Tyco Software House; Tyco International, Ltd.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   d. [**LenelS2; Carrier Global Corporation**]
   e. [**Tyco Software House; Tyco International, Ltd.**]
   f. <**Insert manufacturer's name**>

3. Additional Characteristics:

   a. Provides event logging, notification, and escalation.
   b. Provides threat-level management and response actions.
   c. Provides dashboard view of system health and status.
   d. Maintains credential-driven user records and access history.
   e. Supports network-connected credential readers and controlled doors.
   f. Supports add-on software.
   g. Supports video-surveillance system integration.
   h. Provides email[**and text message**] alerts.
   i. <**Insert characteristics**>.

4. Options:

   a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
   b. User Interface: [**Web browser**][**and**][**mobile app**].
   c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
   d. Drive Space: [**32 GB**][**100 GB**][**500 GB**]<**Insert size**>.
   e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.
   f. Screen Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
   g. Number of Cardholders: Up to [**1000**][**10,000**][**50,000**][**150,000**]<**Insert number**>.
   h. Number of Supported Readers: Up to [**100**][**500**][**1000**]<**Insert number**>.
   i. Number of Inputs: [**128**][**256**][**1024**]<**Insert number**>.
   j. Number of Outputs: [**128**][**256**][**1024**]<**Insert number**>.
   k. Simultaneous Users: [**Five**][**25**][**35**]<**Insert number**>.

D. Access Control System Unit Antivirus and Security Protection Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Avast Software s.r.o.**]
    b. [**McAfee, LLC**]
    c. [**Microsoft Corporation**]
    d. [**S.C. Bitdefender S.R.L.**]
    e. [**Sophos Ltd.; Sophos Group plc**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Avast Software s.r.o.**]
    b. [**McAfee, LLC**]
    c. [**Microsoft Corporation**]
    d. [**S.C. Bitdefender S.R.L.**]
    e. [**Sophos Ltd.; Sophos Group plc**]
    f. <**Insert manufacturer's name**>

3. Additional Characteristics:

    a. Endpoint detection and response.
    b. Anti-ransomware.
    c. Managed threat response.
    d. Exploit prevention.
    e. Active adversary mitigations.
    f. Email alerts.
    g. <**Insert characteristics**>.

4. Options:

    a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
    b. User Interface: [**Web browser**][**and**][**mobile app**].
    c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
    d. Drive Space: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**>.
    e. Memory: [**1 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.

E. Visitor Management Database Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**BluBØX Security, Inc.**]
    b. [**HID Global; ASSA ABLOY**]
    c. [**Splan Inc.**]
    d. [**Traction Guest**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**BluBØX Security, Inc.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**Splan Inc.**]
   d. [**Traction Guest**]
   e. <**Insert manufacturer's name**>

3. Additional Characteristics:

   a. Visitor registration.
   b. Visitor audit trails and reporting.
   c. Badge printing.
   d. Unassisted visitor registration and badging.
   e. Preconfigured security levels of users.
   f. Filters out unsolicited visitors.
   g. Supports integrated credential readers.
   h. <**Insert characteristics**>.

4. Options:

   a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
   b. User Interface: [**Web browser**][**and**][**mobile app**].
   c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
   d. Drive Space: [**100 MB**][**500 MB**][**1 GB**]<**Insert size**>.
   e. Memory: [**500 MB**][**1 GB**][**4 GB**]<**Insert size**> RAM.
   f. Automated Alerts:

      1) Visitor check-in.
      2) Package check-in.
      3) Watch list alert.
      4) Expired badges.
      5) Panic message.
      6) Current visitor.
      7) Maximum visitor.
      8) Frequent visitor.
      9) Time based.

F. Mobile Credential Validation Database Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**HID Global; ASSA ABLOY**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**HID Global; ASSA ABLOY**]

b. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Mobile Validator and Mobile Registration engines.
b. Network-based functionality and database synchronization.
c. Credential audit trail exporting.
d. Contact or contactless verification.
e. Integrated card reader.
f. Biometric finger scanner.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows CE 5.0**][**Windows Mobile 6**]<**Insert operating system**>.
b. Multi-Factor Authentication: [**One**][**Two**][**Three**] factor authentication.
c. Drive Space: [**100 MB**][**500 MB**][**1 GB**]<**Insert size**>.
d. Memory: [**32 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.
e. Credentials:

1) PIV.
2) PIV-1.
3) TWIC.
4) FRAC.
5) CAC.
6) CIV.
7) Prox.
8) DESFire.

2.2 SOFTWARE FOR ACCESS CONTROL SYSTEM SUPPLEMENTARY COMPUTER EQUIPMENT

A. Description: This category covers software products for installation on access control system supplementary computer equipment that do not inhibit safety or intended operation of access control system hardware devices when they are shut off, lose power, or otherwise fail.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. Listing Criteria:

a. Cybersecurity: UL CCN CYBR; including UL 2900-1 and UL 2900-2-3.

C. Access Control System Supplementary Computer Equipment Operating System Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**LenelS2; Carrier Global Corporation**]
e. [**Tyco Software House; Tyco International, Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**LenelS2; Carrier Global Corporation**]
e. [**Tyco Software House; Tyco International, Ltd.**]
f. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Provides event logging, notification, and escalation.
b. Provides threat-level management and response actions.
c. Provides dashboard view of system health and status.
d. Maintains credential-driven user records and access history.
e. Supports network-connected credential readers and controlled doors.
f. Supports add-on software.
g. Supports video-surveillance system integration.
h. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**32 GB**][**100 GB**][**500 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.
f. Screen Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
g. Number of Cardholders: Up to [**1000**][**10,000**][**50,000**][**150,000**]<**Insert number**>.
h. Number of Supported Readers: Up to [**100**][**500**][**1000**]<**Insert number**>.
i. Number of Inputs: [**128**][**256**][**1024**]<**Insert number**>.
j. Number of Outputs: [**128**][**256**][**1024**]<**Insert number**>.
k. Simultaneous Users: [**Five**][**25**][**35**]<**Insert number**>.

D. Access Control System Supplementary Computer Equipment Antivirus and Security Protection Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Avast Software s.r.o.**]
b. [**McAfee, LLC**]
c. [**Microsoft Corporation**]
d. [**S.C. Bitdefender S.R.L.**]

e. [**Sophos Ltd.; Sophos Group plc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Avast Software s.r.o.**]
b. [**McAfee, LLC**]
c. [**Microsoft Corporation**]
d. [**S.C. Bitdefender S.R.L.**]
e. [**Sophos Ltd.; Sophos Group plc**]
f. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Endpoint detection and response.
b. Anti-ransomware.
c. Managed threat response.
d. Exploit prevention.
e. Active adversary mitigations.
f. Email alerts.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Internet Explorer**][**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**>.
e. Memory: [**1 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.

E. Credential Card Personalization Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Credential card design and data-entry customization.

b. Card data fields populated directly from internal or networked database.
c. User-defined privileges.
d. Quick filter for searching internal database.
e. Global find for searching all networked databases.
f. Customized reporting.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**1 GB**][**5 GB**][**10 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.

F. Credential Card Printer and Encoder Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Printer status and diagnostics information.
b. Diagnostics information.
c. Printer integration enables control of printing and encoding through software APIs.
d. Integrates with credential management systems through standard application programming interfaces (APIs).
e. Supports Standard Development Languages:

1) Microsoft Visual Basic.NET.
2) Visual C++.
3) Visual C#.
4) Oracle Java.

f. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web**

browser>.
d. Drive Space: [**1 GB**][**5 GB**][**10 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SOFTWARE

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Installation of Access Control Software: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with requirements in guide information for UL CCN ALVY, UL CCN CYBR, and UL CCN UOJK.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new access control software with existing equipment and network conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 281000 "Access Control" for physical and functional interfaces with access control system and for compliance with system-wide performance requirements.
3. Coordinate with Section 281400 "Access Control System Hardware" for products that require access control software specified in this Section for operation and compliance with system-wide performance requirements.
4. Coordinate with Section 284600 "Fire Detection and Alarm" for interfacing access control system inputs/outputs with fire-alarm system inputs/outputs.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SOFTWARE

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Software will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective software and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete software installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 10 00 00A

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SECTION 28 10 00 00B - ACCESS CONTROL SYSTEM HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control system units.
2. Access control system power supplies and battery chargers.
3. Access control system supplementary computer equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281300 "Access Control Software and Database Requirements" for software required to run hardware specified in this Section.
5. Section 281500 "Integrated Access Control Hardware Devices" for access control field devices controlled by hardware specified in this Section.

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. LAN: Local area network.

C. RAID: Redundant array of inexpensive disks; redundant array of independent disks.

D. RAM: Random-access memory.

E. WAN: Wide area network.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For access control system hardware. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Hardware and equipment locations.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. Hardware and equipment installation details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for access control system servers.
2. Installation instructions for access control system DGPs.
3. Installation instructions for access control system input/output interface.
4. Installation instructions for access control system door controllers.
5. Installation instructions for access control system workstation.
6. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
7. Installation instructions for access control system power supplies and battery chargers.
8. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
9. Installation instructions for access control system printers.
10. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical

testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY FOR ACCESS CONTROL SYSTEM HARDWARE

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system hardware perform in accordance with specified requirements and agrees to repair or replace systems, assemblies, components, or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that access control system hardware perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

1.9 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**Ten**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Extended-Warranty Period for Ni-MH Batteries: [**Three**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
4. Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
5. Warranted Cycle Life for Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

   a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
   b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.

c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

6. Warranted Cycle Life for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

   a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
   b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
   c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

7. Warranted Cycle Life for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)** and preventive maintenance performed in accordance with manufacturer's published instructions:

   a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
   b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
   c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM UNITS

A. Description: This category covers head end units for access control systems, providing a means of regulating or controlling physical entry into an area, or access to or use of device by electrical, electronic, and/or mechanical means. Access control systems are investigated as complete configuration based upon manufacturer's specified system components. Access control systems are intended to comply with applicable life safety access and egress requirements.

B. Performance Criteria:

1. Regulatory Requirements:

   a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Server :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cisco Systems, Inc.**]
   b. [**Dell Technologies Inc.**]
   c. [**International Business Machines Corp. (IBM)**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cisco Systems, Inc.**]
   b. [**Dell Technologies Inc.**]
   c. [**International Business Machines Corp. (IBM)**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Ethernet port for connection to LAN/WAN.
   b. <**Insert characteristics**>.

5. Options:

   a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
   b. Operating Temperature: [**50 to 82 deg F (10 to 28 deg C)**]<**Insert operating temperature**>.
   c. Server Type: [**IBM**][**Windows**][**Lenovo**]<**Insert make**>.
   d. Server Model: <**Insert model**>.
   e. Server Size: [**One rack-unit (1U)**][**Two rack-units (2U)**]<**Insert size**>.
   f. Drive Space: [**100 GB**][**500 GB**][**1 TB**]<**Insert size**>.
   g. Memory: [**16 GB**][**24 GB**][**32 GB**][**48 GB**]<**Insert size**> RAM.
   h. RAID Level: [**RAID 0**][**RAID 1**]<**Insert level**>.
   i. Mounting: EIA/ECA-310 standard **19 inch (482.6 mm)** [**rack mount**][**cabinet mount**].

6. Operation:

   a. <**Insert server operating requirements**>.

7. Accessories:

   a. DIN rails for mounting.

D. Access Control System DGPs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Honeywell Commercial Security; Honeywell International, Inc.**]

b. [**RS2 Technologies; ACRE, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell Commercial Security; Honeywell International, Inc.**]
b. [**RS2 Technologies; ACRE, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Data ports for connection to LAN and downstream DGPs.
b. Integral terminal blocks secured to enclosure.
c. Enclosure lock with tamper switch and monitoring.
d. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
b. Internal Power Supply: [**16.5 V(ac) transformer**][**24 V(dc) power supply**]<**Insert power supply**>.
c. Operating Temperature: [**32 to 120 deg F (0 to 49 deg C)**]<**Insert temperature**>.
d. Enclosure Size: <**Insert size**>.
e. Materials: [**Steel**]<**Insert material**>.
f. Finishes: <**Insert finish**>.
g. Battery Backup: [**12 V**][**24 V**]<**Insert battery type**>.
h. DGP Communication: [**Ethernet**][**TIA-485**]<**Insert type**>.
i. Mounting: [**Wall mount**][**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**].

6. Operation:

a. <**Insert panel operating requirements**>.

7. Accessories:

a. <**Insert accessory**>.

E. Access Control System Door Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HID Global; ASSA ABLOY**]
b. [**IDTECK Global, Inc.**]
c. [**Openpath Security, Inc.**]
d. [**RS2 Technologies; ACRE, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**HID Global; ASSA ABLOY**]
b. [**IDTECK Global, Inc.**]
c. [**Openpath Security, Inc.**]
d. [**RS2 Technologies; ACRE, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Data ports for connection to LAN and downstream controllers.
b. Integral terminal blocks for connection of inputs/outputs to field devices.
c. Controller Inputs:

1) Auxiliary input.
2) Door contact.
3) Request to exit.
4) Cabinet tamper.
5) Power monitor.

d. Controller Outputs:

1) Auxiliary output.
2) Door strike.
3) Door operators.
4) Credential readers.

e. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**12 to 24 V(dc)**]<**Insert power input**>.
b. Operating Temperature: [**32 to 158 deg F (0 to 70 deg C)**]<**Insert temperature**>.
c. Controller Size: <**Insert size**>.
d. Controller Communication: [**Ethernet**][**TIA-232**][**TIA-485**]<**Insert type**>.
e. Mounting: [**Cabinet mount**]<**Insert mounting arrangement**>.

6. Operation:

a. <**Insert controller operating requirements**>.

7. Accessories:

a. <**Insert accessory**>.

F. Access Control System Input/Output Interface :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LenelS2; Carrier Global Corporation**]
b. [**Openpath Security, Inc.**]

c. [**RS2 Technologies; ACRE, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**LenelS2; Carrier Global Corporation**]
   b. [**Openpath Security, Inc.**]
   c. [**RS2 Technologies; ACRE, LLC**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Input Voltage: [**12 to 24 V(dc)**]<**Insert power input**>.
   b. Operating Temperature: [**32 to 158 deg F (0 to 70 deg C)**]<**Insert temperature**>.
   c. Size: <**Insert size**>.
   d. Data ports for connection to LAN and downstream panels/controllers.
   e. Integral terminal blocks for connection of inputs/outputs to field devices.
   f. Inputs:

      1) Auxiliary inputs from building systems.
      2) Door contact.
      3) Request to exit.
      4) Cabinet tamper.
      5) Power monitor.

   g. Outputs:

      1) Auxiliary outputs to building systems.
      2) Door strike.
      3) Credential readers.
      4) Audible devices.

   h. <**Insert characteristics**>.

5. Options:

   a. Communication: [**Ethernet**][**TIA-232**][**TIA-485**]<**Insert type**>.
   b. Mounting: [**Cabinet mount**]<**Insert mounting arrangement**>.

6. Operation:

   a. <**Insert interface operating requirements**>.

7. Accessories:

   a. <**Insert accessory**>.

2.2 ACCESS CONTROL SYSTEM POWER SUPPLIES AND BATTERY CHARGERS

A. Description: This category covers power supplies and battery chargers for access control system units,

controllers, input/output interfaces, workstations, printers, and encoders.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Power Supply and Battery Charger :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Altronix Corp.**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**LifeSafety Power (LSP); ASSA ABLOY**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Altronix Corp.**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**LifeSafety Power (LSP); ASSA ABLOY**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
b. Output Voltage: [**12 to 24 V(dc)**]<**Insert power output**>.
c. Operating Temperature: [**32 to 120 deg F (0 to 49 deg C)**]<**Insert temperature**>.
d. Network connection for remote supervision, management, and testing.
e. Enclosure lock with tamper switch and monitoring.
f. Built-in battery charger.
g. Enclosure Size: <**Insert size**>.
h. Battery Size: <**Insert size**>.
i. Materials: [**Steel**]<**Insert material**>.
j. Finishes: <**Insert finish**>.
k. <**Insert characteristics**>.

5. Options:

a. Output Current: [**2.5 A**][**4 A**][**6 A**]<**Insert current**>.
b. Number of Outputs: [**One**][**Four**][**Eight**][**16**]<**Insert number**>.
c. Mounting: [**Wall mount**][**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**].

6. Operation:

   a. <**Insert power supply and charger operating requirements**>.

7. Accessories:

   a. DIN rails for mounting.

2.3 ACCESS CONTROL SYSTEM SUPPLEMENTARY COMPUTER EQUIPMENT

A. Description: This category covers access control system supplementary computer equipment that does not inhibit safety or intended operation of access control system hardware devices when they are shut off, lose power, or otherwise fail.

B. Performance Criteria:

1. Regulatory Requirements:

   a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN NWGQ; including UL 294.

C. Access Control System Workstation :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apple Inc.**]
   b. [**ASUSTek Computer Inc.**]
   c. [**Dell Technologies Inc.**]
   d. [**HP Inc.**]
   e. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
   f. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   g. [**Microsoft Corporation**]
   h. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apple Inc.**]
   b. [**ASUSTek Computer Inc.**]
   c. [**Dell Technologies Inc.**]
   d. [**HP Inc.**]
   e. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
   f. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
   g. [**Microsoft Corporation**]
   h. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
    b. Operating Temperature: [**50 to 82 deg F (10 to 28 deg C)**]<**Insert temperature**>.
    c. Ethernet port for connection to LAN/WAN.
    d. PC-based operating system with high-definition display.
    e. <**Insert characteristics**>.

5. Options:

    a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system and version**>.
    b. Display Size: [**22 inch (560 mm)**][**24 inch (610 mm)**]<**Insert size**>.
    c. Display Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
    d. Drive Space: [**100 GB**][**500 GB**][**1 TB**]<**Insert size**>.
    e. Memory: [**16 GB**][**24 GB**][**32 GB**][**48 GB**]<**Insert size**> RAM.
    f. User Control: [**Touchscreen**][**and**][**or**][**keyboard and mouse**].
    g. Mounting: [**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**][**desktop mount**].

6. Operation:

    a. <**Insert workstation operating requirements**>.

7. Accessories:

    a. Printer for identification/credential cards.
    b. Encoder for programming of access control credentials.
    c. <**Insert accessory**>.

D. Access Control System Printers and Encoders :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**HID Global; ASSA ABLOY**]
    b. [**Magicard Ltd.**]
    c. [**Zebra Technologies Corp.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**HID Global; ASSA ABLOY**]
    b. [**Magicard Ltd.**]
    c. [**Zebra Technologies Corp.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Password-protected access for secure printing.
    b. User Control: Touchscreen graphical display.

c. Mounting: Desktop mounted.
d. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**100 to 240 V(ac)**]<**Insert power input**>.
b. Operating Temperature: [**65 to 80 deg F (18 to 27 deg C)**]<**Insert temperature**>.
c. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system and version**>.
d. Data Connection: [**USB 2.0**][**Ethernet**]<**Insert connection type**>.
e. Standard Card Size: [**CR-79**][**CR-80**]<**Insert size**>.
f. Printing Resolution: [**300 dpi**]<**Insert resolution**>.
g. Memory: [**16 MB**][**32 MB**][**1 GB**]<**Insert size**> RAM.
h. Access Control Credential Programming: [**Proximity smart card**][**Magnetic stripe card**].
i. Interface with secure visitor management solutions.

6. Operations:

a. <**Insert printer and encoder operating requirements**>.

7. Accessories:

a. WiFi accessory for Ethernet-enabled printers.
b. <**Insert accessory**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM HARDWARE

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Installation of Access Control System Hardware and Wiring: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with requirements in guide information for UL CCN ALVY.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for access control system hardware with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 281000 "Access Control" for physical and functional interfaces with access control system and for compliance with system-wide performance requirements.
3. Coordinate with [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single-**

and Multiple-Station Alarms"] for interfacing security system inputs/outputs with fire-alarm system inputs/outputs.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM HARDWARE

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Hardware and components will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 ADJUSTING

A. Adjust printers and ribbons to function smoothly, and lubricate as recommended in writing by manufacturer.

3.5 PROTECTION

A. After installation, protect access control system hardware from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 28 10 00 00B

SECTION 28 15 00 00 - INTEGRATED ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Integrated credential readers and entry management.
2. Access control credentials.
3. Electrified locking devices and accessories.
4. Egress management devices.
5. Access control remote devices.
6. Electronic key management systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281511 "Integrated Credential Readers and Entry Management" for additional integrated access control hardware device products.
5. Section 281513 "Access Control Credentials" for additional access control hardware credential products.
6. Section 281515 "Electrified Locking Devices and Accessories" for additional electronically controlled lock and latch products.
7. Section 281517 "Egress Management Devices" for additional access control hardware device products intended for use along the means of egress.
8. Section 281519 "Access Control Remote Devices" for additional wireless access control hardware device products.
9. Section 281521 "Telephone Entry Systems" for access control telephone entry products.
10. Section 281523 "Intercom Entry Systems" for access control intercom entry products.
11. Section 281525 "Electronic Key Management Systems" for additional key management system products with access control interfaces.
12. Section 281527 "Access Control Electronic Turnstiles and Mobility Systems" for security turnstile operator products with access control interfaces.

1.2 DEFINITIONS

A. BMS: Building management system.

B. NFC: Near Field Communications.

C. PoE: Power over Ethernet.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For integrated access control hardware devices. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
3. Printing, programming, and handling instructions for access control credentials.
4. Installation instructions for electrified locking devices and accessories.
5. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
6. Installation instructions for egress management devices.
7. Manufacturer's recommended tests and inspections for egress management devices.
8. Installation instructions for access control remote devices.
9. Manufacturer's recommended tests and inspections for access control remote devices.
10. Installation instructions for electronic key management systems.
11. Manufacturer's recommended tests and inspections for electronic key management systems.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreements.

B. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Integrated Credential Readers and Entry Management Devices: [**One**]<**Insert number**> of each type.
2. Electrified Locking Devices and Accessories: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to integrated access control hardware devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.8 REGULATORY AGENCY APPROVALS FOR EGRESS MANAGEMENT DEVICES

A. Submittals for egress management devices requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for egress management devices require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.9 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.10 WARRANTY

A. Integrated Credential Readers and Entry Management Devices Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Special Manufacturer Extended Warranty: Manufacturer warrants that integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

a. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
b. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

B. Electrified Locking Devices and Accessories Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed electrified locking devices and accessories perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Special Manufacturer Extended Warranty: Manufacturer warrants that electrified locking devices and accessories perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

a. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
b. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Swipe Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**aptiQ; an Allegion brand**]
b. [**Cansec Systems Ltd.**]
c. [**HID Global; ASSA ABLOY**]
d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**aptiQ; an Allegion brand**]
b. [**Cansec Systems Ltd.**]
c. [**HID Global; ASSA ABLOY**]
d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) UL CCN ALVY; including UL 294.
2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

c. General Characteristics: Visual LED indication of card read.

5. Options:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
d. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
e. Colors: [**Black**][**Gray**]<**Insert color**>.
f. Climate: [**Indoor**][**and**][**outdoor**].
g. Size: [**Single gang**][**or**][**double gang**].

B. Proximity Reader for Card, Fob, or Smartphone :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Openpath Security, Inc.**]
g. [**XceedID; an Allegion brand**]

h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**XceedID; an Allegion brand**]
   h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

   a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Listing Criteria:

      1) UL CCN ALVY; including UL 294.
      2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

   c. General Characteristics: Visual LED indication of card read.

5. Options:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]**<Insert IP rating>**.
   b. Input Voltage: [**5 to 16 V(dc)**][**PoE**]**<Insert power input>**.
   c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]**<Insert temperature>**.
   d. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
   e. Transmit Frequency: [**125 kHz**][**13.56 MHz**][**2.4 GHz**].
   f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   g. Colors: [**Black**][**Gray**]**<Insert color>**.
   h. Climate: [**Indoor**][**and**][**outdoor**].
   i. Size: [**Single gang**][**or**][**double gang**].

6. Accessories:

   a. Long-range receiver module.

C. Door Lock Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

   a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Listing Criteria:

      1) UL CCN ALVY; including UL 294.
      2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Options:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   b. Visual LED indication of [**three-**][**or**][**six-**]digit code read.
   c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**][**Alkaline batteries**]<**Insert power input**>.
   d. Operating Temperature: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Size: [**Single gang**][**or**][**double gang**].
   i. Mounting:

      1) Door/window mullions.
      2) Outlet boxes.
      3) Flat surfaces.
      4) Integrated door lock keypad.

D. Scramble Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hirsch; a brand of Identiv, Inc.**]
   b. [**Schlage; an Allegion brand**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hirsch; a brand of Identiv, Inc.**]
   b. [**Schlage; an Allegion brand**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Options:

    a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
    b. Visual LED indication of [**three-**][**or**][**six-**][**or**][**nine-**]digit code read.
    c. Input Power: [**8 to 12 V(dc)**]<**Insert power input**>.
    d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert operating temperature**>.
    e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
    f. Colors: [**Black**][**Gray**]<**Insert color**>.
    g. Climate: [**Indoor**][**and**][**outdoor**].
    h. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

E. Combination Card Reader and Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
    b. [**Hirsch; a brand of Identiv, Inc.**]
    c. [**Open Options; ACRE, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
    b. [**Hirsch; a brand of Identiv, Inc.**]
    c. [**Open Options; ACRE, LLC**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

    c. General Characteristics: Visual LED indication of code and/or card read.

5. Options:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   b. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
   c. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
   d. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   e. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
   f. Climate: [**Indoor**][**and**][**outdoor**].
   g. Mounting:

      1) Surface mount.
      2) Triple-gang wall box.

2.2 ACCESS CONTROL CREDENTIALS

A. Access Control Cards :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   c. [**HID Global; ASSA ABLOY**]
   d. [**Hirsch; a brand of Identiv, Inc.**]
   e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   f. [**IDenticard Systems; Precision Dynamics Corporation**]
   g. [**IDTECK Global, Inc.**]
   h. [**Viking Electronics, Inc.**]
   i. [**XceedID; an Allegion brand**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cansec Systems Ltd.**]
   b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   c. [**HID Global; ASSA ABLOY**]
   d. [**Hirsch; a brand of Identiv, Inc.**]
   e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   f. [**IDenticard Systems; Precision Dynamics Corporation**]
   g. [**IDTECK Global, Inc.**]
   h. [**Viking Electronics, Inc.**]
   i. [**XceedID; an Allegion brand**]
   j. <**Insert manufacturer's name**>

3. Performance Criteria:

   a. Reference Standards:

      1) Personal Identity Verification (PIV): FIPS PUB 201-2.
      2) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.

3) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
4) Material Durability: INCITS 322.

b. Format: Customizable, including artwork.[**Provide credential template with provisions for the following:**]

1) On Front: Photograph, full name (surname first), affiliation, organization, card expiration date, color-coding, Owner's name, Owner's logo, two-dimensional bar code.
2) On Back: Physical characteristics of cardholder, employee ID number, card number, magnetic stripe, linear bar code, return address. Include the following message:

a) <**Insert message**>.

3) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, card authenticate data, and PIV authentication data.

4. Options:

a. Data Format: Wiegand [**26 bit**][**34 bit**][**37 bit**].
b. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
c. Data Retention: [**10**][**20**] years.
d. Memory Capacity: [**2.5 kB**][**8 kB**][**16 kB**][**32 kB**].
e. Operating Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**].
f. Materials: [**Plastic**][**ABS**][**PVC laminate**].
g. Color: [**White**][**Off-white**][**Glossy white**]<**Insert color**>.
h. Reading Medium: [**Multi-criteria use**][**Proximity**][**and**][**chip**][**and**][**magnetic strip**].

2.3 ELECTRIFIED LOCKING DEVICES AND ACCESSORIES

A. Electrically Controlled Single-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**Design Hardware; Mesker Openings Group; dormakaba**]
c. [**Schlage; an Allegion brand**]
d. [**Security Door Controls**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**Design Hardware; Mesker Openings Group; dormakaba**]
c. [**Schlage; an Allegion brand**]
d. [**Security Door Controls**]

e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) Electrically Controlled Single-Point Locks and Latches: UL CCN GYQS, UL 10B, and UL 10C; designed to be used with Class 2 control-voltage circuits in accordance with Article 725 of NFPA 70.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**AA batteries**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth, low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.
l. [**With**][**or**][**without**] deadbolt.

B. Electrically Controlled Three-Point Latches :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) Two- and Three-Point Locks and Latches: UL CCN GYXR; including UL 10B.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth, low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

C. Type 1 High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Security Products Co.**]
   b. [**dormakaba USA Inc.**]
   c. [**FireKing International**]
   d. [**NKL Industries Ltd.; FireKing International LLC**]
   e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
   f. [**SECURAM Systems Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

   a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Listing Criteria:

      1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
      2) High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.
      3) Type 1 Locks: UL CCN OZDU.

5. Options:

   a. [**Audible**][**and**][**visual**] indication of door unlock.
   b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
   c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
   d. Connectivity: [**Hardwired**][**Wireless**].
   e. Memory:

      1) Access time/date stamp stored in [**key**][**and**][**cylinder**].
      2) Audit Trail: [**100**][**1000**]<**Insert number**> events.
      3) Directory of authorized keys stored in cylinder.

   f. Cylinder Type: [**Single**][**Double**][**Mortise**]<**Insert type**>.
   g. Materials: [**Zinc**][**Steel**]<**Insert material**>.
   h. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
   i. Integrated credential reader.
   j. Failure Mode: [**Fail-safe**][**Fail-secure**].
   k. Mechanical key override.

D. Type 1F High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Kaba Mas - LA GARD; dormakaba Group**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Kaba Mas - LA GARD; dormakaba Group**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.
3) Type 1F Locks: [**UL CCN OZEM; including**]Fed. Spec. FF-L-2740.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Failure Mode: [**Fail-safe**][**Fail-secure**].
h. Mechanical key override.

E. Request-to-Exit (REX) Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

5. Options:

a. Input Power: [**125 V(ac)**]<**Insert power input**>.
b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
c. Sensing Technology: [**Passive infrared (PIR)**][**Active infrared (AIR)**].
d. Color: [**Black**][**Gray**][**White**]<**Insert color**>.
e. Mounting: [**Wall surface**][**Recessed in ceiling**][**Door frame**].

F. Request-to-Exit (REX) Push Button :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Schlage; an Allegion brand**]
c. [**Von Duprin; Allegion plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Schlage; an Allegion brand**]
c. [**Von Duprin; Allegion plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

5. Options:

a. Input Power: [**12 to 24 V(ac/dc)**]<**Insert power input**>.
b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert operating temperature**>.
c. Operating Mechanism: [**Pneumatic**][**Piezoelectric**].
d. Faceplate Material: [**Stainless steel**]<**Insert material**>.
e. Button Material: [**Plastic**][**Anodized aluminum**]<**Insert material**>.
f. Button Color: [**Green**][**Blue**][**Red**]<**Insert color**>.
g. Lettering Color: [**White**][**Black**]<**Insert color**>.
h. Failure Mode: [**Fail-safe**][**Fail-secure**].

2.4 EGRESS MANAGEMENT DEVICES

A. Magnetic Lock Hardware with Special Locking Arrangement for Fire-Rated Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
   b. [**BEA Americas; Halma plc**]
   c. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
   d. [**Hager Companies**]
   e. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
   f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
   g. [**Schlage; an Allegion brand**]
   h. [**Vanguard Security Engineering Corp. (VGSE)**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
   b. [**BEA Americas; Halma plc**]
   c. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
   d. [**Hager Companies**]
   e. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
   f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
   g. [**Schlage; an Allegion brand**]
   h. [**Vanguard Security Engineering Corp. (VGSE)**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

   a. Regulatory Requirements:

      1) Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
      2) Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

   b. Listing Criteria:

      1) Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
      2) Electromagnetic Locks for Fire-Rated Doors: UL CCN GWXT; including UL 10B and UL 10C.

5. Options:

   a. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
   b. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.

c. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
d. Relock Function: [**Manual**][**Delayed automatic**] relock.
e. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
f. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
g. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

B. Panic Hardware with Special Locking Arrangement for Fire-Rated Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
c. [**Detex Corporation**]
d. [**Kaba Mas - LA GARD; dormakaba Group**]
e. [**Von Duprin; Allegion plc**]
f. [**Yale Security Inc; ASSA ABLOY**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
c. [**Detex Corporation**]
d. [**Kaba Mas - LA GARD; dormakaba Group**]
e. [**Von Duprin; Allegion plc**]
f. [**Yale Security Inc; ASSA ABLOY**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements:

1) Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2) Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
2) Panic Hardware for Fire-Rated Doors: UL CCN GXHX, UL 10C, and UL 305.
3) Controlled-Exit Panic Devices: UL CCN FULA; including UL 305.

5. Options:

a. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
b. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.

c. Door Prop Alarm: [**None**][**Activate after 30 seconds**]<**Insert delay**>.
d. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].
e. Secondary Power: [**9 V battery**]<**Insert power source**>.

2.5 ACCESS CONTROL REMOTE DEVICES

A. Near Field Communications (NFC) Access Control Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Schlage; an Allegion brand**]
g. [**XceedID; an Allegion brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Schlage; an Allegion brand**]
g. [**XceedID; an Allegion brand**]
h. <**Insert manufacturer's name**>

3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

4. Options:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Input Voltage: [**5 to 12 V(dc)**][**PoE**]<**Insert voltage**>.
c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
d. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
e. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
g. Colors: [**Black**][**Gray**]<**Insert color**>.
h. Climate: [**Indoor**][**and**][**outdoor**].
i. Size: [**Single gang**][**or**][**double gang**].

2.6 ELECTRONIC KEY MANAGEMENT SYSTEMS

A. Electronic Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Deister Electronic USA, Inc.**]
   b. [**KEYper Systems; Marcon International, Inc.**]
   c. [**MATRIX Cabinet**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Deister Electronic USA, Inc.**]
   b. [**KEYper Systems; Marcon International, Inc.**]
   c. [**MATRIX Cabinet**]
   d. <**Insert manufacturer's name**>

3. Performance Criteria:

   a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Listing Criteria: UL CCN ALZK; including UL 294.

4. Options:

   a. Input Voltage: [**110 to 240 V(ac)**]<**Insert voltage**>.
   b. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
   c. Key Storage Capacity: <**Insert number**>.
   d. Operating Frequency: [**125 kHz**][**13.56 MHz**].
   e. Materials: [**Stainless steel**]<**Insert material**>.
   f. Finishes: [**Powder coated**]<**Insert finish**>.
   g. Backup Battery: [**12 V(dc)**]<**Insert battery size**>.
   h. Front Cover: [**Clear display window**][**Solid panel**].
   i. Enclosure Size: <**Insert size**>.

5. Operation:

   a. Access Method: [**Proximity card**][**and**][**biometrics**][**and**][**keypad**][**and**][**standard key**].
   b. Alarm output: [**Local sounder**][**Output contacts**].

PART 3 - EXECUTION

3.1 DEPLOYMENT OF CREDENTIALS

A. Comply with manufacturer's published instructions.

B. Third-Party Issuing of Access Control Credentials:

1. Printing of New Credentials: Contractor must be capable of programming and issuing credentials compatible with Owner's access control system.

   a. Initial Issuance: Provide spreadsheet or form for collecting data for generation of credentials. Owner will submit completed form containing data for personnel to be issued credentials. Print and provide initial run, printed and programmed credentials in specified format within [**four**]<**Insert number**> weeks of request.
   b. Ongoing Issuance: Produce additional credentials upon Owner request. Owner will submit completed form containing data for personnel to be issued credentials. Print and program credentials in specified format within [**one**][**two**] weeks of request.

3.2 INSTALLATION OF INTEGRATED ACCESS CONTROL HARDWARE DEVICES

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Analog Maximum Cable Length: [**1000 ft (300 m)**]<**Insert cable length**>.
3. Digital Maximum Cable Length: [**300 ft (100 m)**][**500 ft (150 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for access control hardware devices with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate access control credentials with integrated credential readers and access control system architecture.
3. Egress Management Interfaces:

   a. Coordinate with Section 282000 "Video Surveillance" for automatic video feed callup upon delayed egress activation.
   b. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" for monitoring of egress management device alarms by BMS.
   c. Coordinate with Section 284600 "Fire Detection and Alarm" for monitoring of egress management device alarms by fire-alarm system.

3.3 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service**

representative].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.4 PROTECTION

A. After installation, protect integrated access control hardware devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00

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SECTION 28 15 00 00A - ACCESS CONTROL CREDENTIALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control credentials.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official deployment[**and testing**] instructions issued to Contractor by manufacturer for the following:

1. Printing, programming, and handling instructions for access control credentials.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS FOR CONTINUED USE

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 ACCESS CONTROL CREDENTIALS

A. Access Control Cards :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

3. Standard Features:

a. Reference Standards:

1) Personal Identity Verification (PIV): FIPS PUB 201-2.
2) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
3) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
4) Material Durability: INCITS 322.

b. Configuration: Customizable, including artwork.[**Provide credential template with provisions for the following:**]

1) On Front: Photograph, full name (surname first), affiliation, organization, card expiration date, color-coding, Owner's name, Owner's logo, two-dimensional bar code.
2) On Back: Physical characteristics of cardholder, employee ID number, card number, magnetic stripe, linear bar code, return address. Include the following message:

a) <**Insert message**>.

3) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, card authenticate data, and PIV authentication data.

c. Data Format: Wiegand [**26 bit**][**34 bit**][**37 bit**].

d. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
e. Data Retention: [**10**][**20**] years.
f. Memory Capacity: [**2.5 kB**][**8 kB**][**16 kB**][**32 kB**].
g. Operating Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
h. Materials: [**Plastic**][**ABS**][**PVC laminate**].
i. Color: [**White**][**Off-white**][**Glossy white**]<**Insert color**>.
j. Reading Medium: [**Multi-criteria use**][**Proximity**][**and**][**chip**][**and**][**magnetic strip**].

B. Wireless Key Fobs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Reference Standards:

1) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
2) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
3) Material Durability: INCITS 322.

b. Configuration: Customizable, including artwork.

1) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, and card authenticate data.

c. Memory: [**1 kB**][**4 kB**][**80 kB**].
d. Operating Temperature: [**Minus 49 to plus 185 deg F (Minus 45 to plus 85 deg C)**]<**Insert temperature range**>.
e. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
f. Read Range: Up to [**3/4 inch (19 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
g. Format: Wiegand [**26 bit**][**37 bit**].
h. Data Retention: [**10**][**20**] years.
i. Materials: [**Plastic**][**Epoxy**][**Polycarbonate**][**ABS shell with TPE insert**].
j. Color: [**Dark gray**][**Black**][**Transparent blue**][**White**]<**Insert color**>.
k. Connector: USB 2.0 connector, Type A (male).

l. External numbering.

4. Accessories:

a. Key ring.

PART 3 - EXECUTION

3.1 DEPLOYMENT

A. Comply with manufacturer's published instructions.

B. Third-Party Issuing of Access Control Credentials:

1. Printing of New Credentials: Contractor must be capable of programming and issuing credentials compatible with Owner's access control system.

a. Initial Issuance: Provide spreadsheet or form for collecting data for generation of credentials. Owner will submit completed form containing data for personnel to be issued credentials. Print and provide initial run, printed and programmed credentials in specified format within [**four**]<**Insert number**> weeks of request.

b. Ongoing Issuance: Produce additional credentials upon Owner request. Owner will submit completed form containing data for personnel to be issued credentials. Print and program credentials in specified format within [**one**][**two**] weeks of request.

C. Interfaces with Other Work:

1. Coordinate access control credentials with integrated credential readers and access control system architecture.

END OF SECTION 28 15 00 00A

SECTION 28 15 00 00B - ELECTRIFIED LOCKING DEVICES AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrically controlled single-point locks and latches.
2. Electrically controlled two- and three-point locks and latches.
3. High-security electronic locks.
4. Status monitoring and egress devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. NFC: Near Field Communications.

B. PoE: Power over Ethernet.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For electrified locking devices and accessories. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Electrically controlled single-point locks and latches.
2. Electrically controlled two- and three-point locks and latches.
3. High-security electronic locks.
4. Status monitoring and egress devices.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for electrified locking devices and accessories.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Firmware service agreement.

B. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Electrified Locking Devices and Accessories: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to electrified locking devices and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed electrified locking devices and accessories perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that electrified locking devices and accessories perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 ELECTRICALLY CONTROLLED SINGLE-POINT LOCKS AND LATCHES

A. Description: This category covers single-point electrified locksets, including cylindrical and mortise-style locks, which are connected to the access control system via hardwired cabling or wireless. Electrified locksets communicate with credential readers through the access control system to unlock doors upon credential authorization. Electrified locksets may also be programmed to lock or unlock directly via a signal from the access control system without the need for credential authorization.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.

b. Electrically Controlled Single-Point Locks and Latches: UL CCN GYQS, UL 10B, and UL 10C; designed to be used with Class 2 control-voltage circuits in accordance with Article 725 of NFPA 70.

C. Electrically Controlled Single-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
   b. [**Design Hardware; Mesker Openings Group; dormakaba**]
   c. [**Schlage; an Allegion brand**]
   d. [**Security Door Controls**]
   e. [**Yale Security Inc; ASSA ABLOY**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
   b. [**Design Hardware; Mesker Openings Group; dormakaba**]
   c. [**Schlage; an Allegion brand**]
   d. [**Security Door Controls**]
   e. [**Yale Security Inc; ASSA ABLOY**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

   a. [**Audible**][**and**][**visual**] indication of door unlock.
   b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**AA batteries**]<**Insert power input**>.
   c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
   d. Connectivity: [**Hardwired**][**Wireless**].
   e. Materials: [**Zinc**]<**Insert material**>.
   f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
   g. Integrated Credential Reader:

      1) Proximity (125 kHz).
      2) Smart (13.56 MHz).
      3) Bluetooth low energy (2.4 GHz).
      4) NFC.

   h. Integrated [**combination lock**][**keypad**].
   i. Failure Mode: [**Fail-safe**][**Fail-secure**].
   j. Mechanical key override.
   k. Latch bolt monitor.
   l. [**With**][**or**][**without**] deadbolt.

2.2 ELECTRICALLY CONTROLLED TWO- AND THREE-POINT LOCKS AND LATCHES

A. Description: This category covers two- and three-point electrified locksets, which are connected to the access control system via hardwired cabling or wireless. Electrified locksets communicate with credential readers through the access control system to unlock doors upon credential authorization. Electrified locksets may also be programmed to lock or unlock directly via a signal from the access control system without the need for credential authorization.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
b. Two- and Three-Point Locks and Latches: UL CCN GYXR; including UL 10B.

C. Electrically Controlled Two-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).

3) Bluetooth low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

D. Electrically Controlled Three-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

2.3 HIGH-SECURITY ELECTRONIC LOCKS

A. Description: This category covers high-security electronic locks, which are connected to the access control system via hardwired cabling or wireless. High-security electronic locks typically have multilevel authentication or utilize heavy-duty components for increased security.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
b. High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.

C. Type 1 High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: UL CCN OZDU.
5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Memory:

1) Access time/date stamp stored in [**key**][**and**][**cylinder**].

2) Audit Trail: [**100**][**1000**]<**Insert number**> events.
3) Directory of authorized keys stored in cylinder.

f. Cylinder Type: [**Single**][**Double**][**Mortise**]<**Insert type**>.
g. Materials: [**Zinc**][**Steel**]<**Insert material**>.
h. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
i. Integrated credential reader.
j. Failure Mode: [**Fail-safe**][**Fail-secure**].
k. Mechanical key override.

D. Type 1F High-Security Combination Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Kaba Mas - LA GARD; dormakaba Group**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Kaba Mas - LA GARD; dormakaba Group**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: [**UL CCN OZEM; including**]Fed. Spec. FF-L-2740.
5. Options:

   a. [**Audible**][**and**][**visual**] indication of door unlock.
   b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**][**Electromechanically self-powered**]<**Insert power input**>.
   c. Operating Temperature: [**Minus 10 to plus 155 deg F (Minus 23 to plus 68 deg C)**]<**Insert temperature**>.
   d. Connectivity: [**Hardwired**][**Wireless**].
   e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
   f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
   g. Failure Mode: [**Fail-safe**][**Fail-secure**].
   h. Mechanical key override.

E. Type 2 High-Security Combination Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Security Products Co.**]
   b. [**dormakaba USA Inc.**]
   c. [**NKL Industries Ltd.; FireKing International LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**NKL Industries Ltd.; FireKing International LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: UL CCN OZFE.
5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert operating temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated credential reader.
h. Request-to-Exit (REX) switch.
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Keyed Cylinder Configurations:

1) Standard key in lever.
2) Small-format interchangeable core (SFIC).
3) Yale large-format removeable core.

2.4 STATUS MONITORING AND EGRESS DEVICES

A. Description: This category covers egress devices and sensors, which are installed integral to or adjacent to door assemblies. Equipment under this category may be interconnected to other access control equipment, such as credential readers and locking devices. Equipment under this category may also be directly connected to the access control system to report door status.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Request-to-Exit (REX) Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
   b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   c. [**Vicon Industries, Inc**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

   a. Input Power: [**125 V(ac)**]<**Insert power input**>.
   b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
   c. Sensing Technology [**Passive infrared (PIR)**][**Active infrared (AIR)**].
   d. Color: [**Black**][**Gray**][**White**]<**Insert color**>.
   e. Mounting: [**Wall surface**][**Recessed in ceiling**][**Door frame**].

D. Request-to-Exit (REX) Push Button :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
   b. [**Schlage; an Allegion brand**]
   c. [**Von Duprin; Allegion plc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
   b. [**Schlage; an Allegion brand**]
   c. [**Von Duprin; Allegion plc**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

   a. Input Power: [**12 to 24 V(ac/dc)**]<**Insert power input**>.
   b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
   c. Operating Mechanism: [**Pneumatic**][**Piezoelectric**].
   d. Faceplate Material: [**Stainless steel**]<**Insert material**>.
   e. Button Material: [**Plastic**][**Anodized aluminum**]<**Insert material**>.
   f. Button Color: [**Green**][**Blue**][**Red**]<**Insert color**>.
   g. Lettering Color: [**White**][**Black**]<**Insert color**>.
   h. Failure Mode: [**Fail-safe**][**Fail-secure**].

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**15 ft (5 m)**][**50 ft (15 m)**][**100 ft (30 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for electrified locking devices and accessories with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect electrified locking devices and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00B

SECTION 28 15 00 00C - EGRESS MANAGEMENT DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnetic lock hardware with special locking arrangement for non-fire-rated doors.
2. Magnetic lock hardware with special locking arrangement for fire-rated doors.
3. Panic hardware with special locking arrangement for fire-rated doors.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. BMS: Building management system.

B. NFC: Near Field Communications.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For egress management devices. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.

4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for egress management devices.
2. Manufacturer's recommended tests and inspections for egress management devices.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to egress management devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for egress management devices requiring approval by authorities having jurisdiction must be signed and sealed by qualified professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for egress management devices require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with

[**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 MAGNETIC LOCK HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR NON-FIRE-RATED DOORS

A. Description: Magnetic lock connected to access control system and programmed for desired function. Magnetic lock may be programmed for release by access control system. Magnetic lock may also be pressure sensing, programmed to release and alarm after pressure is applied for a designated period.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Camden Door Controls**]
2. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
3. [**Schlage; an Allegion brand**]
4. [**SECO-LARM U.S.A., Inc.**]
5. [**Vanguard Security Engineering Corp. (VGSE)**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Camden Door Controls**]
2. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
3. [**Schlage; an Allegion brand**]
4. [**SECO-LARM U.S.A., Inc.**]
5. [**Vanguard Security Engineering Corp. (VGSE)**]
6. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
b. Electromagnetic Locks for Non-Fire-Rated Doors: UL CCN CVYT; including UL 1034.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.

2. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.
3. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
4. Relock Function: [**Manual**][**Delayed automatic**] relock.
5. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
6. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
7. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

2.2 MAGNETIC LOCK HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR FIRE-RATED DOORS

A. Description: Magnetic lock connected to access control system and programmed for desired function. Magnetic lock may be programmed for release by access control system. Magnetic lock may also be pressure sensing, programmed to release and alarm after pressure is applied for a designated period.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
2. [**BEA Americas; Halma plc**]
3. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
4. [**Hager Companies**]
5. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
6. [**SARGENT Manufacturing Company; ASSA ABLOY**]
7. [**Schlage; an Allegion brand**]
8. [**Vanguard Security Engineering Corp. (VGSE)**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
2. [**BEA Americas; Halma plc**]
3. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
4. [**Hager Companies**]
5. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
6. [**SARGENT Manufacturing Company; ASSA ABLOY**]
7. [**Schlage; an Allegion brand**]
8. [**Vanguard Security Engineering Corp. (VGSE)**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

   a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
   b. Electromagnetic Locks for Fire-Rated Doors: UL CCN GWXT; including UL 10B and UL 10C.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
2. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.
3. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
4. Relock Function: [**Manual**][**Delayed automatic**] relock.
5. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
6. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
7. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

2.3 PANIC HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR FIRE-RATED DOORS

A. Description: This category covers devices mounted on outward-swinging exit doors to facilitate egress. When activated, devices monitor against unauthorized egress and allow exiting after specified time delay. These devices allow immediate exit in case of power failure or upon activation of fire-alarm system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
2. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
3. [**Detex Corporation**]
4. [**Kaba Mas - LA GARD; dormakaba Group**]
5. [**Von Duprin; Allegion plc**]
6. [**Yale Security Inc; ASSA ABLOY**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
2. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
3. [**Detex Corporation**]
4. [**Kaba Mas - LA GARD; dormakaba Group**]
5. [**Von Duprin; Allegion plc**]
6. [**Yale Security Inc; ASSA ABLOY**]
7. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory

recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
b. Panic Hardware for Fire-Rated Doors: UL CCN GXHX, UL 10C, and UL 305.
c. Controlled-Exit Panic Devices: UL CCN FULA; including UL 305.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
2. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
3. Door Prop Alarm: [**None**][**Activate after 30 seconds**]<**Insert delay**>.
4. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].
5. Secondary Power: [**9 V battery**]<**Insert power source**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF EGRESS MANAGEMENT DEVICES

A. Comply with manufacturer's published instructions.

B. Interfaces with Other Work:

1. Coordinate installation of new products for egress management devices with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 282000 "Video Surveillance" for coordination of automatic video feed callup upon delayed egress activation.
3. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" for monitoring of egress management device alarms by BMS.
4. Coordinate with Section 284600 "Fire Detection and Alarm" for monitoring of egress management device alarms by fire-alarm system.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

END OF SECTION 28 15 00 00C

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SECTION 28 15 00 00D - TELEPHONE ENTRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Analog audio telephone entry systems.
2. Digital audio-video telephone entry systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For telephone entry systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Analog audio telephone entry systems.
2. Digital audio-video telephone entry systems.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for telephone entry systems.
2. Manufacturer's recommended tests and inspections for telephone entry systems.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to telephone entry systems, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed telephone entry system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that telephone entry system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 ANALOG AUDIO TELEPHONE ENTRY SYSTEMS

A. Description: This category covers telephone entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CellGate**]
2. [**DoorKing, Inc**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CellGate**]
2. [**DoorKing, Inc**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.
3. General Characteristics:

a. Minimum Ring Voltage: 25 V(ac rms).
b. Maximum Ring Voltage: 90 V(ac rms).

E. Options:

1. Operating Temperature Range: [**Minus 29 to plus 140 deg F (Minus 34 to plus 60 deg C)**]<**Insert temperature range**>.
2. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
3. CPC Disconnect Time: [**300 ms**][**500 ms**] minimum.

4. REN: [**0.5 A**][**0.8 A**].
5. Materials: [**Painted aluminum**][**Stainless steel**]<**Insert material**>.
6. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**]<**Insert finish**>.
7. Built-in Reader: [**125 kHz**][**and**][**13.56 MHz**] Wiegand proximity card reader.

    a. Proximity Card Reader Power: 5 to 14 V(dc).
    b. Proximity Card Reader Range: **1-1/4 to 2 inch (32 to 51 mm)**.

8. Mounting: [**Wall**][**Flat-sided post**] mounted.
9. Auto Answer: Selectable.
10. Speed Dial Buttons: [**12**]<**Insert number**>.
11. Keyless Entry Code Capacity: [**50**]<**Insert number**>.
12. Communications: [**VoIP**][**POTS**].
13. Input Power: [**12 to 24 V(ac/dc)**][**Telephone line powered 20 V(dc)**].

F. Accessories:

1. Surface-mount box.
2. Pedestal-mount kit.

2.2 DIGITAL AUDIO-VIDEO TELEPHONE ENTRY SYSTEMS

A. Description: This category covers digital audio-video telephone entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CellGate**]
2. [**Enterphone; a brand of Identiv, Inc.**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CellGate**]
2. [**Enterphone; a brand of Identiv, Inc.**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 4 to plus 130 deg F (Minus 20 to plus 55 deg C)**].
2. Input Power: [**120 V(ac)**][**13.8 V(ac) adapter**][**12 to 24 V(ac/dc)**].
3. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.

4. CPC Disconnect Time: [**300 ms**][**500 ms**] minimum.
5. REN: [**0.5 A**][**0.8 A**].
6. Materials: [**Painted aluminum**][**Stainless steel**]<**Insert material**>.
7. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**]<**Insert finish**>.
8. Built-in Reader: [**125 kHz**][**and**][**13.56 MHz**] Wiegand proximity card reader.

    a. Proximity Card Reader Power: 5 to 14 V(dc).
    b. Proximity Card Reader Range: **1-1/4 to 2 inch (32 to 51 mm)**.

9. Video Camera: Color video camera with wide viewing angle and tilt/swivel adjustments.

    a. Display: [**7 inch (178 mm)**][**11 inch (279 mm)**] full-color[**touchscreen**].
    b. Camera Relay Contact: [**0.5 A at 125 V(ac)**][**1.0 A at 30 V(dc)**].
    c. Camera Power: [**6 to 22 V(dc)**][**12 V(dc) adapter**].
    d. Camera Field of View: [**80**][**90**] degrees.
    e. Camera Tilt/Swivel Adjustment: Vertical plus-or-minus 20 degrees; horizontal plus-or-minus 30 degrees.
    f. Night Vision: [**Infrared Illumination**][**Optical filter**].

10. Mounting: Devices must be [**wall**][**flat-sided post**] mounted.
11. Auto Answer: Selectable.
12. Speed Dial Buttons: [**12**]<**Insert number**>.
13. Keyless Entry Code Capacity: [**50**]<**Insert number**>.

F. Accessories:

1. Surface-mount box.
2. Pedestal-mount kit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**1000 ft (300 m)**]<**Insert length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for telephone entry system with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. System will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

3.4 PROTECTION

A. After installation, protect telephone entry system from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version.

Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00D

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SECTION 28 15 00 00E - INTERCOM ENTRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital audio intercom entry systems.
2. Digital audio-video intercom entry systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For intercom entry system. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Digital audio intercom entry systems.
2. Digital audio-video intercom entry systems.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation and startup instructions for intercom entry systems.
2. Manufacturer's recommended tests and inspections for intercom entry systems.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to intercom entry system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed intercom entry system perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that intercom entry system perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 DIGITAL AUDIO INTERCOM ENTRY SYSTEMS

A. Description: This category covers digital audio intercom entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Stentofon; a brand of Zenitel USA**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Stentofon; a brand of Zenitel USA**]
3. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 29 to plus 150 deg F (Minus 34 to plus 65 deg C)**].
2. Input Power: [**18 to 24 V(dc)**].
3. Connectivity: [**Hardwired**][**Wireless**].
4. Minimum Ring Voltage: 25 V(ac rms).
5. Maximum Ring Voltage: 90 V(ac rms).
6. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
7. Materials: [**Painted aluminum**][**Stainless steel**].
8. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**][**Satin white**][**Satin black**][**Textured black**].
9. Climate: [**Indoor**][**and**][**outdoor**].

10. Mounting: Devices must be [**wall**][**flat-sided post**][**gooseneck pedestal**][**flush**] mounted.
11. Push-to-talk button.

F. Accessories:

1. [**Surface**][**Recessed**] back box.
2. External keypad.
3. Mounting adaptor plate.
4. Mullion mounting bracket.
5. Desk stand.

2.2 DIGITAL AUDIO-VIDEO INTERCOM ENTRY SYSTEMS

A. Description: This category covers digital audio-video intercom entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**CAME Americas Automation LLC**]
3. [**Enterphone; a brand of Identiv, Inc.**]
4. [**Stentofon; a brand of Zenitel USA**]
5. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**CAME Americas Automation LLC**]
3. [**Enterphone; a brand of Identiv, Inc.**]
4. [**Stentofon; a brand of Zenitel USA**]
5. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 29 to plus 150 deg F (Minus 34 to plus 65 deg C)**].
2. Input Power: [**18 to 24 V(dc)**].
3. Connectivity: [**Hardwired**][**Wireless**].
4. Minimum Ring Voltage: 25 V(ac rms).
5. Maximum Ring Voltage: 90 V(ac rms).
6. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
7. Materials: [**Painted aluminum**][**Stainless steel**].
8. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**][**Polished brass**][**Satin white**][**Satin black**].
9. Climate: [**Indoor**][**and**][**outdoor**].

10. Mounting: Devices must be [**wall**][**flat-sided post**][**gooseneck pedestal**] mounted.
11. Video Camera:

    a. Display: [**7 inch (178 mm)**][**11 inch (279 mm)**] full-color[**touchscreen**].
    b. Camera Input Power: [**6 to 22 V(dc)**][**12 V(dc) adapter**].
    c. Camera Field of View: 80 degrees horizontal, 60 degrees vertical, and 100 degrees diagonal.
    d. Camera Tilt/Swivel Adjustment: Vertical plus-or-minus 20 degrees; horizontal plus-or-minus 30 degrees.

F. Accessories:

1. [**Surface**][**Recessed**] back box.
2. External keypad.
3. Mounting adaptor plate.
4. Mullion mounting bracket.
5. Desk stand.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Hardwired System:

    a. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
    b. Maximum Line Loop Cable Length: [**6300 ft (1.9 km)**]<**Insert cable length**>.
    c. Maximum Power-over-Ethernet Cable Length: [**150 ft (50 m)**][**300 ft (100 m)**][**450 ft (150 m)**].

2. Wireless Systems:

    a. Maintain compliance with [**Owner's**][**Project**] wireless standards specified in Division 27.
    b. <**Insert requirement**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for intercom entry systems with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Division 27 for wireless network provisioning of wireless intercom entry systems.

D. Wireless Security:

1. IP Security:

    a. Hardware Root of Trust.
    b. SSH.
    c. HTTPS.

d. Firewall.

2. Software Integrity Check: [**SHA256**]<**Insert type**>.
3. Access to system management is restricted via a separate interface.
4. Smartphone Interface: [**Enable**][**Disable**] smartphone connectivity.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. System will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

3.4 PROTECTION

A. After installation, protect intercom entry system from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00E

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SECTION 28 15 00 00F - ELECTRONIC KEY MANAGEMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Key management system units.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For key management systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Key management system units.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. System mounting details.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for key management systems.
2. Manufacturer's recommended tests and inspections for key management systems.

1.5 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 KEY MANAGEMENT SYSTEM UNITS

A. Description: This category covers units for key management systems providing a means of regulating or controlling keys by electrical, electronic and/or mechanical means. Key management systems allow authorized users access to keys upon verification of appropriate credentials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALZK; including UL 294.

C. Electronic Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

3. Options:

a. Input Voltage: [**110 to 240 V(ac)**]<**Insert voltage**>.
b. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
c. Key Storage Capacity: <**Insert number**>.
d. Operating Frequency: [**125 kHz**][**13.56 MHz**].
e. Materials: [**Stainless steel**]<**Insert material**>.
f. Finishes: [**Powder coated**]<**Insert finish**>.
g. Backup Battery: [**12 V(dc)**]<**Insert battery size**>.
h. Front Cover: [**Clear display window**][**Solid panel**].
i. Enclosure Size: <**Insert size**>.

4. Operation:

a. Access Method: [**Proximity card**][**and**][**biometrics**][**and**][**keypad**][**and**][**standard key**].
b. Alarm Output: [**Local sounder**][**Output contacts**].

D. Mechanical Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**XceedID; an Allegion brand**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**XceedID; an Allegion brand**]
d. <**Insert manufacturer's name**>

3. Options:

a. Key Storage Capacity: <**Insert number**>.
b. Materials: [**Stainless steel**]<**Insert material**>.
c. Finishes: [**Powder coated**]<**Insert finish**>.
d. Front Cover: [**Clear display window**][**Solid panel**].
e. Enclosure Size: <**Insert size**>.

4. Accessories:

a. Mirror hangers.
b. Tamper deals.
c. Key plugs.

d. Access pegs.
e. Key connectors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Interfaces with Other Work:

1. Coordinate installation of new products for key management system units with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect key management system units from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 28 15 00 00F

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SECTION 28 15 00 00G - ACCESS CONTROL ELECTRONIC TURNSTILES AND MOBILITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Turnstile operators with access control devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For electronic turnstiles. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for electronic turnstiles.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Maintenance service agreement.
2. Software and firmware service agreement.

B. Warranty documentation.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed turnstile operators with access control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that turnstile operators with access control devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 TURNSTILE OPERATORS WITH ACCESS CONTROL DEVICES

A. Description: This category covers electrical and pneumatic turnstile operators, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aeroturn**]
2. [**Gunnebo; Gunnebo Group**]
3. [**Orion Entrance Control, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aeroturn**]
2. [**Gunnebo; Gunnebo Group**]
3. [**Orion Entrance Control, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements:

   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Comply with the United States Access Board's ADA-ABA Accessibility Guidelines, NFPA 101, and accessibility requirements enforced by authorities having jurisdiction.

2. Listing Criteria:

   a. Turnstile Operators: UL CCN FDDR; including UL 325.
   b. Access Control Devices: UL CCN ALVY; including UL 294.

3. General Characteristics:

   a. Access Control System Integration: Integrated with access control system to grant or deny access to facility.
   b. Accessibility: Coordinated[**with Architect**] to accommodate accessibility requirements where required.
   c. Key Override: Manual key emergency open override available at turnstile cabinet.

d. Climb-over Detection: Sensors detect attempts to circumvent turnstile by climbing or jumping over, activating local alarm.

E. Options:

1. Capable of using [**flush-**][**or**][**surface-**]mounted readers.
2. Reader Mounting Location: [**Top**][**Front**][**Side**].
3. Directional Control: [**Allow free egress**][**Prohibit passage**] in direction opposite of credential reading.
4. Odometer: Passageway odometer is to be [**internally**][**or**][**remotely**] mounted.
5. Locking: Normally locked in the [**egress**][**and**][**ingress**] directions.
6. Operating Element: [**Drop arm**][**Rotary tripod**][**Full-height glazed portal**][**Partial-height glazed portal**].
7. Mounting: Devices must be [**floor**][**wall**][**ceiling**] mounted.
8. Finishes:

a. Stainless steel.
b. Galvanized painted steel.
c. Cast aluminum with painted gray finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL ELECTRONIC TURNSTILES AND MOBILITY SYSTEMS

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable type**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for turnstile operator with access control device with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Division 02[**and Division 03**] to perform cutting/drilling of existing floor slab for installation of electronic turnstiles.
3. Coordinate with Division 26 to provide power to electronic turnstiles.
4. Coordinate with Section 284600 "Fire Detection and Alarm" to interface fire-alarm control circuit with turnstiles to automatically open upon alarm activation.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and

inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for turnstile operator and access control device.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect turnstile operators and access control devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of turnstile operator with access control device Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper turnstile operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes**

operating system and new or revised licenses for using software.]

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00G

Task	Specification	Specification Description
28 15 00 00	28 10 00 00	Access Control
28 15 00 00	28 10 00 00a	Access Control Software and Database Management
28 15 00 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 15 11 00 - INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Credential readers.
2. Keypads.
3. Biometric identity devices.
4. Combination reader devices.

B. Products Installed, but Not Furnished, under This Section:

1. **<Insert products identified in "Owner-Furnished Products" Article, "Existing Products to be Modified" Article, or "Existing Products to be Removed and Re-Installed" Article>**.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281513 "Access Control Credentials" for credential products for use with reader devices.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 DEFINITIONS

A. PoE: Power over Ethernet.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For integrated credential readers and entry management systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.5 ACTION SUBMITTALS

A. Product Data: For each product type.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Inspection and testing recommendations for integrated credential readers and entry management devices.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for firmware upgrades.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Firmware service agreement.

B. Warranty documentation.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

B. Special tools.

1.9 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.10 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

1. Sustainable Design Features:

   a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

1. Sustainable Design Features:

   a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.5 CREDENTIAL READERS

A. Description: Electronic devices that read one or more types of access credentials and are part of overall access control system. These devices read and transfer credential info to access control system for control of door locks and other access control components.

B. Swipe Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**aptiQ; an Allegion brand**]
   b. [**Cansec Systems Ltd.**]
   c. [**HID Global; ASSA ABLOY**]
   d. [**Peripheral Dynamics, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**aptiQ; an Allegion brand**]
   b. [**Cansec Systems Ltd.**]
   c. [**HID Global; ASSA ABLOY**]

d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of credential authorization.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Size: [**Single gang**][**or**][**double gang**].

C. Chip Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**HID Global; ASSA ABLOY**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**XceedID; an Allegion brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**HID Global; ASSA ABLOY**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**XceedID; an Allegion brand**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of credential authorization.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Size: [**Single gang**][**or**][**double gang**].

D. Proximity Reader for Card, Fob, or Smartphone :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**Suprema Inc.**]
   h. [**XceedID; an Allegion brand**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**Suprema Inc.**]
   h. [**XceedID; an Allegion brand**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of credential authorization.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Voltage: [**5 to 16 V(dc)**][**PoE**]<**Insert power input**>.

d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
f. Transmit Frequency: [**125 kHz**][**13.56 MHz**][**2.4 GHz**].
g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
h. Colors: [**Black**][**Gray**]<**Insert color**>.
i. Climate: [**Indoor**][**and**][**outdoor**].
j. Size: [**Single gang**][**or**][**double gang**].

6. Accessories:

a. Long-range receiver module.

E. Proximity Card Reader for Hazardous (Classified) Location :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HID Global; ASSA ABLOY**]
b. [**XceedID; an Allegion brand**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HID Global; ASSA ABLOY**]
b. [**XceedID; an Allegion brand**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.
c. Additional Listing Criteria:

1) UL CCN AATF; including UL 294.
2) UL CCN AAIZ for NFPA 70 Class I, Division 1, Group[**A**][**B**][**C**][**D**] hazardous locations; including NFPA 496, UL 1203, UL 913, or UL 60079-28.
3) UL CCN AAIZ for NFPA 70 Class I, Division 2, Group[**A**][**B**][**C**][**D**] hazardous locations; including NFPA 496, UL 121201, or UL 60079-28.
4) UL CCN AAIZ for NFPA 70 Class II, Division 1, Group[**E**][**F**][**G**] hazardous locations; including NFPA 496, UL 1203, UL 913, or UL 60079-28.
5) UL CCN AAIZ for NFPA 70 Class II, Division 2, Group[**F**][**G**] hazardous locations; including NFPA 496, UL 121201, or UL 60079-28.
6) UL CCN AAIZ for NFPA 70 Class III, Division 1 hazardous locations; including UL 913 or UL 121201.
7) UL CCN AAIZ for NFPA 70 Class III, Division 2 hazardous locations; including UL 913 or UL 121201.

5. Standard Features:

   a. Visual LED indication of credential authorization.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Voltage: [**5 to 16 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
   e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**5 inch (127 mm)**].
   f. Transmit Frequency: [**125 kHz**][**2.4 GHz**].
   g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   h. Colors: [**Black**][**Gray**]<**Insert color**>.
   i. Climate: [**Indoor**][**and**][**outdoor**].
   j. Size: [**Single gang**][**or**][**double gang**].

2.6 KEYPADS

A. Description: Electronic devices with[**numerical**] keypads for keyless entry.

B. Door Lock Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   b. Visual LED indication of [**three-**][**or**][**six-**]digit code read.
   c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**][**Alkaline batteries**]<**Insert power input**>.
   d. Operating Temperature: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].

h. Size: [**Single gang**][**or**][**double gang**].
i. Mounting:

1) Door/window mullions.
2) Outlet boxes.
3) Flat surfaces.
4) Integrated door lock keypad.

C. LCD Alarm Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Open Options; ACRE, LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Open Options; ACRE, LLC**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of code read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Surface mount.
2) Triple-gang outlet box.

D. Scramble Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hirsch; a brand of Identiv, Inc.**]

b. [**Schlage; an Allegion brand**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hirsch; a brand of Identiv, Inc.**]
   b. [**Schlage; an Allegion brand**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   b. Visual LED indication of [**three-**][**or**][**six-**][**or**][**nine-**]digit code read.
   c. Input Power: [**8 to 12 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

2.7 BIOMETRIC IDENTITY DEVICES

A. Description: Electronic devices that read biometrics information, including fingerprint, palm, iris and facial characteristics. These devices read and transfer credential info to the access control system for control of door locks and other access control components.

B. Single Finger Scanners :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**IDTECK Global, Inc.**]
   d. [**Suprema Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**IDTECK Global, Inc.**]
d. [**Suprema Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of fingerprint read.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Power: [**5 to 12 V(dc)**][**5 V(dc)**][**12 V(dc)**][**PoE**][**Alkaline battery**]<**Insert power input**>.
   d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert temperature**>.
   e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
   f. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
   g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   h. Colors: [**Black**][**Gray**]<**Insert color**>.
   i. Climate: [**Indoor**][**and**][**outdoor**].
   j. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

C. Palm Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fujitsu**]
   b. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
   c. [**iDentityTech Solutions, Ltd.**]
   d. [**Schlage; an Allegion brand**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fujitsu**]
   b. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
   c. [**iDentityTech Solutions, Ltd.**]
   d. [**Schlage; an Allegion brand**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of palm read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**8 to 12 V(dc)**][**PoE**][**Alkaline battery**]<**Insert power input**>.
d. Operating Temperature: [**14 to 131 deg F (Minus 10 to plus 55 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] outlet box.

D. Iris Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EyeLock, LLC; VOXX International Corporation**]
b. [**Iris ID Systems, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EyeLock, LLC; VOXX International Corporation**]
b. [**Iris ID Systems, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual indication of iris read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**12 to 24 V(dc)**][**5 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**32 to 113 deg F (0 to 45 deg C)**]<**Insert temperature**>.

e. Scan Range: [**8 inch (203 mm)**][**11 to 15 inch (279 to 381 mm)**]<**Insert scan range**>.
f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
g. Colors: [**Black**][**Gray**]<**Insert color**>.
h. Climate: [**Indoor**][**and**][**outdoor**].
i. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] outlet box.

E. Facial Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
b. [**Suprema Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
b. [**Suprema Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual display indication of facial read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**12 to 24 V(dc)**][**PoE**]<**Insert power input**>.
d. Operating Temperature: [**41 to 113 deg F (5 to 45 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Stand up.
2) Desktop.

2.8 COMBINATION READER DEVICES

A. Description: Electronic devices that read credentials via a combination of swipe or proximity card readers, keypads, and biometrics scanners. These devices read and transfer credential info to the

access control system for control of door locks and other access control components.

B. Combination Card Reader and Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**Open Options; ACRE, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**Open Options; ACRE, LLC**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of code and/or card read.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Mounting:

      1) Surface mount.
      2) Triple-gang wall box.

C. Combination Card Reader/Keypad and Biometrics Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]

c. [**IDTECK Global, Inc.**]
d. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**IDTECK Global, Inc.**]
d. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of fingerprint and/or card read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**9 to 24 V(dc)**][**PoE**][**Lithium ion chargeable battery**]<**Insert power input**>.
d. Operating Temperature: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature**>.
e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
f. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
h. Colors: [**Black**][**Gray**]<**Insert color**>.
i. Climate: [**Indoor**][**and**][**outdoor**].
j. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] wall box.

2.9 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Integrated Credential Readers and Entry Management Devices: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to integrated credential readers and entry management devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**300 ft (100 m)**][**500 ft (150 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for integrated credential readers and entry management devices with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL OF INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>. [**Testing of devices along means of egress must be witnessed by authorities having jurisdiction.**]

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for the following:

a. Credential readers.
b. Keypads.
c. Biometric identity devices.
d. Combination reader devices.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 PROTECTION

A. After installation, protect integrated credential readers and entry management devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system.

3. Field Reports for Firmware Upgrades: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 11 00

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Task	Specification	Specification Description
28 15 11 00	28 10 00 00	Access Control
28 15 11 00	28 10 00 00a	Access Control Software and Database Management
28 15 11 00	28 10 00 00b	Access Control System Hardware
28 15 11 00	28 15 00 00	Integrated Access Control Hardware Devices
28 15 11 00	28 15 00 00a	Access Control Credentials
28 15 11 00	28 15 00 00b	Electrified Locking Devices and Accessories
28 15 11 00	28 15 00 00c	Egress Management Devices
28 15 11 00	28 15 00 00d	Telephone Entry Systems
28 15 11 00	28 15 00 00e	Intercom Entry Systems
28 15 11 00	28 15 00 00f	Electronic Key Management Systems
28 15 11 00	28 15 00 00g	Access Control Electronic Turnstiles and Mobility Systems
28 15 11 13	28 10 00 00	Access Control
28 15 11 13	28 10 00 00a	Access Control Software and Database Management
28 15 11 13	28 10 00 00b	Access Control System Hardware
28 15 11 13	28 15 00 00	Integrated Access Control Hardware Devices
28 15 11 13	28 15 11 00	Integrated Credential Readers and Entry Management
28 15 11 13	28 15 00 00a	Access Control Credentials
28 15 11 13	28 15 00 00b	Electrified Locking Devices and Accessories
28 15 11 13	28 15 00 00c	Egress Management Devices
28 15 11 13	28 15 00 00d	Telephone Entry Systems
28 15 11 13	28 15 00 00e	Intercom Entry Systems
28 15 11 13	28 15 00 00f	Electronic Key Management Systems
28 15 11 13	28 15 00 00g	Access Control Electronic Turnstiles and Mobility Systems
28 16 00 00	28 10 00 00	Access Control
28 16 00 00	28 10 00 00a	Access Control Software and Database Management
28 16 00 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 16 11 00 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sensing devices.
2. Control devices.
3. Notification devices.
4. Security fasteners.

B. Related Sections:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
5. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
6. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
7. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
8. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
9. Section 281300 "Access Control System Software and Database Management" for applications, interfaces, and workstations.
10. Section 283121 "Area and Perimeter Intrusion Detection" for outdoor intrusion detection devices, including lighting and communications associated with chain-link fence gates.
11. Section 282000 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inch (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes[**unless environmental conditions at the site require protective clothing**].

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify [**programmable logic controllers**][**networks**][**and**] control interface devices and media to be used. Describe characteristics of network and other data communication lines.

a. Indicate methods used to achieve systems integration.
b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
c. Describe characteristics of network and other data communication lines.
d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection[**and for systems integration**]. Include designation of devices connected by raceway, raceway type and size, and

type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.[**Include room layout for master control-unit console, terminal cabinet, racks, and UPS.**]
5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge-protection devices and their installation.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

F. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: In addition to qualification data specified in Section 260010 "Supplemental Requirements for Electrical" submit qualification data for [**Installer**][**intrusion detection systems integrator**][**testing agency**].

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field Test Plans: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within [**60 days**]<**Insert number**> of date of Contract award.
3. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Intrusion Detection Devices: Furnish quantity equal to [**five**]<**Insert number**> percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: [**Three**]<**Insert number**> of each kind and size.
3. Tool Kit: Provide [**six**]<**Insert number**> sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than [**1 box for every 50**]<**Insert numbers**> boxes or fraction thereof, of each type and size of security fastener installed.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS International) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

C. Intrusion Detection Systems Installer:

1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by [**an RCDD**][**a Technician**].
4. Installation Supervision: Installation must be under the direct supervision of [**Technician**][**Level 2 Commercial Installer**], who must be present at all times when Work of this Section is performed at Project site.

D. Intrusion Detection Systems Integrator: An experienced intrusion detection equipment supplier[**and Installer**] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. At least one of whom is a Certified Systems Integrator.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to [**4000 ft (1220 m)**]<**Insert elevation**>.
2. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29**

deg C) and a relative humidity of 20 to 80 percent, noncondensing.

3. Interior, Controlled Environment: System components, except master control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments must be rated for continuous operation in ambients of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in [**non-air-conditioned**][**non-temperature-controlled**] interior environments must be rated for continuous operation in ambients of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather must be rated for continuous operation in ambients of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to [**85 mph (137 km/h)**][**and snow cover up to 24 inch (610 mm) thick**].
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings must be rated, listed, and installed according to NFPA 70.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. System Description: [**Hardwired**][**Multiplexed**], modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

1. Supervision: System components must be continuously monitored for normal, alarm, [**supervisory,**]and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

a. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal must indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

2. System Control:

a. Master control unit must directly monitor intrusion detection units and connecting wiring.
b. Master control unit must directly monitor intrusion detection devices[**, perimeter detection units,**][**, control units associated with perimeter detection units,**] and connecting wiring in a multiplexed distributed control system or as part of a network.

3. System must automatically reboot program without error or loss of status or alarm data after any system disturbance.
4. Operator Commands:

    a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, must produce a short explanation of the purpose, use, and system reaction to that command.
    b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
    c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
    d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
    e. Protected Zone Test: Initiate operational test of a specific protected zone.
    f. System Test: Initiate system-wide operational test.
    g. Print reports.

5. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
6. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

    a. Switch selected lights.
    b. Shift elevator control to a different mode.
    c. Open a signal path between certain intercommunication stations.
    d. Shift sound system to "listening mode" and open a signal path to certain system speakers.
    e. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
    f. <**Insert description of automatic control required**>.

7. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands must initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
8. Response Time: [**Two**]<**Insert number**> seconds between actuation of any alarm and its indication at master control unit.
9. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
10. Programmed Secure-Access Control: System must be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations must override programmed settings.
11. Manual Secure-Access Control: Coded entries at manual stations must change status of associated protected zone between secure and access conditions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit must be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
3. Elevators specified in Section 142100 "Electric Traction Elevators."
4. Elevators specified in Section 142400 "Hydraulic Elevators."
5. Lighting controls specified in Section 260923 "Lighting Control Devices."
6. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
7. Intercom and program systems specified in Section 275123.20 "Commercial Intercommunications and Program Systems."
8. Intercom and program systems specified in Section 275123.50 "Educational Intercommunications and Program Systems."
9. Public address and mass notification systems specified in Section 275116 "Public Address Systems."
10. Access control system specified in Section 281300 "Access Control System Software and Database Management."
11. Fire alarm system specified in Section 284600 "Fire Detection and Alarm."
12. Mass notification system specified in Section 284700 "Mass Notification."
13. Perimeter security system specified in Section 283121 "Area and Perimeter Intrusion Detection."
14. Video surveillance system specified in Section 282000 "Video Surveillance."
15. <**Insert system or equipment**> specified in Section <**Insert Section number**> "<**Insert Section title**>."

E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

F. Interference Protection: Components must be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10 000 MHz and conducted interference signals up to 0.25 V(rms) injected into power supply lines at 10 to 10 000 MHz.

G. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display must identify tamper alarms and indicate locations.

H. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to

verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

I. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

J. Addressable Devices: Transmitter and receivers must communicate unique device identification and status reports to master control unit.

K. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

L. Enclosures:

1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
2. Interior Electronics: UL 50E, Type 12.
3. Exterior Electronics: UL 50E, Type 4X, [**fiberglass**][**stainless steel**].
4. Corrosion Resistant: UL 50E, Type 4X, [**PVC**][**stainless steel**].
5. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

M. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.2 SENSING DEVICES

A. Flush-Mounted Door or Window Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]

c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity.
b. Bias magnet and minimum of [**two**][**three**] encapsulated reed switches must resist compromise from introduction of foreign magnetic fields.
c. Unobtrusive and flush with surface of door or window frame.
d. Remote Test: Simulate movement of actuating magnet from master control unit.

B. Overhead Door Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. **<Insert manufacturer's name>**

3. Listing Criteria: Listed and labeled for outdoor locations.
4. Standard Features:

a. Balanced-magnetic switch, complying with UL 634, installed on frame with integral

overcurrent device to limit current to 80 percent of switch capacity.
b. Bias magnet and minimum of [**two**][**three**] encapsulated reed switches must resist compromise from introduction of foreign magnetic fields.
c. Has door-mounted magnet and floor-mounted switch unit.
d. Remote Test: Simulate movement of actuating magnet from master control unit.

C. Wall-Mounted PIR Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   b. Maximum Detection Range: 125 percent of indicated distance for individual units and not less than **50 ft (15 m)**.[**Provide adjustable coverage pattern as indicated.**]
   c. Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
   d. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator must light when sensor detects an intruder. Locate test enabling switch under

sensor housing cover.

e. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

D. Ceiling-Mounted PIR Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   b. Spot-Detection Pattern: Full 360-degree conical.
   c. Pattern Size: **84 inch (2135 mm)** diameter at floor level for units mounted **96 inch (2440 mm)** above floor; **18 ft (5.5 m)** diameter at floor level for units mounted **25 ft (7.6 m)** above floor.
   d. Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
   e. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator must light when sensor detects an intruder. Locate test enabling switch under

sensor housing cover.

f. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

E. Microwave Intrusion Detector (Interior) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Crow Electronic Engineering, Inc**]
   c. [**Digital Security Controls Ltd.**]
   d. [**Interlogix; Carrier Global Corporation**]
   e. [**Visonic Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Crow Electronic Engineering, Inc**]
   c. [**Digital Security Controls Ltd.**]
   d. [**Interlogix; Carrier Global Corporation**]
   e. [**Visonic Inc**]
   f. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
   b. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)**. Sensor sensitivity adjustments must be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
   c. Activation Indicator: LED indicator must not be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
   d. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

F. Acoustic-Type, Glass-Break Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crow Electronic Engineering, Inc**]
b. [**Digital Security Controls Ltd.**]
c. [**Honeywell International Inc.**]
d. [**Interlogix; Carrier Global Corporation**]
e. [**International Electronics, Inc.**]
f. [**Potter Electric Signal Company, LLC**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crow Electronic Engineering, Inc**]
b. [**Digital Security Controls Ltd.**]
c. [**Honeywell International Inc.**]
d. [**Interlogix; Carrier Global Corporation**]
e. [**International Electronics, Inc.**]
f. [**Potter Electric Signal Company, LLC**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect unique, airborne acoustic energy spectrum caused by breaking glass.
b. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern must have at least a **20 ft (6 m)** range.
c. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
d. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
e. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
f. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

G. Piezoelectric-Type, Glass-Break Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]

b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Visonic Inc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Visonic Inc**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect unique, high-frequency vibrations caused by breaking glass.
b. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer.
c. Circular detection pattern, with at least a **60 inch (1525 mm)** radius on a continuous glass pane. Sensor element may not have an area larger than **4 inch2 (25.80 cm2)**.
d. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
e. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
f. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
g. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

H. Vibration Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]

b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.
b. Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to other mechanical vibration.
c. Circular detection pattern, with at least a **72 inch (1830 mm)** radius on protected structure.
d. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
e. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
f. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

I. Photoelectric Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Honeywell International Inc.**]
c. [**Interlogix; Carrier Global Corporation**]
d. [**Optex Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Honeywell International Inc.**]
c. [**Interlogix; Carrier Global Corporation**]
d. [**Optex Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and

equipment.

4. Standard Features:

   a. Detects interruption of a pulsed, infrared, light beam that links transmitter and receiver.
   b. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than **7.5 ft/s (2.3 m/s)** though the beam.
   c. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
   d. Activation Indicator: LED indicator may not be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
   e. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

J. Microwave-PIR Dual-Technology Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Honeywell International Inc.**]
   c. [**Interlogix; Carrier Global Corporation**]
   d. [**Visonic Inc**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Honeywell International Inc.**]
   c. [**Interlogix; Carrier Global Corporation**]
   d. [**Visonic Inc**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Single unit combining a sensor that detects changes in microwave signals and a sensor that detects changes in ambient level of passive infrared emissions caused by standard-intruder movement within detection pattern.
   b. Alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
   c. Minimum Detection Pattern: A room **20 by 30 ft (6 by 9 m)**.

d. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
e. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at speeds within **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)**.
f. Sensor sensitivity adjustments must be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
g. Activation Indicator: LED indicator may not be visible during normal operation. Indicator must light when sensor detects a standard intruder.
h. Locate test enabling switch under sensor housing cover.
i. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

K. Duress-Alarm Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated.
b. Switch locks in activated position until reset with a key.
c. Minimum Switch Rating: 50,000 operations.
d. Foot Rail: Foot activated, floor mounting.
e. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

L. Video Motion Sensor (Interior) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Aleph America Corporation**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
b. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
c. Modular design that allows for expansion or modification of number of inputs.
d. Controls:

1) Number of detection zones.
2) Size of detection zones.
3) Sensitivity of detection of each protected zone.

e. Mounting: Standard **19 inch (480 mm)** rack as described in EIA/ECA 310-E.

2.3 CONTROL DEVICES

A. Intrusion Detection Keypad and Display Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]

f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

B. Intrusion Detection Key-Operated Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]

g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Changes protected zone between secure and access conditions.

C. Intrusion Detection Master Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with [**UL 609**][**UL 1023**][**UL 1076**].
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Supervises sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms

and supervisory and trouble signals, and other indicated functions.

1) System software and programs must be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2) Include real-time clock for time annotation of events on event recorder and printer.
3) Addressable initiation devices that communicate device identity and status.
4) Control circuits for operation of mechanical equipment in response to an alarm.

b. Construction: [**Freestanding equipment rack**][**Desk-mounted console**], modular, with separate and independent alarm and supervisory system modules. [**Alarm-initiating protected zone boards must be plug-in cards.**]Arrangements that require removal of field wiring for module replacement are unacceptable.
c. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
d. Annunciator and Display: LCD, [**one**][**two**][**three**] line(s) of [**40**][**80**] characters, minimum.
e. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
f. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication must return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures must identify the failure and record the failure at the annunciator display and at the system printer.
g. Field Device Network: Communicate between the control unit and field devices of the system. Communications must consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device must be interrogated during each interrogation cycle.
h. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

1) Acknowledge alarm.
2) Silence alarm.
3) System reset.
4) LED test.
5) <**Insert operator functions**>.

i. Timing Unit: Solid state, programmable, 365 days.
j. Confirmation: Relays, contactors, and other control devices must have auxiliary contacts that provide confirmation signals to system for their on or off status. Software must interpret such signals, display equipment status, and initiate failure signals.
k. Alarm Indication:

1) Audible signal sounds and an LED lights at master control unit identifying the [**protected zone**][**addressable detector**] originating the alarm.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
2) Audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**or**][**LCD**] display at master control unit.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
3) Audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**LCD**][**or**][**cathode-ray-tube**] display at master control unit.[**Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.**]

4) Alarm activation sounds a [**bell**][**siren**][**strobe**][**bell or siren and strobe**].

l. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of [**25**]<**Insert number**> percent.
m. Power Supply Circuits: Master control units must provide power for remote power-consuming detection devices. Circuit capacity must be adequate for at least a [**25**]<**Insert number**> percent increase in load.
n. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS must be sized to provide a minimum of six hours of master control-unit operation.
o. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate may not be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
p. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.4 NOTIFICATION DEVICES

A. Intrusion Detection Alarm Bell :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. **10 inch (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

B. Intrusion Detection Alarm Klaxon :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Weatherproof motor-driven hooter.
b. Rated to produce minimum sound output of 120 dB at **3 ft (1 m)**, plus or minus 3 dB, at frequency of 470 Hz.
c. Rated for intermittent use; two minutes on and five minutes off.
d. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

C. Intrusion Detection Alarm Siren :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. 30 W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

D. Intrusion Detection Alarm Strobe :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]

c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with UL 1638.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Xenon light with clear polycarbonate lens.
b. Light Output: 115 cd, minimum.
c. Flash Rate: 60 per minute.

2.5 SECURITY FASTENERS

A. Socket Flat Countersunk Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. **<Insert manufacturer's name>**

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

B. Socket Button Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

C. Socket Head Cap Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM A574 (ASTM A574M)**.
d. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Perimeter security system.
9. Video surveillance.
10. <**Insert applicable systems and equipment**>.

3.3 INSTALLATION OF INTRUSION DETECTION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than **72 inch (1830 mm)** above the

finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [**control**][**monitoring**] equipment as necessary to extend existing [**control**][**monitoring**] functions to the new points. New components must be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools must be required to operate security fasteners for Project.[**Provide stainless-steel security fasteners in stainless-steel materials.**]

F. Wiring Method:

1. Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring may not share conduit with other building wiring systems.
2. Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring may not share conduit with other building wiring systems.
3. Cable, concealed in accessible ceilings, walls, and floors when possible.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

H. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120 V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

I. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

J. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

K. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide [**5 Ω**]<**Insert resistance**> ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.6 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is

complete and fully operable; include names and titles of witnesses to preliminary tests.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment must be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

G. Nonconforming Work:

1. Intrusion detection system will be considered defective if it does not pass tests and inspections.

H. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**three**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.[**Visits for this purpose must be in addition to any required by warranty.**]

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 16 11 00

SECTION 28 16 11 00A - AREA AND PERIMETER INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Sensing devices.
2. Control devices.
3. Notification devices.
4. Security fasteners.

B. Related Sections:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
5. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
6. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
7. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
8. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for cabling between master control units and field-mounted devices and control units.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. EMI: Electromagnetic interference.

C. PIR: Passive infrared.

D. RFI: Radio-frequency interference.

E. UPS: Uninterruptible power supply.

F. Control Unit: System component that monitors inputs and controls outputs through various circuits.

G. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

H. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

I. Protected Zone: A protected premises or an area within a protected premise that is provided with means to prevent an unwanted event.

J. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inch (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes[**unless environmental conditions at the site require protective clothing**].

K. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

L. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

M. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify [**programmable logic controllers**][**networks**][**and**] control interface devices and media to be used. Describe characteristics of network and other data communication lines.

a. Indicate methods used to achieve systems integration.
b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
c. Describe characteristics of network and other data communication lines.
d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for perimeter security[**and for systems integration**]. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.[**Include room layout for master control-unit console, terminal cabinet, racks, and UPS.**]

5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge protection.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

F. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**security systems integrator**][**testing agency**].

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field Test Plans: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within [**60 days**]<**Insert number**> of date of Contract award.
3. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For perimeter security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. [**One**]<**Insert number**> spare control-unit board(s) for strain-sensitive cable system and

[**one**]<**Insert number**> cable repair and splice kit(s).
2. [**One**]<**Insert number**> of each type of microwave sensor and one of each type of power supply for microwave perimeter security system.
3. [**One**]<**Insert number**> of each spare sensor and PIR unit and [**one**]<**Insert number**> alignment telescope(s) for long-range PIR system.
4. [**One**]<**Insert number**> spare control-unit board(s) for electrostatic-field system.
5. [**One**]<**Insert number**> spare control-unit board(s) for buried, ported coaxial cable system, **10 ft (3 m)** of cable; and [**one**]<**Insert number**> cable repair and splice kit(s).
6. Fuses: [**Three**]<**Insert number**> of each kind and size.
7. Tool Kit: Provide [**six**]<**Insert number**> sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
8. Security Fasteners: Furnish no fewer than [**1 box for every 50**]<**Insert numbers**> boxes or fraction thereof, of each type and size of security fastener installed.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS International) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

C. Intrusion Detection Systems Installer:

1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by [**an RCDD**][**a Technician**].
4. Installation Supervision: Installation must be under the direct supervision of [**Technician**][**Level 2 Commercial Installer**], who must be present at all times when Work of this Section is performed at Project site.

D. Security Systems Integrator: An experienced perimeter security equipment supplier[**and Installer**] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to [**4000 ft (1220 m)**]<**Insert elevation**>.
2. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29**

deg C) and a relative humidity of 20 to 80 percent, noncondensing.

3. Exterior Environment: System components installed in locations exposed to weather must be rated for continuous operation in ambients of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to [**85 mph (137 km/h)**][**and snow cover up to 24 inch (610 mm) thick**].
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings must be rated, listed, and installed according to NFPA 70.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of perimeter security devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. System Description: Perimeter protection system with [**fence-mounted systems**][**buried sensors**][**volumetric detectors**] integrated into a single perimeter detection and alarm system.

1. Supervision: System components are to be continuously monitored for normal, alarm, [**supervisory,**]and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

a. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal must indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

2. System Control:

a. Master control unit must directly monitor gate detection devices, perimeter detection units, and connecting wiring.
b. One or more remote, addressable control units operate under control of a master control-unit microcomputer in a multiplexed distributed control system or as part of a network. Control units must receive programming by multiplexed signal transmission from the associated master control unit and hold data in nonvolatile memory. System must automatically reboot program without error or loss of status or alarm data after any system disturbance.

3. Operator Commands:

a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, must produce a short explanation of the purpose, use,

and system reaction to that command.
b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
e. Protected Zone Test: Initiate operational test of a specific protected zone.
f. System Test: Initiate system-wide operational test.
g. Print reports.

4. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
5. Automatic Control of Related Systems: Alarm or supervisory signals from certain perimeter security devices control the following functions in related systems:

a. Switch selected lights.
b. Open a signal path between certain intercommunication stations.
c. Shift sound system to "listening mode" and open a signal path to certain system speakers.
d. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
e. <**Insert description of automatic control required**>.

6. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), control-unit address, protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands must initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
7. Response Time: [**Two**]<**Insert number**> seconds between actuation of any alarm and its indication at master control unit.
8. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, control units, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
9. Programmed Secure-Access Control: System must be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations must override programmed settings.
10. Manual Secure-Access Control: Coded entries at manual stations must change status of associated protected zone between secure and access conditions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."

2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit must be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
3. Lighting controls specified in Section 260923 "Lighting Control Devices."
4. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
5. Intercom and program systems specified in Section 275123.20 "Commercial Intercommunications and Program Systems."
6. Intercom and program systems specified in Section 275123.50 "Educational Intercommunications and Program Systems."
7. Access control system specified in Section 281300 "Access Control System Software and Database Management."
8. Intrusion detection system specified in Section 283100 "Intrusion Detection."
9. Video surveillance system specified in Section 282000 "Video Surveillance."
10. <**Insert system or equipment**> specified in Section <**Insert Section number**> "<**Insert Section title**>."

E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

F. Interference Protection: Components must be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10 000 MHz and conducted interference signals up to 0.25 V(rms) injected into power supply lines at 10 to 10 000 MHz.

G. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display must identify tamper alarms and indicate locations.

H. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

I. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

J. Addressable Devices: Transmitter and receivers must communicate unique device identification and status reports to master control unit.

K. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually

monitored at master control unit for calibration, sensitivity, and alarm condition.

L. Enclosures:

1. Interior Electronics: UL 50E, Type 12.
2. Exterior Electronics: UL 50E, Type 4X, [**fiberglass**][**stainless steel**].
3. Corrosion Resistant: UL 50E, Type 4X, [**PVC**][**stainless steel**].
4. Terminal cabinets in handholes and manholes must be UL 50E, [**Type 6**][**Type 6P**].
5. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

M. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.2 SENSING DEVICES

A. Strain-Sensitive Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BEI Communications, Inc**]
   b. [**Integrated Security Corporation**]
   c. [**Magal-Senstar, Inc.**]
   d. [**Safeguards Technology**]
   e. [**Southwest Microwave, Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**BEI Communications, Inc**]
   b. [**Integrated Security Corporation**]
   c. [**Magal-Senstar, Inc.**]
   d. [**Safeguards Technology**]
   e. [**Southwest Microwave, Inc**]
   f. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Fence-mounted strain-sensitive, coaxial transducer cable must monitor chain-link-type and

welded-mesh-type fence and generate an alarm when a standard intruder attempts to climb over, cut through, or lift fence fabric.

b. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

c. Transducer Cable:

1) UV-resistant cable furnished by system manufacturer.
2) Suitable for up to **1000 ft (300 m)** of sensor cable per single-zone control unit and up to **2000 ft (600 m)** of sensor cable per dual-zone processor.
3) Sensitivity must be uniform throughout its entire length, requiring only one variable sensitivity adjustment throughout its entire length.

d. Control Unit:

1) Field mounted, with tamper switch at control-unit board.
2) Electronic circuitry must discriminate between acceptable fence movement and intrusion-related disturbances.
3) Sensitivity, count control, and climb-over processors must be adjustable with a minimum of five individual count-control and climb-over adjustments.
4) Control-unit output must have adjustable pulse width to adjust the time the alarm relay will activate per detected intrusion attempt.

e. System Performance:

1) Immune to RFI and EMI environments; interference must have no effect on normal operational characteristics.
2) Trouble and Tamper: Entire sensor system must be fully supervised with individually monitored tamper and supervision alarms. Disconnecting, cutting, or shorting of strain-sensitive cable results in supervisory alarm.
3) Intrusion Simulation: Each zone must have a self-test feature that, when activated by a signal from master control unit will produce an intrusion alarm and verify operation of sensor.

B. Microwave Intrusion Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Crow Electronic Engineering, Inc**]
c. [**Honeywell International Inc.**]
d. [**Integrated Security Corporation**]
e. [**Magal-Senstar, Inc.**]
f. [**Optex Inc.**]
g. [**Southwest Microwave, Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Crow Electronic Engineering, Inc**]
c. [**Honeywell International Inc.**]
d. [**Integrated Security Corporation**]
e. [**Magal-Senstar, Inc.**]
f. [**Optex Inc.**]
g. [**Southwest Microwave, Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Volumetric microwave detection system.
b. Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
c. Movement Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.1 to 50 ft/s (0.03 to 15.2 m/s)**. Sensor sensitivity adjustments are be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
d. Detection Range: **15 to 600 ft (5 to 180 m)**.
e. Range Sensitivity: Adjustable for setting area of protection between **15 to 500 ft (5 to 152 m)** in range and from **2 to 40 ft (0.6 to 12 m)** in beam diameter.
f. Trouble and Tamper: Fully supervised with individually monitored tamper and supervision alarms. System failure must result in tamper alarm. System jamming or wrong modulation must result in supervisory alarm.
g. Activation Indicator: LED indicator is not to be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
h. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
i. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 30 to plus 158 deg F (minus 34 to plus 70 deg C)**]<**Insert temperature range**> and in rainfall up to **4 inch (100 mm)**.
2) <**Insert applicable environmental conditions**>.

C. Electrostatic Field :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BEI Communications, Inc**]
b. [**Integrated Security Corporation**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]

f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**BEI Communications, Inc**]
   b. [**Integrated Security Corporation**]
   c. [**Magal-Senstar, Inc.**]
   d. [**Safeguards Technology**]
   e. [**Southwest Microwave, Inc**]
   f. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Fence-mounted[**, independently mounted**], above-ground, electrostatic-field detection system, consisting of electronically balanced phase electrostatic-field detection system with a field generator that generates an electrical field in one or more field wires and that has two or more sensing wires, a sense filter, amplifier, and a control unit.
   b. Detection fields must have a minimum of four different frequencies so adjacent zones cannot interfere with each other.
   c. Environment: Suitable for exterior installation and the following conditions:

      1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
      2) <**Insert applicable environmental conditions**>.

   d. System Performance:

      1) Detect, via sense wires, a compound signal form consisting of amplitude change, rate of change, and preset time disturbance that forms a "signature" of human movement. Generate an alarm when all exist simultaneously. Provide detection fields of no fewer than four different frequencies so adjacent zones do not interfere with each other.
      2) Control Units: Single or multiple zone, with sense filter. Front panel with calibration meter, status of alarm transmitter, sensitivity selector, test point selector, power indicator, and power control. Control unit must reject signals due to wind and small objects striking the wires.
      3) Motion Detection: Sense standard-intruder movement at rates from **0.15 to 26 ft/s (0.045 to 8.0 m/s)**.
      4) Zone Length: Not to exceed [**500 ft (152 m)**][**325 ft (100 m)**].
      5) Supervision: Generate trouble signal if field or sense wires are cut or shorted to ground or to each other. Generate supervisory alarm if received signal is substantially reduced.

   e. Insulators, Wire-Tensioning Devices, and Brackets: Manufacturer's standard for mounting and tensioning of wires.
   f. Field and Sensing Wires: Stainless steel.

D. Buried, Ported Coaxial Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Magal-Senstar, Inc.**]
   b. [**Safeguards Technology**]
   c. [**Southwest Microwave, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Magal-Senstar, Inc.**]
   b. [**Safeguards Technology**]
   c. [**Southwest Microwave, Inc**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Buried electrostatic-field detection system consisting of parallel, ported coaxial cables that generate a detection field between cables.
   b. Environment: Suitable for exterior installation and the following conditions:

      1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
      2) <**Insert applicable environmental conditions**>.

   c. System Performance: One of two parallel cables receives a continuous wave signal from a transmitter module. Second cable, connected to a sensor module, detects, preamplifies, and analyzes variations in signal. When system senses "signature" of a standard intruder in the detection zone, based on mass, motion, and time of day, it generates an alarm.

      1) Transmitter: Locate at one end of zone, with standby battery.
      2) Preamplifier-Sensor: Locate at opposite end from transmitter, with standby battery.
      3) Front panel with sensitivity calibration meter, calibrated self-test potentiometer, power switch, and LED normal and malfunction indicators.
      4) Electromagnetic Radiation: Less than 50 mV per meter at 30 m.
      5) Motion Detection: Sense standard-intruder movement at rates from **0.17 to 26 ft/s (0.05 to 8.0 m/s)**.
      6) Zone Length: Not to exceed [**500 ft (152 m)**][**325 ft (100 m)**].
      7) Zone Width: Not to exceed **15 ft (4.6 m)**, with an average width of **12 ft (3.7 m)**.
      8) Zone Height: Approximately **3.3 ft (1.0 m)**, depending on sensitivity setting.
      9) Supervision: Generate trouble signal if cable is cut or shorted to ground. Generate supervisory alarm if cabinets are tampered with.

d. Enclosures: Hinged cover with tamper switch and security fasteners.
e. Buried, Ported Coaxial Cable: Approximately **1/2 inch (1.3 mm)** diameter, minimum 10 AWG center conductor, foam polyethylene dielectric, braided copper outer conductor, and polyethylene jacket.

E. Long-Range PIR Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Integrated Security Corporation**]
   g. [**Optex Inc.**]
   h. [**Safeguards Technology**]
   i. [**Southwest Microwave, Inc**]
   j. [**Visonic Inc**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Integrated Security Corporation**]
   g. [**Optex Inc.**]
   h. [**Safeguards Technology**]
   i. [**Southwest Microwave, Inc**]
   j. [**Visonic Inc**]
   k. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Volumetric passive infrared detection system.
   b. Environment: Suitable for exterior installation and the following conditions:

      1) Ambient Temperatures: Ranging from [**minus 30 to plus 150 deg F (minus 34 to plus 65 deg C)**]<**Insert temperature range**>.
      2) <**Insert applicable environmental conditions**>.

c. System Performance: Detect an interruption of dual-infrared light beams that link transmitters and receivers. Generate an alarm when signal is interrupted due to presence of an object that interrupts both beams.

1) Sensitivity: Field adjustable to allow adjustment of range from **25 to 500 ft (7.6 to 152 m)**, generating an alarm within 20 to 50 ms when both beams are interrupted.
2) Detection system must adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
3) Motion Detection: Detect standard-intruder movement at rates from **0.1 to 50 ft/s (0.03 to 15.2 m/s)**.
4) Supervision: Generate supervisory alarm if any portion of system is tampered with.
5) Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

F. Geophone Fence Detection :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BEI Communications, Inc**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BEI Communications, Inc**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted system to detect attempts to cut or climb the protected fence, using geophone sensors that respond to specific shock or vibrations.
b. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 30 to plus 150 deg F (minus 34 to**

plus 65 deg C)]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

c. System Performance:

1) Control Unit: [**10**]<**Insert number**> zone capacity for processing geophone generated analog signals. Each zone must consist of not more than [**10**]<**Insert number**> sensors.

a) Adjustments: For each zone, provide stepped gain control for sensitivity and switches for geophone signal filters to minimize nuisance alarms. System must adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
b) Trouble Condition Signal: Generate when any zone fails.
c) Supervisory Condition Signal: Generate on interference with control-unit operation or when detecting a break-in into an enclosure housing electronics.

d. Sensors: Fence mounted [**20 ft (6 m)**]<**Insert dimension**> o.c.
e. Cable for Interconnection of System Components: Shielded, PVC jacketed and armored, as supplied by system manufacturer.
f. Test each zone simulating an alarm condition. Test by [**command from master control**][**test switch at control unit inside the enclosure**].

G. Video Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Video-surveillance-based detection system.
b. Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.

1) Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
2) Modular design that allows for expansion or modification of number of inputs.
3) Adjustable Controls:

a) Number of detection zones.
b) Size of detection zones.
c) Sensitivity of detection of each protected zone.

c. Mounting: Standard **19 inch (480 mm)** rack as described in EIA/ECA 310-E.
d. Environment: Suitable for installation in interior air-conditioned spaces. <**Insert applicable environmental conditions**>.

H. Gate Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Safeguards Technology**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Safeguards Technology**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted gate-movement detectors, balanced-magnetic type, and UL listed for outdoor locations. Units must be designed for mounting on single- or double-leaf swinging or rolling gates and have armored jumper cables between switch and stationary junction box for wiring to master control unit and tamper switches in junction box.
b. Bias magnet and at least three encapsulated-reed switches that resist compromise from introduction of foreign magnetic fields, with integral overcurrent protective device to limit current to 80 percent of switch capacity.
c. Remote Test: Simulate movement of actuating magnet from master control unit.

2.3 CONTROL DEVICES

A. Intrusion Detection Keypad and Display Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Corby Industries, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**DAQ Electronics, Inc**]
   e. [**Digital Security Controls Ltd.**]
   f. [**Edwards; Carrier Global Corporation**]
   g. [**Honeywell International Inc.**]
   h. [**Visonic Inc**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Corby Industries, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**DAQ Electronics, Inc**]
   e. [**Digital Security Controls Ltd.**]
   f. [**Edwards; Carrier Global Corporation**]
   g. [**Honeywell International Inc.**]
   h. [**Visonic Inc**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

B. Intrusion Detection Key-Operated Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Corby Industries, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**DAQ Electronics, Inc**]
   e. [**Digital Security Controls Ltd.**]
   f. [**Edwards; Carrier Global Corporation**]

g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Changes protected zone between secure and access conditions.

C. Field-Mounted Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

3. Standard Features:

a. Field-mounted control units must include the power supply and detector specific functions, and provide for communications with the master control unit. Control unit must include read-only resident software needed for startup, a time clock, and all automatic operations. Software must be downloaded from the master control unit.
b. Battery Backup: UPS, providing [**six**]<**Insert number**> hours of run time during a power outage, with two-rate automatic battery charger to fully recharge batteries within [**12**]<**Insert number**> hours after normal power is restored.

1) Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy.

2) Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger must recharge fully discharged battery within 24 hours.

c. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

D. Master Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Magal-Senstar, Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Magal-Senstar, Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Comply with [**UL 609**][**UL 681**][**UL 1076**].
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Supervises sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1) System software and programs must be held in flash electrically erasable

programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

2) Include a real-time clock for time annotation of events on the event recorder and printer.
3) Addressable initiation devices that communicate device identity and status.
4) Control circuits for operation of mechanical equipment in response to an alarm.

b. Construction: [**Freestanding equipment rack**][**Desk-mounted console**], modular, with separate and independent alarm and supervisory system modules. [**Alarm-initiating protected zone boards must be plug-in cards.**]Arrangements that require removal of field wiring for module replacement are unacceptable.
c. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
d. Annunciator and Display: LCD type, [**one**][**two**][**three**] line(s) of [**40**][**80**] characters, minimum.
e. Keypad: Arranged to permit entry and execution of programming, display, and control commands
f. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication must return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures must identify the failure and record the failure at the annunciator display and at the system printer.
g. Field Device Network: Communicate between the control unit and field devices of the system. Communications must consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device must be interrogated during each interrogation cycle.
h. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

1) Acknowledge alarm.
2) Silence alarm.
3) System reset.
4) LED test.
5) <**Insert operator functions**>.

i. Timing Unit: Solid state, programmable, 365 days.
j. Confirmation: Relays, contactors, and other control devices must have auxiliary contacts that provide confirmation signals to system for their on or off status. Software must interpret such signals, display equipment status, and initiate failure signals.
k. Alarm Indication:

1) An audible signal sounds and an LED lights at master control unit identifying the [**protected zone**][**addressable detector**] originating the alarm.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
2) An audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**or**][**LCD**]display at master control unit.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
3) An audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**LCD**][**or**][**cathode-ray-tube**] display at master control unit.[**Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.**]

4) Alarm activation sounds a [**bell**][**siren**][**strobe**][**bell or siren and strobe**].

l. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of [**25**]<**Insert number**> percent.
m. Power Supply Circuits: Master control units must provide power for remote power-consuming detection devices. Circuit capacity must be adequate for at least a [**25**]<**Insert number**> percent increase in load.
n. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS must be sized to provide a minimum of six hours of master control-unit operation.
o. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate is not to be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
p. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.4 NOTIFICATION DEVICES

A. Intrusion Detection Alarm Bell :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. **10 inch (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

B. Intrusion Detection Alarm Klaxon :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Weatherproof motor-driven hooter.
b. Rated to produce minimum sound output of 120 dB at **3 ft (1 m)**, plus or minus 3 dB, at frequency of 470 Hz.
c. Rated for intermittent use; two minutes on and five minutes off.
d. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

C. Intrusion Detection Alarm Siren :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. **<Insert manufacturer's name>**

3. Listing Criteria:

    a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
    b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
    c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

    a. 30 W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 ft (3 m)** from master control unit.
    b. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

D. Intrusion Detection Alarm Strobe :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]

c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. **<Insert manufacturer's name>**

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. UL 1638.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Xenon light with clear polycarbonate lens.
b. Light Output: 115 cd, minimum.
c. Flash Rate: 60 per minute.

2.5 SECURITY FASTENERS

A. Socket Flat Countersunk Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. **<Insert manufacturer's name>**

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

B. Socket Button Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

C. Socket Head Cap Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM A574 (ASTM A574M)**.
d. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

2.6 SOURCE QUALITY CONTROL

A. Electrostatic-Field and Buried, Ported Coaxial Cable Systems Electronics: Precondition at factory by subjecting modules to at least four days' operational burn-in at temperatures not less than **140 deg F (60 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of perimeter security.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of perimeter security connections before perimeter security installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of perimeter security.

D. Inspect built-in and cast-in anchor installations, before installing perimeter security, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEMS INTEGRATION

A. Integrate perimeter security system with the following systems and equipment:

1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Intrusion detection system.
9. Video surveillance.
10. <**Insert applicable systems and equipment**>.

3.3 INSTALLATION OF AREA AND PERIMETER INTRUSION DETECTION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [**control**][**monitoring**] equipment as necessary to extend existing [**control**][**monitoring**] functions to the new points. New components must be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to public, install perimeter security components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools must be required to operate security fasteners for Project.[**Provide stainless steel security fasteners in stainless steel materials.**]

F. Wiring Method: Install power, signal, and data transmission wire and cable in metal raceways according to Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 270528 "Pathways for Communications Systems." Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring are not to share conduit with other building wiring systems.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with perimeter security system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

H. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120 V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Cable for Low-Voltage Control and Signal Circuits: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

I. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

J. Install power supplies and other auxiliary components for detection devices at control units unless

otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

K. Stain-Sensitive Transducer Cable: Attached to fence at **12 inch (300 mm)** intervals with tie wraps.

L. Electrostatic-Field System: Install field and sense wires on insulators and standoffs on a fence, wall, or roof. Provide intermediate supports recommended in writing by manufacturer as needed for specified performance.

M. Buried, Ported Coaxial Cable: Transmitters may be located at one end of parallel coaxial cables, and preamplifier-sensor module may be located at opposite end. Install cable so shield is uniform throughout the length, without twisting or distorting cable during installation. Field-cut cables to exact zone length at the site. To attach data transmission cable to sensing cable, use heat-shrink splice kits approved by manufacturer. Provide sufficient overlap of detector cables to eliminate the possibility of entry between zones.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide [**5 Ω**]<**Insert resistance**> ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.6 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Perimeter security systems and other systems and equipment that are associated with detection and accessory equipment must be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
3. Geophone System Tests: Test each zone at a minimum of two different locations. Test each zone as follows:

    a. Horizontal Movement: Adjust sensitivity to screen out alarms from wind.
    b. Vertical Climb: 100 percent detection required. Set count at three occurrences within 90-second window.
    c. Cut Test: 100 percent detection required. Set count at two occurrences within 120-second window.
    d. Set sensitivity to value as low as possible, consistent with reliable detection.
    e. If performance tests fail, make adjustments to sensors to comply with requirements. Retest failing and adjacent zones to comply with test.

4. Strain-Sensitive Cable System Tests: Adjust sensitivity and count control to value as low as possible, consistent with reliable detection.
5. Microwave Perimeter Security System Tests: Adjust sensitivity to value as low as possible, consistent with reliable detection.
6. Long-Range PIR System Tests: Adjust sensitivity and hold time between activity duration to value as low as possible, consistent with reliable detection.

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

G. Nonconforming Work:

1. Intrusion detection system will be considered defective if it does not pass tests and inspections.

H. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other than normal occupancy hours for this purpose.[**Visits for this purpose must be in addition to any required by warranty.**]

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the perimeter security system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 16 11 00A

Task	Specification	Specification Description
28 16 11 00	26 33 43 00a	Public Address Systems
28 16 11 00	28 10 00 00	Access Control
28 16 11 00	28 10 00 00a	Access Control Software and Database Management
28 16 11 00	28 10 00 00b	Access Control System Hardware
28 18 00 00	28 10 00 00	Access Control
28 18 00 00	28 10 00 00a	Access Control Software and Database Management
28 18 00 00	28 10 00 00b	Access Control System Hardware
28 18 11 00	28 10 00 00	Access Control
28 18 11 00	28 10 00 00a	Access Control Software and Database Management
28 18 11 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 20 00 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard cameras.
2. Submersible cameras.
3. Reinforced dome cameras.
4. Lenses.
5. Infrared illuminators.
6. Camera-supporting equipment.
7. Monitors.
8. Videotape recorders.
9. Digital video recorders.
10. Network video recorders.
11. Digital switchers.
12. IP video systems.
13. Video motion sensors (interior).
14. Control stations.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281300 "Access Control System Software and Database Management" to integrate access control system interface and control.
5. Section 283100 "Intrusion Detection" to integrate video surveillance used for intrusion detection.
6. Section 283121 "Area and Perimeter Intrusion Detection" to integrate video surveillance used for intrusion detection.
7. Section 285213 "Detention Monitoring and Control System and Interfaces" to integrate video surveillance with detention monitoring interface and control.

1.2 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: In addition to seismic qualification data specified in Section 260010 "Supplemental Requirements for Electrical," submit certificates for cameras, camera-supporting

equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of **60 to 85 deg F (16 to 29 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments are to be rated for continuous operation in ambient temperatures of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing. Use UL 50E, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-[**air-**

conditioned][**temperature-controlled**] interior environments are to be rated for continuous operation in ambient temperatures of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing. Use UL 50E, [**Type 3R**][**Type 4**][**Type 12**][**Type 12K**] enclosures.

4. Exterior Environment: System components installed in locations exposed to weather are to be rated for continuous operation in ambient temperatures of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to **85 mph (137 km/h)**[**and snow cover up to 24 inches (610 mm) thick**]. Use UL 50E, [**Type 3**][**Type 3R**][**Type 3S**][**Type 4**][**Type 4X**] enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers are to be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use UL 50E, [**Type 4X**][**Type 6P**] enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Video-signal format must comply with NTSC standard, composite interlaced video. Composite video-signal termination must be 75 Ω.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components are to initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display is to identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Electronic data exchange between video surveillance system with an access-control system is to comply with SIA TVAC.

2.3 STANDARD CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Axis Communications**]
3. [**Bosch Security Systems, Inc.**]
4. [**CBC (AMERICA) Corp**]
5. [**COP-USA**]
6. [**Crest Electronics, Inc**]
7. [**Elbex Ltd.**]
8. [**ELMO**]
9. [**EverFocus Electronics Corporation**]
10. [**Hitachi Cable America Inc.**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Pixera Corporation**]
20. [**Safety Vision**]
21. [**Samsung Opto-Electronics**]
22. [**SANYO North America Corporation**]
23. [**Telpix Electronics, Inc.**]
24. [**Toshiba International Corporation**]
25. [**Trinus Systems Inc.**]
26. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions**

North America]
27. [**Vicon Industries, Inc**]
28. [**Videology Imaging Solutions, Inc.**]
29. [**Visiontech**]
30. [**VIVOTEK Inc.**]
31. [**Watec America Corporation**]
32. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Axis Communications**]
3. [**Bosch Security Systems, Inc.**]
4. [**CBC (AMERICA) Corp**]
5. [**COP-USA**]
6. [**Crest Electronics, Inc**]
7. [**Elbex Ltd.**]
8. [**ELMO**]
9. [**EverFocus Electronics Corporation**]
10. [**Hitachi Cable America Inc.**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Pixera Corporation**]
20. [**Safety Vision**]
21. [**Samsung Opto-Electronics**]
22. [**SANYO North America Corporation**]
23. [**Telpix Electronics, Inc.**]
24. [**Toshiba International Corporation**]
25. [**Trinus Systems Inc.**]
26. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
27. [**Vicon Industries, Inc**]
28. [**Videology Imaging Solutions, Inc.**]
29. [**Visiontech**]
30. [**VIVOTEK Inc.**]
31. [**Watec America Corporation**]
32. <**Insert manufacturer's name**>

C. B/W Camera:

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 252,000 [**512(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 380 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC, manually selectable on or off.
6. Sensitivity:

   a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of

<**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
9. Motion Detector: Built-in digital.

D. Color Camera:

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 [**771(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity:

a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of <**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
9. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
10. Motion Detector: Built-in digital.

E. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 [**768(H) by 494(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity:

a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of <**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1 V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200 K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed is to be controlled by operator. Movement from preset positions is not to be less than 300 degrees per second.
9. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls are to include the following:

a. In "sequence mode," camera is to continuously sequence through preset positions, with dwell time and sequencing under operator control.

b. Motion detection is to be available at each camera position.
c. Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.

10. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
11. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
12. Motion Detector: Built-in digital.
13. Dome is to support multiplexed control communications using coaxial cable recommended by manufacturer.

2.4 SUBMERSIBLE CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**International Space Optics**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**International Space Optics**]
2. <**Insert manufacturer's name**>

C. Camera: Color, designed for underwater monitoring and for inspecting pipes and storm drains. Attributes as follows:

1. Infrared LEDs to provide illumination in zero-light conditions.
2. **60 ft (18.3 m)** factory-installed cable with BNC connector for video and a 2.1 mm jack for 12 V(dc) power supply.
3. An adjustable swivel mount and attachment base.
4. Pickup Device: CCD interline transfer, 290,000 [**500(H) by 580(V)**]<**Insert other**> pixels.
5. Horizontal Resolution: 380 lines.
6. Signal-to-Noise Ratio: Not less than 50 dB.
7. With AGC, from 4 to 39 dB.
8. Sensitivity: Camera is to provide usable images in low-light conditions, delivering an image at a scene illumination of 0.1 lux at f/2.0.
9. Scanning Synchronization: Internal.
10. White Balance: Auto-tracing white balance, for colors ranging from 2800 to 8200 K.

2.5 REINFORCED DOME CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Axis Communications**]
2. [**Bosch Security Systems, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Axis Communications**]
2. [**Bosch Security Systems, Inc.**]
3. <**Insert manufacturer's name**>

C. Camera: Designed for high-abuse locations, with a weathertight [**semirecessed**][**surface**] mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.

1. Suitable for exterior environment, rated for continuous operation in ambient temperatures of **minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)** dry bulb and up to 85 percent relative humidity.
2. Pickup Device: CCD interline transfer, 290,000 [**510(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 350 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC and automatic backlight compensation.
6. Sensitivity: Camera is to provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.
7. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
8. White Balance: Auto-tracing white balance.

2.6 LENSES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Hitachi Cable America Inc.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Hunt Electronics USA, Inc**]
9. [**Interlogix; Carrier Global Corporation**]
10. [**International Space Optics**]
11. [**Panasonic Corporation of North America**]
12. [**Pelco**]
13. [**Samsung Opto-Electronics**]
14. [**SANYO North America Corporation**]
15. [**Tamron USA, Inc.**]
16. [**Telpix Electronics, Inc.**]
17. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
18. [**Vicon Industries, Inc**]
19. [**Videology Imaging Solutions, Inc.**]
20. [**Watec America Corporation**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]

2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Hitachi Cable America Inc.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Hunt Electronics USA, Inc**]
9. [**Interlogix; Carrier Global Corporation**]
10. [**International Space Optics**]
11. [**Panasonic Corporation of North America**]
12. [**Pelco**]
13. [**Samsung Opto-Electronics**]
14. [**SANYO North America Corporation**]
15. [**Tamron USA, Inc.**]
16. [**Telpix Electronics, Inc.**]
17. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
18. [**Vicon Industries, Inc**]
19. [**Videology Imaging Solutions, Inc.**]
20. [**Watec America Corporation**]
21. **<Insert manufacturer's name>**

C. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lens: With calibrated focus ring.
3. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:

   a. Electrical Leads: Filtered to minimize video signal interference.
   b. Motor Speed: Variable.
   c. Lens is to be available with preset positioning capability to recall the position of specific scenes.

2.7 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera[**, infrared illuminator,**] and lens.

1. Enclosure: UL 50E, [**Type 1**][**Type 3**][**Type 4X**]**<Insert type>**.

2.8 INFRARED ILLUMINATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Honeywell Commercial Security; Honeywell International, Inc.**]
2. [**International Space Optics**]
3. [**Merit Li-Lin (USA) Corp.**]
4. [**Visiontech**]

5. [**VIVOTEK Inc.**]
6. [**Watec America Corporation**]
7. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Honeywell Commercial Security; Honeywell International, Inc.**]
2. [**International Space Optics**]
3. [**Merit Li-Lin (USA) Corp.**]
4. [**Visiontech**]
5. [**VIVOTEK Inc.**]
6. [**Watec America Corporation**]
7. **<Insert manufacturer's name>**

C. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.

1. Field-Selectable Beam Patterns: Narrow, medium, and wide.
2. Rated Lamp Life: More than 8000 hours.
3. Power Supply: [**12 V(ac/dc)**][**120 V(ac)**].

D. Area Coverage: Illumination to **150 ft (50 m)** in a narrow beam pattern.

E. Exterior housings are to be suitable for same environmental conditions as the associated camera.

2.9 CAMERA-SUPPORTING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Honeywell Commercial Security; Honeywell International, Inc.**]
9. [**Ikegami Electronics (USA) Inc**]
10. [**Interlogix; Carrier Global Corporation**]
11. [**Merit Li-Lin (USA) Corp.**]
12. [**Moog, Inc.**]
13. [**Panasonic Corporation of North America**]
14. [**Pelco**]
15. [**Samsung Opto-Electronics**]
16. [**SANYO North America Corporation**]
17. [**Telpix Electronics, Inc.**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**Video Mount Products**]
21. [**Visiontech**]
22. [**Wren Associates Limited**]

23. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Honeywell Commercial Security; Honeywell International, Inc.**]
9. [**Ikegami Electronics (USA) Inc**]
10. [**Interlogix; Carrier Global Corporation**]
11. [**Merit Li-Lin (USA) Corp.**]
12. [**Moog, Inc.**]
13. [**Panasonic Corporation of North America**]
14. [**Pelco**]
15. [**Samsung Opto-Electronics**]
16. [**SANYO North America Corporation**]
17. [**Telpix Electronics, Inc.**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**Video Mount Products**]
21. [**Visiontech**]
22. [**Wren Associates Limited**]
23. <**Insert manufacturer's name**>

C. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

D. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.

1. Scanning Operation: Silent, smooth, and positive.
2. Stops: Adjustable without disassembly, to limit the scanning arc.

E. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
3. Speed: 12 degrees per second in both horizontal and vertical planes.
4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
5. Built-in encoders or potentiometers for position feedback[**, and thermostat-controlled heater**].
6. Pan-and-tilt unit is to be available with preset positioning capability to recall the position of a specific scene.

F. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

G. Protective Housings for Fixed and Movable Cameras: Steel[**or 6061 T6 aluminum**] enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and

mounting and installing arrangement of camera to be housed.

1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit is to identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Section 283100 "Intrusion Detection."
2. Camera Viewing Window: [**Polycarbonate**][**Lexan**] window, aligned with camera lens.
3. Duplex Receptacle: Internally mounted.
4. Alignment Provisions: Camera mounting is to provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
5. Built-in, thermostat-activated [**heater**][**and**][**blower**] units. Units are to be automatically controlled so the environmental limits of the camera equipment are not exceeded.
6. Sun shield is not to interfere with normal airflow around the housing.
7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket is to be of same material as the housing; mounting hardware is to be stainless steel.
8. Finish: Housing and mounting bracket are to be factory finished using manufacturer's standard finishing process suitable for the environment.
9. Enclosure Rating: <**Insert UL 50E Type designation**><**Insert Ingress Protection code designation**>.

2.10 MONITORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Hitachi Cable America Inc.**]
9. [**Honeywell Commercial Security; Honeywell International, Inc.**]
10. [**Hunt Electronics USA, Inc**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**International Space Optics**]
14. [**JVC Americas Corp.**]
15. [**Merit Li-Lin (USA) Corp.**]
16. [**Panasonic Corporation of North America**]
17. [**Pelco**]
18. [**Samsung Opto-Electronics**]
19. [**SANYO North America Corporation**]
20. [**Tatung Company of America, Inc**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Hitachi Cable America Inc.**]
9. [**Honeywell Commercial Security; Honeywell International, Inc.**]
10. [**Hunt Electronics USA, Inc**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**International Space Optics**]
14. [**JVC Americas Corp.**]
15. [**Merit Li-Lin (USA) Corp.**]
16. [**Panasonic Corporation of North America**]
17. [**Pelco**]
18. [**Samsung Opto-Electronics**]
19. [**SANYO North America Corporation**]
20. [**Tatung Company of America, Inc**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

C. Monochrome:

1. Metal cabinet units designed for continuous operation.
2. Screen Size (Diagonal Dimension): <**Insert dimension**>.
3. Horizontal Resolution: [**600**]<**Insert resolution**> lines, minimum, at center.
4. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, horizontal-hold, vertical-hold, and contrast controls.
5. Mounting:

   a. Adjustable tilting and training.
   b. [**Single, 14 inch (356 mm)**][**Dual, 9 inch (229 mm)**], vertical, EIA **19 inch (483 mm)** electronic equipment rack or cabinet complying with CEA 310-E.

6. Electrical: 120 V(ac), 60 Hz.

D. Color:

1. Metal cabinet units designed for continuous operation.
2. Screen Size (Diagonal Dimension): <**Insert dimension**>.
3. Horizontal Resolution: [**300**]<**Insert resolution**> lines.
4. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, contrast, color, and tint controls.
5. Degaussing: Automatic.
6. Mounting: [**Single, 14 inch (356 mm)**][**Dual, 9 inch (229 mm)**], vertical, EIA **19 inch (483 mm)** electronic equipment rack or cabinet complying with CEA 310-E.

7. Electrical: 120 V(ac), 60 Hz.

2.11 VIDEOTAPE RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Honeywell Commercial Security; Honeywell International, Inc.**]
7. [**Ikegami Electronics (USA) Inc**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**JVC Americas Corp.**]
10. [**Panasonic Corporation of North America**]
11. [**Pelco**]
12. [**Samsung Opto-Electronics**]
13. [**SANYO North America Corporation**]
14. [**Toshiba International Corporation**]
15. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
16. [**Vicon Industries, Inc**]
17. [**Videology Imaging Solutions, Inc.**]
18. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Honeywell Commercial Security; Honeywell International, Inc.**]
7. [**Ikegami Electronics (USA) Inc**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**JVC Americas Corp.**]
10. [**Panasonic Corporation of North America**]
11. [**Pelco**]
12. [**Samsung Opto-Electronics**]
13. [**SANYO North America Corporation**]
14. [**Toshiba International Corporation**]
15. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
16. [**Vicon Industries, Inc**]
17. [**Videology Imaging Solutions, Inc.**]
18. **<Insert manufacturer's name>**

C. Description: Industrial, time-lapse type recorder, designed for continuous operation. Tape format is **1/2 inch (13 mm)** using industrial-grade, T-120 cassettes.

1. Horizontal Resolution: 400 lines, minimum.

2. Recording Heads: Rotary-scan type.
3. Integral Timer: Permits programming of recording operation for adjustable daily and weekly periods.
4. Time-Lapse Operating Modes: Multiple, covering 24 to 240 hours, minimum.
5. Other Operating Modes:

    a. Manual play and recording at two- and six-hour speeds.
    b. Forward and reverse high-speed search.
    c. Reverse, slow, and single-frame play.

6. Alarm Recording: Operating mode is automatically switched from time-lapse to two- or six-hour recording mode when an externally generated alarm signal is received.
7. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
8. Time and Date Generator: Records time and date legend in corner of recorded scenes.
9. Tape Counter: Displays tape position.
10. Manual Recording Lock: Key or keypad operated. Prevents unauthorized tampering or control changes during preset operation.
11. Signal-to-Noise Ratio: 45 dB for video output in standard play mode.
12. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

2.12 DIGITAL VIDEO RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]

4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. <**Insert manufacturer's name**>

C. Description: Digital, time-lapse type, full-frame and motion recorder, with removable hard drive.

1. Recording Time: 400 hours minimum.
2. Resolution: 720 by 480 lines, minimum.
3. Programming is to be from trackball and push buttons on face of the recorder, settings are to be displayed on any video monitor connected to the recorder. Programming is to include the following:

   a. Motion analysis graph.
   b. Password protection.
   c. Alarm and timer controls.
   d. Continuous recording option.
   e. Time-lapse operating modes.
   f. Search video by time, event, or motion.

4. Programming: SmartMedia card for software updating, image archiving, and image transfer to a PC.
5. Storage: [**80 GB**]<**Insert size**>, removable hard drive. Software is to permit hot-swapping drives.
6. Compression: [**MPEG-2**]<**Insert type**>.
7. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
8. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
9. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

2.13 NETWORK VIDEO RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]

8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**VIVOTEK Inc.**]
21. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**VIVOTEK Inc.**]
21. **<Insert manufacturer's name>**

C. External storage or internal 250 to 1500 GB hard disk drive.

1. Video and audio recording over TCP/IP network.
2. Video recording of MPEG-2 and MPEG-4 streams.
3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
4. Duplex Operation: Simultaneous recording and playback.
5. Continuous and alarm-based recording.
6. Full-Featured Search Capabilities: Search based on camera, time, or date.
7. Automatic data replenishment to ensure recording even if network is down.
8. Digital certification by watermarking.
9. Internal RAID storage or non-RAID storage of up to 1500 GB.
10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
11. Full integration with LAN, Intranet, or Internet through standard Web browser or video

management software.
12. Integrated Web server FTP server functionality.
13. Supports up to 16[**, 32,**] or [**64**]<**Insert number**> devices.

2.14 DIGITAL SWITCHERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**Communications Specialties, Inc.**]
5. [**Convision Systems GmbH**]
6. [**COP-USA**]
7. [**Crest Electronics, Inc**]
8. [**Dedicated Microcomputers Limited**]
9. [**Elbex Ltd.**]
10. [**EverFocus Electronics Corporation**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Samsung Opto-Electronics**]
20. [**SANYO North America Corporation**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**Communications Specialties, Inc.**]
5. [**Convision Systems GmbH**]
6. [**COP-USA**]
7. [**Crest Electronics, Inc**]
8. [**Dedicated Microcomputers Limited**]
9. [**Elbex Ltd.**]
10. [**EverFocus Electronics Corporation**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]

15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Samsung Opto-Electronics**]
20. [**SANYO North America Corporation**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

C. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher if one or more cameras or monitors are in color.

1. Controls: Unit-mounted front panel.
2. Resolution: [**720 by 480**] lines <**Insert resolution**>.
3. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel is to automatically switch to full screen. If several alarms are activated, channels in alarm are to be in auto-switching mode.
4. Channel Loss Alarm: Audible buzzer; occurrence details are to be recorded.
5. Time: Indicate date and time.
6. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
7. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

D. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches are to be illuminated.

E. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor and videotape recorder.

1. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
2. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
3. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
4. Alarm Switching: In the event of an alarm, alarming channel is to automatically switch the monitor to full screen.
5. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

F. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.

1. Pan-and-Tilt Control: Joystick type.
2. Zoom Control: Momentary-contact, "in-out" push button.
3. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

2.15 IP VIDEO SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Salient Systems Inc.**]
17. [**Samsung Opto-Electronics**]
18. [**SANYO North America Corporation**]
19. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
20. [**Vicon Industries, Inc**]
21. [**VIVOTEK Inc.**]
22. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Salient Systems Inc.**]
17. [**Samsung Opto-Electronics**]
18. [**SANYO North America Corporation**]
19. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
20. [**Vicon Industries, Inc**]
21. [**VIVOTEK Inc.**]
22. **<Insert manufacturer's name>**

C. Description:

1. System is to provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
2. System is to have seamless integration of all video surveillance and control functions.

3. Graphical user interface software is to manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system is to also be capable of integrating into larger system environments.
4. System design is to include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit is to provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
5. All camera signals are to be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units are to be ruggedly built and designed for extreme adverse environments, complying with UL 50E Type environmental standards.
7. Encoder/decoder combinations are to place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices are to be provided for full performance of specified system.

2.16 VIDEO MOTION SENSORS (INTERIOR)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**ICU Security, Inc**]
3. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
4. [**Visiontech**]
5. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**ICU Security, Inc**]
3. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
4. [**Visiontech**]
5. **<Insert manufacturer's name>**

C. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs are to be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.

1. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
2. Modular design that allows for expansion or modification of number of inputs.
3. Controls:

   a. Size of detection zones.
   b. Sensitivity of detection of each protected zone.

4. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

2.17 CONTROL STATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Elbex Ltd.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**Panasonic Corporation of North America**]
10. [**Pelco**]
11. [**Samsung Opto-Electronics**]
12. [**SANYO North America Corporation**]
13. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Vicon Industries, Inc**]
15. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Elbex Ltd.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**Panasonic Corporation of North America**]
10. [**Pelco**]
11. [**Samsung Opto-Electronics**]
12. [**SANYO North America Corporation**]
13. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Vicon Industries, Inc**]
15. **<Insert manufacturer's name>**

C. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.

D. Equipment Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

E. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit is to supply power to all components connected to it unless otherwise indicated.

F. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components are to maintain continuous system operation during outages of both normal and backup ac system supply.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger is to recharge fully discharged battery within 24 hours.

G. Annunciation: Indicate change in system condition and switching of system or component to backup power.

2.18 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Coaxial cable elements have 75 Ω nominal impedance. Comply with requirements in Section 26519 "Low-Voltage Electrical Power Conductors and Cables."

B. Video Surveillance Coaxial Cable Connectors: BNC type, 75 Ω. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. Comply with requirements in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. For communication wiring, comply with the following:

1. Section 271313 "Communications Copper Backbone Cabling."
2. Section 271323 "Communications Optical Fiber Backbone Cabling."
3. Section 271333 "Communications Coaxial Backbone Cabling."
4. Section 271513 "Communications Copper Horizontal Cabling."
5. Section 271523 "Communications Optical Fiber Horizontal Cabling."
6. Section 271533 "Communications Coaxial Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 INSTALLATION OF VIDEO SURVEILLANCE

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with **84 inch (2134 mm)** minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

1. For 12 and 24 V(dc) cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.4 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

    a. Prepare equipment list described in "Informational Submittals" Article.
    b. Verify operation of auto-iris lenses.
    c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
    d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object **50 to 75 ft (17 to 23 m)** away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    e. Set and name all preset positions; consult Owner's personnel.
    f. Set sensitivity of motion detection.
    g. Connect and verify responses to alarms.
    h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Nonconforming Work:

1. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose. Tasks are to include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.

5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 20 00 00

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Task	Specification	Specification Description
28 21 00 00	28 20 00 00	Video Surveillance
28 21 31 00	01 00 00 00MOD000	Supplemental Requirements for Electrical
28 21 31 00	26 09 23 00	Electrical Power Monitoring
28 21 31 00	28 10 00 00a	Access Control Software and Database Management
28 21 31 00	28 20 00 00	Video Surveillance

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SECTION 28 40 00 00 - EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM ERCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency responder communications enhancement system (ERCES) equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**] <**Insert Section number and title**> specifies preinstallation conference procedures.
5. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
7. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
8. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
9. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
10. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
11. Section 284600 "Fire Detection and Alarm" specifies fire-alarm cabling and interfacing ERCES with fire-alarm systems.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

A. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.

B. BDA: Bi-directional amplifier.

C. DAS: Distributed antenna system.

D. Downlink: The signal from a base station to portable radios.

E. ERCES: Emergency responder communications enhancement system(s).

F. FCC: Federal Communications Commission.

G. GROL: General Radiotelephone Operator License (FCC).

H. IB-PSC: In-building public safety communications.

I. LTE: Long-term evolution (mobile device technology standard).

J. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers (NSPE).

K. RF: Radio frequency.

L. UHF: Ultra-high frequency.

M. Uplink: The signal from a portable radio to the base station.

1.6 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals:

1. Engage qualified RF design professional to design ERCES.
2. Engage qualified electrical professional engineer to design power distribution for ERCES.
3. Engage qualified structural professional engineer to design poles, foundations, hangers, and supports for ERCES.
4. Engage qualified fire-alarm system designer for supervision of ERCES components by the building fire-alarm system.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**the Project site**] <**Insert location**>.

B. Preinstallation Coordination Meeting(s): Conduct meeting(s) [**as videoconference**] [**or**] [**at the Project site**] <**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**] [**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.8 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. <**Insert product-specific submittal data requirement**>.
4. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

   a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
   b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
   c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

5. Include manufacturer's sample extended warranty language.
6. Product Certificates: Include product certificate stating compliance with NFPA 72, NFPA 1225, and specified requirements, signed by manufacturer or fabricator.
7. <**Insert requirements**>.

B. Shop Drawings: Prepare and submit the following:

1. ERCES Drawings, Diagrams, and Supporting Documents:

   a. Project general notes.
   b. Include plans, elevations, sections, details, and attachments to other Work.
   c. Device layout.
   d. Block diagrams and cable/conduit routing.
   e. Cable type identification.
   f. Pathway class and survivability identification.
   g. System communications details.
   h. System sequence of operations.
   i. System mounting details.
   j. Roof attachment and penetration details.
   k. Secondary power calculations.
   l. Critical Areas Coverage: Fire command center, fire pump room, exit stairs/passageways, elevators, elevator lobbies, sprinkler standpipe closets and sectional valves locations, and other areas deemed critical by authorities having jurisdiction.

2. Include lightning protection with donor antenna installation as required by adopted codes and standards and in accordance with manufacturers' instructions. <**Insert additional requirements for drawing content or format**>.

C. Delegated Design Submittals: Include analysis data signed by delegated design professional(s) responsible for their preparation. Include FCC GROL license or IB-PSC certification information.

D. Field quality-control reports.

1.9 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Baseline Radio Signal Strength and Quality Testing Report:

1. Detailed report indicating NFPA 1225 plotted interior radio signal strength or delivered audio quality score throughout building critical and general areas with construction of interior partitions and doors completed, but without ERCES installed.
2. Approval from authorities having jurisdiction to omit ERCES installation within building areas where baseline radio signal strength testing demonstrates that minimum required radio signal strength values are provided within these areas.

C. System Record of Inspection and Testing: Record copy of completed system acceptance testing.[**Format must be approved by authorities having jurisdiction.**]

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.
5. Field reports for software and firmware upgrades.

1.10 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.11 REGULATORY AGENCY APPROVALS

A. Submittals for ERCES requiring approval by authorities having jurisdiction must be signed by qualified FCC GROL licensee, NICET IB-PSC design technician, or life-safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect**] [**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction**].

B. Submittals for ERCES must include written authorization from the frequency license holder to operate the two-way emergency responder communications enhancement system identified in the submittal.

1.12 QUALIFICATIONS

A. In-Building Public Safety Communications (IB-PSC) Technician Trainee: Having at least six months of experience and possessing active NICET IB-PSC Level I certification. Able to install passive and active ERCES equipment under direct supervision.

B. In-Building Public Safety Communications (IB-PSC) Associate Engineering Technician: Having at least two years of experience and possessing active NICET IB-PSC Level II certification. Able to conduct surveys, to install, to commission, and to maintain ERCES systems under limited supervision.

C. In-Building Public Safety Communications (IB-PSC) Engineering Technician: Having at least five years of experience and possessing active NICET IB-PSC Level III certification. Able to interpret and evaluate surveys, to layout, and to manage ERCES systems without supervision.

D. In-Building Public Safety Communications (IB-PSC) Design Technician: Having at least two years of IB-PSC design experience and possessing active NICET IB-PSC Design Technician certification. Able to prepare shop drawing plans and details for ERCES in accordance with Project requirements, manufacturer's published instructions, site survey data, and design tools.

E. General Radiotelephone Operator License (GROL) Designer: Having an active FCC Registration Number (FRN). Able to prepare shop drawing plans and details for ERCES in accordance with Project requirements, manufacturer's published instructions, site survey data, and design tools.

F. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

G. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] <**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] <**Insert code enforced by authorities having jurisdiction**> testing standards.

H. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

1.13 WARRANTY FOR ERCES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed ERCES perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] [**Three**] [**Four**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that ERCES perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: The emergency responder communications enhancement system consists of one or more of the following: donor antenna, backbone riser cable, bi-directional amplifier (BDA), coupler, splitter, power divider, and distribution antenna. <**Insert brief description of actual system, assembly, or equipment to be installed**>.

B. Performance Criteria:

1. Regulatory Requirements:

a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 1225, [**NFPA 101,**] [**ICC IBC,**] [**ICC IFC,**] and local regulations enforced by authorities having jurisdiction.
c. Performance objectives include downlink signal sufficient to provide a minimum of DAQ 3.0 (delivered audio quality) for voice communications using either narrowband, analog, or digital P25 signals or wideband LTE digital signals throughout the coverage area. Recommended design to DAQ 3.4 for safety factor.
d. Uplink signal should be sufficient to provide a minimum of DAQ 3.0 (delivered audio quality) for voice communications using either narrowband, analog, or digital P25 signals or widespread LTE digital signals.

2. General Characteristics: ERCES to be installed inside of buildings using approved materials, electrical and radio components, and accepted installation practices. Where required, ensure that systems meet NFPA survivability requirements through the use of fire barrier construction, fireproofing materials, listed cabling, and environmentally rated enclosures. Buildings fully protected by an automatic sprinkler system in accordance with NFPA 13 do not require fire-resistance rating of the backbone cables or backbone cable components.
3. Provide at least two independent and reliable primary and secondary power sources for all RF-emitting devices and other electronic components of the system.
4. To maintain proper alignment with the donor site, permanently affix donor antennas on the building or mount on a moveable sled with visible signage. Where donor antennas exist, maintain isolation between the donor antenna and all inside antennas to a minimum of 20 dB above system gain. The antenna installation must meet applicable codes for weather protection of the building envelope. Additionally, systems must be protected by lightning protection complying with NFPA 1225.

a. <**Insert additional performance requirements for the Project**>.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
2. Component Importance Factor (I_p): [**1.0**] [**1.5**].
3. Component Amplification Factor (a_p): [**1.0**] [**2.5**] <**Insert value**>.
4. Component Response Modification Factor (R_p): [**1.5**] [**2.0**] [**2.5**] [**6.0**] <**Insert value**>.
5. Component Overstrength Factor (Ω_o): [**1.5**] [**2.5**] <**Insert value**>.

2.4 PASSIVE AND ACTIVE SYSTEMS

A. Description: A distributed antenna system (DAS) is one element of an ERCES and does not include an RF signal source such as a BDA or radio base station. The RF distribution part of the system may be either a passive DAS or an active DAS. A passive DAS includes a BDA feeding a coax distribution antenna system through splitters where none of the elements (coax, splitters, antennas) are powered. An active DAS uses powered components to distribute RF signals. A fiber DAS is an example of an active DAS; the head-end device converts RF signals into optical wavelengths sent over the fiber cables. Remote components convert the optical wavelengths back into RF signals and amplify them for broadcast over the distribution antenna system. The head-end device and remote components are powered devices.

2.5 EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM (ERCES) EQUIPMENT

A. Description: This category includes in-building ERCES equipment to improve wireless communication. This FCC-certified enhancement system is inclusive of BDAs, transmission lines, cables, power supplies, antennas, and other ancillary equipment that allow radio signals to pass to and from interior of structure for facilitating radio communications using emergency responder radio frequencies.

B. In-Building ERCES Bi-Directional Amplifiers <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. ERCES: UL CCN UTMH; including UL 2524 and NFPA 1225.

3. Standard Features:

   a. Primary Power Supply: [**120 V(ac)**] [**240 V(ac)**] <**Insert voltage**> supplied from a dedicated branch circuit, permanently connected, protected from overvoltage, and NFPA 72 compliant.
   b. Secondary Power Supply: Provide one of the following:

      1) [**24 V(dc)**] <**Insert voltage**> supplied from a storage battery with capacity of 12 h at 100 percent system operation capacity.
      2) Power source with capacity of 12 h at 100 percent system operation capacity approved by authorities having jurisdiction.
      3) 2 h battery supplemented by a generator power system with capacity to support system load for 12 h.

   c. Monitor the integrity of power sources in accordance with NFPA 1225.
   d. Supervision: Provide auxiliary contacts for remote status supervision by [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**>.

      1) Signal booster failure.
      2) Antenna malfunction.
      3) Loss of normal AC power.
      4) Low battery voltage.
      5) Battery charger failure.
      6) <**Insert system status supervision**>.

   e. Monitor system integrity in accordance with Ch. 10 of NFPA 72. Monitor integrity of the communications link between the [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**> and the in-building ERCES. Where approved by authorities having jurisdiction, a single supervisory input is permitted to the [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**>.
   f. Cabinet Enclosures: UL 50E, [**Type 4**] [**Type 3R**]. Protect battery systems with a Type 3R or higher-rated cabinet. Protect repeater, transmitter, receiver, signal booster components, optical-to-RF converters, and external filters with a Type 4 or Type 4X enclosure.
   g. Mounting: [**Surface**] <**Insert type**> mount.
   h. Finish: [**Factory-finish red enamel**] <**Insert finish**>.

4. Options:

a. Remote Indicator Panel: As required. Install remote indicator panel within the fire command center or at a location designated by authorities having jurisdiction, and in accordance with approved shop drawings showing location, mounting height, and wiring detail. The indicator panel must display the following:

1) Presence of primary AC power.
2) Loss of primary AC power.
3) Battery charger failure.
4) Low-battery capacity.
5) Signal source malfunction.
6) Active RF-emitting device malfunction.
7) Active system component malfunction.

b. Emergency Power-Off (EPO) Switch: As required. The EPO switch interrupts power to the ERCES on direction from authorities having jurisdiction or frequency license holder.

C. In-Building ERCES Distributed Antennas <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard Features:

a. Type: [**Wide-band omnidirectional**] [**and**] [**multi-band**] [**single-band**].
b. Mounting: Low-profile [**ceiling**] <**Insert type**> mount.

D. In-Building ERCES Donor Antennas <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard Features:

a. Configuration: Factory-assembled and -tuned directional UHF Yagi antenna.
b. Mounting: [**Stainless steel**] <**Insert type**> mounting hardware.
c. Finish: [**Welded**] [**or**] [**seamless**] corrosion-resistant aluminum construction.
d. Wind Velocity Rating: [**Comply with minimum ICC IBC requirements**] <**Insert requirements**>.

E. RF Antenna Cable Couplers and Splitters <**Insert drawing designation**>:

1. Description: Physical hardware elements connecting the donor antenna cables to the distributed antennas, mounting hardware, and building elements.
2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
3. Standard Features:

a. Configuration: Nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**>, N-Type, weatherproof, medium-size, RF couplers, and splitters for coaxial cables.
b. Bandwidth: [**As required by in-building emergency radio enhancement system performance requirements**] <**Insert requirement**>.
c. Gain (dB) Rating: [**As required by in-building emergency radio enhancement system performance requirements**] <**Insert requirement**>.
d. Environmental Rating: [**Type 4 and][IP65**] <**Insert IP code**>.

F. Remote Indicator Panel <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard Features:

a. Primary Power Supply: [**24 V(dc)**] [**120 V(ac)**] generally powered from the ERCES power supply as auxiliary nominal 28 V(dc). <**Insert voltage**>.
b. Secondary Power Supply: Provide one of the following:

1) [**24 V(dc)**] <**Insert voltage**> storage battery with capacity for 12 h at 100 percent system operation capacity.
2) Power source with capacity for 12 h at 100 percent system operation capacity approved by authorities having jurisdiction.
3) 2 h battery supplemented by standby generator power system with capacity to support system load for 12 h.

c. Configuration: Zone indicator panel with LED indicators[**, piezoelectric sounder,**] and switches for lamp test and alarm silence.
d. LED Indicators: Green indicator for primary power in normal state; red indicators for each individual fault status required to be indicated by authorities having jurisdiction.
e. Enclosure: [**16-gauge steel**] <**Insert material**> with factory-applied red enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM (ERCES)

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
7. Hot Work: NFPA 51B.
8. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
9. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
10. Communications Work: BICSI N1.
11. Work in ITE Rooms: NFPA 75.
12. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
13. Life-Safety and Means-of-Egress Work: NFPA 101.
14. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
15. Work in Confined Spaces: NFPA 350.
16. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
17. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
18. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
19. Fire-Alarm Circuits and Pathways: Ch. 12 of NFPA 72 and Article 760 of NFPA 70.
20. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Installation for Survivability:

a. Install cables in accordance with Ch. 7 and 8 of NFPA 70.
b. Provide mechanical protection of work and raceways for coax cables in accordance with Article 820 of NFPA 70.
c. Backbone cables and cable components installed in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13 do not require fire-resistance rating.
d. Protect backbone cables and cable components installed in nonsprinklered buildings, in buildings that are partially protected by an automatic sprinkler system, or in high-rise buildings from attack by fire in accordance with one of the following:

1) Provide cable with listed fire-resistance rating in accordance with the following criteria:

a) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 h or more, or is classified as heavy-timber construction, provide minimum 2 h fire-resistance rated cable.
b) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 h, provide minimum 1 h fire-resistance rated cable.
c) Where the primary structural frame of a building does not require a fire-resistance rating, fire-resistance rated cable is not required.

2) Provide protected enclosure or area with fire-resistance rating in accordance with the following criteria:

a) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 h or more, or is classified as heavy-timber construction, provide minimum 2 h fire-resistance rated enclosure or area.
b) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 h, provide minimum 1 h fire-resistance rated enclosure or area.
c) Where the primary structural frame of a building does not require a fire resistance rating, fire-resistance rated enclosure or area is not required.

e. Where the backbone cables and distribution antenna cables are run in a fire-resistant enclosure or protected area, both of the following shall apply, except as permitted in Section 18.12.3.6 of NFPA 1225:

1) Provide connection between backbone cable and distribution antenna cables within an enclosure or protected area in accordance with Section 18.12.3.4 of NFPA 1225, Section 18.12.3.4.
2) Provide firestop assembly for passage of the distribution antenna cable in and out of the enclosure or protected area with equivalent rating to enclosure or protected area.

f. If both the backbone cables and cable components are fire rated in accordance with Section 18.12.3.4 of NFPA-1225, connection of the distribution antenna cable may be made outside enclosure or protected area.

2. Antenna Wiring Methods:

a. Coaxial Cabling:

1) Riser Coaxial Cable: Type CATVR, nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
2) Plenum Coaxial Cable: Type CATVP, nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
3) Plenum Radiating Coaxial Cable: Type CATVP, nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> radiating coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
4) Connectors: Nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> N-Type, weatherproof, medium-size, RF connectors for coaxial cables.

3. Determine in-building service antenna locations based on baseline radio signal strength testing.
4. Request approval from authorities having jurisdiction to omit emergency responder radio coverage system from areas of building where baseline radio signal strength testing demonstrates that minimum required radio signal strength values are achieved without radio coverage system.
5. Install outdoor donor antenna with clear view to donor site with minimum [**2 ft (0.6 m)**] vertical clearance above nearby obstacles.
6. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Coordinate with Section 284600 "Fire Detection and Alarm" for interfaces with fire-alarm system.
2. Identification: Provide labels for ERCES and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3. Coordinate installation of new products for <**Insert system or product group/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ERCES

A. Administrant for Communications Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. Notify the Owner and authorities having jurisdiction no later than ten working days in advance of scheduled acceptance testing of the installed system.
2. Notify the frequency license holder no later than ten working days in advance of scheduled testing of the installed system. Receive written authorization from the frequency license holder to activate active RF components on scheduled date.
3. Provide Owner and authorities having jurisdiction with a written test plan no later than seven working days prior to conducting acceptance tests.

D. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform standard field tests and inspections as required by NFPA 72 for fire-alarm supervision of ERCES components.
3. Perform standard field tests and inspections as required by NFPA 1225.
4. Building Owner to have the ERCES inspected and tested annually or where structural changes occur, including additions or remodels.
5. Baseline radio signal strength testing.
6. <**Insert detailed description of additional tests and inspections required**>.

F. Nonconforming Work:

1. ERCES will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**] [**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain ERCES components.
b. <**Insert system or equipment**>.

2. [**Provide video recordings of training sessions to Owner**] [**Allow Owner to record training sessions**].

3.5 PROTECTION

A. After installation, protect ERCES equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three-month**] [**six-month**] [**nine-month**] [**one-year**] <**Insert duration**> period for full maintenance by [**skilled employees of ERCES Installer**] [**manufacturer's authorized service representative**]. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper ERCES operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**] <**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]

<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: Not less than [**30 days**] <**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

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Task	Specification	Specification Description
28 41 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 41 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 11 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 43 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES

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SECTION 28 46 00 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm system control units.
2. Dedicated function control units.
3. Fire-alarm remote annunciators.
4. Fire-alarm auxiliary power supplies.
5. Fire-alarm audio amplifiers.
6. Fire-alarm terminal cabinets.
7. Manual fire-alarm boxes.
8. Heat-sensing fire detectors.
9. Smoke-sensing fire detectors.
10. Radiant energy-sensing fire detectors.
11. Combination, multi-criteria, and multi-sensor detectors.
12. Carbon monoxide detectors.
13. Sprinkler waterflow alarm-initiating devices.
14. Audible notification appliances.
15. Visual notification appliances.
16. Combination audible/visual notification appliances.
17. Firefighters' two-way, in-building wired telephone communications system.
18. Fire-alarm supervised control module interfaces for fire safety functions.
19. Fire-alarm supervisory signal-initiating devices.
20. Fire-alarm digital alarm communicator transmitters.
21. Fire-alarm radio alarm transmitters.
22. Fire-alarm record documentation cabinets.
23. Passive graphic maps.
24. Fire-alarm cables.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**][**Section 087113 "Power Door Operators"**][**Section 087813 "All-Glass-Entrance Hardware"**] specifies door hardware control interfaces referenced by this Section.
6. [**Section 142100 "Electric Traction Elevators"**][**Section 142113 "Electric Traction Freight**

Elevators"][**Section 142123.16 "Machine Room-Less Electric Traction Passenger Elevators"**][**Section 142400 "Hydraulic Elevators"**][**Section 142413 "Hydraulic Freight Elevators"**][**Section 142600 "Limited-Use/Limited-Application Elevators"**] specifies elevator control interfaces referenced by this Section.

7. Section 143100 "Escalators" specifies escalator control interfaces referenced by this Section.
8. Section 143200 "Moving Walks" specifies moving walk control interfaces referenced by this Section.
9. Section 230923 "Direct Digital Control (DDC) System for HVAC" specifies HVAC control interfaces referenced by this Section.
10. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
11. Section 260533.13 "Conduits for Electrical Systems" specifies raceway types installed by this Section.
12. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
13. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
14. Section 260923 "Lighting Control Devices" specifies emergency lighting control interfaces referenced by this Section.
15. Section 262816 "Enclosed Switches and Circuit Breakers" specifies shunt-trip control interfaces referenced by this Section.
16. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
17. Section 275119 "Sound Masking Systems" specifies sound masking system equipment referenced by this Section.
18. Section 284700 "Mass Notification" specifies mass notification system interfaces referenced by this Section.
19. Section 284800 "Emergency Response Systems" specifies [**ERCES**][**and**][**two-way emergency communications systems for rescue assistance**] referenced by this Section.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. AWG: American wire gauge; see ASTM B258.
2. BAS: Building automation system.
3. BMS: Building management system.
4. cd: Candela, the SI fundamental unit of luminous intensity.
5. DACR: Digital alarm communicator receiver.
6. DACT: Digital alarm communicator transmitter.
7. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
8. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
9. EPS: Emergency power supply.
10. EPSS: Emergency power supply system.
11. ERCES: Emergency responder communications enhancement system.
12. ESS: Energy storage system.
13. FACU: Fire-alarm control unit.
14. FAS: Fire-alarm system.
15. IDC: Initiating device circuit.
16. IP: Internet Protocol.
17. IR: Infrared.

18. LAN: Local area network.
19. LCD: Liquid-crystal display.
20. LED: Light-emitting diode.
21. Li-ion: Lithium-ion.
22. NAC: Notification appliance circuit.
23. N.C.: Normally closed.
24. Ni-Cd: Nickel-cadmium.
25. Ni-MH: Nickel-metal hydride.
26. N.O.: Normally open.
27. PC: Personal computer.
28. PLFA: Power-limited fire alarm.
29. PoE: Power over Ethernet.
30. POTS: Plain old telephone service. See "public switched telephone network" definition.
31. PSTN: Public switched telephone network.
32. RAT: Radio alarm transmitter.
33. SLC: Signaling-line circuit.
34. TR: Tamper resistant.
35. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL Solutions, Inc.
36. UL CCN: UL Category Control Number.
37. UPS: Uninterruptible power supply.
38. VoIP: Voice over Internet Protocol.
39. VPN: Virtual private network.
40. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
41. WAN: Wide area network.
42. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ERMC-A: Aluminum electrical rigid metal conduit.
6. ERMC-S: Steel electrical rigid metal conduit.
7. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
8. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
9. ERMC-SS: Stainless steel electrical rigid metal conduit.
10. FMC: Flexible metal conduit.
11. FMC-A: Aluminum flexible metal conduit.
12. FMC-S: Steel flexible metal conduit.
13. IMC: Steel electrical intermediate metal conduit.
14. LFMC: Liquidtight flexible metal conduit.
15. LFMC-A: Aluminum liquidtight flexible metal conduit.
16. LFMC-S: Steel liquidtight flexible metal conduit.
17. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
18. LFNC: Liquidtight flexible nonmetallic conduit.
19. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
20. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
21. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
22. PVC: Rigid PVC conduit.
23. PVC-40: Schedule 40 rigid PVC conduit.
24. PVC-80: Schedule 80 rigid PVC conduit.
25. RGS: See ERMC-S-G.
26. RMC: See ERMC raceway types above.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. CI: Circuit integrity cable.
2. FPL: Power-limited fire-alarm cable.
3. FPLP: Power-limited fire-alarm plenum cable.
4. FPLR: Power-limited fire-alarm riser cable.
5. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
6. NPLF: Non-power-limited fire-alarm circuit cable.
7. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
8. NPLFR: Non-power-limited fire-alarm circuit riser cable.
9. OFC: Conductive optical fiber general-purpose cable.
10. OFCG: Conductive optical fiber general-purpose cable.
11. OFCP: Conductive optical fiber plenum cable.
12. OFCR: Conductive optical fiber riser cable.
13. OFN: Nonconductive optical fiber general-purpose cable.
14. OFNG: Nonconductive optical fiber general-purpose cable.
15. OFNP: Nonconductive optical fiber plenum cable.
16. OFNR: Nonconductive optical fiber riser cable.

D. Definitions:

1. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
2. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
3. Conduit: A structure containing one or more duct raceways.
4. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."
5. Direct Buried: Installed underground without encasement in concrete or other protective material.
6. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
7. Duct Raceway: A single enclosed raceway for conductors or cable.
8. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
9. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
10. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
11. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For fire-alarm system coordination with [**sound-masking system**][**paging system**][**and**][**mass notification system**]. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.

2. Include manufacturer's sample extended warranty language.
3. <**Insert requirements**>.

B. Shop Drawings: Prepare and submit the following:

1. Cover sheet indicating protected premises name and location and Owner information, name of installer, device legend and symbols [**in accordance with NFPA 170**][**acceptable to the authorities having jurisdiction**], and date of issue and any revision dates.
2. Floor Plans:

a. Floor or level identification.
b. Point of compass (indication of north).
c. Graphic scale.
d. All walls and doors.
e. All partitions extending to within 15 percent of the ceiling height.
f. Room and area descriptions.
g. Acoustically distinguishable spaces.
h. Minimum required illumination levels.
i. System devices/component locations.
j. Locations of the system's primary power disconnecting means.
k. Locations of monitor/control interfaces to other systems.
l. System riser locations.
m. Type and number of system components/devices on each circuit, on each floor or level.
n. Type and quantity of conductors[**and conduit**] for each circuit.
o. Identification of any ceiling over **10 ft (3.0 m)** in height where automatic fire detection is being proposed.
p. Details of ceiling geometries, including beams and solid joists, where automatic fire

detection is being proposed.
q. Acoustic properties of spaces, where known.
r. Pathway class designations, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
s. Pathway survivability level designations.

3. Wiring Diagrams:

a. System riser diagrams coordinated with the floor plans and indicating the following information:

1) General arrangement of the system in building cross-section.
2) Number of risers.
3) Type and number of circuits in each riser.
4) Type and number of system components/devices on each circuit, on each floor or level.
5) Number of conductors for each circuit.
6) Pathway class designation, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
7) Pathway survivability level designations.

b. Control unit diagrams for all control equipment, power supplies, battery chargers, and annunciators indicating the following information:

1) Identification of control equipment depicted.
2) Location(s) of control equipment.
3) All field wiring terminals and terminal identifications.
4) All circuits connected to field wiring terminals and circuit identifications.
5) All indicators and manual controls.
6) Field connections to supervising station signaling equipment[**, releasing equipment,**] and emergency safety control interfaces.

c. Typical fire-alarm component schematic wiring diagrams for all initiating devices, notification appliances,[**remote indicators,**][**remote test stations,**][**end-of-line and power supervisory devices,**] and annunciators.

4. Fire-Alarm Input/Output Sequence: Include a narrative description or input/output matrix of operation to describe the fire-alarm system sequence of operation.
5. Details:

a. Component installation details.
b. Custom graphic annunciator layout.

6. Calculations:

a. Battery calculations.
b. Voltage-drop calculations.
c. Speaker circuit calculations.
d. Spare capacity circuit calculations.

C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for [**software**][**and**][**firmware**] upgrades.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 REGULATORY AGENCY APPROVALS

A. Submittals for fire detection and alarm system requiring approval by authorities having jurisdiction must be signed by qualified NICET FAS[**senior**] engineering technician or life-safety professional engineer responsible for their preparation.[**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.9 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, supervise Level I and Level II technicians, provide submittal packages, and interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, interpret codes and standards, conduct training, and serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

G. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

H. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS[**Senior**] Engineering Technician certification.

I. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [**I**][**II**] certification.

1.10 WARRANTY FOR FIRE DETECTION AND ALARM SYSTEMS

A. Special Installer Extended Warranty: Installer warrants that installed fire detection and alarm system performs in accordance with specified requirements and agrees to repair or replace system components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that fire detection and alarm system components perform in accordance with specified requirements and agrees to repair or replace system components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70 or NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. System Description: Noncoded, [**UL-certified**][**FM Global-placarded**][**addressable**][**conventional**] system with multiplexed signal transmission and [**voice**][**horn**]-and-strobe notification for evacuation.

C. System Inputs:

1. Fire-alarm signal initiation must be by one or more of the following devices[**and systems**]:

   a. Manual fire-alarm boxes.
   b. Heat detectors.
   c. Smoke detectors.
   d. Flame detectors.
   e. Duct smoke detectors.
   f. Air-sampling smoke-detection system.
   g. Carbon monoxide detectors.
   h. Combustible gas detectors.
   i. Automatic sprinkler system water flow.
   j. Preaction system alarm.
   k. Fire-extinguishing system operation.
   l. Fire standpipe system.
   m. Dry-pipe sprinkler system pressure flow switch.
   n. Fire pump is running.
   o. <**Insert alarm-initiating devices and systems**>.

2. Supervisory signal initiation must be by one or more of the following devices and actions:

   a. Valve supervisory switch.

b. High- or low-air pressure switch of dry-pipe or preaction sprinkler system.
c. Alert and Action signals of air-sampling smoke-detection systems.
d. Duct smoke detectors.
e. Elevator shunt-trip control circuit supervision.
f. Independent fire-detection and fire-suppression systems.
g. Fire pump is running.
h. Fire pump has lost power.
i. Power to the fire pump has phase reversal.
j. Zones or individual devices have been disabled.
k. FACU has lost communication with network.
l. Hose cabinet door is open.
m. <**Insert supervisory signal-initiating devices and actions**>.

3. System trouble signal initiation must be by one or more of the following devices and actions:

a. Open circuits, shorts, and grounds in designated circuits.
b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
c. Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, or ethernet module.
d. Loss of primary power at FACU.
e. Ground or single break in internal circuits of FACU.
f. Abnormal AC voltage at FACU.
g. Break in standby battery circuitry.
h. Failure of battery charging.
i. Abnormal position of switch at FACU or remote annunciator.
j. Voice signal amplifier failure.
k. <**Insert trouble signal-initiating devices and actions**>.

4. Carbon monoxide alarm signal initiation must be by the following devices[**and systems**]:

a. Carbon monoxide detectors.

D. System Outputs:

1. Fire-alarm signal must initiate the following actions:

a. Continuously operate alarm notification appliances[**, including voice evacuation notices**].
b. Identify alarm and specific initiating device at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. Transmit alarm signal to remote alarm receiving station.
d. Unlock electric door locks in designated egress paths.
e. Release fire and smoke doors held open by magnetic door holders.
f. Activate voice/alarm communication system.
g. Switch HVAC equipment controls to fire-alarm mode.
h. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
i. Activate stairwell[**and elevator-shaft**] pressurization systems.
j. Close smoke dampers in air ducts of designated air-conditioning duct systems.
k. Activate preaction system.
l. Recall elevators to designated or alternate recall levels only upon activation of smoke detectors in respective elevator lobbies, machine rooms, or hoistways.
m. Activate elevator power shunt trip only upon activation of associated heat detector.
n. Activate emergency lighting control.
o. Activate emergency shutoffs for gas and fuel supplies[**, except for shutoffs serving**

legally required life-safety systems such as emergency generators and fire pumps].

p. Record events in system memory.
q. Indicate device in alarm on graphic annunciator.
r. <**Insert signal-initiating actions**>.

2. System supervisory signal must initiate the following actions:

a. Initiate supervisory notification appliances.
b. Identify specific device initiating event at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. After time delay of [**200 seconds**]<**Insert time**>, transmit trouble or supervisory signal to remote alarm receiving station.
d. Transmit system status to building management system.
e. Display system status on graphic annunciator.

3. Carbon monoxide alarm signal must initiate the following actions:

a. Initiate carbon monoxide notification appliances and sound temporal-4 signal.
b. Identify specific device initiating event at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. Transmit carbon monoxide alarm signal to remote alarm receiving station.

2.4 FIRE-ALARM SYSTEM CONTROL UNITS

A. Description: A component of the fire-alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire-alarm control units, and processes these signals to determine part or all of the required fire-alarm system output functions.

B. UL UOJZ - Addressable Fire-Alarm System Control Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Fike Corporation**]
c. [**Fire-Lite Alarms; Honeywell International, Inc.**]
d. [**Firecom, Inc.**]
e. [**Gamewell-FCI; Honeywell International, Inc.**]
f. [**Keltron Corporation**]
g. [**Kidde Commercial Fire & Life Safety Systems**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Bosch Security Systems, Inc.**]
b. [**Fike Corporation**]
c. [**Fire-Lite Alarms; Honeywell International, Inc.**]
d. [**Firecom, Inc.**]
e. [**Gamewell-FCI; Honeywell International, Inc.**]
f. [**Keltron Corporation**]
g. [**Kidde Commercial Fire & Life Safety Systems**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electrical Control Units for Fire-Protective Signaling Systems: UL CCN UOJZ, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 23 of NFPA 72.
   b. [**Voice**][**Non-voice**]/alarm communications.
   c. Indication of which communication zones have been silenced.
   d. Provide selective silencing of alarm notification appliances by building communication zone.
   e. Real-time clock for time annotation of events on the event recorder[**and printer**].
   f. Communication between the FACU and remote circuit interface panels, annunciators, and displays.
   g. The FACU must be listed for connection to a central station signaling system service.
   h. Provide non-volatile memory for system database, logic, operating system, and event history.
   i. The system must not require manual input to initialize in the event of a complete power-down condition.
   j. Alphanumeric display and system controls.
   k. Minimum of [**two**][**four**]**<Insert number>**[**Class A**][**Class X**][**Class B**] signaling-line circuits[**with expansion capability to add circuits**].
   l. Minimum of [**two**][**four**]**<Insert number>**[**Class A**][**Class B**] notification appliance circuits[**with expansion capability to add circuits**].
   m. Synchronization of notification appliance circuits.

6. Other Available Features Required by Project:

   a. Printer interface.
   b. Smoke-alarm verification.

C. UL UOJZ - Conventional Fire-Alarm System Control Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Edwards; Carrier Global Corporation**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Notifier; Honeywell International, Inc.**]
   e. [**Siemens Industry, Inc.; Fire Safety Division**]
   f. [**Silent Knight; Honeywell International, Inc.**]
   g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Edwards; Carrier Global Corporation**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Notifier; Honeywell International, Inc.**]
   e. [**Siemens Industry, Inc.; Fire Safety Division**]
   f. [**Silent Knight; Honeywell International, Inc.**]
   g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electrical Control Units for Fire-Protective Signaling Systems: UL CCN UOJZ, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 23 of NFPA 72.
   b. Communication between devices and control panel is limited and has only three states: Standby, Fault, and Fire.
   c. Minimum of [**four**][**eight**]<**Insert number**> conventional zones to supervise initiating device circuits.
   d. Built-in alarm and trouble relays.
   e. Capable of being interfaced to supervise third-party systems or equipment via dry contact closure.
   f. Synchronization of notification appliance circuits.

6. Other Available Features Required by Project:

   a. Printer interface.

2.5 DEDICATED FUNCTION CONTROL UNITS

A. Description: A protected premises fire-alarm control unit specifically listed for supervising a single function, such as releasing service that is part of a fire-suppression system and which provides control outputs to release a fire-suppression agent based on either automatic or manual input.

B. UL SYZV - Addressable Non-Extinguishing and Non-Water-Based Releasing Device Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Johnson Controls, Inc.**]
   b. [**Silent Knight; Honeywell International, Inc.**]
   c. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Johnson Controls, Inc.**]
   b. [**Silent Knight; Honeywell International, Inc.**]
   c. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Releasing Device Control Units for Fire-Protective Signaling Systems: UL CCN SYZV, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 23 of NFPA 72.
   b. Built-in alarm, trouble, supervisory, and security relays.
   c. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class X**][**Class B**] signaling-line circuits[**with expansion capability to add circuits**].
   d. Auto programming and walk test reports.
   e. Manual sensitivity adjustments.
   f. Maintenance alerts.
   g. Battery charger supports.
   h. Non-alarm points for lower-priority functions.

6. Other Available Features Required by Project:

   a. Printer interface.
   b. Synchronization of notification appliance circuits.

C. UL SYZV - Conventional Non-Extinguishing and Non-Water-Based Releasing Device Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Releasing Device Control Units for Fire-Protective Signaling Systems: UL CCN SYZV, including UL 864 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 23 of NFPA 72.
   b. Built-in alarm and trouble relays.
   c. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class B**] initiating device circuits[**with expansion capability to add circuits**].
   d. Maintenance alerts.
   e. Battery charger supports.

5. Other Available Features Required by Project:

   a. Printer interface.
   b. Synchronization of notification appliance circuits.

2.6 FIRE-ALARM REMOTE ANNUNCIATORS

A. Description: A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a fire-alarm system device, circuit, condition, or location.

B. UL UOXX - Fire-Alarm System Remote Annunciators :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Security Systems, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 23 of NFPA 72.
b. Compatibility with fire-alarm control unit for alphanumeric display and LED indicating lights.
c. Provide controls to acknowledge, silence, reset and test functions for alarm, supervisory, and trouble signals.

2.7 FIRE-ALARM AUXILIARY POWER SUPPLIES

A. Description: An auxiliary source of low-voltage electrical operating power for fire-alarm system equipment, including the circuits and terminations connecting it to the equipment being powered. Auxiliary power supplies are often referred to as remote power supplies, booster power supplies, or notification appliance power supplies.

B. UL UOXX - Fire-Alarm Auxiliary Power Supplies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Chs. 10 and 23 of NFPA 72.
b. Minimum of [**two**][**four**]<**Insert number**> 24 V(dc) auxiliary power circuits.

5. Other Available Features Required by Project:

a. Synchronization of notification appliance circuits.
b. Addressable-type notification appliance power supply, which connects directly to a signaling-line circuit.

2.8 FIRE-ALARM AUDIO AMPLIFIERS

A. Description: A component of in-building fire emergency voice/alarm communications systems that takes a low-level audio input and amplifies the power output to distribute to fire-alarm loudspeakers. Amplifiers can be an integral component of the fire-alarm control unit or can be remotely located in a separate

cabinet within the building.

B. UL UEAY2 - Fire-Alarm Audio Amplifiers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Wheelock; brand of Eaton**]
   b. [**Extron Electronics**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Wheelock; brand of Eaton**]
   b. [**Extron Electronics**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Amplifiers for Fire-Protective Signaling Systems: UL CCN UEAY2, including UL 1711, UL 1480, UL 1480A, UL 864, and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Chs. 18, 23, and 24 of NFPA 72.
   b. Supervised high-fidelity audio for emergency voice evacuation fire-alarm systems.
   c. Frequency Response: 275 Hz - 6.5 kHz.
   d. Speaker Outputs: [**25 V**][**70 V**] power limited.
   e. Minimum of [**four**][**eight**]<**Insert number**>[**Class A**][**Class B**] speaker output circuits.

6. Other Available Features Required by Project:

   a. Minimum of [**four**][**eight**]<**Insert number**>[**Class A**][**Class B**] synchronized strobe power circuits.
   b. [**Four**][**Eight**]<**Insert number**> digitally pre-recorded voice messages.
   c. Push-to-Talk (PTT) microphone.

2.9 FIRE-ALARM TERMINAL CABINETS

A. Description: A cabinet with hinged, lockable cover clearly labeled and intended for termination of fire-alarm conductors at junction points. Screw-type terminal blocks are provided within the terminal cabinet for conductor splices.

B. UL UOXX - Fire-Alarm Terminal Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Labeled "FIRE ALARM TERMINAL CABINET."
b. Interior field identification labels.
c. Sized accordingly to contain required number of termination points.
d. Accessible by authorized personnel only.

2.10 MANUAL FIRE-ALARM BOXES

A. Description: A manually operated device used to initiate a fire-alarm signal. Manual fire-alarm boxes come in both conventional or addressable models and may require a single-action (pull down) or double-action (push in and pull down) to initiate a fire-alarm signal. These initiating devices are sometimes referred to as manual fire-alarm stations, pull stations, or call points.

B. UL UNIU - Single-Action Manual Fire-Alarm Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]

m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Non-Coded Fire-Alarm Boxes: UL CCN UNIU, including UL 38 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Colored red with raised letters providing operating instructions.
c. [**Surface**][**Recessed**]<**Insert mounting arrangement**> mounted.
d. Station Reset: [**Key**][**Wrench**] operated switch.
e. Material: [**Polycarbonate**][**Metal**].

C. UL UNIU - Double-Action Manual Fire-Alarm Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]

j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Non-Coded Fire-Alarm Boxes: UL CCN UNIU, including UL 38 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Chs. 10 and 17 of NFPA 72.
b. Colored red with raised letters providing operating instructions.
c. [**Surface**][**Recessed**]<**Insert mounting arrangement**> mounted.
d. Station Reset: [**Key**][**Wrench**] operated switch.
e. Material: [**Polycarbonate**][**Metal**].

D. Accessories:

1. Factory-fabricated clear plastic enclosure[**with battery-operated sounder**].
2. Weatherproof protective shield for conventional manual fire-alarm boxes located outdoors.

2.11 HEAT-SENSING FIRE DETECTORS

A. Description: A fire detector that detects either abnormally high temperatures or rate-of-temperature rise, or both.

B. UL UQGS - Fixed-Temperature Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Kidde; Carrier Global Corporation**]
    g. [**Notifier; Honeywell International, Inc.**]
    h. [**Siemens Industry, Inc.; Fire Safety Division**]
    i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Kidde; Carrier Global Corporation**]
    g. [**Notifier; Honeywell International, Inc.**]
    h. [**Siemens Industry, Inc.; Fire Safety Division**]
    i. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
    c. [**Conventional**][**Addressable**]-type initiating device.
    d. Detector must have functional humidity range of 10 to 90 percent.

C. UL UQGS - Rate-Compensated Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Gamewell-FCI; Honeywell International, Inc.**]
    c. [**Honeywell International Inc.**]

d. [**Johnson Controls, Inc.**]
e. [**Notifier; Honeywell International, Inc.**]
f. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Gamewell-FCI; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Notifier; Honeywell International, Inc.**]
f. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Outer metal construction and inner metal components, which eliminate nuisance alarms due to thermal lag.
c. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.

D. UL UQGS - Spot-Type Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Field programmable.
   c. Resettable from the control unit.
   d. Removable from the base assembly without the use of tools and without disturbing the wiring connections.
   e. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
   f. [**Conventional**][**Addressable**]-type initiating device.
   g. Detector must have functional humidity range of 10 to 90 percent.

E. UL UQGS - Line-Type Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**The Protectowire Co., Inc.**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**The Protectowire Co., Inc.**]
   b. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and

NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Cable Type: [**Standard digital heat-sensitive cable**][**Confirmed temperature initiation cable**][**Fiber-optic cable with low-smoke zero-halogen jacket**].
c. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
d. [**Conventional**][**Programmable**]-type initiating device supervised by [**addressable input module**][**intelligent sub-panel**].

F. Accessories:

1. Heat detector protective guard.

2.12 SMOKE-SENSING FIRE DETECTORS

A. Description: A device that detects visible or invisible particles of combustion and initiates an action. Types of smoke-sensing fire detectors include spot-type detectors, air-sampling detectors, projected beam-type detectors, duct detectors, multi-criteria detectors, and video image smoke detectors.

B. UL UROX - Spot-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Field programmable.
    c. Resettable from the control unit.
    d. Removable from the base assembly without the use of tools and without disturbing the wiring connections.
    e. Sensing Type: [**Photoelectric**][**Ionization**].

C. UL UROX - Air Sampling-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Gamewell-FCI; Honeywell International, Inc.**]
    b. [**Honeywell International Inc.**]
    c. [**Notifier; Honeywell International, Inc.**]
    d. [**Siemens Industry, Inc.; Fire Safety Division**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Gamewell-FCI; Honeywell International, Inc.**]
    b. [**Honeywell International Inc.**]
    c. [**Notifier; Honeywell International, Inc.**]
    d. [**Siemens Industry, Inc.; Fire Safety Division**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Piping system and fan to transport particles of combustion to detector chamber.
    c. Detectors must communicate with FACU via addressable smoke detector installed in housing[**, monitored dry contact closures**][**, and interface modules**].
    d. Pipe length and hole sizes must be in accordance with manufacturer's published instructions[**and airflow balancing calculations performed using approved calculation software**].
    e. Detector and Aspirator: Housed in mounting box and arranged such that air is drawn from

detection area and sample passes through detector chamber.

f. Detector must transmit faults to the FACU.

6. Other Available Features Required by Project:

a. <**Insert available feature**>.

D. UL UROX - Projected Beam-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Notifier; Honeywell International, Inc.**]
d. [**Siemens Industry, Inc.; Fire Safety Division**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Notifier; Honeywell International, Inc.**]
d. [**Siemens Industry, Inc.; Fire Safety Division**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Detector Address: Accessible from FACU and able to identify detector's location within system and its sensitivity setting.
c. Operator at FACU, having designated access level, must be able to manually access the following for each detector: primary status, device type, present average value, present sensitivity selected, and sensor range.

E. UL UROX - Duct Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]

c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
d. Integral Visual-Indicating Light: LED type, indicating detector has operated.
e. Detectors must be four- or two-wire type.
f. Detector address must be accessible from fire-alarm control unit and must be able to identify the detector's location within the system and its sensitivity setting.
g. Operator at FACU, having designated access level, must be able to manually access the following for each detector: primary status, device type, present average value, present sensitivity selected, and sensor range.

F. UL UROX - Video Image Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SigniFire, Fike Corp.**]
b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the

following:

a. [**SigniFire, Fike Corp.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Unit dedicated to task of video fire detection should not be running any additional software, as it can compromise its detection.
   c. Camera viewing must use graphic user interface with independent video codecs to provide continuous analysis of video images.
   d. Smoke must be detected by monitoring of small areas of change within image and passing these pixel changes to processor for analysis.
   e. Unit must employ algorithms to process video information from up to four cameras simultaneously.
   f. Unit must achieve 25 Hz frame rate for each of four channels.
   g. Outputs: Minimum of 16 alarm outputs that may be individually assigned to combination of zones or sectors. These outputs must not be linked to any particular camera, allowing for zonal and image association.
   h. Through output logic matrix, operator must have ability to customize systems output to alarm conditions and, therefore, allow easy integration within "house" fire-alarm system.

2.13 RADIANT ENERGY-SENSING FIRE DETECTORS

A. Description: A device that detects radiant energy, such as ultraviolet, visible, or infrared, that is emitted as a product of combustion reaction and obeys the laws of optics. Common types of radiant energy-sensing fire detectors include video image flame detectors.

B. UL UIAZ - Video Image Flame Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fike Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fike Corporation**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Automatic Fire Detectors for Use in Hazardous Locations: UL CCN UIAZ, including UL 268 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Unit dedicated to task of video fire detection should not be running any additional software, as it can compromise its detection.
   c. Camera viewing must use graphic user interface with independent video codecs to provide continuous analysis of video images.
   d. Unit must employ algorithms to process video information from up to four cameras simultaneously.
   e. Unit must achieve 25 Hz frame rate for each of four channels.
   f. Outputs: Minimum of 16 alarm outputs that may be individually assigned to combination of zones or sectors. These outputs must not be linked to any particular camera, allowing for zonal and image association.
   g. Through output logic matrix, operator must have ability to customize systems output to alarm conditions and, therefore, allow easy integration within "house" fire-alarm system.

2.14 COMBINATION, MULTI-CRITERIA, AND MULTI-SENSOR DETECTORS

A. Description: A device that contains multiple sensors that separately respond to physical stimulus such as heat, smoke, or fire gases, or employs more than one sensor to sense the same stimulus. This sensor is capable of generating only one alarm signal from the sensor employed in the design either independently or in combination. The sensor output signal is mathematically evaluated to determine when an alarm signal is warranted. The evaluation can be performed either at the detector or at the control unit. This detector can have a single listing that establishes the primary function of the detector, or can have listings for each sensing method employed.

B. UL UROX - Multi-Criteria Detector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Field programmable.
   c. Resettable from the control unit.
   d. Removable from the base assembly without the use of tools and without disturbing the

wiring connections.
e. Smoke Sensing Type: [**Photoelectric**][**Ionization**].
f. Heat Sensing Type: Fixed temperature[**and combination rate-of-rise**].

2.15 CARBON MONOXIDE DETECTORS

A. Description: A device that detects the presence of a specific carbon monoxide concentration.

B. UL FTAM - Carbon Monoxide Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Digital Monitoring Products**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Notifier; Honeywell International, Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Digital Monitoring Products**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Notifier; Honeywell International, Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors and Sensors Designed to Detect Gases and Vapors: UL CCN FTAM, including UL 2075 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Detector sends trouble alarm when nearing end of life or experiencing power supply problems or internal faults.

c. Detector sounder base emits Temporal-4 signal.
d. Testable by introducing test carbon monoxide into sensing cell.

2.16 SPRINKLER WATERFLOW ALARM-INITIATING DEVICES

A. Description: An initiating device used to monitor the flow of water in a wet-pipe or dry-pipe sprinkler system for the purpose of initiating an alarm signal. These devices employ operating mechanisms that include paddle operation, pressure operation, or mechanical operation.

B. UL USQT - Sprinkler Waterflow Alarm-Initiating Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Activation of the initiating device occurs within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system.
c. Movement of water due to waste, surges, or variable pressure must not initiate an alarm signal.
d. Adjustable time delay.
e. Pressure Range: **20 to 175 psig (1.38 to 12.07 bar)**.
f. Operating Type: [**Paddle**][**Pressure**][**Mechanically**] operated.
g. [**Coded**][**Non-coded**] signaling contacts.

2.17 AUDIBLE NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component such as a horn or loudspeaker that provides audible output to alert occupants by the sense of hearing.

B. UL ULSZ - Horns :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Cerberus; Siemens Industry, Inc.**]
c. [**Cooper Wheelock; brand of Eaton**]

d. [**Edwards; Carrier Global Corporation**]
e. [**Kidde Commercial Fire & Life Safety Systems**]
f. [**Siemens Industry, Inc.; Fire Safety Division**]
g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
   b. [**Cerberus; Siemens Industry, Inc.**]
   c. [**Cooper Wheelock; brand of Eaton**]
   d. [**Edwards; Carrier Global Corporation**]
   e. [**Kidde Commercial Fire & Life Safety Systems**]
   f. [**Siemens Industry, Inc.; Fire Safety Division**]
   g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electrically Operated Signal-Sounding Appliances: UL CCN ULSZ, including UL 464 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 18 of NFPA 72.
   b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
   c. Field-selectable volume settings.
   d. Compatible with wires up to 12 AWG.
   e. Capable of projecting through high ambient sound levels.
   f. Designed to provide accurate reproduction of audible emergency and protective signals.
   g. Flexibility of mounting on vertical or horizontal positions.

C. UL UUMW - Loudspeakers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Sound LP**]
   b. [**Edwards; Carrier Global Corporation**]
   c. [**Federal Signal Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Kidde Commercial Fire & Life Safety Systems**]
   f. [**Potter Electric Signal Company, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atlas Sound LP**]
   b. [**Edwards; Carrier Global Corporation**]
   c. [**Federal Signal Corporation**]
   d. [**Johnson Controls, Inc.**]
   e. [**Kidde Commercial Fire & Life Safety Systems**]
   f. [**Potter Electric Signal Company, LLC**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Speakers and Amplifiers Used in Fire-Alarm and/or Emergency Communication Systems: UL CCN UUMW, including UL 1480 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 18 of NFPA 72.
   b. Flush and ceiling-tile mounting with use of ceiling tile brackets.
   c. Field-selectable voltage and power tap settings.
   d. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
   e. Compatible with wires up to 12 AWG.

D. Accessories:

   1. Audible appliance protective guard.

2.18 VISUAL NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component that provides a visible output to alert occupants by the sense of sight, including visual strobes.[**Textual visual notification appliances are specified in Section 284700 "Mass Notification."**]

B. UL UVAV - Strobe :

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      a. [**Avenger Systems LLC**]
      b. [**Cooper Wheelock; brand of Eaton**]
      c. [**Edwards; Carrier Global Corporation**]
      d. [**Gentex Corporation**]
      e. [**Kidde Commercial Fire & Life Safety Systems**]
      f. [**Potter Electric Signal Company, LLC**]
      g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
      h. [**Triga Life Safety Systems LLC**]
      i. [**VES Fire Detection Systems; Hochiki America Corporation**]

j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Avenger Systems LLC**]
   b. [**Cooper Wheelock; brand of Eaton**]
   c. [**Edwards; Carrier Global Corporation**]
   d. [**Gentex Corporation**]
   e. [**Kidde Commercial Fire & Life Safety Systems**]
   f. [**Potter Electric Signal Company, LLC**]
   g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   h. [**Triga Life Safety Systems LLC**]
   i. [**VES Fire Detection Systems; Hochiki America Corporation**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN UVAV, including UL 1638 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 18 of NFPA 72.
   b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
   c. Compatible with wires up to 12 AWG.
   d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
   e. Field-selectable candela settings.
   f. Clear or nominal white polycarbonate lens mounted on faceplate.

6. Other Available Features Required by Project:

   a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
   b. Weather resistant to provide protection against water, humidity, and corrosion.

C. Accessories:

   1. Visual appliance protective guard.

2.19 COMBINATION AUDIBLE/VISUAL NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component such as a horn/strobe or loudspeaker/strobe that provides both an audible and a visible output to alert occupants by the sense of hearing and sight.

B. UL ULSZ and UVAV - Combination Horn/Strobe Appliances :

   1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electrically Operated Signal-Sounding Appliances or Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN ULSZ and UVAV, including UL 464, UL 1638, and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 18 of NFPA 72.
b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
c. Compatible with wires up to 12 AWG.
d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
e. Clear or nominal white polycarbonate lens mounted on faceplate.
f. Strobe flash rate of 1 Hz over its entire operating range.
g. Operates on a coded or non-coded power supply.
h. Field-selectable candela settings.
i. Field-selectable volume settings.
j. Universal mounting plate for ceiling units.

6. Other Available Features Required by Project:

a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
b. Weather resistant to provide protection against water, humidity, and corrosion.

C. UL UUMW and UVAV - Combination Loudspeaker/Strobe Appliances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Wheelock; brand of Eaton**]
   b. [**Gentex Corporation**]
   c. [**Hochiki America Corporation**]
   d. [**Potter Electric Signal Company, LLC**]
   e. [**VES Fire Detection Systems; Hochiki America Corporation**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electrically Operated Signal-Sounding Appliances or Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN UUMW and UVAV, including UL 1480, UL 1638, and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 18 of NFPA 72.
   b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
   c. Compatible with wires up to 12 AWG.
   d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
   e. Clear or nominal white polycarbonate lens mounted on faceplate.
   f. Strobe flash rate of 1 Hz over its entire operating range.
   g. Field-selectable candela settings.
   h. Field-selectable voltage and power settings.
   i. Universal mounting plate for ceiling units.

6. Other Available Features Required by Project:

   a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.

7. Accessories:

   a. Combination audible/visual appliance protective guard.
   b. Weather resistant to provide protection against water, humidity, and corrosion.

2.20 FIREFIGHTERS' TWO-WAY, IN-BUILDING WIRED TELEPHONE COMMUNICATIONS SYSTEM

A. Description: A two-way in-building telephone communications system used by firefighters and emergency response personnel when responding to, investigating, and conducting rescue activities in a fire incident.

B. Firefighters' Two-Way, In-Building Wired Telephone Communications System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fike Corporation**]
   b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   c. [**Firecom, Inc.**]
   d. [**Gamewell-FCI; Honeywell International, Inc.**]
   e. [**Keltron Corporation**]
   f. [**Kidde; Carrier Global Corporation**]
   g. [**Kingfisher Company, Inc.**]
   h. [**Notifier; Honeywell International, Inc.**]
   i. [**Potter Electric Signal Company, LLC**]
   j. [**Siemens Industry, Inc.; Fire Safety Division**]
   k. [**Silent Knight; Honeywell International, Inc.**]
   l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fike Corporation**]
   b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   c. [**Firecom, Inc.**]
   d. [**Gamewell-FCI; Honeywell International, Inc.**]
   e. [**Keltron Corporation**]
   f. [**Kidde; Carrier Global Corporation**]
   g. [**Kingfisher Company, Inc.**]
   h. [**Notifier; Honeywell International, Inc.**]
   i. [**Potter Electric Signal Company, LLC**]
   j. [**Siemens Industry, Inc.; Fire Safety Division**]
   k. [**Silent Knight; Honeywell International, Inc.**]
   l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
   n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one or more of the following UL product categories:

   a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.
   b. Control Units, System: UL CCN UOJZ, including UL 864 and NFPA 72.
   c. Control Units, Releasing Device: UL CCN SYZV, including UL 864 and NFPA 72, in addition to standards related to suppressant or energy storage system being released.
   d. Control and Communications Equipment: UL CCN PGWM, including UL 2572 and NFPA 72.
   e. Smoke Control System Equipment: UL CCN UUKL, including UL 864, NFPA 72, and NFPA

92.

5. Standard Features:

   a. Product Reference Standards: Ch. 24 of NFPA 72.
   b. <**Insert existing system features that must be maintained**>.

2.21 FIRE-ALARM SUPERVISED CONTROL MODULE INTERFACES FOR FIRE SAFETY FUNCTIONS

A. Description: An addressable fire-alarm control module that interfaces to another building system for the purpose of initiating an action for that system based upon activation of a supervisory or alarm condition on the fire-alarm system. The interface between the control module and the other building system or equipment is supervised.

B. UL UOXX - Fire-Alarm Supervised Control Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   b. [**Firecom, Inc.**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Notifier; Honeywell International, Inc.**]
   f. [**Siemens Industry, Inc.; Fire Safety Division**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   b. [**Firecom, Inc.**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Notifier; Honeywell International, Inc.**]
   f. [**Siemens Industry, Inc.; Fire Safety Division**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Control Unit Accessories - Addressable Control Modules: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Field programmable.
   c. Resettable from the control unit.

d. Supervises [**Class A**][**and**][**Class B**] initiating device circuits.
e. Capable of interfacing with the following systems:

1) Elevator controller.
2) Elevator power shunt-trip.
3) Elevator shunt-trip power monitoring.
4) HVAC line voltage.
5) Building management system.
6) Magnetic door hold-open circuits.
7) High-volume low-speed fans.
8) [**Door**][**Shutter**] release.
9) Electrically locked doors.
10) <**Insert interface type**>.

2.22 FIRE-ALARM SUPERVISORY SIGNAL-INITIATING DEVICES

A. Description: An initiating device such as a valve supervisory switch, water-level indicator, low-air-pressure switch, or low-temperature switch in which the change of state signals to the [**fire-alarm**][**releasing device**] control unit an off-normal condition and its restoration to normal of a fire-protection or life-safety system; or a need for action in connection with guard tours, fire-suppression systems or equipment, or maintenance features of related systems.

B. UL USQT - Control Valve Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kopler, LLC**]
b. [**Lansdale Valve and Manufacturing**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Southern Valve & Fitting USA**]
e. [**Tyco Fire and Building Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Kopler, LLC**]
b. [**Lansdale Valve and Manufacturing**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Southern Valve & Fitting USA**]
e. [**Tyco Fire and Building Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiation of two separate and distinct signals; one indicating movement of the valve from its normal position, and the other indicating restoration of the valve to its normal position.
   c. Off-normal signal must be initiated during the first two revolutions of the handwheel, or during one-fifth of the travel distance of the valve from its normal position.
   d. Off-normal signal must not be restored at any valve position except normal.

C. UL USQT - Pressure-Monitoring/Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Potter Electric Signal Company, LLC**]
   b. [**Viking Group Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Potter Electric Signal Company, LLC**]
   b. [**Viking Group Inc.**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346, and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiation of two separate and distinct signals; one indicating that the required pressure has increased or decreased (off-normal), and the other indicating restoration of the pressure to its normal value.

D. UL USQT - Water Level Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Potter Electric Signal Company, LLC**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Potter Electric Signal Company, LLC**]
b. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiation of two separate and distinct signals; one indicating that the required water level has been lowered or raised (off-normal), and the other indicating restoration of the water level to normal.
   c. Initiates a low-water-level signal when the water level falls **12 inch (300 mm)** in other than pressure tanks.
   d. Pressure Tank: Off-normal signal initiated when the water level falls **3 inch (76 mm)** or rises **3 inch (76 mm)**.

E. UL USQT - Water Temperature Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. **<Insert, in separate subparagraphs, manufacturer's name>**.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiates two separate and distinct signals; one indicating a decrease in water temperature to **40 deg F (4.5 deg C)**, and the other indicating its restoration to above **40 deg F (4.5 deg C)**.

F. UL USQT - Room Temperature Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. **<Insert, in separate subparagraphs, manufacturer's name>**.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Initiates two separate and distinct signals; one indicating a decrease in room temperature to **40 deg F (4.5 deg C)**, and the other indicating its restoration to above **40 deg F (4.5 deg C)**.

G. UL USQT - Fire Extinguisher Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Indicates conditions for a specific fire extinguisher to a fire-alarm control unit.

H. UL USQT - Fire Pump Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Initiates a supervisory signal for any off-normal conditions of a fire pump, including the following:

1) Fire pump running.
2) Fire pump loss of power.
3) Fire pump phase reversal.
4) Fire pump transfer to secondary power.

I. UL UOXX - Generator Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiates a supervisory signal upon indication of generator running condition.

2.23 FIRE-ALARM DIGITAL ALARM COMMUNICATOR TRANSMITTERS

A. Description: A fire-alarm system component at the protected premises to which the fire-alarm control unit connects and transmit signals indicating a status change of initiating devices or groups of devices. The DACT seizes the connected [**telephone line**][**cellular signal**][**ethernet network**], dials a preselected number to connect to a DACR, and transmits signals indicating a status change of the initiating devices.

B. UL UOXX - Fire-Alarm Digital Alarm Communicator Transmitter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ademco; Honeywell**]
   b. [**Digital Monitoring Products**]
   c. [**Fike Corporation**]
   d. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   e. [**Firecom, Inc.**]
   f. [**Gamewell-FCI; Honeywell International, Inc.**]
   g. [**Keltron Corporation**]
   h. [**Kidde; Carrier Global Corporation**]
   i. [**Kingfisher Company, Inc.**]
   j. [**Notifier; Honeywell International, Inc.**]
   k. [**Potter Electric Signal Company, LLC**]
   l. [**Siemens Industry, Inc.; Fire Safety Division**]
   m. [**Silent Knight; Honeywell International, Inc.**]
   n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North**

America]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ademco; Honeywell**]
b. [**Digital Monitoring Products**]
c. [**Fike Corporation**]
d. [**Fire-Lite Alarms; Honeywell International, Inc.**]
e. [**Firecom, Inc.**]
f. [**Gamewell-FCI; Honeywell International, Inc.**]
g. [**Keltron Corporation**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 26 of NFPA 72.
b. Compatible with [**remote alarm receiving station**][**central station**] receiver.
c. Receive alarm, supervisory, or trouble signals from FACU and automatically transmit to [**remote alarm receiving station**][**central station**] via [**telephone line(s)**][**cellular network**][**internet**]<**Insert method**>.
d. Indicate trouble signal at FACU upon loss of communication with the [**remote alarm receiving station**][**central station**].
e. Indicate local trouble signal upon loss of communication with the FACU.
f. Secondary Power: Integral rechargeable battery and automatic charger.
g. Digital data transmission of the following signals:

1) Address of alarm-initiating device.
2) Address of supervisory signal.
3) Address of trouble-initiating device.
4) Loss of AC supply.
5) Loss of power.
6) Low battery.
7) Abnormal test signal.
8) Communication bus failure.

9) <**Insert signal to be transmitted**>.

h. Self-test automatically performed every 24 hours with report transmitted to [**remote alarm receiving station**][**central station**].

2.24 FIRE-ALARM RADIO ALARM TRANSMITTERS

A. Description: A fire-alarm system component at the protected premises to which the fire-alarm control unit connects and transmit signals indicating a status change of initiating devices or groups of devices. The RAT transmits signals through a dedicated, licensed radio channel to the radio alarm receiver.

B. UL UOXX - Fire-Alarm Radio Alarm Transmitter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AES Corporation (The)**]
b. [**Keltron Corporation**]
c. [**Kingfisher Company, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AES Corporation (The)**]
b. [**Keltron Corporation**]
c. [**Kingfisher Company, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 26 of NFPA 72.
b. Modular UL 50E, Type 1 metal enclosure with tamper-resistant flush tumbler lock.
c. Compatible and coordinated with operating characteristics of remote-alarm receiving-station receiver.
d. Receive alarm, supervisory, or trouble signals from FACU and automatically transmit to remote alarm receiving station via [**VHF**][**UHF**]<**Insert frequency**> radio frequency using 2 W power output.
e. Indicate trouble signal at FACU upon loss of communication with the remote alarm receiving station.
f. Indicate local trouble signal upon loss of communication with the FACU.
g. Normal Power Input: 120 V(ac).
h. Secondary Power: Integral sealed, rechargeable, 12 V battery and charger.
i. Omnidirectional, coaxial half-wave, dipole-type antenna with driving point impedance

matched to transmitter and antenna cable output impedance.

j. Dry-contact inputs[**and serial communications interface**] to receive connections from fire-alarm system circuit boards, modules, and other auxiliary devices

k. Digital data transmission of the following signals:

1) [**Address**][**Zone**] of alarm-initiating device.
2) [**Address**][**Zone**] of supervisory signal.
3) [**Address**][**Zone**] of trouble-initiating device.
4) Loss of AC supply.
5) Loss of power.
6) Low battery.
7) Abnormal test signal.
8) Communication bus failure.
9) <**Insert signal to be transmitted**>.

l. Self-test automatically performed every 24 hours with report transmitted to [**remote alarm receiving station**][**central station**].

2.25 FIRE-ALARM RECORD DOCUMENTATION CABINETS

A. Description: A cabinet clearly labeled and intended for the storage of fire-alarm record documents, including as-built drawings; programming documentation; and inspection, testing, and maintenance documentation.

B. UL UOXX - Fire-Alarm-System Record-Documents Storage Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Labeled "SYSTEM RECORD DOCUMENTS."
b. Sized accordingly to contain all necessary documentation.
c. Accessible by authorized personnel only.

2.26 PASSIVE GRAPHIC MAPS

A. Description: A printed graphic map showing building floor plans indicating initiating device locations and control equipment locations for use by emergency responders and maintenance personnel.

B. Fire-Alarm Passive Graphic Map :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Standard Features:

a. Product Reference Standards: Ch. 7 of NFPA 72.
b. Indicates initiating device type, locations, and corresponding addresses.
c. Indicates control equipment locations.
d. Mounted in a plexiglass frame adjacent to the FACU.
e. Legible and sized accordingly.

2.27 FIRE-ALARM CABLES

A. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Cable (NPLF) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. [**West Penn Wire; brand of Belden, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. [**West Penn Wire; brand of Belden, Inc.**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
   b. Vertical-Tray Flame Test: UL 1685.
   c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

4. Standard Features:

   a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
   b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

B. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Plenum Cable (NPLFP) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Prysmian Cables and Systems; Prysmian Group North America**]
   b. [**Southwire Company, LLC**]
   c. [**West Penn Wire; brand of Belden, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Prysmian Cables and Systems; Prysmian Group North America**]
   b. [**Southwire Company, LLC**]
   c. [**West Penn Wire; brand of Belden, Inc.**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
   b. Vertical-Tray Flame Test: UL 1685.
   c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
   d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

   a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
   b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

C. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Riser Cable (NPLFR) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Comtran Corporation**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]

c. [**Radix Wire**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Radix Wire**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
d. Riser Rating: UL 1666.

4. Standard Features:

a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

D. UL HNIR - Power-Limited Fire-Alarm Cable (FPL) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**West Penn Wire; brand of Belden, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**West Penn Wire; brand of Belden, Inc.**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

E. UL HNIR - Power-Limited Fire-Alarm Plenum Cable (FPLP) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
    d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

F. UL HNIR - Power-Limited Fire-Alarm Riser Cable (FPLR) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Comtran Corporation**]
   b. [**Genesis; Resideo Technologies, Inc.**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Radix Wire**]
   e. [**Southwire Company, LLC**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**West Penn Wire; brand of Belden, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Comtran Corporation**]
   b. [**Genesis; Resideo Technologies, Inc.**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Radix Wire**]
   e. [**Southwire Company, LLC**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**West Penn Wire; brand of Belden, Inc.**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
   b. Vertical-Tray Flame Test: UL 1685.
   c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
   d. Riser Rating: UL 1666.

4. Standard Features:

   a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
   b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

G. UL HNIR and FHJR - Fire-Resistive Circuit Integrity Power-Limited Fire-Alarm Plenum Cable (FPLP-CI) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Radix Wire**]
   c. [**VITALink; Omni Cable**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Radix Wire**]
c. [**VITALink; Omni Cable**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Fire-Resistive Circuit Integrity "CI" Marking: UL CCN FHJR; including UL 2196.
d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

a. Twisted, shielded pair.
b. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
c. Conductor Size: [**Not smaller than**][**16 AWG**]<**Insert wire size**>[**Size recommended by manufacturer's published instructions**].

5. Other Available Features Required by Project:

a. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

H. UL HNIR and FHJR - Fire-Resistive Circuit Integrity Power-Limited Fire-Alarm Riser Cable (FPLR-CI) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Comtran Corporation**]
c. [**Radix Wire**]
d. [**VITALink; Omni Cable**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Comtran Corporation**]
c. [**Radix Wire**]
d. [**VITALink; Omni Cable**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Fire-Resistive Circuit Integrity "CI" Marking: UL CCN FHJR; including UL 2196.
d. Riser Rating: UL 1666.

4. Standard Features:

   a. Twisted, shielded pair.
   b. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
   c. Conductor Size: [**Not smaller than**][**16 AWG**]<**Insert wire size**>[**Size recommended by manufacturer's published instructions**].

5. Other Available Features Required by Project:

   a. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

I. UL QAYK - Optical-Fiber Cable for Fire-Alarm Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Corning Optical Communications; Corning Incorporated**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Corning Optical Communications; Corning Incorporated**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Optical-Fiber Cable: UL CCN QAYK; including UL 1651, TIA-568.3, and Article 770 of NFPA 70.
   b. Vertical-Tray Flame Test: UL 1685.
   c. Riser Rating: UL 1666.

4. Standard Features:

   a. Single-mode OS2.
   b. Nonconductive.
   c. Glass core with glass cladding.

5. Other Available Features Required by Project:

   a. Limited Smoke "ST1" Marking: UL 1685.
   b. Halogen-Free "HF" Marking: UL Subject 2885.

2.28 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing fire detection and alarm system components, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Smoke Detectors: <**Insert quantity**>.
2. Heat Detectors: <**Insert quantity**>.
3. Duct Smoke Detectors: <**Insert quantity**>.
4. Manual Fire-Alarm Boxes: <**Insert quantity**>.
5. Addressable Input Modules: <**Insert quantity**>.
6. Addressable Output Modules: <**Insert quantity**>.
7. Audible Notification Appliances: <**Insert quantity**>.
8. Visual Notification Appliances: <**Insert quantity**>.
9. Combination Audible/Visual Notification Appliances: <**Insert quantity**>.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to fire detection and alarm system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Keys for control equipment cabinets.
2. Keys for remote test switches.
3. Wrench for manual fire-alarm boxes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine field conditions with Installer present for compliance with requirements for fire detection and alarm systems and other conditions affecting performance of the Work.

B. Examine all materials, products, and equipment received for defects or damage.

C. Reject all materials, products, and equipment that show signs of defects or damage.

D. Examine roughing-in for fire detection and alarm system piping to verify actual locations of piping connections before equipment installation.

E. Examine walls, floors, ceilings, and roofs for suitable conditions where fire detection and alarm system components will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CABLING FOR FIRE ALARM

A. Field Circuits:

1. SLC: 12 to 18 AWG [**unshielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
2. NAC: 12 to 18 AWG [**unshielded**][**shielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
3. Audio Circuits: 12 to 18 AWG [**unshielded**][**shielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
4. Auxiliary Power Circuits: 12 to 18 AWG [**unshielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**].
5. Network Communication Circuits: [**12 to 18 AWG**][**unshielded**][**shielded**][**twisted pair**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**][**single-mode fiber-optic cable**].

3.3 SELECTION OF RACEWAYS FOR FIRE ALARM

A. Identification: At a minimum, all junction box covers for fire-alarm raceways must be identified using the color red.

B. Outdoor Pathways:

1. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
2. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**]. Locations include the following:

   a. Locations less than 2.5 m (8 ft) above finished grade.
   b. <**Insert designations of applicable spaces or locations**>.

3. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**RTRC-AG**][**LFMC**][**LFNC**].
4. Marine Locations: [**PVC-80**][**Corrosion-resistant EMT**].
5. Concealed Aboveground: [**ERMC**][**IMC**][**EMT**][**LFMC**].
6. Direct Buried: [**PVC-80**][**HDPE-80**][**LFMC**].
7. Concrete Encased Not in Trench: [**PVC-80**].
8. Concrete Encased in Trench: [**PVC-80**][**HDPE-80**].
9. Innerducts inside Other Raceway: [**ENT**][**RTRC-AG**][**RTRC-BG**][**OFR**][**CR**].

C. Indoor Pathways:

1. Hazardous Classified Locations: [**ERMC**][**IMC**].
2. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**]. Locations include the following:

   a. Loading docks.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
   e. <**Insert designations of applicable spaces or locations**>.

3. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**]. Locations include the following:

   a. Locations less than 2.5 m (8 ft) above finished floor.
   b. Stub-ups to above suspended ceilings.
   c. <**Insert designations of applicable spaces or locations**>.

4. Exposed and Not Subject to Physical Damage: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**].
5. Concealed above Suspended Ceilings: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**][**ERMC**][**IMC**][**EMT**][**LFMC**][**Hooks**].
6. Concealed in Ceilings and Interior Walls and Partitions: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**][**ERMC**][**IMC**][**EMT**][**LFMC**][**LFNC**].
7. Damp or Wet Locations: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**LFMC**][**LFNC**].
8. Innerducts inside Metal Raceway: [**ENT**][**RTRC-AG**][**OFR**][**CR**].
9. Exposed to Environmental Air: [**ERMC**][**IMC**][**EMT**][**PVC-80**].
10. In Vertical Runs: [**ERMC**][**IMC**][**EMT**].

3.4 INSTALLATION OF FIRE DETECTION AND ALARM SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Commissioning of Electrical Systems: NECA NEIS 90.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Life-Safety and Means-of-Egress Work: NFPA 101.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
12. Fire-Alarm Circuits and Pathways: Ch. 12 of NFPA 72 and Article 760 of NFPA 70.
13. Fire-Alarm Initiating Devices: Ch. 17 of NFPA 72.
14. Fire-Alarm Notification Appliances: Ch. 18 of NFPA 72.
15. Fire-Alarm Control Equipment: Ch. 23 of NFPA 72.
16. Fire-Alarm Transmitting Equipment: Ch. 23 and Ch. 26 of NFPA 72.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for all initiating devices, control equipment cabinets, and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label initiating devices with unique identification.
   c. Identify source of AC power inside each control equipment cabinet.
   d. Identify circuit disconnecting means at AC power source with red engraved label. Provide approved locking device for circuit disconnecting means.
   e. Label enclosures with engraved metal or laminated-plastic nameplate.
   f. Identify junction box covers using the color red.
   g. Identify <**Insert raceway component**> using the color red.

2. Coordinate installation of new products for <**Insert system or product group/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.5 FIELD QUALITY CONTROL OF FIRE DETECTION AND ALARM SYSTEMS

A. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform system acceptance testing in accordance with Ch. 14[**and Appendix D**] of NFPA 72.
3. Contractor is responsible for completing pre-acceptance testing to verify proper operation of the fire detection and alarm systems. Correct system deficiencies prior to scheduling a final acceptance test.

E. Nonconforming Work:

1. Initiating devices, notification appliances, control equipment, and system accessories will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.6 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Provide power to the FACU and configure internal settings.
3. Test all field wiring prior to connecting field devices and prior to connecting to the FACU. Ensure field wiring is free from ground faults and short circuits.
4. Connect field devices to field wiring.
5. Connect field wiring inside FACU cabinet.
6. Ensure system is normal and free from ground faults, open circuits, or short circuits.

7. Allow system burn-in for [**30**][**60**] days.
8. Correct any issues that occur during the system burn-in period.
9. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.7 PROTECTION

A. After installation, protect fire detection and alarm system equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three-month**][**six-month**][**nine-month**][**one-year**]<**Insert duration**> period for full maintenance by [**skilled employees of fire detection and alarm system Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair, or replacement of worn or defective components; cleaning; and adjusting as required for proper fire detection and alarm system operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**]<**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**][**Conduct reacceptance testing of system components directly affected by software and firmware upgrades.**]

   a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 28 46 00 00

Task	Specification	Specification Description
28 46 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 13 00	28 46 00 00	Fire Detection and Alarm
28 46 13 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 13 31	28 46 00 00	Fire Detection and Alarm
28 46 13 31	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 31 00	28 46 00 00	Fire Detection and Alarm
28 46 31 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 31 11	28 46 00 00	Fire Detection and Alarm
28 46 31 11	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 00	28 46 00 00	Fire Detection and Alarm
28 46 41 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 11	28 46 00 00	Fire Detection and Alarm
28 46 41 11	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 31	28 46 00 00	Fire Detection and Alarm
28 46 41 31	28 40 00 00	Emergency Responder Communications Enhancement System ERCES

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SECTION 28 47 00 00 - MASS NOTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mass notification systems.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260536 "Cable Trays for Electrical Systems" specifies cable trays referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic-restraint devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
9. Section 284600 "Fire Detection and Alarm" for fire-alarm cabling and interfaces with MNS equipment in this Section to create an EVACS.

1.2 DEFINITIONS

A. ATP: Acceptance Test Procedure.

B. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.

C. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

1. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).

2. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
3. Fire-alarm control unit (FACU).
4. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

D. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

1. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
2. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
3. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).

E. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.

F. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).

G. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Power calculations.
4. Battery capacity calculations with the following supporting information:

a. Supervisory power requirements for all equipment.
b. Alarm power requirements for all equipment.
c. Power supply rating.
d. Voltage drop calculations for wiring runs demonstrating worst-case condition.
e. Notification appliance circuit design.

5. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following in accordance with NFPA 72:

1. Floor Plans:

a. Scaled floor plans indicating location and unique identification of each component and point-to-point wiring.
b. Indicating all acoustically distinguishable spaces (ADS) where intelligibility is required, and where intelligibility is not required or is not able to be achieved,
c. Elevations indicating equipment dimensions and mounting heights.

2. Wiring Diagrams:

a. System riser diagram, including power, signal, and control wiring.
b. Mass notification system component schematic wiring diagrams.

3. Details:

a. Component installation details.
b. Details of equipment assemblies, including dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Calculations:

a. Battery calculations.
b. Voltage-drop calculations.
c. Spare capacity circuit calculations.

5. Sequence of Operations: Prepare a narrative description or input/output matrix of operation to describe the mass notification system sequence of operation.
6. Applicable Codes and Standards:

a. Indicate on Shop Drawings the applicable referenced codes and standards and their respective edition adopted in the jurisdiction where the project is located.

C. Field quality control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each amplifier and loudspeaker, for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Computer-generated instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Card must indicate those steps to be taken by an operator when a signal is received as well as functional operation of system under all conditions: normal, alarm, supervisory, and trouble.

B. Record Documentation: System documentation to Owner including, but not limited to, the following:

1. System record Drawings and wiring details, including one set of full-size printed Drawings, and CD-ROM with copies of record Drawings in PDF format and DXF format.
2. Documentation of all component and wiring identification, including a copy of each equipment nameplate.
3. System matrix showing interaction of all input signals with output commands.

4. Documentation of system voltage, current, and resistance readings taken during installation, testing, and ATP phases of system installation.

C. System program showing control devices and operations, and system functions of equipment and devices.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for software and firmware upgrades.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Schedule of maintenance material items.

1.7 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, to supervise Level I and Level II technicians, to provide submittal packages, and to interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, to interpret codes and standards, to conduct training, and to serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and to prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and to prepare related records and reports.

G. Communications Design Professional: Design professional possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Expertise in design of communications infrastructure and distribution equipment.
2. BICSI Registered Communications Distribution Designer (RCDD)[**or Outside Plant Designer (OSP)**] certification.

H. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

I. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] <**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] <**Insert code enforced by authorities having jurisdiction**> testing standards.

J. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

K. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS [**Senior**]Engineering Technician certification.

L. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [**I**] [**II**] certification.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed MNS performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**] [**Three**] [**Four**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that MNS performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with Article 760 of NFPA 70 and Ch. 24 of NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. General Characteristics:

1. ECS Classification: [**One-way, in-building EVACS**] [**One-way, in-building MNS**] [**One-way, wide-area MNS**] [**One-way DRMNS**].
2. Provide the following specified products with the MNS:

   a. ACU.
   b. Prerecorded message device.
   c. Audio amplifiers.
   d. Audible signaling devices.
   e. Indoor speakers for voice notification.
   f. Outdoor HPLAs.
   g. Text displays.
   h. Visual signaling devices for hearing impaired.
   i. Web interfaces.
   j. Overvoltage and surge protection.
   k. LOCs.
   l. Software.

3. Software-operated, network-based communications system with wired and wireless access points for control interface. Designated operators must be able to log in via a web browser and have complete access to their own portion of MNS.
4. ACU must monitor and control the notification appliance network and provide consoles for local operation. Authorized personnel must be able to use a console to initiate delivery of prerecorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. ACU must override audible fire-alarm notification signals and voice messages based on the approved sequence of operation described in the risk analysis.
5. MNS messaging system must be capable of the following:

    a. Communicating through use of wired networks, or wireless networks via wireless control units, for one- or two-way communications and control between a building or area and emergency personnel.
    b. Automatically distribute no fewer than 100 simultaneous and unique messages to appropriate notification appliances.
    c. Allow multiple operators to send messages simultaneously.
    d. Grant access for control to another control station if location in control becomes inoperable and/or authorized operator at that control station can no longer operate the control station.
    e. Send voice messages and text messages with an indication of the source of message that can only be sent from message source.
    f. Send alert messages to end users (recipients) via multiple delivery methods including, but not limited to, the following:

        1) Audio-visual network alerts to computers via desktop pop-up.
        2) Text alerts to cellular phones and pagers.
        3) Text alerts to email clients.
        4) Text alerts to textual visible appliances.
        5) Alerts to visible appliances.
        6) Audio alerts to phones.
        7) Audio alerts to loudspeakers.
        8) Audio alerts to existing wide-area or in-building ECS.
        9) Network alerts to other IP-connected devices via standard XML and CAP protocols.

    g. Suppress contact information for other end users with messages or in message headers.

6. Live announcements or prerecorded messages. Live messages must take precedence over prerecorded messages.
7. Notification appliance network must consist of loudspeakers and visual notification devices located to provide intelligible instructions at all ADS designated by designer to receive messages. [**Areas as indicated on Drawings**] <**Insert locations**>.
8. Interface with FACU to use voice modules, visual alarms, and loudspeakers of fire-alarm system.
9. Give priority to MNS announcements over other audible announcements of the system including fire-alarm system in a normal or alarm state based on the approved risk analysis. When an emergency announcement other than fire is activated during a fire alarm, fire-alarm system functions must continue in an alarm state, except for output signals of fire-alarm audible and visual notification appliances.
10. Comply with speech intelligibility requirements of NFPA 72.
11. Capable of overriding local control of loudspeaker volume levels for emergency communications. Local controls must be permitted to adjust volume levels of non-emergency signals only, such as, but not limited to, background music and convenience paging.
12. Capable of providing separate messages to one individual building or to multiple buildings at given time if MNS serves more than one building.
13. Capable of monitoring emergency notifications from multiple data sources (National Weather Service, Emergency Managers Weather Information Network, Naval Meteorology and

Oceanography, and others as determined locally) and automatically send out notifications to designated facilities and personnel based on predefined rules.

14. Capable of centrally tracking, in real-time, all alerting activities for each individual recipient, including sending, receiving, and responding to alerts, and of generating reports based on tracked information.
15. Capable of operating remote printer via USB output. Provide matching printer listed and labeled as part of MNS.
16. Primary Power: Must be sized to supply not less than 125 percent of the total connected load in a worst-case condition.

    a. Devices Powered by 24 V(dc):

        1) Control units.
        2) Notification appliances.
        3) Text displays.
        4) Trouble signals.
        5) Supervisory signals.
        6) Supervisory and digital alarm communicator transmitters.
        7) Digital alarm radio transmitters.

17. Secondary Power: Must be sized to supply not less than 125 percent of the total connected load in a worst-case condition.

    a. Batteries: [**Sealed lead calcium**] [**Sealed, valve-regulated, recombinant lead acid**] [**Sealed lead-calcium, valve-regulated, recombinant lead acid**].

2.4 MASS NOTIFICATION SYSTEMS

A. UL PGWM - Autonomous Control Units (ACUs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

    a. Fully enclosed in a lockable steel cabinet with access for testing, and maintenance from the front of enclosure.
    b. Solid-state, modular components, internally mounted and arranged for easy access for power, supervision, control, and logic for system.
    c. 120 V ac, 60 Hz power supply.
    d. An indicator for each message source must indicate which sources are available and which are selected.
    e. Indicators for broadcast media used to convey the selected message to selected audience must indicate which sources are available and which are selected.
    f. Capable of confirming receipt of a message. If message was not confirmed received, system must be capable of using other means of contact until receipt of confirmation or until a preset time has elapsed.
    g. Capable of automatically sending another message after receipt of a new information or messages.

h. Operator Access Functions:

1) Select prerecorded message for transmission.
2) Select microphone for live broadcast.
3) Initiate message broadcast.
4) Terminate message broadcast.

i. Supervisory Access Functions:

1) Reset time and date.
2) Enable or disable printouts, initiators, and event-initiated programs.
3) Enable or disable individual message sources and broadcast media.
4) Supervisory level functions must not require computer programming skills. MNS must record changes to program functions, to be maintained in ACU for a minimum of [**one year**] <**Insert time**>. ACU must maintain the ID of supervisor making the change.

j. System Operator Level Access Functions:

1) Clear supervisory trouble alarms.
2) Revise programming.
3) Revise prerecorded messages.
4) Assign access rights to all levels.
5) MNS must record changes at system operator level in ACU, to be maintained for a minimum of [**one year**] <**Insert time**>. ACU must maintain the ID of system operator making the change.

k. Capable of no fewer than [**1000**] [**5000**] <**Insert number**> users, with each user having its own log-in and password credentials and no fewer than four contact methods.
l. Capable of storing users in one or multiple groups and able to create a minimum of [**10**] [**20**] <**Insert number**> groups.
m. Each panel must have supervisory functions for power failure, internal component failure, and operation.
n. MNS must have complete set of self-diagnostics for controller and appliance network, and local diagnostic information display, local diagnostic information, and system event log.
o. Printed records of changes, supervisory functions, message transmission, and operator actions must be maintained for a minimum of [**one year**] <**Insert time**>.

B. UL PGWM - Prerecorded Message Devices <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: Hardware that stores and outputs audible signals or messages.
b. One-way, multichannel voice notification system incorporating no fewer than eight distinct sounds selectable by user for tone signaling and incorporating a voice module for delivery of prerecorded or live messages.
c. Redundant microphones, preamplifiers, amplifiers, and tone generators provided in separate main and remote cabinets.

d. Voice notification system must support facility-wide public address paging.
e. Audible appliances must produce an initial message stating "May I have your attention please?" followed by a voice message with instructions as defined by the risk analysis that is repeated until ACU is reset or silenced. If the intent is for building or floor evacuation, the standard temporal pattern complying with ASA S3.41 will follow the message.
f. Automatic messages must be broadcast through loudspeakers throughout the building or facility, but not in stairs or elevators.
g. When using microphones, live messages must be broadcast throughout a selected floor or floors or all call, including stairs and elevators.
h. Loudspeakers must not be installed in near a microphone that will be used for live messaging.
i. Live voice message must override automatic or recorded audible output through use of a microphone input at ACU or the remote cabinet.
j. Number of alarm channels must be indicated for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone.

1) Allow sending an evacuation signal to selected zones and, concurrently, allow voice paging to other zones selectively or in combination.
2) Programmable tone and message sequence selection.
3) Standard digitally recorded messages for "Evacuation" and "All Clear."

C. UL UUMW - Audio Amplifiers <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Amplifiers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1711 and ISO 7240.

4. Standard Features:

a. Audio output must be selectable for line level. Minimum amplifier output must be [**100**] <**Insert number**> W rms.
b. Capable of operating all loudspeakers at the same time[**with fiber connection**].
c. Loss of operating power, supervisory power, or other malfunction that could render the voice module inoperative must automatically cause the standard temporal tone pattern complying with ASA S3.41 to take over all functions assigned to failed unit in the event an alarm is activated.

D. UL ULSZ - Audible Signaling Devices <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Sounding Devices: UL CCN ULSZ, including UL 464.

4. Standard Features:

a. Handheld push-to-talk microphone must be supervised and a key must be required to enable remote microphone use.
b. Microprocessor must actively integrate circuitry, field wiring, and digital coding necessary for immediate and accurate rebroadcasting of stored voice data into appropriate amplifier input.

E. UL UUMW - Indoor Loudspeakers for Voice Notification <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Loudspeakers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1480.

4. Standard Features:

   a. Construction: High-efficiency, sealed back; for maximum output at minimum power across a frequency range of 150 to 10 000 Hz.
   b. High-Range Units: Rated 2 to 15 W.
   c. Low-Range Units: Rated 1 to 2 W.
   d. Mounting: [**Flush**] [**or**] [**semi-recessed**] [**or**] [**surface mounted and bidirectional**].
   e. Matching Transformers: Tap range matched to acoustical environment of loudspeaker location.

F. UL UUMW - High Power Loudspeaker Arrays (HPLAs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Loudspeakers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1480.

4. Standard Features:

   a. HPLAs, [**1600**] [**3200**] W, with acoustic performance and intelligibility features.
   b. Sound Dispersion: [**Omnidirectional**] [**Horizontal 70 degrees, vertical 80 degrees**].
   c. Control unit providing signal processing, amplification, gain control, battery backup, and antenna surge protection.
   d. Pole designed for HPLA with wind load of [**100 mph (160 km/h)**] [**110 mph (177 km/h)**] <**Insert value**>.

5. Seismic and Wind Performance for Outdoor HPLAs: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Supporting structure must be sized to accommodate the static and dynamic loads produced by the sound systems and all attachments.
   b. Minimum design wind speed of [**100 mph (161 km/h)**] <**Insert other wind speed requirement**>.
   c. Seismic design in accordance with site-specific requirements.
   d. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."

e. Component Importance Factor (I_p): [**1.0**] [**1.5**].
f. Component Amplification Factor (a_p): [**1.0**] [**2.5**] <**Insert value**>.
g. Component Response Modification Factor (R_p): [**1.5**] [**2.0**] [**2.5**] [**6.0**] <**Insert value**>.
h. Component Overstrength Factor (Ω_o): [**1.5**] [**2.5**] <**Insert value**>.

G. UL UVAV - Text Displays <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Visual-Signal Appliances for Fire-Protective Signaling Systems: UL CCN UVAV, including UL 1638.

4. Standard Features:

   a. Indicate location of digital displays on Drawings.
   b. Programmable, digital text displays having a minimum of 4 inch (100 mm) high letters for hearing-impaired occupants displaying content of voice message being played.
   c. Capable of sending static, flashing, or scrolling messages to textual visible appliances.
   d. ACU must interface with and control the programmable display controller to activate the proper message.
   e. Textual visible notification must be primary notification when it is the only method used to convey emergency MNS information to general public or to specific individuals.

H. UL UUKC - Visual Signaling Devices for Hearing Impaired <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Signaling Appliances and Equipment for Hearing Impaired: UL CCN UUKC, UL 1971.

4. Standard Features:

   a. Strobes used solely for MNS must be [**amber**] [**clear**], comply with UL 1971, and have the word "ALERT" factory printed on the trim.
   b. Strobes used in combination systems, where the same strobe is used for both MNS and fire-alarm notification, must be clear and comply with UL 1971.
   c. Strobes used for MNS must be synchronized in accordance with requirements of NFPA 72.

I. UL PGWM - Web Interfaces <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

   a. Description: Systems hardware capable of using dedicated or existing IP networks to send alert messages.
   b. System must be able to communicate with multiple modalities to include, but not be limited to, pop-up alerts on PCs, text messages to cellular phones, email messaging to IP-capable computers or devices, and recorded voice messages to VoIP telephones and PCs.
   c. Capable of activating, through single interface, non-IP alerting systems such as wide-area alerting systems, fire-alarm systems, public address systems, handheld radio systems, radio broadcast systems, personal pager systems, nurse call systems, and traditional dial-up telephone alerting systems.

5. Other Available Features Required by the Project:

   a. Capable of accessing user screens via multiple web browsers such as Microsoft Explorer, Mozilla Firefox, or Apple Safari.
   b. Capable of sending live video stream from IP-based camera or security camera system to PC or video display.

J. UL QVGQ - Signaling Line Circuit Surge Protection <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Isolated Loop Circuit Protectors: UL CCN QVGQ, including UL 497B.

4. Standard Features:

   a. Protected against surges induced on signaling line circuit located outdoors.
   b. Protect cables and conductors that serve as communications links with surge protection devices installed at each end that comply with the following waveforms:

      1) 10 by 1000-microsecond waveform with a peak of 1500 V and a peak current of 60 A.
      2) 8 by 20-microsecond waveform with a peak of 1000 V and a peak current of 500 A. Protection must be provided at the equipment. Additional surge protectors, rated for application, must be installed on each circuit within 36 inch (900 mm) of the cable entrance to building.

   c. Fuses must not be used for surge protection.

K. UL QVRP2 - Sensor Wiring Surge Protection <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Secondary Protectors for Communications Circuits Used with Specified Voltage Suppression - Component: UL CCN QVRP2, including UL 497A and UL Subject 497D.

4. Standard Features:

a. Digital and analog inputs and outputs must be protected against surges induced by sensor wiring. Inputs and outputs must be tested with the following waveforms:

1) 10 by 1000-microsecond waveform with a peak of 1500 V and a peak current of 60 A.
2) 8 by 20-microsecond waveform with a peak of 1000 V and a peak current of 500 A.

b. Fuses must not be used for surge protection.

L. UL PGWM - Local Operator Consoles (LOCs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: Remote message initiation console.
b. Capable of initiating recorded messages and displays, and for delivering live voice messages.
c. Capacity for no fewer than [**eight**] <**Insert number**> prerecorded messages and ability to automatically repeat prerecorded messages.
d. Having a microphone for delivering live messages.
e. FACU Interface: Adequate discrete outputs to temporarily deactivate the fire-alarm audible notification appliances while delivering voice messages.
f. LOC must be capable of being locked out or overridden from ACU.

5. Other Available Features Required by the Project:

a. Provide redundant control of ACU.
b. When an installation has more than one LOC, LOCs must be programmed to allow only one LOC at a time to be available for messaging. Once one LOC becomes active, all other LOCs will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time.

M. UL PGWM - Software <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: PC-based equipment that is field programmable for control, notification, and supervisory functions; menu-driven program configuration; password protected.
b. Loading and editing instructions and operating sequences as necessary.
c. Storing and downloading while the system is in operation.

d. Second set of operating software must reside in control units as backup if primary operating software is corrupted.
e. Allows [**10 to 50**] <**Insert range**> remote users.
f. Operating system used must be compatible with manufacturer software operating system.
g. Memory: Software operations must be stored in nonvolatile programmable memory within MNS control unit. Loss of primary and secondary power must not erase nonvolatile programmable memory.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing MNS, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Loudspeakers: Quantity equal to [**five**] <**Insert number**> percent of quantity installed[**for each type indicated**], but no fewer than [**one**] <**Insert number**> unit(s).
2. Fuses: [**Two**] <**Insert number**> of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to MNS, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Software, connecting cables, and proprietary equipment necessary for maintenance, testing, reprogramming, and implementing future changes to MNS. Tools listed by part number in operation and maintenance manuals are considered special tools.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Commissioning of Electrical Systems: NECA NEIS 90.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Work in ITE Rooms: NFPA 75.
8. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
9. Life Safety and Means of Egress Work: NFPA 101.

10. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
11. Work in Confined Spaces: NFPA 350.
12. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
13. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
14. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install remote amplification and control units in terminal cabinets. Power each remote amplification and control unit from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as remote unit.
2. Equipment Installation: Install MNS cabinets with seismic-restraint devices, seismic-rated anchors, and mounting apparatus.
3. Provide rated fire-alarm cables and conductors for MNS.
4. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

    a. Install plenum cable in environmental airspaces, including plenum ceilings and in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring is used.
    b. Install cables in cable trays where indicated on the Drawings.
    c. Provide raceways and boxes for cables.
    d. Conceal conductors and cables in accessible ceilings, walls, and floors where possible. Suspend cable not in a wireway or pathway a minimum of 8 inch (200 mm) above ceiling by cable supports not more than [**60 inch (1500 mm)**] <**Insert dimension**> apart.
    e. Do not install cable through structural members or in contact with pipes, ducts, or other potentially damaging items.
    f. Secure and support cables at intervals not exceeding 30 inch (750 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
    g. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's written limitations on bending radii. Maintain separation of conductor types as recommended by manufacturer. Install lacing bars and distribution spools.
    h. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
    i. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamp use is prohibited.
    j. Separation of Wires: Separate loudspeaker-microphone, line-level, loudspeaker-level, and power wiring runs. Install MNS wiring in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inch (300 mm) apart for loudspeaker-microphone wiring and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
    k. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Install lacing bars and distribution spools. Route conductors to allow accessibility to equipment for adjustment and maintenance.
    l. Connections:

        1) Make all terminations on numbered terminal strips in terminal cabinets or equipment enclosures. No splices or butt joints will be accepted.
        2) Terminate all conductors; no cable must contain unterminated elements.

3) Crimp-on spade lugs must be used for terminations of stranded conductors to binder screw or stud terminals. Spade lugs must have upset legs and insulation sleeves sized for conductors.

5. Mount all devices and appliances to or in an approved electrical box.
6. Install operating instruction placard on the interior of ACU.
7. Install operating instruction placard on the frame in location acceptable to Architect and observable from ACU.
8. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
9. Cybersecurity:

a. Software:

1) Coordinate security requirements with [**IT department**] [**CIO**] <**Insert entity responsible for IT security**>.
2) Ensure that latest stable software release is installed and properly operating.
3) Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols no fewer than eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

b. Hardware:

1) Coordinate location and access requirements with [**IT department**] [**CIO**] <**Insert entity responsible for IT security**>.
2) Enable highest level of wireless encryption that is compatible with Owner's ICT network.
3) Disable dual network connections.

D. Interfaces with Other Work:

1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Connect to instrument ground system and isolate from power system and equipment grounding.
3. Identification: Provide labels for mass notification appliances and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
d. Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
e. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.
f. Install framed instructions in a location visible from mass notification control unit.

3.3 FIELD QUALITY CONTROL

A. Administrant for Communications Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. Prepare a written ATP for testing MNS components and installation in accordance with NFPA 72 and this Section. Demonstrate specified function of system and verify the correct operation of all system components, circuits, and programming.
2. Prepare a complete listing of device labels for alphanumeric annunciator displays prior to ATP.
3. Schedule tests with no fewer than [**seven**] <**Insert number**> days' advance notice of test performance.

D. Field tests must be witnessed by [**Architect**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Take resistance, current, and voltage readings as work progresses.
2. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Perform additional tests specified in Section 260526 "Grounding and Bonding for Electrical Systems."
3. Verify that wiring for each device is terminated at properly identified terminals.
4. Test wiring runs for continuity, short circuits, and grounds before system is energized.
5. All test equipment, instruments, tools, and labor required to conduct system tests must be made available by installing Contractor. The following equipment must be a minimum for conducting tests:

    a. Ladders and scaffolds as required to access all installed equipment.
    b. Multi-meter for reading voltage, current, and resistance.
    c. Two-way radios and flashlights.
    d. Decibel meter.
    e. In addition to testing specified to be performed by installing Contractor, installation must be subject to test by [**Owner**] [**Architect**] [**Construction Manager**].

6. After installing MNS and after electrical circuitry has been energized, test for compliance with requirements.
7. Perform tests in [**all**] [**50 percent of**] [**25 percent of**] <**Insert quantity**> zones and rooms[**as indicated on Drawings**].
8. Perform indoor sound tests in a single test location in rooms less than 20 by 20 ft (6 by 6 m). Tests must be made on a 20 by 20 ft (6 by 6 m) grid for larger rooms.
9. Sound level measurements must be taken at a worst-case location within each room or grid, not near loudspeakers.

10. Operational Test: Perform tests that include originating messages at microphone outlets, prerecorded messages, [**remote wired and non-wired inputs**] [**telephone**] [**cellular**] and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
11. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000 Hz signal. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

12. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12 000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
13. Intelligibility Test: Test for intelligibility in accordance with NFPA 72. See Annex D of NFPA 72 for additional guidance on speech intelligibility testing.
14. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12 000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB. Outdoor sound levels where personnel may be present must not exceed 120 dB(A-weighted) when measured on the A-scale of a standard sound level meter at slow response. Sound levels must not exceed 85 dB(A-weighted) at local microphone of MNS under the same conditions.
15. System notification appliances must be demonstrated as follows:

    a. All alarm notification appliances actuate as programmed.
    b. Audibility and visibility at required levels.
    c. Messages are intelligible in all areas.

16. System indications must be demonstrated as follows:

    a. Correct message display at MNS ACU for each alarm input.
    b. Correct message display at remote panels and annunciators for each alarm input.
    c. Correct history logging for all system activity.

17. System off-site reporting functions must be demonstrated as follows:

    a. Correct zone transmitted for each alarm input.
    b. Trouble signals received.

18. <**Insert additional tests and inspections**>.

F. Nonconforming Work:

1. MNS will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Demonstration:

1. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain units.

   a. Train a minimum of [**four**] <**Insert number**> employees of Owner.
   b. Conduct training on installed equipment after acceptance testing.
   c. Train on system operation, including manual control of output functions from ACU.
   d. Train on testing of system, including logging of system tests, field test of devices, and response to common troubles.
   e. Total training requirement must be a minimum of [**four**] <**Insert number**> hours but must be sufficient to cover all items specified.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**] <**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**] <**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: Not less than [**30 days**] <**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 28 47 00 00

Task	Specification	Specification Description
28 47 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 15 00	28 47 00 00	Mass Notification
28 47 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 17 00	28 47 00 00	Mass Notification
28 47 17 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 17 17	28 47 00 00	Mass Notification
28 47 17 17	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 21 00	28 47 00 00	Mass Notification
28 47 21 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 21 21	28 47 00 00	Mass Notification
28 47 21 21	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 11 00	28 16 11 00	Intrusion Detection
28 49 11 00	28 16 11 00a	Area and Perimeter Intrusion Detection
28 49 11 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 17 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES

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Task	Specification	Specification Description
31 05 13 00	31 20 00 00	Earth Moving
31 05 13 00	33 46 00 00	Subdrainage
31 05 16 00	31 20 00 00	Earth Moving
31 05 16 00	33 46 00 00	Subdrainage

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SECTION 31 10 00 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and [**removing site utilities**][**abandoning site utilities in place**].
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than **2 inches (50 mm)** in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [**indicated on Drawings**][**indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."**]<**Insert requirement**>.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.6 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property

adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises[**where indicated**]<**Insert location**>.

D. Utility Locator Service: Notify [**utility locator service**][**Miss Utility**][**Call Before You Dig**][**Dig Safe System**][**One Call**]<**Insert name**> for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[**and plant-protection**] measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**]<**Insert requirement**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion-

and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed[**or abandoned in place**].

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than [**two**]<**Insert number**> days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than [**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> in diameter, obstructions, and debris to a depth of [**18 inches (450 mm)**]<**Insert dimension**> below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and [**stockpile in areas approved by Architect**][**dispose of off-site**]<**Insert requirement**>.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of **8 inches (200 mm)**, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth [**indicated on Drawings**][**of 6 inches (150 mm)**]<**Insert requirement**> in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than **2 inches (50 mm)** in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to [**72 inches (1800 mm)**]<**Insert dimension**>.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

A. Remove from [**area indicated on Drawings**][**construction area**]<**Insert requirement**> naturally formed rocks that measure more than [**1 foot (300 mm)**]<**Insert dimension**> across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than **2 inches (50 mm)** in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock [**where indicated on Drawings**][**away from edge of excavations**]<**Insert requirement**> without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to [**36 inches (900 mm)**]<**Insert dimension**>.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00 00

Task	Specification	Specification Description
31 11 00 00	31 10 00 00	Site Clearing
31 13 00 00	31 10 00 00	Site Clearing
31 13 13 00	31 10 00 00	Site Clearing
31 13 16 00	31 10 00 00	Site Clearing

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SECTION 31 20 00 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil materials.
2. Geotextiles.
3. Controlled low-strength material.
4. Geofoam.
5. Accessories.

B. Related Requirements:

1. [**Section 013200 "Construction Progress Documentation"**][**Section 013233 "Photographic Documentation"**] for recording preexcavation and earth-moving progress.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping [**and stockpiling**] topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 012100 "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
2. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
3. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
6. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches, and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .
2. Bulk Excavation: Excavation more than [**10 ft. (3 m)**]<**Insert dimension**> in width and more than [**30 ft. (9 m)**]<**Insert dimension**> in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed [**1 cu. yd. (0.76 cu. m)**]<**Insert volume**> for bulk excavation or [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a **42-inch- (1065-mm-)** maximum-width, short-tip-radius rock bucket; rated at not less than **138-hp (103-kW)** flywheel power with bucket-curling force of not less than **28,700 lbf (128 kN)** and stick-crowd force of not less than **18,400 lbf (82 kN)** with extra-long reach boom.
b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than **230-hp (172-kW)** flywheel power and developing a minimum of **47,992-lbf (213.3-kN)** breakout force with a general-purpose bare bucket.

2. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> or more in volume that exceed a standard penetration resistance of [**100 blows/2 inches (97 blows/50 mm)**]<**Insert value**> when tested by a geotechnical testing agency, in accordance with ASTM D1586/D1586M.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and

electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference [**at Project site**][**by web conference**]<**Insert location**> .

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: **12 by 12 inches (300 by 300 mm)**.
2. Warning Tape: **12 inches (300 mm)** long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each [**on-site**][**and**][**borrow**] soil material proposed for fill and backfill as follows:

1. Classification in accordance with ASTM D2487.
2. Laboratory compaction curve in accordance with [**ASTM D698**][**ASTM D1557**] .

B. Blasting plan [**approved by authorities having jurisdiction**] .

C. Seismic survey report from seismic survey agency.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

E. Qualification Statements: For qualified testing agency.

1.7 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

C. Geotechnical Testing Agency Qualifications: Qualified in accordance with ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify [**utility locator service**][**"Miss Utility"**][**"Call Before You Dig"**][**"Dig Safe System"**][**"One Call"**]<**Insert name**> for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in [**Section 015000 "Temporary Facilities and Controls"**][**and**][**Section 311000 "Site Clearing"**] are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification [**Groups GW, GP, GM, SW, SP, and SM in accordance with ASTM D2487**][**Groups A-1, A-2-4, A-2-5, and A-3 in accordance with AASHTO M 145**] , or a combination of these groups; free of rock or gravel larger than [**3 inches (75 mm)**]<**Insert dimension**> in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <**Insert value**> .
2. Plasticity Index: <**Insert value**> .

C. Unsatisfactory Soils: Soil Classification [**Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT in accordance with ASTM D2487**][**Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 in accordance with AASHTO M 145**] , or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a **1-inch (25-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

H. Drainage Course: Narrowly graded mixture of [**washed**] crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch (37.5-mm)** sieve and zero to 5 percent passing a **No. 8 (2.36-mm)** sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch (25-mm)** sieve and zero to 5 percent passing a **No. 4 (4.75-mm)** sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **157 lbf (700 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **142 lbf (630 N)**; ASTM D4632/D4632M.
3) Tear Strength: **56 lbf (250 N)**; ASTM D4533.
4) Puncture Strength: **56 lbf (250 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.250-mm)**][**No. 70 (0.212-mm)**] sieve, maximum; ASTM D4751.
d. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **247 lbf (1100 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **222 lbf (990 N)**; ASTM D4632/D4632M.
3) Tear Strength: **90 lbf (400 N)**; ASTM D4533/D4533M.
4) Puncture Strength: **90 lbf (400 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
d. Permittivity: 0.02 per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting [**, cellular, low-density**] , flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**or**][**Type III**] .
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, [**3/4-inch (19-mm)**][**3/8-inch (10-mm)**]<**Insert dimension**> nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce cellular, low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: [**30 to 36 lb/cu. ft. (480 to 576 kg/cu. m)**][**36 to 42 lb/cu. ft. (576 to 675 kg/cu. m)**]<**Insert unit weight range**> at point of placement, when tested in accordance with ASTM C138/C138M.
2. Compressive Strength: [**80 psi (550 kPa)**][**140 psi (965 kPa)**]<**Insert value**> , when tested in accordance with ASTM C495/C495M.

C. Produce conventional-weight, controlled low-strength material with [**80-psi (550-kPa)**][**140-psi (965-kPa)**]<**Insert value**> compressive strength when tested in accordance with ASTM C495/C495M.

2.4 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength**][**Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength**][**Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength**][**Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength**][**Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength**] .

B. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength**][**Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength**] .

1. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Rigid Cellular Polystyrene Geofoam: ASTM D6817/D6817M, [**Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation**][**Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation**]<**Insert requirement**> .

D. Connectors: [**Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors**][**Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter**]<**Insert requirement**> .

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

A. Explosives:

1. Do not use explosives.
2. Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

    a. Perform blasting without damaging adjacent structures, property, or site improvements.
    b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
    f. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation in accordance with unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

e. [6 inches (150 mm)]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
f. [6 inches (150 mm)]<**Insert dimension**> beneath pipe in trenches and the greater of [24 inches (600 mm)]<**Insert dimension**> wider than pipe or [42 inches (1065 mm)]<**Insert dimension**> wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: [12 inches (300 mm) **each side of pipe or conduit**][**As indicated**] .

C. Trench Bottoms:

1. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints,

fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

a. For pipes and conduit less than **6 inches (150 mm)** in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
b. For pipes and conduit **6 inches (150 mm)** or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
d. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

2. Excavate trenches **4 inches (100 mm)** deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

a. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 EXCAVATION FOR ELEVATOR CYLINDER

A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in [**Section 142400 "Hydraulic Elevators."**][**Section 142413 "Hydraulic Freight Elevators."**]

B. Provide well casing as necessary to retain walls of well hole.

3.9 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade [**below the building slabs and pavements**]<**Insert locations**> with a pneumatic-tired [**and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes)**]<**Insert requirement**> to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction [**, repeating proof-rolling in direction perpendicular to first direction**] . Limit vehicle speed to **3 mph (5 km/h)**.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi (17.2 MPa)**, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within [**18 inches (450 mm)**]<**Insert dimension**> of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide [**4-inch- (100-mm-)**]<**Insert dimension**> thick, concrete-base slab

support for piping or conduit less than [**30 inches (750 mm)**]<**Insert dimension**> below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of [**4 inches (100 mm)**]<**Insert dimension**> of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of [**subbase material**][**satisfactory soil**] , free of particles larger than [**1 inch (25 mm)**]<**Insert dimension**> in any dimension, to a height of **12 inches (300 mm)** over the pipe or conduit.

   a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of **12 inches (300 mm)** over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, **12 inches (300 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

3.14 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 GEOFOAM FILL

A. Place a leveling course of sand, [**2 inches (50 mm)**]<**Insert dimension**> thick, over subgrade. Finish leveling course to a tolerance of **1/2 inch (13 mm)** when tested with a **10-foot (3-m)** straightedge.

1. Place leveling course on subgrades free of mud, frost, snow, or ice.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement in accordance with geofoam manufacturer's written instructions.

D. Cover geofoam with [**subdrainage**][**separation**] geotextile before placing overlying soil materials.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than [**8 inches (200 mm)**]<**Insert dimension**> in loose depth for material compacted by heavy compaction equipment and not more than **4 inches (100 mm)** in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] :

1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches (300 mm)** of existing subgrade and each layer of backfill or fill soil material at [**95**]<**Insert number**> percent.
2. Under walkways, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**92**]<**Insert number**> percent.
3. Under turf or unpaved areas, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**85**]<**Insert number**> percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at [**85**]<**Insert number**> percent.

3.18 GRADING

A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
2. Walks: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
3. Pavements: Plus or minus [**1/2 inch (13 mm)**]<**Insert dimension**> .

C. Grading inside Building Lines: Finish subgrade to a tolerance of [**1/2 inch (13 mm)**]<**Insert dimension**> when tested with a **10-foot (3-m)** straightedge.

3.19 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a **6-inch (150-mm)** course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of **12 inches (300 mm)** of filter material, placed in compacted layers **6 inches (150 mm)** thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least **6 inches (150 mm)**.

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within **12 inches (300 mm)** of final subgrade, in compacted layers **6 inches (150 mm)** thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least **6 inches (150 mm)**.

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .
2. Place and compact impervious fill over drainage backfill in **6-inch- (150-mm-)** thick compacted layers to final subgrade.

3.20 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course [**and base course**] on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course [**and base course**] under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course [**and base course**] to required crown elevations and cross-slope grades.
4. Place subbase course [**and base course**] **6 inches (150 mm)** or less in compacted thickness in a single layer.
5. Place subbase course [**and base course**] that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
6. Compact subbase course [**and base course**] at optimum moisture content to required grades, lines, cross sections, and thickness to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

C. Pavement Shoulders: Place shoulders along edges of subbase course [**and base course**] to prevent lateral movement. Construct shoulders, at least **12 inches (300 mm)** wide, of satisfactory soil materials and compact simultaneously with each subbase [**and base**] layer to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

3.21 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course **6 inches (150 mm)** or less in compacted thickness in a single layer.
3. Place drainage course that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with ASTM D698.

3.22 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Compaction Testing: Testing agency will test compaction of soils in place in accordance with ASTM D1556/D15556M, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every [**2000 sq. ft. (186 sq. m)**]<**Insert area**> or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every [**100 ft. (30 m)**]<**Insert dimension**> or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every [**150 ft. (46 m)**]<**Insert dimension**> or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

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Task	Specification	Specification Description
31 22 00 00	31 20 00 00	Earth Moving
31 22 13 00	31 20 00 00	Earth Moving
31 22 16 00	31 20 00 00	Earth Moving
31 22 16 13	31 20 00 00	Earth Moving
31 22 19 00	31 20 00 00	Earth Moving
31 22 19 13	31 20 00 00	Earth Moving
31 23 00 00	31 20 00 00	Earth Moving
31 23 16 00	31 20 00 00	Earth Moving
31 23 16 13	31 20 00 00	Earth Moving
31 23 16 16	31 20 00 00	Earth Moving
31 23 16 16	32 31 13 00	Chain Link Fences And Gates
31 23 16 26	31 20 00 00	Earth Moving
31 23 16 33	31 20 00 00	Earth Moving
31 23 16 36	31 20 00 00	Earth Moving

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SECTION 31 23 19 00 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction dewatering.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 015723 "Temporary Storm Water Pollution Control" for temporary storm water pollution controls mandated under the EPA's National Pollutant Discharge Elimination System.
3. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1. Dewatering observation wells are part of [**dewatering**]<**Insert description**> allowance.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered, including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations, including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

B. Delegated Design Submittals: For dewatering system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

B. Qualification Statements: For [**Installer**][**and**][**land surveyor**]<**Insert entity or specialist**>.

C. Delegated design engineer qualifications.

D. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer: An experienced installer that has specialized in [**design of dewatering systems and**]dewatering work.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Land Surveyor: A professional land surveyor who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.
2. The geotechnical report is [**included**][**referenced**] elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dewatering system.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [**Section 015000 "Temporary Facilities and Controls,"**][**Section 015723 "Temporary Storm Water Pollution Control"**][**Section 311000 "Site Clearing,"**] during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below groundwater level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of [**24 inches (600 mm)**][**60 inches (1500 mm)**]<**Insert dimension**> below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of **36 inches (900 mm)** below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well

risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**monthly**]<**Insert time period**> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19 00

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Task	Specification	Specification Description
31 23 19 00	31 20 00 00	Earth Moving
31 23 23 00	31 20 00 00	Earth Moving
31 23 23 23	31 20 00 00	Earth Moving
31 23 23 33	31 20 00 00	Earth Moving
31 24 00 00	31 20 00 00	Earth Moving

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SECTION 31 24 13 00 - LEVEE CLOSURE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor and materials for providing levee closures.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:
   1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
   2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
   3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
   4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 31 24 13 00

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Task	Specification	Specification Description
31 24 13 00	31 20 00 00	Earth Moving
31 25 00 00	31 20 00 00	Earth Moving
31 25 14 00	31 20 00 00	Earth Moving
31 25 14 13	31 20 00 00	Earth Moving
31 25 14 16	31 20 00 00	Earth Moving
31 25 14 23	31 20 00 00	Earth Moving
31 25 14 23	32 14 00 00	Unit Paving
31 25 14 26	31 20 00 00	Earth Moving

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SECTION 31 31 16 00 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment.
2. Wood treatment.
3. Bait-station system.
4. Metal mesh barrier system.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood preservative treatment by pressure process.
2. Section 076200 "Sheet Metal Flashing and Trim" for custom-fabricated, metal termite shields.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Termiticide brand name and manufacturer.
3. Quantity of undiluted termiticide used.
4. Dilutions, methods, volumes used, and rates of application.
5. Areas of application.

E. Bait-Station System Installation Report: After installation of bait-station system is completed, submit report for Owner's records and include the following:

1. Location of areas and sites conducive to termite feeding and activity.
2. Plan drawing showing number and locations of bait stations.
3. Dated report for each monitoring and inspection occurrence, indicating level of termite activity, procedure, and treatment applied before time of Substantial Completion.
4. Termiticide brand name and manufacturer.
5. Quantities of [**termiticide**][**and**][**nontoxic termite bait**] used.
6. Schedule of inspections for one year from date of Substantial Completion.

F. Research/Evaluation Reports: For metal mesh barrier system, from <**Insert applicable model code organization**>.

G. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located[**and who employs workers trained and approved by manufacturer to install manufacturer's products**][**and who is accredited by manufacturer**].

1.6 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites[**, including Formosan termites (Coptotermes formosanus)**]<**Insert requirement**>. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: [**Three**][**Five**]<**Insert number**> years from date of Substantial Completion.

B. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor,

certifying that termite control work consisting of applied wood termiticide treatment will prevent infestation of subterranean termites[**, including Formosan termites (Coptotermes formosanus)**]<**Insert requirement**>. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.

1. Warranty Period: [**12**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain termite control products from single source[**from single manufacturer**].

2.2 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bayer Environmental Science**]
b. [**Ensystex, Inc**]
c. [**Syngenta Crop Protection, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bayer Environmental Science**]
b. [**Ensystex, Inc**]
c. [**Syngenta Crop Protection, LLC**]
d. <**Insert manufacturer's name**>

3. Service Life of Treatment: Soil treatment termiticide that is effective for not less than [**three**][**five**]<**Insert number**> years against infestation of subterranean termites.

2.3 WOOD TREATMENT

A. Borate: EPA-Registered borate termiticide acceptable to authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ensystex, Inc**]
b. [**Nisus Corporation**]
c. [**NovaGuard Technologies, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ensystex, Inc**]
b. [**Nisus Corporation**]
c. [**NovaGuard Technologies, Inc**]
d. <**Insert manufacturer's name**>

2.4 BAIT-STATION SYSTEM

A. Bait-Station System: EPA-Registered system acceptable to authorities having jurisdiction. Provide bait stations based on the dimensions of building perimeter indicated on Drawings, according to product's EPA-Registered Label and manufacturer's written instructions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ensystex, Inc**]
b. [**The Dow Chemical Company**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ensystex, Inc**]
b. [**The Dow Chemical Company**]
c. <**Insert manufacturer's name**>

2.5 METAL MESH BARRIER SYSTEM

A. Stainless-Steel Mesh Barrier System: **0.025-by-0.018-inch (0.64-by-0.45-mm)** mesh of **0.08-inch- (2.0-mm-)** diameter, stainless-steel wire, Type 316.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Termimesh, LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Termimesh, LLC**]
b. <**Insert manufacturer's name**>

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for[**moisture content of soil per termiticide label,**] interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
3. Crawlspaces: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 APPLYING WOOD TREATMENT

A. Wood Treatment: Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.

B. Application: Mix borate wood treatment solution to a uniform consistency. Apply treatment at the product's EPA-Registered Label volume and rate for the maximum borate concentration allowed for each specific use so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment.[**Apply treatment to the height of 8 feet (244 mm) above grade**]<**Insert requirement**>.

1. Framing and Sheathing: Apply termiticide solution by spray to bare wood and with complete coverage.
2. Heavy Wood Members: For wood greater than **4 inches (100 mm)** thick, inject termiticide gel solution under pressure into holes of size and spacing required by manufacturer for treatment.
3. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood only when forecasted weather conditions indicate no precipitation or fog before application of seal coat. After 48 hours, verify that surface is sufficiently dry for seal coat and apply seal coat of [**paint**]<**Insert coating**> as specified in [**Section 099113 "Exterior Painting."**]<**Insert Section title**>.

3.5 INSTALLING BAIT-STATION SYSTEM

A. Bait-Station System: Install [**during construction to determine areas of termite activity**][**and**][**after construction, including landscaping, is completed**].

B. Place bait stations according to product's EPA-Registered Label and manufacturer's written instructions, in the following locations:

1. Conducive sites and locations indicated on Drawings.
2. In and around infested trees and stumps.
3. In mulch beds.
4. Where wood directly contacts soil.
5. Areas of high soil moisture.
6. Near irrigation sprinkler heads.
7. Each area where roof drainage system, including downspouts and scuppers, drains to soil.
8. Along driplines of roof overhangs without gutters.
9. Where condensate lines from mechanical equipment drip or drain to soil.
10. At plumbing penetrations through ground-supported slabs.
11. Other sites and locations as determined by licensed Installer.

C. Spacing: Place bait stations according to manufacturer's written instructions and at a frequency no less than the following:

1. One bait station per [**8 linear feet (2.4 linear meters)**][**20 linear feet (6.1 linear meters)**]<**Insert value**>.
2. One cluster of bait stations per **20 linear feet (6.1 linear meters)**, with no fewer than three bait stations per cluster.

3.6 INSTALLING METAL MESH BARRIER SYSTEM

A. Install metal mesh barrier system to provide a continuous barrier to entry of subterranean termites, according to manufacturer's written instructions.

1. Fit mesh tightly around pipes and other penetrations and terminate at slab and foundation perimeters.
2. Install mesh under the perimeter of concrete slab edges and joints after vapor retarder and reinforcing steel are in place.

3.7 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.8 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by[**skilled employees of termite-control-treatment Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Include [**annual**]<**Insert time period**> inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 31 31 16 00

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Task	Specification	Specification Description
31 31 16 13	31 31 16 00	Termite Control

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SECTION 31 32 19 16 - POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geomembrane liners[**and floating covers**] for ponds and reservoirs fabricated from the following:

1. Linear low-density polyethylene (LLDPE).
2. High-density polyethylene (HDPE).
3. Polypropylene (PP).
4. Ethylene-propylene-diene monomer (EPDM).
5. Polyvinyl chloride (PVC).
6. Ethylene interpolymer alloy (EIA).
7. Chlorosulfonated polyethylene (CSPE).

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for perimeter concrete.
2. Section 221429 "Sump Pumps" for drainage of floating covers.
3. Section 312000 "Earth Moving" for excavating, compacting, and grading the subgrade; for excavating and backfilling the anchor trench; for protecting the earthwork; for removing ground water from subgrade to the extent required by liner manufacturer; for adding requirements for the earth cover; and for the filter fabric and other geotextiles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and accessories for geomembrane liners[**and floating covers**].

B. Shop Drawings: Include panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples: For each exposed product and for each color specified. Include one **12-inch (300-mm)** seam length for factory-bonded sheets and one **12-inch (300-mm)** seam length for field-bonded sheets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of geomembrane liner[**and floating cover**].

C. Product Test Reports: For each geomembrane sheet, for tests performed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For geomembrane liner[**and floating cover**] to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: [**Fabricator of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner[**and floating cover**] that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Leaks in geomembrane liner[**and floating cover**].
b. Defects in seams.
c. Cracks and holes in floating cover.

2. Warranty Period: [**One**][**Five**][**10**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain geomembrane liner[**and floating cover**], accessories, and required seaming materials, solvents, and adhesives from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Provide geomembrane liners[**and floating covers**] that prevent the passage of water[**and gas**].

2.3 LLDPE SHEET MATERIALS

A. LLDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with [**GRI Test Method GM17, non-reinforced,**][**GRI Test Method GM25, reinforced,**] for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Agru America, Inc**]
   b. [**In Line Plastics, LC**]
   c. [**Integra Plastics, Inc**]
   d. [**Layfield Environmental Containment; Layfield Group Limited**]
   e. [**Poly-Flex, Inc**]
   f. [**Solmax International Inc.**]
   g. [**Viaflex**]
   h. [**Watersaver Company, Inc**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Agru America, Inc**]
   b. [**In Line Plastics, LC**]
   c. [**Integra Plastics, Inc**]
   d. [**Layfield Environmental Containment; Layfield Group Limited**]
   e. [**Poly-Flex, Inc**]
   f. [**Solmax International Inc.**]
   g. [**Viaflex**]
   h. [**Watersaver Company, Inc**]
   i. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**20 mils (0.50 mm)**][**30 mils (0.75 mm)**][**40 mils (1.00 mm)**][**50 mils (1.25 mm)**][**60 mils (1.50 mm)**][**80 mils (2.00 mm)**][**100 mils (2.50 mm)**][**120 mils (3.00 mm)**]<**Insert dimension**> per ASTM D5199.
4. Nominal Sheet Thickness: [**24 mils (0.61 mm)**][**36 mils (0.91 mm)**][**45 mils (1.10 mm)**]<**Insert dimension**> per ASTM D5199.
5. Sheet Texture: One side smooth; other side [**smooth**][**textured**].

2.4 HDPE SHEET MATERIALS

A. HDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with GRI Test Method GM13 for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Agru America, Inc**]
   b. [**In Line Plastics, LC**]
   c. [**Integra Plastics, Inc**]
   d. [**Layfield Environmental Containment; Layfield Group Limited**]
   e. [**Plastic Fusion Fabricators, Inc**]
   f. [**Poly-Flex, Inc**]
   g. [**Solmax International Inc.**]
   h. [**Viaflex**]
   i. [**Yunker Plastics, Inc.**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Agru America, Inc**]
   b. [**In Line Plastics, LC**]
   c. [**Integra Plastics, Inc**]
   d. [**Layfield Environmental Containment; Layfield Group Limited**]
   e. [**Plastic Fusion Fabricators, Inc**]
   f. [**Poly-Flex, Inc**]
   g. [**Solmax International Inc.**]
   h. [**Viaflex**]
   i. [**Yunker Plastics, Inc.**]
   j. **<Insert manufacturer's name>**

3. Minimum Average Sheet Thickness: [**30 mils (0.75 mm)**][**40 mils (1.00 mm)**][**50 mils (1.25 mm)**][**60 mils (1.50 mm)**][**80 mils (2.00 mm)**][**100 mils (2.50 mm)**][**120 mils (3.00 mm)**]**<Insert dimension>** per ASTM D5199.
4. Sheet Texture: One side smooth; other side [**smooth**][**textured**].

2.5 PP SHEET MATERIALS

A. PP Sheet: Formulated from virgin PP, compounded for use in hydraulic structures, and formed into uniform, flexible [**non-reinforced**][**reinforced**] sheets with material properties complying with GRI Test Method GM18 for thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Syntec Systems**]
   b. [**Cooley Group**]
   c. [**Elevate; Holcim Building Envelope**]
   d. [**Environmental Protection, Inc**]
   e. [**EVOQUA Water Technologies**]
   f. [**Integra Plastics, Inc**]
   g. [**Layfield Environmental Containment; Layfield Group Limited**]
   h. [**Viaflex**]
   i. [**Watersaver Company, Inc**]
   j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Carlisle Syntec Systems**]
   b. [**Cooley Group**]
   c. [**Elevate; Holcim Building Envelope**]
   d. [**Environmental Protection, Inc**]
   e. [**EVOQUA Water Technologies**]
   f. [**Integra Plastics, Inc**]

g. [**Layfield Environmental Containment; Layfield Group Limited**]
h. [**Viaflex**]
i. [**Watersaver Company, Inc**]
j. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**30 mils (0.75 mm)**][**40 mils (1.00 mm)**][**60 mils (1.50 mm)**][**36 mils (0.91 mm)**][**45 mils (1.10 mm)**]<**Insert dimension**> per ASTM D5199.
4. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

   a. Construction: [**9 x 9 - 1000 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

5. Sheet Texture: One side smooth; other side [**smooth**][**textured**].

2.6 EPDM SHEET MATERIALS

A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible [**non-reinforced**][**reinforced**] sheets with material properties complying with GRI Test Method GM21 for nominal thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Syntec Systems**]
   b. [**Elevate; Holcim Building Envelope**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. [**Watersaver Company, Inc**]
   e. [**Yunker Plastics, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Carlisle Syntec Systems**]
   b. [**Elevate; Holcim Building Envelope**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. [**Watersaver Company, Inc**]
   e. [**Yunker Plastics, Inc.**]
   f. <**Insert manufacturer's name**>

3. Minimum Average Sheet Thickness: [**45 mils (1.10 mm)**][**60 mils (1.50 mm)**]<**Insert dimension**> per ASTM D5199.
4. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

   a. Construction: [**9 x 9 - 1000 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

2.7 PVC SHEET MATERIALS

A. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible non-reinforced sheets with material properties complying with [**ASTM D7176**][**PGI 1104, "Specification for PVC Geomembranes,"**] for nominal thickness indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Environmental Protection, Inc**]
    b. [**Solmax International Inc.**]
    c. [**Watersaver Company, Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Environmental Protection, Inc**]
    b. [**Solmax International Inc.**]
    c. [**Watersaver Company, Inc**]
    d. <**Insert manufacturer's name**>

3. Nominal Thickness: [**10 mils (0.25 mm)**][**20 mils (0.51 mm)**][**30 mils (0.76 mm)**][**40 mils (1.02 mm)**][**50 mils (1.3 mm)**][**60 mils (1.5 mm)**].
4. Sheet Texture: One side smooth; other side [**smooth**][**matte**][**faille textured**].

2.8 EIA SHEET MATERIALS

A. EIA Sheet: Formulated from EIA for use in hydraulic structures and formed into uniform, flexible reinforced sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Burke Industries, Inc.**]
    b. [**Cooley Group**]
    c. [**EVOQUA Water Technologies**]
    d. [**Integra Plastics, Inc**]
    e. [**Seaman Corporation**]
    f. [**Watersaver Company, Inc**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Burke Industries, Inc.**]
    b. [**Cooley Group**]
    c. [**EVOQUA Water Technologies**]
    d. [**Integra Plastics, Inc**]
    e. [**Seaman Corporation**]
    f. [**Watersaver Company, Inc**]
    g. <**Insert manufacturer's name**>

3. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

a. Construction: [**6 x 6 - 1000 d**][**8 x 8 - 500 d**][**10 x 10 - 1000 d**][**10 x 11 - 2520 d x 2000 d**]<**Insert value(s)**>.

4. Nominal Thickness: [**36-mil- (0.91-mm-)**]<**Insert dimension**> thick sheet per ASTM D1593 or ASTM D751, Optical Method.
5. Tensile Strength: Not less than [**400 lbf (1.8 kN)**]<**Insert value**> minimum average per ASTM D751, Procedure A.
6. Tear Strength: Not less than [**35 lbf (0.16 kN)**]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
7. Puncture Resistance: Not less than [**150 lbf (0.67 kN)**]<**Insert value**> minimum average per ASTM D4833.
8. Hydrostatic Resistance: Not less than [**100-psi (690-kPa)**]<**Insert value**> minimum average resistance per ASTM D751, Procedure A.
9. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D1204.
10. Low-Temperature Flexibility: Pass, **1/8-inch (3-mm)** mandrel, four hours at **minus 30 deg F (minus 34 deg C)**, and per ASTM D2136.
11. UV-Light Resistance: Pass, 4000 hours at **176 deg F (80 deg C)**, per ASTM G155.
12. Ply Adhesion: Not less than [**7 lbf/in. (1.2 kN/m)**][**10 lbf/in. (1.75 kN/m)**]<**Insert value**> of seam width, or film tearing bond, according to ASTM D413, Machine Method.

2.9 CSPE SHEET MATERIALS

A. CSPE Sheet: Formulated from CSPE for use in hydraulic structures and formed into uniform, flexible reinforced sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burke Industries, Inc.**]
   b. [**EVOQUA Water Technologies**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burke Industries, Inc.**]
   b. [**EVOQUA Water Technologies**]
   c. [**Layfield Environmental Containment; Layfield Group Limited**]
   d. <**Insert manufacturer's name**>

3. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

   a. Construction: [**6 x 6 - 1000 d**][**8 x 8 - 250 d**][**10 x 10 - 1000 d**]<**Insert value(s)**>.

4. Water Absorption: Not more than 2 percent at **70 deg F (21 deg C)** and not more than 30 percent at **158 deg F (70 deg C)** for 30 days each per ASTM D471, **30-mil- (0.76-mm-)** thick sheet.
5. Nominal Thickness: [**45-mil- (1.14-mm-)**]<**Insert dimension**> thick sheet per ASTM D5199 or ASTM D751, Optical Method.
6. Nominal Thickness over Scrim: [**11-mil- (0.28-mm-)**]<**Insert dimension**> thick sheet per ASTM D5199 or ASTM D751, Optical Method.

7. Breaking Strength: Not less than [**200 lbf (0.89 kN)**]<**Insert value**> minimum average per ASTM D751, Procedure A.
8. Tear Strength, Initial: Not less than [**70 lbf (0.31 kN)**]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
9. Tear Strength, after Aging: Not less than [**35 lbf (0.16 kN)**]<**Insert value**> minimum average per ASTM D5884 or ASTM D751, Procedure B.
10. Puncture Resistance: Not less than [**200 lbf (0.89 kN)**]<**Insert value**> minimum average per ASTM D4833.
11. Hydrostatic Resistance: Not less than [**250-psi (1725-kPa)**]<**Insert value**> minimum average resistance per ASTM D5514, Procedure A or ASTM D751, Method A, Procedure 1.
12. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D1204.
13. Low-Temperature Flexibility: Pass, **1/8-inch (3-mm)** mandrel, four hours at **minus 40 deg F (minus 40 deg C)**, and per ASTM D2136.
14. UV-Light Resistance: Pass, 4000 hours at **176 deg F (80 deg C)**, per ASTM G155.
15. Ply Adhesion: Not less than [**7 lbf/in. (1.2 kN/m)**][**10 lbf/in. (1.75 kN/m)**]<**Insert value**> of seam width, or film tearing bond, according to ASTM D413, Machine Method.

2.10 FLOATING COVER ACCESSORIES

A. Screened Scupper Hoses: Manufacturer's standard.

B. Flotation Blocks: Closed-cell PE foam blocks approximately **4 by 12 inches (102 by 300 mm)**, **2.2 lb/cu. ft. (35.2 kg/cu. m)**.

C. Access Hatch: Manufacturer's standard, in size indicated.

2.11 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

C. Battens: Long-length strips of material indicated, size as indicated on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material:

   a. Liner manufacturer's standard system.
   b. Aluminum; with stainless steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
   c. Stainless steel; with stainless steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
   d. Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.

D. Sand: ASTM C33/C33M; fine aggregate, natural or manufactured sand.

2.12 FABRICATION

A. Fabricate geomembrane liner[**and floating cover**] panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

B. Fabricate flotation blocks, wrap in geomembrane sheet, and attach to underside of floating cover according to manufacturer's written instructions.

C. Fabricate ballast tubes of sand-filled geomembrane sheet and attach to top surface of floating cover according to manufacturer's written instructions.

D. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor [**trench excavation**][**concrete perimeter**], where geomembrane liner[**and floating cover**] will be secured, for substrate conditions indicated above and for correct location and configuration.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

B. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

C. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

B. Field Seams: Comply with geomembrane liner[**and floating cover**] manufacturer's written instructions. Form seams by lapping edges of panels **2 to 4 inches (50 to 102 mm)**, unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials.

Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.
2. Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.

C. Installation in Anchor Trench: Install geomembrane liner[**and floating cover**] in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.

D. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum **8-inch- (200-mm-)** wide concrete substrate unless otherwise indicated.

1. Install batten strips over geomembrane liner[**and floating cover**] as indicated on Drawings.
2. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
3. Install floating cover with perimeter fold.

E. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.

F. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner[**and floating cover**] and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

C. Destructive Testing: Comply with GRI Test Method GM19, as applicable to geomembrane liner[**and floating cover**] and seam construction. Record locations of sample locations and failed seams. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches, and test sample locations.

D. Prepare test and inspection reports.

3.5 DISINFECTION

A. Disinfect the complete installation according to procedures in AWWA C652.

3.6 PROTECTION

A. Protect installed geomembrane liner[**and floating cover**] according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

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SECTION 31 50 00 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Land surveyor.
2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.

4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

1. Corners: [**Site-fabricated mechanical interlock**][**Roll-formed corner shape with continuous interlock**].

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of [**size and strength required for application**][**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

H. Tiebacks: Steel bars, ASTM A722/A722M.

I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.

1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3. Accurately align exposed faces of flanges to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.

1. Trim excavation as required to install lagging.
2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**.
2. Accurately align exposed faces of sheet piling to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**daily**][**weekly**]<**Insert time period**> during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of [**48 (1200)**]<**Insert dimension**> **inches (mm)** below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00 00

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Task	Specification	Specification Description
31 52 00 00	31 50 00 00	Excavation Support and Protection
31 52 21 00	31 50 00 00	Excavation Support and Protection

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SECTION 31 62 13 00 - CONCRETE PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes [**hollow**][**solid**], precast, prestressed concrete piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

    a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For concrete piles. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and lifting devices necessary for handling and driving piles.

1. Indicate pile dimensions, cross sections, locations, and sizes. Show details of pile splices and shoes.
2. Indicate types of reinforcement, including prestressing strand, and detail fabricating, bending, and placing.
3. Indicate layout and dimensions, and identify each pile. Indicate welded connections by AWS standard symbols. Detail cast-in hardware.

4. Indicate transportation, storage, and lifting points.
5. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittal: For concrete piles.

1. Indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Design Mixes: For each concrete mix.

D. Material Certificates: For [**steel reinforcements**][**prestressing strand**][**and**][**concrete admixtures**].

E. Material Test Reports: For concrete materials.

F. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

G. Static Pile Test Reports: Submit within three days of completing each test.

H. Pile-Driving Records: Submit within three days of driving each pile.

I. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

J. Field quality-control reports.

K. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engineering Responsibility: Assumes engineering responsibility to comply with requirements in "Performance Requirements" Article by engaging a qualified professional engineer to prepare design calculations, Shop Drawings, and other structural data for piles.
2. PCI Plant Certification Program: Participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for [**B2**][**and**][**C2**] product group and category, or better.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing

indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

D. Design Practices: Comply with **ACI 318 (ACI 318M)** and the recommendations in PCI Committee Report: "Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling."

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for piles, comply with applicable requirements in PCI MNL-116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load is to be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent cracking, distorting, warping, or other physical damage, and so markings are visible.

B. Lift and support piles only at designated lifting or supporting points as shown on Shop Drawings.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving.[**Comply with Section 013233 "Photographic Documentation."**]

PART 2 - PRODUCTS

2.1 CONCRETE PILES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality

Requirements," to design piles, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Piles withstand transportation, erection, and driving stresses and design loads within limits indicated and under conditions existing at Project site.

1. Design Loads: <**Insert loads**>.

2.3 MOLD MATERIALS

A. Molds: Provide molds of metal, plastic, wood, or another material that is nonreactive with concrete and that produces required finish surfaces.

2.4 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**], deformed.

E. Plain and Deformed Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

F. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**].

2.5 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A416/A416M, **Grade 250 or 270 (Grade 1725 or 1860)**; uncoated, seven-wire, low-relaxation strand.

2.6 CONCRETE MATERIALS

A. General: Limit water-soluble chloride ions in concrete to the maximum percentage by mass of cementitious material permitted by **ACI 318 (ACI 318M)**, but not more than 0.06 percent.

B. Portland Cement: ASTM C150/C150M, [**Type I or Type III**][**Type II**], of same type, brand, and source.

1. Fly Ash: ASTM C618, Class C or F.
2. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: Except as modified by PCI MNL-116, ASTM C33/C33M, with coarse aggregates complying with [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>. Provide aggregates from

single source.

1. Nominal Maximum Size of Aggregate: [**1 inch (25 mm)**][**3/4 inch (19 mm)**].

D. Water: Potable, free of deleterious material that may affect color stability, setting, or strength of concrete, and complying with chemical limits of PCI MNL-116.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
7. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.7 PILE ACCESSORIES

A. Pile Shoes: **1-inch- (25-mm-)** thick minimum, carbon-steel plate fabricated to match shape of pile tip.

B. Pile Splices: Manufactured from carbon-steel plates or castings and capable of developing strength of continuous pile at splice location.

2.8 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in total, [**25**]<**Insert number**> percent of portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified personnel at precast manufacturing plant at precast manufacturer's option.

C. Proportion mixes by either laboratory trial batch or field-test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): [**8000 psi (55.2 MPa)**][**7000 psi (48.3 MPa)**][**6000 psi (41.4 MPa)**][**5000 psi (34.5 MPa)**]<**Insert value**>.
2. Maximum Water-Cementitious Material Ratio: 0.40.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**][**2.5 to 4.5**] percent.

2.9 FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and temperature changes and for pretensioning and detensioning operations. Maintain molds to provide completed piles of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116 and PCI MNL-135.

1. Unless molds are stripped before detensioning, design molds so stresses are not induced in piles due to deformation of concrete under prestress or movement during detensioning.
2. Chamfer edges and corners of square piles.

B. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

1. Accurately position, support, and secure reinforcement against displacement by molds, construction, or concrete placement. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
2. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

C. Prestress tendons for piles by either pretensioning or post-tensioning methods. Comply with PCI MNL-116.

D. Pile Shoes: Accurately position and secure pile shoes at pile tips so as to not affect pile alignment during driving. Weld pile shoes to longitudinal reinforcements.

E. Pile Splices: Accurately position and secure pile-splice segments requiring embedding in tips of piles.

F. Mix concrete according to PCI MNL-116 and requirements in this Section. After initial concrete batching, no additional water may be added.

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in piles. Comply with requirements in PCI MNL-116 for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL-116.
2. Comply with ACI 306.1 procedures for cold-weather concrete placement.
3. Comply with ACI 305R recommendations for hot-weather concrete placement.

H. Identify pickup points of piles with permanent markings that correspond with markings indicated on Shop Drawings. Imprint casting date on each pile.

I. Cure concrete, according to requirements in PCI MNL-116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

J. Delay detensioning piles until concrete has attained at least [**70**]<**Insert number**> percent of its compressive strength as established by test cylinders cured under the same conditions as concrete.

1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

K. Where ends of strands are not enclosed or covered, cut flush and cover with a high-strength mortar bonded to unit with an epoxy-resin bonding agent.

L. Fabricate precast, prestressed concrete piles straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL-116 and PCI MNL-135 product tolerances.

M. Finish: Fabricate concrete piles with normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

1. Finish unformed surfaces by trowel unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

N. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate pile manufacturer's quality-control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency, and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Testing: Test and inspect piles according to PCI MNL-116.

1. Strength of piles will be considered deficient if units fail to comply with requirements.

C. If there is evidence that strength of piles may be deficient or may not comply with PCI MNL-116 requirements, Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores are to be taken from piles of suspect strength, from locations directed by Architect.
2. Cores are to be tested, following immersion in water, in a wet condition in accordance with ACI 301 if piles are wet under service conditions.
3. Cores are to be tested in an air-dry condition in accordance with ACI 301 if piles are dry under service conditions.
4. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
5. Test results are to be reported in writing on same day that tests are performed, with copies to Architect, Contractor, and pile manufacturer. Test reports are to include the following:

   a. Project identification name and number.
   b. Date when tests were performed.
   c. Name of precast concrete manufacturer.
   d. Name of concrete testing agency.
   e. Identification letter, name, and type of pile represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

D. Patching: If core test results are satisfactory and piles comply with requirements, solidly fill core holes with patching mortar and finish to match adjacent pile surfaces.

E. Piles will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

1. Use pile hammer capable of adjustment to deliver reduced impact to maintain tensile stress within 70 percent of yield strength of pile reinforcement.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation, and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

G. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

H. Cut off tops of driven piles square with pile axis and at elevations indicated.

I. Buildups: Construct buildups to elevations indicated of cast-in-place reinforced concrete with compressive strength not less than [**5000 psi (34.5 MPa)**]<**Insert value**> at 28 days.

J. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Type of pile and date of casting.
4. Pile location in pile group and designation of pile group.
5. Sequence of driving in pile group.
6. Pile dimensions.
7. Ground elevation.
8. Elevation of tips after driving.
9. Final tip and cutoff elevations of piles after driving pile group.
10. Records of redriving.
11. Elevation of splices.
12. Type, make, model, and rated energy of hammer.
13. Weight and stroke of hammer.
14. Type of pile-driving cap used.
15. Cushion material and thickness.
16. Actual stroke and blow rate of hammer.
17. Pile-driving start and finish times, and total driving time.
18. Time, pile-tip elevation, and reason for interruptions.
19. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
20. Pile deviations from location and plumb.
21. Preboring, jetting, or special procedures used.
22. Unusual occurrences during pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring is to be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Low-strain integrity measurement is to be performed and reported for each pile.

D. Piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 13 00

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Task	Specification	Specification Description
31 62 13 23	31 62 13 00	Concrete Piles

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SECTION 31 62 16 00 - STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel H piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

   a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For steel H piles. Show fabrication and installation details for piles, including details of driving points, splices, and pile caps.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional

engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Mill Test Reports: For [**steel H piles**][**steel castings**][**and**][**steel plate**], signed by manufacturer.

D. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

E. Static Pile Test Reports: Submit within three days of completing each test.

F. Pile-Driving Records: Submit within three days of driving each pile.

G. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

H. Field quality-control reports.

I. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

a. Procedure B, Maintained Test.

b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent buckling or physical damage.

1. Painted Piles: Protect finish and touch up paint damage before driving piles.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground

utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL H PILES

A. High-Strength, Low-Alloy, Columbium-Vanadium Structural Steel: ASTM A572/A572M, [**Grade 50 (Grade 345)**][**Grade 60 (Grade 415)**]<**Insert grade**>.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

B. High-Strength, Low-Alloy, Nickel, Copper, Phosphorous Steel H Piles: ASTM A690/A690M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

C. High-Strength, Low-Alloy, Structural Steel: ASTM A588/A588M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2.2 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard one-piece driving point, fabricated from steel castings as follows to provide full bearing of web and flange of pile tip:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 65-35 (Grade 450-240)**, **heat treated**][**or**][**Grade N1**].
2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 80-40 (Grade 550-275)**][**or**][**Grade 90-60 (Grade 620-415)**].

B. Splice Unit: Manufacturer's standard splice unit, fabricated from two connected steel plates, of same material as steel H pile or material of equal strength, shaped to encase web and part of each flange.

2.3 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**][**red**][**manufacturer's standard color**].

2.4 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

C. Fabricate full-length piles to eliminate splicing during driving, with ends square.

D. Fabricate full-length piles by splicing lengths of steel H pile together. Accurately mill meeting ends of piles and bevel for welding. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Units: Notch web of pile, fit splice unit into position, and weld according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
2. Continuously Welded Splices: Splice piles by continuously welding according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
3. Splice piles during fabrication[**or field installation**].

E. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.5 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of **60 inches (1524 mm)** below [**finished grade**][**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, spatter, slag, and flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than **8 mils (0.2 mm)**.

1. Apply second coat to provide a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a two-coat paint system thickness of not less than **16 mils (0.4 mm)**.
2. Apply second and third coats with each coat having a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a three-coat paint system thickness of not less than **24 mils (0.6 mm)**.
3. Mark pile lengths after shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

E. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

F. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

G. Cut off tops of driven piles square with pile axis and at elevations indicated.

H. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
19. Pile deviations from location and plumb.
20. Preboring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

I. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract

Documents.

a. Liquid Penetrant Inspection: ASTM E165.
b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Radiographic Inspection: ASTM E94, minimum quality level "2-2T."
d. Ultrasonic Inspection: ASTM E164.

D. Steel H piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.6 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off Owner's property.

END OF SECTION 31 62 16 00

Task	Specification	Specification Description
31 62 16 16	31 62 16 00	Steel Piles
31 62 16 19	31 62 16 00	Steel Piles

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SECTION 31 62 19 00 - TIMBER PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes round timber piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

    a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For timber piles. Show fabrication and installation details for piles, including details of driving shoes, tips or boots, and pile butt protection.

1. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Round timber pile treatment data as follows, including chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material:

1. For each type of preservative-treated timber product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to Project site.

C. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

D. Static Pile Test Reports: Submit within three days of completing each test.

E. Pile-Driving Records: Submit within three days of driving each pile.

F. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile driving completion.

G. Field quality-control reports.

H. Material Certificates: For preservative-treated piles. Indicate type of preservative used and net amount of preservative retained.

I. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][.]

a. Procedure B, Maintained Test.
b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent breaks, cuts, abrasions, or other physical damage and as required by AWPA M4.

1. Do not drill holes or drive spikes or nails into pile below cutoff elevation.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 TIMBER PILES

A. Round Timber Piles: ASTM D25, unused, clean peeled, one piece from butt to tip; of the following species and size basis:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Species: [**Coastal Douglas fir**][**Southern yellow pine**]<**Insert species**>.
3. Size Basis: [**Butt circumference**][**Class A**][**Class B**][**Tip circumference**][**8-inch (203-mm) tip and natural taper**].

B. Pressure-treat round timber piles according to AWPA U1 as follows:

1. Service Condition: [**UC4C Ground Contact, Extreme Duty**][**UC5A Marine Use Northern Waters**][**UC5B Marine Use Central Waters**][**UC5C Marine Use Southern Waters**]
2. Treatment: [**Waterborne preservative**][**Creosote or creosote solution**][**Oil-borne preservative**][**Waterborne preservative, creosote or creosote solution, or oil-borne preservative**][**Waterborne preservative, severe marine borer hazard**][**Dual treatment consisting of waterborne preservative, followed by creosote or creosote solution**]<**Insert treatment**>.

2.2 PILE ACCESSORIES

A. Driving Shoes: Fabricate from ASTM A1011/A1011M, hot-rolled carbon-steel strip to suit pile-tip diameter, of the following type and thickness, and secure to pile tip so as to not affect pile alignment during driving:

1. Type: [**Flat boot**][**Arrow point**].
2. Thickness: [**3/16 inch (4.8 mm)**][**1/4 inch (6 mm)**].

2.3 FABRICATION

A. Pile Tips: Cut and shape pile tips to accept driving shoes. Fit and fasten driving shoes to pile tips according to manufacturer's written instructions.

B. Pile Butt: Trim pile butt and cut perpendicular to longitudinal axis of pile. Chamfer and shape butt to fit tightly to driving cap of hammer.

C. Field-Applied Wood Preservative: Treat field cuts, holes, and other penetrations according to AWPA M4.

1. Coal-tar roofing cement for treating drilled holes or sealing cutoffs shall be free of asbestos.

D. Pile Splices: Splices are not permitted.

E. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Spudding: Drive spud piles through overlying highly resistant strata or obstructions and withdraw for reuse.

C. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

D. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.

3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

G. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place and install new piles in locations as directed by Architect.

H. Cut off butts of driven piles square with pile axis and at elevations indicated.

1. Cover cut-off piling surfaces with [**caps overlapping pile end by minimum 2 inches (51 mm)**][**minimum three coats of preservative treatment**] according to AWPA M4.

I. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile species.
4. Pile location in pile group and designation of pile group.
5. Sequence of driving in pile group.
6. Pile dimensions.
7. Ground elevation.
8. Elevation of tips after driving.
9. Final tip and cutoff elevations of piles after driving pile group.
10. Records of redriving.
11. Elevation of splices.
12. Type, make, model, and rated energy of hammer.
13. Weight and stroke of hammer.
14. Type of pile-driving cap used.
15. Cushion material and thickness.
16. Actual stroke and blow rate of hammer.
17. Pile-driving start and finish times, and total driving time.
18. Time, pile-tip elevation, and reason for interruptions.
19. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
20. Pile deviations from location and plumb.
21. Preboring, jetting, or special procedures used.
22. Unusual occurrences during pile driving.

J. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 31 62 19 00

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SECTION 31 62 23 00 - COMPOSITE PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete-filled [**steel-shell**][**steel pipe**] piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles indicated from tip to cutoff, plus not less than **12 inches (305 mm)** of overlength for cutting piles at cutoff elevations.

B. Work of this Section is affected as follows:

1. Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest **12 inches (305 mm)**.

   a. Additional payment for splices required to extend pile lengths in excess of that indicated is calculated at unit prices stated in the Contract.

2. Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for furnishing, driving, cutting off, capping, and disposing of cutoffs.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles driven out of tolerance, defective piles, or piles damaged during handling or driving.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For composite piles. Show fabrication and installation details for piles, including splices and tip details.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Indicate locations, sizes, type, and arrangement of reinforcement.
3. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**professional engineer**][**and**][**testing agency**].

B. Welding certificates.

C. Design Mixes: For each concrete mix. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Material Certificates: For [**steel-shell piles and accessories**][**steel pipe piles and accessories**][**steel reinforcement**][**and**][**concrete admixtures**].

E. Material Test Reports: For concrete materials.

F. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

1. Include mandrel type and details.

G. Static Pile Test Reports: Submit within three days of completing each test.

H. Pile-Driving Records: Submit within three days of driving each pile.

I. Certified Piles Survey: Submit within [**seven**]<**Insert number**> days of pile-driving completion.

J. Field quality-control reports.

K. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.7 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load

of piles.

1. Furnish test piles [**60 inches (1524 mm)**]<**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**]<**Insert number**> days to elapse after driving test piles before starting pile testing.
2. Number of Test Piles: [**One pile**][**As indicated**]<**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**]<**Insert load**>.

F. Approval Criteria: Allowable load is to be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]<**Insert value**>:

1. Net settlement, after deducting rebound, of not more than **0.01 inch/ton (0.25 mm/907 kg)** of test load.
2. Total settlement exceeds the pile elastic compression by **0.15 inch (4 mm)**, plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile[**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent physical damage.

1. Painted Piles: Protect finish and touch up damage before driving piles.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**][**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL-SHELL PILES

A. Fluted Pile Shells: Manufacturer's standard, vertically fluted, pile shells; cold formed from steel sheet; **50,000-psi (345-MPa)** minimum yield strength after forming. Fabricate watertight, uniformly tapered sections with forged-steel conical nose welded to tip.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Monotube Pile Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Monotube Pile Corporation**]
   b. <**Insert manufacturer's name**>

3. Constant Diameter Extensions: Fabricate with splice overlap capable of telescoping into tapered section.
4. Taper: [**0.14 inch in 12 inches (1:86)**][**0.25 inch in 12 inches (1:48)**][**0.40 inch in 12 inches (1:30)**].
5. Thickness: [**0.150 inch (3.80 mm)**][**0.179 inch (4.55 mm)**][**0.209 inch (5.31 mm)**][**0.239 inch (6.07 mm)**].

B. Helically Corrugated Pile Shells: Manufacturer's standard, helically corrugated, uniform-diameter, steel sheet shell piles; of enough strength and thickness to remain watertight and resist distortion and buckling due to soil pressure, internal mandrel operation, or redriving. Fabricate in one-piece lengths with minimum **3/16-inch- (4.76-mm-)** thick steel-plate boot continuously welded to tip and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Contech Engineered Solutions LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Contech Engineered Solutions LLC**]
b. <**Insert manufacturer's name**>

3. Nominal Diameter: [**8-5/8 inches (219 mm)**][**10-5/8 inches (270 mm)**][**11-1/8 inches (283 mm)**][**12-1/4 inches (311 mm)**][**14 inches (350 mm)**][**16-1/8 inches (410 mm)**].
4. Thickness: [**0.048 inch (1.21 mm)**, **minimum**][**0.060 inch (1.52 mm)**, **minimum**][**0.075 inch (1.90 mm)**, **minimum**][**0.105 inch (2.66 mm)**]<**Insert dimension**>.

2.2 STEEL PIPE PILES

A. Steel Pipe: ASTM A252, [**Grade 2**][**Grade 3**]; seamless or welded.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**]; deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 60 (Grade 420)**][**ASTM A706/A706M**]; deformed.

E. Plain and Deformed Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

F. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**][**deformed**].

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

1. Fly Ash: ASTM C618, Class C or F.
2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

B. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type I (PM), pozzolan-modified portland**][**Type I (SM), slag-modified portland**] cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded, **3/4-inch (19-mm)** maximum aggregate size. Provide aggregates from a single source.

D. Water: Potable, complying with ASTM C94/C94M requirements.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent chloride ions by mass of cementitious material.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.5 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard 60-degree conical driving point, with integral reinforcing ribs, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

B. Inside Cutting Shoes: Manufacturer's standard, inside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

C. Outside Cutting Shoes: Manufacturer's standard, outside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 65-35 (Grade 450-240)**, **heat treated**][**or**][**Grade N1**].
2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 80-40 (Grade 550-275)**][**or**][**Grade 90-60 (Grade 620-415)**].

D. Splice Coupling: Manufacturer's standard splice coupling, rolled from ASTM A36/A36M, carbon-steel bar or cast from heat-treated carbon steel, ASTM A27/A27M, **Grade 65-35 (Grade 450-240)**, with interior stop and internally tapered for friction fit driving.

2.6 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**][**red**][**manufacturer's standard color**].

2.7 CONCRETE MIXES

A. Prepare concrete design mixes according to ACI 301, determined by either laboratory trial batch or field test data basis.

1. Use a qualified testing agency for preparing and reporting proposed mix designs determined by laboratory trial batch.

B. Proportion mixes according to ACI 301 to provide normal-weight concrete suitable for piles with the

following properties:

1. Compressive Strength (28 Days): [**5000 psi (34.5 MPa)**][**4000 psi (27.6 MPa)**][**3000 psi (20.7 MPa)**]<**Insert value**>.
2. Maximum Water-Cementitious Material Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**5 inches (127 mm)**][**8 inches (203 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**][**2.5 to 4.5**] percent.

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

E. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

F. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from Architect of proposed changes to concrete-mix proportions.

2.8 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Fabricate full-length piles to eliminate splicing during driving.

C. Fabricate full-length piles by splicing pile lengths together. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Coupling: Fit splice coupling into position and weld to adjoining steel pipe pile sections according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
2. Welded Splices, Steel Pipe Piles: Accurately mill meeting ends of steel pipe piles, and bevel for welding. Continuously weld pile according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
3. Welded Splices, Steel-Shell Piles: Continuously weld steel-shell pile according to manufacturer's written instructions and AWS D1.1/D1.1M[**and AWS D1.3/D1.3M**] for procedures, appearance and quality of welds, and methods used in correcting welding work.
4. Splice piles during fabrication or field installation.

D. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

E. Fit and weld cutting shoes to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

F. Pile-Length Markings: Mark each pile with horizontal lines at **12-inch (305-mm)** intervals; label the distance from pile tip at **60-inch (1524-mm)** intervals. Maintain markings on piles until driven.

2.9 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of **60 inches (1524 mm)** below [**finished grade**][**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, and remove spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than **8 mils (0.2 mm)**.

1. Apply second coat to provide a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a two-coat paint system thickness of not less than **16 mils (0.4 mm)**.
2. Apply second and third coats with each coat having a dry film thickness of not less than **8 mils (0.2 mm)**, resulting in a three-coat paint system thickness of not less than **24 mils (0.6 mm)**.
3. Mark pile lengths after shop painting.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C94/C94M.

1. Do not add water to concrete mix after mixing.
2. Maintain concrete temperature to not exceed **90 deg F (32 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of **6 to 12 inches (152 to 305 mm)** above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

D. Mandrel: Expandable mandrel, capable of distributing driving energy throughout length of steel-shell pile.

3.3 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcement cages symmetrically about axis of pile [**shell**][**pipe**] in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover on reinforcement.

E. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Do not place concrete until other piles within a radius of [**20 feet (6 m)**]<**Insert value**> have been driven and approved.

B. Inspection: Before placing concrete, allow testing and inspecting agency to visually inspect and verify that each pile [**shell**][**pipe**] is clean, watertight, plumb, and free of distortion or other defects.

C. Place concrete in a continuous operation and without segregation immediately after cleaning out pile [**shell**][**pipe**].

D. Place concrete by means of bottom discharge bucket, flexible drop chute, or steep-sided funnel hopper or tremie or pump concrete into place.

E. Place concrete in a dry pile [**shell**][**pipe**] unless placement underwater is approved by Architect.

1. Place concrete underwater by tremie method or pumping. Control placement operations to ensure tremie is embedded no less than **60 inches (1524 mm)** into concrete, and flow of tremied concrete is continuous from bottom to top of pile [**shell**][**pipe**].
2. Other methods of depositing concrete may be used if approved by Architect.

F. Consolidate final **10 feet (3 m)** of concrete during placement to ensure that concrete is thoroughly worked around steel reinforcement and into corners.

G. Screed concrete level at cutoff elevation and apply a scoured, rough finish.

3.5 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated[**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: **4 inches (102 mm)** from location indicated after initial driving, and **6 inches (152 mm)** after pile driving is completed.
2. Plumb: Maintain **1 inch (25 mm)** in **48 inches (1219 mm)** from vertical, or a maximum of **4 inches (102 mm)**, measured when pile is aboveground in leads.
3. Batter Angle: Maximum **1 inch (25 mm)** in **48 inches (1219 mm)** from required angle, measured when pile is aboveground in leads.

F. Excavation: Clean out steel pipe pile by removing soil and debris from inside pile before placing steel reinforcement or concrete.

G. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding **72 inches (1830 mm)**.
2. Fill holes left by withdrawn piles as directed by Architect.

H. Abandon and cut off rejected piles as directed by Architect. Leave rejected piles in place, and install new piles in locations as directed by Architect.

I. Cut off tops of driven piles square with pile axis and at elevations indicated.

J. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every **12 inches (305 mm)** of penetration, and number of blows per **1 inch (25 mm)** for the last **6 inches (152 mm)** of driving.
19. Pile deviations from location and plumb.
20. Preboring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**][**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring is to be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**][**3 percent of**]<**Insert number or percent of**> piles.
2. Low-strain integrity measurement is to be performed and reported for each pile.
3. Weld Testing: In addition to visual inspection, welds are to be tested and inspected according to AWS D1.1/D1.1M and the inspection procedures listed in subparagraphs below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

   a. Liquid Penetrant Inspection: ASTM E165.
   b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   c. Radiographic Inspection: ASTM E94; minimum quality level "2-2T."
   d. Ultrasonic Inspection: ASTM E164.

4. Concrete: Sampling and testing of concrete for quality control is to include the following:

   a. Sampling Fresh Concrete: ASTM C172/C172M, except modified for slump to comply with ASTM C94/C94M.

      1) Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
      2) Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (5 deg C)** and below or when **80 deg F (27 deg C)** and above, and one test for each set of compressive-strength specimens.
      3) Compression Test Specimens: ASTM C31/C31M; one set of [**four**]<**Insert number**> standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
      4) Compressive-Strength Tests: ASTM C39/C39M; one set for each truck load. One specimen is to be tested at seven days, two specimens are to be tested at 28 days, and one specimen is to be retained in reserve for later testing if required.

   b. When frequency of testing provides fewer than five strength tests for a given class of concrete, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   c. When strength of field-cured cylinders is less than 85 percent of companion laboratory-

cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.

d. Strength level of concrete is considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than **500 psi (3.45 MPa)**.

e. Test results are to be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests are to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in piles, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

f. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but is not to be used as sole basis for acceptance or rejection.

g. Additional Tests: Testing and inspecting agency is to make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

D. Concrete-filled steel piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.8 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off Owner's property.

END OF SECTION 31 62 23 00

Task	Specification	Specification Description
31 62 23 13	31 62 23 00	Composite Piles

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Task	Specification	Specification Description
32 01 11 53	07 18 00 00	Traffic Coatings
32 01 11 53	32 12 16 00	Asphalt Paving
32 01 11 53	32 13 13 00	Concrete Paving
32 01 13 61	32 12 16 00	Asphalt Paving
32 01 16 74	32 12 16 00	Asphalt Paving
32 01 17 61	32 12 16 00	Asphalt Paving
32 01 17 63	32 12 16 00	Asphalt Paving
32 12 13 13	32 12 16 00	Asphalt Paving
32 12 13 19	32 12 16 00	Asphalt Paving

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SECTION 32 12 16 00 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.
5. Asphalt curbs.
6. Asphalt traffic-calming devices.
7. Asphalt surface treatments.

B. Related Requirements:

1. [**Section 024116 "Structure Demolition"**][**and**][**Section 024119 "Selective Demolition"**] for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
5. Section 321400 "Unit Paving" for bituminous setting bed for pavers and for stone and precast concrete curbs.

1.2 UNIT PRICES

A. Work of this Section is affected by <**Insert name of unit price**>.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

   a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Herbicide.
2. Paving geotextile.
3. Joint sealant.

B. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
2. For each hot-mix asphalt design proposed for the Work.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Geotextile: **12 by 12 inches (300 by 300 mm)** minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**paving-mix manufacturer**][**and**][**testing agency**].

B. Material Certificates:[**Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.**]

1. Aggregates.
2. Asphalt binder.
3. Asphalt cement.
4. Cutback prime coat.
5. Emulsified asphalt prime coat.
6. Tack coat.
7. Fog seal.
8. Undersealing asphalt.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: [**A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located**]<**Insert requirement**>.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <**Insert applicable standards**> of <**Insert name of state or local DOT**> for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of **60 deg F (15.6 deg C)**.
2. Tack Coat: Minimum surface temperature of **60 deg F (15.6 deg C)**.
3. Slurry Coat: Comply with weather limitations in ASTM D3910.
4. Asphalt Base Course[**and Binder Course**]: Minimum surface temperature of **40 deg F (4.4 deg C)** and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of **60 deg F (15.6 deg C)** at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: [**ASTM D1073**][**or**][**AASHTO M 29**], sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: [**ASTM D242/D242M**][**or**][**AASHTO M 17**], rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: [**ASTM D6373**][**or**][**AASHTO M 320**] binder designation [**PG 58-28**][**PG 64-22**][**PG 70-22**]<**Insert performance grade**>.

B. Asphalt Cement: [**ASTM D3381/D3381M for viscosity-graded material**][**ASTM D946/D946M for penetration-graded material**].

C. Cutback Prime Coat: ASTM D2027/D2027M, medium-curing cutback asphalt, [**MC-30 or MC-70**][**MC-250**].

D. Emulsified Asphalt Prime Coat: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM D2397/D2397M**][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM D2397/D2397M**][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Fog Seal: [**ASTM D977**][**or**][**AASHTO M 140**] emulsified asphalt, or [**ASTM**

D2397/D2397M][**or**][**AASHTO M 208**] cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

G. Water: Potable.

H. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled [**tires**][**asphalt shingles**][**or**][**glass**] from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: [**ASTM D1073**][**or**][**AASHTO M 29**], Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D6690, [**Type I**][**Type II or III**][**Type IV**], hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**10**][**20**][**40**]<**Insert value**> percent or more than [**15**][**25**][**50**]<**Insert value**> percent by weight.

1. Surface Course Limit: Recycled content no more than [**10**]<**Insert number**> percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes [**approved by authorities having jurisdiction**][**; designed in accordance with procedures in AI MS-2, "Asphalt Mix Design Methods";**] and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: <**Insert mix designation**>.
3. Binder Course: <**Insert mix designation**>.
4. Surface Course: <**Insert mix designation**>.

C. Emulsified-Asphalt Slurry: ASTM D3910, [**Type 1**][**Type 2**][**Type 3**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction[**, repeating proof-rolling in direction perpendicular to first direction**]. Limit vehicle speed to **3 mph (5 km/h)**.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**>.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than **1 inch (25 mm)** after milling, before wearing course is laid.
7. Handle milled asphalt material in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending **12 inches (300 mm)** into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than **1 inch (25 mm)** in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding **3 inches (75 mm)** thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of [**1/4 inch (6 mm)**]<**Insert dimension**>.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than **1/4 inch (6 mm)** wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than **1/4 inch (6 mm)** wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of **0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m)**. Apply enough material to penetrate and seal, but

not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of **0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth)**. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 INSTALLATION OF PAVING GEOTEXTILE

A. Apply [**tack coat**][**asphalt binder**][**asphalt cement**] uniformly to existing pavement surfaces at a rate of **0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m)**.

B. Place paving geotextile promptly in accordance with manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints **4 inches (100 mm)** and transverse joints **6 inches (150 mm)**.

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.8 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course[**and binder course**] in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of **250 deg F (121 deg C)**.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than **10 feet (3 m)** wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap

previous strips. Overlap mix placement about **1 to 1-1/2 inches (25 to 38 mm)** from strip to strip to ensure proper compaction of mix along longitudinal joints.

2. Complete a section of asphalt base course[**and binder course**] before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.9 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of **6 inches (150 mm)**.
3. Offset transverse joints, in successive courses, a minimum of **24 inches (600 mm)**.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints [**using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."**][**as indicated on Drawings.**]<**Insert joint requirement.**>
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.10 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to **185 deg F (85 deg C)**.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with [**ASTM D6927**][**or**][**AASHTO T 245**], but not less than 94 percent or greater than 100 percent.
2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of **250 deg F (121 deg C)**.

1. Hot-Mix Asphalt: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 ASPHALT TRAFFIC-CALMING DEVICES

A. Construct hot-mix asphalt speed [**bumps**][**humps**][**cushions**][**and**][**tables**] over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of **250 deg F (121 deg C)**.

1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m)**.
2. Hot-Mix Asphalt: Same as pavement surface-course mix.
3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of **1 inch (25 mm)** from top of pavement to a clean, rough profile.

B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.13 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course[**and Binder Course**]: Plus or minus **1/2 inch (13 mm)**.
2. Surface Course: Plus **1/4 inch (6 mm)**, no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a **10-foot (3-m)** straightedge applied transversely or longitudinally to paved areas:

1. Base Course[**and Binder Course**]: [**1/4 inch (6 mm)**]<**Insert dimension**>.
2. Surface Course: [**1/8 inch (3 mm)**]<**Insert dimension**>.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is **1/4 inch (6 mm)**.

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to the shapes indicated and within a tolerance of plus or minus **1/8 inch (3 mm)** of height indicated above pavement surface.

3.14 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of **0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m)** to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness in accordance with ASTM D3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with [**ASTM D979/D979M**][**or**][**AASHTO T 168**].

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.

a. One core sample will be taken for every **1000 sq. yd. (836 sq. m)** or less of installed pavement, with no fewer than three cores taken.
b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.16 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 32 12 16 00

Task	Specification	Specification Description
32 12 16 13	32 12 16 00	Asphalt Paving
32 12 16 19	32 12 16 00	Asphalt Paving
32 12 16 39	32 12 16 00	Asphalt Paving
32 12 16 43	32 12 16 00	Asphalt Paving
32 12 33 00	32 12 16 00	Asphalt Paving
32 12 36 13	32 12 16 00	Asphalt Paving
32 12 36 16	32 12 16 00	Asphalt Paving
32 12 73 00	32 13 13 00	Concrete Paving

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SECTION 32 13 13 00 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving[**.**][**including the following:**]

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321316 "Decorative Concrete Paving" for stamped concrete other than stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
4. Section 321713 "Parking Bumpers."
5. Section 321716 "Manufactured Traffic-Calming Devices."
6. Section 321723 "Pavement Markings."
7. Section 321726 "Tactile Warning Surfacing" for detectable warning [**tiles**][**mats**][**and**][**pavers**].

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

   a. Concrete mixture design.
   b. Quality control of concrete materials and concrete paving construction practices.
   c. <**Insert agenda item**>.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete manufacturer.
d. Concrete paving Subcontractor.
e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.
12. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: [**10-lb (4.5-kg)**]<**Insert weight**> Sample of each mix.

E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**Installer of stamped detectable warnings**][**ready-mix concrete manufacturer**][**and**][**testing agency**].

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.

3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates:[**Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.**]

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [**96 inches (2400 mm) by 96 inches (2400 mm)**]<**Insert dimensions**>.[**Include full-size detectable warning.**]
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below **40 deg F (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F (10 deg C)** and not more than **80 deg F (27 deg C)** at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with **ACI 301 (ACI 301M)** and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F (32 deg C)** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[**, steel reinforcement,**] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of **100 feet (30.5 m)** or less.[**Do not use notched and bent forms.**]

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**]<**Insert value**> percent.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from [**as-**

drawn][**galvanized-**]steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

D. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

F. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.

G. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.

H. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A1064/A1064M, [**as drawn**][**galvanized**].

J. Deformed-Steel Wire: ASTM A1064/A1064M.

K. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, [**plain**][**deformed**].

L. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars[**; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating**]. Cut bars true to length with ends square and free of burrs.

M. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars.

N. Tie Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

O. Hook Bolts: **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

P. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

R. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from

aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, [**gray**][**white**] portland cement [**Type I**][**Type II**][**Type I/II**][**Type III**][**Type V**].
2. Fly Ash: ASTM C618, [**Class C**][**or**][**Class F**].
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, Portland-limestone**][**Type IT, ternary blended**] cement.

G. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded. Provide aggregates from a single source[**with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**] nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

H. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: [**3/4 to 1 inch (19 to 25 mm)**][**1/2 to 3/4 inch (13 to 19 mm)**][**3/8 to 5/8 inch (10 to 16 mm)**]<**Insert dimensions**> nominal.
2. Aggregate Source, Shape, and Color: <**Insert requirements**>.

I. Air-Entraining Admixture: ASTM C260/C260M.

J. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

K. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alabama Pigments Company, LLC**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]
   d. [**Butterfield Color, Inc.**]
   e. [**Dynamic Color Solutions, Inc**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Hoover Color Corporation**]
   h. [**Lambert Corporation**]
   i. [**Lanxess Corporation**]
   j. [**Matcrete Inc.**]
   k. [**NewLook International, Inc.**]
   l. [**Proline Concrete Tools, Inc.**]
   m. [**QC Construction Products**]
   n. [**Scofield, a Business Unit of Sika Corporation**]
   o. [**Solomon Colors Inc.**]
   p. [**Stampcrete International, Ltd**]
   q. [**SureCrete Design Products, a Fenix Group SPC Company**]
   r. [**Venator Materials PLC**]
   s. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Alabama Pigments Company, LLC**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]
   d. [**Butterfield Color, Inc.**]
   e. [**Dynamic Color Solutions, Inc**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Hoover Color Corporation**]
   h. [**Lambert Corporation**]
   i. [**Lanxess Corporation**]
   j. [**Matcrete Inc.**]
   k. [**NewLook International, Inc.**]
   l. [**Proline Concrete Tools, Inc.**]
   m. [**QC Construction Products**]
   n. [**Scofield, a Business Unit of Sika Corporation**]
   o. [**Solomon Colors Inc.**]
   p. [**Stampcrete International, Ltd**]
   q. [**SureCrete Design Products, a Fenix Group SPC Company**]
   r. [**Venator Materials PLC**]
   s. **<Insert manufacturer's name>**

3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]**<Insert color>**.

L. Water: Potable and complying with ASTM C94/C94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber, Monofilament Fibers: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**FORTA Corporation**]
   c. [**FullForce by ABC Polymer Industries, LLC**]
   d. [**GCP Applied Technologies Inc.**]
   e. [**Nycon Corporation**]
   f. [**Propex Operating Company, LLC**]
   g. [**Sika Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**FORTA Corporation**]
   c. [**FullForce by ABC Polymer Industries, LLC**]
   d. [**GCP Applied Technologies Inc.**]
   e. [**Nycon Corporation**]
   f. [**Propex Operating Company, LLC**]
   g. [**Sika Corporation**]
   h. <**Insert manufacturer's name**>

B. Synthetic Fiber, Fibrillated Fibers: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   b. [**FORTA Corporation**]
   c. [**FullForce by ABC Polymer Industries, LLC**]
   d. [**GCP Applied Technologies Inc.**]
   e. [**Nycon Corporation**]
   f. [**Propex Operating Company, LLC**]
   g. [**Sika Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, [**Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry**][**or**][**cotton mats**].

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Master Builders Solutions**]
j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**Sika Corporation**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]

e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Master Builders Solutions**]
j. [**Metalcrete Industries**]
k. [**Nox-Crete Products Group**]
l. [**Sika Corporation**]
m. [**SpecChem, LLC**]
n. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
o. [**Vexcon Chemicals Inc.**]
p. [**W. R. Meadows, Inc**]
q. **<Insert manufacturer's name>**

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Nox-Crete Products Group**]
i. [**Right Pointe**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Unitex; a Brand of Dayton Superior Corporation**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Nox-Crete Products Group**]
i. [**Right Pointe**]
j. [**SpecChem, LLC**]
k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
l. [**Unitex; a Brand of Dayton Superior Corporation**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]

o. **<Insert manufacturer's name>**

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**ChemMasters, Inc**]
   c. [**Dayton Superior Corporation**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**Kaufman Products, Inc**]
   f. [**Lambert Corporation**]
   g. [**Laticrete International, Inc.**]
   h. [**SpecChem, LLC**]
   i. [**Vexcon Chemicals Inc.**]
   j. [**W. R. Meadows, Inc**]
   k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Anti-Hydro International, Inc**]
   b. [**ChemMasters, Inc**]
   c. [**Dayton Superior Corporation**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**Kaufman Products, Inc**]
   f. [**Lambert Corporation**]
   g. [**Laticrete International, Inc.**]
   h. [**SpecChem, LLC**]
   i. [**Vexcon Chemicals Inc.**]
   j. [**W. R. Meadows, Inc**]
   k. **<Insert manufacturer's name>**

2.7 RELATED MATERIALS

A. Joint Fillers: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**ASTM D1752, cork or self-expanding cork**][**or**][**ASTM D8139, semirigid, closed-cell polypropylene foam**] in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or

freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of **1/8 to 1/4 inch (3 to 6 mm)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ChemMasters, Inc**]
   b. [**Dayton Superior Corporation**]
   c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   d. [**Kaufman Products, Inc**]
   e. [**Nox-Crete Products Group**]
   f. [**QC Construction Products**]
   g. [**Scofield, a Business Unit of Sika Corporation**]
   h. [**Sika Corporation**]
   i. [**SpecChem, LLC**]
   j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
   k. [**Vexcon Chemicals Inc.**]
   l. [**W. R. Meadows, Inc**]
   m. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ChemMasters, Inc**]
   b. [**Dayton Superior Corporation**]
   c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   d. [**Kaufman Products, Inc**]
   e. [**Nox-Crete Products Group**]
   f. [**QC Construction Products**]
   g. [**Scofield, a Business Unit of Sika Corporation**]
   h. [**Sika Corporation**]
   i. [**SpecChem, LLC**]
   j. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
   k. [**Vexcon Chemicals Inc.**]
   l. [**W. R. Meadows, Inc**]
   m. **<Insert manufacturer's name>**

F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anti-Hydro International, Inc**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]

d. [**Butterfield Color, Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Decosup Inc.**]
g. [**Dynamic Color Solutions, Inc**]
h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Kaufman Products, Inc**]
k. [**Lambert Corporation**]
l. [**Laticrete International, Inc.**]
m. [**Metalcrete Industries**]
n. [**Proline Concrete Tools, Inc.**]
o. [**QC Construction Products**]
p. [**Scofield, a Business Unit of Sika Corporation**]
q. [**Specialty Concrete Products, Inc**]
r. [**Stampcrete International, Ltd**]
s. [**Super Stone, Inc.**]
t. [**SureCrete Design Products, a Fenix Group SPC Company**]
u. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Decosup Inc.**]
g. [**Dynamic Color Solutions, Inc**]
h. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Kaufman Products, Inc**]
k. [**Lambert Corporation**]
l. [**Laticrete International, Inc.**]
m. [**Metalcrete Industries**]
n. [**Proline Concrete Tools, Inc.**]
o. [**QC Construction Products**]
p. [**Scofield, a Business Unit of Sika Corporation**]
q. [**Specialty Concrete Products, Inc**]
r. [**Stampcrete International, Ltd**]
s. [**Super Stone, Inc.**]
t. [**SureCrete Design Products, a Fenix Group SPC Company**]
u. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing **3/8-inch (9.5-mm)** sieve and 85 percent retained on a **No. 8 (2.36-mm)** sieve.

2.8 STAMPED DETECTABLE WARNING MATERIALS

A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Surfaces Inc.**]
   b. [**Butterfield Color, Inc.**]
   c. [**Stampcrete International, Ltd**]
   d. [**Transpo Industries, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Surfaces Inc.**]
   b. [**Butterfield Color, Inc.**]
   c. [**Stampcrete International, Ltd**]
   d. [**Transpo Industries, Inc.**]
   e. <**Insert manufacturer's name**>

3. Size of Stamp: One piece, [**matching detectable warning area shown on Drawings**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1220 mm)**][**26 by 26 inches (660 by 660 mm)**][**26 by 36 inches (660 by 914 mm)**]<**Insert dimensions**>.

B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Surfaces Inc.**]
   b. [**Artcrete, Inc**]
   c. [**Bon Tool Co.**]
   d. [**Brickform; a division of Solomon Colors**]
   e. [**Butterfield Color, Inc.**]
   f. [**Decosup Inc.**]
   g. [**Matcrete Inc.**]
   h. [**Proline Concrete Tools, Inc.**]
   i. [**QC Construction Products**]
   j. [**Scofield, a Business Unit of Sika Corporation**]
   k. [**Specialty Concrete Products, Inc**]
   l. [**Stampcrete International, Ltd**]
   m. [**Super Stone, Inc.**]
   n. [**Venator Materials PLC**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Surfaces Inc.**]

b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. [**Venator Materials PLC**]
o. **<Insert manufacturer's name>**

2.9 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials:[**Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, **1-1/2-inch (38-mm)** Nominal Maximum Aggregate Size: [**5-1/2**][**4-1/2**][**2-1/2**] percent plus or minus 1-1/2 percent.
2. Air Content, **1-inch (25-mm)** Nominal Maximum Aggregate Size: [**6**][**4-1/2**][**3**] percent plus or minus 1-1/2 percent.
3. Air Content, **3/4-inch (19-mm)** Nominal Maximum Aggregate Size: [**6**][**5**][**3-1/2**] percent plus or minus 1-1/2 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use [**water-reducing admixture**][**high-range, water-reducing admixture**][**high-range, water-reducing and retarding admixture**][**plasticizing and retarding admixture**] in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [**1.0 lb/cu. yd. (0.60 kg/cu. m)**][**1.5 lb/cu. yd. (0.90 kg/cu. m)**]<**Insert requirement**>.

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

H. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): [**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**]<**Insert strength**>.
2. Maximum W/C Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**4 inches (100 mm)**][**5 inches (125 mm)**][**8 inches (200 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.
4. Solar Reflectance Index: Not less than 29.
5. Solar Reflectance (SR): Three-year-aged SR value of at least 0.28 or initial SR of at least 0.33.
6. Solar Reflectance (SR): At least 0.30.
7. Solar Reflectance Index: At least 25.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**]. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below [**concrete paving**]<**Insert locations**> to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction[**and repeat in perpendicular direction**]. Limit vehicle speed to **3 mph (5 km/h)**.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [**1/2 inch (13 mm)**]<**Insert dimension**> according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum **2-inch (50-mm)** overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless

otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use [**bonding agent**][**epoxy-bonding adhesive**] at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of [**50 feet (15.25 m)**]<**Insert dimension**> unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[**, to match jointing of existing adjacent concrete paving**]:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes.[**Eliminate grooving-tool marks on concrete surfaces.**]

   a. Tolerance: Ensure that grooved joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat tooling of edges after applying surface

finishes.[**Eliminate edging-tool marks on concrete surfaces.**]

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation[**, steel reinforcement,**] and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface[**and steel reinforcement**] before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with **ACI 301 (ACI 301M)** requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to **ACI 301 (ACI 301M)** by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[**, reinforcement,**] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating [**reinforcement**][**dowels**][**and**] joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of **1/16 inch (1.6 mm)**.

1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**][**40 lb/100 sq. ft. (19.5 kg/10 sq. m)**][**60 lb/100 sq. ft. (29 kg/10 sq. m)**]<**Insert rate of application**> of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial [**floating**][**troweling**][**brooming**], uniformly spread rock salt over paving surface at the rate of **5 lb/100 sq. ft. (0.2 kg/10 sq. m)**.

1. Embed rock salt into plastic concrete with [**roller**][**or**][**magnesium float**]<**Insert tool**>.
2. Cover paving surface with **1-mil- (0.025-mm-)** thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**]<**Insert rate of application**> unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply a hand-troweled finish followed by a broom finish.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 INSTALLATION OF DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."

1. Tolerance for Opening Size: [**Plus 1/4 inch (6 mm), no minus**]<**Insert requirement**>.

B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.

1. Before using stamp mats, verify that the vent holes are unobstructed.
2. Apply liquid release agent to the concrete surface and the stamp mat.
3. Stamping: [**While initially finished concrete is plastic**][**After application and final floating of pigmented mineral dry-shake hardener**], accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
4. Trimming: After [**24**]<**Insert number**> hours, cut off the tips of mortar formed by the vent holes.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h (1 kg/sq. m x h)** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by [**moisture curing**][**moisture-retaining-cover curing**][**curing compound**][**or**][**a combination of these**] as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with **12-inch (300-mm)** lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PAVING TOLERANCES

A. Comply with tolerances in **ACI 117 (ACI 117M)** and as follows:

1. Elevation: **3/4 inch (19 mm)**.
2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
3. Surface: Gap below **10-feet- (3-m-)** long; unleveled straightedge not to exceed **1/2 inch (13 mm)**.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: **1/2 inch per 12 inches (13 mm per 300 mm)** of tie bar.
5. Lateral Alignment and Spacing of Dowels: **1 inch (25 mm)**.
6. Vertical Alignment of Dowels: **1/4 inch (6 mm)**.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches (6 mm per 300 mm)** of dowel.
8. Joint Spacing: **3 inches (75 mm)**.
9. Contraction Joint Depth: Plus **1/4 inch (6 mm)**, no minus.
10. Joint Width: Plus **1/8 inch (3 mm)**, no minus.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each [**100 cu. yd. (76 cu. m)**][**5000 sq. ft. (465 sq. m)**] or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when it is **80 deg F (27 deg C)** and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than **500 psi (3.4 MPa)**.

D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete

bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13 00

Task	Specification	Specification Description
32 13 13 33	32 13 13 00	Concrete Paving
32 13 13 33	32 13 16 00	Decorative Concrete Paving

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SECTION 32 13 16 00 - DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Colored concrete paving.
2. Stamped concrete paving.
3. Stenciled concrete paving.
4. Stained concrete paving.

B. Related Requirements:

1. [**Section 033000 "Cast-in-Place Concrete"**][**Section 033053 "Miscellaneous Cast-in-Place Concrete"**] for general building applications of concrete.
2. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:

   a. Concrete mixture design.
   b. Quality control of concrete materials and decorative concrete paving construction practices.
   c. <**Insert agenda item**>.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Decorative concrete paving Installer.
   e. Manufacturer's representative of decorative concrete paving system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.

D. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

E. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**Installer**][**ready-mix concrete manufacturer**][**and**][**testing agency**].

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates.[**Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.**]

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [**96 inches (2400 mm) by 96 inches (2400 mm)**]<**Insert dimensions**>.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on decorative concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below **40 deg F (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F (10 deg C)** and not more than **80 deg F (27 deg C)** at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with **ACI 301 (ACI 301M)** and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F (32 deg C)** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[**, steel reinforcement,**] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves of a radius of **100 feet (30.5 m)** or less. [**Do not use notched and bent forms.**]

B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**60**]<**Insert value**> percent.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.

C. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.

D. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars; assembled with clips.

E. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.

F. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars. Cut bars true to length with ends square and free of burrs.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater

compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Concrete shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

G. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**gray**][**white**] portland cement [**Type I**][**Type II**][**Type I/II**][**Type III**][**Type V**].
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**][**Type IP, portland-pozzolan**][**Type IL, Portland-limestone**][**Type IT, ternary blended**] cement.

H. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**][**Class 4M**][**Class 1N**]<**Insert class**>, uniformly graded. Provide aggregates from a single source[**with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**][**1 inch (25 mm)**][**3/4 inch (19 mm)**]<**Insert dimension**> nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

I. Air-Entraining Admixture: ASTM C260/C260M.

J. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A[**, colored**].

2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D[**, colored**].
3. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.

K. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alabama Pigments Company, LLC**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]
   d. [**Butterfield Color, Inc.**]
   e. [**Dynamic Color Solutions, Inc**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Hoover Color Corporation**]
   h. [**Lambert Corporation**]
   i. [**Lanxess Corporation**]
   j. [**Matcrete Inc.**]
   k. [**NewLook International, Inc.**]
   l. [**Proline Concrete Tools, Inc.**]
   m. [**QC Construction Products**]
   n. [**Scofield, a Business Unit of Sika Corporation**]
   o. [**Solomon Colors Inc.**]
   p. [**Stampcrete International, Ltd**]
   q. [**SureCrete Design Products, a Fenix Group SPC Company**]
   r. [**Venator Materials PLC**]
   s. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Alabama Pigments Company, LLC**]
   b. [**Bon Tool Co.**]
   c. [**Brickform; a division of Solomon Colors**]
   d. [**Butterfield Color, Inc.**]
   e. [**Dynamic Color Solutions, Inc**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**Hoover Color Corporation**]
   h. [**Lambert Corporation**]
   i. [**Lanxess Corporation**]
   j. [**Matcrete Inc.**]
   k. [**NewLook International, Inc.**]
   l. [**Proline Concrete Tools, Inc.**]
   m. [**QC Construction Products**]
   n. [**Scofield, a Business Unit of Sika Corporation**]
   o. [**Solomon Colors Inc.**]
   p. [**Stampcrete International, Ltd**]
   q. [**SureCrete Design Products, a Fenix Group SPC Company**]
   r. [**Venator Materials PLC**]
   s. **<Insert manufacturer's name>**

L. Water: Potable and complying with ASTM C94/C94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber, Monofilament Fibers: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

B. Synthetic Fiber, Fibrillated Fibers: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**]<**Insert dimensions**> long.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**FORTA Corporation**]
c. [**FullForce by ABC Polymer Industries, LLC**]
d. [**GCP Applied Technologies Inc.**]
e. [**Nycon Corporation**]
f. [**Propex Operating Company, LLC**]
g. [**Sika Corporation**]
h. <**Insert manufacturer's name**>

2.6 SURFACE COLORING MATERIALS

A. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Anti-Hydro International, Inc**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
k. [**Kaufman Products, Inc**]
l. [**Lambert Corporation**]
m. [**Laticrete International, Inc.**]
n. [**Metalcrete Industries**]
o. [**Proline Concrete Tools, Inc.**]
p. [**QC Construction Products**]
q. [**Scofield, a Business Unit of Sika Corporation**]
r. [**Specialty Concrete Products, Inc**]
s. [**Stampcrete International, Ltd**]
t. [**Super Stone, Inc.**]
u. [**SureCrete Design Products, a Fenix Group SPC Company**]
v. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Anti-Hydro International, Inc**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]

f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
j. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
k. [**Kaufman Products, Inc**]
l. [**Lambert Corporation**]
m. [**Laticrete International, Inc.**]
n. [**Metalcrete Industries**]
o. [**Proline Concrete Tools, Inc.**]
p. [**QC Construction Products**]
q. [**Scofield, a Business Unit of Sika Corporation**]
r. [**Specialty Concrete Products, Inc**]
s. [**Stampcrete International, Ltd**]
t. [**Super Stone, Inc.**]
u. [**SureCrete Design Products, a Fenix Group SPC Company**]
v. **<Insert manufacturer's name>**

B. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**Dynamic Color Solutions, Inc**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Proline Concrete Tools, Inc.**]
k. [**QC Construction Products**]
l. [**Scofield, a Business Unit of Sika Corporation**]
m. [**Specialty Concrete Products, Inc**]
n. [**Stampcrete International, Ltd**]
o. [**Super Stone, Inc.**]
p. [**SureCrete Design Products, a Fenix Group SPC Company**]
q. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]

h. [**Dynamic Color Solutions, Inc**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**Proline Concrete Tools, Inc.**]
k. [**QC Construction Products**]
l. [**Scofield, a Business Unit of Sika Corporation**]
m. [**Specialty Concrete Products, Inc**]
n. [**Stampcrete International, Ltd**]
o. [**Super Stone, Inc.**]
p. [**SureCrete Design Products, a Fenix Group SPC Company**]
q. **<Insert manufacturer's name>**

C. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Artcrete, Inc**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Decosup Inc.**]
g. [**Matcrete Inc.**]
h. [**Proline Concrete Tools, Inc.**]
i. [**QC Construction Products**]
j. [**Scofield, a Business Unit of Sika Corporation**]
k. [**Specialty Concrete Products, Inc**]
l. [**Stampcrete International, Ltd**]
m. [**Super Stone, Inc.**]
n. **<Insert manufacturer's name>**

2.7 STAMPING DEVICES

A. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Matcrete Inc.**]
g. [**Proline Concrete Tools, Inc.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. [**Specialty Concrete Products, Inc**]
j. [**Stampcrete International, Ltd**]
k. [**Super Stone, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Bon Tool Co.**]
d. [**Brickform; a division of Solomon Colors**]
e. [**Butterfield Color, Inc.**]
f. [**Matcrete Inc.**]
g. [**Proline Concrete Tools, Inc.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. [**Specialty Concrete Products, Inc**]
j. [**Stampcrete International, Ltd**]
k. [**Super Stone, Inc.**]
l. <**Insert manufacturer's name**>

B. Stamp Tools: Open-grid, aluminum or rigid-plastic stamp tool capable of imprinting joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Matcrete Inc.**]
b. [**Scofield, a Business Unit of Sika Corporation**]
c. [**Super Stone, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Matcrete Inc.**]
b. [**Scofield, a Business Unit of Sika Corporation**]
c. [**Super Stone, Inc.**]
d. <**Insert manufacturer's name**>

C. Rollers: Manually controlled, water-filled aluminum rollers with projecting ridges on drum capable of imprinting texture and joint patterns on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. <**Insert manufacturer's name**>

D. Texture Rollers: Manually controlled, abrasion-resistant polyurethane rollers capable of imprinting texture on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Butterfield Color, Inc.**]
d. [**Proline Concrete Tools, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Butterfield Color, Inc.**]
d. [**Proline Concrete Tools, Inc.**]
e. <**Insert manufacturer's name**>

2.8 STENCIL MATERIALS

A. Stencils: Manufacturer's standard, moisture-resistant paper or reusable plastic stencils, designed for use on plastic concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Specialty Concrete Products, Inc**]
f. [**SureCrete Design Products, a Fenix Group SPC Company**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Artcrete, Inc**]
b. [**Bon Tool Co.**]
c. [**Brickform; a division of Solomon Colors**]
d. [**Butterfield Color, Inc.**]
e. [**Specialty Concrete Products, Inc**]
f. [**SureCrete Design Products, a Fenix Group SPC Company**]
g. <**Insert manufacturer's name**>

2.9 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]
p. **<Insert manufacturer's name>**

B. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]
h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]
h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]
k. **<Insert manufacturer's name>**

2.10 CURING AND SEALING MATERIALS

A. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C171.

B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Sika Corporation**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]
p. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Bon Tool Co.**]
b. [**Brickform; a division of Solomon Colors**]
c. [**ChemMasters, Inc**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**Lambert Corporation**]
h. [**Laticrete International, Inc.**]
i. [**Metalcrete Industries**]
j. [**Nox-Crete Products Group**]
k. [**Sika Corporation**]
l. [**SpecChem, LLC**]
m. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
n. [**Vexcon Chemicals Inc.**]
o. [**W. R. Meadows, Inc**]
p. **<Insert manufacturer's name>**

C. Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, nondissipating, non-yellowing, manufactured for use with colored concrete.

1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.

2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Anti-Hydro International, Inc**]
    b. [**ChemMasters, Inc**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**Lambert Corporation**]
    g. [**Laticrete International, Inc.**]
    h. [**Metalcrete Industries**]
    i. [**Nox-Crete Products Group**]
    j. [**SpecChem, LLC**]
    k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
    l. [**Vexcon Chemicals Inc.**]
    m. [**W. R. Meadows, Inc**]
    n. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Anti-Hydro International, Inc**]
    b. [**ChemMasters, Inc**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**Lambert Corporation**]
    g. [**Laticrete International, Inc.**]
    h. [**Metalcrete Industries**]
    i. [**Nox-Crete Products Group**]
    j. [**SpecChem, LLC**]
    k. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
    l. [**Vexcon Chemicals Inc.**]
    m. [**W. R. Meadows, Inc**]
    n. <**Insert manufacturer's name**>

D. High-Solids, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, non-yellowing, manufactured for use with colored concrete.

1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ChemMasters, Inc**]
    b. [**Dayton Superior Corporation**]
    c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    d. [**Kaufman Products, Inc**]

e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Metalcrete Industries**]
h. [**Nox-Crete Products Group**]
i. [**SpecChem, LLC**]
j. [**V-Seal Concrete Sealers & Specialty Coatings**]
k. [**Vexcon Chemicals Inc.**]
l. [**W. R. Meadows, Inc**]
m. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**Lambert Corporation**]
f. [**Laticrete International, Inc.**]
g. [**Metalcrete Industries**]
h. [**Nox-Crete Products Group**]
i. [**SpecChem, LLC**]
j. [**V-Seal Concrete Sealers & Specialty Coatings**]
k. [**Vexcon Chemicals Inc.**]
l. [**W. R. Meadows, Inc**]
m. <**Insert manufacturer's name**>

E. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A, manufactured for use with colored concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]
o. **<Insert manufacturer's name>**

3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A, manufactured for use with colored concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Concrete Sealers USA**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**Lambert Corporation**]
g. [**Laticrete International, Inc.**]
h. [**Metalcrete Industries**]
i. [**Nox-Crete Products Group**]
j. [**Right Pointe**]
k. [**SpecChem, LLC**]
l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
m. [**Vexcon Chemicals Inc.**]
n. [**W. R. Meadows, Inc**]

o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ChemMasters, Inc**]
   b. [**Concrete Sealers USA**]
   c. [**Dayton Superior Corporation**]
   d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   e. [**Kaufman Products, Inc**]
   f. [**Lambert Corporation**]
   g. [**Laticrete International, Inc.**]
   h. [**Metalcrete Industries**]
   i. [**Nox-Crete Products Group**]
   j. [**Right Pointe**]
   k. [**SpecChem, LLC**]
   l. [**TK Products Construction Coatings, a Fenix Group SPC Company**]
   m. [**Vexcon Chemicals Inc.**]
   n. [**W. R. Meadows, Inc**]
   o. **<Insert manufacturer's name>**

3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Clear Acrylic Sealer, Low-to-Medium Gloss: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, acrylic copolymer emulsion or epoxy-modified acrylic emulsion, manufactured for colored concrete, containing not less than 15 percent solids by volume.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Surfaces Inc.**]
   b. [**Bomanite Co**]
   c. [**Concrete Sealers USA**]
   d. [**Duckback Products**]
   e. [**EPMAR Corporation; a Quaker Houghton company**]
   f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
   g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
   h. [**QC Construction Products**]

i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**United Gilsonite Laboratories (UGL)**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**QC Construction Products**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**United Gilsonite Laboratories (UGL)**]
k. **<Insert manufacturer's name>**

H. Clear Acrylic Sealer, High Gloss: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, high-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 25 percent solids by volume.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Advanced Surfaces Inc.**]
b. [**Bomanite Co**]
c. [**Concrete Sealers USA**]
d. [**Duckback Products**]
e. [**EPMAR Corporation; a Quaker Houghton company**]
f. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
g. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
h. [**Scofield, a Business Unit of Sika Corporation**]
i. **<Insert manufacturer's name>**

I. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving

surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Surfaces Inc.**]
   b. [**Bomanite Co**]
   c. [**Bon Tool Co.**]
   d. [**Dayton Superior Corporation**]
   e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
   f. [**QC Construction Products**]
   g. [**Vexcon Chemicals Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Surfaces Inc.**]
   b. [**Bomanite Co**]
   c. [**Bon Tool Co.**]
   d. [**Dayton Superior Corporation**]
   e. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
   f. [**QC Construction Products**]
   g. [**Vexcon Chemicals Inc.**]
   h. <**Insert manufacturer's name**>

2.11 RELATED MATERIALS

A. Joint Fillers: [**ASTM D1751, asphalt-saturated cellulosic fiber**][**ASTM D1752, cork or self-expanding cork**][**or**][**ASTM D8139, semirigid, closed-cell polypropylene foam**] in preformed strips.

B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

   1. [**Types I and II, nonload bearing**][**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

D. Polyethylene Film: ASTM D4397, **1 mil (0.025 mm)** thick, clear.

2.12 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

C. Cementitious Materials:[**Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content:

a. [**5-1/2**][**4-1/2**][**2-1/2**] percent plus or minus 1.5 percent for **1-1/2-inch (38-mm)** nominal maximum aggregate size.
b. [**6**][**4-1/2**][**3**] percent plus or minus 1.5 percent for **1-inch (25-mm)** nominal maximum aggregate size.
c. [**6**][**5**][**3-1/2**] percent plus or minus 1.5 percent for **3/4-inch (19-mm)** nominal maximum aggregate size.

E. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**][**0.30**] percent by weight of cement.

F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use [**water-reducing admixture**][**water-reducing and retarding admixture**][**water-reducing and accelerating admixture**] in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [**1.0 lb/cu. yd. (0.60 kg/cu. m)**]<**Insert requirement**>.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

I. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): [**4500 psi (31 MPa)**][**4000 psi (27.6 MPa)**][**3500 psi (24.1 MPa)**][**3000 psi (20.7 MPa)**]<**Insert strength**>.
2. Maximum W/C Ratio at Point of Placement: [**0.45**][**0.50**]<**Insert ratio**>.
3. Slump Limit: [**4 inches (100 mm)**][**5 inches (125 mm)**]<**Insert dimension**>, plus or minus **1 inch (25 mm)**.

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M[**and ASTM C1116/C1116M**]. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below [**decorative concrete paving**]<**Insert locations**> to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction[**and repeat in perpendicular direction**]. Limit vehicle speed to **3 mph (5 km/h)**.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [**1/2 inch (13 mm)**]<**Insert dimension**> according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum **2-inch (50-mm)** overlap to adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Butt Joints: Use [**bonding agent**][**epoxy-bonding adhesive**] at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of [**50 feet (15.25 m)**]<**Insert dimension**> unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[**, to match jointing of existing adjacent decorative concrete paving**]:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within [**3 inches (75 mm)**]<**Insert dimension**> either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within [**3 inches (75 mm)**]<**Insert dimension**> in both directions from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a [**1/4-inch (6-mm)**][**3/8-inch (10-mm)**] radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation[**, steel reinforcement,**] and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface[**and steel reinforcement**] before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with **ACI 301 (ACI 301M)** requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to **ACI 301 (ACI 301M)** by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[**, reinforcement,**] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating [**reinforcement**][**dowels**][**and**] joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.9 STENCILING

A. Cut stencils to slab width and lay on wet concrete. Overlap "mortar joint" on trailing edge of each section of stencil onto leading "mortar joint" of previous section.

B. Trim stencils to fit slab and adjacent patterns.

C. Slightly embed stencil into concrete by rolling with stencil roller.

D. Apply pigmented mineral dry-shake hardener materials to concrete surfaces according to manufacturer's written instructions.

E. Stencil Rolling:

1. Apply [**pigmented powder release agent**][**liquid release agent**] according to manufacturer's written instructions prior to applying texture roller to surface of concrete.
2. Perform rolling operation to produce required texture on concrete surface.

F. Remove stencils when concrete has sufficiently cured to bear weight. Do not leave stencils in concrete overnight.

G. Remove debris with mechanical blower prior to application of curing compound. If release agent is applied, delay removal of debris for 24 hours, then flood area with low-pressure water hose, wetting release agent, and follow by cleaning surface with pressure washer.

3.10 PIGMENTED MINERAL DRY-SHAKE HARDENER APPLICATION

A. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**]<**Insert rate of application**> unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply the following finish:

   a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

B. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of **3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m)**.

C. Liquid Release Agent: Uniformly mist surface of dry-shake-hardened and still-plastic concrete at a rate of **5 gal/1000 sq. ft. (0.2 L/sq. m)**.

3.11 STAMPING

A. Mat Stamping: After floating and while concrete is plastic, apply mat-stamped finish.

1. Pigmented Powder Release Agent: Uniformly distribute onto concrete at a rate of **3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m)**.
2. Liquid Release Agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of **5 gal/1000 sq. ft. (0.2 L/sq. m)**.
3. After application of release agent, accurately align and place stamp mats in sequence.
4. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

B. Tool Stamping: After floating and while concrete is plastic, apply tool-stamped finish.

1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends **3 inches (75 mm)**, and secure to edge forms. Lightly broom surface to remove air bubbles.
2. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp tools. Hand stamp edges and surfaces unable to be imprinted by stamp tools.
3. Carefully remove polyethylene film immediately after tool stamping.

C. Roller Stamping: After floating and while concrete is plastic, apply roller-stamped finish.

1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends **3 inches (75 mm)**, and secure to edge forms. Lightly broom surface to remove air bubbles.
2. Accurately align roller and perform rolling operation to produce required imprint pattern and depth of imprint on concrete surface. Hand stamp surfaces inaccessible to roller.
3. Carefully remove polyethylene film immediately after roller stamping.

3.12 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h (1 kg/sq. m x h)** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Compound: Apply immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

1. Cure integrally colored concrete with a[**pigmented**] curing compound.
2. Cure concrete finished with pigmented mineral dry-shake hardener with a[**pigmented**] curing compound.

F. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

3.13 STAINING

A. Newly placed concrete paving shall be at least [**14**][**30**]<**Insert number**> days old before staining.

B. Prepare surfaces according to manufacturer's written instructions and as follows:

1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.

   a. Do not use acidic solutions to clean surfaces.

2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by [**acid etching**][**grinding, sanding, or abrasive blasting**].

Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.

3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F710 to ensure pH is between [**7 and 8**]<**Insert values**>.

C. Scoring: Score decorative jointing in paving surfaces **1/16 inch (1.6 mm)** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [**after**][**before**] staining.

1. Joint Width: [**3/8 inch (10 mm)**]<**Insert dimension**>.

D. Allow paving surface to dry before applying stain. Verify readiness of paving to receive stain according to ASTM D4263 by tightly taping **18-by-18-inch (450-by-450-mm)**, **4-mil- (0.1-mm-)** thick polyethylene sheet to a representative area of paving surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.

E. Reactive Stain: Apply reactive stain to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
2. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.

F. Penetrating Stain: Apply to paving surfaces according to manufacturer's written instructions and as follows:

1. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
2. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
3. Rinse until water is clear. Control, collect, and legally dispose of runoff.

3.14 SEALER APPLICATION

A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.

1. Begin sealing dry surface no sooner than [**14**]<**Insert number**> days after concrete placement.
2. Allow stained concrete surfaces to dry before applying sealer.
3. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

3.15 PAVING TOLERANCES

A. Comply with tolerances in **ACI 117 (ACI 117M)** and as follows:

1. Elevation: **3/4 inch (19 mm)**.
2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
3. Surface: Gap below **10-foot- (3-m-)** long, unleveled straightedge not to exceed **1/2 inch (13 mm)**.
4. Lateral Alignment and Spacing of Dowels: **1 inch (25 mm)**.
5. Vertical Alignment of Dowels: **1/4 inch (6 mm)**.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches (6 mm per 300 mm)** of dowel.
7. Joint Spacing: **3 inches (75 mm)**.
8. Contraction Joint Depth: Plus **1/4 inch (6 mm)**, no minus.
9. Joint Width: Plus **1/8 inch (3 mm)**, no minus.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each [**100 cu. yd. (76 cu. m)**][**5000 sq. ft. (465 sq. m)**] or fraction thereof of each concrete mixture placed each day.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when it is **80 deg F (27 deg C)** and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than **500 psi (3.4 MPa)**.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of

concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.17 REPAIR AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.18 DECORATIVE CONCRETE PAVING SCHEDULE

A. Patterned Decorative Concrete Paving :

1. Locations: Install at [**drives**][**parking lots**][**walks**][**patios**][**and**][**swimming pool decks**]<**Insert location**>.
2. Coloring Method: [**Integrally colored**][**Pigmented mineral dry-shake hardener**].

   a. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

3. Field Patterning Method: [**Stamped**][**Stenciled**].

   a. Texture and Pattern: [**Keystone installed at 45-degrees diagonal to main lines of building**]<**Insert requirement**>.
   b. Pigmented Mineral Dry-Shake Hardener: <**Insert color**>.
   c. Release Agent: [**Match pigmented mineral dry-shake hardener**]<**Insert color**>.

4. Border and Accent Strip Patterning Method: [**Stamped**][**Stenciled**].

a. Texture and Pattern: <**Insert requirement**>.
b. Pigmented Mineral Dry-Shake Hardener: <**Insert color**>.
c. Release Agent: [**Match pigmented mineral dry-shake hardener**]<**Insert color**>.

B. Stained Decorative Concrete Paving :

1. Locations: Install at [**drives**][**parking lots**][**walks**][**patios**][**and**][**swimming pool decks**]<**Insert location**>.
2. Staining Method: [**Reactive**][**Penetrating**] stain.
3. Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

END OF SECTION 32 13 16 00

Task	Specification	Specification Description
32 13 16 13	32 13 13 00	Concrete Paving
32 13 16 13	32 13 16 00	Decorative Concrete Paving
32 13 43 00	32 13 13 00	Concrete Paving

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SECTION 32 13 73 00 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Cold-applied, fuel-resistant joint sealants.
4. Hot-applied, fuel-resistant joint sealants.
5. Joint-sealant backer materials.
6. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: Joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**Installer**][**testing agency**].

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; RoadSaver Silicone.
b. Pecora Corporation; 301 NS.
c. The Dow Chemical Company; Dow Corning 888 Silicone Joint Sealant.
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Pecora Corporation**]
c. [**The Dow Chemical Company**]
d. <**Insert manufacturer's name**>

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; RoadSaver Silicone SL.
b. Pecora Corporation; [**300 SL**][**322FC**].
c. The Dow Chemical Company; Dow Corning 890-SL Silicone Joint Sealant.
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Pecora Corporation**]
c. [**The Dow Chemical Company**]
d. <**Insert manufacturer's name**>

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. W.R. Meadows, Inc; Pourthane NS.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**W. R. Meadows, Inc**]
b. <**Insert manufacturer's name**>

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not**

limited to, the following]:

a. W.R. Meadows, Inc; Pourthane SL.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**W. R. Meadows, Inc**]
b. <**Insert manufacturer's name**>

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Pecora Corporation; [**Dynatred**][**Dynatrol II-SG**][**Urexpan NR-200**].
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Pecora Corporation**]
b. <**Insert manufacturer's name**>

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; [**Asphalt Rubber Plus**][**Asphalt Rubber Plus Type 2**][**RoadSaver 203**][**RoadSaver 211**][**RoadSaver 515**].
b. Right Pointe; JTS Asphalt Rubber Modified 043.
c. W.R. Meadows, Inc; [**Sealtight 1190**][**Sealtight 164**].
d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. [**Right Pointe**]
c. [**W. R. Meadows, Inc**]
d. <**Insert manufacturer's name**>

B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Crafco Inc.; [**RoadSaver 201**][**RoadSaver 220**][**RoadSaver 221**][**RoadSaver 534**].
   b. Right Pointe; [**JTS 3405 Parking Lot Sealant 007**][**JTS 3405 Rubber 009**].
   c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crafco Inc**]
   b. [**Right Pointe**]
   c. <**Insert manufacturer's name**>

C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Crafco Inc.; RoadSaver 222.
   b. Right Pointe; [**JTS 3405 Regular 003**][**JTS 3405 Rubber 009**].
   c. W.R. Meadows, Inc; Sealtight 3405.
   d. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crafco Inc**]
   b. [**Right Pointe**]
   c. [**W. R. Meadows, Inc**]
   d. <**Insert manufacturer's name**>

D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Crafco Inc.; RoadSaver 231.
   b. W.R. Meadows, Inc; Sealtight 3405M.
   c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crafco Inc**]
   b. [**W. R. Meadows, Inc**]
   c. <**Insert manufacturer's name**>

2.5 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. BASF Corporation; MasterSeal CR 125 (Pre-2014: Sonomeric 1).
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Pecora Corporation; <**Insert product name or designation**>.
b. W.R. Meadows, Inc; <**Insert product name or designation**>.
c. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Pecora Corporation**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

2.6 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type I or Type II: ASTM D7116.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; [**Superseal 1614A**][**Superseal 444/777**].
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]

b. <**Insert manufacturer's name**>

B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type III: ASTM D7116.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. Crafco Inc.; Superseal Low-Mod.
b. <**Insert manufacturer's name; product name or designation**>.

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crafco Inc**]
b. <**Insert manufacturer's name**>

2.7 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.8 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joints within concrete paving[**PJS-#**]:

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Single-component, nonsag, silicone joint sealant**][**Single-component, self-leveling, silicone joint sealant**][**Multicomponent, nonsag, urethane, elastomeric joint sealant**][**Single component, pourable, urethane, elastomeric joint sealant**][**Multicomponent, pourable, urethane, elastomeric joint sealant**][**Hot-applied, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

B. Joints within concrete paving and between concrete and asphalt paving[**PJS-#**]:

1. Joint Location:

   a. Joints between concrete and asphalt paving.
   b. Joints between concrete curbs and asphalt paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Hot-applied, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

C. Fuel-resistant joints within concrete paving[**PJS-#**]:

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: [**Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant**][**Fuel-resistant, multicomponent, pourable, modified-urethane, elastomeric joint sealant**][**Hot-applied, fuel-resistant, single-component joint sealant**]<**Insert joint sealant**>.
3. Joint-Sealant Color: [**Manufacturer's standard**]<**Insert color**>.

END OF SECTION 32 13 73 00

Task	Specification	Specification Description
32 13 73 13	32 13 73 00	Concrete Paving Joint Sealants
32 13 73 16	32 12 16 00	Asphalt Paving
32 13 73 16	32 13 73 00	Concrete Paving Joint Sealants
32 13 73 19	32 12 16 00	Asphalt Paving
32 13 73 19	32 13 73 00	Concrete Paving Joint Sealants

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SECTION 32 14 00 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers.
2. Concrete pavers.
3. Asphalt-block pavers.
4. Stone pavers.
5. Curbs and edge restraints.

B. Related Requirements:

1. [**Section 075113 "Built-up Asphalt Roofing"**][**Section 075116 "Built-up Coal Tar Roofing"**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing"**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing"**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing"**][**Section 075416 "Ketone Ethylene Ester (KEE) Roofing"**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing"**][**Section 075423 "Thermoplastic Polyolefin (TPO) Roofing"**][**Section 075552.13 "Atactic-Polypropylene (APP) Modified Bituminous Protected Membrane Roofing"**][**Section 075552.16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing"**][**Section 075556 "Fluid-Applied Protected Membrane Roofing"**] for roof pavers.
2. Section 096313 "Brick Flooring" for brick flooring for interior applications.
3. Section 096340 "Stone Flooring" for dimension stone paving.
4. Section 321216 "Asphalt Paving" for asphalt base under unit pavers.
5. Section 321313 "Concrete Paving" [**for concrete base under unit pavers**][**and**][**for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers**].
6. Section 321443 "Porous Unit Paving" for unit paving using grid pavers or pavers with openings between them.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

   a. Pavers.
   b. Bituminous setting materials.
   c. Mortar and grout materials.
   d. Edge restraints.
   e. Precast concrete curbs.

f. Granite curbs.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

D. Samples for Initial Selection: For each type of unit paver indicated[**.**][**and the following:**]

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.
3. Precast concrete curbs.
4. Granite curbs.

E. Samples for Verification: For full-size units of each type of unit paver indicated.[**Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.**][**Include Samples of the following:**]

1. Joint materials.
2. Exposed edge restraints.
3. Precast concrete curbs.
4. Granite curbs.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's [**field supervisor**][**personnel assigned to the Work**] must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with [**one of**][**both of**] the following designations:

1. Residential Paver Technician Designation.
2. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above **40 deg F (4 deg C)** and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above **50 deg F (10 deg C)** and when temperature has not been below **35 deg F (2 deg C)** for 12 hours immediately before application.

Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of **100 deg F (38 deg C)** and higher.

   a. When ambient temperature exceeds **100 deg F (38 deg C)**, or when wind velocity exceeds **8 mph (13 km/h)** and ambient temperature exceeds **90 deg F (32 deg C)**, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

A. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX[**or Class MX**], [**Type I**][**Type II**][**Type III**], Application [**PS**][**PX**][**PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2-1/4 inches (57 mm)**][**2-5/8 inches (67 mm)**][**As indicated**]<**Insert dimension**>.
2. Face Size: [**3-3/4 by 7-1/2 inches (95 by 190 mm)**][**3-5/8 by 7-5/8 inches (92 by 194 mm)**][**3-5/8**

by 11-5/8 inches (92 by 295 mm)][7-5/8 by 7-5/8 inches (194 by 194 mm)][4 by 8 inches (102 by 203 mm)][4 by 12 inches (102 by 305 mm)][8 by 8 inches (203 by 203 mm)][**As indicated**]<**Insert dimensions**>.

3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Brick Pavers, Heavy Vehicular Paving Brick: ASTM C1272, [**Type F, Application PX**][**Type R, Application PS**][**Type R, Application PX**][**Type R, Application PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [2-1/4 inches (57 mm)][2-5/8 inches (67 mm)][**As indicated**]<**Insert dimension**>.
2. Face Size: [3-3/4 by 7-1/2 inches (95 by 190 mm)][3-5/8 by 7-5/8 inches (92 by 194 mm)][3-5/8 by 11-5/8 inches (92 by 295 mm)][7-5/8 by 7-5/8 inches (194 by 194 mm)][4 by 8 inches (102 by 203 mm)][4 by 12 inches (102 by 305 mm)][8 by 8 inches (203 by 203 mm)][**As indicated**]<**Insert dimensions**>.
3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

H. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

I. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 CONCRETE PAVERS

A. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site.

C. Regional Materials: Concrete pavers shall be manufactured within 100 miles (160 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

D. Indigenous Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M[**and resistant to freezing and thawing when tested according to ASTM C67**], made from normal-weight aggregates.

1. Thickness: [2-3/8 inches (60 mm)][3-1/8 inches (80 mm)]<**Insert dimension**>.
2. Face Size and Shape:

   a. [3-7/8 inches (98 mm)][4-7/16 inches (113 mm)][8-7/8 inches (225 mm)][9 inches (229 mm)] square.
   b. [3-7/8-by-7-7/8-inch (98-by-200-mm)][4-by-8-inch (102-by-203-mm)][4-7/16-by-8-7/8-inch (113-by-225-mm)] rectangle.
   c. [5-1/2-inch (140-mm) **octagon with attached** 3-1/2-inch (89-mm) **square**][4-1/2-by-9-inch (114-by-229-mm) **rectangle with saw-tooth edges**][4-3/4-inch (121-mm) **rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern**][**As indicated**]<**Insert dimensions and shape**>.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Concrete Pavers, Solid Paving Units, Normal-Weight Concrete: Solid paving units made from normal-weight concrete with a compressive strength not less than [5000 psi (34 MPa)][6000 psi (41 MPa)]<**Insert value**>, water absorption not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67.

1. Thickness: [1-5/8 inches (41 mm)][1-3/4 inches (45 mm)][2 inches (51 mm)][2-3/8 inches (60 mm)]<**Insert dimension**>.
2. Face Size and Shape:

   a. [8-7/8 inches (225 mm)][9 inches (229 mm)][12 inches (305 mm)][18 inches (457 mm)][24 inches (610 mm)] square.
   b. [9-by-18-inch (229-by-457-mm)][12-by-24-inch (305-by-610-mm)] rectangle.
   c. [**As indicated**]<**Insert dimensions and shape**>.

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

H. Concrete Pavers, Solid Paving Units, Lightweight Concrete: Solid paving units complying with ASTM C1491, made from lightweight concrete.

1. Thickness: [1-5/8 inches (41 mm)][1-3/4 inches (45 mm)][2 inches (51 mm)]<**Insert dimension**>.
2. Face Size and Shape: [9 inches (229 mm) **square**][12 inches (305 mm) **square**][18 inches (457 mm) **square**][**As indicated**]<**Insert dimensions and shape**>.
3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2.4 ASPHALT-BLOCK PAVERS

A. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hanover Architectural Products**]
   b. <**Insert manufacturer's name**>

3. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**]<**Insert dimension**>.
4. Face Size: [**4 by 6 inches (102 by 152 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (203 by 203 mm)**][**5 by 12 inches (127 by 305 mm)**][**6 by 12 inches (152 by 305 mm)**][**8-inch-(203-mm-) wide hexagon**]<**Insert dimensions**>.
5. Dimensional Tolerances: Plus or minus **1/16 inch (1.6 mm)**.
6. Finish: [**Natural, smooth**][**Ground**][**Ground and sandblasted**].
7. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2.5 STONE PAVERS

A. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C615/C615M.

   1. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
   2. Finish: [**Honed**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
   3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
   4. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**] unless otherwise indicated.
   5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

G. Limestone Pavers: Rectangular paving slabs made from limestone complying with ASTM C568/C568M.

   1. Classification: [**II Medium-Density**][**III High-Density**].
   2. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to

ASTM C241/C241M or ASTM C1353.
3. Indiana Oolitic Limestone Grade and Color: [**Select, buff**][**Select, gray**][**Standard, buff**][**Standard, gray**][**Rustic, buff**][**Rustic, gray**][**Variegated**], according to grade and color classification established by ILI.
4. Finish: [**Smooth**][**Chat sawed**][**Shot sawed**][**As indicated**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

H. Marble Pavers: Rectangular paving slabs made from marble complying with ASTM C503/C503M.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Description: Uniform, fine- to medium-grained, [**white**]<**Insert color**> stone with only slight veining.
3. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

I. Quartz-Based Stone Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from quartz-based stone complying with ASTM C616/C616M, Classification [**I Sandstone**][**II Quartzitic Sandstone**][**III Quartzite**].

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Finish: [**Sand rubbed**][**Natural cleft**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

J. Slate Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from slate complying with ASTM C629/C629M, Classification I Exterior, with a fine, even grain[**and unfading color,**] from clear, sound stock.

1. Color: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**].
2. Stone Abrasion Resistance: Minimum value of [**8**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
3. Finish: [**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**1/2 inch (13 mm)**][**3/4 inch (20 mm)**][**1 inch (25 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm)**

square][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

K. Travertine Pavers: Rectangular paving slabs made from travertine complying with ASTM C1527/C1527M, Classification I Exterior.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Cut: Vein cut.
3. Filling: Fill pores on faces of stone with cementitious filler of color [**selected by Architect**][**matching Architect's sample**].
4. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

L. Rough Granite Pavers: Rectangular[**tumbled**] paving stones, with split[**or thermal-finished**] faces and edges, made from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Buechel Stone Corp**]
   b. [**Cold Spring Granite Company**]
   c. [**Fletcher Granite Company**]
   d. [**Granicor**]
   e. [**Milestone Imports, Inc.**]
   f. [**North Carolina Granite Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Buechel Stone Corp**]
   b. [**Cold Spring Granite Company**]
   c. [**Fletcher Granite Company**]
   d. [**Granicor**]
   e. [**Milestone Imports, Inc.**]
   f. [**North Carolina Granite Corporation**]
   g. <**Insert manufacturer's name**>

3. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
4. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**4 inches (102 mm), plus or minus 1/2 inch (13 mm)**]<**Insert dimension**>.
5. Face Size: [**4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm)**][**3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm)**][**As indicated**]<**Insert dimensions**>.

2.6 CURBS AND EDGE RESTRAINTS

A. Plastic Edge Restraints: Manufacturer's standard triangular PVC extrusions [**1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide**][**3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide**] designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges; with pipe connectors and **3/8-inch (9.5-mm)** diameter by **12-inch- (300-mm-)** long steel spikes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brickstop Corporation**]
   b. [**Dimex LLC**]
   c. [**Oly-Ola Edgings, Inc.**]
   d. [**Pave Tech; Probst, Inc.**]
   e. [**Sure-loc Edging Corporation.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brickstop Corporation**]
   b. [**Dimex LLC**]
   c. [**Oly-Ola Edgings, Inc.**]
   d. [**Pave Tech; Probst, Inc.**]
   e. [**Sure-loc Edging Corporation.**]
   f. <**Insert manufacturer's name**>

B. Steel Edge Restraints: Manufacturer's standard painted steel edging [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**][**1/4 inch (6.4 mm) thick by 5 inches (125 mm) high**] with loops pressed from or welded to face to receive stakes at **36 inches (900 mm)** o.c. and steel stakes **15 inches (380 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Border Concepts, Inc**]
   b. [**COLMET**]
   c. [**J. D. Russell Company (The)**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Border Concepts, Inc**]
   b. [**COLMET**]
   c. [**J. D. Russell Company (The)**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

C. Aluminum Edge Restraints: Manufacturer's standard [**straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high**][**straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high**][**L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high**][**L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high**] extruded-aluminum edging with loops pressed from face to receive stakes at **12 inches (300 mm)** o.c. and aluminum stakes **12 inches (300 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

D. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of **3000 psi (20 MPa)**.

E. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than [**5000 psi (34 MPa)**][**6000 psi (41 MPa)**]<**Insert value**> and water absorption not more than 5 percent, in shapes and sizes indicated.

1. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
2. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site.
3. Regional Materials: Concrete curbs shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
4. Indigenous Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
5. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Color and Texture: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and texture**>.

F. Granite Curbs: Granite curbing, with face battered **1 inch per foot (1:12)**, produced in random lengths not less than **36 inches (900 mm)** from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cold Spring Granite Company**]
   b. [**Fletcher Granite Company**]
   c. [**Granicor**]
   d. [**New England Stone, Inc.**]
   e. [**North Carolina Granite Corporation**]
   f. [**Polycor Inc.**]
   g. [**Swenson Granite Works; a Polycor Inc. company**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cold Spring Granite Company**]
   b. [**Fletcher Granite Company**]
   c. [**Granicor**]
   d. [**New England Stone, Inc.**]
   e. [**North Carolina Granite Corporation**]
   f. [**Polycor Inc.**]
   g. [**Swenson Granite Works; a Polycor Inc. company**]
   h. <**Insert manufacturer's name**>

3. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
4. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.
5. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
6. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
8. Granite Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**fine**][**medium**][**coarse**] grain.
9. Top Width: [**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**]<**Insert dimension**>.
10. Face Height: [**4 inches (102 mm)**][**6 inches (152 mm)**][**8 inches (203 mm)**]<**Insert dimension**>.
11. Total Height: [**12 inches (305 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**]<**Insert dimension**>.
12. Top Finish: [**Sawed**][**Thermal**][**Bush hammered**].

13. Face Finish: [**Split**][**Sawed**][**Thermal**][**Bush hammered**].

G. <**Insert requirements**>.

2.7 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.8 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 57**][**ASTM D2940/D2940M, subbase material**][**requirements in Section 312000 "Earth Moving" for subbase material**].

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 8**][**ASTM D2940/D2940M, base material**][**requirements in Section 312000 "Earth Moving" for base course**].

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.02 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

G. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.9 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D2028/D2028M, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D3381/D3381M, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

2.10 MORTAR SETTING-BED MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Portland Cement: ASTM C150/C150M, Type I or Type II.

G. Hydrated Lime: ASTM C207, Type S.

H. Sand: ASTM C144.

I. Latex Additive: [**Manufacturer's standard**][**acrylic resin**][**or**][**styrene-butadiene-rubber**] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

J. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

3. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
4. Provide prepackaged, dry-mortar mix combined with [**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.
5. Provide product that is approved by manufacturer for application thickness of [**5/8 inch (16 mm)**]<**Insert value**>.

K. Water: Potable.

L. Reinforcing Wire Fabric: Galvanized, welded wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062 inch (1.57 mm)** in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.11 GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) **<Insert manufacturer's name>**

b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) **<Insert manufacturer's name>**

G. Standard Cement Grout: ANSI A118.6, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

H. High-Performance Cement Grout: ANSI A118.7, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]
m. <**Insert manufacturer's name**>

3. Polymer Type:

a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
b. [**Acrylic resin**][**or**][**styrene-butadiene rubber**] in liquid-latex form for addition to prepackaged dry-grout mix.

I. Grout Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

J. Water: Potable.

2.12 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to **300 deg F (149 deg C)**.

2.13 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and [**latex additive**][**water**] to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

F. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

G. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.

1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

H. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected[**and waterproofing protection is in place**].

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase**][**and**][**base**] course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where

possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: [**Running bond**][**Herringbone**][**Basket weave**][**Grid**][**As indicated**][**Match and continue existing unit paver joint pattern**].

F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete**].

G. Tolerances:

1. Do not exceed **1/32-inch (0.8-mm)** unit-to-unit offset from flush (lippage) or **1/8 inch in 10 feet (3 mm in 3 m)** from level, or indicated slope, for finished surface of paving.
2. Do not exceed[**1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and**] **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete**]. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least **1 inch (25 mm)** below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

J. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.

1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least [**95**]<**Insert number**> percent of [**ASTM D698**][**ASTM D1557**] laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least **12 inches (300 mm)**.

D. Place aggregate[**subbase and**] base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate[**subbase and**] base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least **12 inches (300 mm)**.

G. Place leveling course and screed to a thickness of **1 to 1-1/2 inches (25 to 38 mm)**, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of **1/16 inch (1.5 mm)** and a maximum of **1/8 inch (3 mm)**, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed [**3/8 inch (10 mm)**]<**Insert dimension**> with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least **36 inches (900 mm)** of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for **36-inch (900-mm)** width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within **36 inches (90 mm)** of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating **3/4-inch- (19-mm-)** deep control bars approximately **11 feet (3.3 m)** apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of **250 deg F (121 deg C)**. Strike setting bed smooth, firm, even, and not less than **3/4 inch (19 mm)** thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of **3/4 inch (19 mm)**. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to **185 deg F (85 deg C)**.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of **1/16 inch (1.6 mm)**. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately **1/2 inch (13 mm)**.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Wet brick pavers before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform **1/16-inch- (1.5-mm-)** thick bond coat to mortar bed or to back of each paver with a flat trowel.

I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

J. Spaced Joint Widths: Provide [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal joint width with variations not exceeding plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**][**3/16 inch (4.5 mm)**].

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

L. Grout joints as soon as possible after initial set of setting bed.

1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

M. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 32 14 00 00

Task	Specification	Specification Description
32 14 09 00	32 14 00 00	Unit Paving
32 14 09 00	32 93 00 00	Plants
32 14 11 00	32 13 13 00	Concrete Paving
32 14 11 00	32 14 00 00	Unit Paving
32 14 13 00	32 14 00 00	Unit Paving
32 14 13 16	32 13 13 00	Concrete Paving
32 14 13 16	32 14 00 00	Unit Paving
32 14 13 19	32 13 13 00	Concrete Paving
32 14 13 19	32 14 00 00	Unit Paving

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SECTION 32 14 16 00 - VITRIFIED BRICK PAVEMENT REPLACEMENT

1.1 GENERAL

A. General

1. Limits of Brick Pavement Replacement shall be as per the detail entitled “Payment Limits for Surface Restoration” shown in the plans, plus one foot on each side. Alternate individual bricks may have to be removed in order to maintain staggered joint pattern along the edge of the undisturbed brick pavement.

1.2 PRODUCT

A. Preparation

1. Base shall be provided and shaped to match level, kind and thickness (4” min.) of adjoining base. The base material shall be compacted to meet the density standards. 4” 2500 PSI concrete base may be used for irregular patches and where compaction is otherwise impractical. Concrete shall be properly placed, consolidated and cured. One inch of sand, or good grade dirt, free from clay, loam or other foreign matter shall be used for cushion to hold the bricks in place. The sand shall be shaped to a true surface parallel to required finished pavement surface.

B. Materials

1. Existing bricks shall be cleaned, stored, and secured by the Contractor.

1.3 EXECUTION

A. Reinstallation of Bricks

1. The bricks shall be installed in rows, better face upward, sorted by size with joints staggered, then rolled daily with a static tandem wheel roller. Additional bricks, if required, will be supplied by the Owner. City Personnel shall inspect work daily. After inspection, the bricks shall be sprayed with a solution of lime and water, using 26 lbs. of lime to 55 gallons of water. Asphalt steep 7330 or equal shall be used for joint filler. The steep shall be heated until fluid and poured over bricks and removed when cool with square pointed shovels dipped in lime water. Removed asphalt may be reused. If adjoining bricks are grouted, new filler shall be grout (8:1, builders sand: cement).

B. Acceptance

1. Upon completion of the work, and before acceptance and final payment, the Contractor shall remove all false work, equipment, rubbish, surplus, and discarded materials. The Contractor shall restore in an acceptable manner all property, both public and private, damaged during the prosecution of the work. The Contractor shall leave the roadway in a neat and presentable condition each day.

END OF SECTION 32 14 16 00

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Task	Specification	Specification Description
32 14 16 00	32 13 13 00	Concrete Paving
32 14 16 00	32 14 00 00	Unit Paving
32 14 33 00	32 14 00 00	Unit Paving
32 14 33 13	32 14 00 00	Unit Paving
32 14 40 00	32 13 13 00	Concrete Paving
32 14 40 00	32 14 00 00	Unit Paving
32 16 13 13	32 13 13 00	Concrete Paving
32 16 13 14	32 13 13 00	Concrete Paving
32 16 13 16	32 13 13 00	Concrete Paving
32 16 13 19	32 13 13 00	Concrete Paving
32 16 13 23	32 13 13 00	Concrete Paving
32 16 13 33	32 13 13 00	Concrete Paving
32 16 23 00	32 13 13 00	Concrete Paving
32 16 23 00	32 14 00 00	Unit Paving

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SECTION 32 17 13 00 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For wheel stops, [**6 inches (150 mm) long**]<**Insert dimension**>, showing color and cross section; with mounting hardware.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; [**4000-psi (27.6-MPa)**]<**Insert value**> minimum compressive strength; [**manufacturer's standard height and width**][**4-1/2 inches (115 mm) high by 9 inches (225 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners[**, transverse drainage slots on underside,**] and a minimum of [**two**][**three**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Eagle Precast, LLC**]
b. [**American Precast Concrete Inc.**]
c. [**Bush Concrete Products, Inc.**]

d. [**Cast-Crete USA, Inc.**]
e. [**Dura-Crete, Inc.**]
f. [**Granite Precasting and Concrete, Inc.**]
g. [**Oldcastle Infrastructure Inc.; CRH Americas**]
h. [**Steps Plus, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Eagle Precast, LLC**]
b. [**American Precast Concrete Inc.**]
c. [**Bush Concrete Products, Inc.**]
d. [**Cast-Crete USA, Inc.**]
e. [**Dura-Crete, Inc.**]
f. [**Granite Precasting and Concrete, Inc.**]
g. [**Oldcastle Infrastructure Inc.; CRH Americas**]
h. [**Steps Plus, Inc.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
5. Surface Sealer: [**Manufacturer's standard salt-resistant, clear sealer**]<**Insert requirement**>, applied at precasting location.
6. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) diameter, 14-inch (350-mm) minimum length**][**lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].

B. Resilient Wheel Stops: Solid, integrally colored [**rubber**][**or**][**plastic**]; UV stabilized; [**manufacturer's standard height and width**][**4 inches (100 mm) high by 6 inches (150 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners and a minimum of [**two**][**three**][**four**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Checkers; Justrite Safety Group**]
b. [**GNR Technologies Inc.**]
c. [**Plastic Safety Systems, Inc.**]
d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Checkers; Justrite Safety Group**]
b. [**GNR Technologies Inc.**]
c. [**Plastic Safety Systems, Inc.**]

d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
5. Color: [**Black**][**Yellow**][**Gray**][**Green**][**Blue**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) minimum diameter, 14-inch (350-mm) minimum length**][**lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].
8. Adhesive: Polyurethane or epoxy, as recommended in writing by wheel-stop manufacturer for adhesion to substrate.

C. Resilient-Shell, Concrete-Filled Wheel Stops: Integrally colored HDPE polymer; UV-stabilized resilient shell; filled with precast, steel-reinforced concrete; [**4000-psi (27.6-MPa)**]<**Insert value**> minimum compressive strength; [**manufacturer's standard height and width**][**5 inches (125 mm) high by 6 inches (150 mm) wide**]<**Insert dimensions**> by [**72 inches (1800 mm)**]<**Insert dimension**> long. Provide chamfered corners and a minimum of [**two**][**three**] factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Century Group Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Century Group Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.
4. Color: [**Yellow**][**Blue**]<**Insert color**>.
5. Surface Appearance: Smooth and uniform, with straight and sharp corners.
6. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch (13-mm) minimum diameter, 14-inch (350-mm) minimum length**][**hardware as standard with wheel-stop manufacturer**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring to substrate.

C. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 32 17 13 00

Task	Specification	Specification Description
32 17 13 16	32 17 13 00	Parking Bumpers
32 17 13 19	32 17 13 00	Parking Bumpers
32 17 13 23	11 12 00 00	Parking Control Equipment
32 17 13 23	13 34 23 16	Fabricated Control Booths
32 17 13 23	32 17 13 00	Parking Bumpers
32 17 13 26	11 12 00 00	Parking Control Equipment
32 17 13 26	13 34 23 16	Fabricated Control Booths
32 17 13 26	32 17 13 00	Parking Bumpers

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SECTION 32 17 16 00 - MANUFACTURED TRAFFIC-CALMING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Speed bumps.
2. Speed humps.
3. Speed cushions.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Speed bumps.
2. Speed humps.
3. Speed cushions.

B. Sustainable Design Submittals:

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: Manufactured traffic-calming devices, [**6 inches long**]<**Insert dimension**>, showing color and cross section; with fasteners.

PART 2 - PRODUCTS

2.1 SPEED BUMPS

A. Speed Bumps: Solid, integrally colored, preformed [**recycled rubber**][**or**][**polyurethane**]; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barco Products Company**]
b. [**Checkers; Justrite Safety Group**]
c. [**Pawling Corporation**]
d. [**Plasticade**]
e. [**RoadKare; a RubberForm company**]
f. [**RubberForm Recycled Products, LLC**]
g. [**Traffic Logix**]
h. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed bumps from single source from single manufacturer.

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: [**2 inches high by 10 inches wide by 72 inches long**]<**Insert dimensions**>; with tapered, square, or rounded ends.
5. Color: [**Black**][**Yellow**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed bump manufacturer**].
8. Adhesive: [**As recommended in writing by speed bump manufacturer**]<**Insert requirement**> to permanently adhere speed bump to substrate.

2.2 SPEED HUMPS

A. Speed Humps: Solid, integrally colored, preformed recycled rubber; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Barco Products Company**]
   b. [**Checkers; Justrite Safety Group**]
   c. [**Plasticade**]
   d. [**RoadKare; a RubberForm company**]
   e. [**RubberForm Recycled Products, LLC**]
   f. [**Traffic Logix**]
   g. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed humps from single source from single manufacturer.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: Modular assembly [**3 inches high by 12 feet in overall width**][**4 inches high by 14 feet in overall width**]<**Insert dimensions**>, with overall length as dimensioned on Drawings; and with tapered, square, or rounded ends.
5. Surface Profile: [**Circular**][**Sinusoidal**][**Trapezoidal**].
6. Color: [**Black**][**Yellow**]<**Insert color**>.
7. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
8. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed hump manufacturer**].
9. Adhesive: [**As recommended in writing by speed hump manufacturer**]<**Insert requirement**> to permanently adhere speed hump to substrate.

2.3 SPEED CUSHIONS

A. Speed Cushions: Solid, integrally colored, preformed recycled rubber; UV stabilized. Provide factory-formed or -drilled vertical holes for anchoring to substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Barco Products Company**]
b. [**RoadKare; a RubberForm company**]
c. [**RubberForm Recycled Products, LLC**]
d. [**Traffic Logix**]
e. <**Insert manufacturer's name**>

2. Source Limitations: Obtain speed cushions from single source from single manufacturer.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Size: Modular assembly [**3 inches high by 12 feet in overall width**][**4 inches high by 14 feet in overall width**]<**Insert dimensions**>, with overall length as dimensioned on Drawings; and with tapered, square, or rounded ends.
5. Color: [**Black**][**Yellow**]<**Insert color**>.
6. Embedded Markings: Molded-in, [**blue**][**white**][**yellow**] reflective markings, permanently inset in exposed surface.
7. Mounting Hardware: Galvanized-steel [**spike or dowel, 1/2-inch diameter, 10-inch minimum length**][**lag screw, shield, and washers; 1/2-inch diameter, 8-inch minimum length**][**hardware as standard with speed cushion manufacturer**].
8. Adhesive: [**As recommended in writing by speed cushion manufacturer**]<**Insert requirement**> to permanently adhere speed cushions to substrate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install manufactured traffic-calming devices according to manufacturer's written instructions unless otherwise indicated.

B. Install devices in bed of adhesive before anchoring.

C. Securely anchor devices to substrate with hardware spaced as recommended in writing by manufacturer for heavy traffic. Recess head of hardware beneath top surface of device.

END OF SECTION 32 17 16 00

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Task	Specification	Specification Description
32 17 16 00	32 12 16 00	Asphalt Paving

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SECTION 32 17 23 00 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.
2. Painted markings applied to concrete surfaces.

B. Related Requirements:

1. Section 071800 "Traffic Coatings" for painting whole areas of building floors and pavements with coatings having an integral wearing surface.
2. Section 099113 "Exterior Painting" for painting exterior concrete surfaces other than pavement markings.
3. Section 099123 "Interior Painting" for painting interior concrete surfaces other than pavement markings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:

a. Asphalt-paving or concrete-surface aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Pavement-marking paint, alkyd.
2. Pavement-marking paint, solvent-borne.
3. Pavement-marking paint, acrylic.
4. Pavement-marking paint, latex.
5. Glass beads.

B. Shop Drawings:

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each exposed product and for each color and texture specified; on rigid backing, **8 inches (200 mm)** square.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <**Insert applicable standards**> of <**Insert name of state or local DOT**> for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of [**40 deg F (4.4 deg C) for alkyd materials**][**55 deg F (12.8 deg C) for water-based materials**], and not exceeding **95 deg F (35 deg C)**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**]<**Insert requirement**>.

2.2 PAVEMENT-MARKING PAINT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aexcel Corporation**]
2. [**Colorado Paint Company II, LLC; SWARCO America, Inc.**]
3. [**Columbia Paint & Coatings, Inc.; a subsidiary of Sherwin-Williams Company (The)**]
4. [**Conco Paints**]
5. [**Diamond Vogel Paint Company**]
6. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
7. [**Ennis-Flint, Inc.**]
8. [**Farrell-Calhoun**]
9. [**Florida Paints**]
10. [**General Paint**]
11. [**Insl-X Products; Benjamin Moore & Co.**]
12. [**McCormick Paints**]
13. [**PPG Paints; PPG Industries, Inc.**]
14. [**Rodda Paint Co.**]
15. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
16. [**Sherwin-Williams Company (The)**]
17. [**The Dow Chemical Company**]
18. [**Transpo Industries, Inc.**]
19. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aexcel Corporation**]
2. [**Colorado Paint Company II, LLC; SWARCO America, Inc.**]
3. [**Columbia Paint & Coatings, Inc.; a subsidiary of Sherwin-Williams Company (The)**]
4. [**Conco Paints**]
5. [**Diamond Vogel Paint Company**]
6. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
7. [**Ennis-Flint, Inc.**]
8. [**Farrell-Calhoun**]
9. [**Florida Paints**]
10. [**General Paint**]
11. [**Insl-X Products; Benjamin Moore & Co.**]
12. [**McCormick Paints**]
13. [**PPG Paints; PPG Industries, Inc.**]
14. [**Rodda Paint Co.**]
15. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
16. [**Sherwin-Williams Company (The)**]
17. [**The Dow Chemical Company**]
18. [**Transpo Industries, Inc.**]
19. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

D. Pavement-Marking Paint, Alkyd: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, [**Type N**][**Type F**][**Type S**]; colors complying with FS TT-P-1952F.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

E. Pavement-Marking Paint, Solvent-Borne: MPI #32, solvent-borne traffic-marking paint.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

F. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than [**three**][**45**] minutes.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

G. Pavement-Marking Paint, Latex: MPI #97, latex traffic-marking paint.

1. Color: [**White**][**Yellow**][**Blue**][**As indicated**]<**Insert color**>.

H. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325D, Type 1[**, made of 100 percent recycled glass**].

1. Roundness: Minimum [**75**][**80**] percent true spheres by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of [**30**][**90**]<**Insert number**> days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of [**15 mils (0.4 mm)**]<**Insert dimension**>.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of **6 lb/gal. (0.72 kg/L)**.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 17 23 00

Task	Specification	Specification Description
32 17 23 13	07 18 00 00	Traffic Coatings
32 17 23 13	32 12 16 00	Asphalt Paving
32 17 23 13	32 13 13 00	Concrete Paving
32 17 23 13	32 17 23 00	Pavement Markings
32 17 23 23	07 18 00 00	Traffic Coatings
32 17 23 23	32 12 16 00	Asphalt Paving
32 17 23 23	32 13 13 00	Concrete Paving
32 17 23 23	32 17 23 00	Pavement Markings
32 17 23 33	07 18 00 00	Traffic Coatings
32 17 23 33	32 12 16 00	Asphalt Paving
32 17 23 33	32 13 13 00	Concrete Paving
32 17 23 33	32 17 23 00	Pavement Markings

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SECTION 32 17 26 00 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.
2. Surface-applied detectable warning tiles.
3. Detectable warning mats.
4. Cast-in-place detectable warning metal tiles.
5. Surface-applied detectable warning metal tiles.
6. Detectable warning unit pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above **50 deg F (10 deg C)** and when temperature has not been below **35 deg F (2 deg C)** for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of **100 deg F (38 deg C)** and higher.

a. When ambient temperature exceeds **100 deg F (38 deg C)**, or when wind velocity exceeds **8 mph (13 km/h)** and ambient temperature exceeds **90 deg F (32 deg C)**, set unit pavers within 1 minute of spreading setting-bed mortar.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in [**the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities**][**and**][**ICC A117.1**] for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Source Limitations: Obtain each type of tactile warning surfacing[**, joint material**][**, setting material**][**, anchor**][**, and**][**fastener**] from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles[**with replaceable surface**] configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACO Polymer Products, Inc.**]

b. [**ADA Solutions, a division of SureWerx USA**]
c. [**Arcis Corp.**]
d. [**Armor-Tile**]
e. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
f. [**Detectable Warning Systems, Inc.**]
g. [**Detectile Corp.**]
h. [**Ecoglo, Inc.**]
i. [**Mingo Products, Inc.**]
j. [**StrongGo Industries, LLC**]
k. [**Transpo Industries, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACO Polymer Products, Inc.**]
b. [**ADA Solutions, a division of SureWerx USA**]
c. [**Arcis Corp.**]
d. [**Armor-Tile**]
e. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
f. [**Detectable Warning Systems, Inc.**]
g. [**Detectile Corp.**]
h. [**Ecoglo, Inc.**]
i. [**Mingo Products, Inc.**]
j. [**StrongGo Industries, LLC**]
k. [**Transpo Industries, Inc.**]
l. <**Insert manufacturer's name**>

3. Material: [**Cast-fiber-reinforced polymer concrete tile**][**Molded glass- and carbon-fiber-reinforced polyester**].
4. Color: [**Safety yellow**][**Red brick**][**Black**][**Gray**][**As selected by Architect from manufacturer's full line**].
5. Shapes and Sizes:

a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)**][**8-foot (2438-mm)**][**10-foot (3048-mm)**][**12-foot (3658-mm)**][**15-foot (4572-mm)**]<**Insert dimension**> outside radius.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting:

a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
b. Detectable warning tile set into formed recess in concrete and adhered with [**mortar**][**adhesive**].
c. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

B. Surface-Applied Detectable Warning Tiles: Accessible truncated-dome detectable warning concrete tiles configured for surface application on existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ADA Solutions, a division of SureWerx USA**]
   b. [**Arcis Corp.**]
   c. [**Armor-Tile**]
   d. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Detectable Warning Systems, Inc.**]
   f. [**Ecoglo, Inc.**]
   g. [**Transpo Industries, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ADA Solutions, a division of SureWerx USA**]
   b. [**Arcis Corp.**]
   c. [**Armor-Tile**]
   d. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Detectable Warning Systems, Inc.**]
   f. [**Ecoglo, Inc.**]
   g. [**Transpo Industries, Inc.**]
   h. <**Insert manufacturer's name**>

3. Material: [**Cast-fiber-reinforced polymer concrete tile**][**Molded glass- and carbon-fiber-reinforced polyester**].
4. Color: [**Safety yellow**][**Red brick**][**Black**][**Gray**][**As selected by Architect from manufacturer's full line**].
5. Shapes and Sizes:

   a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
   b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)**][**8-foot (2438-mm)**][**10-foot (3048-mm)**][**12-foot (3658-mm)**][**15-foot (4572-mm)**]<**Insert dimension**> outside radius.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting: Adhered[**and fastened**] to existing concrete walkway.

C. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles[**with replaceable surface**] configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ADA Solutions, a division of SureWerx USA**]
    b. [**Advantage Tactile Systems**]
    c. [**EJ Group, Inc.**]
    d. [**Neenah Foundry Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ADA Solutions, a division of SureWerx USA**]
    b. [**Advantage Tactile Systems**]
    c. [**EJ Group, Inc.**]
    d. [**Neenah Foundry Company**]
    e. <**Insert manufacturer's name**>

3. Material:

    a. Stainless-Steel Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].

        1) Finish and Color:

            a) Manufacturer's standard powder coat, [**safety yellow**][**red brick**][**black**][**gray**][**color as selected by Architect from manufacturer's full line**].
            b) Mill finish.

    b. Cast Iron: Gray iron, ASTM A48/A48M, CL 35.

4. Shapes and Sizes:

    a. Rectangular panel, [**12 by 12 inches (305 by 305 mm)**][**18 by 24 inches (457 by 610 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**][**36 by 48 inches (914 by 1219 mm)**][**36 by 60 inches (914 by 1524 mm)**]<**Insert dimensions**>.
    b. Radius panel, nominal **24 inches (610 mm)** deep by [**6-foot (1829-mm)outside radius**][**8-foot (2438-mm)outside radius**][**10-foot (3048-mm)outside radius**][**12-foot (3658-mm)outside radius**][**15-foot (4572-mm) outside radius**][**17.5-foot (5334-mm)outside radius**][**outside radius indicated on Drawings**]<**Insert dimension**>.

5. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
6. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
    b. Permanently embedded detectable warning tile set into formed recess in concrete and adhered with [**mortar**][**adhesive**].
    c. Replaceable embedded detectable warning tile fastened to permanently installed anchors.

D. Surface-Applied Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles or plates configured for fastening to surface of existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advantage Tactile Systems**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advantage Tactile Systems**]
   b. <**Insert manufacturer's name**>

3. Material: Stainless-Steel Plate and Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].
4. Finish and Color:

   a. Manufacturer's standard powder coat, [**safety yellow**][**red brick**][**black**][**gray**][**color as selected by Architect from manufacturer's full line**].
   b. Mill finish.

5. Shapes and Sizes:

   a. Rectangular panel, [**24 by 24 inches (610 by 610 mm)**][**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**]<**Insert dimensions**>.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting:

   a. Replaceable surface-applied detectable warning tile fastened with permanently installed anchors to existing concrete walkway.
   b. Permanently fixed detectable warning tile adhered[**and fastened**] to existing concrete walkway.

2.3 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Detectable Warning Systems, Inc.**]

b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Detectable Warning Systems, Inc.**]
   b. **<Insert manufacturer's name>**

3. Material: Modified rubber compound, UV resistant.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]**<Insert color>**.
5. Shapes and Sizes:

   a. Rectangular panel, [**24 by 36 inches (610 by 914 mm)**][**24 by 48 inches (610 by 1219 mm)**][**24 by 60 inches (610 by 1524 mm)**]**<Insert dimensions>**.

6. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]**<Insert spacing>**, in [**square**][**diamond**][**manufacturer's standard**] pattern.
7. Mounting: Adhered to pavement surface with adhesive[**and fastened with fasteners**].

2.4 DETECTABLE WARNING UNIT PAVERS

A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than **5000 psi (34 MPa)** **<Insert value>**, water absorption of not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67, with accessible detectable warning truncated domes on exposed surface of units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Surfaces Inc.**]
   b. [**Armor-Tile**]
   c. [**ECG, Inc.; a division of Elizabeth City Glass Co.**]
   d. [**Hanover Architectural Products**]
   e. [**Tile Tech Pavers**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Advanced Surfaces Inc.**]
   b. [**Armor-Tile**]
   c. [**ECG, Inc.; a division of Elizabeth City Glass Co.**]
   d. [**Hanover Architectural Products**]
   e. [**Tile Tech Pavers**]
   f. **<Insert manufacturer's name>**

3. Shapes and Sizes:

a. Thickness: [**2 inches (51 mm)**][**2-1/2 inches (63 mm)**]<**Insert dimension**> at field of tile.
b. Face Size: Nominal [**12 by 12 inches (305 by 305 mm)**][**24 by 24 inches (610 by 610 mm)**]<**Insert dimensions**>.

4. Dome Spacing and Configuration: [**1.67-inch (42.4-mm) spacing**][**2.35-inch (59.7-mm) spacing**][**Manufacturer's standard compliant spacing**]<**Insert spacing**>, in [**square**][**diamond**][**manufacturer's standard**] pattern.
5. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

B. Setting Bed: Comply with requirements in Section 321400 "Unit Paving."

C. Aggregate Setting Bed:

1. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 8.
2. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
3. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

D. Mortar Setting Bed:

1. Portland Cement: ASTM C150/C150M, Type I or Type II.
2. Sand: ASTM C33/C33M.
3. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
4. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
5. Water: Potable.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish [**Type 304**][**Type 316**] stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus **1/8 inch (3 mm)** from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

B. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus **1/8 inch (3 mm)** from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

C. Surface-Applied Detectable Warning Tiles:

1. Lay out detectable warning tiles as indicated and mark concrete pavement.
2. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

   a. Cut perimeter kerf in existing concrete pavement to receive metal tile flange.

3. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Firmly seat tiles in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
4. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with top surface of mat.

5. Mask perimeter of tiles and adjacent concrete, and apply sealant in continuous bead around perimeter of tile installation.
6. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning tiles and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.
7. Protect installed tiles from traffic until adhesive has set.

3.4 INSTALLATION OF DETECTABLE WARNING MATS

A. Lay out detectable warning mats as indicated and mark concrete pavement at edges of mats.

B. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

C. Apply adhesive to back of mat in amounts and pattern recommended by manufacturer, and set mat in place. Firmly seat mat in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to mat to ensure full contact with adhesive.

D. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface.

E. Mask mat perimeter and adjacent concrete, and apply sealant in continuous bead around perimeter of mat.

F. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning mat and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.

G. Protect installed mat from traffic until adhesive has set.

3.5 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 321400 "Unit Paving."
2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
4. Tolerances: Do not exceed **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.

B. Aggregate Setting-Bed Applications:

1. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
2. Place leveling course and screed to a thickness of **1 to 1-1/2 inches (25 to 38 mm)**, taking care that moisture content remains constant and density is loose and uniform until unit pavers are set and compacted.
3. Treat leveling course with herbicide to inhibit growth of grass and weeds.
4. Set unit pavers with a minimum joint width of **1/16 inch (1.5 mm)** and a maximum of **1/8 inch (3 mm)**, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
5. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz.
6. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate

pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

C. Mortar Setting-Bed Applications:

1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat.
3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform **1/16-inch- (1.5-mm-)** thick bond coat to mortar bed or to back of each paver with a flat trowel.
6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
7. Spaced Joint Widths: Provide [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**] nominal joint width with variations not exceeding plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**].
8. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.

    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Tool exposed joints slightly concave when thumbprint hard.
    c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

9. Remove excess grout from exposed paver surfaces; wash and scrub clean.
10. Protect installation from traffic until grout has set.

3.6 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 32 17 26 00

SECTION 32 18 16 13 - PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Unitary, seamless surfacing.
2. Unitary, tile surfacing.
3. Organic loose-fill surfacing.
4. Inorganic loose-fill surfacing.

1.2 DEFINITIONS

A. Definitions in ASTM F2223 apply to Work of this Section.

B. Critical Height: Standard measure of shock attenuation according to ASTM F2223; same as "critical fall height" in ASTM F1292. According to ASTM F1292, this approximates "the maximum fall height from which a life-threatening head injury would not be expected to occur."

C. SBR: Styrene-butadiene rubber.

D. Unitary Surfacing: A protective surfacing of one or more material components bound together to form a continuous surface; same as "unitary system" in ASTM F2223.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For each type of protective surfacing.

1. Include plans, sections, placement[**and penetration**] details, and attachment to substrates.
2. Include accessories and edge terminations.
3. Include [**patterns made by varying colors of surfacing**][**and**][**details of graphics**].
4. Include fall heights and use zones for equipment and structures specified in Section 116800 "Play Field Equipment and Structures," coordinated with the critical heights for protective surfacing.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of protective surfacing and exposed finish.

1. Include Samples of accessories to verify color and finish selection.

2. Unitary, Seamless Surfacing: Minimum **6 by 6 inches (150 by 150 mm)**.
3. Unitary, Tile Surfacing: Minimum **6 by 6 inches (150 by 150 mm)**.
4. Loose-Fill Surfacing: Minimum **1 quart (0.95 L)**.
5. Edging: **6 inches (150 mm)** long by full width and cross section.
6. Stabilizing Mats: Minimum **12 by 12 inches (300 by 300 mm)**.
7. Drainage/Separation Geotextile: Minimum **12 by 12 inches (300 by 300 mm)**.
8. Drainage Panel: Minimum **6 by 6 inches (150 by 150 mm)**.
9. Weed-Control Barrier: Minimum **12 by 12 inches (300 by 300 mm)**.

F. Product Schedule: For protective surfacing.[**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**testing agency**].

B. Material Certificates: For each type of loose-fill surfacing.

C. Product Certificates: For each type of unitary surfacing product.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For playground protective surfacing to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Unitary Tile Units: Full-size units equal to [**1**]<**Insert number**> percent of amount installed, but no fewer than [**3**]<**Insert number**> units.
2. Loose Fill: Amount equal to [**1**]<**Insert number**> percent of amount installed, but no fewer than [**3**]<**Insert number**> units
3. Edging Units: [**3**]<**Insert number**> full-size units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for materials and execution.

1. Build mockups for protective surfacing including accessories.

a. Size: [**48 inches (1200 mm) by 48 inches (1200 mm)**]<**Insert dimension(s)**>.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of protective surfacing that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Reduction in impact attenuation as measured by reduction of critical fall height.
b. Deterioration of protective surfacing and other materials beyond normal weathering.
c. <**Insert failure modes**>.

2. Warranty Period: [**Two**][**Three**][**Five**][**10**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain protective surfacing materials[**, including loose-fill accessories,**] from single source from single manufacturer.

1. Provide geosynthetic accessories of each type from source recommended by manufacturer of protective surfacing materials.

2.2 PERFORMANCE REQUIREMENTS

A. Impact Attenuation: Critical fall height tested according to ASTM F1292.

B. Accessibility Standard: Minimum surfacing performance according to ASTM F1951.

2.3 UNITARY, SINGLE-DENSITY, SEAMLESS SURFACING

A. Description: Manufacturer's standard, site-mixed and applied, single-layer material in thickness as required, tested for impact attenuation according to ASTM F1292[**and for accessibility according to ASTM F1951**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Child Safe Products, Inc.**]
2. [**GameTime; a PlayCore Company**]
3. [**Hanover Specialties, Inc.**]
4. [**No Fault LLC**]
5. [**Playsafe Surfacing LLC**]

6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Child Safe Products, Inc.**]
2. [**GameTime; a PlayCore Company**]
3. [**Hanover Specialties, Inc.**]
4. [**No Fault LLC**]
5. [**Playsafe Surfacing LLC**]
6. <**Insert manufacturer's name**>

D. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by protective surfacing manufacturer.

2.4 UNITARY, DUAL-DENSITY, SEAMLESS SURFACING

A. Description: Manufacturer's standard, site-mixed and applied, two-layer material with wearing layer over cushioning layer, with combined, overall thickness as required, tested for impact attenuation according to ASTM F1292[**and for accessibility according to ASTM F1951**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Child Safe Products, Inc.**]
2. [**Fibar Group LLC (The)**]
3. [**GameTime; a PlayCore Company**]
4. [**Hanover Specialties, Inc.**]
5. [**Landscape Structures Inc.**]
6. [**No Fault LLC**]
7. [**Playsafe Surfacing LLC**]
8. [**SpectraTurf, Inc**]
9. [**Surface America, Inc.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Child Safe Products, Inc.**]
2. [**Fibar Group LLC (The)**]
3. [**GameTime; a PlayCore Company**]
4. [**Hanover Specialties, Inc.**]
5. [**Landscape Structures Inc.**]
6. [**No Fault LLC**]
7. [**Playsafe Surfacing LLC**]
8. [**SpectraTurf, Inc**]
9. [**Surface America, Inc.**]
10. <**Insert manufacturer's name**>

D. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by protective surfacing manufacturer.

2.5 UNITARY, TILE SURFACING

A. Description: Manufacturer's standard blend of[**recycled**] SBR, EPDM rubber, or PVC particles forming an integral wearing and cushioning material, with overall thickness as required, tested for impact attenuation according to ASTM F1292[**and for accessibility according to ASTM F1951**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BCI Burke Company, LLC**]
2. [**Ecore International**]
3. [**GameTime; a PlayCore Company**]
4. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
5. [**No Fault LLC**]
6. [**OTS Company, Inc.**]
7. [**SpectraTurf, Inc**]
8. [**Surface America, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BCI Burke Company, LLC**]
2. [**Ecore International**]
3. [**GameTime; a PlayCore Company**]
4. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
5. [**No Fault LLC**]
6. [**OTS Company, Inc.**]
7. [**SpectraTurf, Inc**]
8. [**Surface America, Inc.**]
9. <**Insert manufacturer's name**>

D. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by protective surfacing manufacturer.

2.6 UNITARY, DUAL-DENSITY, TILE SURFACING

A. Description: Manufacturer's standard [**EPDM**] colored wearing layer bonded to[**recycled**] rubber cushioning layer, tested for impact attenuation according to ASTM F1292[**and for accessibility according to ASTM F1951**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ecore International**]
2. [**GameTime; a PlayCore Company**]
3. [**Landscape Structures Inc.**]
4. [**OTS Company, Inc.**]
5. [**Playworld Systems, Inc.**]
6. [**SpectraTurf, Inc**]
7. [**Surface America, Inc.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Ecore International**]
2. [**GameTime; a PlayCore Company**]
3. [**Landscape Structures Inc.**]
4. [**OTS Company, Inc.**]
5. [**Playworld Systems, Inc.**]
6. [**SpectraTurf, Inc**]
7. [**Surface America, Inc.**]
8. **<Insert manufacturer's name>**

D. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by protective surfacing manufacturer.

2.7 ORGANIC LOOSE-FILL SURFACING

A. Engineered Wood Fiber: ASTM F2075; containing no bark, leaves, twigs, or foreign or toxic materials[**; tested for accessibility according to ASTM F1951**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fibar Group LLC (The)**]
   b. [**GameTime; a PlayCore Company**]
   c. [**Sof'Solutions Inc.**]
   d. [**Supreme Forest Products, Inc.**]
   e. [**Zeager Bros., Inc.**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Fibar Group LLC (The)**]
   b. [**GameTime; a PlayCore Company**]
   c. [**Sof'Solutions Inc.**]
   d. [**Supreme Forest Products, Inc.**]
   e. [**Zeager Bros., Inc.**]
   f. **<Insert manufacturer's name>**

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]**<Insert value>** percent.
4. Critical Height: [**4 feet (1.2 m)**][**5 feet (1.5 m)**][**7 feet (2.1 m)**][**10 feet (3 m)**][**As indicated on Drawings**]**<Insert dimension>**.
5. Uncompressed Material Depth: Not less than [**as required for critical height indicated**][**6 inches (150 mm)**][**9 inches (229 mm)**][**as indicated on Drawings**]**<Insert dimension>**.

B. Wood Chips: Random-sized wood chips suitable for mulching trees and shrubs, free of metal scrap and other impurities that can cause injuries[**; complying with the testing and performance requirements for hazardous metals and tramp metal according to ASTM F2075**].

C. Double-Shredded Bark Mulch: Random-sized bark, shredded twice, suitable for mulching trees and shrubs, free of metal scrap and other impurities that can cause injuries[**; complying with the testing and performance requirements for hazardous metals and tramp metal according to ASTM F2075**].

2.8 INORGANIC LOOSE-FILL SURFACING

A. Shredded Rubber: Rubber particles, free from steel wires, rubber dust, and other foreign substances, tested for impact attenuation according to ASTM F1292[**and for accessibility according to ASTM F1951**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GameTime; a PlayCore Company**]
   b. [**IMC Outdoor Living. A Division of Liberty Tire Recycling**]
   c. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   d. [**No Fault LLC**]
   e. [**Playsafe Surfacing LLC**]
   f. [**Sof'Solutions Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GameTime; a PlayCore Company**]
   b. [**IMC Outdoor Living. A Division of Liberty Tire Recycling**]
   c. [**Little Tikes Company U.S. (The); PlayPower Inc.**]
   d. [**No Fault LLC**]
   e. [**Playsafe Surfacing LLC**]
   f. [**Sof'Solutions Inc.**]
   g. <**Insert manufacturer's name**>

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**95**]<**Insert value**> percent.
4. Critical Height: [**4 feet (1.2 m)**][**5 feet (1.5 m)**][**7 feet (2.1 m)**][**10 feet (3 m)**][**As indicated on Drawings**]<**Insert dimension**>.
5. Uncompressed Material Depth: Not less than [**as required for critical height indicated**][**6 inches (150 mm)**][**9 inches (229 mm)**][**as indicated on Drawings**]<**Insert dimension**>.
6. Color(s): [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

B. Inorganic Aggregate Materials: Clean, washed, and free of loam, clay, organic matter, debris, and other foreign substances.

1. Fine Sand: Complying with ASTM C136 for the following sieve analysis test results:

   a. Sieve Sizes and Percent Passing through Screen: No. 16 passing 100 percent, No. 30 passing 98 percent, No. 50 passing 62 percent, No. 100 passing 17 percent, and No. 200 passing zero to 1 percent.

2. Coarse Sand: Complying with ASTM C136 for the following sieve analysis test results:

a. Sieve Sizes and Percent Passing through Screen: No. 4 passing 98 percent, No. 8 passing 73 percent, No. 16 passing 4 percent, No. 30 passing 1 percent, and No. 50 passing zero to 1 percent.

3. Fine Gravel: Rounded, hard, durable stone, free of sand, with particle size less than **3/8 inch (9.5 mm)** in diameter; complying with ASTM C136 for the following sieve analysis test results:

   a. Sieve Sizes and Percent Passing through Screen: **3/8 inch (9.5 mm)** passing 100 percent, No. 3-1/2 passing 93 percent, No. 4 passing 65 percent, No. 8 passing 8 percent, No. 16 passing 5 percent, and No. 30 passing 4 percent.

4. Medium Gravel: Rounded, hard, durable, riverbed gravel or tumbled stone, free of sand, with particle size less than **1/2 inch (13 mm)** in diameter; complying with ASTM C136 for the following sieve analysis test results:

   a. Sieve Sizes and Percent Passing through Screen: **1/2 inch (13 mm)** passing 100 percent, **3/8 inch (9.5 mm)** passing 80 percent, **5/16 inch (8 mm)** passing 20 percent, No. 4 passing 8 percent, and No. 16 passing 3 percent.

5. Critical Height: [**4 feet (1.2 m)**][**5 feet (1.5 m)**][**As indicated on Drawings**]<**Insert dimension**>.
6. Uncompressed Material Depth: Not less than [**as required for critical height indicated**][**9 inches (229 mm)**][**as indicated on Drawings**]<**Insert dimension**>.

2.9 LOOSE-FILL ACCESSORIES

A. Edging: Anchored-in-place, weather-resistant containment barrier designed to minimize sharp edges, protrusions, and tripping hazards; formed by interconnected, modular units.

1. Polyethylene Units: UV-light-stabilized[**, 100 percent recycled**] polyethylene, not less than [**1/4-inch (6-mm)**]<**Insert dimension**> wall thickness; made into smooth-surfaced [**straight**][**and**][**curved**] units with radiused exposed edges and integral, molded-in color; in manufacturer's standard sizes.

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2. Metal Units: Steel fabricated with radiused exposed edges and finished with PVC coating, [**straight**][**right-angled corner**][**and**][**curved**] units, in manufacturer's standard sizes.

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

3. Rubber Units: Compression molded from[**100 percent recycled**] SBR, in manufacturer's standard sizes.

   a. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

4. Anchor Stakes: Manufacturer's standard, of corrosion-resistant-coated metal or noncorrodible material, designed to be nonprotruding when installed, for connecting units and securing in-place.

B. Stabilizing Mats: Water-permeable PVC or rubber mats tested for impact attenuation according to ASTM F1292[**, with anchoring system designed to anchor mat securely to subgrade through loose fill**],

and rated for use in the following locations:

1. Under and in Front of Slide Exits: [**At finished grade of protective surfacing**][**Below surface of protective surfacing**][**As indicated on Drawings**].
2. Under and Around Swings: [**At finished grade of protective surfacing**][**Below surface of protective surfacing**][**As indicated on Drawings**].
3. Around Transfer Stations at Accessible Perimeter: At finished grade of protective surfacing.
4. At high-traffic areas and playground equipment where indicated on Drawings.
5. Size: [**Manufacturer's standard size as recommended in writing**][**36 by 36 inches (914 by 914 mm)**][**40 by 40 inches (1016 by 1016 mm)**][**48 by 48 inches (1200 by 1200 mm)**]<**Insert dimensions**>.
6. Color(s): [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert colors**>.

2.10 GEOSYNTHETIC ACCESSORIES

A. Drainage/Separation Geotextiles: Comply with Section 312000 "Earth Moving."

B. Drainage/Separation Geotextile: Nonwoven, needle-punched geotextile, manufactured for drainage applications and made from polyolefins or polyesters; with the following minimum properties:

1. Weight: [**4 oz./sq. yd. (136 g/sq. m)**]<**Insert value**>; ASTM D5261.
2. Water Flow Rate: [**100 gpm/sq. ft. (68 L/s per sq. m)**][**150 gpm/sq. ft. (102 L/s per sq. m)**]<**Insert value**> according to ASTM D4491.

C. Drainage Panel: Prefabricated, composite drainage panels made with drainage core and filter fabric.

1. Drainage Core: Three-dimensional, nonbiodegradable, molded-plastic-sheet material designed to effectively drain water under maximum fill pressures.
2. Fabric: Nonwoven, needle-punched geotextile, specifically manufactured as a filter geotextile and made from polyolefins or polyesters; with the following minimum properties:

   a. Weight: [**4 oz./sq. yd. (136 g/sq. m)**]<**Insert value**> according to ASTM D5261.
   b. Water Flow Rate: [**100 gpm/sq. ft. (68 L/s per sq. m)**][**150 gpm/sq. ft. (102 L/s per sq. m)**]<**Insert value**> according to ASTM D4491.

3. Minimum Flow Rate: [**9 gpm/foot (1.9 L/s per m)**]<**Insert value**> according to ASTM D4491.

D. Weed-Control Barrier: Composite fabric geotextile consisting of woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, weighing not less than **4.8 oz./sq. yd. (160 g/sq. m)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for subgrade elevations, slope, and drainage and for other conditions affecting performance of the Work.

1. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Hard-Surface Substrates: Verify that substrates are satisfactory for unitary, protective surfacing

installation and that substrate surfaces are dry, cured, and uniformly [**level**][**sloped to drain**] within recommended tolerances according to protective surfacing manufacturer's written requirements for cross-section profile.

1. Asphalt Substrates: Verify that substrates are dry, sufficiently cured to bond with adhesive, and free from surface defects, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with protective surfacing or that may interfere with adhesive bond.
2. Concrete Substrates: Verify that substrates are dry and free from surface defects, laitance, glaze, efflorescence, curing compounds, form-release agents, hardeners, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with protective surfacing or that may interfere with adhesive bond. Determine adhesion, dryness, and acidity characteristics by performing procedures recommended in writing by protective surfacing manufacturer.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates to receive surfacing products according to protective surfacing manufacturer's written instructions.

B. Hard-Surface Substrates: Clean surface free of laitance, efflorescence, curing compounds, and other contaminants incompatible with protective surfacing.

1. Repair: Fill holes and depressions in unsatisfactory surfaces with leveling and patching material.
2. Treatment: Mechanically abrade or otherwise prepare concrete substrates according to protective surfacing manufacturer's written instructions to achieve adequate roughness.
3. Terminal Edges: Saw cut [**concrete**][**asphalt**] for terminal edges of protective surfacing.
4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through protective surfacing.

3.3 INSTALLATION OF GEOSYNTHETIC ACCESSORIES

A. Install geosynthetic accessories before edging and according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions and in a manner that cannot become a tripping hazard.

1. Drainage/Separation Geotextile: Completely cover area beneath protective surfacing, overlapping geotextile sides and edges a minimum of [**4 inches (100 mm)**][**8 inches (200 mm)**]<**Insert dimension**> with [**manufacturer's standard treatment for**][**overlapping loosely laid**][**adhesively bonded or taped**] seams.
2. Drainage Panels: Completely cover area beneath protective surfacing, abutting the drainage cores and overlapping seams with geotextile fabric facing with [**manufacturer's standard treatment**][**overlapping loosely laid**][**adhesively bonded or taped**] seams.
3. Weed-Control Barrier: Completely cover area beneath loose-fill installation, overlapping barrier edges a minimum of [**4 inches (100 mm)**][**8 inches (200 mm)**]<**Insert dimension**> with [**manufacturer's standard treatment for**][**overlapping loosely laid**][**adhesively bonded or taped**] seams.

3.4 INSTALLATION OF SEAMLESS SURFACING

A. Mix and apply components of seamless surfacing according to manufacturer's written instructions to produce uniform, monolithic, and impact-attenuating protective surfacing of required overall thickness.

1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
2. Poured Cushioning Layer: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints.
3. Intercoat Primer: Over cured cushioning layer, apply primer at manufacturer's standard spreading rate.
4. Wearing Layer: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with [**no**][**a minimum of**] cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.

    a. Design: Where [**colored pattern**][**graphic design**] is required, place colored, design material as soon as previously placed material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.

5. Lacquer Topcoat: Spray or roller applied at manufacturer's standard coating rate in one continuous operation.
6. Edge Treatment: [**Flush**][**Extended surface course**][**Saw-cut base and vertical pour**][**As indicated on Drawings**]. Fully adhere edges to substrate with full coverage of substrate. Maintain fully cushioned thickness required to comply with performance requirements.

3.5 INSTALLATION OF TILE SURFACING

A. Apply components of tile surfacing according to manufacturer's written instructions to produce a uniform wearing surface with no unaligned units, raised edges (lipping), or other surface imperfections.

B. Lay out units from center marks established between principal perimeter edges, discounting minor offsets, so units at opposite sides of installation are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half of a unit.[**Allow for edging.**]

1. Alignment Axis and Pattern:

    a. Lay units along axis and in grid pattern indicated on Drawings.
    b. Lay units [**square**][**at a 45-degree angle**] with playground equipment axis. Lay units in straight-line grid pattern with joints aligned.
    c. Lay units [**square**][**at a 45-degree angle**] with playground equipment axis. Lay units in half-unit, offset grid pattern with staggered joints.

C. Cut and fit units around playground equipment supports and vertical surfaces. Do not create voids greater than **3/8 inch (9.5 mm)** wide.

1. Do not stretch units during installation.

D. Adhesively Applied Units: Adhere units to substrates using a full spread of adhesive applied to substrate or to unit[**and to each other**].

E. Mechanically Fastened Units: Anchor to substrates.

F. Mechanically Attached Units: Attach all four sides of units[**, including edging and corner units,**] to each other using number of fasteners per side as recommended in writing by protective surfacing manufacturer.

1. Free lay sheet of attached units on substrate.
2. Adhesively apply perimeter units. Adhere not less than one course of perimeter units[**and**

edging and corner units] to substrates using a full spread of adhesive applied to substrate or to unit[**and to each other**].

G. Edging: Maintain fully cushioned thickness required to comply with performance requirements.

H. Filler/Sealant: Mask area surrounding cutouts around playground equipment supports and other obstructions. Apply a full bead of filler/sealant, filling cutouts immediately after laying tile around cutout.

3.6 INSTALLATION OF LOOSE-FILL SURFACING

A. Apply components of loose-fill surfacing according to manufacturer's written instructions to produce a uniform surface.

B. Edging: Place and permanently secure edging in place, and attach units to each other.

C. Loose Fill: Place loose-fill materials to required depth after installation of playground equipment support posts and foundations.[**Include manufacturer's recommended amount of additional material to offset natural compaction over time.**][**Include manufacturer's recommended amount of additional material to offset mechanical compaction.**]

D. Stabilizing Mats: Coordinate installation of mats and mat anchoring system with placing[**and compacting**] loose fill.

E. Grading: Uniformly grade loose fill to an even surface free from irregularities.

F. Compaction: After initial grading, mechanically compact loose fill before finish grading.

G. Finish Grading: Hand rake to a uniformly smooth finished surface and to required elevations.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Perform the following tests[**with the assistance of a factory-authorized service representative**]:

1. Perform "Installed Surface Performance Test" according to ASTM F1292 for each protective surfacing type and thickness in each playground area.
2. Perform installed-surface-performance tests at no less than one series of tests for each [**1000 sq. ft. (100 sq. m)**]<**Insert dimension**> of each type and thickness of in-place protective surfacing or part thereof.

C. Playground protective surfacing will be considered defective if it does not pass tests.

D. Prepare test reports.

3.8 PROTECTION

A. Prevent traffic over [**seamless**][**tile**] surfacing for not less than 48 hours after installation.

END OF SECTION 32 18 16 13

Task	Specification	Specification Description
32 31 11 00	32 31 13 00	Chain Link Fences And Gates

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SECTION 32 31 13 00 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fence framework.
2. Chain-link fence fabric.
3. Chain-link fittings.
4. Chain-link wires and ties.
5. Chain-link swing gates.
6. Chain-link horizontal-slide gates.
7. Gate operators and controls.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete for post footings[**and equipment bases/pads for gate operators and controls**].
2. Section 281500 "Integrated Access Control Hardware Devices" for gate controls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Inspect and discuss [**electrical roughing-in,**] equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.
5. <**Insert requirement**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
b. Fence [**and gate**] posts, rails, and fittings.
c. Chain-link fabric, reinforcements, [**gate types, hardware,**] and attachments.
d. Accessories: [**Privacy slats**][**Barbed wire**][**Barbed tape**]<**Insert item**>.
e. Gates and hardware.
f. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence [**and gate**] assembly.

1. Include plans, elevations, sections, ground details, [**mounting,**] post spacing, and attachments to

other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In **6-inch (150-mm)** lengths for components and on full-sized units for accessories.

E. Delegated Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**][**factory-authorized service representative**].

B. Product Certificates: For each type of chain-link fence,[**operator,**] and gate.

C. Product Test Reports: For framework strength in accordance with ASTM F1043, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**or**][**a qualified testing agency**].

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: In accordance with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence[**and gate**], including accessories.

a. Size: [**10 ft. (3 m)**]<**Insert dimension**> length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**] to repair or replace components of fences[**, gates, operators, and controls**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.
d. <**Insert failure modes**>.

2. Warranty Period: [**Five**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks are to withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. Design Wind Load: [**As indicated on Drawings**]<**Insert loads**>.

a. Minimum Post Size: Determine in accordance with ASTM F1043 for post spacing not to exceed [**10 feet (3 m)**]<**Insert dimension**> for Material [**Group IA, ASTM F1043, Schedule 40 steel pipe**][**Group IC, electric-resistance-welded round steel pipe**]<**Insert material group**>.
b. Minimum Post Size and Maximum Spacing: Determine in accordance with CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

D. Accessibility: Pedestrian gates to comply with the United States Access Board's ADA-ABA Accessibility Guidelines.

2.2 CHAIN-LINK FENCES, GENERAL

A. CLFMI Publications: Comply with the CLFMI Product Manual unless modified by requirements in the

Contract Documents.

B. Chain-Link Fence and Gate Assemblies: Include materials applicable for a complete assembly of application types, consisting of commercial, industrial, and security chain-link fences and gates.

1. Source Limitations: Obtain chain-link fence and gate components from single source or manufacturer.

2.3 CHAIN-LINK FENCE FRAMEWORK

A. Posts and Rails <**Insert drawing designation**>: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thicknesses in accordance with ASTM F1043[**or ASTM F1083**] based on the following:

1. Fence Height: [**72 inches (1830 mm)**][**96 inches (2440 mm)**][**As indicated on Drawings**]<**Insert dimension**>.
2. Light-Industrial-Strength Material: [**Group IC-L, round steel pipe, electric-resistance-welded pipe**][**Group II-L, roll-formed-steel C-section shapes**][**Group III-L, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

   a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.
   b. End, Corner, and Pull Posts: [**2.375 inches (60 mm)**][**2.875 inches (73 mm)**][**4.0 inches (102 mm)**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.

3. Heavy-Industrial-Strength Material: [**Group IA, round steel pipe, Schedule 40**][**Group IC, round steel pipe, electric-resistance-welded pipe**][**Group II, roll-formed-steel C-section shapes**][**Group III, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

   a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**1.875 by 1.63 inches (48 by 41 mm)**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.
   b. End, Corner, and Pull Posts: [**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.

4. Horizontal Framework Members: [**Intermediate**][**top**][**and**][**bottom**] rails in accordance with ASTM F1043.

   a. Top Rail: [**1.66 inches (42 mm) in diameter**][**1.25 by 1.63 inches (32 by 41 mm)**]<**Insert dimension(s)**>.

5. Brace Rails: ASTM F1043.
6. Metallic Coating for Steel Framework:

   a. Type A: Not less than minimum **2.0 oz./sq. ft. (0.61 kg/sq. m)** average zinc coating in accordance with ASTM A123/A123M or **4.0 oz./sq. ft. (1.22 kg/sq. m)** zinc coating in accordance with ASTM A653/A653M.
   b. Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable

polymer film.

c. External, Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than **0.3-mil- (0.0076-mm-)** thick, zinc-pigmented coating.

d. Type C: Zn-5-Al-MM alloy, consisting of not less than **1.8 oz./sq. ft. (0.55 kg/sq. m)** coating.

e. Coatings: Any coating above.

7. Polymer coating over metallic coating.

a. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

2.4 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist in accordance with "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: <**Insert dimension**>[**As indicated on Drawings**].
2. Steel Wire for Fabric: Wire diameter of [**0.192 inch (4.88 mm)**][**0.148 inch (3.76 mm)**][**0.120 inch (3.05 mm)**][**0.113 inch (2.87 mm)**]<**Insert dimension**>.

a. Mesh Size: [**2-1/8 inches (54 mm)**][**2 inches (50 mm)**][**1-3/4 inches (44 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

b. Aluminum-Coated Fabric: ASTM A491, Type I, [**0.40 oz./sq. ft. (122 g/sq. m)**][**0.35 oz./sq. ft. (107 g/sq. m)**][**0.30 oz./sq. ft. (92 g/sq. m)**].

c. Zinc-Coated Fabric: ASTM A392, Type II, [**Class 1, 1.2 oz./sq. ft. (366 g/sq. m)**][**Class 2, 2.0 oz./sq. ft. (610 g/sq. m)**] with zinc coating applied [**before**][**after**] weaving.

d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, [**Class 1, 0.60 oz./sq. ft. (183 g/sq. m)**][**Class 2, 1.0 oz./sq. ft. (305 g/sq. m)**].

e. Polymer-Coated Fabric: ASTM F668, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1) Color: [**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

f. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F1183, with [**mill**][**caustic-cleaned or etched**] finish, and wire diameter of [**0.148 inch (3.76 mm)**][**0.192 inch (4.88 mm)**].

a. Mesh Size: [**2 inches (50 mm)**][**1 inch (25 mm)**].

4. Selvage: [**Knuckled at both selvages**][**Twisted top and knuckled bottom**].

2.5 CHAIN-LINK FITTINGS

A. Provide fittings in accordance with ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: [**Pressed-steel or round-steel tubing**][**Aluminum Alloy 6063**] not less than **6 inches (152 mm)** long.
2. Rail Clamps: Line and corner boulevard clamps for connecting [**intermediate**][**and**][**bottom**] rails to posts.

E. Tension and Brace Bands: [**Pressed steel**][**Aluminum Alloy 6063**].

F. Tension Bars: [**Steel**][**Aluminum**][**Fiberglass**], length not less than **2 inches (50 mm)** shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: [**Steel, hot-dip galvanized after threading**][**Mill-finished aluminum**] rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: [**Pressed steel or cast iron**][**Aluminum**], with clips, slots, or other means for attaching strands of barbed wire[**, and means for attaching to posts**][**, integral with post cap**], for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: [**Type I, slanted arm**][**Type II, vertical arm**].
4. Double-Arm Type: [**Type III, V-shaped arm**][**Type IV, A-shaped arm**].

I. Tie Wires, Clips, and Fasteners: In accordance with ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, in accordance with the following:

a. Hot-Dip Galvanized Steel: [**0.106-inch- (2.69-mm-)**][**0.148-inch- (3.76-mm-)**] diameter wire[**; galvanized coating thickness matching coating thickness of chain-link fence fabric**].
b. Aluminum: ASTM B211/B211M; Alloy 1350-H19; [**0.148-inch- (3.76-mm-)**][**0.192-inch- (4.88-mm-)**] diameter, mill-finished wire.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.6 CHAIN-LINK WIRE AND TIES

A. Metallic-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, marcelled tension wire in accordance with ASTM A817 or ASTM A824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) by [**hot-dip**][**electrolytic**] process, with the following minimum coating weight:

    a. Class 3: Not less than **0.8 oz./sq. ft. (244 g/sq. m)** of uncoated wire surface.
    b. Class 4: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of uncoated wire surface.
    c. Class 5: Not less than **2 oz./sq. ft. (610 g/sq. m)** of uncoated wire surface.
    d. Matching chain-link fabric coating weight.

3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

    a. Class 60: Not less than **0.6 oz./sq. ft. (183 g/sq. m)** of uncoated wire surface.
    b. Class 100: Not less than **1 oz./sq. ft. (305 g/sq. m)** of uncoated wire surface.
    c. Matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: [**0.177-inch- (4.5-mm-)**][**0.148-inch- (3.8-mm-)**] diameter, tension wire in accordance with ASTM F1664, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

C. Aluminum Wire: **0.192-inch- (4.88-mm-)** diameter tension wire, mill finished, in accordance with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94 with **50,000-psi (344-MPa)** minimum tensile strength.

2.7 CHAIN-LINK SWING GATES

A. General: ASTM F900 for gate posts and [**single**][**double**] swing gate types.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Gate Leaf Width: [**36 inches (914 mm)**][**As indicated**]<**Insert width**>.
2. Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

B. Swing Gate Pipe and Tubing:

1. Swing Gate Posts: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
2. Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
3. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; [**protective coating and finish to match fence framework**][**manufacturer's standard protective coating and finish**]<**Insert finish**>.
4. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.

C. Swing Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Swing Gate Extended Posts and Frame Members: Fabricate gate posts and frame end members to extend [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> above top of chain-link fabric at both ends of gate frame to attach barbed [**wire**][**tape**] assemblies.

E. Swing Gate Hardware:

1. Hinges: [**180-degree inward**][**180-degree outward**][**360-degree inward and outward**] swing.
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].

3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.
4. Padlock and Chain: <**Insert requirements**>.
5. Closer: [**Manufacturer's standard**]<**Insert requirement**>.
6. <**Insert hardware items and accessories**>.

2.8 CHAIN-LINK HORIZONTAL-SLIDE GATES

A. Chain-Link Horizontal-Slide Gates: ASTM F1184 for gate posts and [**single**][**double**] sliding gate types for [**pedestrian**][**and**][**vehicle**] assembly.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Classification:

a. Type I Overhead Slide:

1) Gate Leaf Width: [**As indicated**]<**Insert width**>.
2) Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

b. Type II Cantilever Slide, [**Class 1 with external**][**Class 2 with internal**] roller assemblies:

1) Slide Gate Frame Width and Height: [**48 inches (1220 mm) wide or less by 72 inches (1830 mm) high or less**][**More than 48 inches (1220 mm) wide by any height**][**As indicated**]<**Insert dimension**>.

B. Slide Gate Pipe and Tubing Finish:

1. Zinc-Coated Steel: [**Protective coating and finish to match fence framework**][**Manufacturer's standard protective coating and finish**]<**Insert finish**>.
2. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.
3. Sliding Gate Posts: ASTM F1184. Provide [**round tubular steel**][**rectangular tubular steel**][**round tubular aluminum**][**rectangular tubular aluminum**] posts.
4. Sliding Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].

C. Slide Gate Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Slide Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> as required to attach barbed [**wire**][**tape**] assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framework supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Slide Gate Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished Grade 319 aluminum-alloy casting with stainless steel fasteners**].
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].
3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.

4. Padlock and Chain: <**Insert requirements**>.
5. <**Insert hardware items and accessories**>.

2.9 ACCESSORIES

A. Privacy Slats:

1. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than **0.06 inch (1.5 mm)** thick, sized to fit mesh specified for direction indicated[**, with vandal-resistant fasteners and lock strips**].
2. Tubular Polyethylene Slats: Minimum **0.023-inch (0.58-mm)**-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with [**vandal-resistant fasteners and lock strips**][**fins for increased privacy factor**].
3. Aluminum Slats: Minimum **0.01-inch (0.25-mm)**-thick aluminum, sized to fit mesh specified for direction indicated.
4. Redwood Slats: **5/16-inch (7.9-mm)**-thick redwood, sized to fit mesh specified for direction indicated.
5. Hedge-Type Slats: UV-light-stabilized[**, flame-resistant**], PVC "needles" woven into braided, galvanized wire core, sized to fit mesh specified for direction indicated.
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**]<**Insert color**>.

B. Barbed Wire:

1. Steel Barbed Wire: ASTM A121, two-strand barbed wire, **0.099-inch- (2.51-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point round barbs spaced not more than **5 inches (127 mm)** o.c.

   a. Aluminum Coating: Type A.
   b. Zinc Coating: Type Z, Class 3.

2. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F1665, two-strand barbed wire, **0.080-inch- (2.03-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point, round [**aluminum alloy**][**galvanized-steel**] barbs spaced not more than **5 inches (127 mm)** o.c.

   a. Polymer Coating: [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

      1) Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**] in accordance with ASTM F934.

3. Barbed Tape:

   a. Wire-Reinforced Tape: ASTM F1910; continuous coils with four-point, needle-sharp barbs permanently cold clenched around a core wire.
   b. Core Wire: High-tensile-strength, [**zinc-coated steel**][**or**][**stainless steel**].
   c. Configuration: [**Single**][**Double**] coil.
   d. Style: [**Helical**][**Concertina**] pattern.
   e. Coil Diameter(s): [**18-inch (457-mm)**][**24 inches (610 mm)**][**24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil**][**As indicated on Drawings**]<**Insert diameter**>.
   f. Coil Loop Spacing(s): [**12 inches (300 mm)**][**Manufacturer's standard**][**As indicated on Drawings**]<**Insert spacing**>.

g. Barb Length Classification: [**Long, 1.2-inch (30.5-mm)**][**Medium, 0.4-inch (10.2-mm)**][**Short, 0.1875-inch (4.76-mm)**] barb.
h. Barb Spacing: [**4 inches (102 mm)**]<**Insert dimension**> o.c.
i. Barb Set: [**Straight**][**Offset**][**Manufacturer's standard**].

4. Clips: Stainless steel, **0.065 inch (1.7 mm)** thick by **0.375 inch (9.5 mm)** wide, capable of withstanding a minimum **150-lbf (667-N)** pull load to limit extension of coil, resulting in a concertina pattern when deployed.
5. Tie Wires: Stainless steel, **0.065 inch (1.7 mm)** in diameter.

C. Touch-up Paint: Liquid polymer for field coating with polymer coated fencing components as recommended by manufacturer.

2.10 GATE OPERATORS AND CONTROLS

A. Provide factory-assembled automatic operating system designed for [**pedestrian**][**and**][**vehicle**] gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with [**remote-control stations**], safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide [**UL 325 listed operators for swing gates**][**BHMA A156.19 listed operators for pedestrian gates**][**ASTM F2200 for automated vehicular gates**].

B. Comply with NFPA 70.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: [**110 V**][**220 V**][**24 V dc**][**NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected**]<**Insert voltage**>.
2. Phase: [**One**][**Polyphase**].
3. Enclosure: [**Open dripproof**][**Totally enclosed**][**Manufacturer's standard**].
4. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 ft. (1005 m)** above sea level.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

E. Gate Operators: [**Gate**][**Concrete base**][**Post**][**In-ground**] mounted and as follows:

1. Hydraulic Gate Operators: [**Swing**][**Slide**].

a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
b. Gate Speed: Minimum [**45 feet (13.7 m)**][**60 feet (18.2 m)**] per minute.
c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**Continuous duty**].
e. Hydraulic Fluid: Viscosity required for gate operation at ambient temperature range for Project.
f. Locking: Hydraulic in both directions.

2. Mechanical Gate Operators: [**Swing**][**Slide**].

   a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
   b. Gate Speed: Minimum [**45 feet (13.7 m) per minute**][**60 feet (18.2 m) per minute**][**variable speed**]<**Insert speed**>.
   c. Maximum Gate Weight: [**600 lb (272 kg)**][**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
   d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**].
   e. Operating Type: [**Crank arm**][**Wheel-and-rail drive**][**Roller chain**].
   f. <**Insert feature**>.

F. Activation Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA ICS 6, Type 1**][**NEMA ICS 6, Type 4**]<**Insert type of enclosure**> enclosure for [**surface**][**recessed or flush**][**concrete base**][**pedestal**]<**Insert mounting**> mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1. Control Station:

   a. Keyed, [**two**][**three**]-position switch with open[**, stop,**] and close function; located remotely from gate. Provide two keys per station.
   b. Momentary-contact, [**single**][**three**]-button-operated with open[**, stop,**] and close function; located remotely from gate.[**Key switch to lock out open and close buttons.**]
   c. <**Insert other type**>.

2. Card Reader: Functions only when authorized card is presented. Programmable, [**multiple**][**single**]-code system[**, permitting four different access periods**][**; face-lighted unit fully visible at night**].

   a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
   b. Card Reader Features:

      1) Usage Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].

3. <**Insert other reader type and features**>.
4. Digital Keypad Entry Unit: [**Programmable,**]multiple-code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**1- to 7**][**4**][**5**]-digit codes[**, and permitting four different access periods**].
5. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.
6. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

   a. Transmitters: [**Single**][**Three**]-button operated, with open [**and close**]function.
   b. Channel Settings: [**Two**][**Three**][**Four**]<**Insert number**> independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

7. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

   a. Residential System: Designed to be wired to same line with telephone.
   b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to

access [**20**][**100**]<**Insert number**> telephones[**, and with electronic directory**].
c. <**Insert other system type and features**>.
d. Intercom System: <**Insert requirements**>.

G. Vehicle Sensing System: System includes automatic closing timer with adjustable time delay[**, timer cutoff switch,**] and loop detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert functions**>. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location indicated on Drawings.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles and hold until clear of obstruction**][**Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as recommended by manufacturer.
4. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

I. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

J. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability for monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cutoff switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: [**24-hour**][**Seven-day**]<**Insert time**> programmable for regular events.

K. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.
2. Battery Backup System: Battery-powered drive and access-control system, independent of

primary drive system.

a. Fail-Safe: Gate opens and remains open until power is restored.
b. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is drained.

3. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
4. [**Fire**][**Postal**] box.
5. Fire [**strobe**][**siren**] sensor.
6. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.
7. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (305 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

2.11 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.12 CONCRETE

A. Concrete Post Footings: Minimum 28-day compressive strength of **2500 psi (17.2 MPa)**.

2.13 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, **5/8 by 96 inches (16 by 2440 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for[**a certified survey of property lines and legal boundaries,**] site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by

Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 feet (152 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION OF CHAIN-LINK FENCES

A. Install chain-link fencing in accordance with ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts [**in concrete**][**with mechanical anchors**][**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend **2 inches (50 mm)** above grade; shape and smooth to shed water.
b. Concealed Concrete: Place top of concrete [**2 inches (50 mm)**]<**Insert dimension**> below grade [**as indicated on Drawings**]to allow covering with surface material.
c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
d. Posts Set into Holes in Concrete: Form or core drill holes not less than **5 inches (127 mm)** deep and **3/4 inch (20 mm)** larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of [**30 inches (762 mm)**][**36 inches (914 mm)**]<**Insert dimension**>. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of [**15 degrees or more**][**30 degrees or more**][**as indicated on Drawings**]<**Insert requirement**>. For runs exceeding **500 feet (152 m)**, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at [**96 inches (2440 mm)**][**10 feet (3 m)**]<**Insert dimension**> o.c.

F. Post Bracing and Intermediate Rails: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric **72 inches (1830 mm)** or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with **0.120-inch- (3.05-mm-)** diameter hog rings of same material and finish as fabric wire, spaced a maximum of **24 inches (610 mm)** o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along [**top**][**and**][**bottom**] of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within **6 inches (152 mm)** of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of [**barbed wire arms**][**extended posts**] and top of fence fabric to support barbed tape.
3. [**As indicated on Drawings**]<**Insert requirements**>.

H. Top Rail: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to [**outside**][**inside**] of enclosing framework. Leave [**1-inch (25-mm)**][**2-inch (50-mm)**] bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than **15 inches (380 mm)** o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric in accordance with ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at **12 inches (300 mm)** o.c. and to braces at **24 inches (610 mm)** o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.[**Peen ends of bolts or score threads to prevent removal of nuts.**]

N. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. [**Vertically**][**Horizontally**][**, for privacy factor of 70 to 75**]<**Insert privacy factor range**>.
2. Diagonally[**for privacy factor of 80 to 85**]<**Insert privacy factor range**>.
3. Direction[**and privacy factor**] as indicated on Drawings.

O. Barbed Wire: Install barbed wire uniformly spaced[**, angled toward security side of fence**][**as indicated on Drawings**]. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

P. Barbed Tape: Install in accordance with ASTM F1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 INSTALLATION OF GATE OPERATORS

A. Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations in accordance with gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: [**Cut grooves in pavement, bury, and seal**][**Bury**] wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

D. Ground electric-powered motors, controls, and other devices in accordance with NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts is to be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of [**1500 feet (450 m)**]<**Insert dimension**>.
3. Fences within 100 ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [**750 ft. (225 m)**]<**Insert dimension**>.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground in accordance with IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches**

(152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor in accordance with NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls[**, alarms,**] and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13 00

SECTION 32 31 13 13 - HIGH-SECURITY CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. High-security chain-link fences.
2. Swing gates.
3. Horizontal-slide gates.
4. Soil sterilization.

B. Related Requirements:

1. Section 013513.16 "Special Project Procedures for Detention Facilities" for general requirements of detention work, including responsibilities of a single-source detention specialist.
2. [**Section 033000 "Cast-in-Place Concrete"**][**Section 033053 "Miscellaneous Cast-in-Place Concrete"**] for cast-in-place concrete [**equipment bases/pads for gate operators and controls**][**post footings**][**and**][**continuous concrete grade beam**].
3. Section 119814 "Detention Door Hardware" for detention door hinges and locks for swing and slide gates.
4. Section 281500 "Access Control Hardware Devices" for gate controls.
5. Section 281643 "Perimeter Security Systems" for fence-mounted gate-movement detectors.
6. Section 285213 "Detention Monitoring and Control System and Interfaces" for detection and alarm systems and for gate controls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review coordination of soil sterilization with work specified elsewhere.
3. Review sequence of operation for each type of gate operator.
4. Review coordination of interlocked equipment specified in this Section and elsewhere.
5. Review required testing, inspecting, and certifying procedures.
6. <**Insert requirement**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: [**Barbed wire**][**Barbed tape**]<**Insert item**>.
d. Gates and hardware.

e. Gate operator, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In **6-inch (150-mm)** lengths for components and on full-sized units for accessories.

E. Delegated Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**][**factory-authorized service representative**].

B. Product Certificates: For each type of chain-link fence[**, operator,**] and gate.[**Soil-sterilization certificate of treatment stating materials and quantities used, and date of application.**]

C. Product Test Reports: For framework strength in accordance with ASTM F1043, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**or**][**a qualified testing agency**].

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence[**and gate**], including accessories.

a. Size: [**10-foot (3-m)**]<**Insert dimension**> length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**] to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.
d. <**Insert failure modes**>.

2. Warranty Period: [**Five**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated in accordance with [**ASCE/SEI 7**]<**Insert requirement**>:

1. Design Wind Load: [**As indicated on Drawings**]<**Insert loads**>.

a. Minimum Post Size: Determine in accordance with ASTM F1043 for post spacing not to exceed [**10 feet (3 m)**]<**Insert dimension**> for Material [**Group IA, ASTM F1043, Schedule 40 steel pipe**][**Group IC, electric-resistance-welded round steel pipe**]<**Insert material group**>.
b. Minimum Post Size and Maximum Spacing: Provide line posts of size and in spacing indicated, but not less than sizes and spacings determined in accordance with CLFMI WLG 2445, based on mesh size and pattern specified.

C. Deflection Limits: Fence deflections shall be within the following limits:

1. Fabric Tension: Maximum [**2.5 inches (64 mm)**]<**Insert dimension**>when tested by applying a **30-lbf (133-N)** force at midpoint between rails and horizontally between posts for every eighth

lower panel along the fence line. Measure fabric movement from the relaxed position at the point where the force is applied.

2. Fence Post Rigidity: Maximum [**3/4 inch (19 mm)**]<**Insert dimension**> when a **50-lbf (222-N)** force is applied at midheight of every eighth post along the fence line. Measure post movement from the relaxed position at the point where the force is applied.

D. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in height measured between top and bottom of outer edge of selvage in accordance with "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: One piece <**Insert dimension**>[**as indicated on Drawings**].

   a. Steel Wire for Fabric: Wire diameter of [**0.192 inch (4.88 mm)**][**0.148 inch (3.76 mm)**][**0.120 inch (3.05 mm)**]<**Insert dimension**>.

      1) Mesh Size: [**2 inches (50 mm)**][**1 inch (25 mm)**][**3/8 inch (9.5 mm)**]<**Insert dimension**>.

2. Fabric Heights and Overlap: Two-piece height with lower fabric height of <**Insert dimension**> and upper fabric height of <**Insert dimension**>[**as indicated on Drawings**].

   a. Steel Wire Lower Fabric: Wire diameter of [**0.192 inch (4.88 mm)**][**0.148 inch (3.76 mm)**][**0.120 inch (3.05 mm)**]<**Insert dimension**>.

      1) Mesh Size: [**2 inches (50 mm)**][**1 inch (25 mm)**][**3/8 inch (9.5 mm)**]<**Insert dimension**>.

   b. Steel Wire Upper Fabric: Wire diameter of [**0.120 inch (3.05 mm)**]<**Insert dimension**>.

      1) Mesh Size: [**3/8 inch (9.5 mm)**]<**Insert dimension**>.

3. Aluminum-Coated Fabric: ASTM A491, Type I, [**0.40 oz./sq. ft. (122 g/sq. m)**][**0.35 oz./sq. ft. (107 g/sq. m)**][**0.30 oz./sq. ft. (92 g/sq. m)**].
4. Zinc-Coated Fabric: ASTM A392, Type II, [**Class 1, 1.2 oz./sq. ft. (366 g/sq. m)**][**Class 2, 2.0 oz./sq. ft. (610 g/sq. m)**] with zinc coating applied [**before**][**after**] weaving.
5. Zn-5Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, Class 2, **1.0 oz./sq. ft. (305 g/sq. m)**.
6. Polymer-Coated Fabric: ASTM F668, Class 2b over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

   a. Color: [**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

7. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
8. Selvage: Twisted and barbed top and bottom.

2.3 SECURITY FENCE FRAMEWORK

A. Posts and Rails<**Insert drawing designation**>: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts.

1. Fence Height: [**96 inches (2440 mm)**][**12 feet (3.66 m)**][**As indicated on Drawings**]<**Insert dimension**>.
2. Heavy-Industrial-Strength Material: [**Group IA, round steel pipe, Schedule 40**][**Group IC, round steel pipe, electric-resistance-welded pipe**].

   a. Line Post: [**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102-mm) in diameter**][**6.625 inches (168 mm) in diameter**][**8.625 inches (219 mm) in diameter**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.
   b. End, Corner, and Pull Posts: [**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**8.625 inches (219 mm) in diameter**]<**Insert dimension**>.

3. Rail Members: [**Intermediate**][**top**][**bottom**][**and**][**brace**] rails in accordance with ASTM F1043 for Heavy Industrial.
4. Metallic Coating for Steel Framework:

   a. Type A: Not less than minimum **2.0-oz./sq. ft. (0.61-kg/sq. m)** average zinc coating in accordance with ASTM A123/A123M or **4.0-oz./sq. ft. (1.22-kg/sq. m)** zinc coating in accordance with ASTM A653/A653M.
   b. Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
   c. External, Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than **0.3-mil- (0.0076-mm-)** thick, zinc-pigmented coating.
   d. Type C: Zn-5-Al-MM alloy, consisting of not less than **1.8-oz./sq. ft. (0.55-kg/sq. m)** coating.
   e. Coatings: Any coating above.

5. Polymer coating over metallic coating.

   a. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, marcelled tension wire in accordance with ASTM A817 or ASTM A824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) by [**hot-dip**][**electrolytic**] process, with Class 5 minimum coating weight of not less than **2.0 oz./sq. ft. (610 g/sq. m)** of uncoated wire surface.

B. Polymer-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, tension wire in accordance with ASTM F1664, Class 2b over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

2.5 SWING GATES

A. General: ASTM F900 for gate posts and [**single**][**double**] swing gate types.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Gate Leaf Width: [**36 inches (914 mm)**][**As indicated**]<**Insert width**>.
2. Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; [**protective coating and finish to match fence framework**][**manufacturer's standard protective coating and finish**]<**Insert finish**>.
2. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.
3. Gate Posts: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
4. Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].

C. Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**] and **3/8-inch- (9.5-mm-)** diameter, adjustable truss rods for panels **60 inches (1520 mm)** or wider.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> above top of chain-link fabric at both ends of gate frame as required to attach barbed [**wire**][**tape**] assemblies.

E. Provisions for Electronic Detection System: Isolate gate from fencing to prevent transference of vibration. Gate hinge posts and latch posts may share the same footing but shall not be in contact with fence terminal posts.

1. Separation between Hinge and Latch Posts and Fence Termination Posts: **2 inches (50 mm)** minimum, **2-1/2 inches (63.5 mm)** maximum.

F. Hardware:

1. Hinges: [**180-degree inward**][**180-degree outward**][**360-degree inward and outward**] swing.
2. Latch: Permitting operation from [**one side**][**both sides**] of gate[**with provision for padlocking accessible from both sides of gate**].
3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.
4. Padlock and Chain: <**Insert requirements**>.
5. Closer: [**Manufacturer's standard**]<**Insert requirement**>.
6. Tall Gates: For gates **14 feet (4.27 m)** and higher, add locking device to transom.
7. <**Insert hardware items and accessories**>.

2.6 HORIZONTAL-SLIDE GATES

A. General: ASTM F1184 for gate posts and [**single**][**double**] sliding gate types.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Classification: Type I Overhead Slide.

a. Gate Leaf Width: [**As indicated**]<**Insert width**>.
b. Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

2. Classification: Type II Cantilever Slide, [**Class 1 with external**][**Class 2 with internal**] roller assemblies.

   a. Gate Frame Width and Height: [**48 inches (1220 mm) wide or less by 72 inches (1830 mm) high or less**][**More than 48 inches (1220 mm) wide by any height**][**As indicated**]<**Insert dimension**>.

B. Pipe and Tubing:

1. Zinc-Coated Steel: [**Protective coating and finish to match fence framework**][**Manufacturer's standard protective coating and finish**]<**Insert finish**>.
2. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.
3. Gate Posts: ASTM F1184Provide [**round tubular steel**][**rectangular tubular steel**][**round tubular aluminum**][**rectangular tubular aluminum**] posts.
4. Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].

C. Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**] and **3/8-inch- (9.5-mm-)** diameter, adjustable truss rods for panels **60 inches (1520 mm)** or wider.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> as required to attach barbed [**wire**][**tape**] assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framework supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished Grade 319 aluminum-alloy casting with stainless steel fasteners**].
2. Latch: Permitting operation from [**one side**][**both sides**] of gate[**with provision for padlocking accessible from both sides of gate**].
3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.
4. Padlock and Chain: <**Insert requirements**>.
5. <**Insert hardware items and accessories**>.

2.7 FITTINGS

A. Provide fittings in accordance with ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top-Rail Sleeves: Pressed-steel or round-steel tubing not less than **6 inches (152 mm)** long.
2. Rail Clamps: Line and corner boulevard clamps for connecting [**intermediate**][**and**][**bottom**] rails to posts.

E. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: In accordance with ASTM F2611.

F. Barbed Wire Arms: [**Pressed steel or cast iron**][**Aluminum**], with clips, slots, or other means for attaching strands of barbed wire[**, and means for attaching to posts**][**, integral with post cap**], for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: [**Type I, slanted arm**][**Type II, vertical arm**].
4. Double-Arm Type: [**Type III, V-shaped arm**][**Type IV, A-shaped arm**].
5. Use bolts or rivets for connection to posts.

G. Tie Wires, Clips, and Fasteners: In accordance with ASTM F626.

1. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Metallic-Coated Steel: [**0.148-inch- (3.76-mm-)**][**0.192-inch- (4.88-mm-)**] diameter wire; [**zinc**][**aluminum**] coating.
b. Stainless steel.

H. Power-Driven Fabric Fasteners: As recommended in writing by manufacturer.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than **1.2 oz. /sq. ft. (366 g/sq. m)** of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.8 BARBED WIRE

A. Steel Barbed Wire: ASTM A121, High Security Grade, two-strand barbed wire; **0.099-inch- (2.51-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point round barbs spaced not more than **3 inches (76 mm)** o.c.

1. Aluminum Coating: Type A.

B. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F1665, Type II, two-strand barbed wire; **0.080-inch- (2.03-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point, round [**aluminum-alloy**][**galvanized-steel**] barbs spaced not more than **3 inches (76 mm)** o.c.

1. Polymer Coating: Class 2b over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

a. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**] in accordance with ASTM F934.

2.9 BARBED TAPE

A. Wire-Reinforced Tape: ASTM F1910; continuous coil with four-point, needle-sharp barbs permanently

cold clenched around a core wire.

1. Core Wire: High-tensile-strength, [**zinc-coated steel**][**or**][**stainless steel**].
2. Configuration: [**Single**][**Double**] coil.
3. Style: [**Helical**][**Concertina**] pattern.
4. Coil Diameter(s): [**18-inch (457-mm)**][**24 inches (610 mm)**][**24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil**][**As indicated on Drawings**]<**Insert diameter**>.
5. Coil Loop Spacing(s): [**12 inches (305 mm)**][**Manufacturer's standard**][**As indicated on Drawings**]<**Insert spacing**>.
6. Barb Length Classification: [**Long, 1.2-inch (30.5-mm)**][**Medium, 0.4-inch (10.2-mm)**][**Short, 0.1875-inch (4.76-mm)**] barb.
7. Barb Spacing: [**4 inches (102 mm)**]<**Insert dimension**> o.c.
8. Barb Set: [**Straight**][**Offset**][**Manufacturer's standard**].

B. Clips: Stainless steel, **0.065 inch (1.65 mm)** thick by **0.375 inch (9.5 mm)** wide; capable of withstanding a minimum **150-lbf (667-N)** pull load to limit extension of coil, resulting in a concertina pattern when deployed.

C. Tie Wires: Stainless steel, **0.065 inch (1.65 mm)** in diameter.

D. Ground-Barrier Stakes: **3/8-inch- (9.5-mm-)** diameter galvanized reinforcing bar, **18 inches (457 mm)** long with 180-degree end hook **3-1/2 inches (89 mm)** long.

2.10 GATE OPERATORS

A. Operators: Factory-assembled, automatic gate-operating system designed for gate size, type, weight, and frequency of use. Control system shall have characteristics suitable for Project conditions, with control stations, safety devices, and weatherproof enclosures.

1. Operator design shall allow for removal of cover or motor without disturbing limit-switch adjustment and without affecting auxiliary emergency operation.
2. Electronic components shall have built-in troubleshooting diagnostic feature.
3. Unit shall be designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Standard: Manufacture and label gate operators in accordance with UL 325.

D. Motors: Comply with NEMA MG 1.

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 feet (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
3. Service Factor: 1.15.
4. Electrical Characteristics:

   a. Horsepower: [**1**][**2**][**5**]<**Insert horsepower**>.
   b. Voltage: [**115 V ac, single phase, 60 hertz**][**208 V ac, single phase, 60 hertz**][**230 V ac, single phase, 60 hertz**][**208 V ac, three phase, 60 hertz**][**230 V ac, three phase, 60 hertz**][**460 V ac, three phase, 60 hertz**].

E. Gate Operators: [**Gate**][**Equipment base/pad**][**Pedestal post**][**In ground**] mounted and as follows:

1. Hydraulic [**Swing**][**Slide**] Gate Operators:

   a. Duty: [**Medium**][**Heavy**].
   b. Gate Speed: Minimum [**45 feet (13.7 m)**][**60 feet (18.2 m)**] per minute.
   c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
   d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**]<**Insert requirement**>.
   e. Operating Type: Wheel and rail drive[**with manual release**].
   f. Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
   g. Locking: Hydraulic in both directions.
   h. Heater: Manufacturer's standard track and roller heater with thermostatic control.

2. Mechanical [**Swing**][**Slide**] Gate Operators:

   a. Duty: [**Medium**][**Heavy**].
   b. Gate Speed: Minimum [**45 feet (13.7 m) per minute**][**60 feet (18.2 m) per minute**][**variable speed**]<**Insert requirement**>.
   c. Maximum Gate Weight: [**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
   d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**]<**Insert requirement**>.
   e. Operating Type: [**Crank arm**][**Enclosed**][**Wheel and rail drive**][**Roller chain**], [**with manual release**].
   f. Drive Type:

      1) Enclosed worm gear[**and chain-and-sprocket**] reducers, roller-chain drive.
      2) [**V-belt and**][**worm gear**][**chain-and-sprocket**] reducers, roller-chain drive.

F. Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA 250, Type 3R**][**NEMA 250, Type 4**]<**Insert enclosure type**> enclosure for [**surface**][**recessed or flush**][**equipment base/pad**][**pedestal**]<**Insert mounting**> mounting and with space for additional optional equipment.

G. Control Devices:

1. Control Station, Keyed: [**Two**][**Three**]-position switch, located remotely from gate. Provide two keys per station.

   a. Function: Open[**, stop,**] and close.

2. Control Station, Momentary Contact: [**Single**][**Three**]-button operated, located remotely from gate.[**Key switch to lock out open and close buttons.**]

   a. Function: Open[**, stop,**] and close.

3. Card Reader: Functions only when authorized card is presented. Programmable, magnetic [**multiple**][**single**]-code system[**, permitting four different access time periods**][**; face-lighted unit fully visible at night**].

   a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
   b. Features: [**Timed anti-passback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].

4. Digital Keypad Entry Unit: Multiple-[**programmable-**]code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**one- to seven**][**four**][**five**]-digit codes[**and permitting four different access time periods**].

    a. Features: [**Timed anti-passback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].
    b. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.

5. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability, permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

    a. Transmitters: [**Single**][**Three**]-button operated, with open[**and close**] function.
    b. Channel Settings: [**Two**][**Three**][**Four**]<**Insert number**> independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

6. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system, with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

    a. System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access [**20**][**100**]<**Insert number**> telephones[**and with electronic directory**].

7. Vehicle Loop Detector: System that includes automatic closing timer with adjustable time delay before closing[**, timer cut-off switch,**] and loop detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert function**>. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, and as recommended in writing by detection system manufacturer for function indicated.

    a. Loop: [**Field-assembled**][**Factory-preformed**] wire, in size indicated, for [**pave-over**][**saw-cut with epoxy-grouted**] installation.

8. Vehicle Presence Detector: System that includes automatic closing timer with adjustable time delay before closing[**, timer cut-off switch,**] and presence detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert functions**>.

    a. Provide [**retroreflective**][**emitter/receiver**] detector with adjustable detection zone pattern and sensitivity, designed to detect presence or transit of a vehicle in gate pathway when an infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles and hold until clear of obstruction**][**Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using [**take-up**

cable reel][**self-coiling cable**][**gate edge transmitter and operator receiver system**].

a. Along entire gate leaf leading edge.
b. Along entire gate leaf trailing edge.
c. Across entire gate leaf bottom edge.
d. Along entire length of gate posts.
e. Along entire length of gate guide posts.
f. Where indicated on Drawings.
g. <**Insert extent and location**>.

4. Photoelectric/Infrared Sensor: System designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

I. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully open and fully closed positions.

J. Emergency Release Mechanism: Quick-disconnect release of operator drive system, permitting manual operation if operator fails. Control circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

K. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability of monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cut-off switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: [**24 hour**][**Seven day**]<**Insert time period**>, programmable for regular events.

L. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving and in accordance with [**the U.S. Access Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities**][**and**][**ICC A117.1**].
2. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

   a. Fail Safe: Gate opens and remains open until power is restored.
   b. Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.

3. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
4. [**Fire**][**Postal**] box.
5. Fire [**strobe**][**siren**] sensor.

6. Intercom System: <**Insert requirements**>.
7. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.
8. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (305 mm)**]<**Insert depth 6 to 12 inches (152 to 305 mm) below frost line or detail on Drawings**>, dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

2.11 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.12 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, **5/8 by 96 inches (16 by 2440 mm)**.

2.13 SOIL-STERILIZATION MATERIALS

A. Soil Sterilant: Commercial herbicide for weed control, approved by authorities having jurisdiction.

B. Polyethylene Sheeting: **6 mils (0.15 mm)** thick, black, and serving as soil-separation fabric.

C. Stone Ground Cover: Random-size range of [**3/4- to 2-inch (19- to 50-mm)**]<**Insert dimensions**> crushed stone or washed gravel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for[**a certified survey of property lines and legal boundaries,**] site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 feet (152 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION OF CHAIN-LINK FENCING

A. Install chain-link fencing in accordance with ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts [**in concrete**][**with mechanical anchors**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend **2 inches (50 mm)** above grade[**or to same elevation as concrete grade beam**]; shape and smooth to shed water.
b. Concealed Concrete: Place top of concrete [**2 inches (50 mm)**]<**Insert dimension**> below grade[**as indicated on Drawings**] to allow covering with surface material.
c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
d. Posts Set into Holes in Concrete: Form or core drill holes not less than **5 inches (127 mm)** deep and **3/4 inch (19 mm)** larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than **500 feet (152 m)**. For runs exceeding **500 feet (152 m)**, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at [**96 inches (2440 mm)**][**10 feet (3 m)**]<**Insert dimension**> o.c.

F. Post Bracing and Intermediate Rails: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric **72 inches (1830 mm)** or higher, on fences with

top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.

H. Tension Wire: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with **0.120-inch- (3.05-mm-)** diameter hog rings of same material and finish as fabric wire, spaced a maximum of **24 inches (610 mm)** o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along [**top**][**and**][**bottom**] of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within **6 inches (152 mm)** of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of [**barbed wire arms**][**extended posts**] and top of fence fabric to support barbed tape.
3. [**As indicated on Drawings**]<**Insert requirements**>.

I. Top Rail: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

J. Bottom Rails: Secure to posts with fittings; anchor rail at midspan to concrete [**footing**][**continuous grade beam**].

K. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

1. Overlapping Fabric: Overlap ends of fence fabric at or between posts or rails; overlap **6 inches (152 mm)** and secure with wire ties or steel strap method.
2. Bottom Clearance: Leave [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] between finish grade or surface and bottom selvage unless otherwise indicated.
3. Buried Fabric: Where indicated, bury the bottom [**12 inches (300 mm) of a continuous 18-inch- (457-mm-) wide**][**24 inches (610 mm) of a continuous 30-inch- (762-mm-) wide**], polymer-coated chain-link fabric in a vertical trench below the fencing; overlap above-grade fence fabric **6 inches (152 mm)** and secure to bottom rail with tie wires. Backfill and compact trench.

L. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than **15 inches (380 mm)** o.c.

M. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at **12 inches (305 mm)** o.c. and to braces at **24 inches (610 mm)** o.c.

N. Power-Fastening of Fabric: Fasten **0.192- or 0.148-inch (4.87- or 3.76-mm)** wire fabric with **2- or 1-inch (50- or 25-mm)** mesh size. Fasten fabric to line posts **12 inches (300 mm)** o.c. and to braces **24 inches (610 mm)** o.c.

O. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.[**Peen ends of bolts or score threads to prevent removal of nuts.**]

P. Barbed Wire: Install barbed wire uniformly spaced[**, angled toward security side of fence**][**as indicated on Drawings**]. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

Q. Barbed Tape: Install in accordance with ASTM F1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

R. Ground Barrier: Stake barbed-tape coils at **10 feet (3 m)** o.c., driven into ground to full depth.

S. Provisions for Electronic Detection System: Eliminate wind-induced vibrations and rattles of fabric against posts and rails by placing additional tie wires where necessary. Eliminate rattles from bolted end fittings and other component connections by applying additional tightening or diagonal truss rods secured to fabric with tie wires.

3.4 INSTALLATION OF GATES

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 INSTALLATION OF GATE OPERATORS

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: [**Cut grooves in pavement, bury, and seal**][**Bury**] wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

D. Ground electric-powered motors, controls, and other devices in accordance with NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of [**100 feet (30 m)**]<**Insert dimension**>.
3. Ground fence on each side of gates and other fence openings.

   a. Bond metal gates to gate posts.
   b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground in accordance with IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches (152 mm)** below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor in accordance with NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 SOIL STERILIZATION

A. Apply soil sterilant according to manufacturer's written instructions.

B. Apply sterilant after completing grounding and other below-grade electrical work along fence line[**and within zone between double-row chain-link fence installation**].

C. Polyethylene Sheeting: Install sheeting continuously between double-row chain-link fence installation, overlapping edges and punctures **6 inches (152 mm)**.

D. Stone Ground Cover: Lay continuous **3-inch- (75-mm-)** deep bed of stone ground cover over polyethylene sheeting.

E. Extent: Extend soil sterilization [**48 inches (1220 mm)**][**72 inches (1830 mm)**]<**Insert distance**> beyond outside and inside of fence.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Perform the following tests:

1. Fabric Testing: Test fabric tension according to "Deflection Limits" Paragraph in "Performance

Requirements" Article.
2. Fence Post Rigidity Testing: Test line posts for rigidity according to "Deflection Limits" Paragraph in "Performance Requirements" Article.
3. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.9 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operator, controls,[**alarms,**] and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 32 31 13 13

Task	Specification	Specification Description
32 31 13 13	32 31 13 00	Chain Link Fences And Gates
32 31 13 33	32 31 13 00	Chain Link Fences And Gates

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SECTION 32 31 16 00 - WELDED WIRE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic-coated-steel, welded-wire fences.
2. Swing gates.
3. Horizontal-slide gates.
4. Gate operators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete [**bases for gate operators, drives, and controls**][**and**][**post concrete fill**].
2. Section 281500 "Integrated Access Control Hardware Devices" for access control devices installed at gates and provided as part of a security system.
3. Section 312000 "Earth Moving" for site excavation, fill, and backfill where welded-wire fences and gates are located.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, [**and**][**mounting**][**attachment**] details[**, and grounding details**].
2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.

1. Provide Samples [**12 inches (300 mm)**]<**Insert dimension**> in length for linear materials.
2. Provide Samples [**12 inches (300 mm)**]<**Insert dimension**> square for wire mesh.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include [**10-ft. (3-m)**]<**Insert dimension**> length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading:

1. Fence Height: [**0 to 15 ft. (0 to 4.57 m)**][**15 to 20 ft. (4.57 to 6.10 m)**].
2. Wind Exposure Category: [**B**][**C**][**D**].
3. Design Wind Speed: [**105 mph (169 kph)**][**110 mph (177 kph)**][**120 mph (193 kph)**][**130 mph (209 kph)**][**140 mph (225 kph)**][**150 mph (241 kph)**][**160 mph (257 kph)**][**170 mph (274 kph)**]<**Insert wind speed**>.
4. Design Wind Pressure: <**Insert wind pressure**>.

B. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 METALLIC-COATED-STEEL, WELDED-WIRE FENCES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&T Iron Works, Inc**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Ametco Manufacturing Corporation**]
4. [**BarnettBates Corporation**]
5. [**Betafence; Praesidiad Group Limited**]
6. [**Designmaster; Mid-Continent Steel and Wire, Inc.; Deacero S.A. DE C.V.**]
7. [**Jerith Manufacturing LLC.; ASSA ABLOY**]
8. [**Master-Halco, Inc.**]
9. [**Merchants Metals, LLC**]
10. [**Metalco; MFR Manufacturing Corp, Inc.**]
11. [**Omega II Fence Systems; Metaltech-Omega Inc.**]
12. [**Wallace Perimeter Security**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A&T Iron Works, Inc**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Ametco Manufacturing Corporation**]
4. [**BarnettBates Corporation**]
5. [**Betafence; Praesidiad Group Limited**]
6. [**Designmaster; Mid-Continent Steel and Wire, Inc.; Deacero S.A. DE C.V.**]
7. [**Jerith Manufacturing LLC.; ASSA ABLOY**]
8. [**Master-Halco, Inc.**]
9. [**Merchants Metals, LLC**]
10. [**Metalco; MFR Manufacturing Corp, Inc.**]
11. [**Omega II Fence Systems; Metaltech-Omega Inc.**]
12. [**Wallace Perimeter Security**]
13. <**Insert manufacturer's name**>

C. Fence Fabric: Metallic-coated-steel wire.

1. Spacing of Vertical Wires: [**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**][**As indicated on Drawings**]<**Insert spacing**>.
2. Vertical Wire Size: [**0.187 inch (4.76 mm)**][**0.192 inch (4.88 mm)**][**0.225 inch (5.72 mm)**][**0.25 inch (6.35 mm)**][**0.262 inch (6.67 mm)**]<**Insert size**>.
3. Spacing of Horizontal Wires: [**1-3/4 inches (44 mm)**][**2 inches (51 mm)**][**4 inches (102 mm)**][**8 inches (203 mm)**][**As indicated on Drawings**]<**Insert spacing**>.
4. Horizontal Wire Size: [**0.187 inch (4.76 mm)**][**0.192 inch (4.88 mm)**][**0.225 inch (5.72 mm)**][**0.25 inch (6.35 mm)**][**0.312 inch (7.94 mm)**]<**Insert size**>.

D. Posts:

1. Line Posts: Square tubes [**2 by 2 inches (50 by 50 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**] formed from [**0.064-inch (1.63-mm)**][**0.079-inch (2.01-mm)**][**0.108-inch (2.74-mm)**] nominal-thickness, metallic-coated steel sheet or formed from [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**][**0.105-inch (2.66-mm)**] nominal-thickness steel sheet and hot-dip galvanized after fabrication.
2. End and Corner Posts: Square tubes [**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
3. Posts at Swing Gate Openings:

   a. Square tubes **3 by 3 inches (76 by 76 mm)** formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   b. Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.

4. Posts at Horizontal-Slide Gate Openings up to 12 Ft. (3.7 m): Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.
5. Posts at Horizontal-Slide Gate Openings Wider than 12 Ft. (3.7 m): Square steel tubing **4 by 4 inches (102 by 102 mm)** with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.
6. Guide Posts for Class 1 Horizontal-Slide Gates:

a. Square tubes **3 by 3 inches (76 by 76 mm)** formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication; installed adjacent to gate post to permit gate to slide in space between.

b. Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized; installed adjacent to gate post to permit gate to slide in space between.

E. Post Caps: [**Formed from steel sheet and hot-dip galvanized after forming**][**UV-resistant plastic**][**Aluminum castings**][**Aluminum castings with round ball finials**].

F. Rails: Rectangular tubes.

1. Size: [**1-3/16 by 1-1/2 inches (30 by 38 mm)**][**1-3/8 by 1-1/2 inches (35 by 38 mm) or 1-1/2 by 1-1/2 inches (38 by 38 mm)**].
2. Metal and Thickness: [**0.064-inch (1.63-mm)**][**0.079-inch (2.01-mm)**] nominal-thickness, metallic-coated steel sheet or [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**] nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

G. Fasteners: Manufacturer's standard [**tamperproof,**]corrosion-resistant, color-coated fasteners matching fence components[**with resilient polymer washers or clips**].

H. Finish: [**Organic coating complying with requirements in ASTM F2408**][**Powder coating**].

2.3 SWING GATES

A. Gate Configuration: [**Single leaf**][**Double leaf**] for [**pedestrian**][**and**][**vehicle**] systems.

B. Gate Frame Height: [**72 inches (1830 mm)**][**As indicated on Drawings**]<**Insert height**>.

C. Gate Opening Width: [**36 inches (914 mm)**][**As indicated on Drawings**]<**Insert width**>.

D. Gate Type: [**As indicated on Drawings**][**Pedestrian gate assembly**][**Automated pedestrian gates in accordance with BHMA A156.19 or A156.10**].

1. Automated vehicular gates are to comply with ASTM F2200, [**Class I**][**Class II**][**Class III**][**Class IV**].

E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (50 by 50 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.

F. Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**][**and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].

G. Additional Rails: Complying with requirements for fence rails.

H. Gate Infill: Welded-wire fence fabric matching adjacent fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than **5 ft. (1.52 m)** wide. Provide [**center gate stops**][**and**][**cane bolts**] for pairs of gates.[

Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.]

1. <**Insert requirements for padlocks and chains if not Owner furnished**>.

J. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.

1. Function: [**320 - Gate spring pivot hinge. Adjustable tension**][**321 - Gate spring pivot hinge. Fixed tension**].
2. Material: Malleable iron; galvanized.

K. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

L. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.

1. Function: [**621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside**][**622 - Deadbolt by key from outside and by turn from inside**][**626 - Interlocking deadbolt operated by key from either side**][**627 - Interlocking deadbolt operated by key from outside and by turn from inside**][**629 - Deadlocking latchbolt by key from outside and by turn from inside**]<**Insert function**>.
2. Material: Cast, forged, or extruded brass or bronze.
3. Mounting Plate: Configuration necessary for mounting locks. Fabricate from **1/8-inch- (3.2-mm-)** thick steel plate; hot-dip galvanize after fabrication.

M. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.

1. Function: [**F06 - Holdback lock**][**F07 - Storeroom or closet lock**][**F09 - Apartment, exit, or public toilet lock**][**F16 - Double-cylinder deadlock**][**F17 - Deadlock**]<**Insert function**>.
2. Material: Brass or bronze.
3. Levers: Cast, forged, or extruded brass or bronze.
4. Mounting Box: Configuration necessary to enclose locks. Fabricate from **1/8-inch- (3.2-mm-)** thick steel plate; hot-dip galvanize after fabrication.

N. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail[**-safe**][**-secure**], and suitable for exterior use.

1. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from **1/8-inch- (3.2-mm-)** thick steel plate; hot-dip galvanize after fabrication.
2. Mounting: Mortise into post.

O. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push-pad-actuating bar, suitable for exterior use.

1. Function: [**01 - Exit only, no trim or blank escutcheon**][**04 - Entrance by trim when latch bolt is released by key or set in a retracted position by key**][**08 - Entrance by lever. Key locks or unlocks lever**][**09 - Entrance by lever only when released by key. Key removable only when locked**]<**Insert function**>.
2. Mounting Channel: Bent-plate channel formed from **1/8-inch- (3.2-mm-)** thick steel plate; hot-dip galvanized after fabrication. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending **1/8 inch (3.2 mm)** beyond push-pad surface.

P. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from [**1/2-inch- (12.7-mm-)**][**3/4-inch- (19-mm-)**] diameter round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide

galvanized-steel pipe strikes to receive cane bolts in [**closed position**][**both open and closed positions**].

Q. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

R. Metallic-Coated-Steel Finish: [**High-performance coating**][**Galvanized finish**].

2.4 HORIZONTAL-SLIDE GATES

A. Gate Configuration: [**Single leaf**][**Double leaf**] for [**pedestrian**][**and**][**vehicle**] assembly.

1. Type:

a. Overhead slide.
b. Cantilever slide, with [**external**][**internal**] roller assemblies.

B. Gate Frame Height: [**72 inches (1830 mm)**][**As indicated on Drawings**]<**Insert height**>.

C. Gate Opening Width: [**36 inches (914 mm)**][**As indicated on Drawings**]<**Insert width**>.

D. Automated vehicular gates are to comply with ASTM F2200, [**Class I**][**Class II**][**Class II**][**Class IV**].

E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.

1. Frame Members: Square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (50 by 50 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
2. Bracing Members: Square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (50 by 50 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.

F. Frame Corner Construction:

1. Welded frame [**with panels assembled with bolted or riveted corner fittings**][**and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].
2. Overhead Slide Gates: Welded or assembled with corner fittings[**including 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].

G. Additional Rails: Complying with requirements for fence rails.

H. Gate Infill: Comply with requirements for adjacent fence.

I. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

J. Hardware: Latches permitting operation from both sides of gate, [**locking devices**][**hangers**][**roller assemblies**]<**Insert hardware items and accessories**> and stops fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished, Grade 319 aluminum-alloy casting with stainless**

steel fasteners].[**Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.**]

1. <**Insert requirements for padlocks and chains if not Owner furnished**>.

K. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

L. Metallic-Coated-Steel Finish: [**High-performance coating**][**Galvanized finish**].

2.5 GATE OPERATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amazing Gates of America LLC**]
2. [**AutoGate, Inc.**]
3. [**Begley Automated Gate Systems**]
4. [**Byan Systems, Inc.**]
5. [**CAME Americas Automation LLC**]
6. [**Chamberlain Group, Inc. (The)**]
7. [**DoorKing, Inc**]
8. [**Eagle Access Control Systems, Inc.**]
9. [**FAAC USA**]
10. [**Gates That Open, LLC**]
11. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
12. [**Nice USA; Nice North America; Nice group**]
13. [**TORXUN Inc.**]
14. [**Tymetal Corp.; The Fort Miller Group, Inc.**]
15. [**USAutomatic Inc.**]
16. [**Viking Access Systems LLC; FAAC International Inc.; FAAC SpA**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Amazing Gates of America LLC**]
2. [**AutoGate, Inc.**]
3. [**Begley Automated Gate Systems**]
4. [**Byan Systems, Inc.**]
5. [**CAME Americas Automation LLC**]
6. [**Chamberlain Group, Inc. (The)**]
7. [**DoorKing, Inc**]
8. [**Eagle Access Control Systems, Inc.**]
9. [**FAAC USA**]
10. [**Gates That Open, LLC**]
11. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
12. [**Nice USA; Nice North America; Nice group**]
13. [**TORXUN Inc.**]
14. [**Tymetal Corp.; The Fort Miller Group, Inc.**]
15. [**USAutomatic Inc.**]
16. [**Viking Access Systems LLC; FAAC International Inc.; FAAC SpA**]
17. <**Insert manufacturer's name**>

C. Gate Operator Components: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Design operator so that motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide [**UL325 listed operators for swing gates**][**ANSI 156.19 listed operators for pedestrian gates**][**ASTM F2200 for automated vehicular gates**].

D. Comply with NFPA 70.

E. UL Standard: Manufacturer and label gate operators to comply with UL 325.

F. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

G. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: [**110 V**][**220 V**][**24 V dc**][**NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected**]<**Insert voltage**>.
2. Phase: [**One**][**Polyphase**].
3. Enclosure: [**Open dripproof**][**Totally enclosed**][**Manufacturer's standard**].
4. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 ft. (1005 m)** above sea level.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

H. Gate Operator Supports: [**Gate**][**Concrete base**][**Post**][**In-ground**] mounted and as follows:

1. Hydraulic Gate Operators: [**Swing**][**Slide**].

   a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
   b. Gate Speed: Fully open to fully close. Speed as recommended in writing by manufacturer.
   c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
   d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**Continuous duty**].
   e. Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
   f. Locking: Hydraulic in both directions.

2. Mechanical Gate Operators: [**Swing**][**Slide**].

   a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
   b. Gate Speed: Fully open to fully close. Speed as recommended in writing by manufacturer.
   c. Maximum Gate Weight: [**600 lb (272 kg)**][**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
   d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**].
   e. Operating Type: [**Crank arm**][**Wheel-and-rail drive**][**Roller chain**][**, with manual release**].
   f. <**Insert gate operator feature**>.

I. Activation Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA ICS 6, Type 1**][**NEMA ICS 6, Type 4**]<**Insert type of enclosure**> enclosure for [**surface**][**recessed or flush**][**concrete base**][**pedestal**]<**Insert mounting**> mounting, and with space for additional optional

equipment. Provide the following remote-control device(s):

1. Control Station:

    a. Keyed, [**two**][**three**]-position switch with open[**, stop,**] and close function; located remotely from gate. Provide two keys per station.
    b. Momentary-contact, [**single**][**three**]-button-operated with open[**, stop,**] and close function; located remotely from gate.[**Key switch to lock out open and close buttons.**]
    c. <**Insert other control station type**>

2. Card Reader: Functions only when authorized card is presented. Programmable, [**multiple**][**single**]-code system[**, permitting four different access periods**][**; face-lighted unit fully visible at night**].

    a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
    b. Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].
    c. <**Insert other card reader type and features**>.

3. Digital Keypad Entry Unit: [**Programmable,**]multiple-code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**1- to 7**][**4**][**5**]-digit codes[**, and permitting four different access periods**].

    a. Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].
    b. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.

4. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated on Drawings, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

    a. Transmitters: [**Single**][**Three**]-button operated, with open [**and close**]function.

5. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

    a. Residential System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access [**20**][**100**]<**Insert number**> telephones[**, and with electronic directory**].
    c. <**Insert other telephone-entry system type and features**>.
    d. Intercom System: <**Insert requirements**>.

J. Vehicle-Sensing System: System includes automatic closing timer with adjustable time delay[**, timer cutoff switch,**] and loop detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert function**>. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal that activates the gate operator. Consult detection system manufacturer's written recommendations for number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, and indicate locations on Drawings.

K. Obstruction-Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles, and hold until clear of obstruction**]. [**Stop gate in opening cycle and reverse gate in closing cycle, and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, on Drawings in locations as recommended in writing by manufacturer. Connect to control circuit using [**take-up cable reel**][**self-coiling cable**][**gate edge transmitter and operator receiver system**].
4. <**Insert other obstruction-detection device**>.
5. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

L. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

M. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability for monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Primary/Secondary Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cutoff switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.

N. Clock Timer: [**24-hour**][**Seven-day**]<**Insert time**> programmable for regular events.

O. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

1. Fail-Safe: Gate opens and remains open until power is restored.
2. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is drained.

P. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.
2. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
3. [**Fire**][**Postal**] box.
4. Fire [**strobe**][**siren**] sensor.
5. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.

6. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (300 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate-operator-component manufacturer's written instructions and as indicated on Drawings.

2.6 STEEL AND IRON MATERIALS

A. Metallic-Coated-Steel Wire: Welded-wire fence fabric, hot-dip galvanized after fabrication. Weight of zinc coating is not to be less than **1.0 oz./sq. ft. (305 g/sq. m)**.

B. Plates, Shapes, and Bars: ASTM A36/A36M.

C. Tubing: ASTM A500/A500M, cold-formed steel tubing.

D. Uncoated Steel Sheet: [**Hot-rolled steel sheet, ASTM A1011/A1011M, Structural Steel, Grade 45 (Grade 310)**][**or**][**cold-rolled steel sheet, ASTM A1008/A1008M, Structural Steel, Grade 50 (Grade 340)**].

1. Interior surface of tubes formed from uncoated steel sheet is to be [**hot-dip zinc coated same as exterior**][**or**][**coated with zinc-rich thermosetting coating to comply with ASTM F2408**].

E. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.

F. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 50 (Grade 340)**, with [**G90 (Z275)**][**G60 (Z180)**] coating.

G. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A792/A792M, structural quality, **Grade 50 (Grade 340)**, with **AZ60 (AZM180)** coating.

H. Iron Castings: Either gray or malleable iron unless otherwise indicated.

1. Gray Iron: ASTM A48/A48M, Class 30.
2. Malleable Iron: ASTM A47/A47M.

I. Aluminum Castings: ASTM B26/B26M, Alloy A356.0-T6.

J. Galvanizing: For components indicated to be galvanized and for which galvanized coating is unspecified, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

2.7 COATING MATERIALS

A. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

B. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not**

limited to, the following]:

a. <**Insert manufacturer's name; product name or designation**>.

2.8 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended in writing by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of **3000 psi (20 MPa)**, **3-inch (75-mm)** slump, and **1-inch (25-mm)** maximum aggregate size[**or dry, packaged, normal-weight concrete mix complying with ASTM C387/C387M mixed with potable water in accordance with manufacturer's written instructions**].

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended in writing by manufacturer for exterior applications.

2.9 GROUNDING MATERIALS

A. Comply with requirements of Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: [**Copper**][**Aluminum**].
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: **5/8 by 96 inches (16 by 2440 mm)**.

2.10 STEEL FINISHES

A. Surface Preparation: Clean surfaces in accordance with [**SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**] After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of **2 mils (0.05 mm)** per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

C. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

D. High-Performance Coating: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended in writing by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

2.11 METALLIC-COATED-STEEL FINISHES

A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a [**zinc-phosphate**]conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

C. Powder Coating: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat finish consisting of [**zinc-rich**]epoxy prime coat and TGIC polyester topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of **4 mils (0.10 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and gloss**>.
2. Comply with surface finish testing requirements in ASTM F2408[**except change corrosion-resistance requirement to 3000 hours without failure**].

D. High-Performance Coating: Apply epoxy primer, polyurethane intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended in writing by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 ft. (152.5 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 INSTALLATION OF FENCES

A. Install fences in accordance with manufacturer's written instructions.

B. Install fences by setting posts as indicated on Drawings and fastening [**rails**][**and**][**infill panels**] to posts.[**Peen threads of bolts after assembly to prevent removal.**]

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than **24 inches (600 mm)** plus **3 inches (75 mm)** for each **foot (300 mm)** or fraction of a **foot (300 mm)** that fence height exceeds **4 ft. (1.2 m)**.

D. Post Setting: Set posts [**in concrete**][**with mechanical anchors**][**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around [**posts**][**and**][**sleeves**] and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

   a. Exposed Concrete: Extend **2 inches (50 mm)** above grade. Finish and slope top surface to drain water away from post.
   b. Concealed Concrete: Top [**2 inches (50 mm)**]<**Insert dimension**> below grade [**as indicated on Drawings**]to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within **6 inches (150 mm)** of specified excavation depth, but not closer than **3 inches (75 mm)** to bottom of concrete.
4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least **3/4 inch (20 mm)** larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

   a. Extend posts at least **5 inches (125 mm)** into sleeve.
   b. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than **3/4 inch (20 mm)** larger than outside diagonal dimension of post.

   a. Extend posts at least **5 inches (125 mm)** into concrete.
   b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

6. Mechanically Driven Posts: Drive into soil to depth of [**30 inches (762 mm)**][**36 inches (914 mm)**]<**Insert dimension**>. Protect post top to prevent distortion.
7. Space posts uniformly at [**6 ft. (1.83 m)**][**8 ft. (2.44 m)**]<**Insert dimension**> o.c.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 INSTALLATION OF GATE OPERATORS

A. General: Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for [**support posts**][**pedestals**][**concrete bases**] in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated on Drawings.

C. Concrete Bases: Cast-in-place or precast concrete, [**depth not less than 12 inches (300 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

D. Vehicle-Sensing System: [**Cut grooves in pavement and**]bury and seal wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 GROUNDING AND BONDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence Grounding: Install at maximum intervals of [**1500 ft. (450 m)**]<**Insert a lesser distance if grounding resistance is high**> except as follows:

1. Fences within 100 Ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [**750 ft. (225 m)**]<**Insert a lesser distance if grounding resistance is high**>.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (460 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of **150 ft. (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless

otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches (150 mm)** below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

F. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

H. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method in accordance with IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location, certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices,[**alarms,**] and limit switches.

1. Hydraulic Operators: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor

rotation and unit operation.

3. Test and adjust controls[**, alarms,**] and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware[**, gate operators,**] and other moving parts.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 32 31 16 00

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SECTION 32 31 19 00 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metallic-coated-steel tubular picket fences.
2. Decorative steel fences.
3. Decorative aluminum fences.
4. Swing gates.
5. Horizontal-slide gates.
6. Gate operators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete [**bases for gate operators, drives, and controls**][**and**][**post concrete fill**].
2. Section 281500 "Integrated Access Control Hardware Devices" for access control devices installed at gates and provided as part of a security system.
3. Division 26 Sections for electrical service and connections for system disconnect switches and powered devices including, but not limited to, motor operators, controls, and limit switches.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, [**and**][**mounting**][**attachment**] details[**, and grounding details**].
2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.

1. Provide Samples [**12 inches (300 mm)**]<**Insert dimension**> in length for linear materials.
2. Provide Samples [**12 inches (300 mm)**]<**Insert dimension**> square for [**bar grating**][**and**][**sheet or plate materials**].

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standards[**and other specified requirements**].

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include [**10 ft. (3 m)**]<**Insert dimension**> length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading:

1. Fence Height: [**0 to 15 ft. (0 to 4.57 m)**][**15 to 20 ft. (4.57 to 6.10 m)**].
2. Wind Exposure Category: [**B**][**C**][**D**].
3. Design Wind Speed: [**105 mph (169 kph)**][**110 (mph (177 kph)**][**120 mph (193 kph)**][**130 mph (209 kph)**][**140 mph (225 kph)**][**150 mph (241 kph)**][**160 mph (257 kph)**][**170 mph (274 kph)**]<**Insert wind speed**>.
4. Design Wind Pressure: <**Insert wind pressure**>.

B. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated-Steel Tubular Picket Fence Assembly: Comply with ASTM F2408 for [**residential**][**light-industrial (commercial)**][**industrial**] application (class) unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ameristar Perimeter Security; ASSA ABLOY**]
2. [**Betafence; Praesidiad Group Limited**]

3. [**Builders Fence Company, Inc.**]
4. [**Iron Eagle Industries, Inc.**]
5. [**Iron World Manufacturing, LLC**]
6. [**Master-Halco, Inc.**]
7. [**Merchants Metals, LLC**]
8. [**Virginia Railing and Gates, LLC**]
9. [**XCEL Fence Inc.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ameristar Perimeter Security; ASSA ABLOY**]
2. [**Betafence; Praesidiad Group Limited**]
3. [**Builders Fence Company, Inc.**]
4. [**Iron Eagle Industries, Inc.**]
5. [**Iron World Manufacturing, LLC**]
6. [**Master-Halco, Inc.**]
7. [**Merchants Metals, LLC**]
8. [**Virginia Railing and Gates, LLC**]
9. [**XCEL Fence Inc.**]
10. <**Insert manufacturer's name**>

D. Posts:

1. End and Corner Posts: Square tubes [**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
2. Posts at Swing Gate Openings:

   a. Square tubes **3 by 3 inches (76 by 76 mm)** formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   b. Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.

3. Posts at Horizontal-Slide Gate Openings up to 12 Ft. (3.7 m): Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.
4. Posts at Horizontal-Slide Gate Openings Wider than 12 Ft. (3.7 m): Square steel tubing **4 by 4 inches (102 by 102 mm)** with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized.
5. Guide Posts for Class 1 Horizontal-Slide Gates:

   a. Square tubes **3 by 3 inches (76 by 76 mm)** formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication; installed adjacent to gate post to permit gate to slide in space between.
   b. Square steel tubing [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness, hot-dip galvanized; installed adjacent to gate post to permit gate to slide in space between.

E. Post Caps: [**Formed from steel sheet and hot-dip galvanized after forming**][**UV-resistant plastic**][**Aluminum castings**][**Aluminum castings with round ball finials**].

F. Rails: [**Square tubes**][**Double-wall channels**].

1. Size: [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**].
2. Metal and Thickness: **0.079-inch (2.01-mm)** nominal-thickness, metallic-coated steel sheet or **0.075-inch (1.90-mm)** nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

G. Pickets: Square tubes.

1. Picket Placement: [**Terminate tops of pickets at top rail for flush top appearance**][**Extend pickets beyond top rail as indicated on Drawings and terminate with UV-resistant plastic caps**][**Extend pickets beyond top rail as indicated on Drawings and terminate with galvanized-steel caps**][**Extend pickets beyond top rail as indicated on Drawings and press flat and trim to produce spear point shape**].
2. Picket Spacing: [**6 inches (152.4 mm)**][**4 inches (101.6 mm)**][**1-3/4 inches (44 mm)**]<**Insert dimension**> clear, maximum.

H. Fasteners:

1. Manufacturer's standard concealed fastening system.
2. Manufacturer's standard [**tamperproof,**]corrosion-resistant, color-coated fasteners matching fence components[**with resilient polymer washers**].

I. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.

J. Interior surface of tubes formed from uncoated steel sheet are to be [**hot-dip zinc coated same as exterior**][**or**][**coated with zinc-rich thermosetting coating to comply with ASTM F2408**].

K. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F2408, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

L. Finish: [**Organic coating complying with requirements in ASTM F2408**][**Powder coating**].

2.3 DECORATIVE STEEL FENCES

A. Decorative Steel Fence Assembly: Fences made from steel tubing[**bars**] and shapes[**, hot-dip galvanized**].

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&T Iron Works, Inc**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Ametco Manufacturing Corporation**]
4. [**BarnettBates Corporation**]
5. [**Builders Fence Company, Inc.**]
6. [**Fortress Building Products**]
7. [**Metalco; MFR Manufacturing Corp, Inc.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A&T Iron Works, Inc**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Ametco Manufacturing Corporation**]
4. [**BarnettBates Corporation**]
5. [**Builders Fence Company, Inc.**]
6. [**Fortress Building Products**]
7. [**Metalco; MFR Manufacturing Corp, Inc.**]
8. <**Insert manufacturer's name**>

D. Posts: Square steel tubing.

1. Line Posts: [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**][**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness.
2. End and Corner Posts: [**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**][**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness.
3. Swing Gate Posts: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness.
4. Horizontal-Slide Gate Post, Openings up to 12 Ft. (3.7 m): [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness.
5. Horizontal-Slide Gate Post, Openings Wider than 12 Ft. (3.7 m): **4 by 4 inches (102 by 102 mm)** with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness.
6. Guide Posts for Class 1 Horizontal-Slide Gates: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**3/16-inch (4.76-mm)**]<**Insert dimension**> wall thickness; installed adjacent to gate post to permit gate to slide in space between.

E. Post Caps: [**Formed from steel sheet**][**Formed from steel sheet and hot-dip galvanized after forming**][**Aluminum castings**][**Aluminum castings with round ball finials**].

F. Rails:

1. Steel Tube Rails: Square steel tubing [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**]<**Insert dimension**> wall thickness.
2. Steel Channel Rails: Steel channels [**2 by 1 inch (51 by 25 mm)**][**1-1/2 by 3/4 inch (38 by 19 mm)**][**1-1/2 by 1/2 inch (38 by 13 mm)**]<**Insert dimensions**>.

G. Pickets: [**1/2-inch- (13-mm-) square steel bars**][**3/4-inch- (19-mm-) square steel bars**][**Decorative steel bars of pattern and size indicated on Drawings**][**5/8 inch (16 mm) square by 0.065-inch (1.65-mm) steel tubes**][**5/8 inch (16 mm) square by 0.083-inch (2.11-mm) steel tubes**][**3/4 inch (19 mm) square by 0.065-inch (1.65-mm) steel tubes**][**3/4 inch (19 mm) square by 0.083-inch (2.11-mm) steel tubes**][**1 inch (25 mm) square by 0.065-inch (1.65-mm) steel tubes**][**1 inch (25 mm) square by 0.083-inch (2.11-mm) steel tubes**].

1. Picket Placement: [**Terminate tops of pickets at top rail for flush top appearance**][**Extend pickets beyond top rail as indicated on Drawings and mill ends to pyramid-shaped points**][**Extend pickets beyond top rail as indicated on Drawings and press flat and trim to produce spear point shape**][**Extend pickets beyond top rail as indicated on Drawings and cap with metal spear point finial**][**Extend pickets beyond top rail as indicated on Drawings and cap with metal tripoint finial**].
2. Picket Spacing: [**6 inches (152.4 mm)**][**4 inches (101.6 mm)**][**1-3/4 inches (44 mm)**]<**Insert dimension**> clear, maximum.
3. Treillage: Provide iron castings of pattern indicated between each pair of pickets.

H. Forge-Welded-Steel Bar Grating Infill:

1. Perimeter Bars: Steel flat bars [**1 by 1/8 inch (25 by 3.2 mm)**]<**Insert dimensions**>.
2. Vertical Main Bars: Steel flat bars [**1 by 1/8 inch (25 by 3.2 mm)**][**1-3/16 by 5/32 inch (30 by 4 mm)**]<**Insert dimensions**>.
3. Vertical Main Bar Spacing: [**1-21/32 inches (42 mm)**][**1-7/8 inches (48 mm)**][**2-7/16 inches (62 mm)**]<**Insert dimension**> o.c.
4. Horizontal Cross Rods: [**3/16-inch- (4.8-mm-)**][**1/4-inch- (6.4-mm-)**] diameter, steel rods.
5. Horizontal Cross Rod Spacing: [**1-3/4 inches (45 mm)**][**2-19/32 inches (66 mm)**][**5-3/16 inches (132 mm)**]<**Insert dimension**> o.c.

I. Custom Design Infill: As indicated on Drawings.

1. Bars: [**1/2-inch- (12.7-mm-) square steel bars**][**3/4-inch- (19-mm-) square steel bars**][**1/2-inch- (12.7-mm-) diameter, round steel bars**][**3/4-inch- (19-mm-) diameter, round steel bars**][**1-by-1/8-inch (25-by-3.2-mm) steel flat bars**][**1-by-1/4-inch (25-by-6.4-mm) steel flat bars**][**1-by-1/2-inch (25-by-12.7-mm) steel flat bars**][**unless otherwise indicated on Drawings**].
2. Square Tubes: Square steel tubing [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**]<**Insert dimension**> wall thickness[**unless otherwise indicated on Drawings**].
3. Round Tubes: [**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**][**2-inch- (51-mm-)**][**2-1/2-inch- (64-mm-)**]<**Insert dimension**> diameter, round steel tubing with [**1/8-inch (3.2-mm)**]<**Insert dimension**> wall thickness[**unless otherwise indicated on Drawings**].
4. Steel Plate: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**] thick[**unless otherwise indicated on Drawings**].
5. Perforated Metal Sheet: Uncoated steel sheet, perforated as indicated on Drawings, [**0.060-inch (1.52-mm)**][**0.075-inch (1.90-mm)**][**0.105-inch (2.66-mm)**]<**Insert dimension**> nominal thickness.

J. Fasteners: Stainless steel carriage bolts and [**tamperproof**]nuts.

K. Fabrication:

1. Assemble fences into sections by welding pickets to rails.

   a. Fabricate sections with clips welded to rails for field fastening to posts.
   b. Drill posts and clips for fasteners before finishing to maximum extent possible.

2. Fabricate bar grating infill into sections of size indicated on Drawings.

   a. Fabricate rails with clips welded to rails for field fastening to posts.
   b. Drill posts[**, clips,**] and bar grating for fasteners before finishing to maximum extent possible.

L. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

M. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

1. Hot-dip galvanize posts[**and rails**].
2. Hot-dip galvanize rail and picket assemblies after fabrication.
3. Hot-dip galvanize bar grating infill after fabrication.
4. Hot-dip galvanize custom-design rail and infill assemblies after fabrication.

N. Finish for Bar Grating Infill: Powder coating.

O. Finish for Steel Items: [**Primed**][**Shop painted**][**High-performance coating**].

P. Finish for Metallic-Coated-Steel Items: [**High-performance coating**][**Galvanized finish**].

2.4 DECORATIVE ALUMINUM FENCES

A. Decorative Aluminum Fence Assembly: Fences made from aluminum extrusions.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alumi-Guard; Barrette Outdoor Living, Inc.**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Carfaro, Inc.**]
4. [**Delair Group, L.L.C.**]
5. [**East & West Alum Craft Ltd.**]
6. [**Elegant Aluminum Products, Inc.**]
7. [**Elite Fence Products, Inc.**]
8. [**Fortress Building Products**]
9. [**Ideal Aluminum Products**]
10. [**Iron Eagle Industries, Inc.**]
11. [**Japra Group International**]
12. [**Jerith Manufacturing LLC.; ASSA ABLOY**]
13. [**Knotwood US LLC**]
14. [**Master-Halco, Inc.**]
15. [**Merchants Metals, LLC**]
16. [**Royal Aluminum and Steel, Inc.**]
17. [**Specrail**]
18. [**Superior Aluminum Products, Inc**]
19. [**Tek-Rail Inc.**]
20. [**Ultra Aluminum Manufacturing Inc.**]
21. [**Virginia Railing and Gates, LLC**]
22. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alumi-Guard; Barrette Outdoor Living, Inc.**]
2. [**Ameristar Perimeter Security; ASSA ABLOY**]
3. [**Carfaro, Inc.**]
4. [**Delair Group, L.L.C.**]
5. [**East & West Alum Craft Ltd.**]
6. [**Elegant Aluminum Products, Inc.**]
7. [**Elite Fence Products, Inc.**]
8. [**Fortress Building Products**]
9. [**Ideal Aluminum Products**]
10. [**Iron Eagle Industries, Inc.**]
11. [**Japra Group International**]
12. [**Jerith Manufacturing LLC.; ASSA ABLOY**]
13. [**Knotwood US LLC**]
14. [**Master-Halco, Inc.**]
15. [**Merchants Metals, LLC**]

16. [**Royal Aluminum and Steel, Inc.**]
17. [**Specrail**]
18. [**Superior Aluminum Products, Inc**]
19. [**Tek-Rail Inc.**]
20. [**Ultra Aluminum Manufacturing Inc.**]
21. [**Virginia Railing and Gates, LLC**]
22. <**Insert manufacturer's name**>

D. Posts: Square extruded tubes.

1. Line Posts: [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**]<**Insert dimensions**> with [**0.062-inch (1.57-mm)**][**0.080-inch (2.03-mm)**][**0.093-inch (2.36-mm)**][**0.100-inch (2.54-mm)**][**0.125-inch (3.18-mm)**]<**Insert dimension**> wall thickness.
2. End and Corner Posts: [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**]<**Insert dimensions**> with [**0.062-inch (1.57-mm)**][**0.080-inch (2.03-mm)**][**0.093-inch (2.36-mm)**][**0.100-inch (2.54-mm)**][**0.125-inch (3.18-mm)**]<**Insert dimension**> wall thickness.
3. Swing Gate Posts: [**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**0.125-inch (3.18-mm)**][**0.250-inch (6.35-mm)**]<**Insert dimension**> wall thickness.
4. Horizontal-Slide Gate Post, Openings up to 12 Ft. (3.7 m): [**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**]<**Insert dimensions**> with [**0.125-inch (3.18-mm)**][**0.250-inch (6.35-mm)**]<**Insert dimension**> wall thickness.
5. Horizontal-Slide Gate Post, Openings Wider than 12 Ft. (3.7 m): [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**]<**Insert dimensions**> with [**0.125-inch (3.18-mm)**][**0.250-inch (6.35-mm)**]<**Insert dimension**> wall thickness.
6. Guide Posts for Class 1 Horizontal-Slide Gates: [**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**][**3 by 3 inches (76 by 76 mm)**]<**Insert dimensions**> with [**0.062-inch (1.57-mm)**][**0.093-inch (2.36-mm)**][**0.125-inch (3.18-mm)**]<**Insert dimension**> wall thickness; installed adjacent to gate post to permit gate to slide in space between.

E. Post Caps: Aluminum castings that [**cover entire top of posts**][**project at least 1/4 inch (6 mm) beyond posts**][**with round ball finial**].

F. Rails: Extruded-aluminum channels, [**1-1/2 by 1-1/2 inches (38 by 38 mm), with 0.100-inch- (2.54-mm-) thick sidewalls and 0.070-inch- (1.78-mm-) thick top**][**1 by 1-1/2 inches (25 by 38 mm), with 0.082-inch- (2.08-mm-) thick sidewalls and 0.055-inch- (1.40-mm-) thick top**][**1-1/4 by 1-1/4 inches (32 by 32 mm), with 0.078-inch- (1.98-mm-) thick sidewalls and 0.062-inch- (1.57-mm-) thick top**][**1 by 1 inch (25 by 25 mm), with 0.080-inch- (2.03-mm-) thick sidewalls and 0.055-inch- (1.40-mm-) thick top**][**1 by 1 inch (25 by 25 mm), with 0.078-inch- (1.98-mm-) thick sidewalls and 0.062-inch- (1.57-mm-) thick top**].

G. Pickets: Extruded-aluminum tubes, [**1 inch (25 mm) square, with 0.062-inch (1.57-mm) wall thickness**][**1 inch (25 mm) square, with 0.060-inch (1.52-mm) wall thickness**][**3/4 inch (19 mm) square, with 0.050-inch (1.27-mm) wall thickness**][**1 by 5/8 inch (25 by 16 mm), with 0.050-inch (1.27-mm) wall thickness**][**5/8 inch (16 mm) square, with 0.050-inch (1.27-mm) wall thickness**].

1. Picket Placement: [**Terminate tops of pickets at top rail for flush top appearance**][**Extend pickets beyond top rail as indicated on Drawings and terminate with UV-resistant plastic caps**][**Extend pickets beyond top rail as indicated on Drawings and terminate with cast-aluminum caps**][**Extend pickets beyond top rail as indicated on Drawings and press flat and trim to produce spear point shape**][**Extend pickets beyond top rail as indicated on Drawings and terminate with cast-aluminum spear point finial**][**Extend pickets beyond top rail as indicated on Drawings and terminate with cast-aluminum tripoint finial**].

2. Picket Spacing: [**6 inches (152.4 mm)**][**4 inches (101.6 mm)**][**1-3/4 inches (44 mm)**]<**Insert dimension**> clear, maximum.

H. Fasteners:

1. Manufacturer's standard concealed fastening system.
2. Manufacturer's standard [**tamperproof,**]corrosion-resistant, color-coated fasteners matching fence components[**with resilient polymer washers**].

I. Fabrication: Assemble fences into sections by [**welding**][**fastening**] pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

J. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

K. Finish Coating: Baked enamel or powder coating.

2.5 SWING GATES

A. Gate Configuration: [**Single leaf**][**Double leaf**][**As indicated on Drawings**].

B. Gate Frame Height: [**72 inches (1830 mm)**][**As indicated on Drawings**]<**Insert height**>.

C. Gate Opening Width: [**36 inches (914 mm)**][**As indicated on Drawings**]<**Insert width**>.

D. Gate Type: [**As indicated on Drawings**][**Pedestrian gate system**][**Automated pedestrian gates in accordance with BHMA A156.19 or A156.10**].

1. Automated vehicular gates are to comply with ASTM F2200, [**Class I**][**Class II**][**Class III**][**Class IV**].

E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.

F. Steel Frames and Bracing: Fabricate members from square steel tubing [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**]<**Insert dimension**> wall thickness.[**Hot-dip galvanize frames after fabrication.**]

G. Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**][**and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].

H. Additional Rails: Provide as indicated, complying with requirements for fence rails.

I. Gate Infill: As indicated on Drawings.

J. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than **5 ft. (1.52 m)** wide. Provide [**center gate stops**][**and**][**cane bolts**] for pairs of gates.[

Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.]

1. <**Insert requirements for padlocks and chains if not Owner furnished**>.

K. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.

1. Function: [**320 - Gate spring pivot hinge. Adjustable tension**][**321 - Gate spring pivot hinge. Fixed tension**].
2. Material: Malleable iron; galvanized.

L. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

M. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.

1. Function: [**621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside**][**622 - Deadbolt by key from outside and by turn from inside**][**626 - Interlocking deadbolt operated by key from either side**][**627 - Interlocking deadbolt operated by key from outside and by turn from inside**][**629 - Deadlocking latchbolt by key from outside and by turn from inside**]<**Insert function**>.
2. Material: Cast, forged, or extruded brass or bronze.
3. Mounting Plate: Configuration necessary for mounting locks. Fabricate from **1/8-inch- (3.2-mm-)** thick [**steel plate; galvanized**][**aluminum plate**].

N. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.

1. Function: [**F06 - Holdback lock**][**F07 - Storeroom or closet lock**][**F09 - Apartment, exit, or public toilet lock**][**F16 - Double-cylinder deadlock**][**F17 - Deadlock**]<**Insert function**>.
2. Material: Brass or bronze.
3. Levers: Cast, forged, or extruded brass or bronze.
4. Mounting Box: Configuration necessary to enclose locks. Fabricate from **1/8-inch- (3.2-mm-)** thick [**steel plate; galvanized**][**aluminum plate**].

O. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail[**-safe**][**-secure**], and suitable for exterior use.

1. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from **1/8-inch- (3.2-mm-)** thick [**steel plate; galvanized**][**aluminum plate**].
2. Mounting: Mortise into post.

P. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push-pad-actuating bar, suitable for exterior use.

1. Function: [**01 - Exit only, no trim or blank escutcheon**][**04 - Entrance by trim when latch bolt is released by key or set in a retracted position by key**][**08 - Entrance by lever. Key locks or unlocks lever**][**09 - Entrance by lever only when released by key. Key removable only when locked**]<**Insert function**>.
2. Mounting Channel: Bent-plate channel formed from **1/8-inch- (3.2-mm-)** thick [**steel**][**aluminum**] plate. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending **1/8 inch (3.2 mm)** beyond push-pad surface.

Q. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from [**1/2-inch- (12.7-mm-)**][**3/4-inch-**

(19-mm-)] diameter round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in [**closed position**][**both open and closed positions**].

R. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

S. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

T. Metallic-Coated-Steel Finish: [**High-performance coating**][**Galvanized finish**].

U. Steel Finish: [**Primed**][**Shop painted**][**High-performance coating**].

2.6 HORIZONTAL-SLIDE GATES

A. Gate Configuration: [**Single leaf**][**Double leaf**] for [**pedestrian**][**and**][**vehicle**] assembly.

1. Type:

a. Overhead slide.
b. Cantilever slide, with [**external**][**internal**] roller assemblies.
c. Groundtrack slide.

B. Gate Frame Height: [**72 inches (1830 mm)**][**As indicated on Drawings**]<**Insert height**>.

C. Gate Opening Width: [**36 inches (914 mm)**][**As indicated on Drawings**]<**Insert width**>.

D. Automated vehicular gates are to comply with ASTM F2200, [**Class I**][**Class II**][**Class III**][**Class IV**].

E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.

1. Frame Members: Square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.
2. Bracing Members: Square tubes [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**1-3/4 by 1-3/4 inches (45 by 45 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**] formed from **0.108-inch (2.74-mm)** nominal-thickness, metallic-coated steel sheet or formed from **0.105-inch (2.66-mm)** nominal-thickness steel sheet and hot-dip galvanized after fabrication.

F. Steel Frames and Bracing: Fabricate members from square tubing.[**Hot-dip galvanize frames after fabrication.**]

1. Frame Members: Steel tubing [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**]<**Insert thickness**> wall thickness.
2. Bracing Members: Steel tubing [**1-1/2 by 1-1/2 inches (38 by 38 mm)**][**2 by 2 inches (51 by 51 mm)**][**2-1/2 by 2-1/2 inches (64 by 64 mm)**]<**Insert dimensions**> with [**1/8-inch (3.2-mm)**]<**Insert dimension**> wall thickness.

G. Frame Corner Construction:

1. Welded frame [**with panels assembled with bolted or riveted corner fittings**][**and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].
2. Overhead Slide Gates: Welded or assembled with corner fittings[**including 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 ft. (1.52 m) wide or wider**].

H. Additional Rails: Provide as indicated, complying with requirements for fence rails.

I. Gate Infill: As indicated on Drawings.

J. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

K. Hardware: Latches permitting operation from both sides of gate, [**locking devices**][**hangers**][**roller assemblies**]<**Insert hardware items and accessories**> and stops fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished, Grade 319 aluminum-alloy casting with stainless steel fasteners**].[**Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.**]

1. <**Insert requirements for padlocks and chains if not Owner furnished**>.

L. Finish exposed welds to comply with NOMMA Guideline 1, [**Finish #2 - completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - partially dressed weld with splatter removed**][**Finish #4 - good-quality, uniform undressed weld with minimal splatter**].

M. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

N. Metallic-Coated-Steel Finish: [**High-performance coating**][**Galvanized finish**].

O. Steel Finish: [**Primed**][**Shop painted**][**High-performance coating**].

2.7 GATE OPERATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Amazing Gates of America LLC**]
2. [**AutoGate, Inc.**]
3. [**Begley Automated Gate Systems**]
4. [**Byan Systems, Inc.**]
5. [**CAME Americas Automation LLC**]
6. [**Chamberlain Group, Inc. (The)**]
7. [**DoorKing, Inc**]
8. [**Eagle Access Control Systems, Inc.**]
9. [**FAAC USA**]
10. [**Gates That Open, LLC**]
11. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
12. [**Nice USA; Nice North America; Nice group**]
13. [**TORXUN Inc.**]
14. [**Tymetal Corp.; The Fort Miller Group, Inc.**]
15. [**USAutomatic Inc.**]

16. [**Viking Access Systems LLC; FAAC International Inc.; FAAC SpA**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Amazing Gates of America LLC**]
2. [**AutoGate, Inc.**]
3. [**Begley Automated Gate Systems**]
4. [**Byan Systems, Inc.**]
5. [**CAME Americas Automation LLC**]
6. [**Chamberlain Group, Inc. (The)**]
7. [**DoorKing, Inc**]
8. [**Eagle Access Control Systems, Inc.**]
9. [**FAAC USA**]
10. [**Gates That Open, LLC**]
11. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
12. [**Nice USA; Nice North America; Nice group**]
13. [**TORXUN Inc.**]
14. [**Tymetal Corp.; The Fort Miller Group, Inc.**]
15. [**USAutomatic Inc.**]
16. [**Viking Access Systems LLC; FAAC International Inc.; FAAC SpA**]
17. <**Insert manufacturer's name**>

C. Gate Operator Components: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Design operator so that motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide [**UL 325-listed operators for swing gates**][**BHMA A156.19-listed operators for pedestrian gates**][**ASTM F2200-listed automated vehicular gates**].

D. Comply with NFPA 70.

E. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

F. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: [**110 V**][**220 V**][**24 V dc**][**NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected**]<**Insert voltage**>.
2. Phase: [**One**][**Polyphase**].
3. Enclosure: [**Open dripproof**][**Totally enclosed**][**Manufacturer's standard**].
4. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 ft. (1005 m)** above sea level.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

G. Gate Operator Supports: [**Gate**][**Concrete base**][**Post**][**In-ground**] mounted and as follows:

1. Hydraulic Gate Operators: [**Swing**][**Slide**].

   a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].

b. Gate Speed: Fully open to fully close. Speed as recommended in writing by manufacturer.
c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**Continuous duty**].
e. Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
f. Locking: Hydraulic in both directions.

2. Mechanical Gate Operators: [**Swing**][**Slide**].

a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
b. Gate Speed: Fully open to fully close. Speed as recommended in writing by manufacturer.
c. Maximum Gate Weight: [**600 lb (272 kg)**][**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**].
e. Operating Type: [**Crank arm**][**Wheel-and-rail drive**][**Roller chain**], [**with manual release**].
f. <**Insert gate operator feature**>.

H. Activation Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA ICS 6, Type 1**][**NEMA ICS 6, Type 4**]<**Insert type of enclosure**> enclosure for [**surface**][**recessed or flush**][**concrete base**][**pedestal**]<**Insert mounting**> mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1. Control Station:

a. Keyed, [**two**][**three**]-position switch with open[**, stop,**] and close function; located remotely from gate. Provide two keys per station.
b. Momentary-contact, [**single**][**three**]-button-operated with open[**, stop,**] and close function; located remotely from gate.[**Key switch to lock out open and close buttons.**]
c. <**Insert other control station type**>.

2. Card Reader: Functions only when authorized card is presented. Programmable, [**multiple**][**single**]-code system[**, permitting four different access periods**][**; face-lighted unit fully visible at night**].

a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
b. Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].
c. <**Insert other card reader type and features**>.

3. Digital Keypad Entry Unit: [**Programmable,**]multiple-code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**one- to seven**][**four**][**five**]-digit codes[**, and permitting four different access periods**].

a. Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].
b. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.

4. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated on Drawings, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

a. Transmitters: [**Single**][**Three**] button operated, with open [**and close**]function.

5. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

    a. Residential System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access [**20**][**100**]<**Insert number**> telephones[**, and with electronic directory**].
    c. <**Insert other telephone entry-system type and features**>.
    d. Intercom System: <**Insert requirements**>.

I. Vehicle-Sensing System: System includes automatic closing timer with adjustable time delay[**, timer cutoff switch,**] and presence detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert functions**>. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal that activates the gate operator. Consult detection system manufacturer's written recommendations for number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, and indicate locations on Drawings.

J. Obstruction-Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles, and hold until clear of obstruction**][**Stop gate in opening cycle and reverse gate in closing cycle, and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated on Drawings, in locations as recommended in writing by manufacturer. [**take-up cable reel**][**self-coiling cable**][**gate edge transmitter and operator receiver system**].
4. <**Insert other obstruction-detection device**>.
5. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

K. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

L. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability for monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Primary/Secondary Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cutoff switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.

M. Clock Timer: [**24-hour**][**Seven-day**]<**Insert time**> programmable for regular events.

N. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

1. Fail-Safe: Gate opens and remains open until power is restored.
2. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is drained.

O. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.
2. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
3. [**Fire**][**Postal**] box.
4. Fire [**strobe**][**siren**] sensor.
5. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.
6. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (300 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

2.8 STEEL AND IRON MATERIALS

A. Plates, Shapes, and Bars: ASTM A36/A36M.

B. Tubing: ASTM A500/A500M, cold-formed steel tubing.

C. Uncoated Steel Sheet: [**Hot-rolled steel sheet, ASTM A1011/A1011M, Structural Steel, Grade 45 (Grade 310)**][**or**][**cold-rolled steel sheet, ASTM A1008/A1008M, Structural Steel, Grade 50 (Grade 340)**].

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, **Grade 50 (Grade 340)**, with [**G90 (Z275)**][**G60 (Z180)**] coating.

E. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A792/A792M, structural quality, **Grade 50 (Grade 340)**, with **AZ60 (AZM180)** coating.

F. Castings: Either gray or malleable iron unless otherwise indicated on Drawings.

1. Gray Iron: ASTM A48/A48M, Class 30.
2. Malleable Iron: ASTM A47/A47M.

2.9 COATING MATERIALS

A. Shop Primers for Steel: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

B. Shop Primer for Steel: Manufacturer's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Epoxy Zinc-Rich Primer for Uncoated Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

D. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

E. Epoxy Intermediate Coat for Uncoated Steel: Complying with MPI #77 and compatible with primer and topcoat.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

F. Intermediate Coat for Uncoated Steel: Epoxy or polyurethane intermediate recommended in writing by primer and topcoat manufacturer.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

G. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name; product name or designation**>.

2.10 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of **3000 psi (20 MPa)**, **3-inch (75-mm)** slump, and **1-inch (25-mm)** maximum aggregate size[**or dry, packaged, normal-weight concrete mix complying with ASTM C387/C387M mixed with potable water in accordance with manufacturer's written instructions**].

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended in writing by manufacturer for exterior applications.

2.11 GROUNDING MATERIALS

A. Comply with requirements of Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: [**Copper**][**Aluminum**].
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: **5/8 by 96 inches (16 by 2440 mm)**.

2.12 STEEL FINISHES

A. Surface Preparation: Clean surfaces in accordance with [**SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**] After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of **2 mils (0.05 mm)** per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

C. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

D. High-Performance Coating: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended in writing by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

2.13 METALLIC-COATED-STEEL FINISHES

A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a [**zinc-phosphate**]conversion coating compatible with the organic

coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

C. Powder Coating: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat finish consisting of [**zinc-rich**]epoxy prime coat and TGIC polyester topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of **4 mils (0.10 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and gloss**>.
2. Comply with surface finish testing requirements in ASTM F2408[**except change corrosion-resistance requirement to 3000 hours without failure**].

D. High-Performance Coating: Apply epoxy primer, polyurethane intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended in writing by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 ft. (152.5 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 INSTALLATION OF DECORATIVE FENCES

A. Install fences in accordance with manufacturer's written instructions.

B. Install fences by setting posts as indicated on Drawings and fastening [**rails**][**and**][**infill panels**] to posts.[**Peen threads of bolts after assembly to prevent removal.**]

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than **24 inches (600 mm)** plus **3 inches (75 mm)** for each **foot (300 mm)** or fraction of a **foot (300 mm)** that fence height exceeds **4 ft.**

(1.2 m).

D. Post Setting: Set posts [**in concrete**][**with mechanical anchors**][**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around [**posts**][**and**][**sleeves**] and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

   a. Exposed Concrete: Extend **2 inches (51 mm)** above grade. Finish and slope top surface to drain water away from post.
   b. Concealed Concrete: Top [**2 inches (51 mm)**]<**Insert dimension**> below grade [**as indicated on Drawings**]to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within **6 inches (150 mm)** of specified excavation depth, but not closer than **3 inches (75 mm)** to bottom of concrete.
4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least **3/4 inch (20 mm)** larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

   a. Extend posts at least **5 inches (125 mm)** into sleeve.
   b. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than **3/4 inch (20 mm)** larger than outside diagonal dimension of post.

   a. Extend posts at least **5 inches (125 mm)** into concrete.
   b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

6. Mechanically Driven Posts: Drive into soil to depth of [**30 inches (762 mm)**][**36 inches (914 mm)**]<**Insert dimension**>. Protect post top to prevent distortion.
7. Space posts uniformly at [**6 ft. (1.83 m)**][**8 ft. (2.44 m)**]<**Insert dimension**> o.c.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 INSTALLATION OF GATE OPERATORS

A. General: Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for [**support posts**][**pedestals**][**concrete bases**] in firm, undisturbed

soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated on Drawings.

C. Concrete Bases: Cast-in-place or precast concrete, [**depth not less than 12 inches (300 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

D. Vehicle-Sensing System: [**Cut grooves in pavement and**]bury and seal wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 GROUNDING AND BONDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence Grounding: Install at maximum intervals of [**1500 ft. (450 m)**]<**Insert a lesser distance if grounding resistance is high**> except as follows:

1. Fences within 100 Ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [**750 ft. (225 m)**]<**Insert a lesser distance if grounding resistance is high**>.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (460 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of **150 ft. (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches (150 mm)** below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

F. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

H. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method in accordance with IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices,[**alarms,**] and limit switches.

1. Hydraulic Operators: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls[**, alarms,**] and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware[**, gate operators,**] and other moving parts.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 32 31 19 00

Task	Specification	Specification Description
32 31 19 00	32 31 13 13	High-Security Chain Link Fences and Gates
32 31 34 00	32 31 13 00	Chain Link Fences And Gates
32 32 16 00	03 41 00 00	Precast Structural Concrete

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SECTION 32 32 23 00 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Segmental retaining walls.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavation for segmental retaining walls, base material, soil fill, fill placement and compaction, and field in-place density testing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show sizes, profiles, coursing, and locations of retaining wall units; including backfill and leveling base materials.
2. Show types, sizes, locations of soil reinforcing materials.
3. <**Insert requirements**>.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and textures for segmental retaining wall units.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish of segmental retaining wall units.

1. Size: [**Manufacturers' standard size**][**full-size units**][**sections of units not less than 3 inches (75 mm) square**]<**Insert size**>.

E. Delegated Design Submittals: For segmental retaining walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and

point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of segmental retaining wall unit[**and soil reinforcement**] from manufacturer.

1. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.

C. Test and Evaluation Reports:

1. Product Test Reports: For each type of segmental retaining wall unit[**and soil reinforcement**], for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

a. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
b. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.

2. Research Reports: For segmental retaining wall system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**]<**Insert evaluation agency**> showing compliance with [**building code requirements**]<**Insert requirement**>.
3. Preconstruction Test Reports: For segmental retaining wall units[**and soil reinforcement**].

D. Source Quality-Control Submittals:

1. Source quality-control reports.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

F. Qualification Statements: For [**testing agency**]<**Insert entity or specialist**>.

G. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers certified under the National Concrete Masonry Association (NCMA) Certified Segmental Retaining Wall Installer program at the [**Basic**][**Advanced Commercial**] certification level.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Testing Agency: Qualified in accordance with ASTM E329 for testing indicated.

1.6 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall [**as indicated on Drawings**][**approximately 72 inches (1800 mm) long by not less than 36 inches (900 mm) high above finished grade at front of wall**].

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.
c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include **36-inch (900-mm)** return at one end of mockup, with typical corner construction.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance in accordance with ASTM D6706.
2. Test soil reinforcement and backfill materials for coefficient of friction in accordance with ASTM D5321/D5321M.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above **160 deg F (71 deg C)** or below **32 deg F (0 deg C)**, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

B. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

C. Structural Performance: Engineering design shall be based on the following loads and be in accordance with [**NCMA's "Design Manual for Segmental Retaining Walls."**]<**Insert applicable requirement.**>

1. Gravity loads due to soil pressures resulting from grades[**and sloped backfill**] indicated.
2. Superimposed loads (surcharge) indicated on Drawings.
3. Horizontal Peak Ground Acceleration (A) for Project: <**Insert value**>.

2.2 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C1372, Normal Weight, except that[**maximum water absorption shall not exceed 7 percent by weight and**] units shall not differ in height more than plus or minus **1/16 inch (1.6 mm)** from specified dimension.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allan Block Corporation**]
b. [**Anchor Wall Systems, Inc**]
c. [**CornerStone Wall Solutions Inc.**]
d. [**GeoStone Retaining Wall Systems, Inc.**]
e. [**Keystone Retaining Wall Systems LLC**]
f. [**Nicolock**]
g. [**Risi Stone Inc.**]
h. [**Rockwood Retaining Walls, Inc.**]
i. [**Select ICD; Innovative Concrete Design Corporation**]
j. [**Stone Strong Systems**]
k. [**Tensar International Corporation**]
l. [**Versa-Lok Retaining Wall Systems**]
m. [**WestBlock Systems**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allan Block Corporation**]
b. [**Anchor Wall Systems, Inc**]
c. [**CornerStone Wall Solutions Inc.**]
d. [**GeoStone Retaining Wall Systems, Inc.**]
e. [**Keystone Retaining Wall Systems LLC**]

f. [**Nicolock**]
g. [**Risi Stone Inc.**]
h. [**Rockwood Retaining Walls, Inc.**]
i. [**Select ICD; Innovative Concrete Design Corporation**]
j. [**Stone Strong Systems**]
k. [**Tensar International Corporation**]
l. [**Versa-Lok Retaining Wall Systems**]
m. [**WestBlock Systems**]
n. <**Insert manufacturer's name**>

3. Provide units that comply with requirements in ASTM C1372 for freeze-thaw durability[**as determined by testing**].
4. Provide units that interlock with courses above and below by means of [**integral lugs, lips, or tongues and grooves**][**pins**][**clips**][**splines**][**or**][**and**][**hollow cores filled with drainage fill**].

B. Regional Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Units shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Units shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**].

G. Shape and Texture:

1. Provide units with [**machine-split textured**][**smooth**], [**flat exposed face**][**shaped exposed face with deeply beveled vertical edges**].

a. Face Dimensions:

1) [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert dimension**> high by [**12 inches (300 mm)**][**16 inches (400 mm)**][**18 inches (460 mm)**]<**Insert dimension**> long.
2) Mix of sizes providing appearance of random range ashlar stone masonry.
3) As indicated.

2. Provide units matching basic shape, dimensions, and face texture of basis-of-design product.
3. Provide units of any basic shape and dimensions that produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with [**machine-split textured**][**smooth**], [**flat exposed face**][**shaped exposed face with deeply beveled vertical edges**].

H. Batter: Provide units that offset from course below to provide [**at least**][**1:24**][**1:16**][**1:14**][**1:8**][**1:5**] batter.

I. Cap Units: Provide cap units of [**shape indicated**][**same shape as other units**] with smooth, as-cast top surfaces without holes or lugs.

J. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces [**matching face**][**as indicated**].

2.3 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

D. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for [**base**][**drainage**] course.

1. Leveling Course: Lean concrete with a compressive strength of not more than **500 psi (3.4 MPa)**.

E. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

F. Reinforced Soil Fill:

1. Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.
2. ASTM D2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; complying with the following gradation in accordance with ASTM C136/C136M: 20 to 100 percent passing **No. 4 (4.75 mm)** sieve, zero to 60 percent passing **No. 40 (0.425 mm)** sieve, zero to 35 percent passing **No. 200 (0.075 mm)** sieve, and with fine fraction having a plasticity index of less than 20.

G. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

H. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

I. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation of greater than 50 percent.

1. Apparent Opening Size: **No. 70 to 100 (0.212 to 0.150 mm)** sieve, maximum; ASTM D4751.
2. Minimum Grab Tensile Strength: **110 lb (49.9 kg)**; ASTM D4632/D4632M.
3. Minimum Weight: **4 oz./sq. yd. (132 g/sq. m)**.

J. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanes Geo Components; Leggett & Platt Incorporated**]
b. [**Huesker International**]
c. [**Low & Bonar PLC**]
d. [**Luckenhaus Technical Textiles, Inc.**]
e. [**Propex Operating Company, LLC**]
f. [**Strata Systems, Inc**]
g. [**Synteen Technical Fabrics, Inc.**]
h. [**Tenax Corporation**]
i. [**TenCate Geosynthetics**]
j. [**Tensar International Corporation**]
k. [**Versa-Lok Retaining Wall Systems**]
l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Hanes Geo Components; Leggett & Platt Incorporated**]
b. [**Huesker International**]
c. [**Low & Bonar PLC**]
d. [**Luckenhaus Technical Textiles, Inc.**]
e. [**Propex Operating Company, LLC**]
f. [**Strata Systems, Inc**]
g. [**Synteen Technical Fabrics, Inc.**]
h. [**Tenax Corporation**]
i. [**TenCate Geosynthetics**]
j. [**Tensar International Corporation**]
k. [**Versa-Lok Retaining Wall Systems**]
l. **<Insert manufacturer's name>**

3. Product Type: [**Knitted or woven geogrid made from polyester yarns with a protective coating**][**Molded geogrid made from high-density polyethylene**][**Woven geotextile made from polyamides, polyesters, or polyolefins**].

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect each roll of soil reinforcement for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Grab or single-rib strength.
3. Aperture opening.
4. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF RETAINING WALLS

A. General: Place units in accordance with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in [**running bond**][**bond pattern indicated**].
2. Form corners and ends by [**using special units**][**cutting units with motor-driven saw**][**or**][**splitting units with mason's hammer and chisel**].

B. Do not use units with chips, cracks, or other defects that are visible at a distance of **20 feet (6 m)** where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight in accordance with ASTM D698.

1. Leveling Course: [**At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches (25 to 50 mm) of base**][**Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick**]. Compact and screed concrete to a smooth, level surface.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
4. For units with pins, install pins and align units.
5. For units with clips, install clips and align units.

F. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within **48 inches (1200 mm)** of wall or one-half of height above bottom of wall, whichever is greater.

2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight in accordance with ASTM D698.

   a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight in accordance with ASTM D698.
   b. In areas where fill height exceeds **15 feet (4.5 m),)** compact reinforced-soil fill that will be more than **15 feet (4.5 m)** below finished grade to not less than 98 percent maximum dry unit weight in accordance with ASTM D698.
   c. In areas where fill height exceeds **30 feet (9 m),)** compact reinforced-soil fill that will be more than **30 feet (9 m)** below finished grade to not less than 100 percent maximum dry unit weight in accordance with ASTM D698.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall, and place layer of drainage fill at least [**12 inches (300 mm)**][**6 inches (150 mm)**] wide behind drainage geotextile to within **12 inches (300 mm)** of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least [**12 inches (300 mm)**][**6 inches (150 mm)**] wide behind wall to within **12 inches (300 mm)** of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated[**, sloped not less than 0.5 percent to drain**].

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and in accordance with soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of **8 inches (200 mm)** into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

   1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
   2. Place geosynthetics with seams, if any, oriented perpendicularly to segmental retaining walls.
   3. Do not dump fill material directly from trucks onto geosynthetics.
   4. Place at least **6 inches (150 mm)** of fill over reinforcement before compacting with tracked vehicles or **4 inches (100 mm)** before compacting with rubber-tired vehicles.
   5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed **1-1/4 inches in 10 feet (32 mm in 3 m)**, **3 inches (75 mm)** maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than **1-1/4 inches in 10 feet (32 mm in 3 m)**.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than **1-1/4 inches in 10 feet (32 mm in 3 m)**.

D. Maximum Gap between Units: **1/8 inch (3 mm)**.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

C. Tests and Inspections:

1. In each compacted backfill layer, perform at least one field in-place compaction test for each [**150 feet (45 m)**]<**Insert dimension**> or less of segmental retaining wall length.
2. In each compacted backfill layer, perform at least one field in-place compaction test for each [**24 inches (600 mm)**]<**Insert dimension**> of fill depth and each [**50 feet (15 m)**]<**Insert dimension**> or less of segmental retaining wall length.
3. Segmental retaining wall system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples[**and mockups**].
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 23 00

Task	Specification	Specification Description
32 32 23 13	32 32 23 00	Segmental Retaining Walls
32 32 26 00	32 32 23 00	Segmental Retaining Walls
32 32 29 00	32 32 23 00	Segmental Retaining Walls
32 32 53 00	32 32 23 00	Segmental Retaining Walls

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SECTION 32 33 00 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seating.
2. Tables.
3. Bicycle racks.
4. Bicycle lockers.
5. Trash receptacles.
6. Ash receptacles.
7. Planters.
8. Bollards.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for [**installing pipe sleeves cast**][**installing anchor bolts cast**][**formed voids**] in concrete footings.
2. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish, not less than **6-inch- (152-mm-)** long linear components and **4-inch- (102-mm-)** square sheet components.

1. Include full-size Samples of [**bench**][**table**][**bicycle rack**][**trash receptacle**][**ash receptacle**]<**Insert product**>. Approved samples may be incorporated into the Work.

F. Product Schedule: For site furnishings.[**Use same designations indicated on Drawings**].

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

1. Indicate type of preservative used and net amount of preservative retained.[**For products**

receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.]

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bench Replacement [**Slats**][**Planks**]: No fewer than [**two**]<**Insert number**> full-size units for each size indicated.
2. Trash Receptacle Inner Containers: [**Five**]<**Insert number**> full-size units for each size indicated, but no fewer than [**two**]<**Insert number**> units.
3. Anchors: <**Insert type and number**>.

PART 2 - PRODUCTS

2.1 SEATING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**4Topps Premium Seating**]
2. [**A&T Iron Works, Inc**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**brp by bison**]
6. [**Canterbury Design**]
7. [**Columbia Cascade Company**]
8. [**Country Casual**]
9. [**DuMor Inc.**]
10. [**Fibrex Group, Inc.**]
11. [**Forms+Surfaces**]
12. [**GameTime; a PlayCore Company**]
13. [**Gardenside, Ltd**]
14. [**Henderson Recreation Equipment Ltd**]
15. [**Huntco Supply, LLC**]
16. [**Kay Park Recreation**]
17. [**Keystone Ridge Designs, Inc**]
18. [**Kidstuff Playsystems, Inc.**]
19. [**Kingsley Bate**]
20. [**L.A. Steelcraft, a brand of Americana Outdoor**]
21. [**Landscape Forms**]
22. [**Landscape Structures Inc.**]
23. [**Madrax; Graber Manufacturing, Inc.**]
24. [**Maglin Site Furniture Inc.**]
25. [**Miracle Recreation Equipment Company**]

26. [**Neenah Foundry Company**]
27. [**Petersen Manufacturing Co. Inc.**]
28. [**Playworld Systems, Inc.**]
29. [**Reliance Foundry Co. Ltd**]
30. [**RPI**]
31. [**Sitecraft**]
32. [**Smith & Hawken, Ltd.**]
33. [**SportsPlay Equipment, Inc**]
34. [**Thomas Steele; Graber Manufacturing, Inc.**]
35. [**Tournesol Siteworks LLC**]
36. [**Urban Accessories, Inc**]
37. [**Victor Stanley, Inc**]
38. [**Wausau Tile, Inc.**]
39. [**Weatherend Estate Furniture**]
40. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**4Topps Premium Seating**]
2. [**A&T Iron Works, Inc**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**brp by bison**]
6. [**Canterbury Design**]
7. [**Columbia Cascade Company**]
8. [**Country Casual**]
9. [**DuMor Inc.**]
10. [**Fibrex Group, Inc.**]
11. [**Forms+Surfaces**]
12. [**GameTime; a PlayCore Company**]
13. [**Gardenside, Ltd**]
14. [**Henderson Recreation Equipment Ltd**]
15. [**Huntco Supply, LLC**]
16. [**Kay Park Recreation**]
17. [**Keystone Ridge Designs, Inc**]
18. [**Kidstuff Playsystems, Inc.**]
19. [**Kingsley Bate**]
20. [**L.A. Steelcraft, a brand of Americana Outdoor**]
21. [**Landscape Forms**]
22. [**Landscape Structures Inc.**]
23. [**Madrax; Graber Manufacturing, Inc.**]
24. [**Maglin Site Furniture Inc.**]
25. [**Miracle Recreation Equipment Company**]
26. [**Neenah Foundry Company**]
27. [**Petersen Manufacturing Co. Inc.**]
28. [**Playworld Systems, Inc.**]
29. [**Reliance Foundry Co. Ltd**]
30. [**RPI**]
31. [**Sitecraft**]
32. [**Smith & Hawken, Ltd.**]
33. [**SportsPlay Equipment, Inc**]
34. [**Thomas Steele; Graber Manufacturing, Inc.**]
35. [**Tournesol Siteworks LLC**]
36. [**Urban Accessories, Inc**]
37. [**Victor Stanley, Inc**]

38. [**Wausau Tile, Inc.**]
39. [**Weatherend Estate Furniture**]
40. <**Insert manufacturer's name**>

C. Frame: [**Cast aluminum**][**Cast iron**][**Steel**][**Stainless steel**][**Wrought iron**][**Cedar**][**Teak**]<**Insert material**>.

D. Seat[**and Back**]:

1. Material:

   a. Aluminum Sheet: [**Perforated**][**Expanded**] metal.
   b. [**Painted**]Steel: [**Perforated metal**][**Expanded metal**][**Evenly spaced, parallel flat straps or bars**][**Evenly woven, flat straps or bars**][**Edge framed, evenly spaced, parallel rods or rolled bars**]<**Insert description**>.
   c. Stainless Steel: [**Perforated metal**][**Expanded metal**][**Evenly spaced, parallel flat straps or bars**][**Evenly woven, flat straps or bars**][**Edge framed, evenly spaced, parallel rods or rolled bars**]<**Insert description**>.
   d. Wood: [**Douglas fir**][**Pine**][**Cedar**][**Redwood**][**Teak**]<**Insert species**>; formed into [**evenly spaced parallel slats**][**planks**]<**Insert description**>.
   e. [**Recycled**][**Plastic**][**Fiberglass**] Planks: [**Evenly spaced, parallel**]<**Insert description**>.
   f. [**Recycled**][**Plastic**][**Fiberglass**] Sheet: [**Solid**][**Perforated**].

2. Seat Height: [**As indicated**]<**Insert dimension**>.
3. Seat Surface Shape: [**Flat**][**Contoured or dished**].
4. Overall Height: [**As indicated**]<**Insert dimension**>.
5. Overall Width: [**As indicated**]<**Insert dimension**>.
6. Overall Depth: [**As indicated**]<**Insert dimension**>.
7. Arms: [**None**][**One, as indicated**][**Two, one at each end**][**Three, one at each end and in center**]<**Insert requirements**>.

   a. Arm Material: Match [**frame**][**seat**]<**Insert component**>.

8. Weight: <**Insert weight**>.
9. Seating Configuration: Multiple units[**as indicated**].

   a. [**Straight**][**Angled**][**Curved**] shape.
   b. Closed [**hexagon**][**circle**][**shape indicated**] around a [**tree trunk**][**planter**][**light post**]<**Insert central element**>.

E. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert color**>.

F. Steel Finish: [**Galvanized and**][**color**][**PVC-color**] coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert color**>.

G. Stainless Steel Finish: [**ASTM A480/A480M, No. 6**]<**Insert description**>.

H. Wood Finish: [**Unfinished**][**Factory-applied transparent finish**][**Factory-applied stain and**

transparent finish][**Factory-applied opaque finish**][**Manufacturer's standard finish**].

1. Stain: [**Manufacturer's standard**]<**Insert stain type and color**>.

I. [**Fiberglass**][**HDPE**] Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

J. Graphics: [**Surface-applied**][**Engraved**][**Attached brass plaque with engraved**] copy, content, and style [**according to manufacturer's standard**][**as indicated on Drawings**].

2.2 TABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**4Topps Premium Seating**]
2. [**A&T Iron Works, Inc**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**Canterbury Design**]
6. [**Columbia Cascade Company**]
7. [**Country Casual**]
8. [**DuMor Inc.**]
9. [**Fibrex Group, Inc.**]
10. [**Forms+Surfaces**]
11. [**GameTime; a PlayCore Company**]
12. [**Gardenside, Ltd**]
13. [**Henderson Recreation Equipment Ltd**]
14. [**Huntco Supply, LLC**]
15. [**Kay Park Recreation**]
16. [**Keystone Ridge Designs, Inc**]
17. [**Kidstuff Playsystems, Inc.**]
18. [**Kingsley Bate**]
19. [**L.A. Steelcraft, a brand of Americana Outdoor**]
20. [**Landscape Forms**]
21. [**Landscape Structures Inc.**]
22. [**Madrax; Graber Manufacturing, Inc.**]
23. [**Maglin Site Furniture Inc.**]
24. [**Miracle Recreation Equipment Company**]
25. [**Neenah Foundry Company**]
26. [**Petersen Manufacturing Co. Inc.**]
27. [**Playworld Systems, Inc.**]
28. [**RPI**]
29. [**Sitecraft**]
30. [**Smith & Hawken, Ltd.**]
31. [**SportsPlay Equipment, Inc**]
32. [**Thomas Steele; Graber Manufacturing, Inc.**]
33. [**Tournesol Siteworks LLC**]
34. [**Urban Accessories, Inc**]
35. [**Victor Stanley, Inc**]
36. [**Wausau Tile, Inc.**]
37. [**Weatherend Estate Furniture**]
38. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**4Topps Premium Seating**]
2. [**A&T Iron Works, Inc**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**Canterbury Design**]
6. [**Columbia Cascade Company**]
7. [**Country Casual**]
8. [**DuMor Inc.**]
9. [**Fibrex Group, Inc.**]
10. [**Forms+Surfaces**]
11. [**GameTime; a PlayCore Company**]
12. [**Gardenside, Ltd**]
13. [**Henderson Recreation Equipment Ltd**]
14. [**Huntco Supply, LLC**]
15. [**Kay Park Recreation**]
16. [**Keystone Ridge Designs, Inc**]
17. [**Kidstuff Playsystems, Inc.**]
18. [**Kingsley Bate**]
19. [**L.A. Steelcraft, a brand of Americana Outdoor**]
20. [**Landscape Forms**]
21. [**Landscape Structures Inc.**]
22. [**Madrax; Graber Manufacturing, Inc.**]
23. [**Maglin Site Furniture Inc.**]
24. [**Miracle Recreation Equipment Company**]
25. [**Neenah Foundry Company**]
26. [**Petersen Manufacturing Co. Inc.**]
27. [**Playworld Systems, Inc.**]
28. [**RPI**]
29. [**Sitecraft**]
30. [**Smith & Hawken, Ltd.**]
31. [**SportsPlay Equipment, Inc**]
32. [**Thomas Steele; Graber Manufacturing, Inc.**]
33. [**Tournesol Siteworks LLC**]
34. [**Urban Accessories, Inc**]
35. [**Victor Stanley, Inc**]
36. [**Wausau Tile, Inc.**]
37. [**Weatherend Estate Furniture**]
38. **<Insert manufacturer's name>**

C. Frame: [**Cast aluminum**][**Cast iron**][**Steel**][**Stainless steel**][**Wrought iron**][**Cedar**][**Teak**]**<Insert material>**.

D. Table Top:

1. Material:

   a. Aluminum Sheet: [**Perforated**][**Expanded**] metal.
   b. [**Painted**]Steel: [**Perforated metal**][**Expanded metal**][**Evenly spaced, parallel flat straps or bars**][**Evenly woven, flat straps or bars**][**Edge framed, evenly spaced, parallel rods or rolled bars**]**<Insert description>**.
   c. Stainless Steel: [**Perforated metal**][**Expanded metal**][**Evenly spaced, parallel flat straps or bars**][**Evenly woven, flat straps or bars**][**Edge framed, evenly spaced, parallel rods**

or rolled bars]<**Insert description**>.

d. Wood: [**Douglas fir**][**Pine**][**Cedar**][**Redwood**][**Teak**]<**Insert species**>; formed into [**evenly spaced parallel slats**][**planks**]<**Insert description**>.

e. [**Recycled**][**Plastic**][**Fiberglass**] Planks: [**Evenly spaced, parallel**]<**Insert description**>.

f. [**Recycled**][**Plastic**][**Fiberglass**] Sheet: [**Solid**][**Perforated**].

2. Surface Shape: [**Round**][**Hexagon**][**Shape indicated**]<**Insert shape**>.

3. Feature: [**Center umbrella hole**]<**Insert feature**>.

E. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert color**>.

F. Steel Finish: [**Galvanized and**][**color**][**PVC-color**] coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert color**>.

G. Stainless Steel Finish: [**ASTM A480/480M, No. 6**]<**Insert description**>.

H. Wood Finish: [**Unfinished**][**Factory-applied transparent finish**][**Factory-applied stain and transparent finish**][**Factory-applied opaque finish**][**Manufacturer's standard finish**].

1. Stain: [**Manufacturer's standard**]<**Insert stain type and color**>.

I. [**Fiberglass**][**HDPE**] Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

J. Graphics: [**Surface-applied**][**Engraved**][**Attached brass plaque with engraved**] copy, content, and style [**per manufacturer's standard**][**as indicated on Drawings**].

2.3 BICYCLE RACKS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A A A Ribbon Rack Co., Inc.; a division of Brandir**]
2. [**American Bicycle Security Company**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**brp by bison**]
6. [**Canterbury Design**]
7. [**Columbia Cascade Company**]
8. [**Cora Bike Rack**]
9. [**CycleSafe, Inc.**]
10. [**DuMor Inc.**]
11. [**GameTime; a PlayCore Company**]
12. [**Ground Control Systems**]
13. [**Henderson Recreation Equipment Ltd**]
14. [**Huntco Supply, LLC**]

15. [**Kay Park Recreation**]
16. [**Keystone Ridge Designs, Inc**]
17. [**Kidstuff Playsystems, Inc.**]
18. [**L.A. Steelcraft, a brand of Americana Outdoor**]
19. [**Landscape Forms**]
20. [**Landscape Structures Inc.**]
21. [**Madrax; Graber Manufacturing, Inc.**]
22. [**Maglin Site Furniture Inc.**]
23. [**Miracle Recreation Equipment Company**]
24. [**Neenah Foundry Company**]
25. [**Playworld Systems, Inc.**]
26. [**RPI**]
27. [**Saris Infrastructure**]
28. [**SportsPlay Equipment, Inc**]
29. [**Tournesol Siteworks LLC**]
30. [**Urban Accessories, Inc**]
31. [**Victor Stanley, Inc**]
32. [**Wausau Tile, Inc.**]
33. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A A A Ribbon Rack Co., Inc.; a division of Brandir**]
2. [**American Bicycle Security Company**]
3. [**BCI Burke Company, LLC**]
4. [**Bison, Inc.**]
5. [**brp by bison**]
6. [**Canterbury Design**]
7. [**Columbia Cascade Company**]
8. [**Cora Bike Rack**]
9. [**CycleSafe, Inc.**]
10. [**DuMor Inc.**]
11. [**GameTime; a PlayCore Company**]
12. [**Ground Control Systems**]
13. [**Henderson Recreation Equipment Ltd**]
14. [**Huntco Supply, LLC**]
15. [**Kay Park Recreation**]
16. [**Keystone Ridge Designs, Inc**]
17. [**Kidstuff Playsystems, Inc.**]
18. [**L.A. Steelcraft, a brand of Americana Outdoor**]
19. [**Landscape Forms**]
20. [**Landscape Structures Inc.**]
21. [**Madrax; Graber Manufacturing, Inc.**]
22. [**Maglin Site Furniture Inc.**]
23. [**Miracle Recreation Equipment Company**]
24. [**Neenah Foundry Company**]
25. [**Playworld Systems, Inc.**]
26. [**RPI**]
27. [**Saris Infrastructure**]
28. [**SportsPlay Equipment, Inc**]
29. [**Tournesol Siteworks LLC**]
30. [**Urban Accessories, Inc**]
31. [**Victor Stanley, Inc**]
32. [**Wausau Tile, Inc.**]

33. **<Insert manufacturer's name>**

C. Bicycle Rack Construction:

1. Frame: [**Aluminum**][**Steel**][**Galvanized steel**][**Stainless steel**][**Steel and redwood**][**Steel and pine**]<**Insert description**>.

   a. [**Pipe**][**Tubing**] OD: Not less than [**1-5/8 inches (41 mm)**][**2-3/8 inches (60 mm)**][**2-7/8 inches (73 mm)**][**4-1/2 inches (115 mm)**]<**Insert dimension**>.
   b. Locking Bars: Solid round bar, not less than [**3/4 inch (19 mm)**][**1 inch (25 mm)**] in diameter.

2. Style: [**Single-side parking**][**Double-side parking**][**Bollard**][**As indicated**]<**Insert description**>.

   a. Overall Height: [**As indicated**]<**Insert dimension**>.
   b. Overall Width: [**As indicated**]<**Insert dimension**>.
   c. Overall Depth: [**As indicated**]<**Insert dimension**>.
   d. Capacity: Designed to accommodate no fewer than [**two**][**three**][**four**]<**Insert number**> bicycles.

3. Security: Designed to lock [**wheel**][**and**][**frame**].
4. Accessories: [**Base covers for each pipe and tubing anchored end**][**Wheel stops**]<**Insert accessory**>.
5. Installation Method: [**Freestanding**][**Surface flange anchored at finished grade to substrate indicated**][**Surface flange anchored below finished grade to substrate indicated**][**Cast in concrete**][**Bolted to cast-in anchor bolts**][**Wall mounted**][**As indicated**].

D. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

E. Steel Finish: [**Galvanized**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert color**>.

F. Stainless Steel Finish: [**ASTM A480/A480M, No. 4**]<**Insert description**>.

G. Wood Finish: [**Unfinished**][**Manufacturer's standard finish**].

2.4 BICYCLE LOCKERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Bicycle Security Company**]
2. [**Columbia Cascade Company**]
3. [**Cora Bike Rack**]
4. [**CycleSafe, Inc.**]
5. [**Ground Control Systems**]
6. [**Huntco Supply, LLC**]

7. [**Madrax; Graber Manufacturing, Inc.**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Bicycle Security Company**]
2. [**Columbia Cascade Company**]
3. [**Cora Bike Rack**]
4. [**CycleSafe, Inc.**]
5. [**Ground Control Systems**]
6. [**Huntco Supply, LLC**]
7. [**Madrax; Graber Manufacturing, Inc.**]
8. <**Insert manufacturer's name**>

C. Bicycle Locker Construction:

1. Locker: [**Molded one-piece fiberglass**][**Steel sheet, 0.053 inch (1.4 mm) thick**][**Steel sheet, 0.053 inch (1.4 mm) thick, with perforated metal sides**][**with welded tubular steel frame**]<**Insert material**>.
2. Door: [**Molded one-piece fiberglass**][**Steel sheet, 0.053 inch (1.4 mm) thick**][**with tubular steel frame**][**Match locker**]<**Insert material**>.
3. View [**Window**][**Grille**]: [**Lexan, 12 inches (305 mm) square**][**Perforated metal**].
4. Lock: [**Manufacturer's standard**][**Key lock with internal locking bar**][**Coin/token lock**]<**Insert description**>.

   a. Provide [**four**]<**Insert number**> keys.

5. Overall Height: [**As indicated**]<**Insert dimension**>.
6. Overall Width: [**As indicated**]<**Insert dimension**>.
7. Overall Depth: [**As indicated**]<**Insert dimension**>.
8. Capacity: Designed to accommodate [**one**][**two**] bicycle(s).
9. Installation Method: [**Locker anchored at finished grade to substrate indicated**][**Locker anchored below finished grade to substrate indicated**][**As indicated**].
10. Locker Configuration: [**Multiple**][**Four**]<**Insert number**> units[**as indicated**], in [**straight row**][**curved shape**][**shape indicated**]<**Insert description**>.

D. Steel Finish: Color coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

E. Fiberglass Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

2.5 TRASH RECEPTACLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&T Iron Works, Inc**]

2. [**BCI Burke Company, LLC**]
3. [**Bison, Inc.**]
4. [**brp by bison**]
5. [**Canterbury Design**]
6. [**Columbia Cascade Company**]
7. [**Country Casual**]
8. [**DuMor Inc.**]
9. [**Fiberglass Engineering Company**]
10. [**Fibrex Group, Inc.**]
11. [**Forms+Surfaces**]
12. [**GameTime; a PlayCore Company**]
13. [**Gardenside, Ltd**]
14. [**Henderson Recreation Equipment Ltd**]
15. [**Huntco Supply, LLC**]
16. [**Kay Park Recreation**]
17. [**Keystone Ridge Designs, Inc**]
18. [**Kidstuff Playsystems, Inc.**]
19. [**L.A. Steelcraft, a brand of Americana Outdoor**]
20. [**Landscape Forms**]
21. [**Landscape Structures Inc.**]
22. [**Maglin Site Furniture Inc.**]
23. [**Miracle Recreation Equipment Company**]
24. [**Petersen Manufacturing Co. Inc.**]
25. [**Playworld Systems, Inc.**]
26. [**RPI**]
27. [**Sitecraft**]
28. [**Smith & Hawken, Ltd.**]
29. [**Thomas Steele; Graber Manufacturing, Inc.**]
30. [**Tournesol Siteworks LLC**]
31. [**Urban Accessories, Inc**]
32. [**Victor Stanley, Inc**]
33. [**Wausau Tile, Inc.**]
34. [**Weatherend Estate Furniture**]
35. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A&T Iron Works, Inc**]
2. [**BCI Burke Company, LLC**]
3. [**Bison, Inc.**]
4. [**brp by bison**]
5. [**Canterbury Design**]
6. [**Columbia Cascade Company**]
7. [**Country Casual**]
8. [**DuMor Inc.**]
9. [**Fiberglass Engineering Company**]
10. [**Fibrex Group, Inc.**]
11. [**Forms+Surfaces**]
12. [**GameTime; a PlayCore Company**]
13. [**Gardenside, Ltd**]
14. [**Henderson Recreation Equipment Ltd**]
15. [**Huntco Supply, LLC**]
16. [**Kay Park Recreation**]
17. [**Keystone Ridge Designs, Inc**]
18. [**Kidstuff Playsystems, Inc.**]

19. [**L.A. Steelcraft, a brand of Americana Outdoor**]
20. [**Landscape Forms**]
21. [**Landscape Structures Inc.**]
22. [**Maglin Site Furniture Inc.**]
23. [**Miracle Recreation Equipment Company**]
24. [**Petersen Manufacturing Co. Inc.**]
25. [**Playworld Systems, Inc.**]
26. [**RPI**]
27. [**Sitecraft**]
28. [**Smith & Hawken, Ltd.**]
29. [**Thomas Steele; Graber Manufacturing, Inc.**]
30. [**Tournesol Siteworks LLC**]
31. [**Urban Accessories, Inc**]
32. [**Victor Stanley, Inc**]
33. [**Wausau Tile, Inc.**]
34. [**Weatherend Estate Furniture**]
35. <**Insert manufacturer's name**>

C. Aluminum Facing Surrounds: [**Aluminum sheet**][**Perforated aluminum sheet**][**Grid in tubular frame**][**Evenly patterned, parallel flat aluminum straps, bars, or tubular shapes**][**Match benches**]<**Insert material and description**>.

D. Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

E. Stainless Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

F. Wood Facing Surrounds: [**Evenly spaced, Douglas fir slats**][**Evenly spaced pine slats**][**Evenly spaced cedar slats**][**Redwood panels**][**Evenly spaced redwood slats**][**Teak panels**][**Evenly spaced teak slats**][**Match benches**]<**Insert wood type and description**>.

G. Fiberglass Facing Surrounds: Molded fiberglass shape.

H. Plastic Facing Surrounds: [**Molded HDPE shape**][**Evenly spaced HDPE slats**][**Evenly spaced, recycled HDPE slats**][**Match benches**]<**Insert plastic type and description**>.

I. Support Frames: [**Steel**][**Galvanized steel**]; welded.

J. Trash Receptacles:

1. Receptacle Shape and Form: [**Round cylinder**][**Round cylinder with tapered funnel top**][**Round, tapered column**][**Square column**][**Rectangular column**][**As indicated**]<**Insert shape and form**>; with opening for depositing trash in [**lid or top**][**side of lid or top**][**receptacle side**].
2. Lids and Tops: [**Matching facing panels**][**Aluminum**][**Steel**][**HDPE**][**Recycled HDPE**]<**Insert material and description**> secured by cable or chain, hinged, swiveled, or permanently secured.

    a. Description: [**Flat rim ring lid with center opening**][**Dome top**][**Arched top**][**Elevated flat or shallow dome rain-cap lid**][**Combination ash sand pan and rim lid**][**Combination ash sand pan and dome top**][**Combination ash sand pan and elevated flat or shallow dome rain-cap lid**]<**Insert description**>.
    b. Opening for depositing trash covered by [**self-closing, spring-loaded-hinged, push-**

in][**rotating**] weather flap.

3. Receptacle Height: [**As indicated**]<**Insert dimension**>.
4. Overall Width: [**As indicated**]<**Insert dimension**>.
5. Weight: <**Insert weight**>.
6. Inner Container: [**Aluminum**][**Galvanized-steel sheet**][**Perforated-metal**][**Fiberglass**][**Rigid plastic**] container with [**drain holes**][**lift-out handles**]; designed to be removable and reusable.
7. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
8. Capacity: Not less than [**22 gal. (83 L)**][**28 gal. (106 L)**][**30 gal. (114 L)**][**32 gal. (121 L)**][**40 gal. (151 L)**][**55 gal. (208 L)**]<**Insert value**>.
9. Service Access: [**Removable lid or top**][**Fixed lid or top, side access**]; inner container and disposable liner lift or slide-out for emptying[**; lockable with padlock hasps**][**; keyed lock with two keys per receptacle**][**; self-latching hinge**].
10. Post Mount: [**Color-coated steel pipe; color to match receptacle**][**Galvanized-steel pipe**][**Wood**]; for mounting [**one**][**two**][**three**] receptacle(s).

K. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

L. Steel Finish: [**Galvanized and**][**color**][**PVC-color**] coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

M. Stainless Steel Finish: [**ASTM A480/A480M, No. 6**]<**Insert description**>.

N. Wood Finish: [**Unfinished**][**Factory-applied transparent finish**][**Factory-applied stain and transparent finish**][**Factory-applied opaque finish**][**Manufacturer's standard finish**].

1. Stain: [**Manufacturer's standard**]<**Insert stain type and color**>.

O. [**Fiberglass**][**HDPE**] Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

P. Graphics: [**Surface-applied**][**Engraved**][**Attached brass plaque with engraved**] copy, content, and style [**according to manufacturer's standard**][**as indicated on Drawings**].

1. Copy: [**Litter**][**Trash**][**Waste**][**Recycle**]<**Insert term**>.

2.6 ASH RECEPTACLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A&T Iron Works, Inc**]
2. [**BCI Burke Company, LLC**]
3. [**Canterbury Design**]
4. [**Columbia Cascade Company**]
5. [**Country Casual**]

6. [**DuMor Inc.**]
7. [**Fiberglass Engineering Company**]
8. [**Fibrex Group, Inc.**]
9. [**Forms+Surfaces**]
10. [**GameTime; a PlayCore Company**]
11. [**Gardenside, Ltd**]
12. [**Henderson Recreation Equipment Ltd**]
13. [**Huntco Supply, LLC**]
14. [**Kay Park Recreation**]
15. [**Kidstuff Playsystems, Inc.**]
16. [**L.A. Steelcraft, a brand of Americana Outdoor**]
17. [**Landscape Forms**]
18. [**Landscape Structures Inc.**]
19. [**Maglin Site Furniture Inc.**]
20. [**Miracle Recreation Equipment Company**]
21. [**Playworld Systems, Inc.**]
22. [**RPI**]
23. [**Sitecraft**]
24. [**Smith & Hawken, Ltd.**]
25. [**Thomas Steele; Graber Manufacturing, Inc.**]
26. [**Tournesol Siteworks LLC**]
27. [**Urban Accessories, Inc**]
28. [**Victor Stanley, Inc**]
29. [**Wausau Tile, Inc.**]
30. [**Weatherend Estate Furniture**]
31. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A&T Iron Works, Inc**]
2. [**BCI Burke Company, LLC**]
3. [**Canterbury Design**]
4. [**Columbia Cascade Company**]
5. [**Country Casual**]
6. [**DuMor Inc.**]
7. [**Fiberglass Engineering Company**]
8. [**Fibrex Group, Inc.**]
9. [**Forms+Surfaces**]
10. [**GameTime; a PlayCore Company**]
11. [**Gardenside, Ltd**]
12. [**Henderson Recreation Equipment Ltd**]
13. [**Huntco Supply, LLC**]
14. [**Kay Park Recreation**]
15. [**Kidstuff Playsystems, Inc.**]
16. [**L.A. Steelcraft, a brand of Americana Outdoor**]
17. [**Landscape Forms**]
18. [**Landscape Structures Inc.**]
19. [**Maglin Site Furniture Inc.**]
20. [**Miracle Recreation Equipment Company**]
21. [**Playworld Systems, Inc.**]
22. [**RPI**]
23. [**Sitecraft**]
24. [**Smith & Hawken, Ltd.**]
25. [**Thomas Steele; Graber Manufacturing, Inc.**]

26. [**Tournesol Siteworks LLC**]
27. [**Urban Accessories, Inc**]
28. [**Victor Stanley, Inc**]
29. [**Wausau Tile, Inc.**]
30. [**Weatherend Estate Furniture**]
31. <**Insert manufacturer's name**>

C. Aluminum Facing Surrounds: [**Aluminum sheet**][**Perforated aluminum sheet**][**Grid in tubular frame**][**Evenly patterned, parallel flat aluminum straps, bars, or tubular shapes**][**Match benches**]<**Insert material and description**>.

D. Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

E. Stainless Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

F. Fiberglass Facing Surrounds: Molded fiberglass shape.

G. Support Frames: [**Steel**][**Galvanized steel**]; welded.

H. Ash Receptacles:

1. Receptacle Shape and Form: [**Round cylinder**][**Round cylinder with tapered funnel top**][**Round, tapered column**][**Square column**][**Rectangular column**][**As indicated**]<**Insert shape and form**>; with opening for depositing trash in [**lid or top**][**side of lid or top**][**receptacle side**].
2. Function: [**Uncovered receptacle with sand pan**][**Uncovered receptacle with bowl and funnel**][**Covered receptacle with sand pan**][**Covered receptacle with bowl and screen**][**Covered receptacle with slots**][**Uncovered receptacle with sand pan attaching to side of trash receptacle**]<**Insert description and accessories**> for depositing cigarette butts; fire-proof design; bowl and pan removable for cleaning.
3. Lids and Tops: [**Matching facing panels**][**Aluminum**][**Steel**][**HDPE**][**Recycled HDPE**]<**Insert material and description**> secured by cable or chain, hinged, swiveled, or permanently secured.

    a. Description: [**Flat rim ring lid with center opening**][**Dome top**][**Arched top**][**Elevated flat or shallow dome rain-cap lid**][**Combination ash sand pan and rim lid**][**Combination ash sand pan and dome top**][**Combination ash sand pan and elevated flat or shallow dome rain-cap lid**]<**Insert description**>.

4. Receptacle Height: [**As indicated**]<**Insert dimension**>.
5. Overall Width: [**As indicated**]<**Insert dimension**>.
6. Weight: <**Insert weight**>.
7. Post Mount: [**Color-coated steel pipe; color to match receptacle**][**Galvanized-steel pipe**][**Wood**]; for mounting [**one**][**two**][**three**] receptacle(s).
8. Accessories: [**Sand sifter**][**Butt stub-out**]<**Insert accessory**>.

I. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

J. Steel Finish: [**Galvanized and**][**color**][**PVC-color**] coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

K. Stainless Steel Finish: [**ASTM A480/A480M, No. 6**]<**Insert description**>.

L. [**Fiberglass**][**HDPE**] Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

2.7 PLANTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bison Innovative Products, United Construction Products, Inc.**]
2. [**Country Casual**]
3. [**DuMor Inc.**]
4. [**Fiberglass Engineering Company**]
5. [**Fibrex Group, Inc.**]
6. [**Gardenside, Ltd**]
7. [**Kay Park Recreation**]
8. [**Kingsley Bate**]
9. [**Maglin Site Furniture Inc.**]
10. [**Omni Ecosystems**]
11. [**Petersen Manufacturing Co. Inc.**]
12. [**RPI**]
13. [**Sitecraft**]
14. [**Thomas Steele; Graber Manufacturing, Inc.**]
15. [**Tournesol Siteworks LLC**]
16. [**Victor Stanley, Inc**]
17. [**Wausau Tile, Inc.**]
18. [**Weatherend Estate Furniture**]
19. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bison Innovative Products, United Construction Products, Inc.**]
2. [**Country Casual**]
3. [**DuMor Inc.**]
4. [**Fiberglass Engineering Company**]
5. [**Fibrex Group, Inc.**]
6. [**Gardenside, Ltd**]
7. [**Kay Park Recreation**]
8. [**Kingsley Bate**]
9. [**Maglin Site Furniture Inc.**]
10. [**Omni Ecosystems**]
11. [**Petersen Manufacturing Co. Inc.**]
12. [**RPI**]
13. [**Sitecraft**]
14. [**Thomas Steele; Graber Manufacturing, Inc.**]
15. [**Tournesol Siteworks LLC**]

16. [**Victor Stanley, Inc**]
17. [**Wausau Tile, Inc.**]
18. [**Weatherend Estate Furniture**]
19. <**Insert manufacturer's name**>

C. Aluminum Facing Surrounds: [**Aluminum sheet**][**Perforated aluminum sheet**][**Grid in tubular frame**][**Evenly patterned, parallel flat aluminum straps, bars, or tubular shapes**][**Match benches**]<**Insert material and description**>.

D. Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

E. Stainless Steel Facing Surrounds: [**Steel sheet**][**Perforated-steel sheet**][**Evenly patterned, parallel flat steel straps, bars, or tubular shapes**][**Evenly patterned, parallel round steel rods, bars, or tubular shapes**][**Grid in tubular frame**][**Match benches**]<**Insert material and description**>.

F. Wood Facing Surrounds: [**Evenly spaced, Douglas fir slats**][**Evenly spaced pine slats**][**Evenly spaced cedar slats**][**Redwood panels**][**Evenly spaced redwood slats**][**Teak panels**][**Evenly spaced teak slats**][**Match benches**]<**Insert wood type and description**>.

G. Fiberglass Facing Surrounds: Molded fiberglass shape.

H. Plastic Facing Surrounds: [**Molded HDPE shape**][**Evenly spaced HDPE slats**][**Evenly spaced, recycled HDPE slats**][**Match benches**]<**Insert plastic type and description**>.

I. Support Frames: [**Steel**][**Galvanized steel**]; welded.

J. Planter Shape and Form: [**Round cylinder**][**Round cylinder with tapered funnel top**][**Round, tapered column**][**Square column**][**Rectangular column**][**As indicated**]<**Insert shape and form**>.

K. Style: [**To match benches**][**As indicated by manufacturer's designation**].

L. Overall Height: [**As indicated**]<**Insert dimension**>.

M. Overall [**Diameter**][**Width**]: [**As indicated**]<**Insert dimension**>.

N. Overall Depth: [**As indicated**]<**Insert dimension**>.

O. Weight: <**Insert weight**>.

P. Inner Container: [**Aluminum**][**Galvanized-steel sheet**][**Fiberglass**][**Rigid plastic**] container[**with drain holes**].

Q. Capacity: Not less than [**22 gal. (83 L)**][**28 gal. (106 L)**][**30 gal. (114 L)**][**32 gal. (121 L)**][**40 gal. (151 L)**][**55 gal. (208 L)**]<**Insert value**>.

R. Installation Method: [**Freestanding**][**Freestanding with weighted base**][**Anchored to substrate indicated on Drawings**][**Wall mounted**][**Post mounted**][**Mounted on elevated leg angles anchored at finished grade to substrate indicated on Drawings**][**Mounted on elevated leg angles anchored below finished grade to substrate indicated on Drawings**][**As indicated on Drawings**].

1. Post Mount: [**Color-coated steel pipe; color to match receptacle**][**Galvanized-steel pipe**][**Wood**]; for mounting [**one**][**two**][**three**] planter(s).

S. Aluminum Finish: Color coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

T. Steel Finish: [**Galvanized and**][**color**][**PVC-color**] coated.

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

U. Stainless Steel Finish: [**ASTM A480/A480M, No. 6**]<**Insert description**>.

V. Wood Finish: [**Unfinished**][**Factory-applied transparent finish**][**Factory-applied stained and transparent finish**].

1. Stain: <**Insert stain type and color**>.

W. [**Fiberglass**][**HDPE**] Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

1. Finish: [**Smooth**][**Textured**].

2.8 BOLLARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**1-800-Bollards**]
2. [**brp by bison**]
3. [**CAME Americas Automation LLC**]
4. [**Canterbury Design**]
5. [**Columbia Cascade Company**]
6. [**Dero; a PlayCore company**]
7. [**DuMor Inc.**]
8. [**Huntco Supply, LLC**]
9. [**L.A. Steelcraft, a brand of Americana Outdoor**]
10. [**Maglin Site Furniture Inc.**]
11. [**Neenah Foundry Company**]
12. [**Petersen Manufacturing Co. Inc.**]
13. [**Reliance Foundry Co. Ltd**]
14. [**Thomas Steele; Graber Manufacturing, Inc.**]
15. [**Tournesol Siteworks LLC**]
16. [**Urban Accessories, Inc**]
17. [**Victor Stanley, Inc**]
18. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**1-800-Bollards**]

2. [**brp by bison**]
3. [**CAME Americas Automation LLC**]
4. [**Canterbury Design**]
5. [**Columbia Cascade Company**]
6. [**Dero; a PlayCore company**]
7. [**DuMor Inc.**]
8. [**Huntco Supply, LLC**]
9. [**L.A. Steelcraft, a brand of Americana Outdoor**]
10. [**Maglin Site Furniture Inc.**]
11. [**Neenah Foundry Company**]
12. [**Petersen Manufacturing Co. Inc.**]
13. [**Reliance Foundry Co. Ltd**]
14. [**Thomas Steele; Graber Manufacturing, Inc.**]
15. [**Tournesol Siteworks LLC**]
16. [**Urban Accessories, Inc**]
17. [**Victor Stanley, Inc**]
18. <**Insert manufacturer's name**>

C. Bollard Construction:

1. [**Pipe**][**Tubing**][**Cast Iron**] OD: Not less than [**4-1/2 inches (115 mm)**]<**Insert dimension**>[**, fluted**].

   a. Steel: [**Schedule 40**][**Schedule 80**] pipe.
   b. Aluminum: [**Extruded pipe and tubes**][**Castings**].
   c. Stainless Steel: [**Tubes**][**Pipe**].
   d. Cast Iron: [**Tapered**][**As indicated**].

2. [**Round**][**Square**] Wood: [**Cedar**]<**Insert material**>, [**8 inches (203 mm) square**][**10 inches (254 mm) in diameter**].
3. Style: [**Manufacturer's standard**][**Chamfered top**][**Dome top**][**Ornamental cap**][**As indicated**]<**Insert description**>.
4. Overall Height: [**As indicated**]<**Insert dimension**>.
5. Overall Width: [**As indicated**]<**Insert dimension**>.
6. Overall Depth: [**As indicated**]<**Insert dimension**>.
7. Accessories: [**Eye bolts**]<**Insert accessory**>.
8. Installation Method: [**Surface flange anchored at finished grade to substrate indicated**][**Surface flange anchored below finished grade to substrate indicated**][**Cast in concrete**][**Bolted to cast-in anchor bolts**][**As indicated**].

D. Aluminum Finish: [**Mill finish**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

E. Steel Finish: [**Galvanized**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing schedule**]<**Insert description**>.

F. Cast-Iron Finish: [**Manufacturer's standard**][**Galvanized**][**Color coated**].

1. Color: [**As indicated by manufacturer's designation**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated in a site furnishing**

schedule]<**Insert description**>.

G. Stainless Steel Finish: [**ASTM A480/A480M, No. 4**]<**Insert description**>.

H. Wood Finish: [**Unfinished**][**Manufacturer's standard finish**].

2.9 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: **ASTM B211 (ASTM B211M)**.
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: **ASTM B221 (ASTM B221M)**.
3. Structural Pipe and Tube: ASTM B429/B429M.
4. Sheet and Plate: **ASTM B209 (ASTM B209M)**.
5. Castings: ASTM B26/B26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A36/A36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A53/A53M, or electric-resistance-welded pipe complying with ASTM A135/A135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A500/A500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A513/A513M, or steel tubing fabricated from steel complying with ASTM A1011/A1011M and complying with dimensional tolerances in ASTM A500/A500M; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A1011/A1011M.
6. Perforated Metal: From steel sheet not less than [**0.075-inch (1.9-mm)**][**0.090-inch (2.3-mm)**][**0.120-inch (3.0-mm)**]<**Insert dimension**> nominal thickness; manufacturer's standard perforation pattern.
7. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F1267.
8. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended by fabricator for type of use intended.
9. Gray-Iron Castings: ASTM A48/A48M, Class 200.

C. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M or ASTM A666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A312/A312M.
3. Tubing: ASTM A554.

D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.

1. Wood Species:[**Manufacturer's standard.**]

a. Douglas Fir: Clear Grade, vertical grain.
b. Pine: Southern pine; No. 2 or better[**; preservative treated, kiln dried after treatment**].
c. [**Eastern White**][**Red**][**Yellow**] Cedar: Select Grade or better.
d. Redwood: [**Clear all heart**][**Construction heart or better**], free-of-heart center.
e. Teak (Tectona Grandis): Clear Grade.
f. <**Insert wood species**>: <**Insert grade, if applicable, and other requirements**>.

E. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

F. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

G. Certified Wood: Wood products shall be labeled according to the AFPA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

H. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

I. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AFPA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Finish: Manufacturer's standard [**stain**][**and**][**transparent sealer**][**transparent wood-preservative treatment and sealer**]<**Insert treatment or finish**>.

J. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

K. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.

1. Polyethylene: Fabricated from virgin plastic HDPE resin.
2. Polyethylene with Recycled Content: Fabricated from HDPE and other resins with postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.

L. Anchors, Fasteners, Fittings, and Hardware: [**Stainless steel**][**Brass**][**Galvanized steel**][**Zinc-plated steel**][**Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials**]; commercial quality[**, tamperproof, vandal and theft resistant**][**, concealed, recessed, and capped or plugged**].

1. Angle Anchors: For inconspicuously bolting legs of site furnishings to [**on**][**below**]-grade substrate; [**one per leg**][**extent as indicated**]<**Insert extent**>.
2. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; [**two per unit**][**extent as indicated on Drawings**]<**Insert extent**>.

M. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M; recommended in writing by manufacturer, for exterior applications.

N. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

O. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq.**

ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.

2. Hot-Dip Galvanizing: According to ASTM A123/A123M, ASTM A153/A153M, or ASTM A924/A924M.

2.10 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment: Pressure-treat wood according to AWPA U1, Use Category UC3b, and the following:

1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

2.11 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.12 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.13 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.14 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

2.15 IRON FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.16 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: ASTM A480/A480M, No 4.
3. Dull Satin Finish: ASTM A480/A480M, No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and [**securely anchored**][**positioned**] at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and **3/4 inch (19 mm)** larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 32 33 00 00

Task	Specification	Specification Description
32 33 13 00	32 33 00 00	Site Furnishings
32 33 23 00	32 33 00 00	Site Furnishings
32 33 33 00	32 33 00 00	Site Furnishings
32 33 43 00	32 33 00 00	Site Furnishings
32 33 43 13	32 33 00 00	Site Furnishings
32 33 43 53	32 33 00 00	Site Furnishings
32 33 53 00	32 33 00 00	Site Furnishings
32 33 63 00	32 33 00 00	Site Furnishings

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SECTION 32 84 00 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Encasement for piping.
3. Manual valves.
4. Pressure-reducing valves.
5. Automatic control valves.
6. Automatic drain valves.
7. Transition fittings.
8. Dielectric fittings.
9. Miscellaneous piping specialties.
10. Sprinklers.
11. Quick couplers.
12. Drip irrigation specialties.
13. Controllers.
14. Boxes for automatic control valves.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing" for water metering requirements.
2. Section 230923.14 "Flow Instruments" for water metering equipment.

1.2 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. ET Controllers: EvapoTranspiration Controllers. Irrigation controllers, which use some method of weather-based adjustment of irrigation. These adjusting methods include use of historical monthly averages of ET, broadcasting of ET measurements, or use of on-site sensors to track ET.

D. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipes, tubes, and fittings.

2. Encasement for piping.
3. Manual valves.
4. Pressure-reducing valves.
5. Automatic control valves.
6. Automatic drain valves.
7. Transition fittings.
8. Dielectric fittings.
9. Miscellaneous piping specialties.
10. Sprinklers.
11. Quick couplers.
12. Drip irrigation specialties.
13. Controllers.
14. Boxes for automatic control valves.
15. Include rated capacities, operating characteristics,[**electrical characteristics,**] and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated Design Submittals: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For irrigation control system.
2. Product Data: For irrigation submetering.
3. Irrigation Submetering: Provide manufacturer cut sheets for irrigation metering equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are indicated and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions, such as signs and light standards.

B. Zoning Chart: Indicate each irrigation zone and its control valve.

C. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Qualification Statements: For [**Installer**]<**Insert entity or specialist**>.

F. Delegated design engineer qualifications.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**sprinklers**][**controllers**][**and**][**automatic control valves**] to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Impact Sprinklers: Equal to <**Insert number**> percent of amount installed for each type and size indicated, but no fewer than <**Insert number**> units.
2. Spray Sprinklers: Equal to <**Insert number**> percent of amount installed for each type and size indicated, but no fewer than <**Insert number**> units.
3. Bubblers: Equal to <**Insert number**> percent of amount installed for each type indicated, but no fewer than <**Insert number**> units.
4. Emitters: Equal to <**Insert number**> percent of amount installed for each type indicated, but no fewer than <**Insert number**> units.
5. Drip-Tube System Tubing: Equal to <**Insert number**> percent of total length installed for each type and size indicated, but not less than [**100 ft. (30 m)**][**500 ft. (152 m)**]<**Insert value**>.
6. Soaker Tubes: Equal to <**Insert number**> percent of total length installed for each type and size indicated, but not less than [**50 ft. (15.2 m)**][**100 ft. (30 m)**]<**Insert value**>.

B. Schedule of maintenance material items.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs a [**Certified Irrigation Designer - Landscape qualified by the Irrigation Association**][**Professional Class member of the American Society of Irrigation Consultants**][**Professional Technical Class member of the American Society of Irrigation Consultants**]<**Insert qualifications**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.

1.9 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Irrigation Zone Control: [**Automatic operation with controller and automatic control**][**Manual operation with manual**] valves.

B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions, such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

C. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Available land records indicate the following soil conditions:

a. Type: [**Coarse**][**Medium**][**Fine**]<**Insert type**>.
b. Texture:

1) Sand: <**Insert number**> percent.
2) Silt: <**Insert number**> percent.
3) Clay: <**Insert number**> percent.

c. Particle Size:

1) Sand: <**Insert number**> mm.
2) Silt: <**Insert number**> mm.
3) Clay: <**Insert number**> mm.

d. Structure: [**Single grained**][**Granular**][**Platy**][**Blocky**]<**Insert structure**>.
e. Density: <**Insert lb/cu. ft. (kg./cu. m)**>.
f. Moisture Content: <**Insert number**> percent.
g. Infiltration Rate: <**Insert gph (L/s)**>.

D. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

1. Irrigation Main Piping: [**200 psig (1380 kPa)**]<**Insert value**>.
2. Circuit Piping: [**150 psig (1035 kPa)**]<**Insert value**>.

2.2 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. Galvanized-Steel Pipe: ASTM A53/A53M, Standard Weight, Type E, Grade B.

1. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless-steel pipe with threaded ends.
2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket,

metal-to-metal, bronze seating surface, and female threaded ends.
4. Cast-Iron Flanges: ASME B16.1, Class 125.

C. Ductile-Iron Pipe with Mechanical Joints: AWWA C151, with mechanical-joint bell and spigot ends.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Ductile-Iron Pipe with Push-on Joint: AWWA C151, with push-on-joint bell and spigot ends.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111 rubber.

E. Soft Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

F. Hard Copper Tube: [**ASTM B88, Type L (ASTM B88M, Type B)**,][**and**][**ASTM B88, Type M (ASTM B88M, Type C)**,] water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

G. PE Pipe with Controlled ID: ASTM D2239, PE 3408 compound; [**SIDR 11.5**][**and**][**SIDR 15**].

1. Insert Fittings for PE Pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.

H. PE Pipe with Controlled OD: ASTM D3035, PE 3408 compound, SIDR 11.

1. PE Butt, Heat-Fusion Fittings: ASTM D3261.
2. PE Socket-Type Fittings: ASTM D2683.

I. PE Pressure Pipe: AWWA C906, with DR of 7.3, 9, or 9.3 and PE compound number required to give pressure rating of not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**].

1. PE Butt, Heat-Fusion Fittings: ASTM D3261.
2. PE Socket-Type Fittings: ASTM D2683.

J. PVC Pipe: ASTM D1785, PVC 1120 compound, [**Schedule 40**][**Schedule 80**][**Schedules 40 and 80**].

1. PVC Socket Fittings: ASTM D2466, [**Schedule 40**][**Schedule 80**][**Schedules 40 and 80**].
2. PVC Threaded Fittings: ASTM D2464, Schedule 80.

3. PVC Socket Unions: Construction similar to that of MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

K. PVC Pipe, Pressure Rated: ASTM D2241, PVC 1120 compound, [**SDR 21**][**and**][**SDR 26**].

1. PVC Socket Fittings: ASTM D2467, Schedule 80.
2. PVC Socket Unions: Construction similar to that of MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, **1/8 inch (3 mm)** thick unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

E. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105.

B. Form: [**Sheet**][**Sheet or tube**][**Tube**].

C. Material: [**LLDPE film of 0.008-inch (0.20-mm)**][**LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm)**][**High-density, cross-laminated PE film of 0.004-inch (0.10-mm)**] minimum thickness.

D. Color: [**Black**][**or**][**Natural**]<**Insert color**>.

2.5 MANUAL VALVES

A. Curb Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Amcast Industrial Corporation**]
c. [**Ford Meter Box Company, Inc. (The)**]

d. [**James Jones Company, LLC, Mueller Water Products, Inc.**]
e. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
f. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**A.Y. McDonald Mfg. Co.**]
b. [**Amcast Industrial Corporation**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**James Jones Company, LLC, Mueller Water Products, Inc.**]
e. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
f. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
g. **<Insert manufacturer's name>**

3. Description:

a. Standard: AWWA C800.
b. **NPS 1 (DN 25)** and Smaller Pressure Rating: [**100 psig (690 kPa) minimum**][**150 psig (1035 kPa)**].
c. **NPS 1-1/4 to NPS 2 (DN 32 to DN 50)** Pressure Rating: [**80 psig (550 kPa) minimum**][**150 psig (1035 kPa)**].
d. Body Material: Brass or bronze with ball or ground-key plug.
e. End Connections: Matching piping.
f. Stem: With wide-tee head.

B. Curb-Valve Casing:

1. Standard: Similar to AWWA M44 for cast-iron valve casings.
2. Top Section: Telescoping, of length required for depth of burial of curb valve.
3. Barrel: Approximately **3-inch (75-mm)** diameter.
4. Plug: With lettering "WATER."
5. Bottom Section: With base of size to fit over valve.
6. Base Support: Concrete collar[**or wood frame**].

C. Shutoff Rods for Curb-Valve Casings: Furnish [**one**][**two**]**<Insert number>** steel, tee-handle shutoff rod(s) with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve for Project.

D. Brass Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**DynaQuip Controls**]
c. [**Flow-Tek; a subsidiary of Bray International**]
d. [**Hammond Valve**]
e. [**Jomar Valve**]
f. [**KITZ Corporation**]
g. [**Marwin Valve; Richards Industries**]
h. [**Milwaukee Valve Company**]

i. [**Neles Corporation**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**RuB Inc**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**DynaQuip Controls**]
c. [**Flow-Tek; a subsidiary of Bray International**]
d. [**Hammond Valve**]
e. [**Jomar Valve**]
f. [**KITZ Corporation**]
g. [**Marwin Valve; Richards Industries**]
h. [**Milwaukee Valve Company**]
i. [**Neles Corporation**]
j. [**NIBCO INC.**]
k. [**Red-White Valve Corp.**]
l. [**RuB Inc**]
m. <**Insert manufacturer's name**>

3. Description:

a. Standard: MSS SP-110.
b. SWP Rating: **150 psig (1035 kPa)**.
c. CWP Rating: **600 psig (4140 kPa)**.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded or solder joint if indicated.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full[**or regular, but not reduced**].

E. Bronze Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Valve, Inc**]
b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
c. [**Crane Fluid Systems; Crane Co.**]
d. [**Hammond Valve**]
e. [**Lance Valves**]
f. [**Milwaukee Valve Company**]
g. [**NIBCO INC.**]
h. [**Red-White Valve Corp.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**Crane Fluid Systems; Crane Co.**]
   d. [**Hammond Valve**]
   e. [**Lance Valves**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Red-White Valve Corp.**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

3. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: **150 psig (1035 kPa)**.
   c. CWP Rating: **600 psig (4140 kPa)**.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded or solder joint if indicated.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full[**or regular, but not reduced**].

F. Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**KITZ Corporation**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**KITZ Corporation**]
   c. [**Sure Flow Equipment Inc**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Description:

a. Standard: MSS SP-72.
b. CWP Rating: **200 psig (1380 kPa)**.
c. Body Design: Split body.
d. Body Material: ASTM A126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

G. Plastic Ball Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**NIBCO INC.**]
   i. [**Spears Manufacturing Company**]
   j. [**Thermoplastic Valves, Inc**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Asahi/America**]
   c. [**Colonial Engineering, Inc.**]
   d. [**GF Piping Systems: Georg Fischer LLC**]
   e. [**Hayward Flow Control; Hayward Industries, Inc.**]
   f. [**IPEX USA LLC**]
   g. [**Jomar Valve**]
   h. [**NIBCO INC.**]
   i. [**Spears Manufacturing Company**]
   j. [**Thermoplastic Valves, Inc**]
   k. [**WATTS; A Watts Water Technologies Company**]
   l. **<Insert manufacturer's name>**

3. Description:

   a. Standard: MSS SP-122.
   b. Pressure Rating: [**125 psig (860 kPa) minimum**][**150 psig (1035 kPa)**].
   c. Body Material: PVC.
   d. Type: Union.
   e. End Connections: Socket or threaded.
   f. Port: Full.

H. Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Valve, Inc**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**KITZ Corporation**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Powell Valves**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Valve, Inc**]
   b. [**Crane Fluid Systems; Crane Co.**]
   c. [**Hammond Valve**]
   d. [**Jenkins Valves; a Crane Co. brand**]
   e. [**KITZ Corporation**]
   f. [**Milwaukee Valve Company**]
   g. [**NIBCO INC.**]
   h. [**Powell Valves**]
   i. [**WATTS; A Watts Water Technologies Company**]
   j. [**Zurn Industries, LLC**]
   k. <**Insert manufacturer's name**>

3. Description:

   a. Standard: MSS SP-80, Type 2.
   b. Class: 125.
   c. CWP Rating: **200 psig (1380 kPa)**.
   d. Body Material: ASTM B62 bronze with integral seat and screw-in bonnet.
   e. Ends: Threaded or solder joint.
   f. Stem: Bronze, nonrising.
   g. Disc: Solid wedge; bronze.
   h. Packing: Asbestos free.
   i. Handwheel: Malleable iron, bronze, or aluminum.

I. Iron Gate Valves, Resilient Seated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American AVK Co.**]
   b. [**American Cast Iron Pipe Company**]

c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**M & H Valve Company; a division of McWane, Inc.**]
f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
g. [**NIBCO INC.**]
h. [**U.S. Pipe**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**M & H Valve Company; a division of McWane, Inc.**]
f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
g. [**NIBCO INC.**]
h. [**U.S. Pipe**]
i. [**Zurn Industries, LLC**]
j. <**Insert manufacturer's name**>

3. Description:

a. Standard: AWWA C509.
b. Pressure Rating: [**200 psig (1380 kPa)**][**250 psig (1725 kPa)**] minimum.
c. Body Material: Ductile or gray iron with bronze trim.
d. End Connections: Mechanical joint or push-on joint.
e. Interior Coating: Comply with AWWA C550.
f. Body Design: Nonrising stem.
g. Operator: Stem nut.
h. Disc: Solid wedge with resilient coating.

J. Iron Gate Valve Casings:

1. Standard: AWWA M44 for cast-iron valve casings.
2. Top Section: Adjustable extension of length required for depth of burial of valve.
3. Barrel: Approximately **5-inch (125-mm)** diameter.
4. Plug: With lettering "WATER."
5. Bottom Section: With base of size to fit over valve.
6. Base Support: Concrete collar[**or wood frame**].

K. Operating Wrenches for Iron Gate Valve Casings: Furnish [**one**][**two**]<**Insert number**> steel, tee-handle operating wrench(es) with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut for Project.

L. Iron Gate Valves, NRS:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Flo Fab Inc**]
c. [**Hammond Valve**]
d. [**KITZ Corporation**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Flo Fab Inc**]
c. [**Hammond Valve**]
d. [**KITZ Corporation**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. **<Insert manufacturer's name>**

3. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: **200 psig (1380 kPa)**.
c. Body Material: ASTM A126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: All bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

M. Iron Gate Valves, OS&Y:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crane Fluid Systems; Crane Co.**]
b. [**Flo Fab Inc**]
c. [**Hammond Valve**]
d. [**KITZ Corporation**]
e. [**Milwaukee Valve Company**]
f. [**NIBCO INC.**]
g. [**Powell Valves**]
h. [**Red-White Valve Corp.**]
i. [**WATTS; A Watts Water Technologies Company**]
j. [**Zurn Industries, LLC**]
k. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Crane Fluid Systems; Crane Co.**]
    b. [**Flo Fab Inc**]
    c. [**Hammond Valve**]
    d. [**KITZ Corporation**]
    e. [**Milwaukee Valve Company**]
    f. [**NIBCO INC.**]
    g. [**Powell Valves**]
    h. [**Red-White Valve Corp.**]
    i. [**WATTS; A Watts Water Technologies Company**]
    j. [**Zurn Industries, LLC**]
    k. <**Insert manufacturer's name**>

3. Description:

    a. Standard: MSS SP-70, Type I.
    b. CWP Rating: **200 psig (1380 kPa)**.
    c. Body Material: ASTM A126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: All bronze.
    f. Disc: Solid wedge.
    g. Packing and Gasket: Asbestos free.

2.6 PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cash Acme Plumbing Products; an RWC brand**]
    b. [**Honeywell International Inc.**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Cash Acme Plumbing Products; an RWC brand**]
    b. [**Honeywell International Inc.**]
    c. [**WATTS; A Watts Water Technologies Company**]
    d. [**Zurn Industries, LLC**]
    e. <**Insert manufacturer's name**>

3. Description:

    a. Standard: ASSE 1003.

b. Body Material: Bronze for **NPS 2 (DN 50)** and smaller; cast iron[**with interior lining complying with AWWA C550 or that is FDA approved**] for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.
c. Pressure Rating: Initial pressure of **150 psig (1035 kPa)**.
d. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.

4. Capacities and Characteristics:

a. Size: <**Insert NPS (DN)**>.
b. Design Flow Rate: <**Insert gpm (L/s)**>.
c. Design Inlet Pressure: <**Insert psig (kPa)**>.
d. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

B. Water-Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CLA-VAL**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**OCV Control Valves**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CLA-VAL**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**OCV Control Valves**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Pilot-operation, diaphragm-type, single-seated main water-control valve. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

a. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless steel body.
b. Pattern: [**Angle**][**Globe**]-valve design.
c. Trim: Stainless steel.
d. Pressure Rating: Initial pressure of **150 psig (1035 kPa)** minimum.
e. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.

4. Capacities and Characteristics:

a. Size: <**Insert NPS (DN)**>.
b. Design Flow Rate: <**Insert gpm (L/s)**>.
c. Design Inlet Pressure: <**Insert psig (kPa)**>.
d. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

2.7 AUTOMATIC CONTROL VALVES

A. Bronze, Automatic Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. [**Champion-Arrowhead**]
   c. [**Netafim USA**]
   d. [**Rain Bird Corporation**]
   e. [**Toro Company (The)**]
   f. [**Weathermatic**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. [**Champion-Arrowhead**]
   c. [**Netafim USA**]
   d. [**Rain Bird Corporation**]
   e. [**Toro Company (The)**]
   f. [**Weathermatic**]
   g. **<Insert manufacturer's name>**

3. Description: Cast-bronze body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24 V ac solenoid.

B. Plastic, Automatic Control Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. [**Champion-Arrowhead**]
   c. [**Dig Corporation**]
   d. [**Evoqua Water Technologies, LLC**]
   e. [**Greenlawn Sprinkler Company**]
   f. [**Hit Products Corporation**]
   g. [**Hunter Industries Incorporated**]
   h. [**Irritrol Systems**]
   i. [**Nelson; Fiskars Brands, Inc.**]
   j. [**Netafim USA**]
   k. [**Orbit Irrigation Products, LLC**]
   l. [**Rain Bird Corporation**]
   m. [**Toro Company (The)**]
   n. [**Weathermatic**]
   o. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. [**Champion-Arrowhead**]
   c. [**Dig Corporation**]
   d. [**Evoqua Water Technologies, LLC**]
   e. [**Greenlawn Sprinkler Company**]
   f. [**Hit Products Corporation**]
   g. [**Hunter Industries Incorporated**]
   h. [**Irritrol Systems**]
   i. [**Nelson; Fiskars Brands, Inc.**]
   j. [**Netafim USA**]
   k. [**Orbit Irrigation Products, LLC**]
   l. [**Rain Bird Corporation**]
   m. [**Toro Company (The)**]
   n. [**Weathermatic**]
   o. <**Insert manufacturer's name**>

3. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24 V ac solenoid.

2.8 AUTOMATIC DRAIN VALVES

A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below **2-1/2 to 3 psig (17 to 20 kPa)**.

2.9 TRANSITION FITTINGS

A. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Dresser Utility Solutions**]
   c. [**Ford Meter Box Company, Inc. (The)**]
   d. [**JCM Industries, Inc**]
   e. [**Smith-Blair, a Xylem brand.**]
   f. [**Viking Johnson**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Dresser Utility Solutions**]

c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Smith-Blair, a Xylem brand.**]
f. [**Viking Johnson**]
g. **<Insert manufacturer's name>**

3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Harvel Plastics, Inc.**]
b. [**Spears Manufacturing Company**]
c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Harvel Plastics, Inc.**]
b. [**Spears Manufacturing Company**]
c. **<Insert manufacturer's name>**

3. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket[**or threaded**] end.

D. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. **<Insert manufacturer's name>**

3. Description: MSS SP-107, PVC four-part union. Include one brass[**or stainless steel**] threaded end, one solvent-cement-joint[**or threaded**] plastic end, rubber O-ring, and union nut.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**HART Industrial Unions, LLC**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**HART Industrial Unions, LLC**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated union, **NPS 2 (DN 50)** and smaller.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**][**250 psig (1725 kPa)**] at **180 deg F (82 deg C)**.
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**WATTS; A Watts Water Technologies Company**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**GF Piping Systems: Georg Fischer LLC**]
c. [**WATTS; A Watts Water Technologies Company**]

d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, bolted, companion-flange assembly, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)** and larger.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**][**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

3. Description: Nonconducting materials for field assembly of companion flanges, **NPS 2-1/2 (DN 65)** and larger.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**]<**Insert value**>.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or polyethylene.
d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

3. Description: Galvanized-steel coupling.

a. Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
b. End Connections: Female threaded.
c. Lining: Inert and noncorrosive, thermoplastic lining.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Description: Electroplated steel nipple complying with ASTM F1545.

a. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert values**>.
b. End Connections: Male threaded or grooved.
c. Lining: Inert and noncorrosive, propylene.

2.11 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

B. Pressure Gages: ASME B40.1. Include **4-1/2-inch- (115-mm-)** diameter dial, dial range of two times system operating pressure, and bottom outlet.

2.12 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Metal, Exposed, Impact-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Buckner Superior; Storm Industries, Inc.**]
    b. [**Champion-Arrowhead**]
    c. [**Orbit Irrigation Products, LLC**]
    d. [**Rain Bird Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Buckner Superior; Storm Industries, Inc.**]
    b. [**Champion-Arrowhead**]
    c. [**Orbit Irrigation Products, LLC**]
    d. [**Rain Bird Corporation**]
    e. <**Insert manufacturer's name**>

3. Description:

    a. Construction: Brass and other corrosion-resistant metals.
    b. Mounting: Aboveground, exposed on riser.

4. Capacities and Characteristics:

    a. Flow: <**Insert gpm (L/s)**>.
    b. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
    c. Radius: <**Insert feet (m)**>.
    d. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**]<**Insert value**>.

C. Plastic, Exposed, Impact-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion-Arrowhead**]
    b. [**K-RAIN Manufacturing Corporation**]
    c. [**Nelson; Fiskars Brands, Inc.**]
    d. [**Orbit Irrigation Products, LLC**]
    e. [**Senninger Irrigation, Inc**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Champion-Arrowhead**]
    b. [**K-RAIN Manufacturing Corporation**]
    c. [**Nelson; Fiskars Brands, Inc.**]

d. [**Orbit Irrigation Products, LLC**]
e. [**Senninger Irrigation, Inc**]
f. <**Insert manufacturer's name**>

3. Description:

a. Construction: ABS and corrosion-resistant metals.
b. Mounting: Aboveground, exposed on riser.

4. Capacities and Characteristics:

a. Flow: <**Insert gpm (L/s)**>.
b. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
c. Radius: <**Insert feet (m)**>.
d. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**]<**Insert size**>.

D. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Hunter Industries Incorporated**]
d. [**Irritrol Systems**]
e. [**K-RAIN Manufacturing Corporation**]
f. [**Nelson; Fiskars Brands, Inc.**]
g. [**Rain Bird Corporation**]
h. [**Toro Company (The)**]
i. [**Weathermatic**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Hunter Industries Incorporated**]
d. [**Irritrol Systems**]
e. [**K-RAIN Manufacturing Corporation**]
f. [**Nelson; Fiskars Brands, Inc.**]
g. [**Rain Bird Corporation**]
h. [**Toro Company (The)**]
i. [**Weathermatic**]
j. <**Insert manufacturer's name**>

3. Description:

a. Body Material: ABS.
b. Nozzle: [**ABS**][**Brass**].
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.

4. Capacities and Characteristics:

   a. Flow: <**Insert gpm (L/s)**>.
   b. Pop-up Height: [**4 inches (100 mm)**]<**Insert inches (mm)**> aboveground to nozzle.
   c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   d. Radius: <**Insert feet (m)**>.
   e. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

E. Metal, Pop-up, Impact-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. <**Insert manufacturer's name**>

3. Description:

   a. Case: Brass.
   b. Body Material: Brass.
   c. Pop-up Height: [**4 inches (100 mm)**][**Approximately 3 inches (75 mm)**]<**Insert value**> aboveground to nozzle.
   d. Sprinkler Construction: Brass and other corrosion-resistant metals.

4. Capacities and Characteristics:

   a. Flow: <**Insert gpm (L/s)**>.
   b. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   c. Radius: <**Insert feet (m)**>.
   d. Inlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

F. Plastic, Pop-up, Impact-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Buckner Superior; Storm Industries, Inc.**]
   b. [**Champion-Arrowhead**]
   c. [**Nelson; Fiskars Brands, Inc.**]
   d. [**Rain Bird Corporation**]
   e. [**Toro Company (The)**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Nelson; Fiskars Brands, Inc.**]
d. [**Rain Bird Corporation**]
e. [**Toro Company (The)**]
f. <**Insert manufacturer's name**>

3. Description:

a. Case: ABS.
b. Pop-up Height: [**4 inches (100 mm)**][**Approximately 3 inches (75 mm)**]<**Insert value**> aboveground to nozzle.
c. Sprinkler Construction: ABS and other corrosion-resistant metals.

4. Capacities and Characteristics:

a. Nozzle: [**ABS**][**Brass**].
b. Flow: <**Insert gpm (L/s)**>.
c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
d. Radius: <**Insert feet (m)**>.
e. Inlet: [**NPS 3/4 (DN 20)**][**NPS 1-1/4 (DN 32)**].

G. Metal, Surface Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Champion-Arrowhead**]
b. [**Rain Bird Corporation**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Champion-Arrowhead**]
b. [**Rain Bird Corporation**]
c. <**Insert manufacturer's name**>

3. Description:

a. Body Material and Flange: Brass.
b. Nozzle: Brass.
c. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

a. Flow: <**Insert gpm (L/s)**>.
b. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
c. Radius: <**Insert feet (m)**>.
d. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

H. Plastic, Surface Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion-Arrowhead**]
   b. [**Hit Products Corporation**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Champion-Arrowhead**]
   b. [**Hit Products Corporation**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

3. Description:

   a. Body Material and Flange: ABS.
   b. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

   a. Nozzle: [**ABS**][**Brass**].
   b. Flow: <**Insert gpm (L/s)**>.
   c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   d. Radius: <**Insert feet (m)**>.
   e. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

I. Metal, Surface, Pop-up Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion-Arrowhead**]
   b. [**Orbit Irrigation Products, LLC**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Champion-Arrowhead**]
   b. [**Orbit Irrigation Products, LLC**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

3. Description:

   a. Body Material and Flange: Brass.
   b. Nozzle: Brass.
   c. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

   a. Pop-up Height: [**4 inches (100 mm)**][**1-1/4 or 1-1/2 inches (32 or 38 mm)**][**1-3/4 or 2 inches (44 or 50 mm)**]<**Insert value**>.
   b. Flow: <**Insert gpm (L/s)**>.
   c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   d. Radius: <**Insert feet (m)**>.
   e. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

J. Plastic, Surface, Pop-up Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Champion-Arrowhead**]
   b. [**Hit Products Corporation**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Champion-Arrowhead**]
   b. [**Hit Products Corporation**]
   c. [**Rain Bird Corporation**]
   d. <**Insert manufacturer's name**>

3. Description:

   a. Body Material and Flange: ABS.
   b. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

   a. Pop-up Height: [**4 inches (100 mm)**][**1-1/4 or 1-1/2 inches (32 or 38 mm)**][**1-3/4 or 2 inches (44 or 50 mm)**]<**Insert value**>.
   b. Nozzle: [**ABS**][**Brass**].
   c. Flow: <**Insert gpm (L/s)**>.
   d. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   e. Radius: <**Insert feet (m)**>.
   f. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

K. Plastic, Pop-up Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Hit Products Corporation**]
d. [**Hunter Industries Incorporated**]
e. [**K-RAIN Manufacturing Corporation**]
f. [**Nelson; Fiskars Brands, Inc.**]
g. [**Orbit Irrigation Products, LLC**]
h. [**Rain Bird Corporation**]
i. [**Toro Company (The)**]
j. [**Weathermatic**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Hit Products Corporation**]
d. [**Hunter Industries Incorporated**]
e. [**K-RAIN Manufacturing Corporation**]
f. [**Nelson; Fiskars Brands, Inc.**]
g. [**Orbit Irrigation Products, LLC**]
h. [**Rain Bird Corporation**]
i. [**Toro Company (The)**]
j. [**Weathermatic**]
k. <**Insert manufacturer's name**>

3. Description:

a. Body Material: ABS.
b. Nozzle: [**ABS**][**Brass**].
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.
e. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

a. Nozzle: [**ABS**][**Brass**].
b. Flow: <**Insert gpm (L/s)**>.
c. Pop-up Height: [**4 inches (100 mm)**]<**Insert inches (mm)**> aboveground to nozzle.
d. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
e. Radius: <**Insert feet (m)**>.
f. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

L. Metal Shrub Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Buckner Superior; Storm Industries, Inc.**]

b. [**Champion-Arrowhead**]
c. [**Orbit Irrigation Products, LLC**]
d. [**Rain Bird Corporation**]
e. [**Weathermatic**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Orbit Irrigation Products, LLC**]
d. [**Rain Bird Corporation**]
e. [**Weathermatic**]
f. <**Insert manufacturer's name**>

3. Description:

a. Body Material: Brass.
b. Nozzle: Brass.
c. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

a. Configuration: <**Insert description**>.
b. Flow: <**Insert gpm (L/s)**>.
c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
d. Radius: <**Insert feet (m)**>.
e. Mounting Height: <**Insert inches (mm)**> aboveground to nozzle.
f. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

M. Plastic Shrub Sprinklers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]
c. [**Dig Corporation**]
d. [**Hunter Industries Incorporated**]
e. [**Orbit Irrigation Products, LLC**]
f. [**Rain Bird Corporation**]
g. [**Senninger Irrigation, Inc**]
h. [**Toro Company (The)**]
i. [**Weathermatic**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Buckner Superior; Storm Industries, Inc.**]
b. [**Champion-Arrowhead**]

c. [**Dig Corporation**]
d. [**Hunter Industries Incorporated**]
e. [**Orbit Irrigation Products, LLC**]
f. [**Rain Bird Corporation**]
g. [**Senninger Irrigation, Inc**]
h. [**Toro Company (The)**]
i. [**Weathermatic**]
j. <**Insert manufacturer's name**>

3. Description:

   a. Body Material: ABS or other plastic.
   b. Pattern: Fixed, with flow adjustment.

4. Capacities and Characteristics:

   a. Configuration: <**Insert description**>.
   b. Flow: <**Insert gpm (L/s)**>.
   c. Arc: [**Full**][**Half**][**Quarter**]<**Insert arc**> circle.
   d. Radius: <**Insert feet (m)**>.
   e. Mounting Height: <**Insert inches (mm)**> aboveground to nozzle.
   f. Inlet: [**NPS 1/2 (DN 15)**][**NPS 1/2 or NPS 3/4 (DN 15 or DN 20)**][**NPS 3/4 (DN 20)**].

2.13 QUICK COUPLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Buckner Superior; Storm Industries, Inc.**]
   2. [**Champion-Arrowhead**]
   3. [**Hunter Industries Incorporated**]
   4. [**Nelson; Fiskars Brands, Inc.**]
   5. [**Rain Bird Corporation**]
   6. [**Toro Company (The)**]
   7. [**Weathermatic**]
   8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**Buckner Superior; Storm Industries, Inc.**]
   2. [**Champion-Arrowhead**]
   3. [**Hunter Industries Incorporated**]
   4. [**Nelson; Fiskars Brands, Inc.**]
   5. [**Rain Bird Corporation**]
   6. [**Toro Company (The)**]
   7. [**Weathermatic**]
   8. <**Insert manufacturer's name**>

C. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

1. Locking-Top Option: Vandal-resistant locking feature. Include [**one**][**two**]<**Insert number**> matching key(s).

2.14 DRIP IRRIGATION SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Buckner Superior; Storm Industries, Inc.**]
2. [**Dig Corporation**]
3. [**Evoqua Water Technologies, LLC**]
4. [**Geoflow, Inc.**]
5. [**Hendrickson Bros.**]
6. [**Hit Products Corporation**]
7. [**Irritrol Systems**]
8. [**Jain Irrigation, Inc.**]
9. [**Maxijet, Inc.**]
10. [**NDS Inc**]
11. [**Netafim USA**]
12. [**Orbit Irrigation Products, LLC**]
13. [**Rain Bird Corporation**]
14. [**Roberts Irrigation Products, Inc.**]
15. [**Salco Products**]
16. [**Toro Company (The)**]
17. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Buckner Superior; Storm Industries, Inc.**]
2. [**Dig Corporation**]
3. [**Evoqua Water Technologies, LLC**]
4. [**Geoflow, Inc.**]
5. [**Hendrickson Bros.**]
6. [**Hit Products Corporation**]
7. [**Irritrol Systems**]
8. [**Jain Irrigation, Inc.**]
9. [**Maxijet, Inc.**]
10. [**NDS Inc**]
11. [**Netafim USA**]
12. [**Orbit Irrigation Products, LLC**]
13. [**Rain Bird Corporation**]
14. [**Roberts Irrigation Products, Inc.**]
15. [**Salco Products**]
16. [**Toro Company (The)**]
17. <**Insert manufacturer's name**>

C. Freestanding Emitters: Device to deliver water at approximately **20 psig (138 kPa)**.

1. Body Material: PE or vinyl, with flow control.
2. Riser to Emitter: PE or PVC flexible tubing.
3. Capacities and Characteristics:

a. Flow: [**1/2 gph (1.9 L/h)**][**1 gph (3.8 L/h)**][**2 gph (7.6 L/h)**]<**Insert value**> at approximately

20 psig (138 kPa).
b. Tubing: PE or PVC; 1/8-inch (3-mm) minimum ID.
c. Mounting Height: <**Insert dimension**> aboveground to nozzle.

D. Manifold Emitter Systems: Manifold with tubing and emitters.

1. Manifold: With multiple outlets to deliver water to emitters.

a. Body Material: Plastic.
b. Outlet Caps: Plastic, for outlets without installed tubing.
c. Operation: Automatic pressure compensating.

2. Tubing: PE or PVC; 1/8-inch (3-mm) minimum ID.
3. Emitter: Device to deliver water at approximately 20 psig (138 kPa).

a. Body Material: PE or vinyl, with flow control.

4. Capacities and Characteristics:

a. Manifold:

1) Design Flow: <**Insert** gph (L/h)>.
2) Number of Outlets: [**Four**][**Six**]<**Insert number**>.

b. Emitter No.: <**Insert number**>.

1) Flow: [1/2 gph (1.9 L/h)][1 gph (3.8 L/h)][2 gph (7.6 L/h)]<**Insert value**> at approximately 20 psig (138 kPa).
2) Mounting Height: [**At ground**][**As indicated**]<**Insert dimension**>.

E. Multiple-Outlet Emitter Systems: Emitter with tubing and button-type outlets.

1. Emitter: With multiple outlets to deliver water to remote outlets.

a. Body Material: Plastic, with flow control.
b. Outlet Caps: Plastic, for outlets without installed tubing.
c. Operation: Automatic pressure compensating.
d. Emitters: Devices to deliver water at approximately 20 psig (138 kPa.)

2. Tubing: PE or PVC; 1/8-inch (3-mm) minimum ID.
3. Capacities and Characteristics:

a. Emitter:

1) Flow: [1/2 gph (1.9 L/h)][1 gph (3.8 L/h)][2 gph (7.6 L/h)]<**Insert value**>.
2) Number of Outlets: [**Four**][**Six**]<**Insert number**>.

b. Button-Type Outlet No.: <**Insert number**>.

1) Mounting Height: [**At ground**][**As indicated**]<**Insert dimension**>.

F. Drip Tubes with Direct-Attached Emitters:

1. Tubing: Flexible PE or PVC with plugged end.

2. Emitters: Devices to deliver water at approximately **20 psig (138 kPa)**.

   a. Body Material: PE or vinyl, with flow control.
   b. Mounting: Inserted into tubing at set intervals.

3. Capacities and Characteristics:

   a. Tubing Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**]<**Insert value**>.
   b. Length: <**Insert inches (mm)**>.
   c. Emitter Spacing: <**Insert inches (mm)**>.
   d. Emitter Flow: [**1/2 gph (1.9 L/h)**][**1 gph (3.8 L/h)**][**2 gph (7.6 L/h)**]<**Insert value**>.

G. Drip Tubes with Remote Discharge:

1. Tubing: Flexible PE or PVC with plugged end.
2. Emitters: Devices to deliver water at approximately **20 psig (138 kPa)**.

   a. Body Material: PE or vinyl, with flow control.
   b. Mounting: Inserted into tubing at set intervals.

3. Capacities and Characteristics:

   a. Tubing Size: [**NPS 1/2 (DN 15)**][**NPS 3/4 (DN 20)**][**NPS 1 (DN 25)**]<**Insert value**>.
   b. Length: <**Insert inches (mm)**>.
   c. Emitter Spacing: <**Insert inches (mm)**>.
   d. Emitter Flow: [**1/2 gph (1.9 L/h)**][**1 gph (3.8 L/h)**][**2 gph (7.6 L/h)**]<**Insert value**>.
   e. Branch Tubing Size: [**NPS 1/4 (DN 8)**]<**Insert value**> with button-type outlet.
   f. Branch Tubing Length: <**Insert inches (mm)**>.

H. Off-Ground Supports: Plastic stakes.

I. Application Pressure Regulators: Brass or plastic housing, **NPS 3/4 (DN 20)**, with corrosion-resistant internal parts; capable of controlling outlet pressure to approximately **20 psig (138 kPa)**.

J. Filter Units: Brass or plastic housing, with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.

K. Air Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

L. Vacuum Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

2.15 CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Buckner Superior; Storm Industries, Inc.**]
2. [**Champion-Arrowhead**]
3. [**Hit Products Corporation**]
4. [**Hunter Industries Incorporated**]
5. [**Irritrol Systems**]
6. [**K-RAIN Manufacturing Corporation**]
7. [**Nelson; Fiskars Brands, Inc.**]

8. [**Netafim USA**]
9. [**Orbit Irrigation Products, LLC**]
10. [**Rain Bird Corporation**]
11. [**Toro Company (The)**]
12. [**Weathermatic**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Buckner Superior; Storm Industries, Inc.**]
2. [**Champion-Arrowhead**]
3. [**Hit Products Corporation**]
4. [**Hunter Industries Incorporated**]
5. [**Irritrol Systems**]
6. [**K-RAIN Manufacturing Corporation**]
7. [**Nelson; Fiskars Brands, Inc.**]
8. [**Netafim USA**]
9. [**Orbit Irrigation Products, LLC**]
10. [**Rain Bird Corporation**]
11. [**Toro Company (The)**]
12. [**Weathermatic**]
13. <**Insert manufacturer's name**>

C. Description:

1. Controller Stations for Automatic Control Valves: Each station is variable from approximately [**5 to 60**]<**Insert numbers**> minutes. Include switch for manual or automatic operation of each station.
2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and [**two**]<**Insert number**> matching keys; include provision for grounding.

    a. Body Material: [**Enameled-steel sheet metal**][**Stainless steel sheet metal**][**Molded plastic**].
    b. Mounting: [**Freestanding type for concrete base**][**Surface type for wall**].

3. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and [**two**]<**Insert number**> matching keys.

    a. Body Material: [**Enameled-steel sheet metal**][**Stainless steel sheet metal**][**Molded plastic**].
    b. Mounting: [**Freestanding type for concrete base**][**Surface type for wall**].

4. Control Transformer: 24 V secondary, with primary fuse.
5. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.

    a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
    b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
    c. Surge Protection: Metal-oxide-varistor type on each station and primary power.

6. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
7. Smart Controllers: Use ET, tested in accordance with IA SWAT Climatological Based Controllers 8th Draft Testing Protocol and compliant with ASHRAE 189.1.

8. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.

   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

9. Concrete Base: Reinforced precast concrete not less than **36 by 24 by 4 inches (900 by 600 by 100 mm)** thick, and **6 inches (150 mm)** greater in each direction than overall dimensions of controller. Include opening for wiring.

2.16 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**Nationwide Plastics, Inc.**]
   c. [**NewBasis**]
   d. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   e. [**Orbit Irrigation Products, LLC**]
   f. [**USFilter/Plymouth Products, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**Nationwide Plastics, Inc.**]
   c. [**NewBasis**]
   d. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   e. [**Orbit Irrigation Products, LLC**]
   f. [**USFilter/Plymouth Products, Inc.**]
   g. <**Insert manufacturer's name**>

3. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

   a. Size: As required for valves and service.
   b. Shape: [**Round**][**Square**][**Rectangular**].
   c. Sidewall Material: [**PE**][**PE, ABS, or FRP**]<**Insert material**>.
   d. Cover Material: [**PE**][**PE, ABS, or FRP**]<**Insert material**>.

      1) Lettering: "[**VALVE BOX**][**IRRIGATION**]<**Insert lettering**>."

B. Polymer-Concrete Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**NewBasis**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   b. [**NewBasis**]
   c. [**Oldcastle Infrastructure Inc.; CRH Americas**]
   d. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   e. <**Insert manufacturer's name**>

3. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

   a. Size: As required for valves and service.
   b. Shape: [**Round**][**Square**][**Rectangular**].
   c. Sidewall Material: Polymer concrete with lateral and vertical sidewall design loading of [**5000 lb (2268 kg)**][**10,000 lb (4536 kg)**][**15,000 lb (6800 kg)**] minimum over **10 by 10 inches (254 by 254 mm)** square.
   d. Cover Material: [**Polymer concrete**][**Reinforced polymer concrete**]<**Insert material**> with cover design loading of [**5000 lb (2268 kg)**][**10,000 lb (4536 kg)**][**15,000 lb (6800 kg)**] minimum over **10 by 10 inches (254 by 254 mm)** square.

      1) Lettering: "[**VALVE BOX**][**IRRIGATION**]<**Insert lettering**>."

C. Drainage Backfill: Cleaned gravel or crushed stone, graded from **3/4 inch (19 mm)** minimum to **3 inches (75 mm)** maximum.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

B. Install warning tape directly above pressure piping, [**12 inches (300 mm)**]<**Insert value**> below finished grades, except **6 inches (150 mm)** below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from [**3/4 to 3 inches (19 to 75 mm)**]<**Insert value**>, to [**12 inches (300 mm)**]<**Insert value**> below grade.

Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:

1. Irrigation Main Piping: Minimum depth of [**36 inches (900 mm)**]<**Insert value**> below finished grade, or not less than [**18 inches (450 mm)**]<**Insert value**> below average local frost depth, whichever is deeper.
2. Circuit Piping: [**12 inches (300 mm)**]<**Insert value**>.
3. Drain Piping: [**12 inches (300 mm)**]<**Insert value**>.
4. Sleeves: [**24 inches (600 mm)**]<**Insert value**>.

3.2 PREPARATION

A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.3 INSTALLATION OF PIPING

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

E. Install fittings for changes in direction and branch connections.

F. Install unions adjacent to valves and to final connections to other components with **NPS 2 (DN 50)** or smaller pipe connection.

G. Install flanges adjacent to valves and to final connections to other components with **NPS 2-1/2 (DN 65)** or larger pipe connection.

H. Install underground thermoplastic piping in accordance with ASTM D2774[**and ASTM**].

I. Install expansion loops in control-valve boxes for plastic piping.

J. Lay piping on solid subbase, uniformly sloped without humps or depressions.

K. Install ductile-iron piping in accordance with AWWA C600.

L. Install PVC piping in dry weather when temperature is above **40 deg F (5 deg C)**. Allow joints to cure at least 24 hours at temperatures above **40 deg F (5 deg C)** before testing.

M. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.

N. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.

O. Install piping in sleeves under parking lots, roadways, and sidewalks.

P. Install sleeves made of [**Schedule 40**][**Schedule 80**], PVC pipe and socket fittings, and solvent-cemented joints.

Q. Install transition fittings for plastic-to-metal pipe connections according to the following:

1. Underground Piping:

   a. **NPS 1-1/2 (DN 40)** and Smaller: Plastic-to-metal transition fittings.
   b. **NPS 2 (DN 50)** and Larger: AWWA transition couplings.

2. Aboveground Piping:

   a. **NPS 2 (DN 50)** and Smaller: Plastic-to-metal transition [**fittings**][**unions**].
   b. **NPS 2 (DN 50)** and Larger: Use dielectric flange kits with one plastic flange.

R. Install dielectric fittings for dissimilar-metal pipe connections according to the following:

1. Underground Piping:

   a. **NPS 2 (DN 50)** and Smaller: Dielectric coupling or dielectric nipple.
   b. **NPS 2-1/2 (DN 65)** and Larger: Prohibited except in control-valve box.

2. Aboveground Piping:

   a. **NPS 2 (DN 50)** and Smaller: Dielectric union.
   b. **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Dielectric flange.
   c. **NPS 5 (DN 125)** and Larger: Dielectric flange kit.

3. Piping in Control-Valve Boxes:

   a. **NPS 2 (DN 50)** and Smaller: Dielectric union.
   b. **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Dielectric flange.
   c. **NPS 5 (DN 125)** and Larger: Dielectric flange kit.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select rubber gasket material of size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.

F. Copper-Tubing Brazed Joints: Construct joints in accordance with CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.

G. Copper-Tubing Soldered Joints: Apply ASTM B813 water-flushable flux to tube end unless otherwise indicated. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.

H. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners in accordance with piping manufacturer's written instructions.

I. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

J. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
3. PVC Nonpressure Piping: Join in accordance with ASTM D2855.

3.5 INSTALLATION OF VALVES

A. Underground Curb Valves: Install in curb-valve casings with tops flush with grade.

B. Underground Iron Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve casing with top flush with grade.

1. Install valves and PVC pipe with restrained, gasketed joints.

C. Aboveground Valves: Install as components of connected piping system.

D. Pressure-Reducing Valves: Install in boxes for automatic control valves or aboveground between shutoff valves.[**Install full-size valved bypass.**]

E. Throttling Valves: Install in underground piping in boxes for automatic control valves.

F. Drain Valves: Install in underground piping in boxes for automatic control valves.

3.6 INSTALLATION OF SPRINKLERS

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of **4 inches (100 mm)** from walls and **2 inches (50 mm)** from other boundaries unless otherwise indicated.

3.7 INSTALLATION OF DRIP IRRIGATION SPECIALTIES

A. Install freestanding emitters on pipe riser to mounting height indicated.

B. Install manifold emitter systems with tubing to emitters. Plug unused manifold outlets. Install emitters on off-ground supports at height indicated.

C. Install multiple-outlet emitter systems with tubing to outlets. Plug unused emitter outlets. Install outlets on off-ground supports at height indicated.

D. Install drip tubes with direct-attached emitters on ground.

E. Install drip tubes with remote discharge on ground with outlets on off-ground supports at height indicated.

F. Install off-ground supports of length required for indicated mounted height of device.

G. Install [**application pressure regulators**][**and**][**filter units**] in piping near device being protected, and [**aboveground**][**in control-valve boxes**].

H. Install [**air relief valves**][**and**][**vacuum relief valves**] in piping, and [**aboveground**][**in control-valve boxes**].

3.8 INSTALLATION OF AUTOMATIC IRRIGATION CONTROL SYSTEM

A. Equipment Mounting, Interior: Install controllers on interior [**floor**][**concrete bases**][**wall**].

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Equipment Mounting, Exterior: Install exterior freestanding controllers on precast concrete bases.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install control cable in same trench as irrigation piping and at least **2 inches (50 mm)** below[**or beside**] piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

3.9 CONNECTIONS

A. Comply with requirements for piping specified in Section 331415 "Site Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

C. Connect wiring between controllers and automatic control valves.

3.10 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service with Test Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Irrigation system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that controllers are installed and connected in accordance with the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.13 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each

sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than [**1/2 inch (13 mm)**]<**Insert value**> above, finish grade.

3.14 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.15 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain [**automatic control valves**][**and**][**controllers**].

3.16 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

C. Aboveground Irrigation Main Piping:

1. **NPS 4 (DN 100)** and Smaller:

a. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.
b. [**Type L (Type B)**][**Type M (Type C)**] hard copper tube, wrought- or cast-copper fittings, and [**brazed**][**soldered**] joints.
c. [**Schedule 40**][**Schedule 80**], PVC pipe; socket-type PVC fittings; and solvent-cemented joints.
d. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.

2. **NPS 5 (DN 125)** and Larger:

a. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.
b. [**Schedule 40**][**Schedule 80**], PVC pipe and socket fittings; and solvent-cemented joints.
c. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.

D. Underground Irrigation Main Piping:

1. **NPS 4 (DN 100)** and Smaller:

a. **NPS 3 and NPS 4 (DN 80 and DN 100)** ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings, glands, bolts, and nuts; and gasketed joints.
b. **NPS 3 and NPS 4 (DN 80 and DN 100)** ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
c. **Type L (Type B)** soft copper tube, wrought-copper fittings, and brazed joints.
d. **NPS 4 (DN 100)** PE pressure pipe; PE butt, heat-fusion or socket-type fittings; and heat-fusion joints.

e. [**Schedule 40**][**Schedule 80**], PVC pipe and socket fittings, and solvent-cemented joints.
f. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
g. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

2. **NPS 5 (DN 125)** and Larger:

a. **NPS 6 (DN 150)** and larger ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings, glands, bolts, and nuts; and gasketed joints.
b. **NPS 6 (DN 150)** and larger ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
c. PE pressure pipe; PE butt, heat-fusion fittings; and heat-fusion joints.
d. [**Schedule 40**][**Schedule 80**], PVC pipe and socket fittings; and solvent-cemented joints.
e. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

E. Circuit Piping:

1. **NPS 2 (DN 50)** and Smaller:

a. [**SIDR 7**][**SIDR 9**], PE, controlled ID pipe; insert fittings for PE pipe; and fastener joints.
b. [**DR 9**][**DR 11**], PE, controlled OD pipe; PE butt, heat-fusion, or PE socket-type fittings; and heat-fusion joints.
c. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
d. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

2. **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**:

a. [**SIDR 7**][**SIDR 9**], PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
b. [**DR 9**][**DR 11**], PE, controlled OD pipe; PE socket or butt-fusion fittings; and heat-fusion joints. **NPS 3 (DN 80)** pipe and fittings if **NPS 2-1/2 (DN 65)** pipe and fittings are not available.
c. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
d. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

F. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.

1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

G. Risers to Aboveground Sprinklers and Specialties:

1. [**Type L (Type B)**][**Type M (Type C)**] hard copper tube, wrought-copper fittings, and [**brazed**][**soldered**] joints.
2. Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.

H. Drain piping shall be[**one of**] the following:

1. SIDR 9, 11.5, or 15; PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
3. SDR 21, 26, or 32.5; PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-

cemented joints.

3.17 VALVE SCHEDULE

A. Underground, Shutoff-Duty Valves: Use the following:

1. **NPS 2 (DN 50)** and Smaller: Curb valve, curb-valve casing, and shutoff rod.
2. **NPS 3 (DN 80)** and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).

B. Aboveground, Shutoff-Duty Valves:

1. **NPS 2 (DN 50)** and Smaller:

   a. [**Brass**][**Brass or bronze**][**Bronze**][**Plastic**] ball valve.
   b. Bronze gate valve.

2. **NPS 2-1/2 (DN 65)** and Larger:

   a. Iron ball valve.
   b. Iron gate valve, [**NRS**][**OS&Y**].

C. Throttling-Duty Valves:

1. **NPS 2 (DN 50)** and Smaller:

   a. [**Bronze**][**Plastic**] automatic control valve.
   b. [**Brass**][**Brass or bronze**][**Bronze**][**Plastic**] ball valve.

2. **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**:
3. [**Bronze**][**Plastic**] automatic control valve.
4. Iron ball valve.

D. Drain Valves:

1. **NPS 1/2 and NPS 3/4 (DN 15 and DN 20)**:

   a. Automatic drain valve.
   b. [**Brass**][**Brass or bronze**][**Bronze**][**Plastic**] ball valve.
   c. Bronze gate valve.

2. **NPS 1 to NPS 2 (DN 25 to DN 50)**:

   a. [**Brass**][**Brass or bronze**][**Bronze**][**Plastic**] ball valve.
   b. Bronze gate valve.

END OF SECTION 32 84 00 00

Task	Specification	Specification Description
32 84 13 00	32 84 00 00	Planting Irrigation
32 84 23 00	21 05 00 00	Common Work Results for Fire Suppression
32 84 23 00	22 05 00 00	Common Work Results for Plumbing
32 84 23 00	23 05 00 00	Common Work Results for HVAC
32 84 23 00	32 84 00 00	Planting Irrigation

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SECTION 32 91 13 00 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils[**and layered soil assemblies**] specified by composition of the mixes.

B. Related Requirements:

1. Section 077273 "Vegetated Roof Systems" for growing media (soil).
2. Section 129200 "Interior Planters and Artificial Plants" for placing planting soil in planters for live interior plants.
3. Section 323300 "Site Furnishings" for placing planting soil in exterior unit planters.
4. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
5. Section 321443 "Porous Unit Paving" for placing planting-soil fill in porous paving.
6. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
7. Section 329300 "Plants" for placing planting soil for plantings.
8. Section 329600 "Transplanting" for placing planting soil in tree planting pits.

1.2 ALLOWANCES

A. [**Preconstruction**][**and**][**field quality-control**] testing [**is**][**are**] part of testing and inspecting allowance.

1.3 UNIT PRICES

A. Work of this Section is affected by [**unit prices specified in Section 012200 "Unit Prices."**]<**Insert name of unit price.**>

1.4 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of [**imported soil**][**and**][**soil amendment and fertilizer**]<**Insert item**> before delivery to the site, according to the following:

   a. Manufacturer's qualified testing agency's certified analysis of standard products.
   b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
   c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples: For each bulk-supplied material, [**1-quart (1-L)**][**1-gal. (4-L)**]<**Insert value**> volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements, [**provide testing by the following**][**provide testing by one of the following**]:

   a. <**Insert laboratory's name and address**>.

2. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction soil analyses on [**existing, on-site soil**][**imported soil**]<**Insert item**>.

1. Notify Architect [**seven**]<**Insert number**> days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and

furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by [**Owner**][**Contractor in presence of Architect**][**soil scientist (CPSS) certified by SSSA**][**soil classifier (CPSC) certified by SSSA**][**soil scientist (RPSS) registered by the National Society of Consulting Soil Scientists**][**or**][**state-certified, -licensed, or -registered soil scientist**]<**Insert requirement**> under the direction of the testing agency.

1. Number and Location of Samples: Minimum of [**three**][**eight**]<**Insert number**> representative soil samples [**from varied locations**][**where indicated on Drawings**][**where directed by Architect**]<**Insert requirement**> for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: [**According to USDA-NRCS's "Field Book for Describing and Sampling Soils."**][**As directed by Architect.**]<**Insert requirement.**>
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by[**one of**] the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
   b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of [**SSSA NAPT NCR-13**][**SSSA NAPT NEC-67**][**SSSA NAPT SERA-6**][**SSSA NAPT WERA-103**], including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm[**and sodium absorption ratio**].
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight [**per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm)depth of soil**]<**Insert requirement**>.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight [**per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm)depth of soil**]<**Insert requirement**>.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on

existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Regional Materials: [**Imported soil**][**manufactured planting soil**][**and**][**soil amendments and fertilizers**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: [**Imported soil**][**manufactured planting soil**][**and**][**soil amendments and fertilizers**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Indigenous Materials: [**Imported soil**][**manufactured planting soil**][**and**][**soil amendments and fertilizers**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

D. Regional Materials: [**Imported soil**][**manufactured planting soil**][**and**][**soil amendments and fertilizers**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.2 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type <**Insert drawing designation**>: Existing, on-site surface soil, with the duff layer, if any, retained[**; and stockpiled on-site**]; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Soil: [**1:4**][**1:3**][**1:2**]<**Insert ratio**> by volume.
2. Ratio of Loose [**Sphagnum**][**Muck**] Peat to Soil: <**Insert ratio**> by volume.
3. Ratio of Loose Wood Derivatives Soil: <**Insert ratio**> by volume.
4. Weight of Lime: <**Insert weight**> per [**1000 sq. ft. (100 sq. m)**]<**Insert area**> per [**6 inches (150 mm)**]<**Insert dimension**> of soil depth.
5. Weight of [**Sulfur**][**Iron Sulfate**]: <**Insert weight**> per [**1000 sq. ft. (100 sq. m)**]<**Insert area**> per [**6 inches (150 mm)**]<**Insert dimension**> of soil depth.
6. Weight of Agricultural Gypsum: <**Insert weight**> per [**1000 sq. ft. (100 sq. m)**]<**Insert area**> per

[6 inches (150 mm)]<**Insert dimension**> of soil depth.

7. Weight of Superphosphate: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
8. Weight of Commercial Fertilizer: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
9. Weight of Slow-Release Fertilizer: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.

C. Planting-Soil Type <**Insert drawing designation**>: Imported, naturally formed soil from off-site sources and consisting of [**sandy loam**][**loam**][**silt loam**][**loamy sand**][**or**][**sand**] soil <**Insert soil texture**> according to USDA textures; and modified to produce viable planting soil.

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from [**agricultural land,**]bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
2. Additional Properties of Imported Soil before Amending: Soil reaction of [**pH 6 to 7**]<**Insert range**> and minimum of [**2**][**4**][**6**]<**Insert number**> percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
3. Unacceptable Properties: Clean soil of the following:

   a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
   b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of [**8**]<**Insert number**> percent by dry weight of the imported soil.
   c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> in any dimension.

4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

   a. Ratio of Loose Compost to Soil: [**1:4**][**1:3**][**1:2**]<**Insert ratio**> by volume.
   b. Ratio of Loose [**Sphagnum**][**Muck**] Peat to Soil: <**Insert ratio**> by volume.
   c. Ratio of Loose Wood Derivatives to Soil: <**Insert ratio**> by volume.
   d. Weight of Lime: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
   e. Weight of [**Sulfur**][**Iron Sulfate**]: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
   f. Weight of Agricultural Gypsum: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
   g. Weight of Superphosphate: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
   h. Weight of Commercial Fertilizer: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.
   i. Weight of Slow-Release Fertilizer: <**Insert weight**> per [1000 sq. ft. (100 sq. m)]<**Insert area**> per [6 inches (150 mm)]<**Insert dimension**> of soil depth.

D. Planting-Soil Type <**Insert drawing designation**>: Manufactured soil consisting of manufacturer's basic [**topsoil,**][**sandy loam according to USDA textures,**]<**Insert soil texture or manufacturer's base-soil designation**> blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.

1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of [**pH 6 to 7**]<**Insert range**> and minimum of [**2**][**4**][**6**]<**Insert number**> percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
2. Unacceptable Properties: Manufactured soil shall not contain the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of [**5**]<**Insert number**> percent by dry weight of the manufactured soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**]<**Insert dimension**> in any dimension.

3. Blend manufacturer's basic soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

    a. Ratio of Loose Compost to Soil: [**1:4**][**1:3**][**1:2**]<**Insert ratio**> by volume.
    b. Ratio of Loose [**Sphagnum**][**Muck**] Peat to Soil: <**Insert ratio**> by volume.
    c. Ratio of Loose Wood Derivatives Soil: <**Insert ratio**> by volume.
    d. Volume of Sand: <**Insert volume**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    e. Volume of Perlite: <**Insert volume**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    f. Weight of Lime: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    g. Weight of [**Sulfur**][**Iron Sulfate**]: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    h. Weight of Agricultural Gypsum: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    i. Weight of Superphosphate: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    j. Weight of Commercial Fertilizer: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.
    k. Weight of Slow-Release Fertilizer: <**Insert weight**> per [**cu. yd. (cu. m)**]<**Insert value**>.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

    1. Class: T, with a minimum of 99 percent passing through a **No. 8 (2.36-mm)** sieve and a minimum of 75 percent passing through a **No. 60 (0.25-mm)** sieve.
    2. Class: O, with a minimum of 95 percent passing through a **No. 8 (2.36-mm)** sieve and a minimum of 55 percent passing through a **No. 60 (0.25-mm)** sieve.
    3. Form: Provide lime in form of ground [**dolomitic limestone**][**calcitic limestone**][**mollusk shells**]<**Insert material**>.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a **No. 6 (3.35-mm)** sieve and a maximum of 10 percent passing through a **No. 40 (0.425-mm)** sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a **No. 50 (0.30-mm)** sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to [**ASTM C33/C33M**]<**Insert requirement**>.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: [**Limited to leaves**][**May include sewage sludge**][**May include animal waste**]<**Insert requirement**>.
2. Reaction: [**pH of 5.5 to 8**]<**Insert range**>.
3. Soluble-Salt Concentration: Less than [**4**]<**Insert value**> dS/m.
4. Moisture Content: [**35 to 55**]<**Insert number range**> percent by weight.
5. Organic-Matter Content: [**30 to 40**][**50 to 60**]<**Insert number range**> percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a [**4-inch (100-mm)**][**2-inch (50-mm)**][**1-inch (25-mm)**][**1/2-inch (13-mm)**] sieve.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a [**1/2-inch (13-mm)**]<**Insert dimension**> sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of [**maximum 5**]<**Insert value or range**> dS/m.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a [**1/2-inch (13-mm)**]<**Insert dimension**> sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of [**maximum 5**]<**Insert value or range**> dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of [**0.15 lb/cu. ft. (2.4 kg/cu. m)**]<**Insert value**> of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of [**0.25 lb/cu. ft. (4 kg/cu. m)**]<**Insert value**> of loose sawdust or ground bark.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of [**20**][**33**][**50**] percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: [**1 lb/1000 sq. ft. (0.5 kg/100 sq. m)**]<**Insert value**> of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports

from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of [**6 inches (150 mm)**]<**Insert dimension**> and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of [**8**]<**Insert number**> percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**][**12 inches (300 mm)**][**18 inches (450 mm)**]<**Insert dimension**>. Remove stones larger than [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top [**2 inches (50 mm)**][**4 inches (100 mm)**] of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth [**of 4 inches (100 mm)**][**of 6 inches (150 mm)**][**of 8 inches (200 mm)**][**of 12 inches (300 mm)**][**indicated on Drawings**]<**Insert dimension**>, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread

if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments[**, except compost,**] and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

   a. Mix [**lime**][**and**][**sulfur**] with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding [**8 inches (200 mm)**][**12 inches (300 mm)**]<**Insert dimension**> in loose depth for material compacted by compaction equipment, and not more than [**4 inches (100 mm)**][**6 inches (150 mm)**] in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to [**75 to 82**]<**Insert number range**> percent of maximum Standard Proctor density according to ASTM D698 and tested in-place[**except where a different compaction value is indicated on Drawings**].

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**][**12 inches (300 mm)**][**18 inches (450 mm)**]<**Insert dimension**>. Remove stones larger than [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

   1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top [**2 inches (50 mm)**][**4 inches (100 mm)**] of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth [**of 4 inches (100 mm)**][**of 6 inches (150 mm)**][**of 8 inches (200 mm)**][**of 12 inches (300 mm)**][**indicated on Drawings**]<**Insert dimension**>, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

   1. Lifts: Apply planting soil in lifts not exceeding [**8 inches (200 mm)**][**12 inches (300 mm)**]<**Insert dimension**> in loose depth for material compacted by compaction equipment, and not more than [**4 inches (100 mm)**][**6 inches (150 mm)**] in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to [**75 to 82**]<**Insert number range**> percent of maximum Standard Proctor density according to ASTM D698[**except where a different compaction value is indicated on Drawings**].

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of [**of 4 inches (100 mm)**][**of 6 inches (150 mm)**][**of 8 inches (200 mm)**][**of 12 inches (300 mm)**][**of 18 inches (450 mm)**][**indicated on Drawings**]<**Insert dimension**>. Remove stones larger than [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (75 mm)**]<**Insert dimension**> in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments[**, except compost,**] and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix [**lime**][**and**][**sulfur**] with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to [**75 to 82**]<**Insert number range**> percent of maximum Standard Proctor density according to ASTM D698[**except where a different compaction value is indicated on Drawings**].

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply [**compost component of planting-soil mix**][**4 inches (100 mm) of compost**][**6 inches (150 mm) of compost**]<**Insert depth**> to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 LAYERED SOIL ASSEMBLIES

A. Layered Soil Assembly <**Insert designation**>:

1. [**Top Layer**]<**Insert layer designation**>: Planting-soil type <**Insert drawing designation**>.
2. <**Insert layer designation**>: Planting-soil type <**Insert drawing designation**>.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform the following tests[**and inspections**]:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each [**1000 sq. ft. (100 sq. m)**][**2000 sq. ft. (200 sq. m)**]<**Insert dimension**> of in-place soil or part thereof.

2. **<Insert name of test>**: **<Insert requirement>**.
3. **<Insert name of inspection>**: **<Insert requirement>**.

C. Soil will be considered defective if it does not pass tests[**and inspections**].

D. Prepare test[**and inspection**] reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.9 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.10 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 13 00

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Task	Specification	Specification Description
32 91 13 16	32 91 13 00	Soil Preparation
32 91 13 16	32 96 00 00	Transplanting
32 91 13 26	32 91 13 00	Soil Preparation
32 91 13 26	32 96 00 00	Transplanting
32 91 13 33	31 20 00 00	Earth Moving
32 91 13 33	32 91 13 00	Soil Preparation
32 91 13 33	32 92 00 00	Turf and Grasses
32 91 13 36	32 91 13 00	Soil Preparation
32 91 13 36	32 92 00 00	Turf and Grasses
32 91 13 36	32 96 00 00	Transplanting
32 91 19 13	31 10 00 00	Site Clearing
32 91 19 13	31 20 00 00	Earth Moving
32 91 19 13	32 92 00 00	Turf and Grasses

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SECTION 32 92 00 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.
5. Sprigging.
6. Meadow grasses and wildflowers.
7. Turf renovation.
8. Erosion-control materials.
9. Grass-paving materials.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See [**Section 329113 "Soil Preparation"**][**Section 329115 "Soil Preparation (Performance Specification)"**] and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. <**Insert definition**>.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. <**Insert requirements**>.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for [**turfgrass sod**][**plugs**]. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf[**and meadows**] during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf[**and meadow**] establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: [**Three**][**Five**]<**Insert number**> years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's [**field supervisor**][**personnel assigned to the Work**] shall have certification in [**one of**][**all of**] the following categories from the National Association of Landscape Professionals:

   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Lawn Care Manager.
   c. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

1. Spring Planting: <**Insert dates**>.
2. Fall Planting: <**Insert dates**>.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than [**85**]<**Insert number**> percent germination, not less than [**95**]<**Insert number**> percent pure seed, and not more than [**0.5**]<**Insert number**> percent weed seed:
3. Full Sun, Warm-Season Grass: Bermudagrass (Cynodon dactylon).
4. Full Sun, Cool-Season Grass: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
5. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:

   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

6. Shade, Cool-Season Grass: Proportioned by weight as follows:

   a. 50 percent chewings red fescue (Festuca rubra variety).
   b. 35 percent rough bluegrass (Poa trivialis).
   c. 15 percent redtop (Agrostis alba).

C. Grass-Seed Mix: Proprietary seed mix as follows:

1. Products: Subject to compliance with requirements, [**provide the following**][**provide one of the following**][**available products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert manufacturer's name; product name or designation**>.

2.2 TURFGRASS SOD

A. Turfgrass Sod: [**Certified**][**Approved**][**Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects**], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species, Warm-Season Grass: [**Bermudagrass (Cynodon dactylon)**][**Carpetgrass (Axonopus affinis)**][**Centipedegrass (Eremochloa ophiuroides)**][**St. Augustinegrass (Stenotaphrum secundatum)**][**Zoysiagrass (Zoysia japonica)**][**Zoysiagrass (Zoysia matrella)**][**Turf-type tall fescue (Festuca arundinacea), shade tolerant blend**]<**Insert species**>.

C. Turfgrass Species, Cool-Season Grass: Sod of grass species as follows, with not less than [**85**]<**Insert number**> percent germination, not less than [**95**]<**Insert number**> percent pure seed, and not more than [**0.5**]<**Insert number**> percent weed seed:

1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
2. Sun and Partial Shade: Proportioned by weight as follows:

    a. 50 percent Kentucky bluegrass (Poa pratensis).
    b. 30 percent chewings red fescue (Festuca rubra variety).
    c. 10 percent perennial ryegrass (Lolium perenne).
    d. 10 percent redtop (Agrostis alba).

3. Shade: Proportioned by weight as follows:

    a. 50 percent chewings red fescue (Festuca rubra variety).
    b. 35 percent rough bluegrass (Poa trivialis).
    c. 15 percent redtop (Agrostis alba).

2.3 PLUGS

A. Plugs: Turfgrass sod, [**Certified**][**Approved**][**Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects**], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is cut into square or round plugs, strongly rooted, and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:

1. Turfgrass Species: [**Bermudagrass (Cynodon dactylon)**][**Carpetgrass (Axonopus affinis)**][**Centipedegrass (Eremochloa ophiuroides)**][**St. Augustinegrass (Stenotaphrum secundatum)**][**Zoysiagrass (Zoysia japonica)**][**Zoysiagrass (Zoysia matrella)**]<**Insert species**>.
2. Plug Size: [**2 inches (50 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.

2.4 SPRIGS

A. Sod Sprigs: Healthy living stems, rhizomes, or stolons with a minimum of two nodes and attached roots free of soil, of the following turfgrass species:

1. Turfgrass Species, Warm-Season Grass: [**Bermudagrass (Cynodon dactylon)**][**Carpetgrass (Axonopus affinis)**][**Centipedegrass (Eremochloa ophiuroides)**][**St. Augustinegrass (Stenotaphrum secundatum)**][**Zoysiagrass (Zoysia japonica)**][**Zoysiagrass (Zoysia matrella)**]<**Insert species**>.
2. Turfgrass Species, Cool-Season Grass: Creeping bentgrass (Agrostis palustris).

2.5 MEADOW GRASSES AND WILDFLOWERS

A. Wildflower Seed: Fresh, clean, and dry new seed, of mixed species as follows:

1. <**Insert mix of wildflower species**>.

B. Native-Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:

1. <**Insert mix of native-grass species**>.

C. Wildflower and Native-Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:

1. <**Insert mix of wildflower and native-grass species**>.

D. Seed Carrier: Inert material, sharp clean sand or perlite.

2.6 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:

a. [**1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m)**]<**Insert value**> of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:

a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye,

oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through **1-inch (25-mm)** sieve; soluble salt content of [**2 to 5**]<**Insert range or value**> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: [**50 to 60**]<**Insert number range**> percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of **0.92 lb/sq. yd. (0.5 kg/sq. m)**, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of [**3-inch (75-mm)**][**4-inch (100-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal mat thickness. Include manufacturer's recommended

anchorage system for slope conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Geo Products, LLC**]
   b. [**Invisible Structures, Inc.**]
   c. [**Presto Products Company**]
   d. [**Tenax Corporation**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Geo Products, LLC**]
   b. [**Invisible Structures, Inc.**]
   c. [**Presto Products Company**]
   d. [**Tenax Corporation**]
   e. <**Insert manufacturer's name**>

2.10 GRASS-PAVING MATERIALS

A. Grass Paving: Cellular, nonbiodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of [**1-inch (25-mm)**][**1-3/4-inch (45-mm)**][**2-inch (50-mm)**][**manufacturer's standard**]<**Insert dimension**> nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Airfield Systems, LLC**]
   b. [**Geo Products, LLC**]
   c. [**Grid Technologies, Inc.**]
   d. [**Invisible Structures, Inc.**]
   e. [**NDS Inc**]
   f. [**PermaTurf Co., Inc.**]
   g. [**Presto Products Company**]
   h. [**RK Manufacturing, Inc.**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Airfield Systems, LLC**]
   b. [**Geo Products, LLC**]
   c. [**Grid Technologies, Inc.**]
   d. [**Invisible Structures, Inc.**]
   e. [**NDS Inc**]
   f. [**PermaTurf Co., Inc.**]

g. [**Presto Products Company**]
h. [**RK Manufacturing, Inc.**]
i. <**Insert manufacturer's name**>

B. Base Course: Sound crushed stone or gravel complying with [**ASTM D448 for Size No. 8**][**Section 312000 "Earth Moving" for base-course material**]<**Insert requirements**>.

C. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Proprietary Growing Mix: As submitted and acceptable to Architect.

E. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate blended with planting soil . Use blend consisting of [**1/2 sand and 1/2 planting soil**][**2/3 sand and 1/3 planting soil**]<**Insert proportions**>.

F. Soil for Paving Fill: Planting soil .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to [**Section 329113 "Soil Preparation."**][**Section 329115 "Soil Preparation (Performance Specification)."**]

B. Placing Planting Soil: [**Place and mix planting soil in place over exposed subgrade**][**Place manufactured planting soil over exposed subgrade**][**Blend planting soil in place**]<**Insert requirement**>.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 PREPARATION FOR GRASS-PAVING MATERIALS

A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus **1/2 inch (13 mm)** of finish elevation. Roll and rake, remove ridges, and fill depressions.

B. Install [**base course**][**and**][**sand course**] and [**sandy loam soil mix**][**proprietary growing mix**][**soil for paving fill**] as recommended by paving-material manufacturer for site conditions and according to details indicated on Drawings. Compact according to paving-material manufacturer's written instructions.

C. Install paving mat and fasten according to paving-material manufacturer's written instructions.

D. Before planting, fill cells of paving mat with [**planting soil**][**sandy loam soil mix**][**proprietary growing mix**][**sand half full**] and compact according to manufacturer's written instructions.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of [**2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m)**][**3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m)**][**5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m)**]<**Insert values**>.

C. Rake seed lightly into top **1/8 inch (3 mm)** of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding [**1:4 with erosion-control blankets**][**and**][**1:6 with erosion-control fiber mesh**] installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of [**2 tons/acre (42 kg/92.9 sq. m)**]<**Insert values**> to form a continuous blanket [**1-1/2 inches (38 mm)**]<**Insert dimension**> in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of [**10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m)**]<**Insert values**>. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying [**compost mulch**][**peat mulch**][**planting soil**] within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of [**3/16 inch (4.8 mm)**]<**Insert dimension**>, and roll surface smooth.

3.7 HYDROSEEDING

A. Hydroseeding: Mix specified seed, [**commercial fertilizer**][**slow-release fertilizer**]<**Insert type**>, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with [**nonasphaltic**][**asphalt-emulsion**][**fiber-mulch manufacturer's recommended**] tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [**1500-lb/acre (15.6-kg/92.9 sq. m)**]<**Insert values**> dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than [**500-lb/acre (5.2-kg/92.9 sq. m)**]<**Insert values**> dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of [**1000 lb/acre (10.4 kg/92.9 sq. m)**]<**Insert values**>.

3.8 SODDING

A. Lay sod within 24 hours of harvesting[**unless a suitable preservation method is accepted by Architect prior to delivery time**]. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs[**or steel staples**] spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of **1-1/2 inches (38 mm)** below sod.

3.9 PLUGGING

A. Plant plugs in holes or furrows, spaced [**12 inches (300 mm)**][**18 inches (450 mm)**]<**Insert dimension**> apart in [**both directions**][**triangular pattern**]. On slopes, contour furrows to near level.

3.10 SPRIGGING

A. Plant freshly shredded sod sprigs in furrows [**1 to 1-1/2 inches (25 to 38 mm)**][**1-1/2 to 2 inches (38 to 50 mm)**][**2-1/2 to 3 inches (64 to 75 mm)**] deep. Place individual sprigs with roots and portions of stem in moistened soil, [**6 inches (150 mm)**][**12 inches (300 mm)**]<**Insert dimension**> apart in rows [**10 inches (250 mm)**][**18 inches (450 mm)**]<**Insert dimension**> apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.

B. Broadcast sprigs uniformly over prepared surface at a rate of [**10 cu. ft./1000 sq. ft. (0.28 cu. m/92.9 sq. m)**]<**Insert values**> and mechanically force sprigs into lightly moistened soil.

1. Spread a **1/4-inch- (6-mm-)** thick layer of [**compost mulch**][**peat mulch**][**planting soil**] on sprigs.
2. Lightly roll and firm soil around sprigs after planting.
3. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

3.11 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of **6 inches (150 mm)**.

I. Apply[**soil amendments and**] initial fertilizer required for establishing new turf and mix thoroughly into top **4 inches (100 mm)** of existing soil. Install new planting soil to fill low spots and meet finish grades.

1. Soil Amendment(s): <**Insert required soil amendment(s)**> according to requirements of [**Section 329113 "Soil Preparation."**][**Section 329115 "Soil Preparation (Performance Specification)."**] Apply <**Insert soil amendment**> at the rate of <**Insert application rate**>.
2. Initial Fertilizer: [**Commercial fertilizer**][**Slow-release fertilizer**]<**Insert type**> applied according to manufacturer's recommendations.

J. Apply [**seed and protect with straw mulch**][**sod**][**plugs**][**sprigs**] as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.12 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of **4 inches (100 mm)**.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of **1 inch (25 mm)** per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow [**bentgrass**]<**Insert grass species**> to a height of **1/2 inch (13 mm)** or less.
2. Mow [**bermudagrass**]<**Insert grass species**> to a height of **1/2 to 1 inch (13 to 25 mm)**.
3. Mow [**carpetgrass**][**centipedegrass**][**perennial ryegrass**][**zoysiagrass**]<**Insert grass species**> to a height of **1 to 2 inches (25 to 50 mm)**.
4. Mow [**Kentucky bluegrass**][**buffalograss**][**annual ryegrass**][**chewings red fescue**]<**Insert grass species**> to a height of **1-1/2 to 2 inches (38 to 50 mm)**.
5. Mow [**bahiagrass**][**turf-type tall fescue**][**St. Augustinegrass**]<**Insert grass species**> to a height of **2 to 3 inches (50 to 75 mm)**.

D. Turf Postfertilization: Apply [**commercial fertilizer**][**slow-release fertilizer**]<**Insert type**> after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least [**1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m)**]<**Insert value**> to turf area.

3.13 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding [**90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm)**]<**Insert coverage**>.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.14 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**.

1. Before sowing, mix seed with seed carrier at a ratio of not less than [**two**][**three**][**four**]<**Insert number**> parts seed carrier to one part seed.
2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
3. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of [**4 oz./1000 sq. ft. (113 g/92.9 sq. m)**][**5 oz./1000 sq. ft. (142 g/92.9 sq. m)**][**6 oz./1000 sq. ft. (170 g/92.9 sq. m)**]<**Insert values**>.

C. Brush seed into top **1/16 inch (1.6 mm)** of soil, roll lightly, and water with fine spray.

D. Protect seeded areas from hot, dry weather or drying winds by applying [**peat**][**or**][**compost**] mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of **3/16 inch (4.8 mm)**, and roll surface smooth.

E. Water newly planted areas and keep moist until meadow is established.

3.15 MEADOW MAINTENANCE

A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of **1/2 inch (13 mm)** per week for [**four**][**six**][**eight**] weeks after planting unless rainfall precipitation is adequate.

C. <**Insert requirements**>.

3.16 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.17 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.18 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: [**60**]<**Insert number**> days from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: [**30**]<**Insert number**> days from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.
3. Plugged Turf: [**30**]<**Insert number**> days from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.
4. Sprigged Turf: [**30**]<**Insert number**> days from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

B. Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.

1. Maintenance Period: [**40**]<**Insert number**> days from date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

END OF SECTION 32 92 00 00

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Task	Specification	Specification Description
32 92 16 00	32 92 00 00	Turf and Grasses
32 92 19 00	32 92 00 00	Turf and Grasses
32 92 19 13	32 92 00 00	Turf and Grasses
32 92 19 19	32 92 00 00	Turf and Grasses
32 92 23 00	32 92 00 00	Turf and Grasses

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SECTION 32 93 00 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree grates.
9. Tree-watering devices.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 129200 "Interior Planters and Artificial Plants" for planters for live and artificial interior plants.
3. Section 328400 "Planting Irrigation" for complete irrigation systems.
4. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
5. Section 329600 "Transplanting" for transplanting non-nursery-grown trees.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Tree grates.
9. Tree-watering devices.

B. Product Data Submittals: For each product.

1. Plant Materials: Include quantities, sizes, quality, and verified sources for plant materials.

C. Samples for Verification: Actual sample of finished products for each of the following:

1. Organic Mulch: [**1-pint (0.5-L)**][**1-quart (1-L)**]<**Insert value**> volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: [**2 lb (1.0 kg)**][**5 lb (2.5 kg)**]<**Insert value**> of each mineral mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
3. Weed-Control Barrier: **12 by 12 inches (300 by 300 mm)**.
4. Proprietary Root-Ball-Stabilization Device: One unit.
5. Slow-Release, Tree-Watering Device: One unit of each size required.
6. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
7. Root Barrier: Width of panel by **12 inches (300 mm)**.

1.7 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: Percolation tests for tree pits. Include the following:

1. Tree identification number matching the plans.
2. Date of test.
3. Time when water was added to tree pit to start percolation test.
4. Time with photo documentation showing increments of testing with water level in tree pit.
5. Identification of tester.

B. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.

D. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

E. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: [**Three**][**Five**]<**Insert number**> years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certification: Installer's [**field supervisor**][**personnel assigned to the Work**] certified in [**one**][**all**] of the following categories from the National Association of Landscape Professionals:

   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Interior.
   c. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements **6 inches (150 mm)** above the root flare for trees up to **4-inch (100-mm)** caliper size, and **12 inches (300 mm)** above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials [**seven**]<**Insert number**> days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within [**24 hours**][**36 hours**]<**Insert time**> of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at **60 to 65 deg F (16 to 18 deg C)** until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system

components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: <**Insert dates**>.
2. Fall Planting: <**Insert dates**>.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures, including plantings falling or blowing over.
c. Faulty performance of [**tree stabilization**][**edgings**][**and**][**tree grates**]<**Insert item**>.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of [**planting completion**][**Substantial Completion**]<**Insert starting time**>.

a. Trees, Shrubs, Vines, and Ornamental Grasses: [**12**]<**Insert number**> months.
b. Ground Covers, Biennials, Perennials, and Other Plants: [**12**][**Nine**][**Six**][**Three**]<**Insert number**> months.
c. Annuals: [**Three**][**Two**]<**Insert number**> months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and

complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than **3/4 inch (19 mm)** in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.

D. Labeling: Label [**each**][**at least one**] plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to ensure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery[**and that are in bud but are not yet in bloom**].

G. <**Insert requirements**>.

2.2 FERTILIZERS

A. Granular Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:

a. [**0.75 lb/1000 sq. ft. (0.34 kg/92.9 sq. m),)**]3 percent of actual nitrogen, 4 percent phosphorous, and 3 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per **lb (0.45 kg)** of vesicular-arbuscular mycorrhizal fungi and 95 million spores per **lb (0.45 kg)** of ectomycorrhizal fungi, 33 percent hydrogel, and maximum of 5.5 percent inert material.

2.3 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, **3 oz./sq. yd. (101 g/sq. m)** minimum, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, **4.8 oz./sq. yd. (162 g/sq. m)**.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: [**Shredded hardwood**][**Ground or shredded bark**][**Wood and bark chips**][**Pine straw**][**Salt hay or threshed straw**][**Pine needles**][**Peanut, pecan, and cocoa-bean shells**]<**Insert type**>.
2. Size Range: [**3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum**]<**Insert dimensions**>.
3. Color: Natural.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a **1-inch (25-mm)** sieve; soluble-salt content of [**2 to 5**]<**Insert range or value**> dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: [**50 to 60**]<**Insert number range**> percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: [**Rounded riverbed gravel or smooth-faced stone**][**Crushed stone or gravel**][**Marble chips**][**Granite chips**]<**Insert type**>.
2. Size Range: [**1-1/2 inches (38 mm) maximum, 3/4 inch (19 mm) minimum**][**3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum**]<**Insert dimensions**>.
3. Color: [**Uniform tan-beige color range acceptable to Architect**][**Readily available natural gravel color range**]<**Insert color**>.

2.5 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new [**hardwood**][**softwood with specified wood pressure-preservative treatment**], free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring **8 inches (200 mm)** in diameter and **48 inches (1200 mm)** long, treated with specified wood pressure-preservative treatment.
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or [**turnbuckles**][**compression springs**].
4. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, **0.106 inch (2.7 mm)** in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five-strand, **3/16-inch- (4.8-mm-)** diameter, galvanized-steel cable, with zinc-coated [**turnbuckles**][**compression springs**], a minimum of **3 inches (75 mm)** long, with two **3/8-inch (10-mm)** galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, **6 inches (150 mm)** long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and in accordance with manufacturer's written instructions.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**Arborbrace**]
        2) [**Better Bilt Products, Inc.**]
        3) [**DeepRoot Green Infrastructure, LLC**]
        4) [**J. R. Partners**]
        5) [**MacLean Power Systems**]
        6) [**Villa Root Barrier; Villa Landscape Products**]
        7) **<Insert manufacturer's name>**

    b. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

        1) [**Arborbrace**]
        2) [**Better Bilt Products, Inc.**]
        3) [**DeepRoot Green Infrastructure, LLC**]
        4) [**J. R. Partners**]
        5) [**MacLean Power Systems**]
        6) [**Villa Root Barrier; Villa Landscape Products**]
        7) **<Insert manufacturer's name>**

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.
3. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized in accordance with

manufacturer's written instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

C. Palm Bracing: Battens or blocks, struts, straps, and protective padding.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-4-inch nominal (38-by-89-mm actual)** by lengths indicated.
2. Straps: Adjustable steel or plastic package banding.
3. Padding: Burlap.
4. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized in accordance with manufacturer's written instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Arborbrace**]
2) [**Better Bilt Products, Inc.**]
3) [**Horticultural Consultants, Inc.**]
4) [**Villa Root Barrier; Villa Landscape Products**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Arborbrace**]
2) [**Better Bilt Products, Inc.**]
3) [**Horticultural Consultants, Inc.**]
4) [**Villa Root Barrier; Villa Landscape Products**]
5) <**Insert manufacturer's name**>

2.7 LANDSCAPE EDGINGS

A. Wood Edging: Of sizes indicated on Drawings, and wood stakes as follows:

1. Species: [**Western red cedar, all heart**][**Southern pine with specified wood pressure-preservative treatment**].
2. Stakes: Same species as edging, **1-by-2-inch nominal (19-by-38-mm actual)** by **18 inches (450 mm)** long, with galvanized nails for anchoring edging.

B. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Border Concepts, Inc**]
   b. [**COLMET**]
   c. [**J. D. Russell Company (The)**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Border Concepts, Inc**]
   b. [**COLMET**]
   c. [**J. D. Russell Company (The)**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

3. Edging Size: [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) deep**][**1/4 inch (6.4 mm) thick by 5 inches (125 mm) deep**][**1/4 inch (6.4 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 6 inches (150 mm) deep**][**0.1 inch (2.5 mm) thick by 4 inches (100 mm) deep**]<**Insert dimensions**>.
4. Stakes: Tapered steel, a minimum of [**12 inches (300 mm)**][**15 inches (380 mm)**]<**Insert dimension**> long.
5. Accessories: Standard tapered ends, corners, and splicers.
6. Finish: [**Manufacturer's standard paint**][**Zinc coated**][**Unfinished**].

   a. Paint Color: [**Black**][**Green**][**Brown**].

C. Aluminum Edging: Standard-profile extruded-aluminum edging, **ASTM B221 (ASTM B221M)**, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Curv-Rite, Inc**]
   b. [**J. D. Russell Company (The)**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Curv-Rite, Inc**]
   b. [**J. D. Russell Company (The)**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

3. Edging Size: [**3/16 inch (4.8 mm) thick by 5-1/2 inches (140 mm) deep**][**3/16 inch (4.8 mm) thick by 4 inches (100 mm) deep**][**1/8 inch (3.2 mm) thick by 5-1/2 inches (140 mm) deep**][**1/8 inch (3.2 mm) thick by 4 inches (100 mm) deep**]<**Insert dimensions**>.
4. Stakes: Aluminum, **ASTM B221 (ASTM B221M)**, Alloy 6061-T6, approximately **1-1/2 inches (38 mm)** wide by **12 inches (300 mm)** long.
5. Finish: [**Manufacturer's standard paint**][**Powder-coat paint**][**Mill (natural aluminum)**][**Black anodized**].

   a. Paint Color: [**Black**][**Green**][**Brown**].

D. Plastic Edging: Standard black polyethylene or vinyl edging, [**V-lipped bottom**][**horizontally grooved**]<**Insert configuration**>, extruded in standard lengths, with **9-inch (225-mm)** [**steel angle**][**plastic**] stakes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Oly-Ola Edgings, Inc.**]
   b. [**Permaloc Corporation**]
   c. [**Sure-loc Edging Corporation.**]
   d. [**Valley View Industries**]
   e. [**Villa Root Barrier; Villa Landscape Products**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Oly-Ola Edgings, Inc.**]
   b. [**Permaloc Corporation**]
   c. [**Sure-loc Edging Corporation.**]
   d. [**Valley View Industries**]
   e. [**Villa Root Barrier; Villa Landscape Products**]
   f. <**Insert manufacturer's name**>

3. Edging Size: [**0.1 inch (2.5 mm) thick by 5 inches (125 mm) deep**][**0.07 inch (1.8 mm) thick by 5 inches (125 mm) deep**]<**Insert dimensions**>.
4. Top Profile: [**Straight, with top 2 inches (50 mm) being 1/4 inch (6.4 mm) thick**][**Round top, 1/2 inch (13 mm) in diameter**][**Round top, 1 inch (25 mm) in diameter**].
5. Accessories: Manufacturer's standard alignment clips or plugs.

2.8 TREE GRATES

A. Tree Grates: Manufacturer's [**standard**][**custom designed**] tree grates[**and frames**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Barry Pattern & Foundry Co., Inc**]
   b. [**EJ Group, Inc.**]
   c. [**Ironsmith Inc.**]
   d. [**Neenah Foundry Company**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Barry Pattern & Foundry Co., Inc**]
   b. [**EJ Group, Inc.**]
   c. [**Ironsmith Inc.**]
   d. [**Neenah Foundry Company**]
   e. <**Insert manufacturer's name**>

3. Grates: ASTM A48/A48M, **Class 35 (Class 250)** or better, gray-iron castings.
4. Frames: [**ASTM A48/A48M, Class 35 (Class 250) or better, gray-iron castings**][**or**][**ASTM A36/A36M steel-angle, hot-dip galvanized,**] of shape, pattern, and size indicated.

B. Shape and Size: [**As indicated on Drawings**][**Round, 36 inches (914 mm) in diameter**][**Round, 72 inches (1828 mm) in diameter**][**48 inches (1219 mm) square**][**60 inches (1524 mm) square**][**Rectangular, 36 by 60 inches (914 by 1524 mm)**][**Rectangular, 48 by 72 inches (1219 by 1828 mm)**]<**Insert shape and dimensions**>.

C. Finish: [**As fabricated**][**Powder-coat finish**]<**Insert finish**>.

1. Color: Low-gloss [**black**][**dark brown**][**dark green**][**dark gray**]<**Insert color**>.

2.9 TREE-WATERING DEVICES

A. Watering Pipe: PVC pipe **4 inches (100 mm)** in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over [**an extended time period**][**two to nine hours**][**two to three weeks**]<**Insert number or range**>; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**BIO-PLEX**]

b. [**Engineered Watering Solutions; PQ Partners, LLC**]
c. [**Spectrum Products, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BIO-PLEX**]
b. [**Engineered Watering Solutions; PQ Partners, LLC**]
c. [**Spectrum Products, Inc.**]
d. <**Insert manufacturer's name**>

3. Color: [**As selected by Architect from manufacturer's full range**][**black**][**dark chocolate**][**green**][**or**][**tan**]<**Insert color**>.

2.10 MISCELLANEOUS PRODUCTS

A. Root Barrier: Black, molded, modular panels [**18 inches (457 mm)**][**24 inches (610 mm)**]<**Insert dimension**> high (deep), **85 mils (2.2 mm)** thick, and with vertical root deflecting ribs protruding **3/4 inch (19 mm)** out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DeepRoot Green Infrastructure, LLC**]
b. [**NDS Inc**]
c. [**Villa Root Barrier; Villa Landscape Products**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**DeepRoot Green Infrastructure, LLC**]
b. [**NDS Inc**]
c. [**Villa Root Barrier; Villa Landscape Products**]
d. <**Insert manufacturer's name**>

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with [**ASTM D448 for Size No. 8**]<**Insert requirements**>.

D. Planter Filter Fabric: [**Woven**][**Nonwoven**] geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil in accordance with [**Section 329113 "Soil Preparation."**][**Section 329115 "Soil Preparation (Performance Specification)."**]

B. Placing Planting Soil: [**Place and mix planting soil in-place over exposed subgrade**][**Place manufactured planting soil over exposed subgrade**][**Blend planting soil in place**]<**Insert requirement**>.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate [**indicated on Drawings**][**in accordance with manufacturer's written instructions**]<**Insert application rate**>.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for [**balled and burlapped**][**balled and potted**][**container-grown**][**fabric bag-grown**] stock.
3. Excavate at least **12 inches (300 mm)** wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected [**overnight**][**after working hours**][**when unattended by Installer's personnel**].
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may[**not**] be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill **6-inch- (150-mm-)** diameter holes, **24 inches (600 mm)** apart, into free-draining strata or to depth of **10 ft. (3 m)**, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap,

rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.

    a. Quantity: [**As indicated on Drawings**][**Two per plant**][**Three for each caliper inch of plant**]<**Insert requirement**>.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. [**Balled and Potted**][**and**][**Container-Grown**] Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grades.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare [**1 inch (25 mm) above**][**2 inches (50 mm) above**]<**Insert requirement**> adjacent finish grade.

1. Backfill: Planting soil .[**For trees, use excavated soil for backfill.**]
2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole or touching the roots.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Watering Pipe: During backfilling, install watering pipe **4 ft. (1.25 m)** deep into the planting pit outside the root ball [**as indicated on Drawings**][**and**][**with top of pipe 1 inch (25 mm) above the mulched**

surface].

H. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Plant trees with approved mechanized tree spade at designated locations. Do not use tree spade to move trees larger than maximum size allowed for similar field-grown, balled-and-burlapped, root-ball diameter in accordance with ANSI Z60.1, or trees larger than manufacturer's maximum size recommendation for tree spade being used, whichever is smaller.

B. Use same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting tree, center the trunk within the tree spade and move tree with solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines in accordance with standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:

a. Stake trees of **2- through 5-inch (50- through 125-mm)** caliper. Stake trees of less than **2-inch (50-mm)** caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least **18 inches (450 mm)** below bottom of backfilled excavation and to extend [**to the dimension indicated on Drawings**][**at least 72 inches (1830 mm)**][**one-third of trunk height**]<**Insert dimension or requirement**> above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

b. Stake trees with two stakes for trees up to **12 ft. (3.6 m)** high and **2-1/2 inches (63 mm)** or less in caliper; three stakes for trees less than **14 ft. (4.2 m)** high and up to **4 inches (100 mm)** in caliper. Space stakes equally around trees.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than **14 ft. (4.2 m)** in height and more than **3 inches (75 mm)** in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

   a. Securely attach guys to stakes **30 inches (760 mm)** long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
   b. For trees more than [**6 inches (150 mm) in caliper**]<**Insert size**>, anchor guys to wood deadmen buried at least **36 inches (900 mm)** below grade. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
   c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
   d. Support trees with [**guy cable**][**or**][**multiple strands of tie wire**], connected to brass grommets of tree-tie webbing at contact points with tree trunk and reaching to [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
   e. Attach flags to each guy wire, **30 inches (760 mm)** above finish grade.
   f. Paint [**turnbuckles**][**compression springs**] with luminescent white paint.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by root ball unless otherwise indicated.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of vertical stakes.

   a. Install stakes of length required to penetrate at least [**to dimension indicated on Drawings**][**18 inches (450 mm)**]<**Insert dimension**> below bottom of backfilled excavation. Saw stakes off at horizontal stake.
   b. Install screws through horizontal hold-down and penetrating at least **1 inch (25 mm)** into stakes. Predrill holes if necessary to prevent splitting wood.
   c. Install second set of stakes on other side of root trunk for larger trees.

2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

1. Site-Fabricated Palm-Bracing Method:

   a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact

trunk.

b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.

2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.9 INSTALLATION OF ROOT BARRIER

A. Install root barrier where trees are planted within [**60 inches (1500 mm)**][**48 inches (1200 mm)**]<**Insert dimension**> of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.

B. Align root barrier [**vertically**][**with bottom edge angled at 20 degrees away from the paving or other hardscape element**], and run it linearly along and adjacent to paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for distance of [**60 inches (1500 mm)**]<**Insert dimension**> in each direction from tree trunk, for total distance of [**10 ft. (3 m)**]<**Insert dimension**> per tree. If trees are spaced closer, use single continuous piece of root barrier.

1. Position top of root barrier [**flush with finish grade**][**1/2 inch (13 mm) above finish grade**][**in accordance with manufacturer's written instructions**].
2. Overlap root barrier minimum of **12 inches (300 mm)** at joints.
3. Do not distort or bend root barrier during construction activities.
4. Do not install root barrier surrounding the root ball of tree.

3.10 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least **4 inches (100 mm)** thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric [**4 inches (100 mm)**][**6 inches (150 mm)**]<**Insert dimension**> up on all sides. Duct tape along the entire top edge of filter fabric, to secure filter fabric against the sides during soil-filling process.

B. Fill planter with planting soil . Place soil in lightly compacted layers to elevation of **1-1/2 inches (38 mm)** below top of planter, allowing natural settlement.

3.11 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines [**9 inches (225 mm) apart**][**12 inches (300 mm) apart**][**18 inches (450 mm) apart**][**24 inches (600 mm) apart**][**as indicated on Drawings**] in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system

but to depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 INSTALLATION OF MULCHES

A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of [**6 inches (150 mm)**][**12 inches (300 mm)**], and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply [**organic**][**mineral**] mulch ring of [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness, with [**12-inch (300-mm)**][**24-inch (600-mm)**][**36-inch (900-mm)**]<**Insert dimension**> radius around trunks or stems. Do not create a mulch cone or place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.
2. Organic Mulch in Planting Areas: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of organic mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit or trench**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.
3. Mineral Mulch in Planting Areas: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of mineral mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit or trench**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.

3.13 INSTALLATION OF LANDSCAPE EDGINGS

A. Wood Edging: Install wood edging where indicated.[**Mitre cut joints and connections at a 45-degree angle.**] Fasten each cut joint or connection with two galvanized nails. Anchor with wood stakes spaced up to **36 inches (900 mm)** apart, driven at least **1 inch (25 mm)** below top elevation of edging. Use two galvanized nails per stake to fasten edging, of length as needed to penetrate both edging and stake and provide **1/2-inch (13-mm)** clinch at point. Predrill stakes if needed to avoid splitting. Replace stakes that crack or split during installation process.

B. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately **30 inches (760 mm)** apart, driven below top elevation of edging.

C. Aluminum Edging: Install aluminum edging where indicated in accordance with manufacturer's written instructions. Anchor with aluminum stakes spaced approximately [**36 inches (900 mm)**][**48 inches (1200 mm)**] apart, driven below top elevation of edging.

D. Plastic Edging: Install plastic edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately [**36 inches (900 mm)**][**48 inches (1200**

mm)] apart, driven through upper base grooves or V-lip of edging.

E. Shovel-Cut Edging: Separate mulched areas from turf areas[**, curbs, and paving**] with 45-degree, **4- to 6-inch- (100- to 150-mm-)** deep, shovel-cut edge[**as indicated on Drawings**].

F. Mow-Strip Installation:

1. Excavate for mow strip[**as indicated on Drawings**].
2. Compact subgrade uniformly beneath mow strip.
3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
4. Install [**wood**][**steel**][**aluminum**][**plastic**] edging, delineating the edge of mow strip.
5. Install weed-control barrier before mulching, covering area of mow strip, and overlapping and pinning edges of barrier at least **6 inches (150 mm)** and in accordance with manufacturer's written instructions.
6. Place indicated thickness of [**organic**][**mineral**] mulch, fully covering weed barrier.
7. Rake mulch to uniform surface level with adjacent finish grades.

3.14 INSTALLATION OF TREE GRATES

A. Tree Grates: Install in accordance with manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate with soil-resistant plastic. Maintain **3-inch- (75-mm-)** minimum growth radius around base of tree; break away portions of casting, if necessary, in accordance with manufacturer's written instructions.

3.15 INSTALLATION OF TREE-WATERING DEVICES

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water in accordance with manufacturer's written instructions.

3.16 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.17 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace

mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tree pit percolation tests.
2. Tree pit construction will be considered defective if it does not pass percolation tests and inspections.
3. Do not proceed with planting in tree pits until satisfactory percolation is demonstrated.

C. Prepare test and inspection reports.

3.19 REPAIR AND REPLACEMENT

A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than [**25**]<**Insert number**> percent dead or in unhealthy condition[**before end of corrections period**] or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of [**6 inches (150 mm)**][**4 inches (100 mm)**]<**Insert dimension**> or smaller in caliper size.
2. Provide [**one**][**two**]<**Insert number**> new tree(s) of [**6-inch (150-mm)**][**4-inch (100-mm)**]<**Insert dimension**> caliper size for each tree being replaced that measures more than [**6 inches (150 mm)**][**4 inches (100 mm)**] in caliper size.
3. Species of Replacement Trees: [**Same species being replaced**][**Species selected by Architect**]<**Insert species**>.

3.20 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before [**Substantial Completion**]<**Insert time**>, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

END OF SECTION 32 93 00 00

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Task	Specification	Specification Description
32 93 13 00	32 93 00 00	Plants
32 93 23 00	32 93 00 00	Plants
32 93 33 00	31 10 00 00	Site Clearing
32 93 33 00	32 93 00 00	Plants
32 93 43 00	32 93 00 00	Plants
32 93 83 00	32 93 00 00	Plants
32 93 83 00	32 96 00 00	Transplanting
32 94 13 00	32 13 13 00	Concrete Paving
32 94 13 00	32 93 00 00	Plants
32 94 16 00	32 93 00 00	Plants
32 94 43 00	32 33 00 00	Site Furnishings
32 94 49 00	32 93 00 00	Plants

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SECTION 32 96 00 00 - TRANSPLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Planting materials.
2. Tree-stabilization materials.
3. Tree-watering devices.

B. Owner-Furnished Material: <**Insert product or material**>.

C. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 329300 "Plants" for new trees from nursery-grown sources.

1.2 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

B. Unit prices apply to additions to and deletions from the Work as authorized by Change Orders.

1.3 DEFINITIONS

A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.

B. Caliper: Diameter of a trunk as measured by [**diameter tape**][**or**][**average of the smallest and largest diameters**] at height **6 inches (150 mm)** above the root flair for trees up to, and including, **4-inch (100-mm)** size at this height; and as measured at height of **12 inches (300 mm)** above the root flair for trees larger than **4-inch (100-mm)** size.

C. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by [**diameter tape**][**or**][**average of the smallest and largest diameters**] at height **54 inches (1372 mm)** above the groundline[**for trees with caliper of 8 inches (200 mm) or greater as measured at height of 12 inches (300 mm) above the root flair**].

D. Root-Ball Depth: Measured from bottom of trunk flare to bottom of root ball.

E. Root-Ball Width: Measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, not necessarily centered on the tree trunk[**, but within tolerance in accordance with ANSI Z60.1**].

F. Root Flare: Also called "trunk flare." Area at the base of tree's stem or trunk where stem or trunk broadens to form roots; area of transition between root system and stem or trunk.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Methods and procedures related to transplanting work include, but are not limited to, the following:

a. Construction schedule. Verify availability of materials, personnel, equipment, and unimpeded access needed to make progress and avoid delays.
b. Tree and plant protection.
c. Tree maintenance.
d. Arborist's responsibilities.
e. <**Insert agenda items**>.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Planting materials.
2. Tree-stabilization materials.
3. Tree-watering devices.

B. Samples for Verification: Actual sample of finished products for each of the following:

1. Weed-control barriers.
2. Proprietary Root-Ball-Stabilization Device: One unit.
3. Slow-Release Watering Device: One unit of each size required.

C. Pruning Schedule: Written schedule prepared by arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.

1. Species and size of plant.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Seasonal limitations on pruning.
5. Preparatory Pruning: Time schedule and description of preparatory pruning to be performed.

a. Indicate time in months preceding extraction of tree.
b. Indicate diameter of root ball and depth of root pruning for each tree.

6. Description of root and crown pruning during and subsequent to transplanting.
7. Description of maintenance after pruning.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For tree-service firm and arborist.

B. Certification: From arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.

1. Submit before completing the Work.

D. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed color photographs or video recordings. Color must accurately depict hue condition of foliage and bark.
2. Include drawings and notations to indicate specific wounds and damage conditions of each tree designated to be transplanted.

E. Tree-Transplanting Program: Submit before work begins.

F. Sample Warranties: For special warranties.

G. Tree-maintenance reports.

1.7 QUALITY ASSURANCE

A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

1. Arborist Qualifications: [**ISA Certified Arborist**][**ISA Board Certified Master Arborist**][**ISA Certified Arborist-Municipal Specialist**][**Licensed arborist in jurisdiction where Project is located**][**Current member of ASCA**][**Registered Consulting Arborist as designated by ASCA**]<**Insert requirement**>.

B. Tree-Transplanting Program: Prepare a written plan by arborist for transplanting trees for whole Project, including each phase or process, tree maintenance, and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of transplanting work.

1. Include transplanting times appropriate for each species at Project location unless otherwise indicated on Drawings[**or directed by arborist**].
2. Include transplanting schedule for each species to be transplanted, coordinated with Project schedule.
3. Include site plans clearly marked to show tree-moving routes from extraction to planting locations. Indicate proposed equipment, weight, and turning radii.
4. Show details of temporary protective barriers where needed.
5. Include diagrams showing clearances to utility lines and other encumbrances along route.
6. Include care and maintenance provisions[**and eventual removal of tree stabilization**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or trees.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance

systems, or walkways.
3. Accompany each delivery with appropriate certificates.

C. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.

D. Completely cover foliage when transporting trees while they are in foliage.

E. Handle trees by root ball. Do not drop trees.

F. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.

B. Seasonal Restrictions: Transplant trees during the following in-season periods:

1. Spring: <**Insert dates**>.
2. Summer: <**Insert dates**>.
3. Fall: <**Insert dates**>.
4. Winter: <**Insert dates**>.

C. Weather Limitations: Proceed with transplanting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Do not transplant during excessively wet or frozen conditions. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

D. Coordination with Turf Areas (Lawns): Perform transplanting before planting turf areas unless otherwise indicated.

1. When transplanting after planting turf areas, protect turf areas, and promptly repair damage caused by transplanting operations.

E. Coordination with Planting Beds: Perform transplanting before planting bedded areas unless otherwise indicated.

1. When transplanting after planting bedded areas, protect bedding plants, and promptly repair damage caused by transplanting operations.

1.10 WARRANTY

A. Installer's Special Warranty: Tree-service firm agrees to repair or replace trees and related materials that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner; or incidents that are beyond Contractor's control.
b. Death and unsatisfactory growth is defined as more than 25 percent dead or in an unhealthy condition or failure to meet general performance requirements at end of warranty period.
c. Structural failures, including trees falling or blowing over.
d. Faulty performance of materials and devices related to tree plantings including [**tree stabilization**][**and**][**watering devices**]<**Insert item**>.

2. Warranty Periods from Date of [**Transplanting Completion**][**Substantial Completion**]<**Insert starting time**>:

a. Trees: [**12**][**18**]<**Insert number**> months.

3. Include the following remedial actions as a minimum:

a. Remove dead trees and trees with unsatisfactory growth at end of warranty period; replace when directed.
b. Limit of one replacement of each tree will be required except for losses or replacements due to failure to comply with requirements.
c. Replace materials and devices related to tree plantings.
d. Provide extended warranty for period equal to original warranty period, for replaced trees.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after [**preparatory pruning**][**trees are installed**] and continue until plantings are healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: [**12**][**18**]<**Insert number**> months from date of [**transplanting completion**][**Substantial Completion**]<**Insert starting time**>.

B. Continuing Maintenance Proposal: From tree-service firm to Owner, in the form of standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Transplanted trees are to be healthy and resume vigorous growth within [**one year**][**two years**]<**Insert period**> of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 PLANTING MATERIALS

A. Backfill Soil: [**Excavated soil**][**Excavated soil mixed with planting soil**][**Planting soil**] of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Mixture: Well-blended mix of [**two parts excavated soil to one part planting soil**]<**Insert requirement**>.
2. Planting Soil: as specified in [**Section 329113 "Soil Preparation."**][**Section 329115 "Soil Preparation (Performance Specification)."**]

2.3 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new [**hardwood**][**softwood with specified wood preservative treatment by pressure process**], free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring **8 inches (200 mm)** in diameter and **48 inches (1200 mm)** long, treated with specified wood preservative treatment by pressure process.
3. Flexible Ties: Wide rubber or elastic bands or straps.
4. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, **0.106 inch (2.7 mm)** in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cable: Five-strand, **3/16-inch- (4.8-mm-)** diameter, galvanized-steel cable, fitted with zinc-coated **3/8-inch (10-mm)** galvanized eyebolts at ends.
7. Flags: Standard surveyor's plastic flagging tape, white, **6 inches (150 mm)** long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by tree stem; sized as indicated and in accordance with manufacturer's written instructions.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Anchor Tie Down, Inc.**]
      2) [**Arborbrace**]
      3) [**DeepRoot Green Infrastructure, LLC**]
      4) [**J. R. Partners**]
      5) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**Anchor Tie Down, Inc.**]
      2) [**Arborbrace**]
      3) [**DeepRoot Green Infrastructure, LLC**]
      4) [**J. R. Partners**]
      5) <**Insert manufacturer's name**>

B. Root-Ball-Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal (38-by-38-mm actual)** by length indicated; stakes pointed at one end.
2. Wood Screws: Hot-dip galvanized or stainless steel.
3. Proprietary Root-Ball-Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized in accordance with manufacturer's written

instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Border Concepts, Inc**]
2) [**MacLean Power Systems**]
3) [**Tree Staple, Inc.**]
4) <**Insert manufacturer's name**>

C. Palm Bracing: Battens or blocks, struts, straps, and protective padding as indicated.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, **2-by-4-inch nominal (38-by-89-mm actual)** by lengths indicated.
2. Straps: Adjustable steel or plastic package banding straps.
3. Padding: Burlap.
4. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized in accordance with manufacturer's written instructions unless otherwise indicated.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Arborbrace**]
2) [**Horticultural Consultants, Inc.**]
3) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Arborbrace**]
2) [**Horticultural Consultants, Inc.**]
3) <**Insert manufacturer's name**>

2.4 TREE-WATERING DEVICES

A. Watering Pipe: PVC pipe **4 inches (100 mm)** in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over a period of [**2 to 9**]<**Insert number or range**> hours; manufactured

from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Spectrum Products, Inc.**]
   b. [**Turf Chemicals Plus, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Spectrum Products, Inc.**]
   b. [**Turf Chemicals Plus, Inc.**]
   c. <**Insert manufacturer's name**>

2.5 MISCELLANEOUS PRODUCTS

A. Organic Mulch: [**Shredded hardwood**][**Ground or shredded bark**][**Wood and bark chips**][**Compost mulch**]<**Insert mulch type**> as specified in Section 329300 "Plants."

B. Mineral Mulch: [**Rounded riverbed gravel or smooth-faced stone**][**Crushed stone or gravel**][**Marble chips**][**Granite chips**]<**Insert mulch type**> as specified in Section 329300 "Plants."

C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

D. Burlap: Non-synthetic, biodegradable.

E. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

   1. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling germination or growth of weeds within planted areas at soil level directly below the mulch layer.
   2. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

F. Weed-Control Barriers:

   1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, **3 oz./sq. yd. (101 g/sq. m)** minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric is to be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
   2. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, **4.8 oz./sq. yd. (162 g/sq. m)**.

G. Wood Preservative Treatment by Pressure Process: AWPA U1; Use Category UC4a, using preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.

PART 3 - EXECUTION

3.1 TREE-TRANSPLANTING SPECIALIST

A. Tree-Transplanting Specialist Firms: Subject to compliance with requirements, have tree transplanting performed by one of the following firms:

1. <**Insert, in separate subparagraphs, names of tree-transplanting specialist firms**>.

3.2 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross transplanting areas.

B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to transplanting work and tree protection and health.

C. Proceed with transplanting only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations.

B. Utility Locator Service: Notify [**utility locator service**][**"Miss Utility"**][**"Call Before You Dig"**][**"Dig Safe System"**][**"One Call"**]<**Insert name**> for area where Project is located before beginning excavation.

C. Locate and clearly identify trees for transplanting. [**Flag**][**Tie a 1-inch (25-mm) blue-vinyl tape around**]<**Insert requirement**> each tree at **54 inches (1372 mm)** above the ground.

D. Lay out individual transplant locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before transplanting. Make minor adjustments as required.

E. Apply antidesiccant to trees uniformly, using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during extracting, handling, and transportation.

1. If deciduous trees are moved in full leaf, spray with antidesiccant before extracting and again two weeks after transplanting.

F. Wrap trees with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during extracting, handling, and transporting.

3.4 PREPARATORY PRUNING

A. Root Pruning: Perform preparatory root pruning under direction of arborist as far in advance of extracting each tree as Project schedule allows.

1. Dig exploratory pits or trench [**by hand**][**or**][**with air spade**] around perimeter of tree at indicated

root-ball width to determine locations of main lateral roots.

2. Dig trench [**by hand**][**or**][**with tree spade**] around perimeter of tree at indicated root-ball width to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
3. Root-Ball Width: Minimum [**9 inches (229 mm)**]<**Insert dimension**> of root-ball diameter, or least dimension for non-round root balls, for each **1 inch (25 mm)** of tree caliper being transplanted.
4. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
5. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
6. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
7. Do not paint or apply sealants on cut root ends.
8. Backfill trench with excavated soil.

B. Crown Pruning (Tip Pruning):

1. Do not perform preparatory crown pruning (tip pruning).
2. Perform preparatory crown pruning [**as indicated on Drawings, under direction of arborist**][**as directed by arborist**]. Follow procedures as specified in "Crown Pruning" Article.

3.5 EXCAVATION AND PLANTING EQUIPMENT

A. Tree Spade: Track-mounted mechanized tree mover; sized in accordance with manufacturer's size recommendation for each tree being transplanted.

3.6 EXCAVATION OF PLANTING PITS

A. General: Excavate under supervision of arborist.

1. Excavate planting pits or trenches with sides sloping. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately [**two**][**three**]<**Insert requirement**> times as wide as root ball.
3. Keep excavations covered or otherwise protected until replanting trees.

B. Subsoil and topsoil removed from excavations may[**not**] be used as planting soil.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees are encountered in excavations.

1. Hardpan Layer: Drill **6-inch- (150-mm-)** diameter holes, **24 inches (600 mm)** apart, into free-draining strata or to a depth of **10 ft. (3 m)**, whichever is less, and backfill with free-draining material.

D. Seepage: Notify Architect if subsoil conditions evidence unexpected water seepage into tree-planting pits.

E. Drainage: Fill planting pit or trench with [**6 inches (152 mm)**]<**Insert dimension**> of water and time the infiltration rate of soil. If drainage rate is less than [**0.25 inch (6 mm)**]<**Insert dimension**> per hour, notify Architect to determine need for subsurface drainage.

F. Saline or Sodic Soils: Completely fill excavations with water and allow to percolate away before positioning trees.

3.7 EXTRACTION OF TREES

A. General: Extract trees under supervision of arborist.

B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.

C. Root-Ball Width: Minimum [**10 inches (250 mm)**]<**Insert dimension**> of root-ball diameter, or least dimension for non-round root balls, for each **1 inch (25 mm)** of tree caliper being transplanted.

1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide minimum root-ball diameter of [**12 inches (305 mm)**]<**Insert dimension**> for each **1 inch (25 mm)** of tree caliper being transplanted.

D. Root-Ball Depth: As determined by arborist for each species and size of tree and for site conditions at original and planting locations.

E. Digging:

1. Dig and clear a pit [**by hand**][**or**][**with tree spade**] to depth of root system. Do not use backhoe or other equipment that rips, tears, or pulls roots.
2. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
3. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
4. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not paint or apply sealants on cut root ends.
5. Construct box tight against root system sides and bottom as pit is dug. Brace and support box to prevent breaking of root ball.
6. Temporarily support and protect exposed roots from damage until they are permanently redirected and covered with soil. Cover roots with burlap and keep them moist until planted.

F. Extracting with Tree Spade: Use same tree spade to extract the tree as will be used to transport and plant the tree.

1. Do not use tree spade to move trees larger than manufacturer's maximum size recommendation for tree spade being used.
2. When extracting the tree, center the trunk within tree spade and move tree with solid ball of earth.

3.8 PLANTING

A. Planting Standard: Perform planting in accordance with ANSI A300 (Part 6) unless otherwise indicated.

B. Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

C. Ensure that root flare is visible after planting.

D. Remove injured roots by cutting cleanly; do not break. Do not paint or apply sealants on cut root ends.

E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new

location.

F. Set tree plumb and in center of planting pit with [**bottom**][**top**] of root flare [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**> above adjacent finish grades.

1. Use specified backfill soil for backfill.
2. If area under the tree was initially dug too deep, add backfill to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
3. After placing some backfill around root ball to stabilize plant, begin backfilling.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Redirect exposed root ends downward in backfill areas where possible. Hand-expose roots as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is impractical, cut roots approximately **3 inches (75 mm)** back from new construction and as required for root pruning.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Watering Pipe: During backfilling, install watering pipe **4 ft. (1220 mm)** deep into the planting pit outside the root ball [**as indicated on Drawings**][**and**][**with top of pipe 1 inch (25 mm) above the mulched surface**].

H. Planting with Tree Spade: Use same tree spade for planting as was used to extract and transport the tree. Do not use tree spade for trees larger than manufacturer's maximum size recommendation for tree spade being used.

I. Slopes: When planting on slopes, set the tree so root flare on the uphill side is flush with surrounding soil on the slope; edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.9 CROWN PRUNING

A. Prune branches [**as indicated on Drawings, under direction of arborist**][**as directed by arborist**].

1. Prune to remove only[**injured,**] broken, dying, or dead branches. Do not prune for shape.
2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form.
3. Pruning Standards: Perform pruning in accordance with ANSI A300 (Part 1).

B. Unless otherwise directed by arborist and acceptable to Architect, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance during Contract period as recommended by arborist.

F. Chip removed branches and [**spread over areas identified by Architect**][**stockpile in areas approved by Architect**][**dispose of off-site**]<**Insert requirement**>.

3.10 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated on Drawings[**or directed by arborist**].

1. Upright Staking and Tying: Stake only as required to prevent wind tip out. Use a minimum of [**two**][**three**] stakes of length required to penetrate at least **18 inches (450 mm)** below bottom of backfilled excavation and to extend [**to dimension indicated on Drawings**][**one-third of trunk height**]<**Insert dimension or requirement**> above grade. Set stakes vertical and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings[**or directed by arborist**].

1. Site-Fabricated Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

   a. Securely attach guys to stakes **30 inches (760 mm)** long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
   b. For trees more than [**6 inches (150 mm) in caliper**]<**Insert size**>, anchor guys to wood deadmen buried at least **36 inches (900 mm)** below grade. Provide [**turnbuckle**][**compression spring**] for each guy wire and tighten securely.
   c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to a [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
   d. Support trees with [**guy cable**][**or**][**multiple strands of tie wire**], connected to brass grommets of tree-tie webbing at contact points with tree trunk and reaching to [**turnbuckle**][**compression spring**]. Allow enough slack to avoid rigid restraint of tree.
   e. Attach flags to each guy wire, **30 inches (760 mm)** above finish grade.
   f. Paint [**turnbuckles**][**compression springs**] with luminescent white paint.

2. Proprietary Staking-and-Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by root ball unless otherwise indicated on Drawings[**or directed by arborist**].

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of vertical stakes.

   a. Install stakes of length required to penetrate at least [**to dimension indicated on Drawings**][**18 inches (450 mm)**]<**Insert dimension**> below bottom of backfilled excavation. Saw stakes off at horizontal stake.
   b. Install screws through horizontal hold-down and penetrating at least **1 inch (25 mm)** into stakes. Predrill holes if necessary to prevent splitting wood.
   c. Install second set of stakes on other side of root trunk for larger trees as indicated.

2. Proprietary Root-Ball-Stabilization Device: Install root-ball-stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

1. Site-Fabricated Palm-Bracing Method:

a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.

b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.

2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.11 INSTALLATION OF MULCHES

A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of [**6 inches (150 mm)**][**12 inches (300 mm)**] and secure seams with galvanized pins.

B. Organic Mulch: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of organic mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.

C. Mineral Mulch in Planting Areas: Apply [**2-inch (50-mm)**][**3-inch (75-mm)**]<**Insert dimension**> average thickness of mineral mulch [**extending 12 inches (300 mm) beyond edge of individual planting pit**][**and**][**over whole surface of planting area**], and finish level with adjacent finish grades. Do not place mulch within [**3 inches (75 mm)**][**6 inches (150 mm)**]<**Insert distance**> of trunks or stems.

3.12 INSTALLATION OF TREE-WATERING DEVICES

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree and fill with water in accordance with manufacturer's written instructions.

3.13 TREE MAINTENANCE

A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.

B. Maintain trees by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Treat as required to keep trees free of insects and disease.

C. From time of [**preparatory root pruning**][**or**][**tree extraction**], measure soil moisture adjacent to edge of each root ball [**weekly**]<**Insert period**>. Record findings and weather conditions.

D. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.

E. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

F. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

1. Pre-Emergent Herbicides (Selective and Non-Selective): Apply in accordance with manufacturer's written instructions. Do not apply to seeded areas.
2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

G. Reports: Have arborist prepare [**monthly**]<**Insert period**> inspection reports.

3.14 REPAIR AND REPLACEMENT

A. Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by arborist and approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than [**25**]<**Insert number**> percent dead or in unhealthy condition[**before end of corrections period**] or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of [**6 inches (150 mm)**][**4 inches (100 mm)**]<**Insert dimension**> or smaller in caliper size.
2. Provide [**one**][**two**]<**Insert number**> new tree(s) of [**6-inch (150-mm)**][**4-inch (100-mm)**]<**Insert dimension**> caliper size for each tree being replaced that measures more than [**6 inches (150 mm)**][**4 inches (100 mm)**] in caliper size.
3. Species of Replacement Trees: [**Same species being replaced**][**Species selected by Architect**]<**Insert species**>.

3.15 CLEANING AND PROTECTION

A. During transplanting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect trees from damage due to transplanting operations and operations of other contractors and trades. Maintain protection during transplanting and maintenance periods. Treat, repair, or replace damaged plantings.

C. After planting and before [**Substantial Completion**]<**Insert time**>, remove tags, markings, tie tape, labels, wire, burlap, and other debris from transplanted trees, planting areas, and Project site.

END OF SECTION 32 96 00 00

Task	Specification	Specification Description
32 96 33 00	32 96 00 00	Transplanting
32 96 43 00	32 96 00 00	Transplanting

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Task	Specification	Specification Description
33 01 10 54	33 01 30 41	Cleaning of Sewers
33 01 10 58	33 01 30 41	Cleaning of Sewers

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SECTION 33 01 30 41 - CLEANING OF SEWERS

1.1 GENERAL

A. Description Of Work
1. This specification covers sewer line cleaning. Cleaning procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's instruction.

1.2 PRODUCTS

A. All materials shall be clean, free of defects, corrosion, and damage. All items shall be of proper type, size, design, and characteristics for the use intended. Unless otherwise specified, all items shall be factory-made.

B. Portable Cleaning Equipment: Equipment used in the cleaning of sewer lines shall be as required to complete the work for the size, length, and conditions of the sewer. Portable and mobile equipment shall comply with Water Pollution Control Federation Manual No. 7.

C. Chemicals shall be of the strength required to perform the work. The chemicals shall not be damaging to pipe materials, manholes, pumping equipment, nor treatment process and shall not be contaminated by foreign substances.

1.3 EXECUTION

A. Preparation
1. Protection required to prevent damage to adjacent materials, equipment, fixtures, and finishes shall be provided. Necessary protective clothing and accessories for personnel working with chemicals shall be provided.
2. Ventilation of Sewers: Contractor shall provide proper ventilation for personnel working in the sewer.
3. Alternate Sewage Discharge: Contractor shall provide an alternate routing of sewage discharge to a downstream manhole.
4. Traffic: Contractor shall provide all traffic signs required to safely direct traffic at and around work areas.

B. Installation
1. Direction of Work: Sewer line cleaning work, with the exception of hydraulic scouring, shall proceed in the downstream direction. Cleaning by hydraulic scouring shall proceed in the upstream direction.
2. Testing: Upon completion of cleaning operation, test sewer lines for proper operation and observe for a period of 24 hours. Clean out all stoppages and the retest the line for proper operation.

END OF SECTION 33 01 30 41

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Task	Specification	Specification Description
33 01 30 42	33 01 30 41	Cleaning of Sewers
33 01 30 81	26 05 43 00	Underground Ducts and Utility Structures
33 01 30 81	33 42 00 00	Stormwater Conveyance
33 01 40 00	33 42 00 00	Stormwater Conveyance

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SECTION 33 05 00 00 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Piping joining materials.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Identification devices.
6. Grout.
7. Flowable fill.
8. Piped utility demolition.
9. Piping system common requirements.
10. Equipment installation common requirements.
11. Painting.
12. Concrete bases.
13. Metal supports and anchorages.

1.2 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. CPVC: Chlorinated polyvinyl chloride plastic.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, **1/8 inch (3.2 mm)** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.
2. CPVC Piping: ASTM F493.
3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
4. PVC to ABS Piping Transition: ASTM D3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:

1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Utility Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Smith-Blair, a Xylem brand.**]
f. [**Viking Johnson**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dresser Utility Solutions**]
c. [**Ford Meter Box Company, Inc. (The)**]
d. [**JCM Industries, Inc**]
e. [**Smith-Blair, a Xylem brand.**]

f. [**Viking Johnson**]
g. <**Insert manufacturer's name**>

3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Spears Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Spears Manufacturing Company**]
b. <**Insert manufacturer's name**>

3. Description: [**CPVC**][**CPVC and PVC**][**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint[**or threaded**] end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Colonial Engineering, Inc.**]
b. [**NIBCO INC.**]
c. [**Spears Manufacturing Company**]
d. <**Insert manufacturer's name**>

3. Description: MSS SP-107, [**CPVC**][**CPVC and PVC**][**PVC**] four-part union. Include brass[**or stainless steel**] threaded end, solvent-cement-joint[**or threaded**] plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. [**Plastic Oddities**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. [**Plastic Oddities**]
e. <**Insert manufacturer's name**>

3. Description: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Capitol Manufacturing Company**]
b. [**Epco Sales, Inc**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**HART Industrial Unions, LLC**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

3. Description: Factory fabricated, union, **NPS 2 (DN 50)** and smaller.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**][**250 psig (1725 kPa)**] at **180 deg F (82 deg C)**.
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Capitol Manufacturing Company**]
   b. [**Epco Sales, Inc**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Capitol Manufacturing Company**]
   b. [**Epco Sales, Inc**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Description: Factory-fabricated, bolted, companion-flange assembly, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)** and larger.

   a. Pressure Rating: [**150 psig (1035 kPa) minimum**][**175 psig (1200 kPa) minimum**][**300 psig (2070 kPa)**].
   b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GF Piping Systems: Georg Fischer LLC**]
   d. [**GPT; a division of EnPRO Industries**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Products & Systems, LLC**]

b. [**CALPICO, Inc.**]
c. [**GF Piping Systems: Georg Fischer LLC**]
d. [**GPT; a division of EnPRO Industries**]
e. <**Insert manufacturer's name**>

3. Description: Nonconducting materials for field assembly of companion flanges, **NPS 2-1/2 (DN 65)** and larger.

a. Pressure Rating: [**150 psig (1035 kPa) minimum**]<**Insert pressure**>.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or polyethylene.
d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CALPICO, Inc.**]
b. [**Lochinvar, LLC**]
c. <**Insert manufacturer's name**>

3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, **NPS 3 (DN 80)** and smaller.

a. Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
b. End Connections: Threaded.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Elster Perfection; Honeywell**]
b. [**Precision Plumbing Products**]

c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.

a. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure and temperature**>.
b. End Connections: Threaded or grooved.

2.4 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220500 "Common Work Results for Plumbing."

B. Galvanized-Steel Sheet Sleeves: **0.0239-inch (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.5 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is **1-1/4 inches (30 mm)** for ducts, and **3/4 inch (20 mm)** for access door signs and similar operational instructions.

1. Material: [**Fiberboard**][**Brass**].
2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

F. Pipes with OD, Including Insulation, Less Than **6 Inches (150 mm)**: Full-band pipe markers, extending 360 degrees around pipe at each location.

G. Pipes with OD, Including Insulation, **6 Inches (150 mm)** and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

H. Lettering:

1. Manufacturer's standard preprinted captions as selected by Architect.
2. Use piping system terms indicated and abbreviate only as necessary for each application length.

   a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least **3 mils (0.08 mm)** thick.

1. Width: **1-1/2 inches (40 mm)** on pipes with OD, including insulation, less than **6 inches (150 mm)**; **2-1/2 inches (65 mm)** for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

J. Valve Tags: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** sequenced numbers. Include **5/32-inch (4-mm)** hole for fastener.

1. Material:

   a. **0.032-inch- (0.8-mm-)** thick, [**polished brass**][**or**][**aluminum**].
   b. **0.0375-inch- (1-mm-)** thick stainless steel.
   c. **3/32-inch- (2.4-mm-)** thick plastic laminate with 2 black surfaces and a white inner layer.
   d. Valve manufacturer's standard solid plastic.

2. Size: **1-1/2 inches (40 mm)** in diameter, unless otherwise indicated.
3. Shape: As indicated for each piping system.

K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

L. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
2. Thickness:

   a. [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**], unless otherwise indicated.
   b. **1/16 inch (1.6 mm)**, for units up to **20 sq. in. (130 sq. cm)** or **8 inches (200 mm)** in length, and **1/8 inch (3 mm)** for larger units.

3. Fasteners: Self-tapping, stainless steel screws or contact-type permanent adhesive.

M. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: **2-1/2 by 4 inches (65 by 100 mm)** for control devices, dampers, and valves; **4-1/2 by 6 inches (115 by 150 mm)** for equipment.

N. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

1. Size: **3-1/4 by 5-5/8 inches (83 by 143 mm)**.
2. Fasteners: Brass grommets and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.7 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C150, Type I, portland.
2. Density: [**115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m)**]<**Insert value**>.
3. Aggregates:

    a. ASTM C33, natural sand, fine and crushed gravel or stone, coarse.
    b. ASTM C33, natural sand, fine.

4. Admixture: ASTM C618, fly-ash mineral.
5. Water: Comply with ASTM C94/C94M.

6. Strength: [**100 to 200 psig (690 to 1380 kPa)**]<**Insert value**> at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric unions.
2. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges[**or dielectric flange kits**].

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric [**couplings**][**couplings or dielectric nipples**][**nipples**].
2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
3. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples[**or dielectric flange kits**].
4. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

3.3 INSTALLATION OF PIPING

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. Pipe Sleeves: [**PVC**][**Steel**]. For pipes smaller than **NPS 6 (DN 150)**.
b. Steel Sheet Sleeves: For pipes **NPS 6 (DN 150)** and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
5. PVC Nonpressure Piping: Join according to ASTM D2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 INSTALLATION OF EQUIPMENT

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect

equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: According to ASME A13.1.
2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
3. Locate pipe markers on exposed piping according to the following:

a. Near each valve and control device.
b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
d. At manholes and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum **1/4 inch (6.4 mm)** high for name of unit if viewing distance is less than **24 inches (610 mm)**, **1/2 inch (13 mm)** high for distances up to **72 inches (1800 mm)**, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than **4 inches (100 mm)** larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [**3000-psi (20.7-MPa)**]<**Insert strength**>, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 33 05 00 00

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Task	Specification	Specification Description
33 05 05 43	33 01 30 41	Cleaning of Sewers
33 05 07 00	33 05 00 00	Common Work Results For Utilities
33 05 07 13	33 05 00 00	Common Work Results For Utilities
33 05 07 23	33 05 00 00	Common Work Results For Utilities
33 05 07 24	33 05 00 00	Common Work Results For Utilities
33 05 09 00	33 05 00 00	Common Work Results For Utilities
33 05 09 23	33 05 00 00	Common Work Results For Utilities
33 05 09 33	33 05 00 00	Common Work Results For Utilities
33 05 16 00	33 05 00 00	Common Work Results For Utilities
33 05 17 00	33 05 00 00	Common Work Results For Utilities
33 05 19 00	33 05 00 00	Common Work Results For Utilities
33 05 24 00	33 05 00 00	Common Work Results For Utilities
33 05 24 23	33 05 00 00	Common Work Results For Utilities
33 05 27 00	33 05 00 00	Common Work Results For Utilities
33 05 27 13	33 05 00 00	Common Work Results For Utilities
33 05 27 23	33 05 00 00	Common Work Results For Utilities
33 05 27 33	33 05 00 00	Common Work Results For Utilities
33 05 31 00	33 05 00 00	Common Work Results For Utilities
33 05 31 11	33 05 00 00	Common Work Results For Utilities
33 05 31 13	33 05 00 00	Common Work Results For Utilities
33 05 31 16	33 05 00 00	Common Work Results For Utilities
33 05 33 00	33 05 00 00	Common Work Results For Utilities
33 05 33 13	33 05 00 00	Common Work Results For Utilities
33 05 33 23	33 05 00 00	Common Work Results For Utilities
33 05 33 33	33 05 00 00	Common Work Results For Utilities
33 05 33 36	33 05 00 00	Common Work Results For Utilities
33 05 33 53	33 05 00 00	Common Work Results For Utilities
33 05 33 56	33 05 00 00	Common Work Results For Utilities
33 05 33 63	33 05 00 00	Common Work Results For Utilities
33 05 39 00	33 05 00 00	Common Work Results For Utilities
33 05 39 13	33 05 00 00	Common Work Results For Utilities
33 05 39 41	33 05 00 00	Common Work Results For Utilities
33 05 39 46	33 05 00 00	Common Work Results For Utilities
33 05 41 00	33 05 00 00	Common Work Results For Utilities
33 05 61 00	33 05 00 00	Common Work Results For Utilities
33 05 61 00	33 42 00 00	Stormwater Conveyance
33 05 63 00	26 05 43 00	Underground Ducts and Utility Structures
33 05 63 00	33 05 00 00	Common Work Results For Utilities
33 05 81 00	26 05 43 00	Underground Ducts and Utility Structures
33 05 81 00	33 05 00 00	Common Work Results For Utilities
33 05 81 00	33 42 00 00	Stormwater Conveyance
33 05 83 00	26 05 43 00	Underground Ducts and Utility Structures
33 05 83 00	33 05 00 00	Common Work Results For Utilities
33 05 83 00	33 42 00 00	Stormwater Conveyance
33 05 84 00	33 05 00 00	Common Work Results For Utilities
33 05 84 00	33 42 00 00	Stormwater Conveyance
33 05 97 00	33 05 00 00	Common Work Results For Utilities
33 05 97 16	33 05 00 00	Common Work Results For Utilities
33 05 97 23	33 05 00 00	Common Work Results For Utilities

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SECTION 33 11 13 00 - REHABILITATION OF WATER SUPPLY WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for repair and maintenance of water wells. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Repair and Replacement Parts shall be clean, free of rust and scale, and of proper size and design for the specific well repair to be made.

1.3 EXECUTION

A. Cement Grout may be hand mixed at the site.

B. Level and Re-Sod Area, after heavy equipment has been used or if chemicals have been spilled.

C. Abandoned Wells shall be sealed in accordance with AWWA A100.

D. Disinfect well, after repair, in accordance with AWWA A100.

END OF SECTION 33 11 13 00

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SECTION 33 11 13 00A - POTABLE WATER SUPPLY WELLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Well casings.
2. Grout.
3. Water well screens.
4. Pack materials.
5. Jet well pumps.
6. Line-shaft well pumps.
7. Submersible well pumps.

1.2 ALLOWANCES

A. Allowance amounts and quantities are specified in Section 012100 "Allowances."

1. Water Supply Well Depth Allowance: Install complete and functional well to depth indicated in Section 012100 "Allowances." If water supply well depths vary from quantities in the allowance, the Contract Sum will be adjusted according to unit prices listed in "Unit Prices" Article. Include the following in the Contract Amount:

   a. Labor for water supply well installation.
   b. Furnishing and installing casing materials, grout, well screen, and packing materials in required diameter to comply with minimum performance requirements specified in the Section Text.
   c. Furnishing and installing well pump.

B. Water supply wells and well pumps are covered by cash allowance.[**Allowance includes labor and materials.**]

C. Well pumps are covered by cash allowance.[**Allowance includes labor and materials.**]

1.3 UNIT PRICES

A. Unit-Price Amounts: As stipulated in the Form of Agreement.

B. Measurement and Payment Procedures: Specified in Section 012200 "Unit Prices."

C. Measurement Units for Water Supply Wells, Casings, and Grout: Per linear **foot (meter)** of well depth.

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. PA: Polyamide (nylon) plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

1.5 ACTION SUBMITTALS

A. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties and accessories for each type and size of well pump indicated.

B. Shop Drawings: For well pumps. Show layout and connections.

1. Include diagrams for power, signal, and control wiring.
2. Setting Drawings: Include templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

1.6 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. For each well pump, include the following:

a. Substrata formations.
b. Water-bearing formations.
c. Water levels.
d. Laboratory water analysis.
e. Well-screen analysis.
f. Performance test data.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each well pump to include in emergency, operation, and maintenance manuals.

1. Project Record Documents: Record the following data for each water supply well:

a. Casings: Material, diameter, thickness, weight per **foot** **(meter)** of length, and depth below grade.
b. Screen: Material, construction, diameter, and opening size.
c. Pumping Test: Static water level, maximum safe yield, and drawdown at maximum yield.
d. Log: Formation log indicating strata encountered.
e. Alignment: Certification that well is aligned and plumb within specified tolerances.

1.8 QUALITY ASSURANCE

A. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located.

B. Testing Agency Qualifications: Certified by the EPA or State to analyze drinking water for compliance monitoring.

1.9 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

B. Well Drilling Water: [**Owner will provide**][**Provide**] temporary water and piping for drilling purposes. Provide necessary piping for water supply.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AWWA A100 for water supply wells.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Tested Water Supply Well Performance Capacity: <**Insert capacity in gpm (L/s)**>.

2.3 WELL CASINGS

A. Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

B. ABS Casing: ASTM F480, ABS, Schedule [**40**][**80**] bell-and-spigot pipe and couplings for solvent-cemented joints.

C. PVC Casing: ASTM F480[**and NSF 14,**] PVC, Schedule [**40**][**80**] bell-and-spigot pipe and couplings for solvent-cemented joints.[**Include NSF listing mark "NSF wc."**]

D. Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.

E. Pitless Unit: Factory-assembled equipment that includes pitless adapter.

F. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

2.4 GROUT

A. Cement: ASTM C150/C150M, Type II.

B. Aggregates: ASTM C33/C33M, fine and coarse grades.

C. Water: Potable.

2.5 WATER WELL SCREENS

A. Screen Material: Fabricated of ASTM A666, Type 304 stainless steel[**, welded; with continuous-slot, V-shaped openings that widen inwardly**][**tube; with slotted or perforated surface and designed for well-screen applications**].

1. Screen Couplings: Butt-type, stainless steel coupling rings.
2. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
3. Maximum Entering Velocity: **0.1 fps (0.03 m/s)**.

2.6 PACK MATERIALS

A. Coarse, uniformly graded filter sand, maximum **1/8 inch (3 mm)** in diameter.

B. Fine gravel, maximum **1/4 inch (6 mm)** in diameter.

2.7 JET WELL PUMPS

A. Description: [**Shallow**][**Deep**]-well-design, jet well pump; self-priming; centrifugal pump capable of continuous operation.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Goulds Pumps; a brand of Xylem, Inc.**]
3. [**Jacuzzi Inc.**]
4. [**Myers, F.E.; Pentair Ltd**]
5. [**Pentair Pump Group; Layne/Verti-Line**]
6. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
7. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Goulds Pumps; a brand of Xylem, Inc.**]
3. [**Jacuzzi Inc.**]
4. [**Myers, F.E.; Pentair Ltd**]
5. [**Pentair Pump Group; Layne/Verti-Line**]
6. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
7. **<Insert manufacturer's name>**

D. Housing: Cast iron.

E. Impeller: [**Single stage**][**Multistage**], centrifugal; fabricated of corrosion-resistant materials.

F. Seals: Mechanical.

G. Shaft: Stainless steel.

H. Motor: Manufacturer's standard, NEMA MG 1 motor, panel, and accessories.

I. Motor Controls: Electronic; variable speed.

J. Check valve, ejector, and pressure-control valve.

K. Pump Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.
14. Compression Tank Capacity: <**Insert gal. (L)**>.

L. Pump Accessories:

1. Compression Tanks:

a. Comply with requirements in Section 221223 "Facility Indoor Potable-Water Storage Tanks."
b. Precharged butyl rubber diaphragm, steel shell, fused polymeric lining, and **100-psig (690-kPa)** working pressure.

2. Pressure Switches: For pump control; for installation in piping.
3. Water Piping:

a. ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends.

1) Cast-Iron Fittings: ASME B16.4, threaded, galvanized.

b. ASTM D2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**]. Include NSF listing mark "NSF pw."

1) Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

2.8 LINE-SHAFT WELL PUMPS

A. Description: Line-shaft, [**water**][**oil**]-lubricated, vertical-turbine well pump.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Turbine Pump Co**]
2. [**Crane Pumps & Systems**]
3. [**Fairbanks Morse**]
4. [**Flowserve Corporation**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**Peerless Pump Company**]
7. [**Pentair Pump Group; Layne/Verti-Line**]
8. [**Sulzer Pumps Inc.**]
9. [**WDM Pumps**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Turbine Pump Co**]
2. [**Crane Pumps & Systems**]
3. [**Fairbanks Morse**]
4. [**Flowserve Corporation**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**Peerless Pump Company**]
7. [**Pentair Pump Group; Layne/Verti-Line**]
8. [**Sulzer Pumps Inc.**]
9. [**WDM Pumps**]
10. <**Insert manufacturer's name**>

D. Standards: HI 2.1-2.2 and HI 2.3.

E. Impeller Material: [**Stainless steel**][**Carbon steel**][**Bronze**].

F. Pump Base: Cast iron or fabricated steel.

G. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

H. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 SUBMERSIBLE WELL PUMPS

A. Description: Submersible, vertical-turbine well pump.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Aermotor**]
3. [**American Turbine Pump Co**]
4. [**Crane Pumps & Systems**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**GRUNDFOS CBS Inc.**]
7. [**Jacuzzi Inc.**]
8. [**Myers, F.E.; Pentair Ltd**]
9. [**Peerless Pump Company**]
10. [**Pentair Pump Group; Layne/Verti-Line**]
11. [**Reda Productions Services; Schlumberger Limited**]
12. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
13. [**Sulzer Pumps Inc.**]
14. [**Weber Industries, Inc**]
15. [**Wilo USA LLC**]
16. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Aermotor**]
3. [**American Turbine Pump Co**]
4. [**Crane Pumps & Systems**]
5. [**Goulds Pumps; a brand of Xylem, Inc.**]
6. [**GRUNDFOS CBS Inc.**]
7. [**Jacuzzi Inc.**]
8. [**Myers, F.E.; Pentair Ltd**]
9. [**Peerless Pump Company**]
10. [**Pentair Pump Group; Layne/Verti-Line**]
11. [**Reda Productions Services; Schlumberger Limited**]
12. [**Sta-Rite Industries, Inc.; Pentair Ltd.**]
13. [**Sulzer Pumps Inc.**]
14. [**Weber Industries, Inc**]
15. [**Wilo USA LLC**]
16. **<Insert manufacturer's name>**

D. Standards: HI 2.1-2.2 and HI 2.3.

E. Impeller Material: [**Stainless steel**][**Silicon bronze**].

F. Motor: Capable of continuous operation under water, with protected submersible power cable.

G. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

H. Discharge Piping: ASTM D2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**]. Include NSF

listing mark "NSF pw."

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

I. Capacities and Characteristics:

1. Capacity: <**Insert gpm (L/s)**>.
2. Discharge Head: <**Insert psig (kPa)**>.
3. Discharge Size: <**Insert NPS (DN)**>.
4. Speed: <**Insert rpm**>.
5. Motor Horsepower: <**Insert value**>.
6. Lift: <**Insert feet (m)**>.
7. Pressure Rating: <**Insert psig (kPa)**>.
8. Volts: <**Insert value**>.
9. Phases: <**Insert value**>.
10. Hertz: <**Insert value**>.
11. Full-Load Amperes: <**Insert value**>.
12. Minimum Circuit Ampacity: <**Insert value**>.
13. Maximum Overcurrent Protection: <**Insert amperage**>.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Pilot-Hole Data: Review pilot-hole test analysis furnished by Owner.

B. Neighborhood Well Data: Review operating and test analyses.

3.2 INSTALLATION OF WELLS

A. Construct well using [**cable-tool**][**rotary drilling**][**reverse-rotary drilling**][**driven**] method.

B. Take samples of substrata formation at **10-foot (3-m)** intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.

C. Excavate for mud pit or provide aboveground structure, acceptable to authorities having jurisdiction, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.

D. Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.

E. Set casing and liners round, plumb, and true to line.

F. Join casing pipe as follows:

1. Ream ends of pipe and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside casing before installation.
3. Cut bevel in ends of casing pipe and make threaded joints.
4. Clean and make solvent-cemented joints.

G. Mix grout in proportions of **1 cu. ft. (0.03 cu. m)** or a **94-lb (42.6-kg)** sack of cement with **5 to 6 gal. (19 to 23 L)** of water. Bentonite clay may be added in amounts of **3 to 5 lb/cu. ft. (1.4 to 2.3 kg/0.03 cu. m)** for a **94-lb (42.6-kg)** sack of cement. If bentonite clay is added, water may be increased to **6.5 gal./cu. ft. (25 L/0.03 cu. m)** of cement.

H. Place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.

I. Provide permanent casing with temporary well cap. Install with top of casing **36 inches (910 mm)** above finished grade.

J. Develop wells to maximum yield per **foot (meter)** of drawdown.

1. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
2. Avoid settlement and disturbance of strata above water-bearing formation.
3. Do not disturb sealing around well casings.
4. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.

K. Install jet well pumps with ejector in or attached to pump housing. Place check valve on suction line to prevent drainage of compression tank.

L. Install jet well pumps and pressure and suction lines. Install ejector where pressure and suction lines connect above well screen. Install check valve in suction line, or install foot valve below ejector, to prevent drainage of compression tank.

M. Install [**line-shaft**][**submersible**] well pumps according to HI 2.4 and provide access for periodic maintenance.

1. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
2. Before lowering permanent pump into well, start pump to verify correct rotation.
3. Securely tighten discharge piping joints.
4. Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.
5. Connect motor to submersible pump and locate near well bottom.

   a. Connect power cable while connection points are dry and undamaged.
   b. Do not damage power cable during installation; use cable clamps that do not have sharp edges.

c. Install water-sealed surface plate that will support pump and piping.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 331415 "Site Water Distribution Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

1. Connect piping between well pump and water piping.
2. Connect water distribution system in trench to well pipe at pitless [**adapter**][**unit**].
3. Connect building water distribution to well pipe inside well house.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 WELL ABANDONMENT

A. Comply with AWWA A100 when abandoning water supply wells. Fill and seal holes and casings, and restore ground surface to finished grade.

B. Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.

3.5 FIELD QUALITY CONTROL

A. Test Preparation: Clean water supply wells of foreign substances. Swab casings using alkalis, if necessary, to remove foreign substances.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Plumbness and Alignment Testing: Comply with AWWA A100.
2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Test Preparation: Start well pump and adjust controls and pressure setting. Replace damaged and malfunctioning controls and equipment.
5. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.

a. Arrange to conduct tests, with seven days' advance notice, after test pump and auxiliary equipment have been installed. Note water-level elevations referred to for each assigned datum in wells.
b. Provide discharge piping to conduct water to locations where disposal will not create a

nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.

c. Provide and maintain equipment of adequate size and type for measuring flow of water, such as weir box, orifice, or water meter.
d. Measure elevation to water level in wells.
e. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
f. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
g. Start and adjust test pumps and equipment to required pumping rates.
h. Record readings of water levels in wells and pumping rates at [**30**]<**Insert number**>-minute maximum intervals throughout 24-hour minimum period.
i. Record maximum yields when drawdown is [**60 inches (1500 mm)**]<**Insert dimension**> above top of suction screens after designated times.
j. Operate pumping units continuously for [**eight**]<**Insert number**> hours after maximum drawdown is reached.
k. Record returning water levels in wells and plot curves of well recovery rates.
l. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.

E. Water supply well will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Water Analysis Testing:

1. [**Owner will engage**][**Engage**] a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.
2. Analyze water sample from each finished well for bacteriological, physical, and chemical quality and report the results. Make analyses according to requirements of authorities having jurisdiction.

3.6 CLEANING

A. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.

B. Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.

3.7 PROTECTION

A. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.

B. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.

C. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.

D. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.

E. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well

cap until installation is complete.

END OF SECTION 33 11 13 00A

SECTION 33 14 00 00 - SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. PE pipe and fittings.
4. PVC pipe and fittings.
5. Fiberglass pipe and fittings.
6. Special pipe fittings.
7. Piping joining materials.
8. Piping specialties.
9. Encasement for piping.
10. Gate valves.
11. Gate valve accessories and specialties.
12. Check valves.
13. Detector check valves.
14. Butterfly valves.
15. Corporation valves, curb valves, and meter valves.
16. Water meters.
17. Water meter boxes.
18. Pressure-reducing valves.
19. Relief valves.
20. Vacuum breakers.
21. Backflow preventers.
22. Concrete vaults.
23. Protective enclosures.
24. Fire hydrants.
25. Flushing hydrants.
26. Sampling stations.
27. Fire department connections.
28. Alarm devices.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories."
2. Section 032000 "Concrete Reinforcing."
3. Section 211000 "Water-Based Fire-Suppression Systems."
4. Section 221216 "Facility Elevated, Potable-Water Storage Tanks."
5. Section 221219 "Facility Ground-Mounted, Potable-Water Storage Tanks."
6. Section 221223.11 "Facility Indoor Potable-Water Storage Tanks."
7. Section 315000 "Excavation Support and Protection."

1.2 DEFINITIONS

A. CDA: Copper Development Association.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
2. Include diagrams for power, signal, and control wiring for alarms.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Ensure that piping, valves, meters, backflow prevention devices, and fire hydrants are dry and internally protected against rust and corrosion.
2. Protect threaded ends and flange faces against damage.
3. Set piping, valves, meters, backflow prevention devices, and fire hydrants in best position for handling and to prevent rattling.

B. During Storage: Use precautions for piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle products if size requires handling by crane or lift. Rig products to avoid

damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate connection to water main with utility company.

B. Content includes water-distribution piping and related components outside the building for [**domestic water service**][**fire-suppression water service**][**combined domestic water service and fire-suppression water service**][**and terminated 5 ft. (1.5 m) from building**][**and service entrance piping to a point 1 ft. (0.3 m) above finished floor**][**and service entrance piping to a point 1 ft. (0.3 m) inside finished wall**]. Terminate water-service piping with appropriate fitting for extension by [**Division 21**][**Division 22**][**Divisions 21 and 22**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.

C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and

application.

F. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

G. Comply with FM Approvals' "Approval Guide" and/or UL's "Fire Protection Equipment Directory" for fire-suppression water-service products.

H. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

I. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.

B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372.[**Include marking "NSF-pw" on piping.**]

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**].

B. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**][**and**][**ASTM B88, Type L (ASTM B88M, Type B)**].

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
   c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   d. [**Mueller Streamline Co.; a company of Mueller Industries**]
   e. [**NIBCO INC.**]
   f. [**Viega LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems**]
c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
d. [**Mueller Streamline Co.; a company of Mueller Industries**]
e. [**NIBCO INC.**]
f. [**Viega LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain copper tube, pressure-seal-joint fittings from single manufacturer.
4. Standard: UL 213.
5. Fittings: Cast brass, cast bronze, or wrought copper with EPDM O-ring seal in each end. **NPS 2-1/2 (DN 65)** and larger with stainless steel grip ring and EPDM O-ring seal.
6. Minimum **200 psig (1379 kPa)** working-pressure rating at **250 deg F (121 deg C)**.

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock-body, ball-and-socket, metal-to-metal seating surfaces; and solder-joint or threaded ends.

H. Wrought-Copper Unions: ASME B16.22.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

B. Mechanical-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
3. AWWA C104/A21.4 cement mortar-lined.

C. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

D. Push-on-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Gaskets: AWWA C111/A21.11, rubber.
3. AWWA C104/A21.4 cement mortar-lined.

E. Grooved-End, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with cut, rounded-grooved ends.
2. AWWA C104/A21.4 cement mortar-lined.

F. Grooved-End, Ductile-Iron Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**GroovJoint**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Anvil; an ASC Engineered Solution**]
   b. [**GroovJoint**]
   c. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
   d. [**Smith-Cooper International**]
   e. [**Star Pipe Products**]
   f. [**Victaulic Company**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain grooved-end, ductile-iron pipe appurtenances from single manufacturer.
4. Grooved-End, Ductile-Iron Fittings:

   a. ASTM A536, ductile-iron castings with dimensions matching pipe.
   b. AWWA C104/A21.4 cement mortar-lined.

5. Grooved-End, Ductile-Iron-Piping Mechanical Couplings:

   a. AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

G. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**].

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**].

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than [**160 psig (1100 kPa)**][**200 psig (1380 kPa)**].

C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FM Global approved, with minimum thickness equivalent to FM Global [**Class 150**][**and**][**Class 200**].

1. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, and made to match PE pipe dimensions and class.

2.6 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

C. PVC Pipe: [**AWWA C900**][**UL 1285**], [**Class 150**][**and**][**Class 200**], with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-suppression water service.
2. PVC Fabricated Fittings: AWWA C900, [**Class 150**][**and**][**Class 200**], with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.7 FIBERGLASS PIPE AND FITTINGS

A. RTRP Pipe: AWWA C950, [**Class 150**][**Class 200**][**and**][**Class 250**], Type I[**or II**], [**Grade 1, epoxy**][**or**][**Grade 2, polyester**], with bell-and-spigot ends [**for bonded**][**with gasket or seal for gasketed**] joints. Liner is optional unless otherwise indicated.[**Include FM Global approval if used for fire-service mains.**]

B. Fittings, RTRF, AWWA C950: Similar to pipe in material, pressure class, and joining method.

C. Fittings: Compatible with pipe size, pressure class, and joining method.

2.8 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, end sections.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron rigid expansion joints from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

B. Ductile-Iron Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBAA Iron Sales, Inc.**]
b. [**Star Pipe Products**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. [**Star Pipe Products**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron flexible expansion joints from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.
6. Offset: <**Insert inches (mm)**>.
7. Expansion Required: <**Insert inches (mm)**>.

C. Ductile-Iron Deflection Fittings, Lead Free: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EBAA Iron Sales, Inc.**]
b. [**U.S. Pipe**]

c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**EBAA Iron Sales, Inc.**]
   b. [**U.S. Pipe**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

2.9 PIPING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

B. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

C. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.10 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Ford Meter Box Company, Inc. (The)**]
   c. [**JCM Industries, Inc**]
   d. [**Smith-Blair, a Xylem brand.**]
   e. [**United Water Products**]
   f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Ford Meter Box Company, Inc. (The)**]
   c. [**JCM Industries, Inc**]
   d. [**Smith-Blair, a Xylem brand.**]

e. [**United Water Products**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain tubular-sleeve pipe couplings from single manufacturer.
4. Standard: AWWA C219.
5. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].
6. Gasket Material: Natural or synthetic rubber.
7. Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert pressure**> minimum.
8. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Victaulic Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Victaulic Company**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain split-sleeve pipe couplings from single manufacturer.
4. Standard: AWWA C227.
5. Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**].
6. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
7. Gasket Material: O-rings made of EPDM rubber unless otherwise indicated.
8. Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert pressure**> minimum.
9. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless steel hose covered with stainless steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

1. Dielectric Unions:

a. Standard: ASSE 1079.
b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**250 psig (1725 kPa)**]<**Insert pressure rating and temperature**>.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**][**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure rating and temperature**>.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits: Nonconducting materials for field assembly of companion flanges.

a. Pressure Rating: [**150 psig (1035 kPa)**]<**Insert pressure rating**>.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or PE.
d. Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple complying with ASTM F1545.
c. Pressure Rating: [**300 psig (2070 kPa) at 225 deg F (107 deg C)**]<**Insert pressure rating and temperature**>.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, PP.

2.11 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Form: [**Sheet**][**or**][**tube**].

C. Material: [**Linear low-density PE film of 0.008-inch (0.20-mm) minimum thickness**][**or**][**high-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.12 GATE VALVES

A. Gate Valves - AWWA, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**EJ Group, Inc.**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Zurn Industries, LLC**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American AVK Co.**]
   b. [**American Cast Iron Pipe Company**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**EJ Group, Inc.**]
   e. [**Flomatic Valves; Flomatic Corporation**]
   f. [**M & H Valve Company; a division of McWane, Inc.**]
   g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   h. [**NIBCO INC.**]
   i. [**Zurn Industries, LLC**]
   j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain gate valves - AWWA, cast iron, from single manufacturer.
4. Gate Valves - Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

   a. Standards: AWWA C509 or AWWA C515.
   b. Minimum Pressure Rating: **200 psig (1380 kPa)**.
   c. End Connections: Mechanical joint, flanged, threaded, or push on.
   d. Interior Coating: Complying with AWWA C550.

5. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, and bronze stem.

   a. Standard: AWWA C509 or AWWA C515.
   b. Minimum Pressure Rating: **200 psig (1380 kPa)**.
   c. End Connections: Mechanical joint, flanged, threaded, or push on.

B. Gate Valves - UL/FM Global, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American AVK Co.**]
   b. [**American Cast Iron Pipe Company**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**Kennedy Valve Company; a division of McWane, Inc.**]
   e. [**M & H Valve Company; a division of McWane, Inc.**]
   f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   g. [**NIBCO INC.**]
   h. [**Zurn Industries, LLC**]
   i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American AVK Co.**]

b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**Kennedy Valve Company; a division of McWane, Inc.**]
e. [**M & H Valve Company; a division of McWane, Inc.**]
f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
g. [**NIBCO INC.**]
h. [**Zurn Industries, LLC**]
i. **<Insert manufacturer's name>**

3. Source Limitations: Obtain gate valves - UL/FM Global, cast iron, from single manufacturer.
4. Gate Valves - UL/FM Global, Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with flange for indicator post, bronze seating material, and inside screw.

   a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
   b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
   c. End Connections: Mechanical joint or flanged.
   d. Interior Coating: Complying with AWWA C550.

5. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet and bronze seating material.

   a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
   b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
   c. End Connections: Mechanical joint or flanged.
   d. Interior Coating: Complying with AWWA C550.

C. Gate Valves - Bronze:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Crane Fluid Systems; Crane Co.**]
   b. [**Hammond Valve**]
   c. [**Jenkins Valves; a Crane Co. brand**]
   d. [**Milwaukee Valve Company**]
   e. [**NIBCO INC.**]
   f. [**Red-White Valve Corp.**]
   g. [**Stockham; a Crane Co. brand**]
   h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Crane Fluid Systems; Crane Co.**]
   b. [**Hammond Valve**]
   c. [**Jenkins Valves; a Crane Co. brand**]
   d. [**Milwaukee Valve Company**]
   e. [**NIBCO INC.**]
   f. [**Red-White Valve Corp.**]
   g. [**Stockham; a Crane Co. brand**]
   h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain gate valves - bronze, from single manufacturer.

4. Gate Valves - OS&Y, Rising Stem: Bronze body and bonnet and bronze stem.

    a. Standards: UL listed and FM Global approved.
    b. Minimum Pressure Rating: **175 psig (1207 kPa)**.
    c. End Connections: Threaded.

5. Gate Valves - Nonrising Stem: Class 125, bronze with solid wedge.

    a. Standard: MSS SP-80.
    b. End Connections: Threaded or solder.
    c. Handwheel: Malleable iron.

2.13 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies: Sleeve and valve compatible with drilling machine.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Cast Iron Pipe Company**]
    b. [**Kennedy Valve Company; a division of McWane, Inc.**]
    c. [**U.S. Pipe**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Cast Iron Pipe Company**]
    b. [**Kennedy Valve Company; a division of McWane, Inc.**]
    c. [**U.S. Pipe**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain tapping-sleeve assemblies from single manufacturer.
4. Standard: MSS SP-60.
5. Tapping Sleeve: Cast- or ductile-iron or stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
6. Valve: AWWA, cast-iron, nonrising-stem, [**metal**][**resilient**]-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately **5 inches (125 mm)** in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FM Global approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.14 CHECK VALVES

A. Check Valves - AWWA: Swing-check type with resilient seat with ends to match piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Stockham; a Crane Co. brand**]
j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**American AVK Co.**]
b. [**American Cast Iron Pipe Company**]
c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
d. [**DeZURIK**]
e. [**Flomatic Valves; Flomatic Corporation**]
f. [**M & H Valve Company; a division of McWane, Inc.**]
g. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
h. [**NIBCO INC.**]
i. [**Stockham; a Crane Co. brand**]
j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain check valves, AWWA, from single manufacturer.
4. Standards:

a. AWWA C508.
b. Interior coating in accordance with AWWA C550.

5. Pressure Rating: **175 psig (1207 kPa)**.

B. Check Valves - UL/FM Global: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Cast Iron Pipe Company**]
b. [**Matco-Norca**]
c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
d. [**NIBCO INC.**]
e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**American Cast Iron Pipe Company**]
   b. [**Matco-Norca**]
   c. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   d. [**NIBCO INC.**]
   e. [**Reliable Automatic Sprinkler Co., Inc. (The)**]
   f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain check valves - UL/FM Global, from single manufacturer.
4. Standards: UL listed and FM Global approved.
5. Pressure Rating: [**175 psig (1207 kPa)**][**250 psig (1725 kPa)**].

2.15 DETECTOR CHECK VALVES

A. Detector Check Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**FEBCO; A WATTS Brand**]
   c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**FEBCO; A WATTS Brand**]
   c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain detector check valves from single manufacturer.

B. Description: Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

1. Standards: UL listed and FM Global approved.
2. Pressure Rating: **175 psig (1207 kPa)**.

C. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.16 BUTTERFLY VALVES

A. Butterfly Valves - AWWA:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**DeZURIK**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Henry Pratt Company; a Mueller brand**]
   d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
   e. [**Milliken Valve Company; a Mueller brand.**]
   f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**DeZURIK**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**Henry Pratt Company; a Mueller brand**]
   d. [**Homestead Valve: a division of Olson Technologies, Inc.**]
   e. [**Milliken Valve Company; a Mueller brand.**]
   f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   g. [**Val-Matic Valve & Manufacturing Corp.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain butterfly valves - AWWA, from single manufacturer.
4. Standard: AWWA C504.
5. Body: Cast or ductile iron.
6. Body Type: [**Wafer**][**or**][**flanged**]<**Insert type**>.
7. Seat: Rubber.
8. Pressure Rating: **150 psig (1035 kPa)**.

B. Butterfly Valves - UL:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Henry Pratt Company; a Mueller brand**]
   b. [**NIBCO INC.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Henry Pratt Company; a Mueller brand**]
   b. [**NIBCO INC.**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain butterfly valves - UL, from single manufacturer.
4. Standards: UL 1091 and FM Global approved.
5. Body: Cast or ductile iron.

6. Body Type: [**Wafer**][**or**][**flanged**]<**Insert type**>.
7. Seat: Metal or resilient material.
8. Pressure Rating: **175 psig (1207 kPa)**.

2.17 CORPORATION VALVES, CURB VALVES, AND METER VALVES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Ford Meter Box Company, Inc. (The)**]
3. [**James Jones Company, LLC; a Mueller brand**]
4. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**A.Y. McDonald Mfg. Co.**]
2. [**Ford Meter Box Company, Inc. (The)**]
3. [**James Jones Company, LLC; a Mueller brand**]
4. [**Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corporation valves, curb valves, and meter valves from single manufacturer.

D. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body, ground-key plug or ball, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

E. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

1. Service Boxes for Curb Valves: ASTM A48/A48M, Class 25 cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately **3 inches (75 mm)** in diameter.

a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

F. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle or straight-through-pattern bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material.

2.18 WATER METERS

A. Water Meter - Utility Company Furnished:

1. Utility Company: <**Insert name**>.

B. Water Meters - Displacement Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**Carlon Meter**]
   c. [**Master Meter, Inc**]
   d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   e. [**Neptune Technology Group Inc.**]
   f. [**Niagara Meters**]
   g. [**Sensus; a Xylem brand**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**Carlon Meter**]
   c. [**Master Meter, Inc**]
   d. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   e. [**Neptune Technology Group Inc.**]
   f. [**Niagara Meters**]
   g. [**Sensus; a Xylem brand**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - displacement type, from single manufacturer.
4. Standard: AWWA C700.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Nutating disc; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Stainless steel**].
9. End Connections: Threaded or flanged <**Insert connection**>.

C. Water Meters - Turbine Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**Carlon Meter**]
   c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   d. [**Neptune Technology Group Inc.**]
   e. [**Niagara Meters**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**Carlon Meter**]
   c. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   d. [**Neptune Technology Group Inc.**]
   e. [**Niagara Meters**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - turbine type, from single manufacturer.
4. Standard: AWWA C701.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Turbine; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Epoxy-coated cast iron**].
9. End Connections: Threaded or flanged <**Insert connection**>.

D. Water Meters - Compound Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Badger Meter, Inc.**]
   b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   c. [**Neptune Technology Group Inc.**]
   d. [**Sensus; a Xylem brand**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Badger Meter, Inc.**]
   b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
   c. [**Neptune Technology Group Inc.**]
   d. [**Sensus; a Xylem brand**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - compound type, from single manufacturer.
4. Standard: AWWA C702.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: With integral mainline and bypass meters; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Coated ductile iron**].
9. End connections: Flanged <**Insert connection**>.

E. Water Meters - Ultrasonic Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Master Meter, Inc**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain water meters - ultrasonic type, from single manufacturer.
4. Standard: AWWA C715.
5. Pressure Rating: **150 psig (1035 kPa)** working pressure.
6. Body Design: Ultrasonic open flow tube; totalization meter.
7. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**] as required by utility company.
8. Case: [**Bronze**][**Stainless steel**][**Engineered polymer**][**Epoxy-coated ductile iron**]<**Insert type**>.
9. End Connections: Threaded or flanged <**Insert connection**>.

F. Ultrasonic Type Water Meter, Remote Registration System, Direct-Reading Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].

G. Ultrasonic Type Water Meter, Remote Registration System, Encoder Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Standard: AWWA C707.
2. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
3. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
4. Visible Display Units: Comply with utility company requirements for type and quantity.

H. Water Meters - Detector Type:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Badger Meter, Inc.**]
b. [**Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.**]
c. [**Neptune Technology Group Inc.**]
d. **<Insert manufacturer's name>**

3. Source Limitations: Obtain water meters - detector type, from single manufacturer.
4. Standards: AWWA C703, and UL listed or FM Global approved.
5. Pressure Rating: **175 psig (1207 kPa)**.
6. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
7. Bypass Meter: [**AWWA C700, disc**][**AWWA C701, turbine**][**AWWA C702, compound**]-type, bronze case.

I. Detector Type Water Meter, Remote Registration System, Direct-Reading Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].

J. Detector Type Water Meter, Remote Registration System, Encoder Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Standard: AWWA C707.
2. Registration: Flow in [**gal. (L)**][**cu. ft. (cu. m)**].
3. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
4. Visible Display Units: Comply with utility company requirements for type and quantity.

2.19 WATER METER BOXES

A. Water Meter Boxes:

1. Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

a. Option: Base section may be cast-iron, PVC, clay, or other pipe.

2. Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
3. Water Meter Boxes: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of **15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm)** square.

2.20 PRESSURE-REDUCING VALVES

A. Pressure-Reducing Valves - Direct Acting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**Cash Acme Plumbing Products; an RWC brand**]
c. [**Flomatic Valves; Flomatic Corporation**]
d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-reducing valves - direct acting, from single manufacturer.
4. Standard: ASSE 1003.
5. Pressure Rating: Initial pressure of **150 psig (1035 kPa)**.
6. Size: <**Insert NPS (DN)**>.
7. Design Flow Rate: <**Insert gpm (L/s)**>.
8. Design Inlet Pressure: <**Insert psig (kPa)**>.
9. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
10. Body: Bronze[**with chrome-plated finish**].
11. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; flanged for **NPS 2-1/2 and NPS 3 (DN 65 and DN 80)**.

B. Pressure-Reducing Valves - Pilot Operated: Pilot-operation, diaphragm-type, single-seated main water control valve with interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**CLA-VAL**]
c. [**Dorot Control Valves Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**OCV Control Valves**]
f. [**Zurn Industries, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
b. [**CLA-VAL**]
c. [**Dorot Control Valves Inc.**]
d. [**Flomatic Valves; Flomatic Corporation**]
e. [**OCV Control Valves**]
f. [**Zurn Industries, LLC**]

g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-reducing valves - pilot operated, from single manufacturer.
4. Pressure Rating: Initial pressure of **150 psig (1035 kPa)** minimum.
5. Main Valve Body: Cast- or ductile-iron, or stainless steel body.
6. Size: <**Insert NPS (DN)**>.
7. Pattern: [**Angle**][**Globe**]-valve design.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Design Inlet Pressure: <**Insert psig (kPa)**>.
10. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.
11. End Connections: [**Threaded**][**or**][**grooved**][**or**][**flanged**].

2.21 RELIEF VALVES

A. Air-Release Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Crispin Valve**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**GA Industries, Inc**]
   d. [**Val-Matic Valve & Manufacturing Corp.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Crispin Valve**]
   b. [**Flomatic Valves; Flomatic Corporation**]
   c. [**GA Industries, Inc**]
   d. [**Val-Matic Valve & Manufacturing Corp.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air-release valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Water Inlet Size: <**Insert NPS (DN)**>.
9. Air Outlet Size: <**Insert NPS (DN)**>.
10. Orifice Size: <**Insert inches (mm)**>.
11. Design Air-Release Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> pipeline pressure.

B. Air/Vacuum Valves: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain air/vacuum valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Inlet and Outlet Size: <**Insert NPS (DN)**>.
9. Orifice Size: <**Insert inches (mm)**>.
10. Design Air Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> differential pressure.

C. Combination Air Valves: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crispin Valve**]
b. [**Flomatic Valves; Flomatic Corporation**]
c. [**GA Industries, Inc**]
d. [**Val-Matic Valve & Manufacturing Corp.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain combination air valves from single manufacturer.
4. Standard: AWWA C512.
5. Pressure Rating: [**300 psig (2070 kPa)**]<**Insert pressure**>.
6. Body Material: [**Cast iron**]<**Insert material**>.
7. Trim Material: Stainless steel[**, brass, or bronze**].
8. Inlet and Outlet Size: <**Insert NPS (DN)**>.
9. Orifice Size: <**Insert inches (mm)**>.

10. Design Air Capacity: <**Insert cfm (L/s)**> at <**Insert psig (kPa)**> differential pressure.

2.22 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**FEBCO; A WATTS Brand**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**FEBCO; A WATTS Brand**]
   c. [**WATTS; A Watts Water Technologies Company**]
   d. [**Zurn Industries, LLC**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure vacuum breaker assembly from single manufacturer.
4. Standard: ASSE 1020.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Accessories: Ball valves on inlet and outlet.

2.23 BACKFLOW PREVENTERS

A. Backflow Preventers - Reduced-Pressure Principle:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - reduced-pressure principle, from single manufacturer.
4. Standard: [**ASSE 1013**][**or**][**AWWA C511**].
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**12 psig (83 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
11. Body: Bronze for **NPS 2 (DN 50)** and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**steel with interior lining complying with AWWA C550 or that is FDA approved**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
12. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of **NPS 2 (DN 50)** and smaller; OS&Y gate type with flanged ends on inlet and outlet of **NPS 2-1/2 (DN 65)** and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Backflow Preventers - Double-Check Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]

d. [**WATTS; A Watts Water Technologies Company**]
e. [**Zurn Industries, LLC**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - double-check assembly, from single manufacturer.
4. Standard: [**ASSE 1015**][**or**][**AWWA C510**].
5. Operation: Continuous-pressure applications unless otherwise indicated.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**> for **NPS 2 (DN 50)** and smaller; <**Insert psig (kPa)**> for **NPS 2-1/2 (DN 65)** and larger.
11. Body: Bronze for **NPS 2 (DN 50)** and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**steel with interior lining complying with AWWA C550 or that is FDA approved**][**stainless steel**] for **NPS 2-1/2 (DN 65)** and larger.
12. End Connections: Threaded for **NPS 2 (DN 50)** and smaller; [**flanged**]<**Insert type**> for **NPS 2-1/2 (DN 65)** and larger.
13. Configuration: Designed for [**horizontal, straight through**]<**Insert configuration**> flow.
14. Accessories: Ball valves with threaded ends on inlet and outlet of **NPS 2 (DN 50)** and smaller; OS&Y gate valves with flanged ends on inlet and outlet of **NPS 2-1/2 (DN 65)** and larger.

C. Backflow Preventers - Reduced-Pressure-Detector, Fire-Protection Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
   b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   c. [**FEBCO; A WATTS Brand**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - reduced-pressure-detector, fire-protection assembly, from single manufacturer.
4. Standards: ASSE 1047, and UL listed or FM Global approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**12 psig (83 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.

7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Body: [**Cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**Steel with interior lining complying with AWWA C550 or that is FDA approved**][**Stainless steel**].
12. End Connections: Flanged.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: UL 262, FM Global approved, OS&Y gate type with flanged ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
    c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Backflow Preventers - Double-Check, Detector Assembly:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventers - double-check, detector-assembly, from single manufacturer.
4. Standards: ASSE 1048, and UL listed or FM Global approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: [**5 psig (35 kPa)**]<**Insert pressure**> maximum, through middle one-third of flow range.
7. Size: <**Insert NPS (DN)**>.
8. Design Flow Rate: <**Insert gpm (L/s)**>.
9. Selected Unit Flow Range Limits: <**Insert gpm (L/s)**>.
10. Pressure Loss at Design Flow Rate: <**Insert psig (kPa)**>.
11. Body: [**Cast iron with interior lining complying with AWWA C550 or that is FDA approved**][**Steel with interior lining complying with AWWA C550 or that is FDA approved**][**Stainless steel**].

12. End Connections: Flanged.
13. Configuration: Designed for [**horizontal, straight through**][**vertical inlet, horizontal center section, and vertical outlet**][**vertical**]<**Insert configuration**> flow.
14. Accessories:

    a. Valves: UL 262, FM Global approved, OS&Y gate type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow Preventer Test Kits: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ames Fire & Waterworks; A Watts Water Technologies Company**]
    b. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
    c. [**FEBCO; A WATTS Brand**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Zurn Industries, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain backflow preventer test kits from single manufacturer.

2.24 CONCRETE VAULTS

A. Concrete Vault - Precast, Reinforced Concrete: Designed for A-16 load designation in accordance with ASTM C857 and made in accordance with ASTM C858.

1. Ladder: ASTM A36/A36M, steel or PE-encased steel steps.
2. Manhole:

    a. ASTM A48/A48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover; **24-inch (610-mm)** minimum diameter unless otherwise indicated.
    b. ASTM A536, Grade 60-40-18, ductile-iron traffic frame and cover: **24-inch (610-mm)** minimum diameter unless otherwise indicated.

3. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.25 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of **40 deg F (4 deg C)** when external temperatures reach as low as **minus 30 deg F (minus 34 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**AquaSHIELD**]
   c. [**BF Products Inc.**]
   d. [**DekoRRa Products LLC**]
   e. [**G&C Enclosures**]
   f. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   g. [**HydroCowl, Inc**]
   h. [**WATTS; A Watts Water Technologies Company**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Apollo Valves; a part of Aalberts Integrated Piping Systems**]
   b. [**AquaSHIELD**]
   c. [**BF Products Inc.**]
   d. [**DekoRRa Products LLC**]
   e. [**G&C Enclosures**]
   f. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   g. [**HydroCowl, Inc**]
   h. [**WATTS; A Watts Water Technologies Company**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freeze-protection enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

   a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
   b. Drain opening for units with drain connection.
   c. Access doors with locking devices.
   d. Insulation inside housing.
   e. Anchoring devices for attaching housing to concrete base.

8. Electric heating cable or heater with self-limiting temperature control.

B. Freeze-Retardant Enclosures: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage with minimum external temperatures of **33 deg F (0.5 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain freeze-retardant enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class II: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class II-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

    a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
    b. Drain opening for units with drain connection.
    c. Access doors with locking devices.
    d. Anchoring devices for attaching housing to concrete base.

C. Non-Freeze Protection Enclosures: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AquaSHIELD**]
    b. [**BF Products Inc.**]
    c. [**DekoRRa Products LLC**]
    d. [**G&C Enclosures**]
    e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    f. [**HydroCowl, Inc**]
    g. [**WATTS; A Watts Water Technologies Company**]

h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AquaSHIELD**]
   b. [**BF Products Inc.**]
   c. [**DekoRRa Products LLC**]
   d. [**G&C Enclosures**]
   e. [**Hot Box; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   f. [**HydroCowl, Inc**]
   g. [**WATTS; A Watts Water Technologies Company**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain non-freeze protection enclosures from single manufacturer.
4. Standard: ASSE 1060.
5. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
6. Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
7. Housing: Reinforced[**-aluminum**][**or**][**-fiberglass**]<**Insert housing**> construction.

   a. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
   b. Drain opening for units with drain connection.
   c. Access doors with locking devices.
   d. Anchoring devices for attaching housing to concrete base.

D. Expanded-Metal Enclosures: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cross Brothers Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cross Brothers Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain expanded-metal enclosures from single manufacturer.
4. Standard: ASTM F1267.
5. Material: Expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
6. Type: [**I, expanded**][**II, expanded and flattened**].
7. Class: [**1, uncoated carbon steel**][**2, hot-dip, zinc-coated carbon steel**][**3, corrosion-resistant steel**].
8. Finish: Manufacturer's enamel paint.
9. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

10. Locking device.
11. Lugs or devices for securing enclosure to base.

E. Enclosure Bases: [**4-inch- (100-mm-)**][**6-inch- (150-mm-)**] minimum thickness precast concrete, of dimensions required to extend at least **6 inches (150 mm)** beyond edges of enclosure housings. Include openings for piping.

2.26 FIRE HYDRANTS

A. Fire Hydrants - Dry Barrel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American AVK Co.**]
   b. [**American Cast Iron Pipe Company**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**EJ Group, Inc.**]
   e. [**M & H Valve Company; a division of McWane, Inc.**]
   f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American AVK Co.**]
   b. [**American Cast Iron Pipe Company**]
   c. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   d. [**EJ Group, Inc.**]
   e. [**M & H Valve Company; a division of McWane, Inc.**]
   f. [**Mueller Co. LLC; Mueller Water Products, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire hydrants - dry barrel, from single manufacturer.
4. Pressure Rating: [**150 psig (1035 kPa) minimum**][**250 psig (1725 kPa)**].
5. Standard: AWWA C502.
6. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **5-1/4-inch (133-mm)** main valve, drain valve, and **NPS 6 (DN 150)** mechanical-joint inlet. Include interior coating in accordance with AWWA C550. Hydrant to have cast-iron body, compression-type valve opening against pressure and closing with pressure.
7. Standards: UL 246, and FM Global approved.
8. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **5-1/4-inch (133-mm)** main valve, drain valve, and **NPS 6 (DN 150)** mechanical-joint inlet. Hydrant to have cast-iron body, compression-type valve opening against pressure and closing with pressure.

   a. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
   b. Operating and Cap Nuts: Pentagon, **1-1/2 inches (38 mm)** point to flat.
   c. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.

d. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.

B. Fire Hydrants - Wet Barrel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American AVK Co.**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**James Jones Company, LLC; a Mueller brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American AVK Co.**]
   b. [**Clow Valve Company; a subsidiary of McWane, Inc.**]
   c. [**James Jones Company, LLC; a Mueller brand**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire hydrants - wet barrel, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Standard: AWWA C503.
6. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **NPS 6 (DN 150)** threaded or flanged inlet, and base section with **NPS 6 (DN 150)** mechanical-joint inlet. Include interior coating in accordance with AWWA C550.
7. Standards: UL 246, and FM Global approved.
8. Freestanding configuration, with one **NPS 4-1/2 (DN 115)** and two **NPS 2-1/2 (DN 65)** outlets, **NPS 6 (DN 150)** threaded or flanged inlet, and base section with **NPS 6 (DN 150)** mechanical-joint inlet.

   a. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
   b. Operating and Cap Nuts: Pentagon, **1-1/2 inches (38 mm)** point to flat.
   c. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
   d. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.

2.27 FLUSHING HYDRANTS

A. Flushing Hydrants - Post Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flushing hydrants - post type, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Outlet: One, with horizontal discharge.
6. Hose Thread: **NPS 2-1/2 (DN 65)**, with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
7. Barrel: Cast-iron or steel pipe with breakaway feature.
8. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
9. Security: Locking device for padlock.
10. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.
11. Inlet: **NPS 2 (DN 50)** minimum.
12. Operating Wrench: One for each unit.

B. Flushing Hydrants - Ground Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain flushing hydrants - ground type, from single manufacturer.
4. Pressure Rating: **150 psig (1035 kPa)** minimum.
5. Outlet: One, with [**vertical**][**angle**] discharge.
6. Hose Thread: **NPS 2-1/2 (DN 65)**, with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
7. Barrel: Cast-iron or steel pipe.
8. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
9. Inlet: **NPS 2 (DN 50)** minimum.
10. Hydrant Box: Cast iron with cover, for ground mounting.
11. Operating Wrench: One for each unit.

2.28 SAMPLING STATIONS

A. Sampling Station - Post Type: Nonfreeze and drainable, of length required for shutoff valve installation

below frost line.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GIL Industries, Inc**]
   b. [**Kupferle Foundry Co. (The)**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain sampling stations - post type, from single manufacturer.
4. Pressure Rating: **100 psig (690 kPa)** minimum.
5. Sampling Outlet: One unthreaded nozzle with handle.
6. Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
7. Drain: Tubing with separate manual vacuum pump.
8. Inlet: **NPS 3/4 (DN 20)** minimum.
9. Housing: Weatherproof material with locking device. Include anchor device.
10. Operating Wrench: One for each unit.

2.29 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Croker; a Division of Morris Group International**]
   b. [**Elkhart Brass Mfg. Co., Inc**]
   c. [**Guardian Fire Equipment, Inc**]
   d. [**Kidde; Carrier Global Corporation**]
   e. [**Potter Roemer LLC; a Division of Morris Group International**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Croker; a Division of Morris Group International**]
   b. [**Elkhart Brass Mfg. Co., Inc**]
   c. [**Guardian Fire Equipment, Inc**]
   d. [**Kidde; Carrier Global Corporation**]
   e. [**Potter Roemer LLC; a Division of Morris Group International**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fire department connections from single manufacturer.
4. Standard: UL 405.
5. Configuration: Freestanding, with cast-bronze body, thread inlets in accordance with NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; **18-inch- (460-mm-)** high, brass sleeve; and round escutcheon plate.
6. Connections:

    a. [**Two**][**Three**] **NPS 2-1/2 (DN 65)** inlets and one [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**] outlet.
    b. Two **NPS 3 (DN 80)** inlets and one [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**] outlet.
    c. [**Three**][**Four**] **NPS 2-1/2 (DN 65)** inlets and one **NPS 6 (DN 150)** outlet.
    d. Six **NPS 2-1/2 (DN 65)** inlets and one [**NPS 6 (DN 150)**][**NPS 8 (DN 200)**] outlet.

7. Inlet Alignment: [**Inline, horizontal**][**Square**].
8. Finish Including Sleeve: [**Polished chrome-plated**][**Rough chrome-plated**][**Polished bronze**].
9. Escutcheon Plate Marking: "[**AUTO SPKR**][**&**][**STANDPIPE**]."

2.30 ALARM DEVICES

A. Alarm Devices: UL 753 and FM Global approved, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for **250 psig (1725 kPa)** working pressure; designed for horizontal or vertical installation; with 2 SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: SPDT; designed to signal valve in other than fully open position.

D. Pressure Switches: SPDT; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.

B. Do not use flanges or unions for underground piping.

C. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping [**NPS 3/4 to NPS 3 (DN 20 to DN 80)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Soft copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; [**wrought-copper, solder-joint fittings; and brazed**][**copper, pressure-seal fittings; and pressure-sealed**] joints.
2. PE, ASTM pipe; [**insert fittings for PE pipe; and clamped**][**molded PE fittings; and heat-fusion**] joints.
3. PVC, Schedule [**40 pipe; PVC, Schedule 40**][**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints.
4. **NPS 1 to NPS 3 (DN 25 to DN 80)** fiberglass, RTRP, AWWA pipe, [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.
5. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF; and bonded joints.

E. Underground water-service piping [**NPS 4 to NPS 8 (DN 100 to DN 200)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Soft copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; wrought-copper, solder-joint fittings; and brazed joints.
2. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
3. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
4. PVC, Schedule [**40 pipe; PVC, Schedule 40**][**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints.
5. NPS 4 and NPS 6 (DN 100 and DN 150): **NPS 6 (DN 150)** PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 [**fabricated**][**or**][**molded**] fittings; and gasketed joints.
6. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; [**PVC, AWWA Class 200 fabricated**][**push-on-joint, ductile-iron**][**mechanical-joint, ductile-iron**] fittings; and gasketed joints.
7. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

F. Water Meter Box Water-Service Piping: [**NPS 3/4 to NPS 2 (DN 20 to DN 50)**]<**Insert pipe size range**> to be same as underground water-service piping.

G. Aboveground[**and vault**] water-service piping [**NPS 3/4 to NPS 3 (DN 20 to DN 80)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Hard copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; [**wrought-copper, solder-joint fittings; and brazed**][**copper, pressure-seal fittings; and pressure-sealed**] joints.
2. PVC, Schedule 80 pipe; PVC, Schedule 80 [**socket fittings; and solvent-cemented**][**threaded fittings; and threaded**] joints.
3. **NPS 1 to NPS 2 (DN 25 to DN 50)** fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

H. Aboveground [**and vault**]water-service piping [**NPS 4 to NPS 8 (DN 100 to DN 200)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Hard copper tube, [**ASTM B88, Type K (ASTM B88M, Type A)**][**ASTM B88, Type L (ASTM B88M, Type B)**]; wrought-copper, solder-joint fittings; and brazed joints.
2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
3. PVC, Schedule 80 pipe; PVC, Schedule 80 [**socket fittings; and solvent-cemented**][**threaded fittings; and threaded**] joints.
4. Fiberglass, RTRP, AWWA pipe [**Class 150**][**Class 200**][**Class 250**]; RTRF, AWWA pipe; and bonded joints.

I. Underground fire-service-main piping [**NPS 4 to NPS 12 (DN 100 to DN 300)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
2. PE, [**Class 150**][**Class 200**], fire-service pipe; molded PE fittings; and heat-fusion joints.
3. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
4. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
5. Fiberglass, AWWA, FM Global approved RTRP, [**Class 150**][**Class 200**]; RTRF; and gasketed joints.

J. Aboveground[**and vault**] fire-service-main piping [**NPS 4 to NPS 12 (DN 100 to DN 300)**]<**Insert pipe size range**> to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

K. Underground Combined Water-Service and Fire-Service-Main Piping [**NPS 6 to NPS 12 (DN 150 to DN 300)**]<**Insert pipe size range**> to be[**any of**] the following:

1. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**][**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**][**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
2. PVC, AWWA [**Class 150**][**Class 200**] pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
3. Fiberglass, AWWA, FM Global approved RTRP, [**Class 150**][**Class 200**]; RTRF; and gasketed joints.

L. Aboveground[**and vault**] combined water service and fire-service-main piping [**NPS 6 to NPS 12 (DN 150 to DN 300)**]<**Insert pipe size range**> to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for **NPS 3 (DN 80)** and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for **NPS 2 (DN 50)** and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, [**metal**][**resilient**][**high-pressure, resilient**]-seated gate valves with valve box.
2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FM Global, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:

   a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, [**nonrising**][**rising**] stem.
   b. Gate Valves, NPS 3 (DN 80) and Larger: [**AWWA, cast iron, OS&Y rising stem, metal seated**][**AWWA, cast iron, OS&Y rising stem, resilient seated**][**UL/FM Global, cast iron, OS&Y rising stem**].
   c. Check Valves: [**AWWA C508**][**UL/FM Global**], swing type.

4. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
5. Relief Valves: Use for water-service piping in vaults and aboveground.

a. Air-Release Valves: To release accumulated air.
b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
c. Combination Air Valves: To release or admit air.

6. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Comply with Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

B. Provide a continuous bare copper or aluminum tracer wire not less than **0.10 inch (2.5 mm)** in diameter in sufficient length over each separate run of nonmetallic pipe.

3.5 INSTALLATION OF PIPING

A. Water-Main Connection:

1. Arrange with utility company for tap of size and in location indicated in water main.
2. Tap water main in accordance with requirements of water utility company and of size and in location indicated.

B. Make connections larger than **NPS 2 (DN 50)** with tapping machine according to the following:

1. Install tapping sleeve and tapping valve in accordance with MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections **NPS 2 (DN 50)** and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA C105/A21.5.
2. Install copper tube and fittings in accordance with CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping in accordance with AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA

C105/A21.5.

F. Install PE pipe in accordance with ASTM D2774 and ASTM F645.

G. Install PVC, AWWA pipe in accordance with ASTM F645 and AWWA M23.

H. Install fiberglass AWWA pipe in accordance with AWWA M45.

I. Bury piping with depth of cover over top at least [**30 inches (750 mm)**]<**Insert dimension**>, with top at least [**12 inches (300 mm)**]<**Insert dimension**> below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least [**36 inches (910 mm)**]<**Insert dimension**> of cover over top.
2. Under Railroad Tracks: With at least [**48 inches (1220 mm)**]<**Insert dimension**> of cover over top.
3. In Loose Gravelly Soil and Rock: With at least [**12 inches (300 mm)**]<**Insert dimension**> of additional cover.

J. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

K. Extend [**water-service**][**and**][**fire-suppression water-service**] piping and connect to water-supply source and building [**water-piping**][**and**][**fire-suppression piping**] systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate [**water-service**][**and**][**fire-suppression water-service**] piping at building wall until building [**water-piping**][**and**][**fire-suppression piping**] systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building [**water-piping**][**and**][**fire-suppression piping**] systems when those systems are installed.

L. Sleeves are specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

M. Mechanical sleeve seals are specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in [**Section 210500 "Common Work Results for Fire Suppression"**][**and**][**Section 220500 "Common Work Results for Plumbing."**]

O. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

P. Comply with Section 211000 "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

Q. Comply with Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in [**Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment"**][**and**][**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**]

B. Comply with requirements for hangers, supports, and anchor devices specified in [**Section 210529 "Hangers and Supports for Fire-Suppression Piping and Equipment"**][**and**][**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."**]

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than **20 ft. (6 m)** long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping **20 ft. (6 m)** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On [**PVC**][**and**][**fiberglass**] piping, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for copper tubing with maximum spacing and minimum rod diameters to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for PVC piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Install hangers for fiberglass piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support horizontal piping within [**12 inches (300 mm)**]<**Insert dimension**> of each fitting and coupling.

H. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

I. Support vertical runs of [**PVC**][**fiberglass**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 JOINT CONSTRUCTION

A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts in accordance with coupling manufacturer's written instructions.
5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners in accordance with fitting manufacturer's written instructions.
6. PVC Piping Gasketed Joints: Use joining materials in accordance with AWWA C900. Construct joints with elastomeric seals and lubricant in accordance with ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.

7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
8. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

    a. Dielectric Fittings:

        1) Dielectric [**nipples**][**unions**] for [**NPS 2 (DN 50)**]<**Insert pipe size**> and smaller.
        2) Dielectric [**flanges**][**flange kits**][**nipples**] for [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**]<**Insert pipe size range**>.
        3) Dielectric flange kits for [**NPS 5 (DN 125)**]<**Insert pipe size**> and Larger.

3.8 INSTALLATION OF ANCHORAGE

A. Anchorage: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.
7. <**Insert devices**>.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: In accordance with AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: In accordance with AWWA M23.
3. Bonded-Joint Fiberglass, Water-Service Piping: In accordance with AWWA M45.
4. Fire-Service-Main Piping: In accordance with NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.9 INSTALLATION OF VALVES

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.[**Install full-size valved bypass.**]

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.10 INSTALLATION OF DETECTOR-CHECK VALVES

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers. Comply with requirements of concrete piers in Section 033000 "Cast-in-Place Concrete."

3.11 INSTALLATION OF WATER METERS

A. Install water meters, piping, and specialties in accordance with utility company's written instructions.

B. Water Meters:

1. Install [**displacement**][**turbine**]-type water meters, **NPS 2 (DN 50)** and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
2. Install [**compound**][**turbine**]-type water meters, **NPS 3 (DN 80)** and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
3. Install detector-type water meters in meter vault in accordance with AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

C. Support water meters and piping **NPS 3 (DN 80)** and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.12 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation in accordance with utility company's written instructions.

3.13 INSTALLATION OF VACUUM BREAKER ASSEMBLIES

A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.14 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support **NPS 2-1/2 (DN 65)** and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.15 INSTALLATION OF WATER METER BOXES

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top [**2 inches (50 mm)**]<**Insert dimension**> above surface.

3.16 INSTALLATION OF CONCRETE VAULTS

A. Install precast concrete vaults in accordance with ASTM C891.

3.17 INSTALLATION OF PROTECTIVE ENCLOSURES

A. Install concrete base level and with top approximately [**2 inches (50 mm)**]<**Insert measurement**> above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.18 INSTALLATION OF FIRE HYDRANTS

A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FM Global Fire Hydrants: Comply with NFPA 24.

3.19 INSTALLATION OF FLUSHING HYDRANTS

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant

box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.20 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install ball drip valves at each check valve for fire department connection to mains.

B. Install protective pipe bollards [**on two sides of**][**on three sides of**]<**Insert arrangement**> each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.21 INSTALLATION OF ALARM DEVICES

A. Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building fire-alarm system. Wiring and fire-alarm devices are specified in [**Section 284600 "Fire Detection and Alarm."**][**Section 284614 "Single- and Multiple-Station Alarms."**][**Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."**]

3.22 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to [**utility water main**][**existing water main**]<**Insert piping system**>. Use [**tapping sleeve and tapping valve**][**service clamp and corporation valve**]<**Insert method**>.

C. Connect water-distribution piping to interior [**domestic water**][**and**][**fire-suppression**] piping.

D. Connect waste piping from concrete vault drains to [**sanitary sewerage system. See Section 333115 "Site Sanitary Sewerage Piping" for connection to sanitary-sewer**][**storm-drainage system. See Section 334400 "Storm Utility Drainage Piping" for connection to storm-sewer**] piping.

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.23 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in **50 psig (350 kPa)** increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to **0 psig (0 kPa)**. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is **2 quarts (1.89 L)** per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.24 IDENTIFICATION

A. Install continuous underground[**detectable**] warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.25 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure

if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 14 00 00

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Task	Specification	Specification Description
33 14 11 00	33 14 00 00	Site Water Distribution Piping
33 14 13 00	33 14 00 00	Site Water Distribution Piping
33 14 13 13	31 62 23 00	Composite Piles
33 14 13 13	33 14 00 00	Site Water Distribution Piping
33 14 13 13	33 42 00 00	Stormwater Conveyance
33 14 13 23	33 14 00 00	Site Water Distribution Piping
33 14 13 23	33 42 00 00	Stormwater Conveyance
33 14 13 23	33 46 00 00	Subdrainage
33 14 13 26	33 14 00 00	Site Water Distribution Piping
33 14 13 36	33 14 00 00	Site Water Distribution Piping
33 14 13 39	33 14 00 00	Site Water Distribution Piping
33 14 13 43	33 14 00 00	Site Water Distribution Piping
33 14 13 53	21 05 00 00	Common Work Results for Fire Suppression
33 14 13 53	22 05 00 00	Common Work Results for Plumbing
33 14 13 53	22 11 16 00	Domestic Water Piping
33 14 13 53	22 13 16 00	Sanitary Waste And Vent Piping
33 14 13 53	22 14 13 00	Storm Drainage Piping
33 14 13 53	22 15 13 00	General-Service Compressed-Air Piping
33 14 13 53	23 05 00 00	Common Work Results for HVAC
33 14 13 53	23 21 13 00	Hydronic Piping
33 14 13 53	22 11 16 00a	Steam And Condensate Piping
33 14 13 53	23 23 00 00	Refrigerant Piping
33 14 13 53	33 14 00 00	Site Water Distribution Piping
33 14 19 00	33 14 00 00	Site Water Distribution Piping
33 14 23 00	33 14 00 00	Site Water Distribution Piping

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SECTION 33 31 00 00 - SITE SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-iron soil pipe and fittings - hub and spigot.
2. Cast-iron soil pipe and fittings - hubless.
3. Ductile-iron, pressure pipe and fittings.
4. ABS pipe and fittings.
5. PVC pipe and fittings.
6. Fiberglass sewer pipe and fittings.
7. Concrete pipe and fittings.
8. Nonpressure-type transition couplings.
9. Pressure-type pipe couplings.
10. Expansion joints and deflection fittings.
11. Encasement for piping.
12. Manholes.
13. Concrete.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans and elevations, or Building Information Model (BIM), drawn to scale, showing items described in this Section and coordinated with all building trades. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than **1 inch equals 50 ft. (1:50)** and to vertical scale of not less than **1 inch equals 5 ft. (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

1.6 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Sanitary Sewage Piping: [**10-ft. head of water (30 kPa)**]<**Insert pressure**>.
2. Sanitary Sewage Piping, Force-Main: [**50 psig (345 kPa)**][**100 psig (690 kPa)**][**150 psig (1035 kPa)**]<**Insert pressure**>.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]

2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain cast-iron, hub-and-spigot pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Class:[**Service (SV)**][**and**][**Extra-Heavy (XH)**]; ASTM A74.

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain cast-iron, hubless pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 or CISPI 301.

E. Shielded Couplings, CISPI-Trademark:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. [**Charlotte Pipe and Foundry Company**]
c. [**Dallas Specialty & Mfg. Co.**]
d. [**Fernco Inc**]
e. [**Mission Rubber Company, LLC**]
f. [**Tyler Pipe; a part of the McWane family of companies**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Mission Rubber Company, LLC**]
   f. [**Tyler Pipe; a part of the McWane family of companies**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain CISPI-trademark, shielded couplings from single manufacturer.
4. Marked with CISPI collective trademark and NSF certification mark.
5. Standards: ASTM C1277 and CISPI 310.
6. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Shielded Couplings, Heavy-Duty:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Mission Rubber Company, LLC**]
   f. [**Tyler Pipe; a part of the McWane family of companies**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Mission Rubber Company, LLC**]
   f. [**Tyler Pipe; a part of the McWane family of companies**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain heavy-duty, shielded couplings from single manufacturer.
4. Standard: ASTM C1540.
5. Description: Stainless steel shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

G. Shielded Couplings, Cast-Iron:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**MG Coupling**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**MG Coupling**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron, shielded couplings from single manufacturer.
4. Standard: ASTM A1056.
5. Description: Two-piece, ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

H. Unshielded Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded couplings from single manufacturer.
4. Standard: ASTM C1461.
5. Description: Rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS - SANITARY SEWERAGE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]

2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Push-on-Joint Piping:

1. Pipe: AWWA C151/A21.51.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
3. Compact Fittings: AWWA C153/A21.53.
4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

F. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

G. Pipe Outer Coating:

1. Type: Asphaltic.
2. Minimum Uniform Thickness: [**1 mil (0.025 mm)**]<**Insert thickness**>.
3. Comply with AWWA C151/A21.51.

H. Cement Mortar Lining: AWWA C104/A21.4.

I. Seal Coating-Applied Lining:

1. Nominal Pipe Sizes 6 through 12 Inches (150 through 300 mm): **1/8 inch (3 mm)**.
2. Nominal Pipe Sizes 14 through 24 Inches (250 through 600 mm): <**Insert inches (mm)**>.

J. Asphaltic Sealcoat Lining:

1. Minimum Uniform Lining: [**1 mil (0.025 mm)**]<**Insert thickness**>.
2. Comply with AWWA C104/A21.4.

K. PE Encasement: Comply with AWWA C105/A21.5.

L. Coating:

1. Coat pipe and fittings exposed inside of structures with two coats of <**Insert paint type and paint code**> bituminous paint to achieve minimum dry film of thickness of <**Insert mils (mm)**> per coat.

2.5 ABS PIPE AND FITTINGS

A. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

B. Piping materials to bear label, stamp, or other markings of specified testing agency.

C. ABS Solid-Wall Pipe: ASTM D2661, Schedule 40.

1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
2. Joints: ASTM D2235, solvent weld.

D. ABS Cellular-Core Pipe: ASTM F628, Schedule 40.

1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
2. Joints: ASTM D2235, solvent weld.

E. ABS Pipe and Fittings: SDR [**23.5**][**35**][**42**] with bell-and-spigot-style, solvent-sealed ends.

1. Joints: ASTM D2235, solvent weld.

F. Solvent Cement: ASTM D2235.

2.6 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atkore**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**Silver-line Plastics**]
6. [**Westlake Pipe & Fittings**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atkore**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**Silver-line Plastics**]
6. [**Westlake Pipe & Fittings**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. PVC Type PSM Gravity Sewer Piping:

1. Pipe: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

F. PVC Pressure Piping:

1. Pipe: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Type DWV Piping:

1. Pipe: ASTM D1785 or ASTM D2665, [**Schedule 40**][**and**][**Schedule 80**] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [**ASTM D2466, Schedule 40**][**and**][**ASTM D2467, Schedule 80**] PVC, socket type.
3. Adhesive Primer: ASTM F656.
4. Solvent Cement: ASTM D2564.

2.7 FIBERGLASS SEWER PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Fiberglass Sewer Pipe: ASTM D3262, RTRP, for gasketed joints fabricated with [**Type 2, polyester**][**or**][**Type 4, epoxy**] resin.

1. Liner: [**Reinforced thermoset**][**Nonreinforced thermoset**][**Thermoplastic**][**No liner**].
2. Grade: [**Reinforced, surface layer matching pipe resin**][**Nonreinforced, surface layer matching pipe resin**][**No surface layer**]<**Insert grade**>.
3. Stiffness: [**9 psig (62 kPa)**][**18 psig (124 kPa)**][**36 psig (248 kPa)**][**72 psig (496 kPa)**]

F. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF, for gasketed joints.

1. Laminating Resin: [**Type 1, polyester**][**or**][**Type 2, epoxy**] resin.
2. Reinforcement: Grade with finish compatible with resin.

G. Gaskets: ASTM F477, elastomeric seals.

2.8 CONCRETE PIPE AND FITTINGS - SANITARY SEWERAGE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Northern Concrete Pipe, Inc.**]
2. [**Rinker Materials Corporation, Concrete Pipe Division**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Northern Concrete Pipe, Inc.**]
2. [**Rinker Materials Corporation, Concrete Pipe Division**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M)**, [**Class 1**][**Class 2**][**Class 3**], with [**bell-and-spigot**][**or**][**tongue-and-groove**] ends for gasketed joints with **ASTM C443 (ASTM C443M)**, rubber gaskets.

F. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.

1. [**Bell-and-spigot**][**or**][**tongue-and-groove**] ends for gasketed joints, with **ASTM C443 (ASTM C443M)**, rubber gaskets.
2. Class II, [**Wall A**][**Wall B**][**Wall C**].
3. Class III, [**Wall A**][**Wall B**][**Wall C**].
4. Class IV, [**Wall A**][**Wall B**][**Wall C**].
5. Class V, [**Wall A**][**Wall B**].

2.9 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
2. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Fernco Inc**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
4. Description: Elastomeric sleeve with[**stainless steel shear ring and**] corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dallas Specialty & Mfg. Co.**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fernco Inc**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fernco Inc**]
b. [**Mission Rubber Company, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ANACO-Husky; a part of the McWane family of companies**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain nonpressure-type, rigid couplings from single manufacturer.
4. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.10 PRESSURE-TYPE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**JCM Industries, Inc**]
5. [**Romac Industries, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**JCM Industries, Inc**]
5. [**Romac Industries, Inc.**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pressure-type pipe couplings from single manufacturer.

D. Standard: AWWA C219.

E. Description: Tubular-sleeve coupling with center sleeve, gaskets, end rings, and bolt fasteners.

F. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include [**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum pressure rating and ends of same sizes as piping to be joined.

G. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].

H. Gasket Material: Natural or synthetic rubber.

I. Metal Component Finish: Corrosion-resistant coating or material.

2.11 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**EBAA Iron Sales, Inc.**]
   b. [**Romac Industries, Inc.**]
   c. [**Star Pipe Products**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**EBAA Iron Sales, Inc.**]
   b. [**Romac Industries, Inc.**]
   c. [**Star Pipe Products**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
4. Standards:

   a. AWWA C110/A21.10.
   b. AWWA C153/A21.53.

5. Description: Compound fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for **250 psig (1725 kPa)** minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**EBAA Iron Sales, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EBAA Iron Sales, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Standards:

a. AWWA C110/A21.10.
b. AWWA C153/A21.53.

5. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends. Include rating for **250 psig (1725 kPa)** minimum working pressure and for up to 15 degrees of deflection.

2.12 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.13 MANHOLES

A. Standard Precast Concrete Manholes:

1. Standard: ASTM C478/C478M.
2. Description: Precast, reinforced concrete, of depth indicated, with provision for sealant joints.
3. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
4. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
5. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (100-mm)** minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
6. Riser Sections: **4-inch (100-mm)** minimum thickness, of length to provide depth indicated.
7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
8. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
9. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
10. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in**

ASTM D4101, PP]<**Insert material**>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.

11. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Standards: ASTM C913 and ASTM C890.
2. Description: Designed in accordance with ASTM C890 for A-16 designation, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
3. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
4. Joint Sealant: **ASTM C990 (ASTM 990M)**, bitumen or butyl rubber.
5. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
6. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
7. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
8. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Associated Fiberglass Enterprises**]
   b. [**Containment Solutions, Inc**]
   c. [**L. F. Manufacturing, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Associated Fiberglass Enterprises**]
   b. [**Containment Solutions, Inc**]

c. [**L. F. Manufacturing, Inc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP manholes from single manufacturer.
4. Standard: ASTM D3753.
5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
6. Ballast: Increase thickness of concrete base as required to prevent flotation.
7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
8. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert dimension**>.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser, with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: [**ASTM A536, Grade 60-40-18 ductile**][**ASTM A48/A48M, Class 35 gray**] iron unless otherwise indicated.

E. Manhole-Cover Inserts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**L. F. Manufacturing, Inc**]
   b. [**Vortex Companies**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**L. F. Manufacturing, Inc**]
   b. [**Vortex Companies**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain manhole-cover inserts from single manufacturer.
4. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
5. Type: [**Solid**][**Drainage with vent holes**][**Valve**].

2.14 CONCRETE

A. Description: Cast-in-place concrete complying with ACI 318, **ACI 350 (ACI 350M)**, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420-MPa)** deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: [**1**][**2**] percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: [**4**][**8**] percent.

D. Ballast and Pipe Supports: Portland cement design mix, **3000 psi (20.7 MPa)** minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420 MPa)** deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for using lubricants, cements, and other installation

requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow, at minimum slope of [**1**][**2**]<**Insert number**> percent unless otherwise indicated.
2. Install piping [**NPS 6 (DN 150)**]<**Insert pipe size**> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with [**36-inch (915-mm)**][**48-inch (1220-mm)**][**60-inch (1520-mm)**][**72-inch (1830-mm)**]<**Insert dimension**> minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
7. Install PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM F1668.
8. Install PVC Type DWV gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
9. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
10. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."
11. Install reinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."

G. Install force-main, pressure piping in accordance with the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with [**36-inch (915-mm)**][**48-inch (1220-mm)**][**60-inch (1520-mm)**][**72-inch (1830-mm)**]<**Insert dimension**> minimum cover.
3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings in accordance with AWWA C600.
5. Install PVC pressure piping in accordance with AWWA M23 or to ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
5. Join PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
6. Join fiberglass sewer piping in accordance with ASTM D4161 for elastomeric-seal joints.
7. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
8. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
9. Join dissimilar pipe materials with nonpressure-type, flexible[**or rigid**] couplings.

B. Join force-main, pressure piping in accordance with the following:

1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

   a. [**Unshielded**][**Shielded**] flexible[**or rigid**]couplings for pipes of same or slightly different OD.
   b. Unshielded, increaser/reducer-pattern, flexible[**or rigid**]couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure pipe couplings for force-main joints.

3.4 INSTALLATION OF MANHOLES

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

C. Install FRP manholes in accordance with manufacturer's written instructions.

D. Form continuous concrete channels and benches between inlets and outlet.

E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [**3 inches (76 mm)**]<**Insert dimension**> above finished surface elsewhere unless otherwise indicated.

F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with ACI 318.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus **6-inch (150-mm)** overlap with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
2. Make branch connections from side into existing piping, **NPS 4 to NPS 20 (DN 100 to DN 500)**. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
3. Make branch connections from side into existing piping, **NPS 21 (DN 525)** or larger, or to underground manholes by cutting opening into existing unit large enough to allow **3 inches (76 mm)** of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in **6 inches (150 mm)** of concrete for minimum length of **12 inches (300 mm)** to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of **3000 psi (20.7 MPa)** unless otherwise indicated.
   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to [**grease**][**oil**][**and**][**sand**] interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [**8-inch- (203-mm-)**]<**Insert dimension**> thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least [**36 inches (915 mm)**]<**Insert dimension**> below final grade. Fill to within [**12 inches (300 mm)**]<**Insert dimension**> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (600 mm)** of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction and the following:

a. Fill sewer piping with water. Test with pressure of at least **10-ft. (3-m)** head of water, and maintain such pressure without leakage for at least 15 minutes.
b. Close openings in system and fill with water.
c. Purge air and refill with water.
d. Disconnect water supply.
e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

   a. Test plastic gravity sewer piping in accordance with ASTM F1417.
   b. Test concrete gravity sewer piping in accordance with ASTM C1628.

7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than one and one-half times the maximum system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert value**>.

   a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
   b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

8. Manholes: Perform hydraulic test in accordance with **ASTM C969 (ASTM C969M)**.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.[**Flush with potable water.**]

END OF SECTION 33 31 00 00

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Task	Specification	Specification Description
33 31 11 00	33 31 00 00	Site Sanitary Sewerage Piping
33 31 11 00	33 42 00 00	Stormwater Conveyance
33 31 11 00	33 46 00 00	Subdrainage

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SECTION 33 32 00 00 - SITE PACKAGED SEWAGE PUMPING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged sewage pumping stations - dry well.
2. Packaged sewage pumping stations - wet well.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for seismic-load, wind-load, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration and seismic controls.

1.2 PERFORMANCE REQUIREMENTS

A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than **125 psig (860 kPa)**.

B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Show fabrication and installation details for each packaged sewage pumping station.

1. Indicate layout at minimum scale of **1/2 inch per foot (1:25)**.
2. Detail pumping station assemblies and indicate dimensions.
3. Indicate size, materials, and components.
4. Indicate shipping, installed, and operating weights; loads; required clearances; method of field assembly; components.
5. Indicate basin size, inlet and discharge locations, cover dimensions, vent location, check valve and isolation valve locations.
6. Indicate electrical characteristics and junction box locations.
7. Indicate power, signal, and control wiring diagrams.
8. Signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of sewage pump, signed by product manufacturer.

B. Source quality-control test reports.

C. Field quality-control reports.

D. Qualification Statements: For [**Installer**][**testing agency**].

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Comply with HI 14.1-14.2, HI 14.3, and HI 14.4.

E. Comply with UL 778.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including shell.
b. Faulty operation of sewage pumps, controls, or accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Shells: <**Insert number**> years from date of Substantial Completion.
3. Warranty Period for Sewage Pumps and Controls: <**Insert number**> years from date of Substantial Completion.
4. Warranty Period for Accessories: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED SEWAGE PUMPING STATIONS - DRY WELL

A. Packaged Sewage Pumping Stations - Dry Well with Dry-Well Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dakota Pump Incorporated**]
   b. [**PumpTech, LLC**]
   c. [**Smith & Loveless**]
   d. [**USEMCO**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dakota Pump Incorporated**]
   b. [**PumpTech, LLC**]
   c. [**Smith & Loveless**]
   d. [**USEMCO**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain dry well with dry-well sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor and**]collection of sanitary sewage and with dry equipment chamber for sewage pumps, controls, and accessories.

   a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
   b. Shell:

      1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

         a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
         b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
         c) Entrance Tube: From dry compartment to entrance at grade, and of size

required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.

d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

a) Attach structural-steel reinforcement to top and bottom heads.
b) Fabricate shell with continuous joints to make watertight and gastight construction.
c) Attach air vent to pump chamber[**and entrance tube**].
d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
b) Use fittings for changes in direction and branch connections.
c) Flanged and union joints may be used instead of joints specified.
d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: [**NEMA 250, Type 12**]<**Insert designation**> enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> dry-well-type, nonclog sewage pumps with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; and pedestal-mounted motor.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.

2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**>.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.

g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Packaged Sewage Pumping Stations - Dry Well with Vacuum-Primed Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dakota Pump Incorporated**]
   b. [**PumpTech, LLC**]
   c. [**USEMCO**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain dry well with vacuum-primed sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor and**]collection of sanitary sewage and with dry equipment chamber for sewage pumps, vacuum pumps, controls, and accessories.

   a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
   b. Shell:

      1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

         a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
         b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
         c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
         d) Weld steel access ladder and air vent to shell[**and entrance tube**].
         e) Apply three coats of epoxy resin to interior and exterior surfaces.
         f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

      2) Fabricate shell from fiberglass with structural-steel reinforcement.

         a) Attach structural-steel reinforcement to top and bottom heads.
         b) Fabricate shell with continuous joints to make watertight and gastight construction.
         c) Attach air vent to pump chamber[**and entrance tube**].
         d) Ladder: [**Steel**][**Fiberglass**].

      3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
      4) Entrance tube may be furnished separately for field installation.
      5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
      6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade,

outlet turned down, and with insect screen in outlet.

7) Factory fabricate piping between unit components.

a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
b) Use fittings for changes in direction and branch connections.
c) Flanged and union joints may be used instead of joints specified.
d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> dry-chamber-mounting, vacuum-primed, nonclog sewage pumps located in dry compartment above wet pit, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; pedestal-mounted motor; and suction piping extending to bottom of wet pit.

e. Vacuum Pumps: Duplex arrangement with controls, vacuum piping, and vent piping of size and capacity required for system. Include automatic alternator, with manual disconnect switch, to change sequence of lead-lag vacuum pumps at completion of each cycle.

f. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel

if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.

2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

    a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
    b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

g. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

h. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

2.2 PACKAGED SEWAGE PUMPING STATIONS - WET WELL

A. Packaged Sewage Pumping Stations - Wet Well with Submersible Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Metropolitan Industries, Inc**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Metropolitan Industries, Inc**]
b. [**PumpTech, LLC**]
c. [**USEMCO**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with submersible sewage pumps, packaged sewage pumping

stations from single manufacturer.

4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor,**]submersible sewage pumps and collection of sanitary sewage and dry equipment chamber for controls and accessories.

   a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
   b. Shell:

      1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

         a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
         b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
         c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
         d) Weld steel access ladder and air vent to shell[**and entrance tube**].
         e) Apply three coats of epoxy resin to interior and exterior surfaces.
         f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

      2) Fabricate shell from fiberglass with structural-steel reinforcement.

         a) Attach structural-steel reinforcement to top and bottom heads.
         b) Fabricate shell with continuous joints to make watertight and gastight construction.
         c) Attach air vent to pump chamber[**and entrance tube**].
         d) Ladder: [**Steel**][**Fiberglass**].

      3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
      4) Entrance tube may be furnished separately for field installation.
      5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
      6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
      7) Factory fabricate piping between unit components.

         a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
         b) Use fittings for changes in direction and branch connections.
         c) Flanged and union joints may be used instead of joints specified.
         d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

      8) Piping Connections: Unless otherwise indicated, make the following piping connections:

         a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.

b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> submersible-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and

covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

a) Type: <**Insert type**>.
b) Diameter: <**Insert inches (mm)**>.
c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

B. Packaged Sewage Pumping Stations - Wet Well with Submersible Grinder Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Environment One Corporation**]
b. [**Metropolitan Industries, Inc**]
c. [**PumpTech, LLC**]
d. [**USEMCO**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Environment One Corporation**]
b. [**Metropolitan Industries, Inc**]
c. [**PumpTech, LLC**]
d. [**USEMCO**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with submersible grinder sewage pumps, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for submersible grinder sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.

a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
b. Shell:

1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s)

for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

   a) Attach structural-steel reinforcement to top and bottom heads.
   b) Fabricate shell with continuous joints to make watertight and gastight construction.
   c) Attach air vent to pump chamber[**and entrance tube**].
   d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

   a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
   b) Use fittings for changes in direction and branch connections.
   c) Flanged and union joints may be used instead of joints specified.
   d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

   a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
   b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

   a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
   b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
   c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
   d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Sewage Pumps: [**Two**][**Three**]<**Insert number**> submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
d. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

    a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
    b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

e. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

f. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
f. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller: [**Cutter**][**Cutter or grinder**][**Grinder**] type.
5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

9) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

g. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.

b) Phases: [**Single**][**Three**].
c) Hertz: 60.

7) Motors:

a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

C. Packaged Sewage Pumping Stations - Wet Well with Suspended Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**Smith & Loveless**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Dakota Pump Incorporated**]
b. [**PumpTech, LLC**]
c. [**Smith & Loveless**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wet well with suspended sewage pumps, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for [**comminutor,**]suspended sewage pumps and collection of sanitary sewage and with dry equipment chamber for pump motors, controls, and accessories.

a. Orientation: Shell underground with dry equipment chamber [**underground with top flush with grade**][**partially recessed underground**][**above grade**][**underground with entrance tube to grade**]<**Insert orientation**>.
b. Shell:

1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.

a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than [**36 inches (914 mm)**]<**Insert dimension**> in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.

d) Weld steel access ladder and air vent to shell[**and entrance tube**].
e) Apply three coats of epoxy resin to interior and exterior surfaces.
f) Include [**at least two**][**four**]<**Insert number**> exterior magnesium anode(s) for cathodic protection.

2) Fabricate shell from fiberglass with structural-steel reinforcement.

a) Attach structural-steel reinforcement to top and bottom heads.
b) Fabricate shell with continuous joints to make watertight and gastight construction.
c) Attach air vent to pump chamber[**and entrance tube**].
d) Ladder: [**Steel**][**Fiberglass**].

3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4) Entrance tube may be furnished separately for field installation.
5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7) Factory fabricate piping between unit components.

a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
b) Use fittings for changes in direction and branch connections.
c) Flanged and union joints may be used instead of joints specified.
d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.

8) Piping Connections: Unless otherwise indicated, make the following piping connections:

a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

9) Valves: Ferrous alloy.

a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10) Wiring: Tin-coated copper.

c. Comminutor: Full size of sewage inlet pipe.

1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with

controls; for pipeline installation.
2) Body: Stainless steel or ductile iron with flanged ends and access plate.
3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
4) Motor: Explosion proof, directly connected to body.
5) Control Panel: [**NEMA 250, Type12**]<**Insert designation**> enclosure for installation in dry equipment chamber.
6) <**Insert special control features**>.

d. Sewage Pumps: [**Two**][**Three**]<**Insert number**> wet-well-mounting-type, nonclog sewage pumps suspended from dry-compartment floor, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; grease-lubricated bearings and stuffing-box seal; shaft coupling; and pedestal-mounted motor.

e. Controls:

1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

a) Mounting: [**Inside, on dry-chamber wall**][**Outside, on pedestal, at grade**]<**Insert building description and room number**>.
b) Enclosure: NEMA 250, [**Type 1**][**Type 4**][**Type 4X**]<**Insert type**>.

7) Install labels on panel face to identify switches and controls.
8) Wiring: Tin-copper wiring.
9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

f. Submersible Sump Pump:

1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
2) Pump End Bell and Motor Shell: Cast iron.
3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload

protection.
4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
5) Shaft: Stainless steel.
6) Bearings: Grease-lubricated, factory-sealed ball bearings.
7) Seals: Mechanical.
8) Accessories: Inlet strainer.
9) Controls: Float switch.

g. Accessories:

1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.

3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.

a) Ventilating system capacity to change air in dry equipment chamber every two minutes.

4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: <**Insert inches (mm) or other dimensions**>.
b. Height of Shell Base Section: <**Insert inches (mm)**>.
c. Pumping Station, Inlet Pipe Size: <**Insert NPS (DN)**>.
d. Pumping Station, Discharge Pipe Size: <**Insert NPS (DN)**>.
e. Comminutor:

1) Capacity: <**Insert gpm (L/s)**>.
2) Pipe Size: <**Insert NPS (DN)**>.
3) Motor Size: <**Insert value**> hp.
4) Electrical Characteristics:

a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
b) Phases: [**Single**][**Three**].
c) Hertz: 60.

f. Sewage Pumps: [**Two**][**Three**]<**Insert number**> required.
g. Each Sewage Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Impeller:

   a) Type: <**Insert type**>.
   b) Diameter: <**Insert inches (mm)**>.
   c) Solids Size Design: <**Insert inches (mm)**>.

5) Inlet Size: <**Insert NPS (DN)**>.
6) Discharge Size: <**Insert NPS (DN)**>.
7) Motor Size: <**Insert value**> hp.
8) Electrical Characteristics:

   a) Volts: [**240**][**277**][**480**]<**Insert value**> V.
   b) Phases: [**Single**][**Three**].
   c) Hertz: 60.

9) Motors:

   a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

1) Capacity: <**Insert gpm (L/s)**>.
2) Total Dynamic Head: <**Insert feet (kPa)**>.
3) Speed: <**Insert rpm**>.
4) Discharge Size: <**Insert NPS (DN)**>.
5) Motor Size: <**Insert value**> hp.
6) Electrical Characteristics:

   a) Volts: [**120**][**240**][**277**][**480**]<**Insert value**> V.
   b) Phases: [**Single**][**Three**].
   c) Hertz: 60.

7) Motors:

   a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

1) Full-Load Amperes: <**Insert value**>.
2) Minimum Circuit Ampacity: <**Insert value**>.
3) Maximum Overcurrent Protection: <**Insert amperage**>.

2.3 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A6/A6M, W or HP shapes, or ASTM A36/A36M, plates or beams.

B. Grout: ASTM C1107/C1107M, Grade B, nonshrink cement grout.

1. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.

C. Concrete: Specified in Section 033000 "Cast-in-Place Concrete."

2.4 SOURCE QUALITY CONTROL

A. Test and inspect sewage[**and sump**] pumps in accordance with HI 14.6. Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.

B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF PACKAGED SEWAGE PUMPING STATIONS

A. Install packaged sewage pumping station components where indicated, in accordance with specific equipment and piping arrangement indicated.

B. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.

1. Use elevator blocks attached to bottom of shell to slope station floor **1 inch in 10 ft. (25.4 mm in 3 m)** down toward sump.

C. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.

D. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.

E. Connect anode conductors to grounding lugs on steel housing.

F. Join separate sections of housing by field welding.

G. Field weld entrance tube to housing.

3.4 PIPING CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Section 333115 "Site Sanitary Sewerage Piping." Drawings indicate general arrangement of piping.

B. Install piping adjacent to machine to allow service and maintenance.

3.5 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

C. Arrange for installing green[**warning tape or**] detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Section 312000 "Earth Moving."

3.7 PAINTING

A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with an epoxy-polyamide paint in accordance with SSPC-Paint 16.

B. Paint field-welded areas to match factory coating.

3.8 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Adjust pump, accessory, and control settings, and safety and alarm devices.
3. <**Insert, in separate subparagraphs, startup steps if any**>.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service, Including Testing: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Packaged sewage pumping stations will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations. See Section 017900 "Demonstration and Training."

END OF SECTION 33 32 00 00

Task	Specification	Specification Description
33 32 16 00	33 32 00 00	Site Packaged Sewage Pumping Stations
33 40 00 00	22 14 13 00	Storm Drainage Piping
33 41 00 00	22 14 13 00	Storm Drainage Piping
33 41 16 13	22 14 13 00	Storm Drainage Piping
33 41 16 13	33 42 00 00	Stormwater Conveyance
33 41 16 13	33 46 00 00	Subdrainage
33 41 19 00	22 14 13 00	Storm Drainage Piping
33 41 19 13	22 14 13 00	Storm Drainage Piping
33 41 19 13	33 46 00 00	Subdrainage

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SECTION 33 42 00 00 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron, culvert pipe and fittings.
4. Ductile-iron, pressure pipe and fittings.
5. Corrugated-steel pipe and fittings.
6. Corrugated-aluminum pipe and fittings.
7. ABS pipe and fittings.
8. Corrugated-PE pipe and fittings.
9. PVC pipe and fittings.
10. Fiberglass sewer pipe and fittings.
11. Concrete pipe and fittings.
12. Nonpressure transition couplings.
13. Pressure pipe couplings.
14. Expansion joints and deflection fittings.
15. Backwater valves.
16. Cleanouts.
17. Drains.
18. Concrete trench drain forming system.
19. Encasement for piping.
20. Manholes.
21. Polymer-concrete, channel drainage systems.
22. Plastic, channel drainage systems.
23. Catch basins.
24. Stormwater inlets.
25. Stormwater detention structures.
26. Pipe outlets.
27. Dry wells.
28. Stormwater disposal systems.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. [**Catch basins**][**stormwater inlets**][**and**][**dry wells**]. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers,

design calculations, and concrete design-mix reports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and vertical scale of not less than **1 inch equals 5 feet (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials are to bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle [**catch basins**][**and**][**stormwater inlets**] in accordance with manufacturer's written rigging instructions.

1.7 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain hub-and-spigot, cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A74, [**Service**][**and**][**Extra Heavy**] class(es).

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AB & I Foundry; a part of the McWane family of companies**]
2. [**Charlotte Pipe and Foundry Company**]
3. [**Tyler Pipe; a part of the McWane family of companies**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain hubless cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A888 or CISPI 301.

E. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. [**Tyler Pipe; a subsidiary of McWane Inc.**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain CISPI, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:

    a. ASTM C1277 and CIPSI 310 for couplings.
    b. ASTM C564 for gaskets.

F. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ANACO-Husky; a part of the McWane family of companies**]
    b. [**Charlotte Pipe and Foundry Company**]
    c. [**Dallas Specialty & Mfg. Co.**]
    d. [**Fernco Inc**]
    e. [**Ideal Tridon Group**]
    f. [**Matco-Norca**]
    g. [**MIFAB, Inc**]
    h. [**Mission Rubber Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ANACO-Husky; a part of the McWane family of companies**]
   b. [**Charlotte Pipe and Foundry Company**]
   c. [**Dallas Specialty & Mfg. Co.**]
   d. [**Fernco Inc**]
   e. [**Ideal Tridon Group**]
   f. [**Matco-Norca**]
   g. [**MIFAB, Inc**]
   h. [**Mission Rubber Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain heavy-duty, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:

   a. ASTM C1277 and ASTM C1540 for couplings.
   b. ASTM C564 for rubber gaskets.

G. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**MG Coupling**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**MG Coupling**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron, hubless-piping couplings from single manufacturer.
4. Description: Two-piece, cast-iron housing; stainless steel bolts and nuts; and rubber sleeve with integral, center pipe stop.
5. Standards:

   a. ASTM C1277 for couplings.
   b. ASTM A48/A48M for cast-iron castings.
   c. ASTM C564 for gaskets.

2.3 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

A. Pipe: ASTM A716, for push-on joints.

B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153/A21.53, for push-on joints.

D. Gaskets: AWWA C111/A21.11, rubber.

2.4 PPE Channel Drainage Systems

A. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. **<Insert manufacturer's name>**

2.5 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**American Cast Iron Pipe Company**]
2. [**McWane Ductile; a part of the McWane family of companies**]
3. [**U.S. Pipe**]
4. **<Insert manufacturer's name>**

C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

D. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

E. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 CORRUGATED-STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**American Piping Products**]
2. [**Specialty Pipe & Tube**]
3. [**Steel Mart, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Piping Products**]
2. [**Specialty Pipe & Tube**]
3. [**Steel Mart, Inc.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corrugated-steel pipe and fittings from single manufacturer.

D. Description: ASTM A760/A760M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated steel with O-ring seals.
2. Standard-Joint Bands: Corrugated steel.
3. Coating: [**Aluminum**][**Zinc**].

2.7 CORRUGATED-ALUMINUM PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Brunner Enterprises, Inc.**]
2. [**Continental Steel & Tube**]
3. [**Sapa North America**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Brunner Enterprises, Inc.**]
2. [**Continental Steel & Tube**]
3. [**Sapa North America**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain corrugated-aluminum pipe and fittings from single manufacturer.

D. Description: ASTM B745/B745M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated aluminum with O-ring seals.
2. Standard-Joint Bands: Corrugated aluminum.

2.8 ABS PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**JM Eagle**]
3. [**Royal Building Products, a Westlake Company**]
4. **<Insert manufacturer's name>**

C. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

D. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

E. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

F. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

G. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.

H. Gaskets: ASTM F477, elastomeric seals.

I. Solvent Cement: ASTM D2235.

2.9 CORRUGATED-PE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Emco Industrial Plastics**]
2. [**Industrial Specialties Mfg, Inc.**]
3. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Emco Industrial Plastics**]
2. [**Industrial Specialties Mfg, Inc.**]
3. **<Insert manufacturer's name>**

C. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.

D. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252, Type S, with smooth waterway for coupling joints.

E. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294, Type S, with smooth waterway for coupling joints.

F. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

G. Corrugated-PE Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

2.10 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Charlotte Pipe and Foundry Company**]
2. [**GF Piping Systems**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**North America Pipe Corporation**]
6. [**Rocky Mountain Colby Pipe Company**]
7. [**Silver-line Plastics**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Charlotte Pipe and Foundry Company**]
2. [**GF Piping Systems**]
3. [**JM Eagle**]
4. [**National Pipe and Plastic, Inc. (Oldcastle)**]
5. [**North America Pipe Corporation**]
6. [**Rocky Mountain Colby Pipe Company**]
7. [**Silver-line Plastics**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

D. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

E. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC socket-type fittings.

F. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

H. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, [**SDR 35**]<**Insert SDR**>, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

I. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, [**T-1**][**T-2**] wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

J. PVC Pressure Piping:

1. Pipe: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [**Class 100**][**Class 150**][**and**][**Class 200**] PVC pipe with bell ends
3. Gaskets: ASTM F477, elastomeric seals.

K. PVC Water-Service Piping:

1. Pipe: ASTM D1785, [**Schedule 40**][**and**][**Schedule 80**] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [**ASTM D2466, Schedule 40**][**and**][**ASTM D2467, Schedule 80**] PVC, socket type.

L. Adhesive Primer: ASTM F656.

2.11 FIBERGLASS SEWER PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Augusta Fiberglass**]
2. [**Industrial Fiberglass Specialties, Inc.**]
3. <**Insert manufacturer's name**>

C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.

D. Fiberglass Sewer Pipe: ASTM D3262, RTRP for gasketed joints fabricated with [**Type 2, polyester**][**Type 4, epoxy**][**Type 2, polyester or Type 4, epoxy**] resin.

1. Liner: [**Reinforced thermoset**][**Nonreinforced thermoset**][**Thermoplastic**][**No liner**].
2. Grade: [**Reinforced, surface layer matching pipe resin**][**Nonreinforced, surface layer matching pipe resin**][**No surface layer**]<**Insert grade**>.
3. Stiffness: [**9 psig (62 kPa)**][**18 psig (124 kPa)**][**36 psig (248 kPa)**][**72 psig (496 kPa)**].

E. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF for gasketed joints.

1. Laminating Resin: [**Type 1, polyester**][**Type 2, epoxy**][**Type 1, polyester or Type 2, epoxy**] resin.
2. Reinforcement: Grade with finish compatible with resin.

F. Gaskets: ASTM F477, elastomeric seals.

2.12 CONCRETE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**FOLTZ Concrete Pipe Co.**]
2. [**Northern Concrete Pipe, Inc.**]
3. [**Rinker Materials Corporation, Concrete Pipe Division**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**FOLTZ Concrete Pipe Co.**]
2. [**Northern Concrete Pipe, Inc.**]
3. [**Rinker Materials Corporation, Concrete Pipe Division**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

D. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M)**, [**Class 1**][**Class 2**][**Class 3**], with [**bell-and-spigot**][**or**][**tongue-and-groove**] ends and [**gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets**][**sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant**].

E. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.

1. [**Bell-and-spigot**][**or**][**tongue-and-groove**] ends and [**gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets**][**sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant**]
2. Class I, Wall [**A**][**B**].
3. Class II, Wall [**A**][**B**][**C**].
4. Class III, Wall [**A**][**B**][**C**].
5. Class IV, Wall [**A**][**B**][**C**].
6. Class V, Wall [**B**][**C**].

2.13 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-

resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
2. For Cast-Iron Soil Pipes: ASTM C564, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dallas Specialty & Mfg. Co.**]
   b. [**Fernco Inc**]
   c. [**Logan Clay Pipe**]
   d. [**Mission Rubber Company, LLC**]
   e. [**NDS Inc**]
   f. [**Plastic Oddities**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dallas Specialty & Mfg. Co.**]
   b. [**Fernco Inc**]
   c. [**Logan Clay Pipe**]
   d. [**Mission Rubber Company, LLC**]
   e. [**NDS Inc**]
   f. [**Plastic Oddities**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
4. Description: Elastomeric sleeve with[**stainless steel shear ring and**] corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cascade Waterworks Mfg. Co.**]
   b. [**Dallas Specialty & Mfg. Co.**]
   c. [**Mission Rubber Company, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Cascade Waterworks Mfg. Co.**]
b. [**Dallas Specialty & Mfg. Co.**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fernco Inc**]
b. [**Logan Clay Pipe**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fernco Inc**]
b. [**Logan Clay Pipe**]
c. [**Mission Rubber Company, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.14 PRESSURE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
5. [**JCM Industries, Inc**]
6. [**Romac Industries, Inc.**]
7. [**Victaulic Company**]
8. [**Viking Johnson**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cascade Waterworks Mfg. Co.**]
2. [**Dresser Utility Solutions**]
3. [**Ford Meter Box Company, Inc. (The)**]
4. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
5. [**JCM Industries, Inc**]
6. [**Romac Industries, Inc.**]
7. [**Victaulic Company**]
8. [**Viking Johnson**]
9. <**Insert manufacturer's name**>

C. Source Limitations: Obtain pressure pipe couplings from single manufacturer.

D. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.

E. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include [**150-psig (1035-kPa)**][**200-psig (1380-kPa)**]<**Insert psig (kPa)**> minimum pressure rating and ends sized to fit adjoining pipes.

F. Center-Sleeve Material: [**Manufacturer's standard**][**Carbon steel**][**Stainless steel**][**Ductile iron**][**Malleable iron**].

G. Gasket Material: Natural or synthetic rubber.

H. Metal Component Finish: Corrosion-resistant coating or material.

2.15 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**EBAA Iron Sales, Inc.**]
   b. [**Romac Industries, Inc.**]
   c. [**Star Pipe Products**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**EBAA Iron Sales, Inc.**]
   b. [**Romac Industries, Inc.**]
   c. [**Star Pipe Products**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
4. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for **250-psig (1725-kPa)** minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Dresser Utility Solutions**]
   b. [**EBAA Iron Sales, Inc.**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**JCM Industries, Inc**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Dresser Utility Solutions**]
   b. [**EBAA Iron Sales, Inc.**]
   c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   d. [**JCM Industries, Inc**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron expansion joints from single manufacturer.
4. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile iron [**or**][**steel with protective coating**]; bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53.
5. Pressure Rating: **250-psig (1725-kPa)** minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**EBAA Iron Sales, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**EBAA Iron Sales, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include AWWA C111/A21.11, ductile-iron glands, rubber gaskets, and steel bolts. Include AWWA C111/A21.11 ductile-iron glands, rubber gaskets, and steel bolts.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

2.16 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   d. [**WATTS; A Watts Water Technologies Company**]
   e. [**Zurn Industries, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain cast-iron backwater valves from single manufacturer.
4. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
5. Horizontal type; with swing check valve and hub-and-spigot ends.
6. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
7. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]
   c. [**NDS Inc**]
   d. [**Plastic Oddities**]
   e. [**Sioux Chief Manufacturing Company, Inc.**]
   f. [**Zurn Industries, LLC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Endura; a brand of IPEX**]
   b. [**IPS Corporation**]

c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain PVC backwater valves from single manufacturer.
4. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.17 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain cast-iron cleanouts from single manufacturer.
4. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
5. Top-Loading Classification(s): [**Light Duty**][**Medium Duty**][**Heavy Duty**][**and**][**Extra-Heavy Duty**].
6. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Endura; a brand of IPEX**]

b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Endura; a brand of IPEX**]
b. [**IPS Corporation**]
c. [**NDS Inc**]
d. [**Plastic Oddities**]
e. [**Sioux Chief Manufacturing Company, Inc.**]
f. [**Zurn Industries, LLC**]
g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain PVC cleanouts from single manufacturer.
4. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.18 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Neenah Foundry Company**]
e. [**Tyler Pipe; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Josam Company**]
c. [**MIFAB, Inc**]
d. [**Neenah Foundry Company**]
e. [**Tyler Pipe; a subsidiary of McWane Inc.**]
f. [**WATTS; A Watts Water Technologies Company**]
g. [**Zurn Industries, LLC**]
h. **<Insert manufacturer's name>**

3. Source Limitations: Obtain cast-iron area drains from single manufacturer.
4. Description: ASME A112.6.3 gray-iron round body with anchor flange and round[**secured**] grate. Include bottom outlet with inside caulk or spigot connection, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][**and**][**Heavy Duty**].

B. Cast-Iron Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Josam Company**]
   c. [**MIFAB, Inc**]
   d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
   e. [**WATTS; A Watts Water Technologies Company**]
   f. [**Zurn Industries, LLC**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain cast-iron trench drains from single manufacturer.
4. Description: ASME A112.6.3, **6-inch- (150-mm-)** wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular[**secured**] grate. Include units of total length indicated and quantity of bottom outlets with inside caulk or spigot connections, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][**Heavy Duty**][**and**][**Extra-Heavy Duty**].

C. Steel Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Rockford Sanitary Systems, Inc**]
   b. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Rockford Sanitary Systems, Inc**]
   b. **<Insert manufacturer's name>**

3. Source Limitations: Obtain steel trench drains from single manufacturer.

4. Description: Factory fabricated from ASTM A242/A242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
5. Plate Thicknesses: [**1/8 inch (3.2 mm)**][**and**][**1/4 inch (6.4 mm)**].
6. Overall Widths: [**7-1/2 inches (190 mm)**][**and**][**12-1/3 inches (313 mm)**].

D. Grate Openings: [**1/4 inch (6.4 mm) circular**][**3/8 inch (9.5 mm) circular**][**3/8 inch (9.5 mm) circular or 3/8-by-3-inch (9.5-by-76-mm) slots**][**3/8-by-3-inch (9.5-by-76-mm) slots**].

2.19 CONCRETE TRENCH DRAIN FORMING SYSTEM

A. Concrete Trench Drain Forming System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABT, Inc.**]
   b. [**Eric'sons Dura Trench**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABT, Inc.**]
   b. [**Eric'sons Dura Trench**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain concrete trench drain forming system from single manufacturer.
4. Description: Radius trench drain forming system including a removable form that is customizable for width, depth, length, shape, slope, frame material, and grate material.
5. Form Bottom: [**Smooth radius**][**Vee**][**Flat**]<**Insert option**>.
6. Form Use: [**Single use**][**or**][**reusable**].
7. Form Covers: Plywood or metal to keep concrete out of trench form during installation.
8. Width: [**8 inches (203 mm)**][**10 inches (254 mm)**][**12 inches (305 mm)**][**18 inches (457 mm)**][**24 inches (610 mm)**]<**Insert width**> inside dimension.
9. Depth: [**See drawings**]<**Insert dimension**>.
10. Length: [**See drawings**]<**Insert dimension**>.
11. Bottom Shape: [**Smooth radius**][**Vee**]<**Insert shape**>.
12. Slope: [**Level - no slope**][**0.5 percent**][**1.0 percent**]<**Insert slope**>.
13. Frame/Grate Seat:

    a. Load Bearing, <**Insert loading requirement**>.
    b. Material: [**Powder-coated steel**][**Galvanized steel**][**Iron**][**Aluminum**][**Plastic**][**FRP**][**Stainless steel**]<**Insert material**>.

14. Concrete Anchors: [**18 inches (457 mm) on center**]<**Insert spacing**>
15. Grate:

    a. Manufacturer's Load Bearing Designation: "[**Heavy**][**Medium**] Duty."

b. Material: [**Ductile iron**][**FRP**][**Galvanized steel**][**Cast iron**][**Stainless steel**]<**Insert material**>.
c. Grate Type: [**ADA**][**Heel-proof**][**slotted**][**perforated**][**bar**]<**Insert grate type**>.

2.20 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**][**or**][**cross-laminated HDPE film of 0.004-inch (0.10-mm)**] minimum thickness.

C. Form: [**Sheet**][**or**][**tube**].

D. Color: [**Black**][**or**][**natural**]<**Insert color**>.

2.21 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: **4-inch (102-mm)** minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Description: ASTM C913; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.

3. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
4. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
5. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Associated Fiberglass Enterprises**]
   b. [**Containment Solutions, Inc**]
   c. [**L. F. Manufacturing, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Associated Fiberglass Enterprises**]
   b. [**Containment Solutions, Inc**]
   c. [**L. F. Manufacturing, Inc**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain fiberglass manholes from single manufacturer.
4. Description: ASTM D3753.
5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
6. Ballast: Increase thickness of concrete base as required to prevent flotation.
7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (102-mm-)** minimum width flange and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: [**ASTM A536, Grade 60-40-18 ductile**][**ASTM A48/A48M, Class 35 gray**] iron unless otherwise indicated.

2.22 CONCRETE

A. General: Cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**, **ACI 350 (ACI 350M)**, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: [**1**][**2**] percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: [**4**][**8**] percent.

D. Ballast and Pipe Supports: Portland cement design mix, **3000 psi (20.7 MPa)** minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.23 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Forté Composites, Inc.**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
f. [**Josam Company**]
g. [**MultiDrain Systems, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABT, Inc.**]
   b. [**ACO, Inc.**]
   c. [**Forté Composites, Inc.**]
   d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   f. [**Josam Company**]
   g. [**MultiDrain Systems, Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

   a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
   b. Include extension sections necessary for required depth.
   c. Dimensions: **4-inch (102-mm)** inside width. Include number of units required to form total lengths indicated.
   d. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**].
   e. Joining Section: As recommended in writing by system manufacturer.

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

   a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

B. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Forté Composites, Inc.**]
e. [**Josam Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Forté Composites, Inc.**]
e. [**Josam Company**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain narrow, level-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
b. Dimensions: [**5-inch (127-mm)**]<**Insert inches (mm)**> inside width and [**9-3/4 inches (248 mm)**]<**Insert inches (mm)**> deep. Include number of units required to form total lengths indicated.
c. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**].

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABT, Inc.**]
b. [**ACO, Inc.**]
c. [**Eric'sons Dura Trench**]
d. [**Hubbell Utility Solutions; Hubbell Incorporated**]

e. [**Josam Company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABT, Inc.**]
   b. [**ACO, Inc.**]
   c. [**Eric'sons Dura Trench**]
   d. [**Hubbell Utility Solutions; Hubbell Incorporated**]
   e. [**Josam Company**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain wide, level-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

   a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
   b. Dimensions: [**8-inch (203-mm)**]<**Insert inch (mm)**> inside width and [**13-3/4 inches (350 mm)**]<**Insert inches (mm)**> deep. Include number of units required to form total lengths indicated.
   c. Frame: [**Gray iron or galvanized steel for grates**][**Not required**].
   d. Channel-Section Joining and Fastening Materials: As recommended in writing by system manufacturer.

6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

   a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
   b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

D. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:

   a. **24-by-12-inch (610-by-305-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

2. Small Catch Basins:

   a. **19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.

c. Frame: Include gray-iron or steel frame for grate.

3. Oil Interceptors:

a. Polymer-concrete body with interior baffle and four steel support channels and two **1/4-inch- (6.4-mm-)** thick, steel-plate covers.
b. Capacity: [**140 gal. (530 L)**][**200 gal. (757 L)**][**260 gal. (984 L)**].
c. Inlet and Outlet: [**NPS 4 (DN 100)**][**NPS 6 (DN 150)**].

4. Sediment Interceptors:

a. **27-inch- (686-mm-)** square, polymer-concrete body, with outlets in quantities and sizes indicated.
b. **24-inch- (610-mm-)** square, gray-iron frame and slotted grate.

2.24 PLASTIC, CHANNEL DRAINAGE SYSTEMS

A. General Requirements for Plastic, Channel Drainage Systems:

1. Modular system of plastic channel sections, grates, and appurtenances.
2. Designed so grates fit into frames without rocking or rattling.
3. Number of units required to form total lengths indicated.

B. FRP Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ACO, Inc.**]
b. [**Aquaduct, Inc.**]
c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ACO, Inc.**]
b. [**Aquaduct, Inc.**]
c. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

a. Dimensions: [**4 inches (102 mm)**][**4 or 6 inches (102 or 152 mm)**][**6 inches (152 mm)**][**6 or 8 inches (152 or 203 mm)**][**8 inches (203 mm)**] wide. Include number of units required to form total lengths indicated.

b. Frame: [**Galvanized steel**][**Stainless steel**][**Manufacturer's standard metal**]<**Insert material**> for grates.

6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].

7. Covers: Solid [**ductile or gray iron**]<**Insert material**>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. HDPE or PE Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Tuf-Tite Corporation**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Sioux Chief Manufacturing Company, Inc.**]
c. [**Tuf-Tite Corporation**]
d. [**Zurn Industries, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.

6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: [**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<**Insert material**>.
b. Color: <**Insert color or delete subparagraph**>.

7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.25 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: **4-inch (102-mm)** minimum thickness, **48-inch (1200-mm)** diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
8. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
9. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C913, precast, reinforced concrete; designed in accordance with ASTM C890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
4. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.
5. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

C. Rectangular Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: **24 by 24 inches (610 by 610 mm)** minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Round Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with

4-inch- (102-mm-) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.26 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening[**, of materials and dimensions in accordance with utility standards**].

B. Gutter Inlets: Made with horizontal gutter opening[**, of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings[**, of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty[**, in accordance with utility standards**].

2.27 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete as required to prevent flotation.
2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.
3. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<**Insert material**>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of structure to finished grade is less than [**60 inches (1500 mm)**]<**Insert inches (mm)**>.

B. Manhole Frames and Covers: ASTM A536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2.28 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone in accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control."

1. Average Size:

a. NSSGA No. R-3, screen opening 2 inches (51 mm).
b. NSSGA No. R-4, screen opening 3 inches (76 mm).

c. NSSGA No. R-5, screen opening **5 inches (127 mm)**.

C. Filter Stone: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

D. Energy Dissipaters: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, **3-ton (2721-kg)** average weight armor stone, unless otherwise indicated.

2.29 DRY WELLS

A. ASTM C913, precast, reinforced, perforated concrete rings. Include the following:

1. Floor: Cast-in-place concrete.
2. Cover: Liftoff-type concrete cover with cast-in lift rings.
3. Wall Thickness: **4 inches (102 mm)** minimum with **1-inch (25-mm)** diameter or **1-by-3-inch- (25-by-76-mm-)** maximum slotted perforations arranged in rows parallel to axis of ring.

   a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
   b. Ring Construction: Designed to be self-aligning.

4. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.

B. Manufactured PE Dry Wells:

1. Description: Manufactured PE side panels and top cover that assemble into **50-gal. (190-L)** storage capacity units.
2. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**NDS Inc**]
   b. <**Insert manufacturer's name**>

3. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**NDS Inc**]
   b. <**Insert manufacturer's name**>

4. Source Limitations: Obtain manufactured PE dry wells from single manufacturer.
5. Side Panels: With knockout ports for piping and seepage holes.
6. Top Cover: With knockout port for drain.
7. Filter Fabric: As recommended by unit manufacturer.
8. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.

C. Constructed-in-place aggregate type. Include the following:

1. Lining:

   a. Clay or concrete bricks.

b. Concrete blocks or precast concrete rings with notches or weep holes.

2. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
3. Cover: Precast, reinforced-concrete slab, designed for structural loading in accordance with ASTM C890 and made in accordance with ASTM C913. Include slab dimensions that will extend **12 inches (300 mm)** minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
4. Manhole: **24-inch- (610-mm-)** diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

2.30 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Drainage Systems, Inc**]
   b. [**CULTEC, Inc**]
   c. [**Hancor Inc.**]
   d. [**Infiltrator Systems Inc**]
   e. [**Interface H2O**]
   f. [**StormTech LLC**]
   g. [**Suntree Technologies, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Drainage Systems, Inc**]
   b. [**CULTEC, Inc**]
   c. [**Hancor Inc.**]
   d. [**Infiltrator Systems Inc**]
   e. [**Interface H2O**]
   f. [**StormTech LLC**]
   g. [**Suntree Technologies, Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain chamber systems from single manufacturer.
4. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
5. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
6. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of **4 oz./sq. yd. (135 g/sq. m)**.

B. Piping Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252 for **NPS 10 (DN 250)** and smaller, AASHTO M 294 for **NPS 12 to NPS 60 (DN 300 to DN 1500)**. Include proprietary fittings, couplings, seals, and filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advanced Drainage Systems, Inc**]
    b. [**Hancor Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advanced Drainage Systems, Inc**]
    b. [**Hancor Inc.**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pipe systems from single manufacturer.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping in accordance with the following:

    1. Install piping pitched down in direction of flow.
    2. Install piping [**NPS 6 (DN 150)**]<**Insert value**> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

3. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<**Insert** inch- (mm-)> minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
7. Install corrugated-steel piping in accordance with ASTM A798/A798M.
8. Install corrugated-aluminum piping in accordance with ASTM B788/B788M.
9. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
10. Install PE corrugated sewer piping in accordance with ASTM D2321.
11. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
12. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
13. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
14. Install PVC water-service piping in accordance with ASTM D2321 and ASTM F1668.
15. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
16. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
17. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install force-main pressure piping in accordance with the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
2. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<**Insert** inch- (mm-)> minimum cover.
3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings in accordance with AWWA C600.
5. Install PVC pressure piping in accordance with AWWA M23, or ASTM D2774 and ASTM F1668.
6. Install PVC water-service piping in accordance with ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
6. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.

7. Join corrugated-aluminum sewer piping in accordance with ASTM B788/B788M.
8. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
9. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
10. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
12. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
14. Join fiberglass sewer piping in accordance with ASTM D3839 for elastomeric-seal joints.
15. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
17. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Join force-main pressure piping in accordance with the following:

1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join PVC water-service piping in accordance with ASTM D2855 for solvent-cemented joints.
5. Join dissimilar pipe materials with pressure-type couplings.

3.4 INSTALLATION OF BACKWATER VALVES

A. Install horizontal-type backwater valves in piping where indicated.

B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.

C. Install terminal-type backwater valves on end of piping and in manholes where indicated.

3.5 INSTALLATION OF CLEANOUTS

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in [**earth or unpaved foot-traffic**]<**Insert area type**> areas.
2. Use Medium-Duty, top-loading classification cleanouts in [**paved foot-traffic**]<**Insert area type**> areas.
3. Use Heavy-Duty, top-loading classification cleanouts in [**vehicle-traffic service**]<**Insert area type**> areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in [**roads**]<**Insert area**>.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**]<**Insert inches (mm)**> deep. Set with tops [**1 inch (25 mm)**]<**Insert inch(es (mm)**> above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 INSTALLATION OF DRAINS

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in [**earth or unpaved foot-traffic**]<**Insert area type**> areas.
2. Use Medium-Duty, top-loading classification drains in [**paved foot-traffic**]<**Insert area type**> areas.
3. Use Heavy-Duty, top-loading classification drains in [**vehicle-traffic service**]<**Insert area type**> areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in [**roads**]<**Insert area**>.

B. Embed drains in **4-inch- (102-mm-)** minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in [**4-inch- (102-mm-)**]<**Insert inch- (mm-)**> minimum concrete around bottom and sides.

3.7 INSTALLATION OF MANHOLES

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [**3 inches (76 mm)**]<**Insert inches (mm)**> above finished surface elsewhere unless otherwise indicated.

3.8 INSTALLATION OF CATCH BASINS

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.9 INSTALLATION OF STORMWATER INLETS/OUTLETS

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.10 INSTALLATION OF DRY WELLS

A. Excavate hole to diameter of at least **6 inches (150 mm)** greater than outside of dry well. Do not extend excavation into ground-water table.

B. Install precast, concrete-ring dry wells in accordance with the following:

1. Assemble rings to depth indicated.
2. Extend rings to height where top of cover will be approximately **8 inches (203 mm)** below finished grade.
3. Backfill bottom of inside of rings with filtering material to level at least **12 inches (300 mm)** above bottom.
4. Extend effluent inlet pipe **12 inches (300 mm)** into rings and terminate into side of tee fitting.
5. Backfill around outside of rings with filtering material to top level of rings.
6. Install cover over top of rings.

C. Install manufactured, PE dry wells in accordance with manufacturer's written instructions and the following:

1. Assemble and install panels and cover.
2. Backfill bottom of inside of unit with filtering material to level at least [**12 inches (300 mm)**]<**Insert inches (mm)**> above bottom.
3. Extend effluent inlet pipe [**12 inches (300 mm)**]<**Insert inches (mm)**> into unit and terminate into side of tee fitting.
4. Install filter fabric around outside of unit.
5. Install filtering material around outside of unit.

D. Install constructed-in-place dry wells in accordance with the following:

1. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
2. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
3. Extend lining material to height where top of manhole will be approximately [**8 inches (203 mm)**]<**Insert inches (mm)**> below finished grade.
4. Backfill bottom of inside of lining with filtering material to level at least [**12 inches (300 mm)**]<**Insert inches (mm)**> above bottom.
5. Extend effluent inlet pipe [**12 inches (300 mm)**]<**Insert inches (mm)**> into lining and terminate into side of tee fitting.
6. Backfill around outside of lining with filtering material to top level of lining.
7. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

3.11 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**.

3.12 INSTALLATION OF CHANNEL DRAINAGE SYSTEMS

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in [**4-inch- (102-mm-)**]<**Insert inch- (mm-)**> minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in [**4-inch- (102-mm-)**]<**Insert inch- (mm-)**> minimum concrete around bottom and sides.

3.13 INSTALLATION OF STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, in accordance with piping manufacturer's written instructions.

3.14 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221414 "Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Section 221414 "Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus **6-inch (150-mm)** overlap, with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
2. Make branch connections from side into existing piping, **NPS 4 to NPS 20 (DN 100 to DN 500)**. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
3. Make branch connections from side into existing piping, **NPS 21 (DN 525)** or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow **3 inches (76 mm)** of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in **6 inches (150 mm)** of concrete for minimum length of **12 inches (300 mm)** to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of **3000 psi (20.7 MPa)** unless otherwise indicated.
   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. [**Unshielded**][**Shielded**] flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.15 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [**8-inch- (203-mm-)**]<**Insert inch- (mm-)**> thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least [**36 inches (915 mm)**]<**Insert inches (mm)**> below final grade. Fill to within [**12 inches (300 mm)**]<**Insert inches (mm)**> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.16 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.17 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (610 mm)** of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping in accordance with ASTM F1417.

6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [**150 psig (1035 kPa)**]<**Insert psig (kPa)**>.

    a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.18 CLEANING

A. Clean interior of piping of dirt and superfluous materials.[**Flush with potable water.**]

END OF SECTION 33 42 00 00

Task	Specification	Specification Description
33 42 00 00	22 14 13 00	Storm Drainage Piping
33 42 11 00	22 14 13 00	Storm Drainage Piping
33 42 11 00	33 42 00 00	Stormwater Conveyance
33 42 11 00	33 46 00 00	Subdrainage
33 42 13 00	22 14 13 00	Storm Drainage Piping
33 42 13 00	33 42 00 00	Stormwater Conveyance
33 42 13 13	22 14 13 00	Storm Drainage Piping
33 42 13 13	33 42 00 00	Stormwater Conveyance
33 42 23 00	22 14 13 00	Storm Drainage Piping
33 42 23 00	23 43 00 00	Electronic Air Cleaners
33 42 23 00	33 42 00 00	Stormwater Conveyance
33 42 26 00	33 42 00 00	Stormwater Conveyance
33 42 26 16	22 14 13 00	Storm Drainage Piping
33 42 26 16	33 42 00 00	Stormwater Conveyance
33 42 26 19	22 14 13 00	Storm Drainage Piping
33 42 26 19	33 42 00 00	Stormwater Conveyance
33 42 26 23	22 14 13 00	Storm Drainage Piping
33 42 26 23	33 42 00 00	Stormwater Conveyance
33 42 31 00	22 14 13 00	Storm Drainage Piping
33 42 31 00	23 43 00 00	Electronic Air Cleaners
33 42 31 00	33 42 00 00	Stormwater Conveyance
33 42 33 00	22 14 13 00	Storm Drainage Piping
33 42 33 00	23 43 00 00	Electronic Air Cleaners
33 42 33 00	33 42 00 00	Stormwater Conveyance
33 42 36 00	22 14 13 00	Storm Drainage Piping
33 42 36 00	33 42 00 00	Stormwater Conveyance
33 44 00 00	22 14 13 00	Storm Drainage Piping

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SECTION 33 44 36 00 - OIL WATER SEPARATOR

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for oil/water separator. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Scope

1. The separator shall be designed for gravity separation of sand, grit, settleable solids, or semisolids, and free oils (hydrocarbons and other petroleum products) from wastewater. Separator shall be installed belowground with top access at or above grade level. The source of the influent to the separator shall be gravity flow from storm water runoff, hydrocarbon spills, and/or cleaning/maintenance operations.

C. Performance

1. Influent Characteristics
   a. Provide separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures. Minimum separator retention time shall be 10 minutes. Operating temperatures of the influent oil in water mixture shall range from 40 degrees F. to 80 degrees F. The specific gravity of the oils at operating temperatures shall range from 0.71 to 0.92. The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.
2. Effluent Characteristics
   a. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

D. Design Criteria

1. The separator shall be listed to Underwriters' Laboratories UL-SU2215. Construction and performance of the oil/water separators shall be in accordance with UL-SU2215. Provide certification documentation detailing criteria under which the system was tested. UL-SU2215 label shall be prominently displayed on manway covers.
2. Separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Publication 421, "Monographs on Refinery Environmental Control - Management of Water Discharges; Design and Operation of Oil/Water Separators." Effective surface area calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document specified effluent quality based on complete removal of the specified oil globule at design flow. A separator with lower effective surface area than required is not permissible.
3. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters' Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, September 30, 1997, Double Wall construction with 360 degree Steel Secondary Containment. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank shall have a double steel shell with a space between the layers. The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from a small sump at the bottom. Tank construction using thin walled primary tank with external fiberglass jacket shall not be permissible.
4. Separator Corrosion Control System shall be in strict accordance with Underwriters' Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks and the HighGuard® External Corrosion Protection Specifications.

5. Oil/water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
6. Separator vessel volume shall allow for a hydraulic retention time of ten (10) minutes to ensure laminar flow conditions which result in hydraulic uniformity and high effluent quality. Volume reduction will adversely affect separator performance by increasing horizontal velocity and turbulence, therefore a separator of smaller volume is not permissible.
7. Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment. Manufacturer shall have at least 20 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.
8. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
9. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58, September 30, 1997. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
10. Separator shall have an oil storage capacity equal to about 43% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.
11. To prevent extensive shutdown and maintenance, the separator design must allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids. The use of plastic perforated tubes, spherical balls, or irregular shaped media will increase the facility's maintenance costs and shall not be permitted.
12. Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removable parallel flat/corrugated plate coalescer, with removable plates, and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

E. Submittals:
1. Shop Drawings: shop drawings for oil water separators shall show principal dimensions and location of all fittings.
2. Instructions: provide three complete sets of installation, operation, and maintenance instructions with separator.
3. Quality Control: Quality control, inspection procedures, and reports shall be considered part of the submittal package.

F. Warranty
1. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
2. The manufacturer's warranty shall be standard limited warranty in effect at time of purchase.

1.2 PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Highland Tank, One Highland Road, Box 338, Stoystown, PA 15563, Phone 814-893-5701, FAX 893-6126, E-mail ows.info@highlandtank.com, Website http://www.highlandtank.com

B. Product

1. Provide and install Highland Tank Model HTC Series "G" UL-SU2215 approved Belowground Double Wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral Sand Interceptor Compartment. Separator shall be furnished with oil level alarm and leak detection systems. Oil/Water Separator shall be of capacity to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.
2. Separator shall be furnished with a Corella™ inclined parallel flat/corrugated plate coalescer to simultaneously separate free oil droplets and settleable or suspended solids particles from water without clogging of the coalescer.

C. Description

1. Separator shall be standard prefabricated inclined parallel flat/corrugated plate, gravity displacement type unit.
2. Separator shall be cylindrical with capacities, dimensions, construction, and thickness in strict accordance with Underwriters' Laboratories Subject 58, Double Wall construction using flat-flanged heads. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
3. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:
   a. An influent connection, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.
   b. An integral sand interceptor compartment containing one (1) manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from entering the separation chamber. Bulkhead shall have a transfer pipe.
   c. A velocity head diffusion baffle at the inlet to:
      1) reduce horizontal velocity and flow turbulence.
      2) distribute the flow equally over the separators cross sectional area.
      3) direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
      4) completely isolate all inlet turbulence from the separation chamber.
   d. A sediment chamber to disperse flow and collect oily solids and sediments.
   e. A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
   f. An Oil/Water Separation Chamber containing a removable Corella™ inclined parallel flat/corrugated plate coalescer. The coalescer shall have individual removable plates, sloped towards the sediment chamber. Each coalescing polate shall be flat on the top and corrugated on the bottom. The flat top plate shall resist clogging and clotting with solids. The corrugations of each of the plate bottoms shall be shaped and positioned to enhance collisions between the rising oil droplets and coalesce between them thereby improving separator efficiency. The coalescer shall:
      1) effect separation of oil and solids from all strata of the wastewater stream.
      2) shorten the vertical distance that an oil globule or solid particle has to rise or sink, respectively, for effective removal. Minimum plate gap to be 3/4".
      3) enhance coalescence and agglomeration by causing the smaller globules and particles (those possessing smaller rising/settling rates) to coalesce and collect on the plates thereby forming larger globules and particles that separate rapidly in water.
      4) direct the flow paths of the separated oil to the surface of the separator and separated solids to the bottom of the separator.
      5) allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids.
   g. The Oil/Water Separation Chamber shall also contain a sectionalized removable "Petro-Screen"™ polypropylene impingement coalescer designed to intercept oil globules of less

than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

h. An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.

i. An effluent connection, flanged.

j. Fittings for vent, interface/level sensor, leak detection, waste oil pump-out, sampling, and gauge.

k. Two (2) manholes, UL approved, complete with extension, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.

l. Lifting lugs at balancing points for handling and installation.

m. Identification plates: Plates shall be affixed in prominent location and be durable and legible throughout equipment life.

n. HighGuard® Corrosion Protection System consisting of:

1) Isolation Spool Pieces

2) Dielectric Isolation Gaskets and Bushings

3) External surfaces commercial grit blast, coated 75 mils DFT Self-Reinforcing Polyurethane.

o. Internal surfaces commercial grit blast and coated with 10 mils DFT heavy duty Polyurethane.

D. Accessories

1. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator and an audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) shall be intrinsically safe. Level sensor floats shall be made of stainless steel. The control panel shall contain both level sensor and detection control. The control panel shall be NEMA 4. Power to the control panel shall be as directed by the Owner.

2. Separator shall be supplied with Polyester Hold-down straps.

3. Separator shall be supplied with prefabricated Concrete Deadman Anchors.

4. Separator shall be supplied with cylindrical and/or rectangular steel Grade Level Manways designed to AASHTO H20 requirements.

1.3 EXECUTION

A. Installation

1. Installation shall be in strict compliance with manufacturer's instructions and shall comply with all applicable local, state, and federal requirements.

END OF SECTION 33 44 36 00

Task	Specification	Specification Description
33 44 36 00	22 13 19 00	Sanitary Waste Piping Specialties
33 44 36 00	22 14 13 00	Storm Drainage Piping

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SECTION 33 46 00 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipes and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airfield Systems, LLC**]
b. [**American Wick Drain Corporation (AWD)**]
c. [**JDR Enterprises, Inc**]
d. [**MAPEI Corporation**]
e. [**TenCate Geosynthetics**]
f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Airfield Systems, LLC**]
   b. [**American Wick Drain Corporation (AWD)**]
   c. [**JDR Enterprises, Inc**]
   d. [**MAPEI Corporation**]
   e. [**TenCate Geosynthetics**]
   f. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Varicore Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Varicore Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**15 gpm (57 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 12 Inches (305 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   c. 18 Inches (457 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven, needle-punched geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

6. Couplings: HDPE.

C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.
6. Couplings: Corrugated HDPE band.

D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

3. Nominal Size: **6 inches (150 mm)** high by approximately **0.9 inch (23 mm)** thick.

   a. Minimum In-Plane Flow: [**2.4 gpm (9.1 L/min.)**]<**Insert value**> at hydraulic gradient of

[**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**82 gpm (310 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 36 Inches (1 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**164 gpm (621 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [**36 to 60 inches (915 to 1525 mm)**]<**Insert dimensions**> wide with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Wick Drain Corporation (AWD)**]
   b. [**Dorken Systems Inc.**]
   c. [**Eljen Corporation**]
   d. [**JDR Enterprises, Inc**]
   e. [**MAPEI Corporation**]
   f. [**Mar-flex Waterproofing & Building Products**]
   g. [**Midwest Diversified Technologies Incorporated**]
   h. [**Sika Greenstreak**]

i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Wick Drain Corporation (AWD)**]
b. [**Dorken Systems Inc.**]
c. [**Eljen Corporation**]
d. [**JDR Enterprises, Inc**]
e. [**MAPEI Corporation**]
f. [**Mar-flex Waterproofing & Building Products**]
g. [**Midwest Diversified Technologies Incorporated**]
h. [**Sika Greenstreak**]
i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.

a. Minimum Compressive Strength: [**10,000 lbf/sq. ft. (479 kPa)**][**15,000 lbf/sq. ft. (718 kPa)**][**18,000 lbf/sq. ft. (862 kPa)**][**21,000 lbf/sq. ft. (1005 kPa)**]<**Insert value**> when tested in accordance with ASTM D1621.
b. Minimum In-Plane Flow Rate: [**2.8 gpm/ft. (35 L/min. per m)**][**7 gpm/ft. (87 L/min. per m)**][**15 gpm/ft. (186 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and compressive stress of [**25 psig (172 kPa)**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum.

5. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**][**No. 30 (0.6-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**][**0.02**] per second, minimum.

6. Film Backing: Polymeric film bonded to drainage core surface.

B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

3. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately **0.4 inches (10.2 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately **0.25 inches (6 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**][**5 gpm/ft. (62 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates

range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately **1 inch (25 mm)** thick.

   a. Minimum In-Plane Flow Rate: [**40 gpm/ft. (500 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

A. Material: Comply with [**ASTM D226, Type I, asphalt**][**or**][**ASTM D227, coal-tar**]-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from **110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m)** when tested in accordance with ASTM D4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO [**M 288 Class 2**]<**Insert class**>.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF FOUNDATION DRAINAGE

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than **6 inches (150 mm)** deep and **12 inches (300 mm)** wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Final backfill to finish elevations and

slope away from building.

3.4 INSTALLATION OF UNDERSLAB DRAINAGE

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least **6 inches (150 mm)** between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footing.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 INSTALLATION OF RETAINING-WALL DRAINAGE

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than **4 inches (100 mm)**.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

G. Place drainage course in layers not exceeding **3 inches (75 mm)** in loose depth; compact each layer

placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

I. Install drainage panels on wall as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut **1/2-inch- (13-mm-)** diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal calk line on wall at a point **6 inches (150 mm)** less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from **2 to 6 inches (50 to 150 mm)** below top of panel, approximately **48 inches (1200 mm)** apart.[**Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.**] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away **4 inches (100 mm)** of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with **4 inches (100 mm)** of fabric.
9. Cut panel as necessary to keep top **12 inches (300 mm)** below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide **3 inches (75 mm)** for overlap.

J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.6 INSTALLATION OF LANDSCAPING DRAINAGE

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least **6 inches (150 mm)** between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [**adhesive**][**or**][**tape**].

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within **12 inches (300 mm)** of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course,

overlapping edges at least **4 inches (100 mm)**.

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.7 INSTALLATION OF PIPING

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Plaza Deck Subdrainage: Install piping level.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [**0.5**]<**Insert value**> percent and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 CONSTRUCTION OF PIPE JOINTS

A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 INSTALLATION OF BACKWATER VALVES

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping[**in manholes or pits**] where indicated.

3.10 INSTALLATION OF CLEANOUTS

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for [**Foundation**][**Retaining-Wall**][**and**][**Landscaping**] Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**]<**Insert dimensions**> deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use **NPS 4 (DN 100)** [**cast-iron**][**PVC**] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**12 by 12 by 4 inches (300 by 300 by 100 mm)**]<**Insert dimensions**> deep. Set top of cleanout [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**> above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to[**building's**] solid-wall-piping storm drainage system.

C. Where required, connect low elevations of [**foundation**][**underslab**] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are

satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00 00

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Task	Specification	Specification Description
33 46 23 00	33 46 00 00	Subdrainage
33 46 53 00	33 11 13 00a	Potable Water Supply Wells
33 46 53 00	33 46 00 00	Subdrainage
33 52 16 13	21 05 00 00	Common Work Results for Fire Suppression
33 52 16 13	22 05 00 00	Common Work Results for Plumbing
33 52 16 13	23 05 00 00	Common Work Results for HVAC
33 52 16 13	23 11 23 00	Facility Natural-Gas Piping
33 52 16 13	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
33 52 16 23	23 11 23 00	Facility Natural-Gas Piping
33 52 16 23	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
33 52 16 26	23 11 23 00	Facility Natural-Gas Piping
33 52 16 26	23 11 26 00	Facility Liquefied-Petroleum Gas Piping

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SECTION 33 71 00 00 - OVERHEAD MEDIUM-VOLTAGE WIRING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.

1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.

B. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.

C. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

1.3 COORDINATION

A. Coordinate with utility supplying electricity to lines specified in this Section, and make [**final connections**][**arrangements for final connections by utility**].

B. Coordinate with those responsible for [**voice**][**data**][**video**]<**Insert services involved**> systems that will have cables supported by poles installed in accordance with this Section.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory Test Reports:

a. Wood poles.
b. Concrete poles.
c. Crossarms.
d. Cutouts, switches, and fuses.
e. Pole-mounted distribution transformers.
f. Primary metering products.

2. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Fuses: [**One**]<**Insert number**> additional spare fuse(s) or fuse element(s) for each furnished fuse or fuse element.
2. Padlocks: [**One**]<**Insert number**> for every [**three**]<**Insert number**> installed, but no fewer than [**three**]<**Insert number**>.
3. Insulators: [**One**]<**Insert number**> for every 10 of each type, but no fewer than [**three**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to overhead medium-voltage wiring, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. [**Two**]<**Insert number**> sets of special-purpose tools required for maintenance of cutouts, switches, and reclosers, complete with toolbox.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

C. Comply with [**IEEE C2**][**CPUC General Order 95**], except where stricter requirements are indicated or where local requirements that are stricter apply.

D. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for [**heavy**][**medium**][**light**] line loading unless otherwise indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than **1 inch (25 mm)**.

PART 2 - PRODUCTS

2.1 CONDUCTORS, CONNECTORS, AND SPLICES

A. Conductor Type AAC: [**Bare**][**and covered**], all-aluminum, Alloy 1350-H19, complying with ASTM B230/B230M and ASTM B231/B231M.

B. Conductor Type AAAC: [**Bare**][**and covered**], all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B398/B398M and ASTM B399/B399M.

C. Conductor Type ACSR: [**Bare**][**and covered**], aluminum conductor, steel reinforced, complying with ASTM B232/B232M.

D. Conductor Type CU: [**Bare**][**and covered**], hard-drawn copper, complying with ASTM B1 and ASTM B8.

E. Conductor Covering: UV resistant, complying with ICEA-S-70-547. [**HDPE**][**or**][**XLP**], [**150 mil (3.81 mm)**]<**Insert value**> thick.

F. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.

1. Conductors: [**Aluminum, Alloy 1350, complying with ASTM B230/B230M and ASTM**

B231/B231M][**Hard-drawn copper, complying with ASTM B1 and ASTM B8**]; stranded for 2 AWG and larger.

2. Conductor Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**EPR, complying with NEMA WC 70/ICEA S-95-658**]<**Insert insulation**>.
3. Insulation Level: [**100**][**133**]<**Insert number**> percent of rated circuit line-to-line voltage.
4. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; **18 mil (460 µm)** minimum thickness.
5. Insulation Shield: Include the following two components:

    a. Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
    b. Metallic Tape Shield: Bare copper, **5 mil (127 µm)** minimum thickness, helically applied with a 15 percent minimum overlap.

6. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
7. Messenger: [**Copper**][**Composite copper and copper**]-clad steel.
8. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.

G. Aluminum Secondary-Voltage Line Conductors: [**Aluminum conductor, steel reinforced, complying with ASTM B232/B232M**][**Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.

H. Copper Secondary-Voltage Line Conductors: [**Bare hard-drawn copper, complying with ASTM B1 and ASTM B8**][**Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.[**Neutral-supported, secondary service-drop cable.**]

I. Racked Secondary Conductors, 600 V and Less: [**Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658**]<**Insert conductor and insulation combination**>.

J. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:

1. Conductors and Neutral: [**Copper with copper-clad-steel neutral**][**Aluminum with bare Alloy 1350 aluminum neutral**][**Aluminum with ACSR neutral**].
2. Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**High-modular-weight, low-density polyethylene**][**Weather-resistant polyolefin, complying with ICEA S-70-547**].

K. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:

1. Copper to Copper: Copper alloy, complying with UL 486A-486B.
2. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
3. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
4. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
5. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
6. Splices under Tension: Compression type with strength exceeding the conductors spliced.
7. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of

each splice.

8. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Section 260513 "Medium-Voltage Cables."

2.2 WOOD POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

C. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol,**][**ammoniacal copper arsenate,**][**ammoniacal copper zinc arsenate**][**chromated copper arsenate**].

D. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]<**Insert wood species selected from ATIS O5.1**>.

E. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high, with aluminum nails.

F. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.3 CONCRETE POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

C. Description: Spuncast prestressed concrete, complying with requirements of ASTM C1089.

1. Comply with requirements of RUS Bulletin 1724E-216.

D. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C)**]<**Insert design temperature range at site location**>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

E. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

F. Water Absorption: Not more than 3 percent.

G. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

H. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high.

2.4 CROSSARMS

A. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.

B. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch (6 mm)** thick by **1-1/4 inch (30 mm)** wide, minimum, with length to suit crossarm dimensions.

2.5 GUYS AND ANCHORS

A. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

1. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb (45 kN)**]<**Insert value**>.
2. Cable Termination:

a. Thimble eye.
b. Hooks and guy strain plates, complying with IEEE C135.1.
c. Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

B. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

1. Power-installed screw-type anchors.

a. **15 inch (380 mm)** screw; with rod **8 ft (2.4 m)** long by **1-1/2 inch (38 mm)** in diameter. Rated at **10,000 lb (45 kN)** when installed.
b. Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

2. <**Insert anchor size or type**>.

C. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Article.

D. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft (2.4 m)** long. Shatter resistant at temperatures below **0 deg F (minus 18 deg C)**.

2.6 HARDWARE AND ACCESSORIES

A. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.

1. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings[**with the exception that base material must be malleable iron or ductile iron, and finish must be hot-dip galvanized**].

B. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with [**one**][**two**]-bolt attachment to pole.

C. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12 gage struts designed to support [**two**][**three**][**four**] spool insulators for attachment of secondary drop conductors. Spool spacing of [**4 inch (100 mm)**][**8 inch (200 mm)**][**12 inch (300 mm)**].

D. Pole Riser Shields: Galvanized steel with [**boot**][**backplate**][**vent**].

E. Padlocks: ASTM F883.

1. Class: [**PO1**][**PO2**].
2. Grade: [**1**][**2**][**3**][**3**][**5**][**6**].

3. Option: [**A**][**B**][**C**][**D**][**E**][**F**][**G**].

F. Insulators: Units rated 6 kV and above must be free from radio interference.

1. Porcelain insulators must be wet-process type, complying with the following:

a. Pin: ANSI C29.5.
b. Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
c. Suspension: ANSI C29.2.
d. Guy Strain: ANSI C29.4.
e. Secondary Spool: ANSI C29.3, Class 53-2.

2. Polymer-composite, fiberglass-reinforced insulators must comply with the following:

a. Line Post: CEA LWIWG-02.
b. Dead End/Suspension: CEA LWIWG-01.
c. Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

G. Grounding Materials: Comply with Section 260526 "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.

1. Conductors: 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B8 unless otherwise indicated.
2. Ground Conductor Protectors: PVC or half-round wood molding, [**fir, pressure treated in accordance with AWPA C25**][**cypress**][**cedar**].

2.7 SURGE ARRESTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. **<Insert manufacturer's name>**

C. Distribution-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type[**with automatic-indicating type, ground-lead disconnection feature**], complying with IEEE C62.11 and NEMA LA 1.

D. Intermediate-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.

1. Voltage Rating: [**3**][**6**][**9**][**10**][**12**][**15**][**27**][**30**][**36**] kV[**, at the altitude of Project,**] unless otherwise indicated.

2.8 CUTOUTS, SWITCHES, AND FUSES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

C. Description: Medium-voltage disconnect, protective[**, and bypass**] units must be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are [**45**][**60**][**75**][**95**][**150**][**200**] kV.

1. Momentary Current Rating of Switching Devices: [**20**][**40**]<**Insert value**> kA, asymmetrical at nominal system operating voltage.
2. Fuse Characteristics: Time-current characteristics for each set of fuses selected in accordance with published recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves in accordance with IEEE 242 that illustrate optimum coordination of devices in this Project.
3. Interrupting Rating of Fuses: <**Insert value**> symmetrical A at nominal system operating voltage.

D. Fuse Cutouts: [**Open**][**enclosed**] type, rated [**100**][**200**] A, continuous, complying with ANSI C37.42.

1. Fuses: Enclosed link, [**Type K**][**Type T**], complying with ANSI C37.42.
2. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
3. Switching Application: Include switch link instead of fuse.
4. Switch Current Interrupting Rating: [**Transformer magnetizing current**]<**Insert value**>.

E. Fused Switches: Single-pole, manual units.

1. Switch Rating: [**400**][**600**] A(rms) continuous and load-current interrupting.
2. Fuses: Dropout-type power fuses.

F. Nonfused Switches: Single-pole, manual units, rated [**100**][**200**][**400**][**600**] A(rms) continuous.

G. Group-Operated, Load-Interrupter Switches: [**Fused**][**Nonfused**], three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. High-pressure contact type, complying with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Current Interrupting Rating: Equal to continuous current rating of switch.
5. Fuses: Nondropout power type.

H. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. Comply with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

2.9 POLE-MOUNTED DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

C. Description: Single-phase, two-winding, [**single**][**two**]-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested in accordance with IEEE C 57.12.90[**.**][**and with the following additional requirements:**]

1. Cooling Class: OA.

2. Temperature Rise: 65 deg C.
3. Insulating Liquid:

   a. Mineral oil, ASTM D3487, Type II.
   b. High molecular weight, mineral oil based, and UL listed as less-flammable type.
   c. Biodegradable insulating and cooling liquid, UL listed as less flammable type.
   d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.

D. BIL: [**95**][**75**][**60**] kV.

E. Primary Voltage: <**Insert voltage**>.

F. Taps: [**Two, 2.5 percent above and below**][**Four, 2.5 percent below**], high-voltage and full-load rated.[**Tap changer must have an external operating handle.**]

G. Mounting Brackets: [**Single**][**Double**], integral; suitable for pole mounting, individually or in cluster, or on crossarm.

H. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.

I. Bushings: Creepage distance must exceed nominal value standard for unit rating by at least 75 percent.

J. Hardware: Stainless steel.

K. Tank and Cover: Stainless steel, complying with ASTM A167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.

L. Show transformer kiloampere capacity using **2-1/2 inch (65 mm)** numerals placed near the low-voltage bushings.

2.10 PRIMARY METERING PRODUCTS

A. Primary Metering Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**GE Power; General Electric Company**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Landis+Gyr Inc.**]
   e. [**Schweitzer Engineering Laboratories, Inc.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]

b. [**GE Power; General Electric Company**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Landis+Gyr Inc.**]
e. [**Schweitzer Engineering Laboratories, Inc.**]
f. <**Insert manufacturer's name**>

B. Metering Transformers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**GE Power; General Electric Company**]
   b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   c. [**Kuhlman Electric Corporation**]
   d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**GE Power; General Electric Company**]
   b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   c. [**Kuhlman Electric Corporation**]
   d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   e. <**Insert manufacturer's name**>

C. Description: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:

1. BIL: [**45**][**60**][**75**][**95**][**150**][**200**] kV.
2. Secondary connection box arranged for conduit connection.
3. Potential-Transformer Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV to 120 V(ac), 60 Hz.
4. Potential-Transformer Accuracy Class: Minimum 0.3 at [**75**]<**Insert value**> VA burden.
5. Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV.
6. Current Rating: <**Insert value**> to 5 A.
7. Accuracy Class: Minimum 0.2 at [**50**]<**Insert value**> VA burden.

D. Watt-Hour Meter: Outdoor solid-state unit, [**with demand register,**][**arranged for pulse initiation,**] complying with ANSI C12.10, and including the following ratings and features:

1. Form: [**8S**][**9S**].
2. Element: [**2**][**2-1/2**][**3**].
3. Voltage: 120 V.
4. Current: 2-1/2 A.
5. Frequency: 60 Hz.
6. Kilowatt-Hour Register: Five-digit type.
7. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
8. Demand-Register Interval: [**15**][**30**] minutes.
9. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
10. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches

designed to isolate each metering component for test.

11. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:

    a. Hinged Door: Arranged for padlocking in closed position.
    b. Size: Adequate to house meter and other equipment indicated, but not less than **20-by-30-by-11 inch (510-by-760-by-280 mm)** deep.

2.11 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Material Certificates: For the following items, from manufacturers:

    a. Wood poles.
    b. Concrete poles.
    c. Wood crossarms.

3. Listing Documentation: Indicate that products comply with requirements specified in "Quality Assurance" Article.
4. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Factory Tests:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified pole and crossarm inspection agency to evaluate poles and crossarms.
2. Factory Tests and Inspections:

    a. Inspect poles and crossarms, by, or under supervision of, qualified pole and crossarm inspection agency recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified pole and crossarm inspection agency's**] certification of system compliance.

        1) RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.

    b. Conduct routine tests of [**transformers**][**medium-voltage switches**][**and**][**metering equipment**] by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

3. Nonconforming Work: Units that do not pass tests and inspections will be considered defective.
4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING

A. Clear right of way in accordance with Section 015639 "Temporary Tree and Plant Protection" and Section 311000 "Site Clearing."

B. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of **15 ft (4.5 m)** on both sides horizontally and below medium-voltage conductors and **60 inch (1500 mm)** on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install underground power and metering circuits and those circuits indicated to be in raceways in accordance with Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 260513 "Medium-Voltage Cables," and make splices and terminations for those circuits in accordance with the applicable Sections.

B. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Apply warning signs and equipment labels in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF MEDIUM-VOLTAGE LINE CONDUCTORS

A. Selection: Install bare conductors unless otherwise indicated.

B. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.

1. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
2. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.

C. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.

1. Splice Location: Do not install within **10 ft (3 m)** of a support.
2. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
3. Splices and Terminations of Covered Conductors: Comply with manufacturer's published

instructions.
4. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's published instructions.

D. Armor Rod: Install to protect conductors if line conductors are supported by insulators.

E. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.

F. Support line conductors and taps as follows:

1. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
2. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
3. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

3.4 INSTALLATION OF POLES AND CROSSARMS

A. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.

B. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

1. On level ground, set poles so tops of consecutive poles vary not more than **60 inch (1500 mm)** in elevation.
2. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

C. Set poles in accordance with the following:

1. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
2. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

   a. Poles up to 35 ft (10.6 m) Long: **24 inch (600 mm)**.
   b. Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch (760 mm)**.
   c. Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch (900 mm)**.

3. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
4. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch (25 mm)** minimum, **2 inch (51 mm)** maximum, (after conductors are installed at required tension) for each **10 ft (3 m)** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
5. Backfill holes in **6 inch (150 mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
6. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
7. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead

ends; place gains on last two poles on side facing terminal or dead end.

8. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch (150 mm)** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch (25 mm)** below top of concrete slab.

D. Field treat factory-treated poles and crossarms as follows:

1. Poles Treated More Than One Year before Installation: Treat portion from **24 inch (600 mm)** above ground line to butt.
2. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
3. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
4. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

E. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

1. Buck Arms: Install at corners and junction poles unless otherwise indicated.
2. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
3. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
4. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

F. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.5 INSTALLATION OF GUYS AND ANCHORS

A. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch (900 mm)** or more. Comply with IEEE C2.

1. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
2. At the anchor end, attach guy strand assembly with preformed grips.

B. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.

C. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.

D. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch (150 to 230 mm)** from ground.

E. Install strain insulators to provide a minimum of **12 inch (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

F. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

3.6 INSTALLATION OF HARDWARE AND ACCESSORIES

A. Install washers against wood and under nuts, including eyenuts and locknuts.

B. Install nuts and locknuts wrench-tight on threaded connections.

C. Medium-Voltage Line Insulators: Install [**pin**][**or**][**post**] type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.

1. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
2. Install horizontal line-post insulators for armless construction.

D. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.

E. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.

F. Guy Strain Type Insulators: Install [**porcelain**][**fiberglass-reinforced**] units.

3.7 INSTALLATION OF SURGE ARRESTERS

A. Install surge arresters to protect [**distribution**][**metering equipment**][**reclosers**], [**group-operated, load-interrupter switches**], [**aerial-to-underground transitions**], and other items indicated.

1. Units Installed 6000 ft (1800 m) or More above Sea Level: Use arresters specifically rated for this service.

3.8 INSTALLATION OF CUTOUTS, SWITCHES, AND FUSES

A. Hook-Stick-Operated Switches: Install to maximize safe operating access.

B. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle **42 inch (1067 mm)** above finished grade.

1. Locking Provisions: Install padlock at hasp.

3.9 INSTALLATION OF PRIMARY METERING PRODUCTS

A. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of [**galvanized rigid steel**][**intermediate metal**][**PVC**] conduit. Install to prevent collection of moisture in raceway and cabinet system.

B. Meter Cabinet: Mount on pole, **72 inch (1825 mm)** above finished grade to center of cabinet.

1. Make conduit connections with raintight hubs.
2. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
3. Install meter and meter test block within cabinet.
4. Install identical phase sequence, and color-code for both potential and current leads.
5. Identify leads using designations consistent with marking on transformer terminals.

3.10 GROUNDING

A. Comply with IEEE C2 grounding requirements.

B. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch-by-10 ft (19 mm-by-3 m)**][**5/8 inch-by-8 ft (16 mm-by-2.4 m)**] in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
2. Drive ground rods until tops are **12 inch (300 mm)** below finished grade in undisturbed earth.

C. Grounding Conductors:

1. 4 AWG minimum, soft-drawn copper.
2. Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
3. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
4. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
5. Transformer Enclosures and Secondary Neutrals: Interconnect and connect to grounding conductor.

3.11 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
2. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

   a. Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
   b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

3. Ground Resistance: Comply with Section 260526 "Grounding and Bonding for Electrical Systems." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

   a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
   b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground,

tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft (3 m)** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch (300 mm)** below furnished grade.

4. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and published recommendations.
5. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply DC voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
6. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 MΩ.
7. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 MΩ and more.
8. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.

    a. Verify proper grounding of metallic equipment parts.
    b. Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
    c. Switches:

        1) Manually operate each cutout and switch at least three times, to verify proper operation.
        2) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.

    d. Group-Operated, Load-Interrupter Switches and Air-Break Switches:

        1) Perform mechanical operator tests in accordance with manufacturer's published instructions.
        2) Test resistance to ground of parts to be energized. Acceptable value is 200 000 MΩ.
        3) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.

    e. Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.

9. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

    a. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
    b. Perform preenergizing inspections and tests recommended by manufacturer.
    c. Verify proper equipment grounding.
    d. Verify that clearances of terminals and connecting wires comply with IEEE C2.

10. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
b. Verify that required grounding and shorting connections provide good contact.
c. Verify that clearances of terminals and connecting wires comply with IEEE C2.
d. Perform electrical tests in accordance with manufacturer's published instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

11. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify tightness of electrical connections.
b. Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers in accordance with manufacturer's published instructions.

D. Nonconforming Work:

1. Units will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.12 ADJUSTING

A. Pole-Mounted Distribution Transformers: Set voltage taps as directed by Architect.

3.13 CLEANING

A. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

1. Clean enclosures internally, on completion of installation, in accordance with manufacturer's published instructions.

END OF SECTION 33 71 00 00

Task	Specification	Specification Description
33 71 19 00	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 13	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 23	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
33 71 19 23	26 05 43 00	Underground Ducts and Utility Structures
33 71 19 23	27 11 00 00	Communications Equipment Room Fittings
33 71 19 23	27 13 13 00	Communications Copper Backbone Cabling
33 71 19 23	27 15 33 00	Communications Coaxial Horizontal Cabling
33 71 19 23	33 71 00 00	Overhead Medium-Voltage Wiring

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Task	Specification	Specification Description
34 41 13 00	26 27 26 00	Wiring Devices

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SECTION 34 71 00 00 - ROADWAY CROSSING CONTROL EQUIPMENT

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of products for crosswalk and grade crossing. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Crosswalk

1. Timber: Number 2 pressure-treated yellow pine. Stamp each timber AWPI DRY and AWPI LP-2 before treating timber. Reduce moisture content of decking and decking support members to not more than 19 percent by weight by kiln drying before treating those products. Maintain water-absorbing property which is not greater than that of untreated lumber.
2. Hardware
   a. Fastener for securing deck timbers to cross beams: Joist hanger nail galvanized in accordance with ASTM A 153; Cleveland Specialty Co., or accepted equivalent.
   b. Fastener for securing cross beams to support beams: Galvanized dome head drive spike or washer-head timber screw; Lewis Nut and Bolt Co.'s Sealtite, Cancar Div. of Textron Industries, Inc.'s Torx Truss Washer Head, or accepted equivalent.
   c. Fastener for securing support beams to concrete ties: Threaded hook bolt galvanized in accordance with ASTM A 153 after threading; Lewis Bolt and Nut Co.'s Sealtite having Sealtite washer nut and hook lock plate, or accepted equivalent.
   d. Fastener for securing flangeway timbers to direct fixation concrete: Anchor bolt, conforming to ASTM A 307 and hot-dip galvanized in accordance with ASTM A 153, and concrete insert.
3. Preservative solution for treating field-cut timber: 0.9 Osmose Solution, or accepted equivalent.
4. Anti-slip coating: Two-part epoxy resin and graded aggregate dispersed throughout epoxy. Not less than 100 percent of aggregate shall pass the No. 30 sieve and not less than 95 percent shall pass the No. 50 sieve; Tasa Corp., or accepted equivalent.
5. Sealant: Asphalt mastic conforming to ASTM D 491, or accepted equivalent.
6. Bonding agent: Preco Co.'s Rockweld C, or accepted equivalent.
7. Concrete formwork: CONCRETE FORMWORK.
8. Concrete reinforcement: CONCRETE REINFORCEMENT.
9. Portland cement concrete: Class 3000 PORTLAND CEMENT CONCRETE.
10. Grout: Nonshrink type conforming to CRD C621.
11. Asphaltic concrete
    a. Bituminous prime coat: Cutback asphalt MC250.
    b. Bituminous tack coat.
    c. Base course: Asphaltic Concrete "Base".
    d. Surface course: Asphaltic Concrete “Surface”.
12. Fabrication
    a. Orient timber heartwood face downward.
    b. Cut beams square. Bevel outside ends of timber decking and flangeway timbers four inches at 45 degrees.
    c. Drill holes for anchor bolts; countersink ends of holes for washers and nuts. Drill no holes the centerline of which is less than two inches from edge of timber.
    d. Pressure-treat cut and drilled timbers by the Osmose K-33 method in accordance with AWPI; develop preservative retention of not less than 0.25 pound per cubic foot.

e. Assemble crosswalk with heartwood facing downward and ends of decking timbers, cross-beams, and support beams being aligned. Nail decking to cross-beams with two nails per timber.

B. Grade Crossing
1. Timber: Maple, gum, or birch.
2. Fastener for securing timber flangeway to wood tie: Dome-head drive spike; Lewis Nut and Bolt Co.'s Sealtite, or accepted equivalent.
3. Preservative: Creosote type.
4. Asphaltic concrete
   a. Bituminous prime coat: Cutback asphalt MC250.
   b. Base course: Asphaltic Concrete "Base".
   c. Surface course: Asphaltic Concrete "Surface".
5. Fabrication
   a. Orient flangeway timber heartwood to face downward.
   b. Cut timbers square except bevel ends of flangeway timbers, which will not abut other timber, four inches at 45 degrees. Notch flangeway timber to clear tie plate hardware by not less than 1/2 inch.
   c. Pressure-treat cut and drilled timbers in accordance with AREA MRE Chapter 3, Part 9.

1.3 EXECUTION

A. Examination: Examine surfaces on which crosswalk and grade crossing will be placed.
1. Ensure that track has been raised and aligned to its final alignment and profile and has been accepted by the Owner.
2. Ensure that ballast has been dressed to final cross section.

B. Surveying: Survey installed CWR; determine its horizontal and vertical track alignments.

C. Preparation
1. Remove loose material from tie, rail, and rail fastenings.
2. If wood products have been field-drilled and field-cut, coat drilled and cut surfaces with preservative solution immediately after holes have been drilled and surfaces have been cut.

D. Installation
1. Anchor timbers; seat solidly.
2. Drive spikes and nails, and torque screws; make timber connections rigid.
3. Fill space between countersunk timber and bolt and washer with sealant.
4. Apply not less than 1/16 inch of anti-slip compound to wearing surfaces of flangeway timber and crosswalk timber decking in accordance with anti-slip manufacturer's printed instructions.
5. Place concrete formwork in accordance with CONCRETE FORMWORK. Place concrete reinforcement in accordance with CONCRETE REINFORCEMENT. Place concrete in accordance with CAST-IN-PLACE CONCRETE. Broom- finish concrete surface in accordance with UNFORMED- CONCRETE FINISHES.
6. Tolerances
   a. Top of flangeway and timber, vertical depression below top of rail: plus 1/4 inch, minus zero.
   b. Clearance between sides of flangeway and timbers and edge of rail: plus 1/4 inch, minus zero.
   c. Difference in elevation between surfaces of flangeway and timber and surface of abutting paving: 1/8 inch.

END OF SECTION 34 71 00 00

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SECTION 34 71 13 00 - ACTIVE VEHICLE BARRIERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Installation, Equipment, and Electrical Work
   a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
2. Product Data:
   a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
   b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
3. Test Reports
   a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
4. Operation and Maintenance Data
   a. Vehicle Barriers: Operating and Maintenance Instructions
      1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

C. General Requirements
1. Performance levels shall be based on the following:
   a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
      1) Impact Conditions:

Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:
   a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
   b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
   c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates
1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
   a. Manufacturer's name.
   b. Model number.
   c. Serial number.
   d. Date of manufacture.

E. Delivery And Storage
1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts
1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services
1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.2 PRODUCT

A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable

of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.

2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.

B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

1. Powered Retractable Bollards: The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
      1) Flexible hydraulic lines shall be in accordance with SAE J517.
      2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
   e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Bollards: Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.

C. Crash Gate: The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).
   1. Powered Crash Gate: The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).

a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.

2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).

D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).

1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.

a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.
2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.

E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be accordance with AASHTO HB-17.

1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.

a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.

2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the

"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).

1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
   a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
   b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
   c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.

G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with YYYY597YYYY. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with YYYY597YYYY.

H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.

1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.

2. Main Control Panel: A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
3. Remote Control Panel: A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

I. Miscellaneous Equipment
1. Safety Equipment
   a. Barrier Systems Sensors: The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
      1) Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
      2) Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
      3) Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to ennunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
   b. Traffic Lights: Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
2. Warning Annunciator: Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
3. Heater: A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
4. Signage: Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).

5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.
6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.

J. Finish: Surfaces shall be painted in accordance with requirements of YYYY267|268YYYY, as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR** 3, **as directed**, inch (50 **OR** 75, **as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.

K. Concrete: The concrete shall conform to YYYY73YYYY.

L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.

M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

1.3 EXECUTION

A. Installation: Installation shall be in accordance with manufacturer’s instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).

D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. the Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 34 71 13 00

Task	Specification	Specification Description
34 71 13 00	34 71 00 00	Roadway Crossing Control Equipment
34 71 13 13	34 71 13 26	Vehicle Guide Rails
34 71 13 13	34 71 13 00	Active Vehicle Barriers
34 71 13 13	34 71 00 00	Roadway Crossing Control Equipment
34 71 13 16	34 71 13 26	Vehicle Guide Rails
34 71 13 16	34 71 13 00	Active Vehicle Barriers
34 71 13 16	34 71 00 00	Roadway Crossing Control Equipment

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SECTION 34 71 13 26 - VEHICLE GUIDE RAILS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Rail Elements, End Sections, and Fasteners
1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

B. Posts
1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

C. Bolts, Nuts, and Washers
1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.

E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.

F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 3 Section “Cast-in-place Concrete".

1.3 EXECUTION

A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.

B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 34 71 13 26

Task	Specification	Specification Description
34 71 13 26	34 71 13 00	Active Vehicle Barriers
34 71 13 26	34 71 00 00	Roadway Crossing Control Equipment
34 71 16 00	34 71 13 26	Vehicle Guide Rails
34 71 16 00	34 71 13 00	Active Vehicle Barriers
34 71 16 00	34 71 00 00	Roadway Crossing Control Equipment
34 71 19 00	34 71 00 00	Roadway Crossing Control Equipment
34 71 19 16	11 12 00 00	Parking Control Equipment
34 71 19 16	13 34 23 16	Fabricated Control Booths
34 71 19 16	34 71 00 00	Roadway Crossing Control Equipment

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SECTION 35 22 26 00 - SLUICE GATES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of sluice gate. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Sluice Gates: The sluice gate shall conform to the latest edition of AWWA 501 Sluice Gate Standards. Gate and accessories shall be as manufactured by Rodney Hunt Company or Hydrogate, or approved equal.

1. Sluice gates shall be cast iron, fully bronze mounted, and will have side wedges for seating head conditions and side, top and bottom wedges for unseating head conditions, where scheduled.
2. Liberal safety factors shall be used in the design of all the equipment. Working stresses shall not exceed the lower value of one-third (1/3) of the yield strength or one-fifth (1/5) of the ultimate strength of the material. The slide or disc shall be designed with a minimum safety factor of six (6). The sluice gates and operators shall be completely shop-assembled, inspected and tested to ensure proper fit and adjustment of all parts.
3. The sluice gate shall be substantially watertight under the design head conditions. The leakage shall not exceed 0.10 gallons per minute per foot of periphery for either the rated seating or unseating of the gate. The gate shall be rated for 60 feet of seating head and 35 feet of unseating head.
4. All materials used in the construction of the gates and appurtenances shall be designed for the application and shall conform to the following specifications.
5. Iron casting for wall thimbles, frame, disc, and guides, stem guides, floor stands and other items - ASTM A 126, Class B.
6. Bronze castings for wedges, thrust nut, and lift nut - ASTM B 584, Alloy 86500 or 87200.
7. Bronze for seat facings in frame and disc - ASTM B 21, Alloy 48200, extruded or ASTM B 139, Alloy 510, extruded.
8. Stainless steel for stems, stem couplings and fasteners - ASTM A 276, Type 304.
9. Silicon bronze for fasteners - ASTM B 98, Alloy 651, or 661.
10. Rubber for flush bottom seal - ASTM D 2000, grade AA625.

B. Frame: The frame shall be of cast iron, one-piece construction, flanged with rectangular or circular. All contact surfaces of the frame shall be machined. The frame shall have machined dovetailed grooves on the front face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. The back flange of the frame shall be machined to bolt directly to the machined face of the “F” type wall thimble. Frames for the sluice gates subject to unseating heads shall have integrally cast pads machined with keyways to receive top and bottom wedge seats.

C. Disc: The disc shall be of cast iron, one-piece construction rectangular with integrally cast vertical and horizontal ribs. The disc shall have a minimum thickness of 3/4 inch on gates which are 18 inches in diameter or larger. A heavy vertical reinforcing rib along each side shall be provided to ensure rigidity between the side wedges. All interior vertical ribs shall be of equal depth and shall not have any horizontal jogs along their entire length. Spacing of horizontal ribs shall not exceed 12 inches. The maximum deflection of horizontal ribs based on a working stress of 6,000 pounds per square inch for cast iron shall not exceed 0.07 inch under design pressure. The disc shall have machined dovetailed grooves on the seating face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. A tongue on each side, extending the full length of the disc, shall be machined on all sides

with a 1/8 inch clearance maintained between the disc tongue and the gate guide groove. Wedge pads for side wedges and for top and bottom wedges when required, shall be cast integrally on the disc and machined to receive the adjustable bronze wedges. A heavily reinforced nut pocket shall be cast integrally on the vertical centerline and above the horizontal center and be of such shape as to receive the square backed bronze thrust nut.

D. Guides: The guides shall be one piece, integrally cast type, designed to withstand the total thrust due to the water pressure and the wedging action. The guides shall be either bolted onto or integrally cast with the frame. The guides shall be machined on all contact surfaces and a groove shall be machined along the entire length of the guide to allow not more than 1/8 inch clearance between the disc tongue and the guide groove. The guides shall be of such length as to retain and support at least one-half (1/2) of the disc in the full open position. The bolt-on guides shall be attached to the frame with silicon bronze or stainless steel studs and nuts and shall be doweled to prevent any relative motion between the guides and the frame. The integrally cast guides shall have wedge blocks which are attached to the guide with silicon bronze fasteners. Gates having integrally cast frames, guides and wedge blocks shall be unacceptable. Both the integrally cast and bolt-on blocks shall have machined dove-tailed grooves in which the bronze wedge seats shall be driven and machined. Wedge seats which are bolted onto the wedge block or guide shall be unacceptable.

E. Wedges: Each gate shall be provided with a sufficient number of wedging devices to assure its compliance with the leakage requirements. Side wedges shall be designed to make full metal-to-metal contact with the wedge seats mounted on the guide wedge blocks. The wedges shall be solid cast bronze, machined on all contact surfaces, and keyed to the cast iron pads on the disc to prevent rotation and lateral motion. The wedges shall be attached to the disc with silicon bronze studs and nuts to lock them securely in position after they have been adjusted.

1. Adjustable top and bottom wedges, where applicable, shall be attached to the disc either by tongue-and-groove arrangement with a signal fastener or by two fasteners. All mating and contact surfaces on the wedging devices shall be fully machined.

F. Seat Facings: The extruded seat facings shall be of a special shape to fill and permanently lock in the machined dovetail grooves on the frame and disc when pneumatically impacted into place. Attaching pins and screws shall not be acceptable. The installed seat facings shall be machined to a 63 micro-inch finish or better. Maximum clearance between seating faces shall not exceed 0.004 inch when the disc is in the fully closed position.

G. Stem

1. The operating stem shall be of a size to safely withstand the stresses induced by normal operating forces without buckling or permanent distortion. The stem shall be designed to transmit in compression at least two (2) times the rated output of the floorstand or benchstand with a 40-pound effort on the crank or handwheel. The sluice gate manufacturer shall submit these calculations, if required by the Owner. The threaded portion of the stem shall have machined cut or rolled threads.
2. Acme type. The contact surfaces of the threads shall have a maximum 16 micro-inch finish. Stems of more than one (1) section shall be jointed by stainless steel couplings threaded and keyed or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Manually operated, rising stem gates shall be provided with an adjustable bronze stop collar on the stem above the floorstand lift nut.

H. Stem Guides: Stem guides shall be cast iron, bronze brushed, mounted on cast iron brackets. They shall be adjustable in two (2) directions and shall be spaced at sufficient intervals to adequately support the stem. Stem guide spacing shall not exceed 10 feet, or an L/R ratio of 200.

I. Pipe Covers: Provide fabricated galvanized steel stem cover w/position indication on all rising stems.

J. Crank Operators: All gates shall have crank-operated floorstands or benchstands. Crank handle shall be removable. Crank operated type shall be geared and shall have a weatherproof housing with a solid bronze operating nut mounted on high-strength cast iron pedestals or base plates. The operating nut shall be internally threaded with threads corresponding to stem threading. Tapered roller or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. All gears shall be constructed of steel and shall be accurately machine cut and of proper design to provide smooth operation and to support load conditions. Lubrication fittings shall be provided in the gear housing to permit lubrication of all gears and bearings. All reduction gear cases shall be precision machined and equipped with tapered rolled or needle bearings and sealed about all reduction shafts. Geared hoists shall have a 4:1 ratio. Each hoist shall be supplied with a 2-inch square operating nut, and a removable cast iron crank arm with revolving brass grip. Floorstands shall include a cast iron pedestal designed to position the input shaft approximately 36 inches above the operating floor. Where called for, the floorstand shall be mounted on a cast iron wall bracket which is specifically designed for the particular operator being used. An arrow with the word “Open” will be permanently attached or cast in the floorstand indicating the direction of rotation to open the gate.

K. All geared and handwheel floorstands shall operate with a maximum effort not to exceed 40 pounds on the crank or handwheel.

L. Painting - All submerged ferrous metal components (i.e., gate and frame, thimble, stem guides) shall be shop painted as follows: prepare surfaces to SSPC-SP-6; Primer - Amer Lock 400 by Ameron International Inc. Performance Coatings and Finishes Group, or approved equal, 5.0 mil dry film thickness; Top Coat - Amer Lock 400, or approved equal, 5.0 mil dry film thickness.

M. All exposed ferrous metal components (i.e., crank operator and floor stand) shall be shop painted as follows: prepare surfaces to SSPC-SP-3; Primer - Amer Lock 400, or approved equal, 5.0 mil dry film thickness, Top Coat - Amer Lock 450 HS, or approved equal, 2.0 mil dry film thickness

N. All bolts, studs and nuts required for setting the sluice gates, frames and operating stands shall be stainless steel and shall be supplied by the manufacturer.

1.3 EXECUTION

A. Provide and deliver cast iron thimble to be cast into wall as per manufacturer’s recommendations and as specified herein. Install the sluice gate with all appurtenances in strict conformance with manufacturer’s instructions.

END OF SECTION 35 22 26 00

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Task	Specification	Specification Description
35 22 59 00	35 22 26 00	Sluice Gates
35 22 63 00	35 22 26 00	Sluice Gates

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SECTION 35 24 00 00 - DREDGING

1.1 GENERAL

A. Description Of Work
1. This specification covers dredging. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition
1. Hard material is defined as material requiring blasting or the use of special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

C. Submittals: Submit the following:
1. Shop Drawings: Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.
2. Protection plan: If blasting will be allowed, submit a plan for protection of surrounding structures, equipment, and vessels.

D. Material to be Removed
1. The material to be removed is silt and mud **OR** new material, **as directed**, applicable to the specific project.
   a. Hard Material: Remove hard material. Blasting will not be permitted **OR** Blasting shall be performed only by experienced persons, **as directed**. Conduct operations in strict accordance with applicable regulations. Protect exposed structures from the effects of the blast in accordance with the protection plan

E. Artificial Obstructions
1. Except as indicated, the Owner has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. If actual conditions differ from those stated or shown, or both, an adjustment in contract price or time for completion, or both, will be made.
   OR
   The Owner has knowledge of debris such as, but not limited to, metal bands, pallets, pieces of broken cable, rope, fire hose, and broken piles. The Owner has no knowledge of existing wrecks, wreckage, or other material of such size or character as to require the use of explosives or special or additional plant for its economical removal. Prior to dredging, the Contractor shall rake the dredge areas and shall remove debris encountered. Debris removed from the dredged area shall be removed from the water. Disposal shall be the responsibility of the Contractor and disposal shall be outside the limits of government property. In case the actual conditions differ from those stated or shown, or both, an adjustment in contract price or time of completion, or both, will be made.

F. Side Slopes
1. Dredging on side slopes shall follow, as closely as practicable, the lines indicated or specified. An allowance will be made for dredging beyond the lines indicated or specified for side slopes. The allowance will be determined by projecting a line upwards, paralleling the project design side slopes, from the intersection of the overdepth dredging limit (at a point located vertically below the limit of dredging at the top of slope). The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.

G. Permit
1. The Contractor shall comply with conditions and requirements of State or Federal permits. the Owner will secure the permit for dredging and disposal of material as indicated. Make arrangements for disposal of excavated materials.

H. Environmental Protection Requirements
1. Provide and maintain during the life of the contract, environmental protective measures. Also, provide environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. Conduct Of Dredging Work
1. Order of Work Interference with Navigation: Minimize interference with the use of channels and passages. the Owner will direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary.
2. Compensation for Interruption of Operations: If dredging operations are interrupted due to the movement of vessels or floating equipment, an adjustment in the contract price or time for completion, or both, will be made as provided by the contract. the Owner will notify the Contractor 7 days prior to ship movements that will affect dredging operations.
3. Lights: Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting shall conform to United States Coast Guard requirements for visibility and color.
4. Ranges, Gages, and Lines: Furnish, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. the Owner will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.
5. Plant: Maintain the plant, scows, coamings, barges, pipelines, and associated equipment to meet the requirements of the work. Promptly repair leaks or breaks along pipelines. Remove dredged material placed due to leaks and breaks.
6. Disposal of Excavated Material: Provide for safe transportation and disposal of dredged materials. Transport and dispose of dredged material in the area designated for disposal of dredged material.
OR
The Contractor may, at his option, dispose of dredge material at an approved disposal area. The deposit of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of local port and harbor governing authorities.
   a. Method of Disposal: Deposit dredged material by the hydraulic process **OR** hopper dredge **OR** self-dumping scow or barge, **as directed**. Pipeline for hydraulic dredging shall discharge into the disposal area.
   b. Disposal in Indicated Fill Areas: In depositing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.
   c. Operation of Sluiceways: Sluiceways on the disposal area levees will be operated and maintained by the Owner. The Contractor will be relieved of operations thereof.

d. Submerged Pipeline: If a leak occurs in the discharge pipeline, immediately discontinue using the line until leaks are repaired. Remove material placed due to leaks or breaks.

7. Navigation Warnings: Furnish and maintain navigation warning signs along the pipeline.
8. Method of Communication: Provide a system of communication between the dredge crew and the crew at the disposal area. A portable two-way radio is acceptable.
9. Salvaged Material: Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, shall remain or become the property of the Owner and shall be deposited on shore at a convenient location near the site of the work, as directed.
10. Safety of Structures: The prosecution of work shall ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract.
11. Plant Removal: Upon completion of the work, promptly remove plant, including ranges, buoys, piles, and other markers or obstructions.

B. Measurement

1. Contractor shall take soundings before and after dredging.
   a. Method of Measurement: The material removed will be measured by means of soundings taken before and after dredging. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Soundings will be taken by lead line or 200 kHz sonic methods, or both, as determined by the Owner; results of soundings by either or both methods will be the basis for payment. Areas sounded more than 30 days prior to dredging will be re-sounded when requested by the Contractor. The Contractor has the option of being present when such soundings are made.
   b. Surveys During Progress of Work: Contract depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The Contractor shall take progress soundings or sweepings.

C. Final Examination And Acceptance

1. As soon as practicable after the completion of areas, which in the opinion of the Owner, will not be affected by further dredging operations, each area will be examined by the Owner by sounding or sweeping, or both. Remove shoals and lumps by dragging the bottom or by dredging. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Owner. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final estimate. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete. Final estimates will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or disposal of material in an unauthorized manner.

END OF SECTION 35 24 00 00

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Task	Specification	Specification Description
35 24 23 00	35 24 00 00	Dredging
35 24 26 00	35 24 00 00	Dredging

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Task	Specification	Specification Description
40 05 19 00	33 42 00 00	Stormwater Conveyance
40 05 23 23	21 05 00 00	Common Work Results for Fire Suppression
40 05 23 23	22 05 00 00	Common Work Results for Plumbing
40 05 23 23	23 05 00 00	Common Work Results for HVAC
40 05 23 23	33 11 13 00a	Potable Water Supply Wells
40 05 23 23	33 31 00 00	Site Sanitary Sewerage Piping
40 05 23 23	33 32 00 00	Site Packaged Sewage Pumping Stations
40 05 41 00	21 05 00 00	Common Work Results for Fire Suppression
40 05 41 00	22 05 00 00	Common Work Results for Plumbing
40 05 41 00	23 05 00 00	Common Work Results for HVAC

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SECTION 41 22 23 00 - HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with air motor powered hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions
1. The Contractor shall be responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the the Owner of any discrepancy before order to the monorail manufacturer is finalized.

C. Submittals
1. Shop Drawings
2. Design Data
3. Test Reports
4. Certificates
5. Operation and Maintenance Data

D. Quality Assurance
1. Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, air system details, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Certificates: Submit certification of minimum wire rope breaking strength for each hoist. Where applicable, submit factory certification of the load chain rated capacity.
3. Design Data: Submit design calculations verifying the size of structural members, structural supports (fittings, rods, brackets, and components), and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

E. Maintenance: Submit data package for the entire monorail system.

1.2 PRODUCTS

A. Fabrication And Construction
1. The hoist and trolley shall conform to ANSI/ASME HST-5M or ANSI/ASME HST-6M, **2 OR 3 OR** 5, **as directed**, ton (2 **OR** 3 **OR** 5, **as directed**, metric ton), for general service **OR** protected indoor **OR** all weather outdoor, **as directed**, (0 degrees to 100 degrees F (-18 to 38 degrees C)) working conditions. 2 ton (2 metric ton) design criteria shall apply to hoists of 2 ton (2 metric ton), or less, rated lifting capacity. Hoists of 2, 3, or 5 ton (2, 3, or 5 metric ton) rated capacity, shall be equipped with an automatic mechanical load lowering brake.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: Shall be the manufacturer's standard within the limits specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M. The hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a minimum as required to meet project requirements below the finished floor.

OR

B. Fabrication And Construction

1. The 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist and trolley shall meet the design requirements specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M for the 2 ton (2 metric ton) hoist trolley.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: For 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist(s), the hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a maximum **OR** minimum, **as directed**, as required to meet project requirements above **OR** below, **as directed**, the finished floor. The hook lift and speed limits for 1/4 **OR** 1/2, **OR** 1 ton, **as directed**, (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) rated capacity hoists shall be within the limits shown in the following table.

Standardized hoist lift ranges and rated lifting speed ranges for 1/4, 1/2, and 1 metric ton rated capacity

Rated load Capacity (metric tons)	Hoist lift range (meter)	Hoist lifting speed range (mm/s) Low	High
1/4	3 to 15	120	350
1/2	3 to 12	80	250
1	3 to 10	40	225

Standardized hoist lift ranges and rated lifting speed ranges for 1/4-, 1/2-, and 1-ton rated capacity

Rated load capacity (tons)	Hoist lift range (feet)	Hoist lifting speed range (feet per minute) Low	High
1/4	10 to 50	24	70
1/2	10 to 40	16	50
1	10 to 30	8	45

4. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.
5. Hoist Wire Rope: Rope lengths shall be sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position.
6. Hoist Chain: Chain hoists of 10 foot (3 m) lift or more shall be equipped with a load chain bucket.
7. Hoist Limit Switch: Hoists shall be equipped with upper and lower hoist limit switches/devices.
8. Control Pendant: Shall extend as required to meet project requirements below the underside of the track beam.
9. Trolley: Shall have a manual **OR** geared manual **OR** air motor powered, **as directed**, drive and shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.

C. Monorail Track Beam System
1. Shall conform to MMA MH27.1, for powered hoists. The maximum allowable deflection shall not exceed 1/600 of the unsupported span, with the hoist(s) at rated load(s) and at any location(s). The track beam system shall have trolley stops at all open end locations. The stops shall be designed to retain the hoist on the track. Wheel stops shall interface with the trolley wheel treads on both sides of the track web simultaneously and shall not interface with the trolley wheel flanges. The air supply valve specified shall be of the quick shutoff type, readily accessible from the floor, and located within proximity to the monorail system.
2. Color of Finished Equipment: Shall be the manufacturer's standard brilliant yellow.
3. Identification Plates: The manufacturer shall furnish and install identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

1.3 EXECUTION

A. Erection And Installation
1. The Contractor shall erect and install the hoist and monorail system in accordance with of MMA MH27.1. The monorail supplier shall provide supervisory erection services.

B. Field Inspection And Tests
1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and detail drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.
2. Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be tested in operation as specified, carrying 125 percent of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. The air equipment will not necessarily operate at rated speed with a 125 percent overload. For hoists that incorporate mechanical load brakes, the mechanical load brake shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and other apparatus as necessary to conduct field tests on hoist and monorail. The test and final adjustments of the equipment shall be under the supervision of the the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00

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SECTION 41 22 23 00a - SPECIALTY HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material handling hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Electric Chain Hoists
1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Hoists shall employ AC motor brakes employing single or multiple all-steel disks. Controls shall be hand-held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks.

B. Manual Chain Hoists
1. Load capacity of hoist shall be as specified. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Load hook shall be heavy-duty drop forged with safety latch. Hoist mechanism shall be double pawl ratchet system with Weston type brake using a non-asbestos friction disk. Hoist shall have swivel top and bottom hooks. Hoist shall require between 50 and 80 pounds effort to move load.

C. Electric Wire Rope Hoists
1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Lift range shall be between 20 and 150 feet. Lifting cable shall be pre-formed wire rope, of hoisting service construction, made of extra improved steel (XIP) with an independent wire rope center. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks. Controls shall be hand held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail-safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard.

1.3 EXECUTION

A. Installation
1. The Contractor shall complete the assembly of any equipment furnished partially assembled and place the items in position as directed. The hoists shall be assembled and securely bolted in position, hoisting chain or wire rope installed, and the hoist made ready for regular operation. The Contractor shall furnish all miscellaneous hardware items required to complete the installation of all equipment and components. Equipment shall be primed and finish painted with a suitable corrosion-resistant paint on all parts and components not made of corrosion-resistant materials or otherwise protected.

END OF SECTION 41 22 23 00a

SECTION 41 22 23 00b - MONORAILS WITH ELECTRIC POWERED HOISTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with electric powered hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. System Description
1. Provide a monorail system with electric powered hoist(s) and plain type (hand operated) **OR** hand chain operated **OR** electric powered, **as directed**, trolley(s) complete, tested and ready for operation. Monorails, hoist(s), trolley(s), equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME/ANSI B30.11, ASME/ANSI B30.16, ASME HST-1M, ANSI/ASME HST-4M, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "the Owner."

C. Submittals
1. Shop Drawings: Monorail system
2. Product Data: Monorail track system including switches, suspension system and other components; Electric wire rope hoist; Electric chain hoist; Trolley; Pendant pushbutton station; Electrification.
3. Design Data: Load and sizing calculations.
4. Test Reports
5. Certificates
6. Operation and Maintenance Data

D. Delivery, Storage, and Handling
1. Delivery and Storage: Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
2. Handling: Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to the Owner.

E. Quality Assurance
1. Certificates: Overload Test Certificate: Submit a statement that the monorail system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.
2. Drawings: Monorail System: Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.
3. Design Data: Load and Sizing Calculations: Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the monorail system manufacturer's standard cataloged product.

1.2 PRODUCTS

A. Overhead Monorail System: Provide overhead monorail system conforming to MMA MH27.1, Class C, for indoor **OR** outdoor, **as directed**, service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be plain type (hand operated) **OR** hand chain operated **OR** motor operated, **as directed**. Monorail system shall operate on AC voltage as required to meet project requirements, 60 Hz, single **OR** three, **as directed**, phase power source.
   1. Capacity: The monorail system shall have a minimum rated capacity as required to meet project requirements. Mark the hoist capacity in pounds (kg) on both sides of the hoist or load block.
   2. Speeds: The hoist shall have two operating speeds, **unless directed otherwise,** and shall be capable of hoisting and lowering the rated load at a high speed of 20 feet per minute (fpm) (100 mm/s). The trolley shall have two operating speeds, **unless directed otherwise,** and shall be capable of moving the rated load at a high speed of 50 fpm **OR** 100 fpm, **as directed**, (250 mm/s **OR** 500 mm/s, **as directed**,). Low speed(s) shall be one quarter to one third of high speed(s). Actual speed(s) shall be within plus or minus 15 percent of those specified.
   3. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.
   4. Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and 29 CFR 1910.179.

B. Monorail Track System: MMA MH27.1. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam.
   1. Track Suspension System: Monorail suspension shall be flexible **OR** rigid, **as directed**, type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325/A 325M bolts, ASTM A 563/A 563M nuts, and ASTM F 959/F 959M load indicator washers. ASTM A 325/A 325M bolts shall be fully pre-tensioned in accordance with AISC S329. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Division 5 Section “Structural Steel Framing".

C. Electric Wire Rope Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein. Hoist shall be double reeved, **unless directed otherwise**.
   1. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.
   2. Sheaves: Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.
   3. Drum: Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.

D. Electric Chain Hoist: ASME HST-1M, Class H3, except as modified herein. Provide load chain proof test.

E. Trolley: Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1M and ANSI/ASME HST-4M. Trolley shall have elastomeric bumpers to engage runway stops.

F. Motors: NEMA MG 1. Hoist motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Trolley motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM.

G. Controls: Provide single **OR** two, **as directed**, speed magnetic control for the hoist. Provide single **OR** two, **as directed**, speed magnetic controls for the trolley. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.

H. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor.

I. Brakes: Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent (for outdoor monorails) or 50 percent (for indoor monorails) of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.

J. Load Block And Hook: Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. Hook throat opening shall not be less than as required to meet project requirements. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number.
   1. Hook and Hook Nut Magnetic Particle Inspection: Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times it width.

K. Bearings: All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.

L. Pendant Pushbutton Station: Hoist and trolley, **unless directed otherwise,** shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME/ANSI B30.11recommendations. Locate station 4 feet (1.2 m) above the finished floor

M. Electrification: Runway electrification shall be of the flat festooned type **OR** enclosed safety bar type, **as directed**, with four continuous copper conductors. Provide electrical work for the monorail system in accordance with NFPA 70.

N. Identification Plates: Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.

O. Painting System: Painting shall be manufacturers standard. Provide a primer and a finish coat. For outdoor monorail systems, blast clean all components prior to painting and prime with inorganic zinc type primer; finish coat shall be an epoxy formulated for marine environments. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.

1.3 EXECUTION:

A. Erection And Installation: Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

B. Erection Services: Provide supervisory erection services from the monorail system manufacturer.

C. Field Quality Control
   1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and

approved submittals. The Contractor shall notify the the Owner 3 days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests

2. Operational Tests: After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than 100 miles (161 km) from the job site and shall return them to that location after the tests have been completed.
3. Test Data: Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist and trolley speeds during each test cycle.
4. Hook Test: Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.
5. No-Load Test
   a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.
   b. Trolley: Operate trolley assembly the full length of the monorail in both directions. Operate trolley at low and high speed in each direction. Verify satisfactory operation and verify trolley speed. Operate all rail switches.
6. Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity
   a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
   b. Hoist Dynamic Test: Raise the test load to approximately 5 feet (1.5 m) above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
   c. Load Brake Test: Raise test load approximately 5 feet (1.5 m). With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.
   d. Loss of Power Test: Raise the test load approximately 3 feet (1 m) and while lowering test load at low speed, cut main power to hoist. Load should stop.
   e. Trolley Test: With test load hoisted to a height of one foot (300 mm) above the floor, operate trolley the full distance of the monorail in both directions using both speed points in the process. Observe for any malfunctioning of the trolley assembly and monorail system. Operate all rail switches.
   f. Rated Load Speed Test: With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley

speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, and motor speed for each motor.

END OF SECTION 41 22 23 00b

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SECTION 41 22 23 00c - MONORAILS WITH MANUAL HOIST

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monorails with manual hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions:
1. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Owner of any discrepancy before the order to the monorail manufacturer is finalized.

C. Submittals
1. Shop Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Design Data: Structural design calculations.
3. Test Reports
   a. Hook and hook nut magnetic-particle tests.
   b. Monorail system load tests
4. Certificates: Manual hoist load chain
5. Operation and Maintenance Data
   a. Track beam system
   b. Hoist and trolley

D. Quality Assurance
1. Certifications: Submit factory certification of load chain rated capacity.
2. Design Data: Submit design calculations verifying the size of structural members, structural support fittings, rods, brackets, components, and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.2 PRODUCTS

A. Fabrication And Construction: Provide manual hoist and trolley, ANSI/ASME HST-2M, ANSI/ASME HST-3M, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.
1. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
2. Hook Lift: Shall be the manufacturer's standard. The hoist lift shall be at its highest point a minimum of 8 feet (2400 mm) above the finished floor and at its lowest point a minimum of 2 feet (600 mm) below the finished floor.
3. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle

inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.

4. Trolley: Shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.
5. Load Chain: High strength steel links, flexible; minimum safety factor of 5 to 1 based on ratio of minimum chain breaking load to the calculated load on the chain when the hoist is assumed loaded to rated capacity. Certification from hoist manufacturer of provided chain's breaking strength shall be submitted to the Owner and approved prior to final acceptance of hoist. Do not paint or coat the load chain.
6. Load Hooks and Load Hook Components
   a. Hook: Forged steel; complete with spring-loaded steel throat opening safety device. The hook shall be carried on suitably sealed or shielded anti-friction thrust bearings and shall swivel freely through 360 degrees rotation with full load without twisting chain.
      1) Disassembly. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of the hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device.
      2) Hook Non-Destructive Test. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
         a) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
         b) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
         c) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.

B. Monorail Track Beam System: Comply with MMA MH27.1 except as modified and supplemented herein.
   1. Patented Track: Provide specially designed trackage, e.g., patented track beam, curves, and switches constructed from welded steel components. The lower flange of the track section shall have flat wheel treads; minimum lower flange width of 3.25 inches (80 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum Brinell Hardness Number of 225. Upper flange and web of the track section shall be steel, continuously welded together or provided as one monolithic piece.
   2. Track Suspension: Provide means of suspending the monorail track system, including curves and switches from the structural supports. The suspension system shall be the sole responsibility of the track supplier; however, design shall be subject to the requirements specified herein.
      a. Cataloged Products: If possible, provide track manufacturer's standard cataloged devices for connection of the track to the indicated supporting structures. If track manufacturer's cataloged devices are not provided for this suspension system, complete shop drawings and calculations for the custom suspension device shall be submitted for review and approval by the the Owner. Track suspension devices which are not the track

manufacturer's cataloged products shall meet the additional requirements specified in YYYY99YYYY.

b. Design: The suspension system shall be designed and constructed to ensure no impairment of the strength of track or the structural support. A hanger or suspension shall be located at each rack splice joint. Provide bracing to hold track sections in rigid alignment at all joints.

c. Suspension of Curves and Switches: Provide steel framing (structural supports), in addition to that indicated, as required by monorail curve and switch manufacturer to support curves and switches. The additional steel framing shall be the sole responsibility of the monorail supplier. Submit shop drawings and framing design calculations to the the Owner for approval.

d. Sway Bracing: Where the track is suspended from hanger rods, track shall be braced laterally and longitudinally to prevent sway.

e. Lock Nuts: Where the track is suspended from hanger rods, lock nuts or other means shall be provided to prevent the nuts from backing off the rods.

f. Multiple Suspension Devices: Where more than one suspension device attached to the track at a single point, the suspension devices shall be provided so that the loads shall be induced in each in proportion to the device's size.

3. Identification Plates: Provide identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

C. Painting Of System: Provide manufacturer's standard painting or shop painting of components specified in this section; comply with the requirements specified in YYYY578YYYY. Do not paint, coat, or galvanize load chain, load, hook nut, or load chain sheave.

1.3 EXECUTION

A. Erection And Installation: The Contractor shall erect and install the hoist trolley and monorail system in accordance with manufacturers written instructions, MMA MH27.1, and the contract drawings. The monorail supplier shall provide supervisory erection services. Welding new sections of monorail track to existing shall conform to AWS D1.1.

B. Field Inspection And Tests

1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.

2. Operational Inspection and Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be given the rated load test specified in ASME/ANSI B30.11, carrying 125 percent (plus 5 percent, minus 0 percent) of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. Hoists shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and all other necessary apparatus at no additional cost to the Owner. The test and final adjustments of the equipment will be under the supervision of the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00c

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Task	Specification	Specification Description
41 22 23 13	41 22 23 00	Hoists
41 22 23 13	41 22 23 00a	Specialty Hoists
41 22 23 13	41 22 23 00b	Monorails With Electric Powered Hoists
41 22 23 13	41 22 23 00c	Monorails With Manual Hoist

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01 22 20 00	01 00 00 00, 01 22 00 00
01 22 23 00	01 00 00 00, 01 22 00 00
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01 66 19 00	01 00 00 00, 01 22 00 00, 01 60 00 00

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03 81 13 00	02 41 19 13
03 81 16 00	02 41 19 13
04 01 00 00	04 01 00 00
04 01 20 00	04 01 00 00
04 01 20 41	04 01 00 00
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04 22 23 00	04 22 00 00, 04 20 00 00a
04 22 23 13	04 20 00 00, 04 22 00 00, 04 20 00 00a
04 22 23 23	04 20 00 00, 04 22 00 00, 04 20 00 00a
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04 22 23 31	04 20 00 00, 04 22 00 00, 04 20 00 00a
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04 23 13 00	04 20 00 00, 04 23 00 00, 04 20 00 00a
04 41 00 00	04 42 00 00
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04 42 43 00	04 42 00 00
04 43 16 00	01 22 00 00, 04 42 00 00
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05 15 19 00	05 70 00 00
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05 43 00 00	01 22 00 00, 05 40 00 00, 05 50 00 00
05 45 00 00	05 40 00 00
05 45 13 00	05 40 00 00
05 45 16 00	05 40 00 00
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05 51 13 00	05 51 13 00, 05 50 00 00, 05 71 13 00
05 51 19 00	05 51 19 00, 05 50 00 00, 05 51 13 00, 05 71 13 00
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05 52 13 00	05 52 13 00, 05 50 00 00
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05 53 13 00	05 53 13 00, 01 22 00 00, 05 50 00 00, 05 53 00 00
05 53 16 00	05 53 16 00, 05 53 00 00
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05 55 13 00	05 50 00 00, 05 51 13 00, 05 71 13 00
05 55 16 00	05 50 00 00, 05 51 13 00, 05 71 13 00
05 56 00 00	05 50 00 00
05 58 00 00	05 58 00 00
05 58 16 00	05 58 00 00, 05 70 00 00, 05 75 00 00
05 58 23 00	05 58 00 00
05 59 65 00	01 22 00 00, 05 70 00 00
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05 71 13 00	05 71 13 00, 05 70 00 00, 05 71 00 00
05 73 00 00	05 73 00 00, 05 73 00 00a, 05 70 00 00, 05 75 00 00
05 73 23 00	05 70 00 00, 05 73 00 00, 05 73 00 00a, 05 75 00 00
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06 11 16 00	01 22 00 00, 06 10 00 00
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06 13 23 00	06 13 00 00
06 15 00 00	06 15 00 00, 06 15 00 00a

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06 18 16 00	06 10 00 00, 06 18 00 00
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06 41 13 00	06 41 13 00, 06 41 00 00
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07 01 50 19	07 01 50 19
07 01 50 81	07 51 13 00, 07 53 23 00
07 01 70 00	07 51 13 00, 07 53 23 00, 07 62 00 00, 07 71 00 00
07 05 13 00	07 52 13 00, 07 52 16 00, 07 53 16 00, 07 53 23 00
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07 21 16 00	07 21 00 00

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07 31 16 00	07 31 16 00, 07 31 13 00
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07 31 29 16	07 31 29 00
07 31 29 19	01 22 00 00, 07 31 29 00
07 31 33 00	01 22 00 00
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07 32 16 00	07 32 16 00
07 34 00 00	07 31 13 00, 07 31 16 00, 07 31 26 00, 07 31 29 00, 07 32 13 00
07 41 13 00	07 41 13 00, 07 41 13 00a, 07 41 13 00b, 07 61 00 00
07 42 13 19	07 42 13 19, 08 80 00 00
07 42 13 23	07 42 13 23
07 42 63 00	01 22 00 00
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07 46 16 00	07 46 16 00, 07 46 16 00a
07 46 19 00	07 46 19 00, 07 46 16 00, 07 46 16 00a
07 46 23 00	06 10 00 00, 06 16 00 00
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07 46 33 00	07 46 33 00
07 46 46 00	07 46 46 00, 01 22 00 00
07 46 63 00	07 46 16 00a
07 51 13 00	07 51 13 00, 07 52 13 00, 07 52 16 00, 07 53 23 00
07 52 13 00	07 52 13 00
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07 54 23 00	07 54 23 00
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07 62 13 00	07 62 00 00
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07 63 00 00	07 62 00 00, 21 05 00 00, 22 05 00 00, 23 05 00 00
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07 71 13 00	07 71 00 00
07 71 19 00	07 71 00 00
07 71 23 00	01 22 00 00, 07 62 00 00, 07 71 00 00
07 71 26 00	07 62 00 00, 07 71 00 00
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07 72 13 00	07 72 00 00, 23 37 23 00
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07 72 53 00	07 72 53 00, 07 31 13 00, 07 72 00 00
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07 81 16 00	07 81 00 00
07 81 23 00	07 81 23 00, 07 81 00 00
07 81 33 00	07 81 00 00
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07 84 13 16	07 84 13 00, 07 84 43 00
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07 84 16 00	03 30 00 00
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07 91 00 00	07 91 00 00
07 91 23 00	07 91 00 00, 07 92 00 00
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07 92 19 00	07 92 19 00, 07 92 00 00
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07 95 13 13	07 95 13 13, 07 95 13 00
07 95 13 16	07 95 13 16, 07 95 13 13, 07 95 13 00
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08 11 73 00	08 11 73 00
08 12 13 00	08 12 13 00
08 12 13 13	08 12 13 00
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08 14 16 00	08 14 16 00

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08 14 73 00	08 14 16 00
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08 18 16 00	08 18 16 00, 08 18 16 00a, 08 18 16 00b, 08 18 16 00c
08 31 13 00	08 31 13 00
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08 33 16 00	08 33 26 00
08 33 23 00	08 33 23 00
08 33 23 11	08 33 23 00, 08 33 26 00
08 33 23 13	01 22 00 00, 08 33 23 00
08 33 26 00	08 33 26 00
08 33 43 00	08 33 43 00
08 34 00 00	02 41 16 00
08 34 13 00	01 22 00 00
08 34 23 00	08 31 13 00
08 34 49 13	13 49 00 00
08 34 56 00	11 98 12 00
08 34 73 13	08 34 73 13
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08 35 13 13	08 35 13 13, 08 35 13 00
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08 43 19 00	01 22 00 00
08 44 13 00	08 44 13 00, 08 44 13 00a
08 45 23 00	08 45 23 00, 08 62 00 00, 08 63 00 00
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08 54 66 00	08 53 13 00, 08 54 00 00
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08 56 49 00	13 49 00 00
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08 63 13 00	08 63 00 00
08 66 00 00	08 62 00 00
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08 71 11 00	08 71 11 00, 01 22 00 00, 08 71 00 00
08 71 13 00	08 71 13 00
08 72 33 00	08 14 16 00, 08 71 00 00
08 72 43 00	08 71 00 00
08 75 13 00	08 71 00 00, 08 71 13 00
08 78 00 00	08 71 11 00
08 80 00 00	08 80 00 00
08 81 23 13	08 80 00 00
08 81 23 23	08 80 00 00
08 83 00 00	08 83 00 00
08 83 13 00	08 80 00 00, 08 83 00 00
08 84 00 00	08 84 00 00
08 87 13 00	08 80 00 00
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08 88 53 00	08 88 53 00, 08 80 00 00
08 91 16 00	08 91 16 00
08 91 19 00	08 91 19 00, 01 22 00 00
08 95 13 00	01 22 00 00
08 95 16 00	08 95 16 00, 01 22 00 00, 05 50 00 00
09 01 20 00	09 01 20 00
09 01 20 91	09 01 20 91, 09 01 20 00
09 01 30 91	09 30 13 00
09 01 60 91	01 22 00 00, 07 92 00 00, 09 66 13 00, 09 68 13 00, 09 68 16 00
09 01 90 52	09 01 90 52, 03 01 30 00
09 05 61 13	09 05 61 13
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09 30 33 00	09 30 33 00
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09 51 33 13	09 51 33 00
09 51 33 23	09 51 33 00
09 51 33 33	09 51 33 00
09 53 23 00	09 51 13 00
09 54 00 00	09 54 00 00, 09 54 00 00a
09 54 16 00	09 54 00 00, 09 54 00 00a
09 54 23 00	09 54 23 00, 09 51 33 00, 09 54 00 00, 09 54 00 00a
09 63 13 00	09 63 13 00
09 63 43 00	09 67 23 00
09 64 00 00	09 64 00 00
09 64 13 00	09 64 00 00
09 64 23 00	09 64 00 00, 09 64 66 00
09 64 29 00	09 64 00 00, 09 64 66 00
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09 65 13 33	01 22 00 00, 09 65 13 00, 09 65 16 00, 09 65 43 00
09 65 13 36	09 65 13 00
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09 65 43 00	09 65 43 00, 09 65 16 00
09 65 66 00	09 65 66 00
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09 72 23 00	09 72 00 00
09 73 00 00	09 68 16 00, 09 72 00 00
09 74 00 00	09 72 00 00
09 74 16 00	09 72 00 00
09 77 00 00	09 77 00 00, 09 77 00 00a, 09 72 00 00
09 77 11 00	09 77 00 00, 09 77 00 00a
09 78 00 00	09 72 00 00
09 84 13 00	09 29 00 00
09 91 13 00	09 91 13 00, 01 22 00 00, 09 93 00 00
09 91 23 00	09 91 23 00, 09 91 13 00
09 91 33 00	09 93 00 00
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09 96 56 00	09 96 00 00
09 96 66 00	09 97 26 00
09 97 13 23	09 96 00 00
09 97 13 24	09 96 00 00
09 97 26 00	09 97 26 00
09 97 26 13	09 96 00 00, 09 97 26 00
09 97 35 00	09 91 23 00
09 97 63 00	01 22 00 00, 09 96 00 00, 23 05 00 00a
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10 14 23 11	10 14 23 00b
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10 21 23 13	10 21 23 00
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10 22 19 00	10 22 19 00, 10 22 00 00, 10 22 00 00a
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11 11 36 00	11 11 36 00
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11 12 26 00	11 12 00 00
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11 97 26 00	11 97 26 00, 12 55 00 00
11 98 12 00	11 98 12 00, 08 71 11 00, 12 55 00 00
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12 21 13 00	12 21 13 00
12 21 13 13	12 21 13 00, 12 21 16 00
12 21 13 33	12 21 13 00, 12 21 16 00
12 21 16 00	12 21 16 00
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30 Patewood Drive
Building 2, Suite 350
Greenville, South Carolina 29615